



SAGE

GOOD PEOPLE. SMART SOLUTIONS.

Operation & Maintenance Manual

Westfire Energy

S90 G1

TeePee Creek

6-2-74-4-W6

100495



OPERATIONS AND MAINTENANCE
MANUAL

CC60	CC90
CC99	CC135
CC180	CC200
CC280	CC325
CC400	CC600

FOR ENGINE AND ELECTRIC DRIVE UNITS

TABLE OF CONTENTS

1.0	COMPRESSOR UNIT SAFETY	3
1.1	DANGER	3
1.2	WARNING	3
1.3	CAUTION	3
2.0	MANUAL USE/CONTACT INFORMATION	4
3.0	INSTALLATION RECOMMENDATIONS	4
3.1	SKID INSTALLATION RECOMMENDATION	4
3.2	ON SITE UNIT HOOK-UP	4
3.2.1	ISOLATION VALVES	4
4.0	BASIC PACKAGE OPERATION	5
4.1	SPECIAL FEATURE	5
4.1.1	ENGINE DRIVE PACKAGES	5
4.1.2	MOTOR DRIVE PACKAGES	5
4.2	PROCESS GAS CIRCUIT	6
4.2.1	SUCTION SCRUBBER (V-1)	6
4.2.2	COMPRESSOR	6
4.2.3	COMPRESSOR DRIVER	9
4.2.4	OIL SEPARATOR (V-2)	10
4.3	COMPRESSOR LUBE OIL CIRCUIT	11
4.3.1	LUBE OIL FUNCTION	11
4.3.2	LUBE OIL SYSTEM	11
4.4	COOLING WATER CIRCUIT (50/50 EG)	12
4.4.1	ENGINE DRIVE PACKAGES	12
4.4.2	MOTOR DRIVE PACKAGES	12
4.5	CONTROL SYSTEM	13
4.5.1	SHUTDOWNS	13
5.0	PRE – COMMISSIONING PROCEDURES	14
5.1	PRESSURE TESTING AND PURGING	14
5.2	COMPRESSOR AND DRIVE SHAFT ALIGNMENT	14
5.3	COOLING WATER SYSTEM (50/50 EG)	14
5.4	CONTROL SYSTEMS	14
6.0	START – UP CHECK LIST	15
7.0	STARTING	15
7.1	STARTING COLD SKID	15
7.1.1	ENGINE DRIVE PACKAGES	15
7.1.2	MOTOR DRIVE PACKAGES	16
7.2	RESTART FROM HOT SHUTDOWN	16
7.2.1	ENGINE DRIVE PACKAGES	16
7.2.2	MOTOR DRIVE PACKAGES	16
8.0	CONTROLLED SHUTDOWN	16
8.1	ENGINE DRIVE PACKAGES	16
8.2	MOTOR DRIVE PACKAGES	16
9.0	PACKAGE MAINTENANCE	17
9.1	COMPRESSOR RECOMMENDATIONS	17
9.2	ENGINE RECOMMENDATIONS	18
9.2.1	ARROW ENGINE	18

9.2.2	CATERPILLAR NATURALLY ASPIRATED ENGINE	19
9.2.3	CATERPILLAR TURBO CHARGED ENGINE	20
9.2.4	CUMMINS NATURALLY ASPIRATED ENGINE.....	20
9.2.5	CUMMINS TURBO CHARGED ENGINE.....	20
9.3	FUEL FILTER.....	20
9.4	WEEKLY LOG SHEET.....	21
10.0	TROUBLE SHOOTING	22
11.0	OPTIONS	25
11.1	SUCTION PRESSURE CONTROL VALVE.....	25
11.2	SUCTION PRESSURE CONTROL VALVE AUTOMATIC CLOSE	25
11.3	PURGE SYSTEM.....	25
11.4	VENT SYSTEM	26
11.5	BLOWCASE	27
11.6	BYPASS CONTROL HIGH DISCHARGE	28
11.7	BYPASS CONTROL LOW SUCTION	28
11.8	BACK PRESSURE CONTROL VALVE.....	28
11.9	START GAS REGULATOR BYPASS VALVE.....	28
11.10	FIRE LOOP	28
12.0	WARRANTY	29

1.0 COMPRESSOR UNIT SAFETY

This package has been designed to local codes and safety regulations. It is the responsibility of the client to ensure that personnel operating this equipment are trained and familiar with its safe operation. Equipment is only as safe as the operator running it.

1.1 DANGER

- a. The compression unit is compressing natural gas (extremely flammable). As long as the natural gas is not exposed to air, it is relatively incombustible. Ensure that there is no possible way for air to enter the system during operation. Always purge unit of any air prior to start-up.
- b. Ensure that the unit is kept clean, so that in a case of fire an escape route will be obvious.
- c. There is to be no smoking on or near the unit.
- d. Ensure exhaust fumes are ventilated properly
- e. All modifications to the unit have to be approved by Concept Compression.
- f. All service work should be performed by trained technicians.
- g. **DO NOT** operate the unit outside the parameters indicated on the curves without written approval from Concept Compression Corp. **DO NOT** change any of the factory package set points without approval by Concept Compression Corp.

1.2 WARNING

- a. Under no circumstances is the engine to operate without belt guards & coupling guards installed, secured and degreased.
- b. The package must cool down and be blocked in prior to servicing.

1.3 CAUTION

- a. It is the customer's responsibility to ensure that all local safety codes and regulations are being followed.
- b. It is the customer's responsibility to install any gas detection devices.

FURTHER CAUTIONS, WARNINGS AND DANGERS OUTLINED THROUGHOUT THIS MANUAL.

2.0 MANUAL USE/CONTACT INFORMATION

This natural gas compressor package was designed and built by Concept Compression Corp. The entire package is built to meet or exceed all local governing codes and regulations.

The information included in this manual is based on a standard package with a variety of different options. Please use P&ID in conjunction with this manual.

Should there be any questions regarding the operating parameters or servicing of this package, please contact Concept Compression Corp. at (403)-250-8810.

This package is a standard booster compressor designed to operate within the range outlined on the performance curves shown in the Appendices of this Manual.

3.0 INSTALLATION RECOMMENDATIONS

3.1 SKID INSTALLATION RECOMMENDATION

Due to the wide variety of site conditions, Concept Compression cannot provide recommended pile locations for this unit. ***It is the customers' responsibility to determine the appropriate footing for the compression unit.***

3.2 ON SITE UNIT HOOK-UP

We recommend you connect your piping system to the package using our piping schematic shown by the dashed lines on Page 1 of the P&ID.

3.2.1 ISOLATION VALVES

- a. The isolation valves (supplied by customer) are installed off skid so the unit can be blocked in and moved in the future without changing any site piping.
- b. The check valve (supplied by customer) between the suction and discharge piping will allow the gas to flow around the package at a reduced rate in the event the compressor is not operating.
 - ▶ This will also prevent a down stream compressor from drawing the gas through this package and forcing it to turn over without lubrication.
- c. The check valve on the discharge side is also installed as a typical industry practice.
 - ▶ We recommend installing a 1.5" bypass valve around this check to ensure sufficient start gas supply to the unit.

4.0 BASIC PACKAGE OPERATION

This section of the manual is dedicated to describing the overall process of the unit and should refer to the P&ID. The unit consists of three circuits:

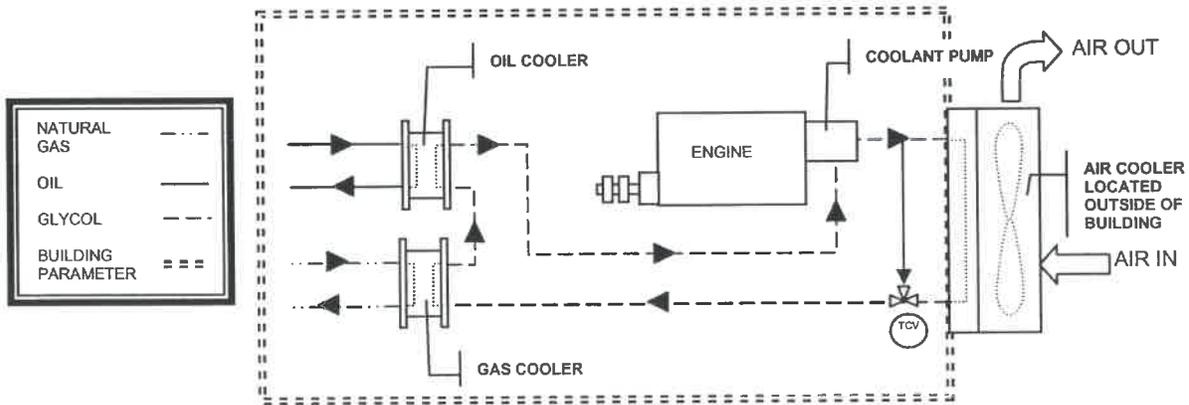
- a. NATURAL GAS
- b. LUBRICATING OIL
- c. COOLING WATER

4.1 SPECIAL FEATURE

By utilizing the systems described below, ambient air is kept outside the building, preventing the freezing of water drain lines from the suction scrubber or the gas section of the cooler, while the unit is in operation.

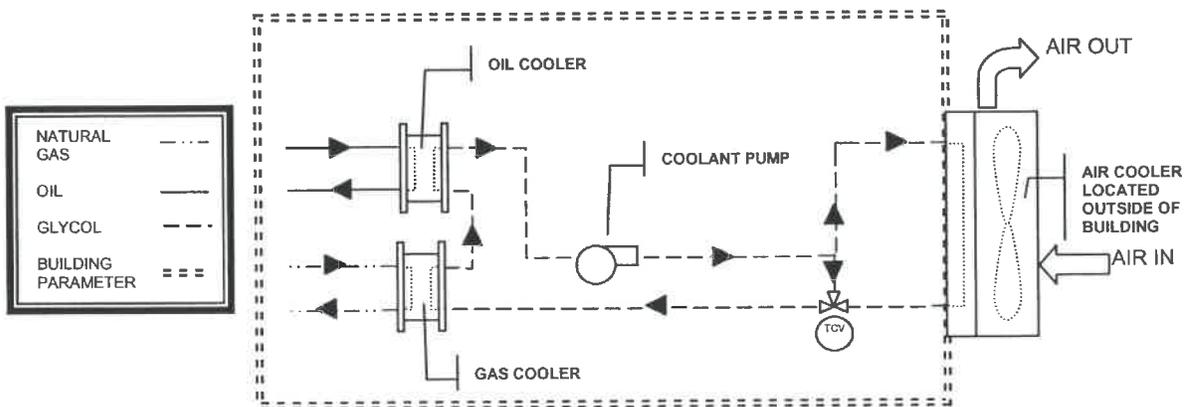
4.1.1 ENGINE DRIVE PACKAGES

Concept Compression offers an indirect oil and gas cooling circuit using engine jacket water or turbo after cooler water and as indirect cooling media rather than a radiator style direct air-cooling system.



4.1.2 MOTOR DRIVE PACKAGES

Concept Compression offers an indirect oil and gas cooling circuit using a 50/50 glycol as an indirect cooling media rather than a radiator style direct air-cooling system.



4.2 PROCESS GAS CIRCUIT

Natural gas enters the package at suction pressure through connection N1 and will immediately enter the suction scrubber (V-1).

4.2.1 SUCTION SCRUBBER (V-1)

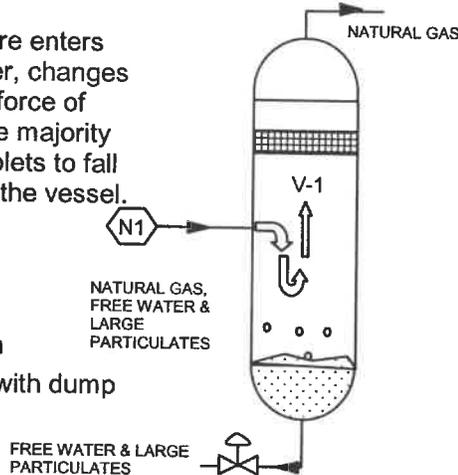
- a. Free water and large particulates separate from the gas stream in two stages.

Stage 1:

Gas/liquid mixture enters Suction Scrubber, changes in direction and force of gravity cause the majority of the liquid droplets to fall to the bottom of the vessel.

Accessories:

- Level gauge
- High level switch
- Level controller with dump valve



Stage 2:

Smaller liquid droplets are removed when gas passes through the mesh pad.

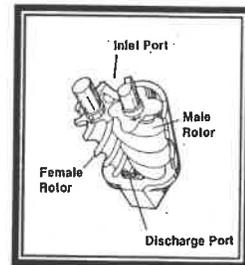
Available Options:

- a. Blowcase
- See section 11.5 for further information.

- b. Liquids are drained from the bottom of the vessel via a dump valve. ***The customer is responsible for any liquid handling off skid.***

4.2.2 COMPRESSOR

- a. A water saturated gas stream will come off the top of the scrubber, pass through a suction check valve and strainer and enters the top of the compressor, (C-1).
- b. The gas in the machine will mix with compressor lube oil as it travels along the rotors during the compression process.
 - ▶ Gas compresses as the male and female rotors mesh together and the pocket size between the two rotors reduces in size.
- c. Gas and oil mixture will exit compressor through the discharge port.



COMPRESSOR MODELS

COMPRESSION PACKAGE	COMPRESSOR							
	MAKE	MODEL	CAPACITY					
			Control	Min	Max			
CC60	SULLAIR	PDX12-GD	NO CAPACITY CONTROL	N/A	N/A			
CC60-H		PDH12-G1	ROTARY VALVE:	50 %	100 %			
CC90/CC99		PDH12-G1 PDH12-G2	ROTARY VALVE					
CC135		PDH12-G2	ROTARY VALVE					
CC180 - CC280		PDR20-X	DIAL OPERATED FROM CONTROL PANEL					
		PDH12-G2	ROTARY VALVE					
CC325		PDR	DIAL OPERATED FROM CONTROL PANEL					
		PC	PROGRAMMABLE CONTROL PANEL SET POINT.					
CC400		PDR	DIAL OPERATED FROM CONTROL PANEL					
		PC	PROGRAMMABLE CONTROL PANEL SET POINT.					
CC600		PDR	DIAL OPERATED FROM CONTROL PANEL					
		PC	PROGRAMMABLE CONTROL PANEL SET POINT.					
CHECK P&ID FOR APPLICABLE COMPRESSOR MODEL								

CC60 CAPACITY CONTROL

Not available for this unit.

CC60-H – CC135 CAPACITY CONTROL

Compressor capacity is adjusted by a rotary valve located on the opposite end of the compressor from the input shaft. Valve can be used to reduce throughput when the compressor is oversized for a specific application.

Capacity Control:

Capacity of Compressor is adjustable while the machine is in operation.

- ▶ Loosen setscrew on handle and rotate valve clockwise or counter-clockwise.
 - Fully unloaded: Valve turned COUNTER-CLOCKWISE to approximately 8 o'clock.
 - Fully loaded: Valve turned CLOCKWISE to approximately 4 o'clock.

CC180 - CC280 CAPACITY CONTROL

Compressor capacity is adjusted by a pneumatic actuator that is controlled via a 0 to 30 psi pneumatic signal. Pneumatic signal is controlled from control panel via a dial

Capacity Control:

Capacity of Compressor is adjustable while the machine is in operation.

PDR

- ▶ Turn dial located at the control panel to the desired output pressure.
 - Fully unloaded: Signal to actuator is at 30 psi.
 - Fully loaded: Signal to actuator is at 0 psi.

PDH-12

- ▶ Loosen setscrew on handle and rotate valve clockwise or counter-clockwise.
 - Fully unloaded: Valve turned COUNTER-CLOCKWISE to approximately 8 o'clock.
 - Fully loaded: Valve turned CLOCKWISE to approximately 4 o'clock.

CC325, CC400 AND CC600 CAPACITY CONTROL

Compressor capacity for the PDR type machines is adjusted by a pneumatic actuator that is controlled via a 0 to 30 psi pneumatic signal. Pneumatic signal is controlled from control panel via a dial.

Compressor capacity for the PC type machines is controlled by the electronic panel. The panel will pulse the motor driven actuator to either load or unload the unit depending on operating conditions and adjustable setpoints. A master controller within the electronic panel uses suction pressure, discharge pressure and (optional) manifold boost to control the slide valve to maximize load on the unit within the parameters of the package. Limit switches are installed to provide feedback to the panel when the slide valve is either fully loaded or fully unloaded. This will stop the pulse signal to protect the actuator motor from burning out and/or jamming the slide valve in a fully loaded or unloaded state.

24 VDC power is required in order to operate the panel.

Capacity Control:

Capacity of Compressor is adjustable while the machine is in operation.

PDR

- ▶ Turn dial located at the control panel to the desired output pressure.
 - Fully unloaded: Signal to actuator is at 30 psi.
 - Fully loaded: Signal to actuator is at 0 psi.

PC

- ▶ See control panel section for adjustment of setpoints.
 - Fully unloaded: Micro Switch at minimum load position.
 - Fully loaded: Micro Switch at maximum load position.
 - Input is required from panel, logic adjusted to reflect change and output changed on motor.

COMPRESSOR DRIVER

Unit will come equipped with either an engine or motor. See P&ID for model and driver type.

ENGINE DRIVE PACKAGES

COMPRESSION PACKAGE	DRIVER			
	MAKE	MODEL	*HP	SPEED
CC60	ARROW	VRG 330	63	1800 RPM
CC90	CATERPILLAR	3304NA	89	
CC99	CUMMINS	G8.3	99	
CC135	CATERPILLAR	3306NA	138	
CC180	CUMMINS	G855	180	
CC200	CATERPILLAR	3306TA	195	
CC280	CUMMINS	GTA855	280	
CC325	CATERPILLAR	3406TA	325	
CC400	CATERPILLAR	3408TA	400	
CC600	CATERPILLAR	3412TA	600	
<i>CHECK P&ID FOR APPLICABLE ENGINE MODEL</i>				
*HP is derated power available at 2500 f.a.s.l. and 90°F Ambient.				

- a. Engine Speed: The engine will direct drive the compressor.
 - ▶ Set using a vernier adjustment, mounted on engine for more precise control.
- b. Start Gas: Supplied from discharge pipe downstream of gas cooler.
 - ▶ Minimum start gas pressure required is roughly 40 psig at starter.
 - If start gas pressure is below required starter pressure the following option can be added to the system: The primary regulator (PCV 100) may be bypassed with a full port spring loaded bypass valve (not included with unit); this will provide the engine with enough volume to start at a lower system pressure.
- c. Starter: The starter used is a TDI low pressure, turbine style starter.
 - ▶ The starter is engaged using:
 - Push button for CC60 – CC400
 - CC600 starters are auto controlled from the control panel.
 - Spring loaded ball valve for CC135 units (up to unit number 100148)
- d. Fuel Gas: Supplied from discharge pipe downstream of gas cooler including inline fuel gas filter. Optional off skid fuel gas supply (Maximum 120 psi, minimum 70 psi) is available.
- e. Engine oil: Supplied from a day tank mounted above the engine.
 - ▶ The engine oil drain is located in the building.
 - If an optional waste oil tank is supplied, the tank is located under the cooler and the drain will be piped to the tank.
- f. Engine oil Day Tank: Mounted above Engine
 - ▶ Complete with filter, automatic level controller and shut down to monitor engine oil level.
 - ▶ Tank shares a common structure with the cooling water surge tank.
- g. Crank case vent: Run outside the building and connected into the exhaust down stream of the muffler to help draw the fumes outside and prevent freeze offs in the building. Tail pipe designed as a venturi.
- h. Engine exhaust: Includes expansion joint and insulation for personnel protection.
 - ▶ The insulation includes a 1" air gap to provide a chimney effect and prevent the piping from forming hot spots and developing holes in the future.
- i. Engine is equipped with an automatic fuel gas shutoff valve.

MOTOR DRIVE PACKAGES

To start motor reset control panel.

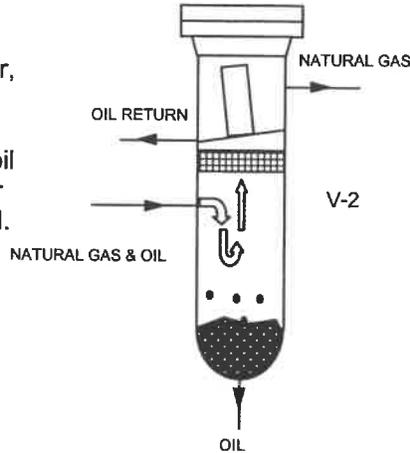
- Refer to P&ID for specific compressor model and motor details.

4.2.3 OIL SEPARATOR (V-2)

a. The oil will separate from the gas stream in three stages:

Stage 1:

As the Gas/oil mixture enters the oil separator, a change in direction and force of gravity cause the majority of oil to drop to the reservoir at the bottom of vessel.



Stage 2:

Smaller oil droplets are removed when gas passes through the mesh pad and drops to bottom of the vessel.

Accessories:

- Level gauge
- Low level switch
- Oil return line

Stage 3:

Any remaining oil removed in the coalescer is returned via an oil return line to compressor suction.

Available Options:

- High level switch

IMPORTANT:

Oil returned via the oil return line to compressor suction should feel warm during operation. Oil flow through the flow indicator will be visible while the unit is in operation. Prior to starting unit, oil should be at 60°F minimum in the oil separator.

- b. Oil that has collected in the bottom of the vessel is re-circulated to the compressor through the compressor lube oil circuit.
- c. The gas stream will leave the top of the oil separator at typical discharge temperatures of 180-220°F and will enter a heat exchanger for cooling, (E-2).
- d. Gas will exit the exchanger at approximately 120-130°F and exit the skid at connection N2.

4.3 COMPRESSOR LUBE OIL CIRCUIT

4.3.1 LUBE OIL FUNCTION

- a. To lubricate moving parts.
- b. To seal clearance between:
 - ▶ Each rotor lobe and casing
 - ▶ The male and female rotor.
 - ▶ To prevent metal-to-metal contact.
- c. To absorb heat of compression of the gas.
 - ▶ Oil is injected into compressor at roughly 140-175°F. The oil absorbs heat generated during the compression cycle and enables our packages to operate at high ratios of compression.

4.3.2 LUBE OIL SYSTEM

The lube oil system on a screw compressor is a closed loop circuit. Oil is circulated through the system using differential pressure. If differential pressure is insufficient to circulate the oil an optional full time pump or back pressure valve will be provided.

- a. Lube oil separates from the gas stream and collects in the bottom of oil separator (V-2).
- b. Oil is piped from the bottom of the Oil Separator (V-2), through a strainer and into the heat exchanger for cooling, (E-1).
- c. The oil is cooled from discharge temperature to roughly 140-175°F and fed back to the compressor.
- d. The cooled oil enters the oil header and separates into two streams
- e. Stream one: Supplies oil to the rotors.
 - ▶ A globe valve is used to throttle the oil flow to the rotors.
 - This valve is adjustable and will modulate the discharge temperature of the gas stream leaving the compressor.
 - A ¼" minimum flow bypass line around this valve is included, in case the valve is inadvertently closed.
- f. Stream two: Supplies oil to shaft seal and bearings.
 - ▶ The oil is fed through a lube oil filter and connected to the compressor shaft seal and bearings.

Caution:

If the filter becomes obstructed, the oil will internally bypass the filter element bypassing dirty oil. Check differential pressure indicator. Replace filters only with Concept Compression approved filters.

- g. Oil drains from the bearings and seal and mixes with the process gas in the machine and feeds back to the oil separator to begin the cycle again.

Note:

Units equipped with PC type Sullair compressor come equipped with a hook up for a manual pre-lube pump. All PC type compressors have to be pre-lubed prior to start up.

4.4 COOLING WATER CIRCUIT (50/50 EG):

The cooling water circuit is a closed loop system.

IMPORTANT: Purge all air from cooling circuit
--

4.4.1 ENGINE DRIVE PACKAGES

- a. One common circuit is piped in series to cool the gas stream and compressor oil.
 - ▶ On Naturally Aspirated and Cummins Turbo Charged Engines the gas and oil are cooled by the engine Jacket water cooling circuit.
 - ▶ On Caterpillar Turbo Charged Engines, the gas and oil are cooled by the engine Turbo water cooling circuit.
- b. The coolant will exit the aerial fin-fan cooler, (E-3), at a maximum of 128°F, based on a 90°F day.
 - ▶ A three way thermostat, (TCV 200), around the aerial cooler is used to provide a minimum coolant temperature of roughly 100°F on cold ambient days.
- c. Coolant runs from the fin-fan cooler to the brazed pack natural gas cooler, (E-2).
- d. The coolant will exit the gas cooler and enter the brazed pack oil cooler, (E-1).
- e. From the oil cooler the water then flows to the engine coolant pump and is pumped through the engine and back to the fin-fan cooler, (E-3).

4.4.2 MOTOR DRIVE PACKAGES

- a. One common circuit is piped in series to cool the gas stream and compressor oil.
- b. The cooling water will exit the aerial fin-fan cooler, (E-3), at a maximum of 128°F, based on a 90°F day.
 - ▶ A three way thermostat, (TCV 200), around the aerial cooler is used to provide a minimum water temperature of roughly 100°F on cold ambient days.
- c. Cooling water runs from the fin-fan cooler to the brazed pack natural gas cooler, (E-2).
- d. The water will exit the gas cooler and immediately enter the brazed pack oil cooler, (E-1).
- e. The water then is pumped back to the fin-fan cooler, (E-3).

4.5 CONTROL SYSTEM

CC60 – CC200 FOR PDH/PDR TYPE SULLAIR COMPRESSORS

These units come equipped with a Murphymatic Control Panel, which is powered by the ignition system. The control panel is designed to protect the engine, compressor and any other equipment on the compression skid.

CC325, CC400 AND CC600 FOR PDR/PC TYPE SULLAIR COMPRESSORS

These units come equipped with a Electronic Control Panel, which is powered by An external power supply of 24 volts that is required. The control panel is designed to protect the engine, compressor and any other equipment on the compression skid.

4.5.1 SHUTDOWNS

The Panel comes equipped with the following Shutdowns:

TYPE OF SHUTDOWN

CLASS A: Are shutdowns only.

CLASS B: Allows sensor input to be locked out at start-up.

SHUTDOWN/ALARM	CLASS	TIMER (TYPICAL)	SETTINGS (TYPICAL)	OTHER	
High Suction Pressure	B1	30 seconds	100 PSIG		
Low Compressor Differential pressure			50 PSIG		
Low Engine Oil Pressure			25 PSIG		
High Engine Jacket Water Temperature			210 °F		
Low Suction Pressure			5 PSIG		
High Discharge Pressure	A	N/A	380 PSIG		
High Compressor Oil Temperature			190 °F		
High Suction Scrubber Level					
Low Oil Separator Level					
High Compressor Oil Level				Optional	
Low Engine Oil Level					
Engine Vibration					
Low Coolant Level					
High Compressor Discharge Temperature				240 °F	
Engine Over speed				2000 RPM MAX	
Manual Stop					
Underspeed/ Loss of Ignition	B	N/A	600 RPM MIN		

For further information, see Control Panel Drawings and manual in the instrument section of this manual.

5.0 PRE – COMMISSIONING PROCEDURES

5.1 PRESSURE TESTING AND PURGING

DANGER: The natural gas going into the package can act like an explosive, making it very important to purge the air from the system. Natural gas can be used to displace this air.

5.2 COMPRESSOR AND DRIVE SHAFT ALIGNMENT

- a. During transit, alignment may have shifted. Alignment must be checked once the unit is placed at site.
- b. A hot alignment must be done during the 500-hour inspection.
- c. All hold down bolting should be checked again and dowels installed if required.
- d. Check the tension on all belts.
- e. The air cooler fan unit should be checked for correct direction of rotation (electric driven units only) and the belts checked for excess vibration, belt slip, noise and sufficient airflow.

5.3 COOLING WATER SYSTEM (50/50 EG)

The cooling water system should be purged on the initial shutdown to get any trapped air out of the system. Top up surge tank until it remains at a steady level.

5.4 CONTROL SYSTEMS

- a. Prior to start – up, ensure that all electrical seals have been poured.
- b. All system trip switches, etc. must be pre – set and tested for logic and function.
- c. A complete point-to-point function test of each device and the associated wiring should be done, along with testing all functions of the control panel and end device settings.

6.0 START – UP CHECK LIST

Caution: Do not overfill oil separator

All PC type Sullair Compressor packages have to be pre-lubed prior to start up.

a.	Fill compressor lubrication system with oil.	
b.	Fill engine lubrication system with oil (engine drive units only).	
c.	Fill cooling water circuit with 50/50 glycol.	
d.	Check to ensure all equipment is clear of loose items.	
e.	Check to ensure all bearings are properly lubricated.	
f.	Check and align engine and compressor.	
g.	Check the equipment hold down bolts to ensure they are tight.	

The driver can now be bumped for rotation and checked for excess noise.

Ensure the following items are in their correct operating position:

a.	All valves.	
b.	Control panel switches.	
c.	Oil and glycol systems charged and pumps commissioned.	
d.	All pressure and level controls are in the proper operating position.	
e.	Compressor in minimum load position (where applicable).	

7.0 STARTING

Caution: ON A FAILED START, ENSURE THE TURBINE STARTER HAS COME TO A COMPLETE STOP BEFORE ATTEMPTING TO RE-START THE UNIT (APPROXIMATELY 30 SECONDS). FAILURE TO WAIT WILL RESULT IN SEVERE STARTER DAMAGE.

7.1 STARTING COLD SKID

7.1.1 ENGINE DRIVE PACKAGES

- a. The driver crank/start must be performed manually. The fuel gas valve must be manually reset to the open position prior to attempting an engine start.
- b. The package should be a minimum of 60°F prior to start up. If starting from a completely cold condition allow the engine to idle for 10 minutes.
- c. Once the warm up cycle has been completed and equipment is operating properly, load compressor above 50%.
- d. Check the following items:
 - ▶ Lube oil supply pressure and temperature.
 - ▶ Glycol pressure and temperature.
 - ▶ Oil Separator oil sump level.
 - ▶ Compressor, engine pump, fan noise and vibration.

- ▶ Compressor and engine temperatures and pressures.
- ▶ Shaft seals.
- ▶ Oil filter differential pressure.
- ▶ All operating pressures and temperatures.
- e. Upon verification of above listed items the compressor can be loaded to design conditions and engine speed of 1800 rpm.
- f. The oil separator oil return and the suction scrubber level control need to be monitored for proper operation.
- g. For a period of time until the system has stabilized the operation should be monitored. Once stability is assured, then the system can be shutdown and restarted as required.

7.1.2 MOTOR DRIVE PACKAGES

- a. Push Motor start button.
- b. The package should be a minimum of 60°F prior to start up.
- c. Once the warm up cycle has been completed and equipment is operating properly, load compressor above 50%.
- d. Check the following items:
 - ▶ Lube oil supply pressure and temperature.
 - ▶ Glycol pressure and temperature.
 - ▶ Oil Separator oil sump level.
 - ▶ Compressor, coolant pump, fan noise and vibration.
 - ▶ Compressor temperatures and pressures.
 - ▶ Shaft seals.
 - ▶ Oil filter differential pressure.
 - ▶ All operating pressures and temperatures.
- e. Upon verification of above listed items the compressor can be loaded to design conditions.
- f. The oil separator oil return and the suction scrubber level control need to be monitored for proper operation.
- g. For a period of time until the system has stabilized the operation should be monitored. Once stability is assured, then the system can be shutdown and restarted as required.

7.2 RESTART FROM HOT SHUTDOWN

7.2.1 ENGINE DRIVE PACKAGES

- a. Correct shutdown problem
- b. Reset fuel gas valve after shutdown
- c. Follow steps in section 8.1.1 Engine Drive Packages

7.2.2 MOTOR DRIVE PACKAGES

- a. Correct shutdown problem
- b. Follow steps in section 7.1.2 Motor Drive Packages

8.0 CONTROLLED SHUTDOWN

8.1 ENGINE DRIVE PACKAGES

- a. Unload compressor
- b. Slow down engine
- c. Allow package to cool down
- d. Push stop button

8.2 MOTOR DRIVE PACKAGES

- a. Unload compressor
- b. Allow package to cool down
- c. Push stop button

9.0 PACKAGE MAINTENANCE

9.1 COMPRESSOR RECOMMENDATIONS

	Change Oil	Change Filter**	Clean Oil/Liquid Strainer	Change Coalescer**	Check & Clean Suction Screen	Check Alignment	Check Coupling	Check Temp. & Pressure Calibration	Replace Seal**	Inspect Compressor	Oil Analysis	Check & Calibrate all Shutdowns
500												
1,000												
5,000												
8,000												
10,000												
15,000									☒	☒		
20,000												
25,000									✕	✕		
30,000									☐	☐		
35,000												
40,000												
45,000												
50,000												
55,000												
60,000												
65,000												
70,000												
75,000												
80,000												
85,000												
90,000												
95,000												
MONTHLY												
EVERY 6 MONTH												
☒	Gas processing – High operating pressures											
✕	High volume duty											
☐	Low booster duty											

*Above are guide lines only and are based on clean dry (0.6 sp. gr.) natural gas. the original OEM manual for details and further schedules.

**Life expectancy of filters, coalescing elements and seals will change based on impurities in the gas stream.

9.2 ENGINE RECOMMENDATIONS

The following schedules are guide lines only. Please refer the original OEM manual for details and further schedules. Maintenance intervals can vary with quality of fuel gas utilized.

9.2.1 ARROW ENGINE

EVERY 20000/28000	EVERY 10000/14000	EVERY 3000	EVERY 1500	EVERY 500	INITIAL 500	DAILY	Naturally Aspirated Engines (SHOWN IN HOURS OF OPERATION)
							Coolant Level - Check
							Engine Air Pre/Cleaner – Check / Clean
							Engine Oil Level - Check
							Fuel Filter - Drain / Check
							Fan Belts - Inspect / Adjust / Replace
							Cooling System - Test / Add
							Engine Oil and Filter - Change
							Inlet Air System/Exhaust Piping - Inspect
							Gas Pressure Regulator - Check
							Hoses and Clamps - Inspect / Replace
							Spark Plugs - Check / Adjust / Replace
							Engine Oil Sample – Obtain
							Ignition Timing - Check / Adjust
							Carburetor Air/Fuel Ratio - Check / Adjust
							Magneto Drive Gear – Inspect
							Cylinder Pressure - Measure / Record
							Engine Crankcase Breather - Clean
							Water Pump - Inspect
							Engine Valve Lash - Inspect / Adjust
							Valve Stem Projection - Measure / Record
							Carburetor Diaphragm - Inspect
							Cooling System Coolant Analysis & Change
							Engine Mounts - Check
							Thermostat - Replace
							Overhaul Top End
							Overhaul Major

9.2.2 CATERPILLAR NATURALLY ASPIRATED ENGINE

EVERY 24000	EVERY 20000/28000	EVERY 10000/14000	EVERY 3000	EVERY 1500	EVERY 750	INITIAL 750	EVERY 250	DAILY	Naturally Aspirated Engines (SHOWN IN HOURS OF OPERATION)
									Coolant Level - Check
									Engine Air Pre/Cleaner - Check
									Engine Oil Level - Check
									Fuel Filter - Drain / Check
									Engine Oil Sample – Obtain
									Cooling System - Test / Add
									Fan Belts - Inspect / Adjust / Replace
									Crankshaft Vibration Damper - Check
									Engine Oil and Filter - Change
									Inlet Air System/Exhaust Piping - Inspect
									Gas Pressure Regulator - Check
									Hoses and Clamps - Inspect / Replace
									Spark Plugs - Check / Adjust / Replace
									Ignition Timing - Check / Adjust
									Engine Valve Lash - Inspect / Adjust
									Engine Valve Rotators - Inspect
									Valve Stem Projection - Measure / Record
									Actuator Control Linkage - Lubricate
									Carburetor Air/Fuel Ratio - Check / Adjust
									Crankcase Blowby - Measure / Record
									Cylinder Pressure - Measure / Record
									Engine Crankcase Breather - Clean
									Cooling System Coolant Analysis
									Engine Mounts - Check
									Ignition System Transformer - Test
									Water Pump - Inspect
									Overhaul Top End
									Overhaul Major
									Cooling System Coolant – Change

10.0 TROUBLE SHOOTING

LOCATION	DESCRIPTION	CAUSE	RESOLUTION
SUCTION SCRUBBER	High liquid level	Drain system not working	Check valves and drain line
		Level control not working	Check valve
		Too much liquid in gas supply	Check for alternate method of removing excess liquids
BLOWCASE (if applicable)	Not draining	Not enough differential pressure	Install means of adding back pressure to the system
		Check valve from scrubber not holding	Check valve and repair if needed
		Level controller not switching	Check controller and repair if needed
COMPRESSOR	High suction pressure	Suction pressure control valve	Check set points on valves
		Bypass control high discharge pressure valve	
		Bypass control low suction pressure valve	
		Field pressure too high	Install pressure control
	Low suction pressure	Suction pressure control valve	Check setting on valve, repair if needed
		Bypass valve fails or set too low	
		Compressor operating too high capacity	Unload compressor
	Low oil differential pressure	Dirty oil filter, filter bypass line blocked	Replace filter and check bypass line.
		Restriction in oil line	Check oil line and valve
		Cold oil	Package at least 60°F.
Suction pressure too high/discharge pressure too low		Adjust suction pressure control valve Adjust discharge pressure control valve Add oil pump Add back pressure control valve	

LOCATION	DESCRIPTION	CAUSE	RESOLUTION
COMPRESSOR	High discharge pressure	Discharge line blocked	Check discharge line and valves for blockage
		Back pressure control valve	Check set points for accuracy and adjust Repair if needed
		Compressor bypass not operating	Check set points for accuracy and adjust Repair if needed
		Oil Separator coalescing element blockage	Inspect coalescing elements and replace if necessary
		High line pressure	Check line pressure
	High discharge gas temperature/High oil temperature	Temperature control valve stuck	Repair
		Dirty oil filter	Replace filter
		Low coolant flow	Purge system to remove air Clean system Clean coolers
		High glycol flow	Reduce flow
		Gas cooler dirty	Clean cooler (E-2)
		Oil cooler dirty	Clean cooler (E-1)
		Insufficient air flow to cool glycol	Check fan Clean cooler (E-3)
		Insufficient oil flow	Adjust oil flow control valve
*More than 10 compression ratios	Reduce compression ratios to below 10		

*Note: Compression ratios are based on absolute pressures (gauge pressure + barometric pressure).

LOCATION	DESCRIPTION	CAUSE	RESOLUTION
OIL SEPARATOR	Low oil liquid level	Oil return line plugged	Check line and valves
		Plugged elements	Replace elements
		Ruptured elements	Replace elements
		Shaft seal leaking	Replace seal.
		Initial filling of lines	Add oil as required
		Coalescing element not installed properly	Check elements and reseal properly if needed
	High oil level	After start-up oil aerates and expands due to temperature	fill separator to allow for expansion
		Foaming, liquid or chemical carry over from suction scrubber	Flush system, change oil and ensure proper front end separation
		Condensing in the discharge separator	Check composition of natural gas and operating parameters
ENGINE	Low engine oil pressure	Plugged oil filter	Replace filter
		Oil pump not working	Check oil pump
	High jacket water temperature	Stuck thermostat	Check thermostat
		Low coolant flow	Add glycol
			Repair pump Lower coolant line restriction
		Cooling system	Clean cooling circuit
	Driver \Speed	Governor	Check governor
	High vibration	Unit not stable	Ensure compression unit is on appropriate foundation
		Engine miss firing	Check engine
		Bearings failure	Replace bearings
		Pump cavitation (50/50EG pump)	Purge air from system
		Coupling loose	Tighten coupling
		Alignment	Check alignment
	Low lube oil level	Day tank low	Check oil line and drain valve, refill system
		Drain valve from tank open	
Isolation valves to/from level controller closed		Open Valves	

11.0 OPTIONS

See P&ID to determine which of the following options are part of your package.

For further information on any control valves listed below see the instrumentation section of you manual.

11.1 SUCTION PRESSURE CONTROL VALVE

Used to maintain the suction pressure to the compressor at a maximum pressure should field pressures be too high.

11.2 SUCTION PRESSURE CONTROL VALVE AUTOMATIC CLOSE

The automatic close feature is controlled via the fuel gas.

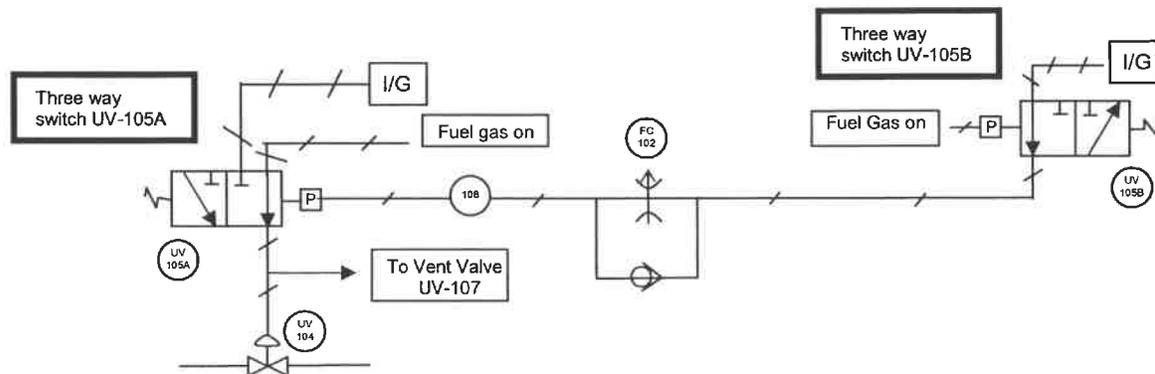
- a. Fuel gas line loses pressure.
- b. Relay valve (UV-103) closes.
- c. Suction Control valve closes.

11.3 PURGE SYSTEM

Used to purge system with an inert/sweet gas (supplied by customer) at shutdown.

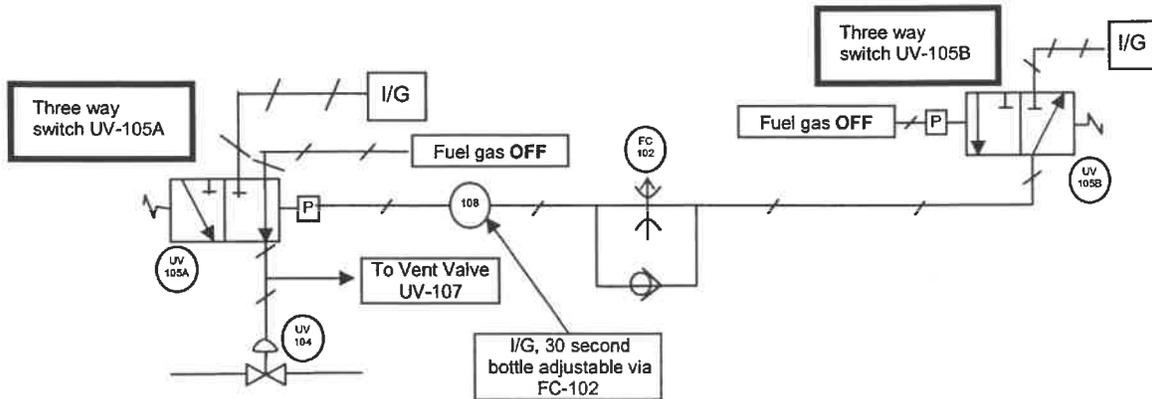
Purge System closed.

- a. Compression unit is operational
- b. Fuel gas pushes onto three-way switch (UV-105B), pushing the switch into the open position.
 - ▶ Instrument gas is allowed to pass through the switch.
- c. The instrument gas presses onto three-way switch (UV-105A) controlling the purge and vent valves, pushing the switch in the open position
 - ▶ Fuel gas is allowed to pass through the switch and thereby the purge and vent valves (UV-104 and UV-107) remain closed.

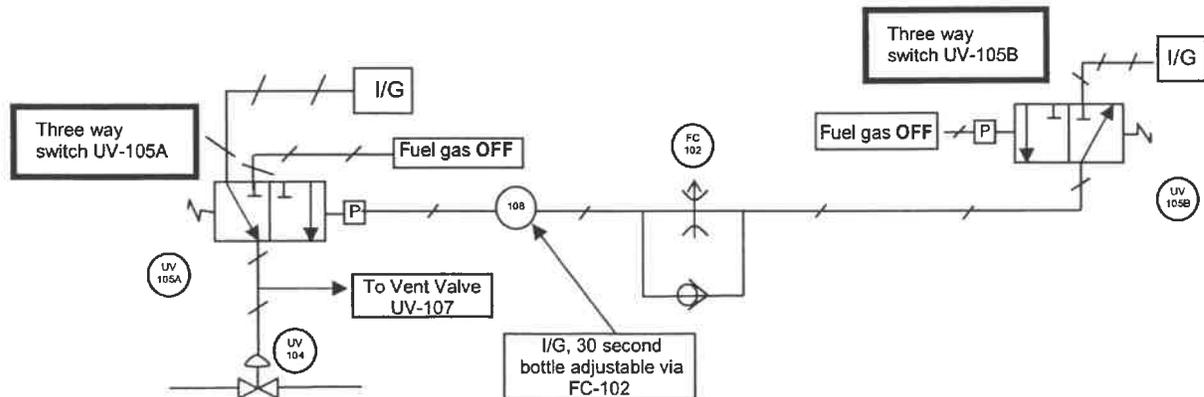


Purge System Activated

- a. Unit just shut down
- b. Fuel gas shut off and the three way switch (UV-105B) changes to the vent position.
 - ▶ Instrument gas can no longer pass through the three way switch and will vent the signal from UV-105A.
- c. Instrument gas line to three way switch (UV-105A) comes equipped with a bottle that can hold sufficient instrument gas to keep the three way switch (UV-105A) in the open position for 30 seconds.
 - ▶ Fuel gas is vented and the purge and vent valves (UV-104 and UV-107) open for 30 seconds to allow the system to purge.



- d. After 30 seconds, three way switch (UV-105A) is pushed by a spring into reset allowing instrument gas (I/G) through and thereby closes the purge and vent valves.



11.4 VENT SYSTEM

Used to Vent all natural gas through the vent header, if unit shuts down.

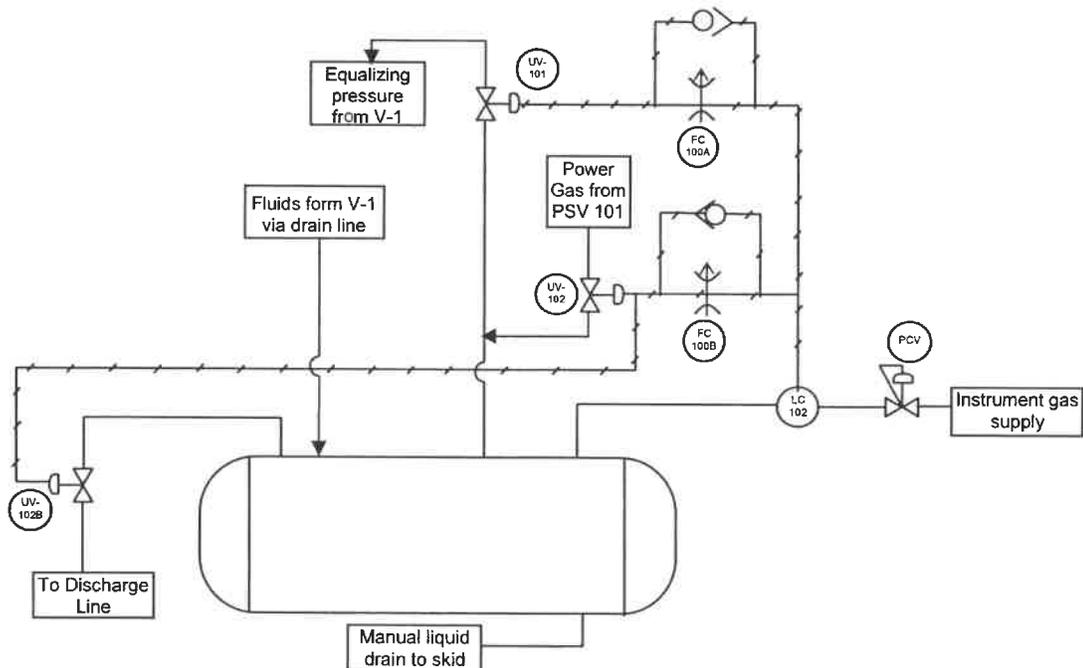
- a. Unit shuts down
- b. Fuel gas shuts off
- c. Vent Valve (UV-107) opens

11.5 BLOWCASE

The blowcase acts as a reservoir to store liquids that have been removed from the natural gas suction stream. The liquids are then transferred into the discharge stream (via use of differential pressure) for processing at a downstream facility.

CAUTION: Ensure that the equalizing valve and power gas supply valve are never open at the same time (adjustable through FC100 A and B).

- a. Blowcase fill sequence: Pressure of the Suction Scrubber and Blowcase are equalized and gravity is used to drain Suction Scrubber liquids into the blowcase.
 - ▶ Blowcase has completed draining or is empty
 - ▶ Blowcase level controller (LC-102) vents pneumatic signal to control valves
 - Blowcase drain valve (UV-102B) closes
 - Power gas supply valve (UV-102A) closes
 - Equalization valve (UV-101) opens
 - ▶ Liquid drains from Suction Scrubber to Blowcase
- b. Blowcase drain sequence: Pressure of the blowcase is raised to the same pressure as oil separator. The differential pressure between oil separator and skid edge discharge is used to transfer the liquids from the blowcase into the discharge line. The pressure loss in the discharge line is a result of pressure drops through the gas cooler, piping and associated valves. The greater the differential pressure, the faster the liquids are drained into the discharge line.
 - ▶ Blowcase reaches maximum capacity
 - ▶ Level controller (LC-102) sends pneumatic signal to control valve
 - Equalization valve (UV-101) closes
 - Blowcase drain valve (UV-102B) opens
 - Power gas supply valve (UV-102A) opens
 - ▶ Liquid drains from Blowcase into discharge line



11.6 BYPASS CONTROL HIGH DISCHARGE

The control valve is used maintain a maximum system Discharge Pressure and to allow recirculation of the discharge gas back to unit suction.

- a. The pressure control valve senses the pressure upstream of the valve (discharge pressure).
- b. The valve modulates with the change in sensed pressure.

11.7 BYPASS CONTROL LOW SUCTION

The control valve is used to maintain a minimum Suction Pressure and to allow recirculation of the discharge gas back to unit suction.

- a. The pressure control valve senses the pressure downstream of the valve (suction pressure).
- b. As the suction pressure fluctuates, the valve modulates to maintain a constant suction pressure.

11.8 BACK PRESSURE CONTROL VALVE

The control valve is used to raise the discharge pressure to a minimum.

- a. The pressure control valve senses the pressure upstream of the valve (discharge pressure).
- b. The valve modulates to maintain the required compressor discharge pressure.

11.9 START GAS REGULATOR BYPASS VALVE

Used if the supply pressure is too low to start the engine.

A spring loaded bypass valve is installed around the primary regulator, (PCV 100). This will eliminate the pressure drop through the regulator and allow the engine to start at lower start gas supply pressure.

11.10 AUTOMATIC PRE-LUBE FOR PC TYPE SULLAIR COMPRESSORS

Automatic pre-lube system for units equipped with PC type Sullair Compressors.

The system comes equipped with a pre-lube pump and pre-lube timer.

- a. The EMS will display prelubing message.
- b. Prelube timer and pre-lube pump will start.
- c. Prelube timer expires the lube pump will turn off
- d. Start engine message will be displayed on the EMS.

11.11 FIRE LOOP

Automatic shutdown of the unit in case of fire.

The fire loop is maintained at a pressure above 20 psig.

System comes equipped with two fusible plugs.

- ▶ One is mounted above the compressor
- ▶ The second over the engine.
- a. In case of fire the fusible plugs will melt.
- b. The fire loop will open up to the atmosphere, at which point the pressure in the system will fall.
- c. Compressor unit will shutdown if pressure in the fire loop falls below 20 psig

12.0 WARRANTY

Concept Compression Corp. (Concept) warrants only to the original purchaser that the package delivered shall conform to the specification stated in the proposal for 12 months from the date the package is first operated, or 18 months from the date of original shipment, whichever comes first. This warranty does not cover equipment supplied by third parties, which is warranted to the extent of the third parties warranty to Concept.

Concept will determine the parts which do not conform to the specifications and will repair or replace the parts, at their option. This warranty will be considered void unless the original purchaser advises Concept of the non-conformance before the end of the warranty term. Necessary repairs shall be made at Concept's factory, less any shipping charges to and from the facility. No allowances will be made for any alterations made to the equipment by the original purchaser without the written consent of Concept. If repair of the component is not feasible, Concept may, at its option, redesign, redevelop or replace the faulty component.

All travel time, overtime charges, truck charges and subsistence will be charged according to Concept's standard rate sheet. In no event shall Concept be liable for any special, consequential, incidental, or indirect damages, or for any loss of use of or any damage to any installation, operation or service in which the package is installed, or for interest, work stoppage, impairment of other goods, loss by reason of shutdown or non-operation, increased operation expense, cost of replacement equipment, service interruption, whether or not such loss is based on contract, warranty, negligence, indemnity, strict liability or otherwise.

Under no circumstances shall Concept's liability exceed the cost of the repair or replacement of the defective parts as indicated herein and shall be limited to the duration of this warranty.

This warranty is expressly in lieu of all other warranties, including but not limited to the implied warranties of merchantability, description and fitness for a particular purpose. All warranties which exceed the above obligations are hereby disclaimed and excluded from this warranty.



INTRODUCTION

This natural gas compressor package was designed and built by Concept Compression Corp. The entire package is built to meet or exceed all local governing codes and regulations. All service work should be performed by trained technicians. The information included in this manual is based on a standard package with a variety of different options. Please consult your P&ID for specific options that were included on your package. Should there be any questions regarding the operating parameters or servicing of this package, please contact Concept Compression Corp. at (403)-250-8810.

This package is a standard booster compressor designed to operate within the range outlined on the performance curves which you will find at the end of this section. The curves are generic and cover a wide variety of gear ratios for different applications. Please consult your Equipment Summary page located at the beginning of this section to determine the actual gear ratio of your particular compressor. Each line on the performance curve indicates a different gear ratio. **DO NOT** operate the unit outside the parameters indicated on the curves without prior written approval from Concept Compression.

INSTALLATION RECOMMENDATIONS

Due to the wide variety of site conditions, Concept can not provide recommended pile locations for this unit. Typically, most clients install these units on compacted gravel pads or wooden timbers. Our experience indicates that this is usually sufficient.

We recommend you connect your piping system to the package using our piping schematic shown by the dashed lines on Page 1 of the P&ID. The isolation valves are installed off skid so the unit can be blocked in and moved in the future without changing any site piping. The check valve between the suction and discharge piping will allow the gas to flow around the package at a reduced rate in the event the compressor is not operating. This will also prevent a down stream compressor from drawing the gas through this package and forcing it to turn over without lubrication. The check valve on the discharge side is also installed as a typical industry practice. We recommend installing a 1.5" bypass valve around this check to ensure sufficient start gas supply to the unit.



DISCLAIMER

The enclosed is a standard manual with sections that do not apply to natural gas service.



SERIES PDH127 GAS COMPRESSOR

OPERATOR'S MANUAL

Part Number 02250051-521
©Sullair Corporation, 1994
Effective 6/94

KEEP YOUR MACHINE IN TOP
OPERATING CONDITION
USE

GENUINE



SULLAIR®

SERVICE PARTS

CONTACT YOUR NEAREST SULLAIR
DISTRIBUTOR OR CALL 1-800-348-2722

SULLAIR OPERATORS MANUAL AND RECOMMENDED SPARE PARTS LIST
SERIES PDH GAS COMPRESSOR

Sullair Process & Gas Compressors, Inc.
3700 E. Michigan Boulevard
Michigan City, Indiana 46360

TABLE OF CONTENTS

SECTION 1 - SPECIFICATIONS

- 1.1 Compressor Specifications

SECTION 2 - DESCRIPTION

- 2.1 Introduction
- 2.2 The Compressor Unit
- 2.3 The Capacity Control System

SECTION 3 - INSTALLATION

- 3.1 General
- 3.2 Long-Term Storage
- 3.3 Foundation and Rigging
- 3.4 Piping
- 3.5 Pressure Test
- 3.6 Rotation Check
- 3.7 Pre Start-up Lubrication Charge

SECTION 4 - OPERATION

- 4.1 Start-up Service Outline
- 4.2 Pre-Start Checklist
- 4.3 Initial Start-Up Procedure
- 4.4 Lube Pressure Adjustment
- 4.5 Start-Up Data Record
- 4.6 After Start-Up Maintenance

SECTION 5 - MAINTENANCE

- 5.1 General
- 5.2 Daily Operation
Table 10
- 5.3 Maintenance After Initial 200 Hours of Operation
- 5.4 Maintenance Schedule
- 5.5 Trouble Shooting
- 5.6 Seasonal or Long-Term Shutdown

TABLE OF CONTENTS (continued)

SECTION 6 - SERVICE

- 6.1 General
- 6.2 Shutdown Procedure
- 6.3 Bolt Tightening Torques
Table 12
- 6.4 Lube Separator Element Servicing
- 6.5 Shaft Seal Replacement
- 6.6 Compressor Unit Replacement
- 6.7 Capacity Control Servicing
- 6.8 Capacity Control Actuator Servicing

SECTION 7 - VENDOR DATA, SULLAIR DRAWINGS, RECOMMENDED SPARE PARTS LIST

- 7.1 Recommended Spare Parts List

SECTION 1

SPECIFICATIONS

1.1 Compressor Specifications

Machine

Physical Measurements

	<u>PDH127</u>				
Weight lb.	545				
Length in.	33.30				
Width in.	19.95				
Height in.	21.25				
Rotor Dia. mm.	127.50				
Gear Ratio	1.31	1.51	1.76	1.91	Direct Drive
WR ² lb.-in. ²	248	322	425	498	118
L/D Ratio	1.70				
Shaft Rotation (Facing Driveshaft)	CW Geared, CCW Direct				
Built-in Volume Ratio:	2.2-2.6 (Low Compression)				
	3.7 (Medium Compression)				
	4.8 (High Compression)				
Max Inlet Pressure:	150 PSIG				
Max Outlet Pressure:	350 PSIG				
Operational Speed:	2256 Min - 7519 Max (Male Rotor RPM)*				
Bearings (Rad):	Cylindrical, roller type				
Bearings (Thr/Rad):	back-to-back tapered, roller type				

NOTES: * 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:

- . 350 PSIG design casting
 - . Stator, inlet and discharge housings are ASTM A159-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
 - . Optional rotary capacity control actuator
 - . Bearings: back-to-back tapered, roller type
cylindrical, roller type
- Also included:
- . Shaft seal, rotary face mechanical
 - . 600 PSIG maximum hydrostatic pressure test

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 radial 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, pumper, etc.)
Gas composition (including liquids)
Flowing pressures & temperatures
Ambient temperatures
Compressor speed

OIL PROPERTIES

Composition
Viscosity
Lubricity
Solubility
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 reinjection.

2.3 The Capacity Control System

Compressor capacity is governed by internally bypassing, before compression takes place, a portion of the gas trapped in the screws back into the suction port.

Bypassing is done through a rotary valve located below the screws and driven by a hydraulic actuator. As the body of the valve spool is rotated, its radially cut ports progressively open a common channel of gas flow between the screws and the suction plenum, thus providing a controlled flow of gas.

The direct coupled rotary hydraulic actuator is fed by a combination of electro-hydraulic spool valves and pressure switches - not supplied with the bare compressor. The pressure switches, located in the gas (suction or discharge) line, respectively react to high/low levels of pressure within a defined deadband, and energize the spool valves which feed the hydraulic actuator.

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 packager 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. 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, if available, 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 Driver Rotation Check

IMPORTANT

SEE SECTION 1.1 FOR PROPER COMPRESSOR SHAFT 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.

3.7 Pre-Start-Up Lubrication Charge

Before starting the compressor for the first time, a pre-lubrication charge should be administered. This is achieved by running the pre-lube pump prior to start-up to insure that the compressor, cooler and all lubrication lines have sufficient lube oil for start-up lube pressure. Run the pump until 10 to 15 PSIG is achieved but no longer than 60 seconds for serious damage could result to the pre-lube pump in the case of insufficient lube flow. If this pressure is not achieved, refer to Section 5.5 "Low Lube Pressure".

After the charge has been completed, a check for lube oil leaks at all supply lines should be done. If leaks are found, correct this by tightening the fittings, flanges, etc.

When this is completed, rotate the compressor shaft approximately ten revolutions to equalize the lubricant level in the compressor. Failure to do this could result in possible damage to the drive shaft seals during initial start-up.

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 compressor is to be filled with the correct type and amount of lubricant (see Section 1.1).
9. 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).
10. The lubricant is to be warmed up (if applicable).
11. The control panel is to be energized to check the protective switches and the capacity control. (See Section 3.9)
12. The direction of rotation of the compressor is to be checked.
13. 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.
14. 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 all protective controls.
3. Check capacity control actuator adjustment.
4. Start the compressor for the first time and adjust all the valves and controls on the package.
5. 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 compressor 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

IMPORTANT

FOR INITIAL START ONLY, THE LOAD CONTROL SWITCH SHOULD BE SET IN THE "MANUAL POSITION. CHECK FOR "MINIMUM LOAD" STATUS BEFORE STARTING. THIS STATUS SHOULD ALWAYS BE SATISFIED BEFORE ATTEMPTING TO START THE COMPRESSOR. IF THE COMPRESSOR SHUTS DOWN FOR ANY REASON, IT WILL AUTOMATICALLY RETURN TO THE "MINIMUM LOAD" POSITION.

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.

4.4 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.

START UP DATA RECORD

Customer _____

Contractor _____

Persons Contacted _____

Persons Contacted _____

Phone _____

Phone _____

Telex _____

Telex _____

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 (Sections 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

4.5 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

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.

TABLE 10
COMPRESSOR LOG EXAMPLE

Plant Name _____ Model No. _____ Serial No. _____
 Date _____ Logged By (Initials) _____ Time Run (Hours) _____

Item	Symbols	Units	Normal Range		Time		
			From	To	8 AM	4 PM	12 PM
Inlet Pressure	Ps	PSIG/In HG/kP ag					
Inlet Temperature	Ts	oF/oC					
Discharge Pressure	Pd	PSIG/kp ag					
Discharge Temperature	Td	oF/oC					
Oil Pressure (at Manifold)	Po	PSIG/kP ag					
Oil Temperature (at Manifold)	To	oF/oC					
Oil Pressure Minus Discharge Pressure	Po-Pd	PSI/kPa					
Oil Pressure (at Filter Inlet)	Pf	PSIG/kP ag					
Oil Filter Pressure Drop	Pf-Po	PSI/kPa					
Water Temperature (at Cooler Inlet)	Ti	oF/oC					
Water Temperature (at Cooler Outlet)	To	oF/oC					
Oil Level	-						
Oil Added	-						
Capacity	-	amp					
Motor Current							
Machine Room Temp.		oF/oC					
Outside Temperature		oF/oC					
Outside Wet Bulb Temperature		oF/oC					

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.
4. Check the pressure gauge calibration (0 PSIG or 0 kPa when open to atmosphere).
5. Tighten package fasteners, specially 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 pertinent protection switches.
8. Check lubricant oil separator element and gaskets (if oil loss is excessive).
9. Perform driver maintenance as required.
10. 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
Lubricant Driver Motor Bearings	Yearly or as recommended by motor manufacturer
Engine Lubricant Sump (if applicable)	Yearly or as recommended by motor 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 Lubricant Separator Filter Element	Inspect if oil loss is excessive.
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 (if 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 strainers
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. Contact Sullair with results. B. Loose compressor anchoring. Tighten bolts. C. Check coupling alignment. D. Any other persistent vibration or 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.

Section 6
SERVICING

TABLE 12
TIGHTENING TORQUES FOR THREADED BOLTS

Fastener Diameter	Pitch Thread	Tightening torques:																			
		Grade 2 **						Grade 5 **						Grade 8 **							
		*Condition			*Condition			*Condition			*Condition			*Condition			*Condition				
Inch	A	B	C	D	E	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	16.3	12.2	10.8	8.1	14.9
5/16	18	7.5	5.4	5.0	3.8	6.8	10.8	8.1	7.5	5.4	9.8	25	18	17	15.3	22.5	34	24	23	16.9	31
3/8	16	11	8.0	7.5	5.5	10	17	13	11.5	8.5	15.3	30	23	20	18	27	45	35	31	22.5	40
1/2	13	27	20	18.3	13.6	24	41	31	27	20	37	61	47	42	31	54	110	80	74	55	99
5/8	11	50	35	34	25	45	75	55	50	38	68	149	108	100	75	134	220	170	147	110	198
3/4	10	136	102	91	68	122	203	149	136	102	183	298	230	199	149	268	380	280	255	190	342
7/8	9	237	176	159	92	214	353	271	236	176	317	515	380	346	258	464	600	460	402	300	540
1	8	250	190	168	125	225	640	480	429	320	576	900	680	603	450	810	1220	922	818	610	1098

GRADE **	IDENTIFICATION MARK	TENSILE STRENGTH		YIELD STRENGTH		DIAMETER
		PSI	MPa	PSI	MPa	
2		74,000	510	57,000	390	Up to 3/4
5		60,000	415	36,000	250	7/8 to 1
8		105,000	725	81,000	500	All Sizes
		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 loxite 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 Seal Replacement Instructions - Gear Driven Compressors

Compressor Units

DXH127170	-----	NC	001812B
DXH127170	-----	GC	001812C
DXH127170	-----	CC	001812E

PART NO.	DESCRIPTION	QTY 001812B	QTY 001812C	QTY 001812E
240627	Seal, Shaft 1-7/8 21 Neoprene	1		
240048	Seal, Shaft 1-7/8 21 Viton		1	
240876	Seal, Shaft 1-7/8 9 Teflon			1
826202-042	O-Ring, Neoprene 3-1/4 x 1/16	1		1
826502-042	O-Ring, Viton, 3-1/4 x 1/16		1	
827501-025	Pin, Spring 3/32 x 1/4	2	2	3
043438	Ring, Ret-Int Spiro 2-3/4	1	1	1
067481	Instructions, Seal Replacement	1	1	1
001901A	Lube Kit, Shaft Seal	1	1	1

Refer to Sullair for compressor units with part numbers not shown.

1.0 PREPARATION

- 1.1 Make sure that the starter is disconnected BEFORE any work is performed on electric driven compressors.
- 1.2 Refer to the operator and maintenance manual for instructions on coupling removal and/or any other work to be done prior to the removal of the shaft seal.

2.0 DISASSEMBLY

- 2.1 Remove the six screws (S19) which hold the oil seal retainer (S5) in place.
- 2.2 Remove the retaining ring (S17) and seal seat from the oil seal retainer. If the spring pin (S15) in the oil seal retainer is sheared or bent, remove it.
- 2.3 Remove the O-ring (S14, S28) from the oil seal retainer (S5).
- 2.4a (Type 9 seal only) The shaft seal (S8) is located on the shaft by a pin (S15) located behind the shaft seal. Slide the seal straight off the shaft. If either of the pins (S15) located in the oil seal spacer (S1) are sheared or bent, remove the spacer from the shaft and remove the damaged pins. If not, replace the spacer on the shaft.

6.5 Seal Replacement - Gear Driven (continued)

- 2.4b (Type 21 seal) Remove the seal (S10, S12) from the shaft. The rubber bellows is bonded to the shaft and has 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 in any way. Remove the oil seal spacer (S1). If the pin (S15) located in the oil seal spacer is sheared or bent, remove it. If not, replace the spacer on the shaft.

3.0 INSPECTION & PREPARATION FOR SEAL ASSEMBLY

- 3.1 Clean all parts thoroughly and scrape off any debris or material on the parts.
- 3.2 Check the bore edges of the seal retainer (S5) and the adapter housing for burrs and break any sharp edges. Make sure the oil supply orifice in the adapter housing is open and clean.
- 3.3 Remove all burrs and break all sharp edges on the shaft

WARNING

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

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

4.0 ASSEMBLE THE OIL SEAL RETAINER ASSEMBLY

- 4.1 If a new pin (S15) is required in the oil seal retainer (S5), install it at this time.
- 4.2 Lightly coat the bore of the seal retainer (S5) with lubricant provided in the Shaft Seal Lube Kit #001901A.
- 4.3 Unwrap the seat.

WARNING

THE FINISH OF THE LAPPED SURFACE IS EASILY DAMAGED AND MUST BE HANDLED CAREFULLY. THE LAPPED FACE CAN BE IDENTIFIED BY ITS HIGHLY POLISHED SURFACE. FINGERS SHOULD NOT COME IN DIRECT CONTACT WITH THE LAPPED SURFACE. COAT THE LAPPED SURFACE OF THE SEAL SEAT WITH LUBRICANT PROVIDED IN THE SHAFT SEAL LUBE KIT #001901A.

- 4.4 Install the seal seat in the oil seal retainer (S5) with the lapped surface facing the inside of the compressor. Check to make sure that the seat is evenly seated. Do not use grease or Vaseline.

6.5 Seal Replacement - Gear Driven (continued)

- 4.5 Install the retaining ring (S17).
- 4.6 Install the O-ring (S14, S28) in the groove of the oil seal retainer (S5).

5.0 INSTALLATION OF SEAL

- 5.1 If the oil seal spacer (S1) was removed, continue with 5.1-1. If it was not removed, skip the following and proceed to 5.2.
 - 5.1-1 If a new pin (S15) is needed, install it in the oil seal spacer (S1), being careful not to allow it to stick out farther than the slot in the seal will allow.
 - 5.1-2 Slide the spacer (S1) over the shaft until the pin (S15) on the back side of the spacer lines up with the slot in the input shaft. The spacer should fit flat against the shaft shoulder.
- 5.2 Coat the shaft with lubricant provided in the Shaft Seal Lube Kit #001901A.
- 5.3 Unwrap the seal assembly.

WARNING

THE CARBON IS EASILY DAMAGED AND MUST BE HANDLED CAREFULLY. FINGERS SHOULD NOT COME IN DIRECT CONTACT WITH THE LAPPED SURFACE OF THE CARBON FACE.

Coat the lapped surface of the carbon face with lubricant provided in the Shaft Seal Lube Kit #001901A.

- 5.4a (Type 9 seal only) (NOTE: This seal (S8) is kept unloaded by three or four clips mounted on the outside of the seal. These clips must not be taken off until after the seal assembly is in place on the drive shaft.) Install the seal assembly (S8) on the shaft with the carbon surface facing out.

WARNING

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

Align the slot on the back of the seal with the pin (S15). Remove the clips. Push the seal all the way back against the spacer (S1).

- 5.4b (Type 21 seal) Install the seal assembly (S10, S12) on the shaft, with the carbon surface facing out, just far enough to assure that the tail section is past the shaft chamber.

6.5 Seal Replacement - Gear Driven (continued)

WARNING

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

- 5.5 Coat the carbon surface of the seal and the lapped surface of the seat in the oil seal retainer assembly with lubricant provided in the Shaft Seal Lube Kit #001901A.

Install the seal retainer (S5) over the shaft and line up the bolt holes. (NOTE: The bolt pattern is irregular and the retainer will only bolt on one way.) Push down squarely and slowly against the seal assembly until the seal retainer (S5) contacts the housing. The seal will then be at proper operating height. Hold the retainer assembly in position with one hand while installing any two screws (S19) opposite each other. Torque the screws to 35 ft/lbs.

WARNING

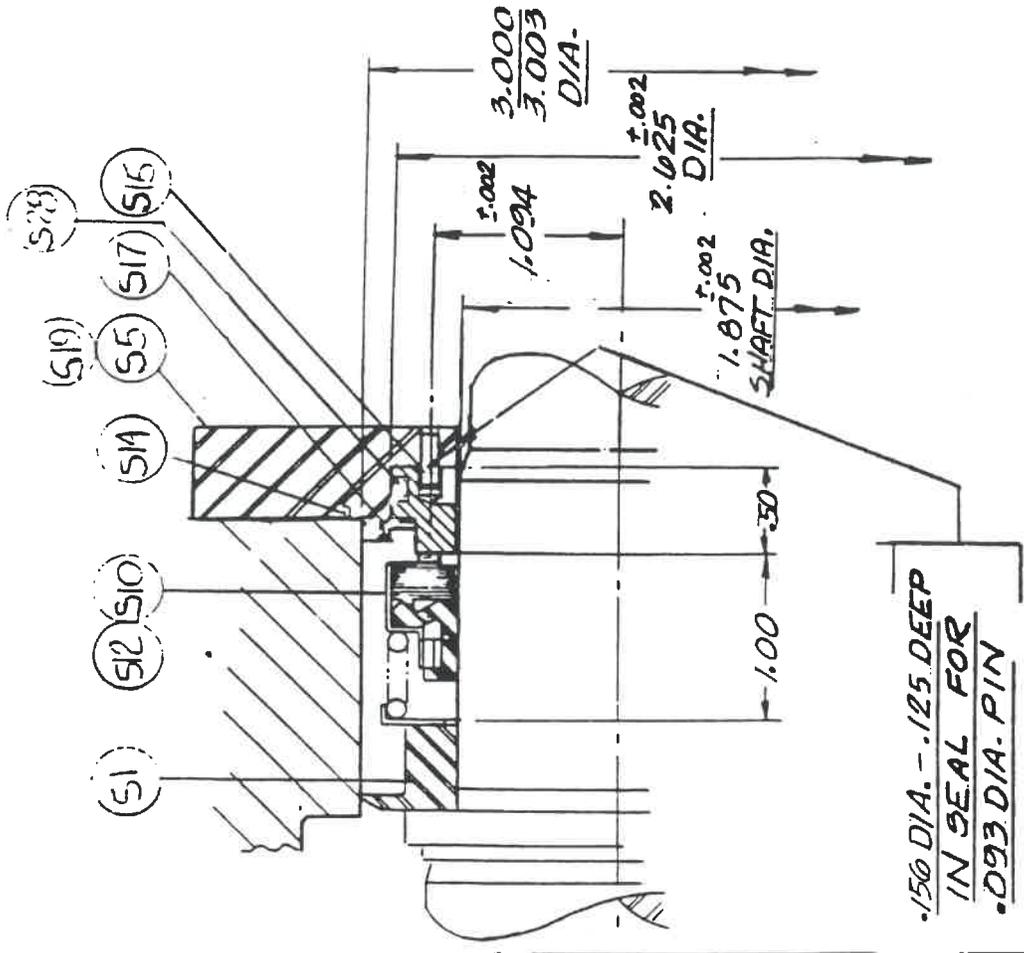
THE RETAINER ASSEMBLY MUST BE HELD IN POSITION UNTIL THE TWO SCREWS (S19) ARE INSTALLED SINCE RELEASING THE ASSEMBLY MAY NOT ALLOW THE SPRING TO EXERT THE CORRECT PRESSURE BETWEEN THE LAPPED FACES OF THE SEAT AND CARBON. THIS WILL RESULT IN SEAL FAILURE WITHIN A SHORT PERIOD OF TIME.

- 5.6 Once the two screws (S19) are in place, install the remaining four screws and torque them to 35 ft/lbs.

6.0 COUPLING INSTALLATION

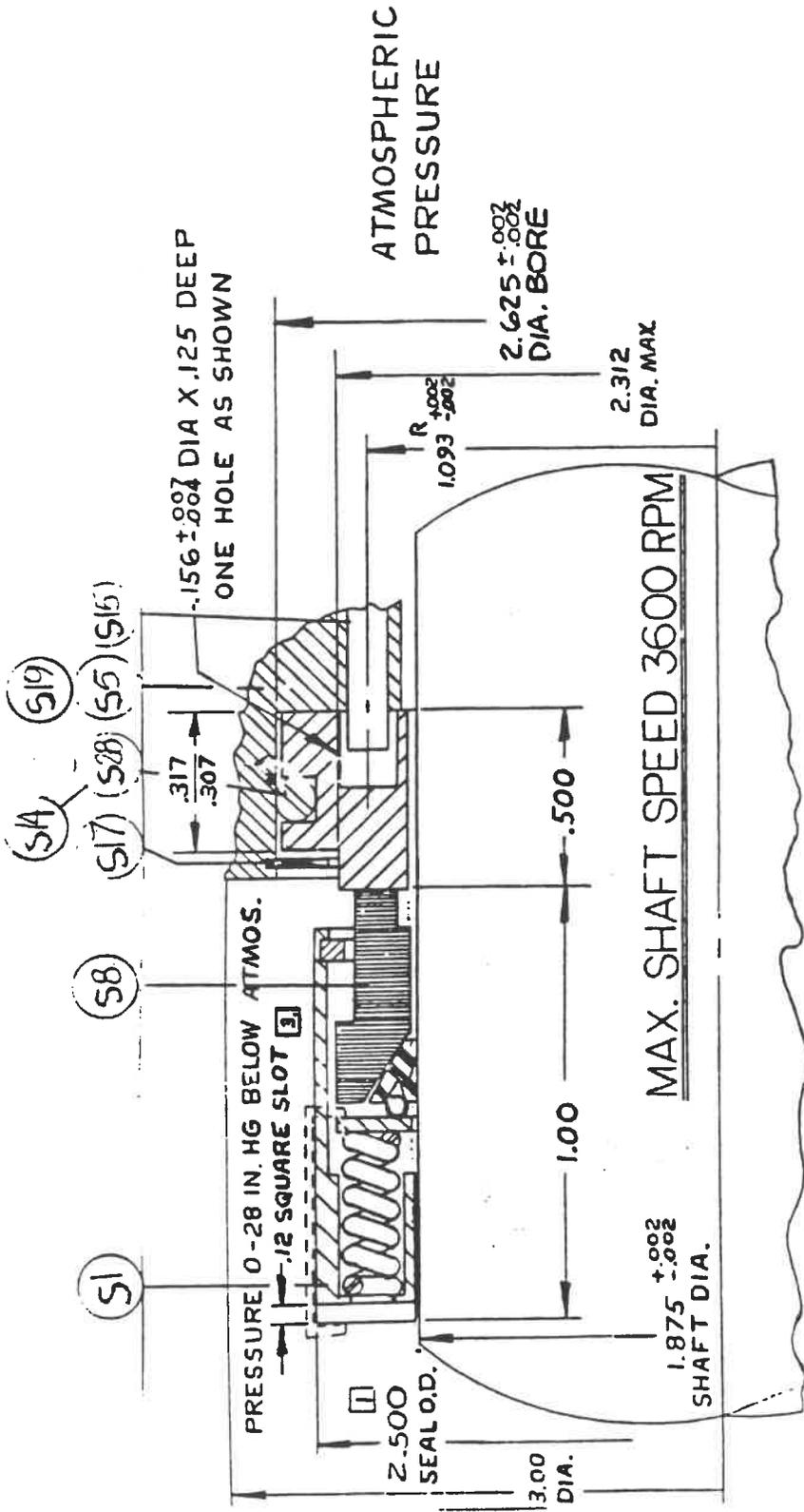
- 6.1 For instructions relative to coupling installation and alignment, refer to the Operator and Maintenance Manual.

6.5 Seal Replacement - Gear Driven (continued)



WEIGHT	SCALE	DESIGNER	CLASS	DATE
	1:1	JM	DW12	2.9.77
			PHOTO.	
			PROO.	
SEAL, SHAFT - 1 7/8 (NEOPRENE)				
SULLAIR CORPORATION MICHIGAN CITY, INDIANA				240627

6.5 Seal Replacement - Gear Driven (continued)



CF-5P-70266
 F35 CARBON RING,
 NI-RESIST SEAT,
 NEOPRENE O-RING
 CODE Q/NF 161

WEIGHT	CLASS	D12
SCALE	DESIGNER	PROO.
NONE	RJD	
DATE	3-16-78	
SULLAIR CORPORATION MICHIGAN CITY, INDIANA 81D		SEAL, SHAFT-1 7/8 (TEFLON-TYPE 9T)
		240876

6.5 Seal Replacement Instructions - Direct Drive Compressors

Compressor Units

DXH127170C10ME35CC	-----	001919A
DXH127170C10ME35GC	-----	001919B
DXH127170C10ME35NC	-----	001919C

PART NO.	DESCRIPTION	QTY		
		001919A	001919B	001919C
406616	Seal, Shaft 1.625 Type 9 Teflon	1		
406617	Seal, Shaft 1.625 Type 21 Viton		1	
001901A	Lube Kit, Shaft Seal	1	1	1
406618	Seal, Shaft 1.625 Type 21 Neoprene			1
499044-040	V-Ring	2	2	2
826202-238	O-Ring 3-1/2 x 1/8	1	1	1
827502-038	Pin, Spring-M 1/8 x 3/8	1		
004386	Instructions, Seal Replacement	1	1	1

Refer to Sullair for seal information on compressor units with part numbers not shown.

1.0 PREPARATION

- 1.1 Make sure that the starter is disconnected BEFORE any work is performed on electric driven compressors.
- 1.2 Refer to the operator and maintenance manual for instructions on coupling removal and/or any other work to be done prior to the removal of the shaft seal.

2.0 DISASSEMBLY

- 2.1 Remove the three screws (S18) which hold the v-ring cover (S9) up against the seat retainer (S8). Remove the V-ring cover (S9).
- 2.2 Remove both rubber V-rings (S13).
- 2.3 Remove the seven screws (S17) which hold the seat retainer (S8) and remove the retainer assembly (S7, S8, S16, seal seat and crush ring).
- 2.4 Disassemble the retainer assembly by removing the three screws (S16) from the seat retainer (S8).
- 2.5 Remove the seal seat and crush ring from the seal housing (S7).
- 2.6 Remove the O-ring (S14) from the seal housing (S7).

6.5 Seal Replacement - Direct Drive (continued)

- 2.7a (Type 9 seal only) The shaft seal (S1) is located on the shaft by pin (P15) located behind the shaft seal (S1). Slide the seal straight off the shaft. If the pin (S15) is sheared or bent, remove the spacer (S6) from the shaft and remove the pin (S15). If not, leave the spacer in place.

WARNING

THE SHIM SET (S10) BEHIND THE SPACER (S6) MUST NOT BE REMOVED.

- 2.7b (Type 21 seal) Remove the seal (S2, S3) from the shaft. The rubber bellows is bonded to the shaft and has 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 in any way.

WARNING

THE SEAL SPACER (S6) AND SHIM SET (S10) BEHIND THE SPACER MUST NOT BE REMOVED.

3.0 INSEPTION & PREPARATION FOR SEAL ASSEMBLY

- 3.1 Clean all parts thoroughly and scrape off any debris or material on the parts.
- 3.2 Check the bore edges of the seat retainer (S8) and seal housing (S7) for burrs and break any sharp edges. Make sure oil supply orifice in housing (S7) is open and clean.
- 3.3 Remove all burrs and break all sharp edges on the shaft.

WARNING

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

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

4.0 ASSEMBLE THE RETAINER ASSEMBLY

- 4.1 Unwrap the seat.

WARNING

THE FINISH OF THE LAPPED SURFACE IS EASILY DAMAGED AND MUST BE HANDLED CAREFULLY. THE LAPPED FACE CAN BE IDENTIFIED BY ITS HIGHLY POLISHED SURFACE. FINGERS SHOULD NOT COME IN DIRECT CONTACT WITH THE LAPPED SURFACE. COAT THE LAPPED SURFACE OF THE SEAL SEAT WITH LUBRICANT PROVIDED IN THE SHAFT SEAL LUBE KIT #001901.

6.5 Seal Replacement - Direct Drive (continued)

- 4.2 Install the crush ring and seal seat in the seal housing (S7) with lapped surface facing the inside of the compressor. Check to make sure the seat is evenly seated.
- 4.3 Attach the seat retainer (S8) to the seal housing (S7) with the three screws (S16). (NOTE: The bolt pattern is irregular and the parts will only fit together one way.) Torque the screws to 9 ft/lbs.
- 4.4 Install the O-ring (S14) in the groove of the seal housing (S7).

5.0 INSTALLATION OF SEAL

- 5.1 If the seal spacer (S6) was removed for the Type 9 seal (S1), continue with 5.1-1. If it was not removed, skip the following and proceed to 5.2.
 - 5.1-1 If a new pin is needed, install it in the spacer (S6), being careful not to allow it to stick out farther than the slot in the seal will allow.
 - 5.1-2 Align the holes in the shims (S10) with the hole in the locknut. Slide the spacer (S6) over the shaft and push it against the shims allowing the pin (S15) to slide into the mating hole of the locknut. The spacer (S6) should fit flat against the shims (S10) and locknut.
- 5.2 Coat the shaft with lubricant provided in the Shaft Seal Lube Kit #001901.
- 5.3 Unwrap the seal assembly.

WARNING

THE CARBON IS EASILY DAMAGED AND MUST BE HANDLED CAREFULLY. FINGERS SHOULD NOT COME IN DIRECT CONTACT WITH THE LAPPED SURFACE OF THE CARBON FACE.

COAT THE LAPPED SURFACE OF THE CARBON FACE WITH LUBRICANT PROVIDED IN THE SHAFT SEAL LUBE KIT #001901.

- 5.4a (Type 9 seal only) (NOTE: This seal (S1) is kept unloaded by three or four clips mounted on the outside of the seal. These clips must not be taken off until after the seal assembly is in place on the shaft.) Install the seal assembly (S1) on the shaft with the carbon surface facing out.

WARNING

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

6.5 Seal Replacement - Direct Drive (continued)

Align the slot on the back of the seal with the pin (S15). Remove the clips. Push the seal all the way back against the spacer (S6).

- 5.4b (Type 21 seal) Install the seal assembly (S2, S3) on the shaft, with the carbon surface facing out, just far enough to assure that the tail section is past the shaft chamber.

WARNING

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

- 5.5 Install the retainer assembly over the shaft and line up the bolt holes. (NOTE: The bolt pattern is irregular and the retainer will only bolt on one way.) Push down squarely and slowly against the seal assembly until the seat retainer (S8) contacts the housing. The seal will then be at proper operating height. Hold the retainer assembly in position with one hand while installing any two screws (S17) opposite each other. Torque the screws to 35 ft/lbs.

WARNING

THE RETAINER ASSEMBLY MUST BE HELD IN POSITION UNTIL THE TWO SCREWS (S17) ARE INSTALLED SINCE RELEASING THE ASSEMBLY MAY NOT ALLOW THE SPRING TO EXERT THE CORRECT PRESSURE BETWEEN THE LAPPED FACES OF THE SEAT AND CARBON. THIS WILL RESULT IN SEAL FAILURE WITHIN A SHORT PERIOD OF TIME.

- 5.6 Once the two screws (S17) are in place, install the remaining five screws and torque them to 35 ft/lbs.

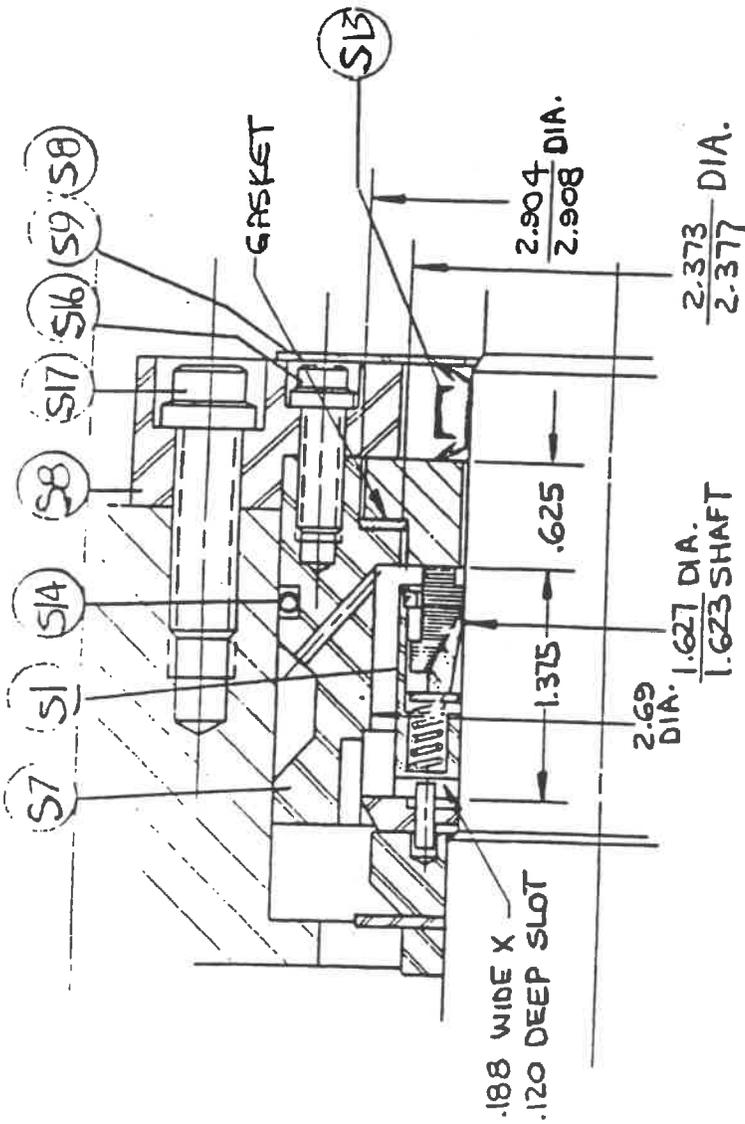
6.0 INSTALLATION OF V-RINGS

- 6.1 Coat the shaft and I.D. of V-rings (S13) with the lubricant provided in Shaft Seal Lube Kit #001901.
- 6.2 Install the V-rings (S13) on the shaft to the dimension specified with the lips facing as shown. See Fig. 1.
- 6.3 Install the V-ring cover (S9) with the three screws (S18).

7.0 COUPLING INSTALLATION

- 7.1 For instructions relative to coupling installation and alignment, refer to the Operator and Maintenance Manual.

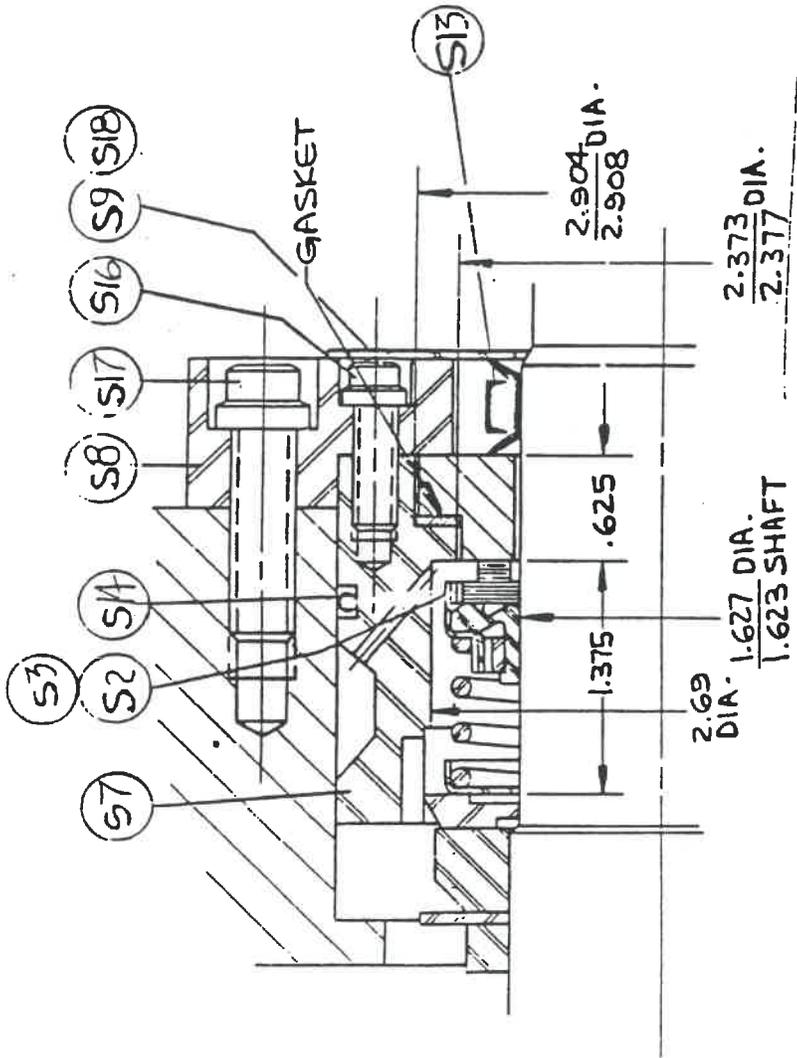
6.5 Seal Replacement Instructions - Direct Drive Compressors (Continued)



MATERIAL:
 SEAT ~ CAST IRON (NI-RESIST)
 PRIMARY RING ~ CARBON
 WEDGE ~ TEFLON
 HARDWARE ~ STAINLESS STEEL
 RETAINER ~ STAINLESS STEEL
 GASKET ~ TO BE SUPPLIED BY SULLAR,
 SEE DWG. 499099-163. M-81

WEIGHT	CLASS	DH127C	SEAL, SHAFT 1-625	REV. 1
SCALE	DESIGNER	PROT.	9	TEFLON
1:1	<i>[Signature]</i>			
DATE	11-17-80	12-15-80		
SULLAIR CORPORATION		406616		
MICHIGAN CITY, INDIANA		O1D		

6.5 Seal Replacement Instructions - Direct Drive Compressors (continued)



MATERIAL:
 SEAT ~ CAST IRON (NI-RESIST)
 PRIMARY RING ~ CARBON
 BELLOW'S ~ VITON
 HARDWARE ~ STAINLESS STEEL
 RETAINER ~ STAINLESS STEEL
 GASKET ~ TO BE SUPPLIED BY SULLAIR,

WEIGHT	CLASS	DH127C
SCALE	DESIGNER	PROD.
1:1	<i>[Signature]</i>	
DATE	11-17-80	12-15-80
SULLAIR CORPORATION		406617
MICHIGAN CITY, INDIANA		OID
SEAL, SHAFT 1.625		REV. 1
21 VITON		

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. 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.
7. Replace the drain plugs, close the lube separator drain valve and charge the system with new lubricant.
8. Follow the pre-start check list, Section 4.2.
9. Follow the initial start-up procedure, section 4.3.
10. Follow the initial maintenance procedures as for a new machine, Section 5.3.

6.7 Capacity Control Servicing (A & B Models Only)

Should it be necessary to replace the seals on the capacity control shaft, refer to Figure 6-5 for component identification.

DISASSEMBLY

1. Carry out the shutdown procedure in Section 6.2.
2. Disconnect the actuator by removing the four screws with a 12 point socket.
3. Loosen the four mounting bolts from the mounting adaptor and remove the complete valve assembly. A 12 point socket set is necessary to fit the mounting bolts.
4. Remove retaining ring and pull the valve assembly from the adaptor.
5. Press oil seals from their mount.

REASSEMBLY

1. Deburr the capacity control valve shaft and adaptor.
2. Press seals into housing with a light coating of sealant around the outside diameter of the seal to ease installation.
3. Carefully insert control valve and mount the seal ring and snap ring.
4. Reinsert valve assembly into adaptor, using care to properly align the assembly to prevent binding the valve as it is rotated. Fasten in four mounting bolts through mounting adaptor.
5. Close the blowdown valve.
6. Open the suction stop valve and discharge stop valve.
7. Start the compressor.

6.8 Capacity Control Actuator Servicing

Refer to Figure 6-6

DISASSEMBLY

1. Carry out the shutdown procedure in Section 6.2.
2. Disconnect fluid lines and drain the oil.
3. Remove the actuator as in Section 6.7.
4. Remove all burrs from shaft assembly extension.
5. Remove screws and indicator screw and remove indicator.
6. Strike end of shaft opposite loosened head with plastic mallet to free it from dowels.
7. Remove head, shaft assembly and shoe from body.
8. Remove all seals (and dowels if necessary for repair).

INSPECTION AND REPAIR

1. Inspect inside of actuator. Presence of foreign material may indicate the need to clean and filter the driving system.
2. Inspect all internal surfaces for excessive scoring or galling which can cause seal damage or internal leakage.
3. Minor score marks can be polished out with fine emery cloth or equivalent. Score marks in any part in excess of .005 in (0.12mm) require replacement of that part.
4. Check dowel holes in head and body for elongation. Excessive elongation requires replacement of that part.
5. Place short end of shaft through bearing area in body, shake to determine the condition of the shaft bearing area. Repeat procedure using long end of shaft through head. If excessively worn, replacement of the head and/or body is necessary.

REASSEMBLY

1. Thoroughly wash all parts to remove any foreign material that might cause damage and remove any burrs. DO NOT break the corners of the body bore or the corners of the large diameter of the shaft.
2. Lubricate all seals and internal parts with grease compatible with the system fluid used.
3. Replace and install shaft seal in its groove in the head and body.

6.8 Capacity Control Actuator Servicing (continued)

4. Replace and install shoulder seal cushion in its groove and in the head and body.
5. Replace and install shoulder seal cap with radiused corners toward cushion.

NOTE

CORNER RADII ARE VERY SMALL. A MAGNIFYING GLASS MAY BE NECESSARY TO DETERMINE PROPER SEAL ORIENTATION.

6. Replace and install head seal in its groove in the head.
7. Replace and install shoe seal in groove around shoe.

NOTE

REPLACEMENT SHOE MUST BE ALUMINUM OR STEEL. NO PLASTIC ACCEPTABLE.

8. Place vane seal in its groove around vane.
9. Insert dowel pins into body.
10. Install shoe into body. Leave approximately 1/8 inch (3mm) between end of shoe and body.
11. To assemble shaft, tuck in corners of seal. DO NOT TWIST. Push straight in until shaft is seated against end of body.
12. Complete shoe installation by seating shoe against end of body.
13. Press corners of shoe and vane seals below end surface of body.
14. Install head on body, pull down evenly and secure with screws and torque to 35 in. lb. (4N.m).

ADJUSTMENT

1. With actuator in the position shown in right end view of sketch, rotate shaft counterclockwise until physical stop in actuator is reached.
2. Position indicator handle as shown in line with port.
3. Using pilot hole in indicator handle drill a 1/8" diameter hole in shaft approximately 5/16" deep. (This is not required on factory adjusted units.)
4. Insert spring pin in hole flush with indicator handle. Secure handle with bolt.
5. Install complete actuator in unit.
6. Reverse the shutdown procedure in Section 6.2.

Section 6
SERVICING

Figure 6-5A Capacity Control System - Typical

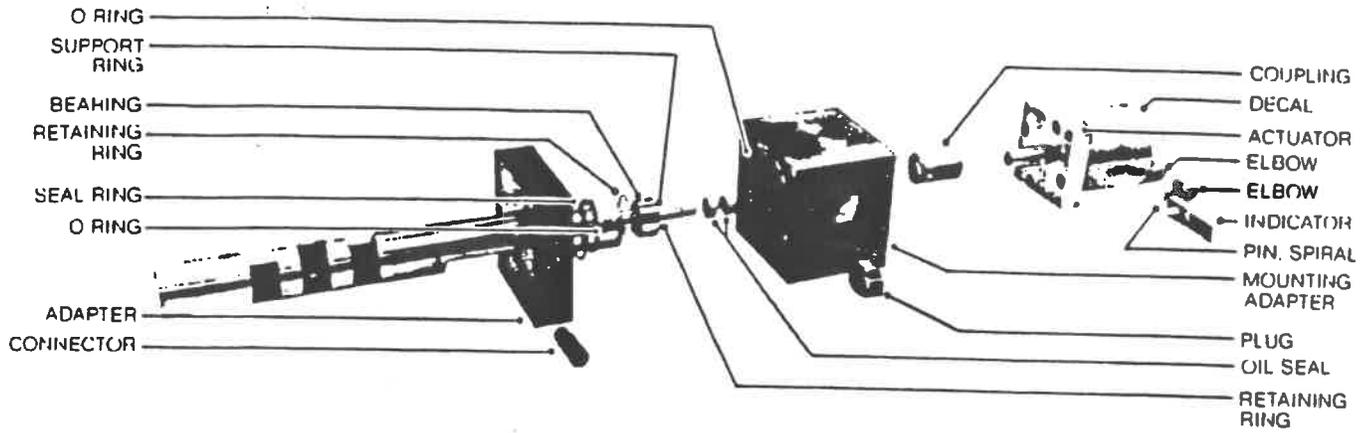
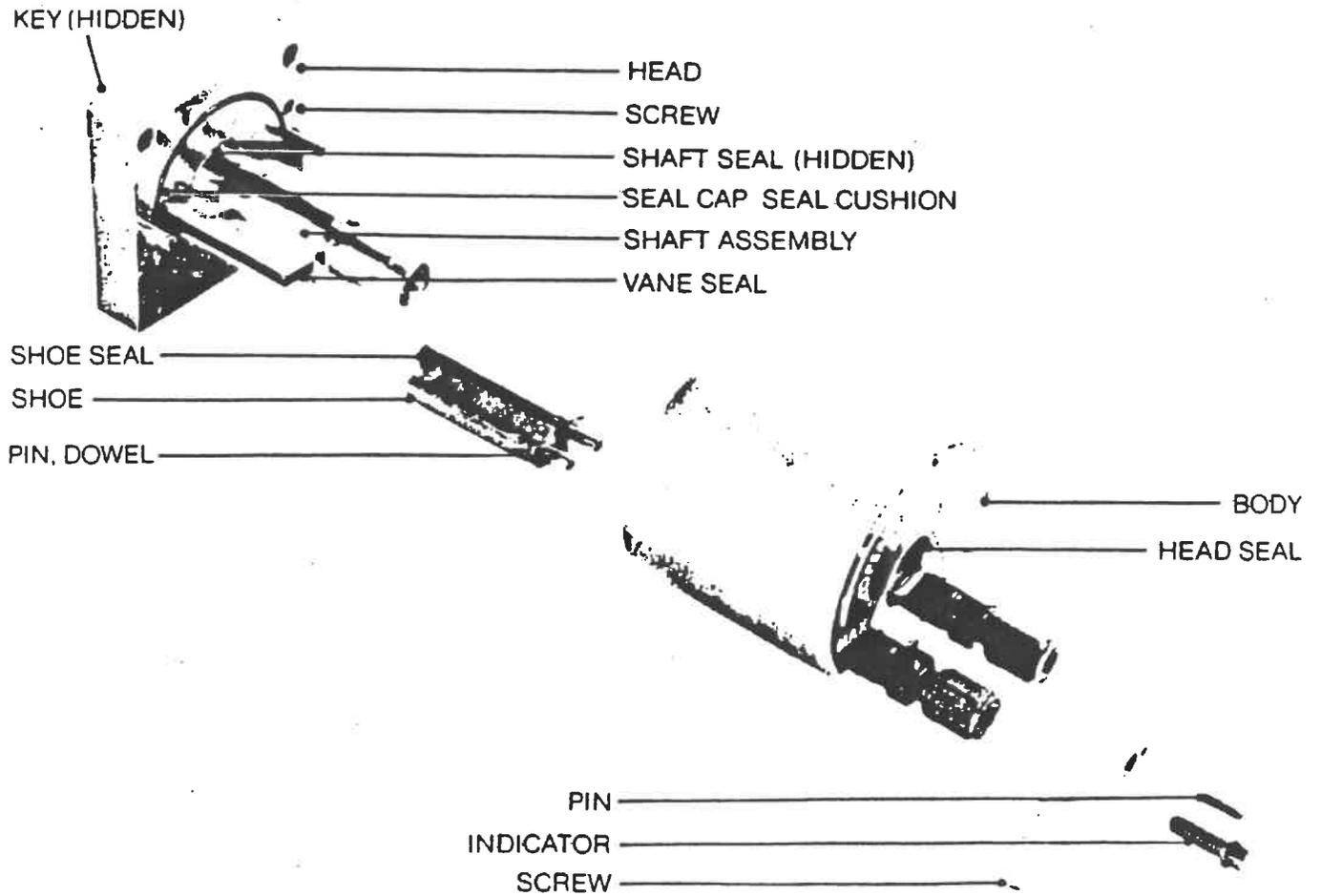


Figure 6-5B Valve Actuator - Typical



SECTION 7

RECOMMENDED SPARE PARTS LIST, VENDOR DATA AND CATALOGS

7.1 Recommended Spare Parts List

Procedure for Ordering Parts

Parts should be ordered from the nearest Sullair Distributor or the Distributor from whom the machine was purchased. If, for any reason, parts cannot be obtained in this manner, contact the factory directly at the address below.

When ordering parts, always indicate the Serial Number of the machine. This can be obtained from the Bill of Lading for the machine or from the Serial Number Plate located on the side of the instrument panel.

Standard fasteners (bolts, nuts, washers, etc.) tubing and hose fittings plus other standard hardware have not been included in the Parts List. These are items which can be obtained quicker and more economically from local sources. Consult Sullair for proper fastener grades.

Process and Gas Compressor Division
Engineered Equipment / Sullair Corporation
3700 East Michigan Boulevard
Michigan City, Indiana 46360

Telephone: (219) 874-1500

Telex: 703395

RECOMMENDED SPARE PARTS LIST

DESCRIPTION	PART NO.	QTY.
Kit, Repair - Valve Actuator	C	1
Kit, Repair - Shaft Seal	C	1
Installation, DH127C = Gear	C	1
Lubricant	C	As Needed

NOTE: C - Refer to Sullair

NOTE: SERVICE KITS DO NOT CONTAIN TOOLS, WRENCHES, SCREWDRIVERS, ETC., WHICH ARE REQUIRED TO DISASSEMBLE THE COMPRESSOR.



WORLDWIDE SALES AND SERVICE



SULLAIR ASIA, LTD.
ROOM 2304A
Shartex Plaza Ctr.
No. 88 Zun Yi Nan Rd.
Shanghai, P.R.C.
Telephone: 21-2192066
FAX: 21-2196568

SULLAIR EUROPE, S.A.
Chemin de Genas BP 639
69800 Saint Priest, France
Telephone: 33-72232425
FAX: 33-78907168

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

Part Number



02250051-521

Printed in U.S.A.

Specifications Subject To
Change Without Prior Notice



Operation and Maintenance Manual

G3304 and G3306 Engines

H4D1-Up (Engine)
H6D1-Up (Engine)
N4F1-Up (Engine)
G6X1-Up (Engine)
07Y1-Up (Engine)
37Y1-Up (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Table of Contents

Foreword	4
----------------	---

Safety Section

Safety Messages	6
General Hazard Information	9
Burn Prevention	11
Fire Prevention and Explosion Prevention	11
Crushing Prevention and Cutting Prevention	13
Mounting and Dismounting	13
Ignition Systems	13
Before Starting Engine	14
Engine Starting	14
Engine Stopping	14
Electrical System	15

Product Information Section

Model Views and Specifications	16
Product Identification Information	20

Operation Section

Lifting and Storage	22
Gauges and Indicators	24
Features and Controls	27
Engine Starting	32
Engine Operation	38
Engine Stopping	39

Maintenance Section

Refill Capacities	41
Maintenance Interval Schedule ((Standby Generator Set Engines))	44
Maintenance Interval Schedule ((Naturally Aspirated Engines))	45

Maintenance Interval Schedule ((Turbocharged Engines))	47
--	----

Reference Information Section

Customer Service	93
Reference Materials	94

Index Section

Index	100
-------------	-----

Foreword

Literature Information

This manual contains safety, operation instructions, lubrication and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study and keep it with the literature and engine information.

English is the primary language for all Caterpillar publications. The English used facilitates translation and consistency in electronic media delivery.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Caterpillar dealer for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance and repair on this product.

Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use service hours to determine intervals. Calendar intervals shown (daily, annually, etc) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should always be performed at the service hour interval. The actual operating environment of the engine also governs the maintenance schedule. Therefore, under extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the maintenance schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, "Maintenance Records" for information regarding documents that are generally accepted as proof of maintenance or repair. Your authorized Caterpillar dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

California Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Caterpillar dealer. Your Caterpillar dealer offers a variety of options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Caterpillar dealer. Consult with your dealer for information regarding these options.

Safety Section

i02034913

Safety Messages

SMCS Code: 1000; 7405

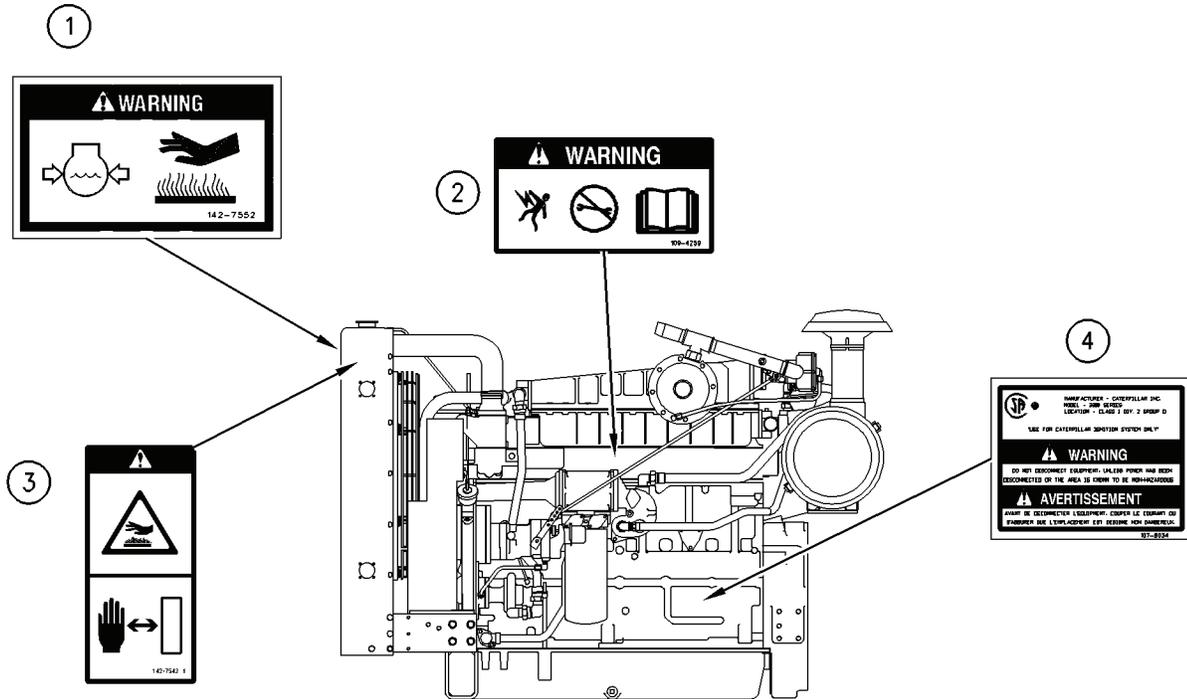


Illustration 1
G3306 engine

g00904648

There may be several specific safety messages on an engine. The exact location of the safety messages and the description of the safety messages are reviewed in this section. Please become familiar with all safety messages.

Ensure that all of the safety messages are legible. Clean the safety messages or replace the safety messages if the words cannot be read or if the illustrations are not visible. When the safety messages are cleaned, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the safety signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety messages. The safety messages that are loosened could drop off of the engine.

Replace any safety messages that are damaged or missing. If a safety message is attached to a part of the engine that is replaced, install a new safety message on the replacement part. Any Caterpillar dealer can provide new safety messages.

⚠ WARNING

Do not operate or work on this engine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.

(1) Coolant Under Pressure / Hot Surface

The warning label for the coolant under pressure and the hot surface is located near the top of the radiator on the front.



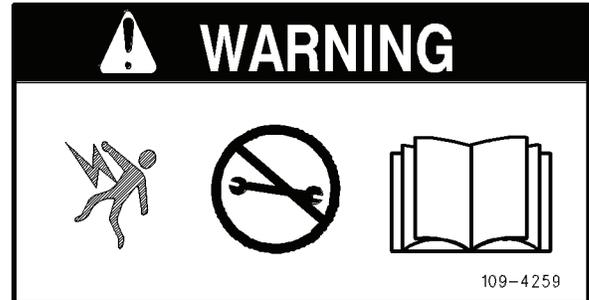
g00107971

WARNING

The coolant is hot and the coolant is under pressure. Do not touch the hot surfaces. Refer to the Operation and Maintenance Manual for the procedure to follow when you check the radiator.

(2) Electrical Shock

The warning labels for electrical shock are located on the valve covers on each side of the engine near the center.



g00305892

WARNING

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring.

Do not attempt to remove the valve covers when the engine is operating. The transformers are grounded to the valve covers. Personal injury or death may result and the ignition system will be damaged if the valve covers are removed during engine operation. The engine will not operate without the valve covers.

(3) Hot Surface / Do Not Touch!

The warning label for hot surface / do not touch is located on both sides of the radiator.



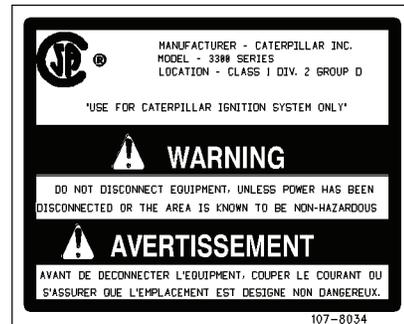
g00905976



Hot surface! Do not touch!

(4) CSA Hazardous Atmosphere

The warning label for the Canadian Standards Association (CSA) hazardous atmosphere is located on the left side of the G3306 engine on a flat surface.



g00524055



Do not disconnect equipment unless power has been disconnected or the area is known to be non-hazardous

Approval by the CSA is a requirement for engines that operate in hazardous locations. Volatile flammable gases are present in these locations. The gases are normally confined within closed systems. The gases can only escape if the system accidentally breaks down. The CSA warning is intended to prevent a hazardous atmosphere from igniting.

Volatile flammable gas that is contacted by a spark will cause an explosion. This could result in personal injury or death. Also, property could be damaged.

Do not disconnect electrical equipment unless the power has been disconnected. Otherwise, ensure that the atmosphere is not hazardous.

i02602865

General Hazard Information

SMCS Code: 1000; 4450; 7405

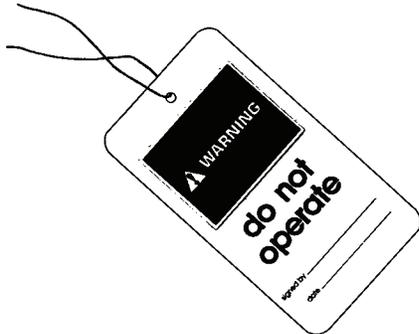


Illustration 2

g00104545

Attach a “Do Not Operate” warning tag or a similar warning tag to the start switch or to the controls before the engine is serviced or before the engine is repaired. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer. Attach the warning tags to the engine and to each operator control station. When it is appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

Engine exhaust contains products of combustion which may be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- Grease fittings
- Pressure taps
- Breathers
- Drain plugs

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure or other pressure.

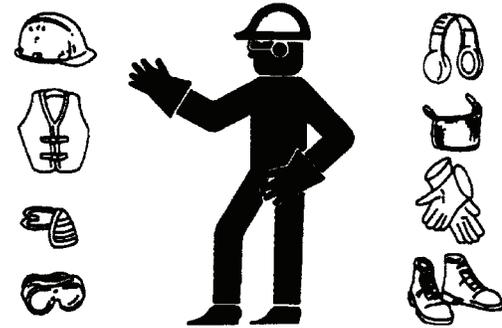


Illustration 3

g00702020

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears in order to help prevent damage to hearing.
- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.
- Use all cleaning solutions with care.
- Report all necessary repairs.

Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine is stopped. Ensure that the engine cannot be started.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

California Proposition 65 Warning

Some engine exhaust constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi) when the air nozzle is deadheaded. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Fluid Penetration

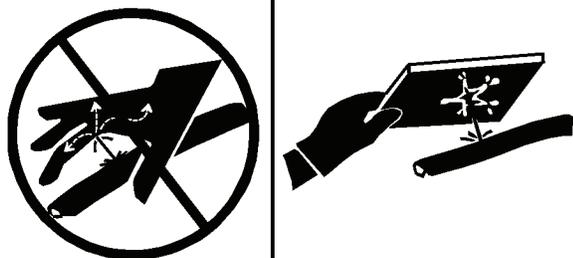


Illustration 4

g00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the engine. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component that contains fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tools Catalog" for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

Asbestos Information

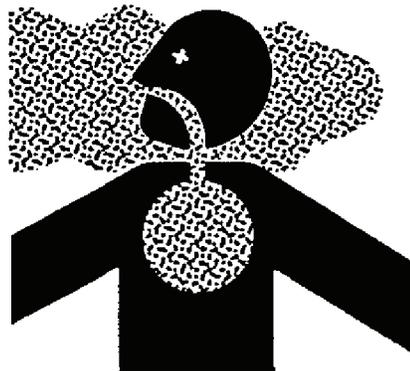


Illustration 5

g00702022

Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.

- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in “29 CFR 1910.1001”.
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

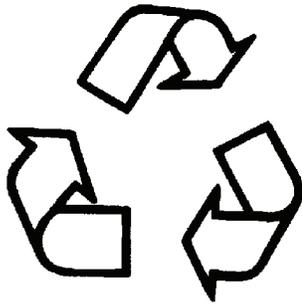


Illustration 6

g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

i01480768

Burn Prevention

SMCS Code: 1000; 4450; 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

i01372262

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 4450; 7405



Illustration 7

g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within fifteen minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Caterpillar dealer for additional information about suitable protection devices.

Remove all flammable materials such as fuel, oil, and debris from the engine. Do not allow any flammable materials to accumulate on the engine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a hose, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines that contain flammable fluid. Clean any such lines thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. All electrical wires must be properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be properly installed. The filter housings must be tightened to the proper torque.



Illustration 8

g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Lines, Tubes and Hoses

Do not bend high pressure lines. Do not strike high pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Caterpillar dealer for repair or for replacement parts.

Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During engine operation, this will help to prevent vibration, rubbing against other parts, and excessive heat.

i01359666

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 4450; 7405

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

i01372247

Mounting and Dismounting

SMCS Code: 1000; 4450; 7405

Inspect the steps, the handholds, and the work area before mounting the engine. Keep these items clean and keep these items in good repair.

Mount the engine and dismount the engine only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the engine in order to mount the engine or dismount the engine. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the engine or when you dismount the engine. Use a hand line to raise and lower tools or supplies.

i00998909

Ignition Systems

SMCS Code: 1550

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring.

Magneto

The storage capacitor in a breakerless magneto can be charged by turning the magneto by hand. The storage capacitor can be charged even when the wiring harness is disconnected from the magneto.

If the ignition switch is in the ON position and the wiring harness is being connected, the storage capacitor may discharge and a spark plug will ignite. The spark plug will ignite any gas that has accumulated in that cylinder. The crankshaft and the driven equipment can move. Personal injury may result. The driven equipment could be damaged. Gas that has accumulated in the exhaust system can also be ignited.

Before connecting the wiring harness to a breakerless magneto, discharge the storage capacitor to the ground. Use the following procedure to discharge the storage capacitor:

i02136012

1. Attach one end of a wire to the magneto housing.
2. Contact the other end of the wire to the connector pins for the wiring harness that is on the magneto.

You will hear a “snap” when the storage capacitor discharges.

3. Ground all of the connector pins.

This will ensure that no charge is in the magneto. Some breakerless magnetos have more than one storage capacitor.

Turn the ignition switch to the OFF position before connecting the wiring harness. If the ignition switch is in the OFF position, the storage capacitor is immediately discharged to the ground when the wiring harness is connected to the magneto.

i00659904

Before Starting Engine

SMCS Code: 1000

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

Ensure that the engine is equipped with a lighting system that is suitable for the conditions. Ensure that all lights work properly.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

On the initial start-up of a new engine or an engine that has been serviced, be prepared to stop the engine if an overspeed condition occurs. This may be accomplished by shutting off the fuel supply to the engine, or shutting off the ignition system.

See the Service Manual for repairs and for adjustments.

Engine Starting

SMCS Code: 1000

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

If there is a possibility that unburned gas remains in the exhaust system, refer to the purge procedure in this Operation and Maintenance Manual, “Engine Starting” topic in the Operation Section.

Start the engine from the operator’s compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, “Engine Starting” topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working properly, check the water temperature and the oil temperature during heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

i00659907

Engine Stopping

SMCS Code: 1000

To avoid overheating of the engine and accelerated wear of the engine components, stop the engine according to the instructions in this Operation and Maintenance Manual, “Engine Stopping” topic (Operation Section).

Use the Emergency Stop Button (if equipped) **ONLY** in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, **DO NOT** start the engine until the problem that caused the emergency stop has been corrected.

On the initial start-up of a new engine or an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel supply to the engine, or shutting off the ignition system.

Rubber couplings may connect the steel piping of the cooling system and the radiator. This causes the piping and the radiator to be electrically isolated. Ensure that the piping and the radiator is continuously grounded to the engine. Use ground straps that bypass the rubber couplings.

Ensure that all grounds are secure and free of corrosion.

i00887114

Electrical System

SMCS Code: 1000; 1400

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is operated. Repair all frayed electrical wires before the engine is started.

Grounding Practices

Proper grounding is necessary for optimum engine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft journal surfaces, and to aluminum components. Uncontrolled electrical circuit paths can also cause electrical activity that may degrade the engine electronics and communications.

For the starting motor, do not attach the battery negative terminal to the engine block.

Use a ground strap to ground the case of all control panels to the engine block.

Ground the engine block with a ground strap that is furnished by the customer. Connect this ground strap to the ground plane.

Use a separate ground strap to ground the battery negative terminal for the control system to the ground plane.

Product Information Section

Model Views and Specifications

i02060975

Model View Illustrations

SMCS Code: 1000; 4450

The illustrations show various typical features of G3300 Engines. The illustrations do not show all of the options that are available.

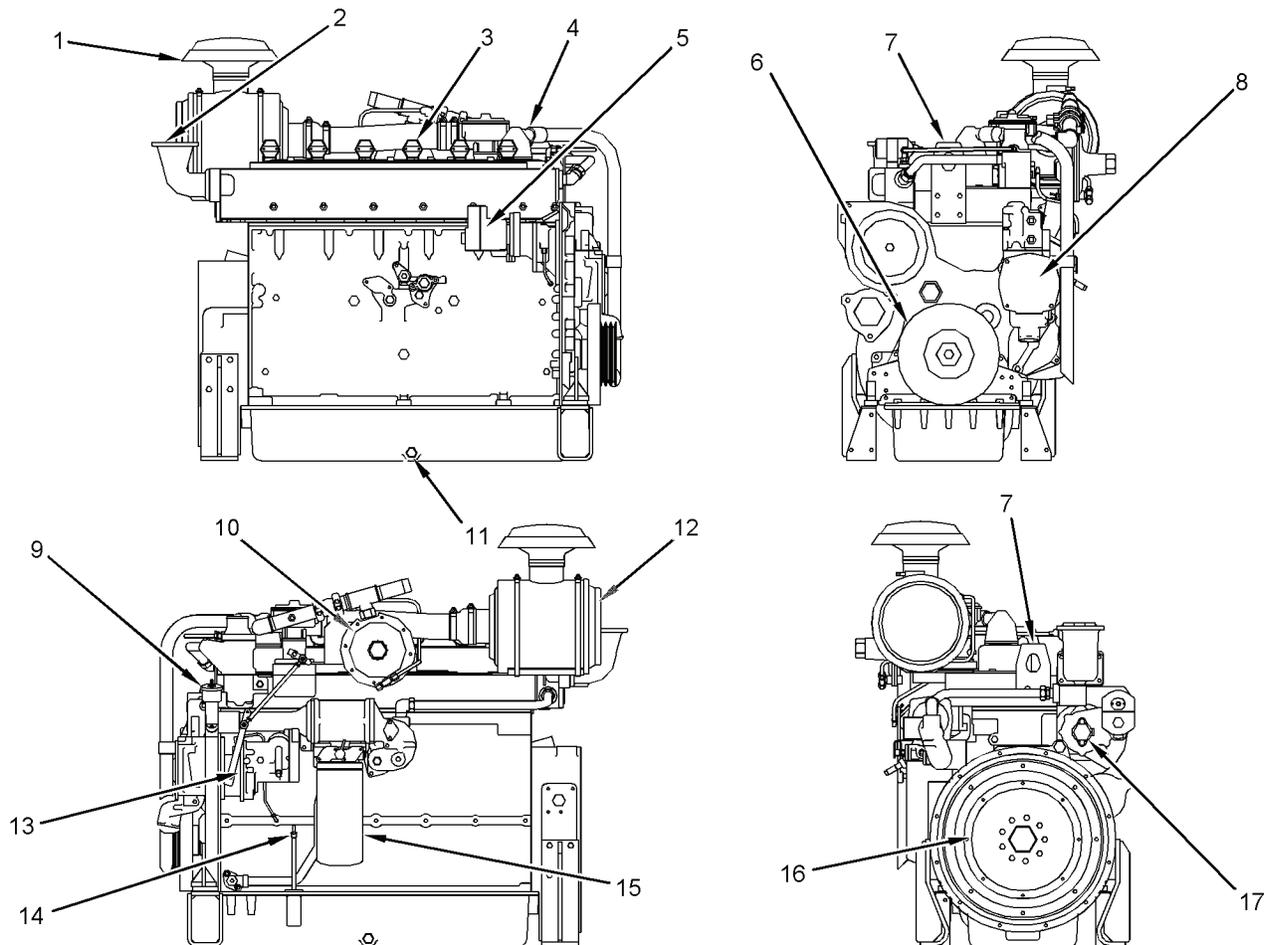


Illustration 9

g01056105

Naturally aspirated engine

- (1) Air inlet
- (2) Exhaust
- (3) Ignition transformer
- (4) Crankcase breather
- (5) Magneto
- (6) Crankshaft vibration damper

- (7) Lifting eye
- (8) Water pump
- (9) Oil filler
- (10) Gas pressure regulator
- (11) Oil drain
- (12) Air cleaner

- (13) Governor
- (14) Oil level gauge (dipstick)
- (15) Oil filter
- (16) Flywheel
- (17) Service hour meter

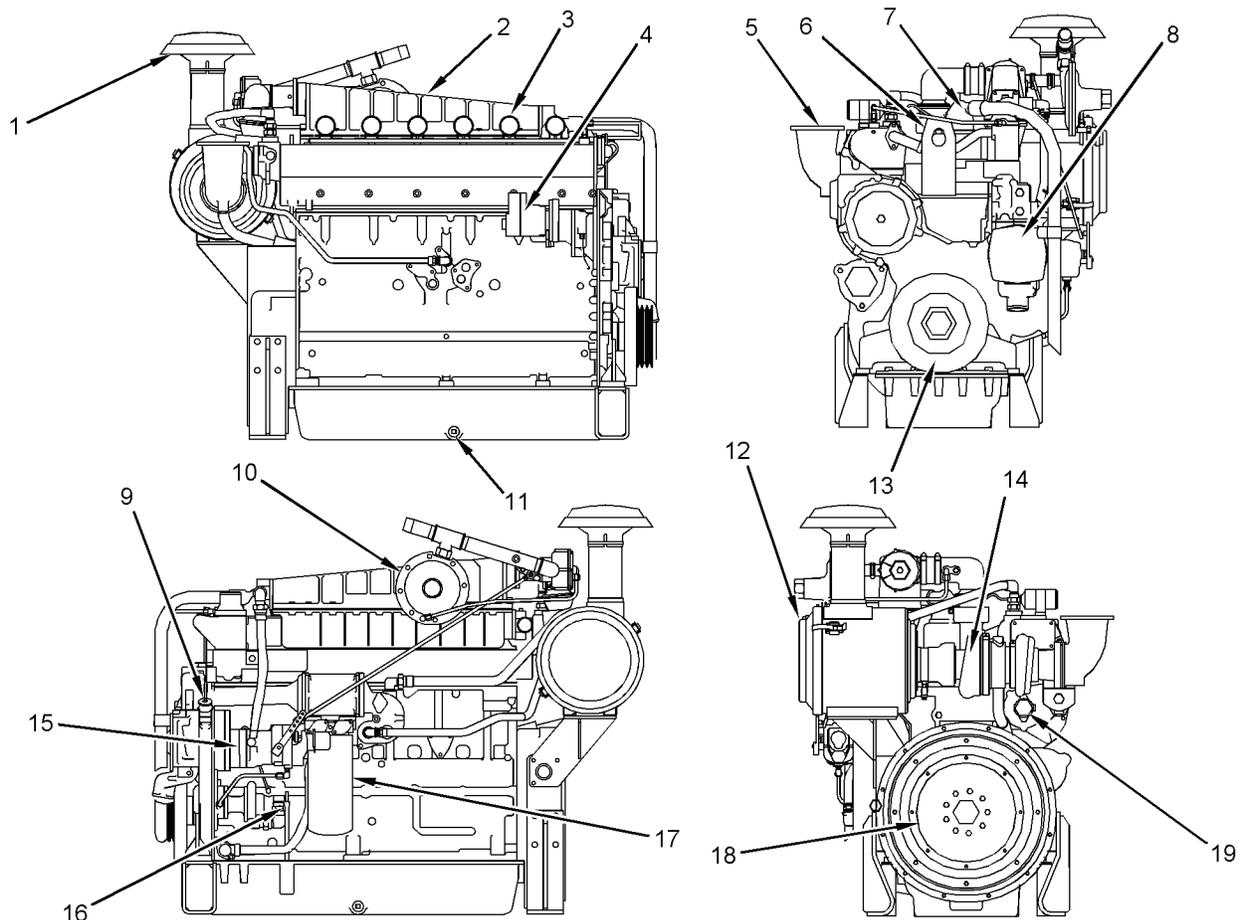


Illustration 10

g01056116

Turbocharged engine with a separate circuit aftercooler

- | | | |
|--------------------------|----------------------------------|---------------------------------|
| (1) Air inlet | (8) Water pump | (15) Governor |
| (2) Aftercooler | (9) Oil filler | (16) Oil level gauge (dipstick) |
| (3) Ignition transformer | (10) Gas pressure regulator | (17) Oil filter |
| (4) Magneto | (11) Oil drain | (18) Flywheel |
| (5) Exhaust | (12) Air cleaner | (19) Service hour meter |
| (6) Lifting eye | (13) Crankshaft vibration damper | |
| (7) Crankcase breather | (14) Turbocharger | |

i02061007

Product Description

SMCS Code: 1000; 4450

Caterpillar G3304 and G3306 Engines were developed in order to provide gas engines for industrial applications and for generator set applications. The engines have the ability to burn a wide variety of gaseous fuels.

Ignition System

The ignition system has five basic components: magneto, an ignition transformer for each cylinder, wiring harness, spark plugs, and control panel.

The magneto generates the electric current that is necessary for spark ignition. The current from the magneto travels through the wiring harness to the ignition transformer. The transformer increases the voltage. The transformer creates an electrical impulse that arcs across the electrodes of the spark plug. Engine operation is monitored by the control panel.

Inlet Air and Fuel System

Inlet air is filtered by an air cleaner. The G3304 Engine is naturally aspirated. Naturally aspirated G3306 Engines are also available.

G3306 Engines are also available with these types of aspiration: turbocharged, turbocharged with separate circuit aftercooling, and turbocharged with air-to-air aftercooling.

For turbocharged engines, the inlet air is compressed by the turbocharger. The turbocharger is driven by the engine exhaust. The air is cooled in an aftercooler (if equipped) after the air enters the carburetor. The compressed air becomes more dense from being cooled. This provides more oxygen for combustion.

Air is mixed with fuel in the carburetor before combustion. The carburetor is controlled by a governor. The governor efficiently maintains the engine rpm that is selected by the operator.

The valves and the valve mechanism control the flow of air and exhaust gases in the cylinder during engine operation. Each cylinder has one inlet valve and one exhaust valve. The camshaft actuates the rocker arms and valves through mechanical lifters and pushrods.

Lubrication System

The engine lubrication oil is circulated by a gear-driven pump. The oil is cooled and the oil is filtered. However, bypass valves provide an unrestricted flow of lubrication oil to the engine if the following conditions occur:

- The viscosity of the oil is high because the oil is cold.
- The oil cooler becomes plugged.
- The oil filter becomes plugged.

Cooling System

The jacket water coolant is circulated by a gear-driven centrifugal pump. A 90 °C (194 °F) temperature regulator regulates the temperature of the coolant. Heat can be removed from the coolant by a radiator or a heat exchanger.

For engines with a Separate Circuit Aftercooler (SCAC), the air is cooled by a heat exchanger. The water that cools the air in the heat exchanger is in a circuit that is separate from the jacket water. The aftercooler coolant is pumped by an auxiliary water pump. The SCAC is required to operate at one of the following temperatures. The engine rating depends on the temperature and the application.

- 32 °C (90 °F)
- 54 °C (129 °F)

For engines with air-to-air aftercooling, the aftercooler is supplied by the customer. This aftercooler is similar to a radiator. The inlet air is cooled by a fan that moves the ambient air through the radiator.

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on adherence to proper operation and maintenance recommendations. This includes the use of recommended lubricants, fuels, and coolants.

For the engine maintenance that is required, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

101625818

Specifications

SMCS Code: 1000

Table 1

G3304 Engine Specifications	
Cylinders and arrangement	4 in-line
Aspiration	Naturally Aspirated
Bore	121 mm (4.75 inch)
Stroke	152 mm (6 inch)
Total displacement	7 L (425 cubic inch)
Firing order	1-3-4-2
Rotation (flywheel end)	Counterclockwise
Inlet valve lash	.38 mm (.015 inch)
Exhaust valve lash	.76 mm (.030 inch)

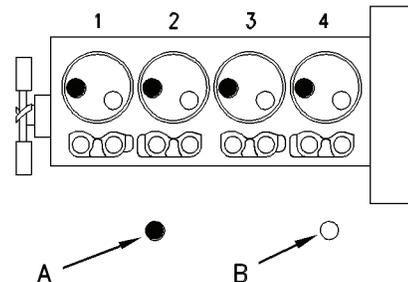


Illustration 11

g00511194

G3304 Engine design
 (A) Exhaust valves
 (B) Inlet valves

Table 2

G3306 Engine Specifications	
Cylinders and Arrangement	6 in-line
Aspiration	Naturally Aspirated
	Turbocharged
	Turbocharged with Jacket Water Aftercooling
	Turbocharged with Separate Circuit Aftercooling
Bore	121 mm (4.75 inch)
Stroke	152 mm (6 inch)
Total displacement	10.5 L (638 cubic inch)
Firing order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise
Inlet valve lash	.38 mm (.015 inch)
Exhaust valve lash	.76 mm (.030 inch)

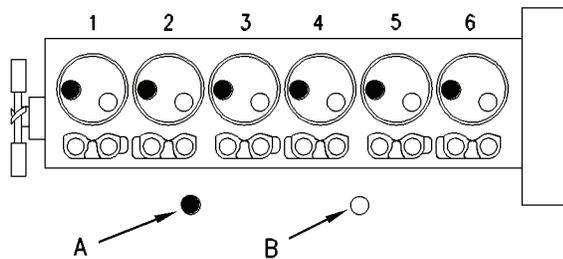


Illustration 12

g00316303

G3306 Engine design

- (A) Exhaust valves
- (B) Inlet valves

Product Identification Information

i01625991

Plate Locations and Film Locations

SMCS Code: 1000; 4450

Engine Identification

Caterpillar engines are identified with serial numbers, with performance specification numbers, and with arrangement numbers. In some of the cases, modification numbers are used. These numbers are shown on the Serial Number Plate and the Information Plate that are mounted on the engine.

Caterpillar dealers need these numbers in order to determine the components that were included with the engine. This permits accurate identification of replacement part numbers.

Serial Number Plate

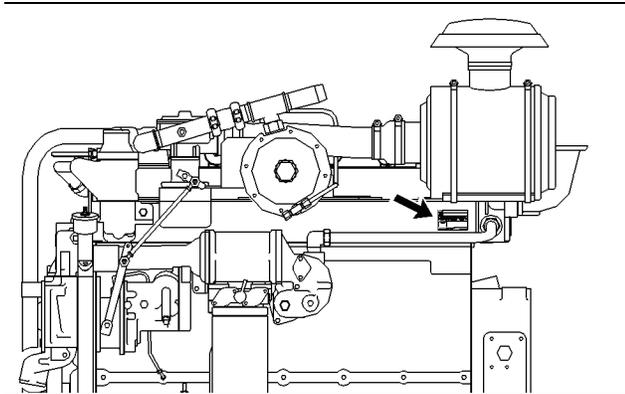


Illustration 13

g00512029

Location of the Serial Number Plate

The Serial Number Plate is on the left side of the cylinder block near the rear of the engine.

ENGINE MODEL	
SERIAL NUMBER	
CATERPILLAR® CAT®	
ARRANGEMENT NUMBER	
(ALWAYS GIVE ALL NUMBERS) MADE IN U.S.A.	
3N-3790 12	

Illustration 14

g00123229

The following information is stamped on the Serial Number Plate: engine serial number, model, and arrangement number.

Information Plate

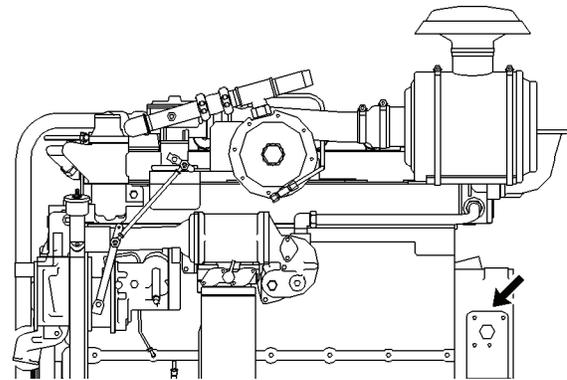


Illustration 15

g00513136

Location of the Information Plate

The Information Plate is on the top surface of the flywheel housing above the timing window.

CAT®		
SER. NO.		
AR NO.	COMP. RATIO	TO 1
AFTERCOOLER DEG.C	TEMPERATURE DEG.F	IGNITION TIMING BTDC CONSULT FUEL USAGE GUIDE
POWER	kw	
FULL LOAD RPM		
159-8314		

Illustration 16

g00361974

Typical Information Plate

The following information is stamped on the Information Plate: compression ratio, aftercooler temperature, power (kilowatts and horsepower), full load rpm, and other information.

i02135788

Reference Information

SMCS Code: 1000; 4450

Identification of the items in Table 3 may be needed in order to obtain parts and service. Some of the numbers are on the engine Serial Number Plate and/or Information Plate. Locate the information for your engine. Record the information on the appropriate space in Table 3. Make a copy of this list for a record. Retain the information for future reference.

The top level part numbers in the Parts Manual for the engine are listed with the engine arrangement number.

The packaging arrangement may also be called a pricing arrangement or a customer arrangement. This is the total package with attachments and options that are not included in the engine arrangement.

The performance specification can be used by your Caterpillar dealer with the Technical Marketing Information system. Before the engine leaves the factory, the engine performance is tested. Detailed performance data is recorded. The performance specification number can be used for obtaining the data.

Table 3

Reference Numbers	
Engine Model	
Serial Number	
Arrangement Number	
Packaging Arrangement	
Turbocharger	
Fuel Filter Element	
Lubrication Oil Filter Element	
Auxiliary Oil Filter Element	
Air Cleaner Element	
Fan Drive Belt	
Alternator Belt	
Capacity of the Lubrication System	
Oil type	
Capacity of the Cooling System	
Performance Specification Number	
Low Idle rpm	
High Idle rpm	
Full Load rpm	
Power Rating	

Operation Section

Lifting and Storage

Product Lifting

i01536259

SMCS Code: 7000; 7002

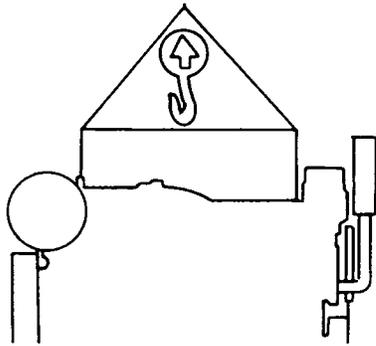


Illustration 17

g00103219

NOTICE

Never bend the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting fixtures in order to obtain proper balance and safety.

To remove the engine **ONLY**, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

Engine Lifting with a Generator

NOTICE

Do not use the engine lifting eyes to remove the engine and generator together.

A lifting plate is provided with the package generator set. Instructions for lifting the package generator set are stamped on the lifting plate.

Consult your Caterpillar dealer for information regarding proper fixtures and lifting devices.

Lifting packaged generator sets will not be level if you lift the unit with a single point lift. A counterweight can be added between the package frame rails whenever the application requires frequent relocation of the unit. For complete information about adding the counterweight, consult your Caterpillar dealer.

The single point lifting eye is secured from the factory before the enclosure is shipped. The correct orientation of the single point lifting eye will allow you to look through the eye when you stand at the side of the enclosure. The lifting eye may stretch when the package is lifted. This may cause the locking nuts to loosen. This could cause the lifting eye to swivel. Ensure that the lifting eye is correctly oriented on the packaged generator set. Ensure that the lifting eye is tightened to the correct torque before you lift the packaged generator set.

i02784832

Product Storage

SMCS Code: 7002

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface, which will increase engine wear which can reduce engine service life.

To help prevent excessive engine wear, use the following guidelines:

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See the Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations".

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than one month, a complete protection procedure is recommended.

Your Caterpillar dealer will have instructions for preparing the engine for extended storage periods.

For more detailed information on engine storage, see Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products".

Generator Storage

For information on generator storage, see the literature that is provided by the OEM of the generator. Consult your Caterpillar dealer for assistance.

Gauges and Indicators

i01781351

Gauges and Indicators

SMCS Code: 7450

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings can indicate potential gauge or engine problems. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine and correct the cause of any significant change in the readings. Consult your Caterpillar dealer for assistance.

Your engine may not have the same gauges or all of the gauges that are described below.

NOTICE

If no oil pressure is indicated, STOP the engine. The engine will be damaged from operating without oil pressure.



Engine Oil Pressure – This gauge indicates the pressure of the engine oil. This pressure will be highest after a cold engine is started. The pressure will decrease as the engine warms up. The pressure will increase when the engine rpm is increased. The pressure will stabilize when the engine rpm and temperature are stable.

For G3304 Engines, the typical oil pressure at rated rpm is 280 to 520 kPa (40 to 75 psi).

For G3306 Engines, the typical oil pressure at rated rpm is 240 to 480 kPa (35 to 70 psi).



Oil Filter Differential Pressure – This gauge indicates the difference in pressure between the inlet side and the outlet side of the engine oil filters. As the oil filter elements become plugged, the pressure will increase. Replace the engine oil filter elements when the oil filter differential pressure reaches 103 kPa (15 psi).



Jacket Water Coolant Temperature – This gauge indicates the temperature of the engine coolant at the outlet for the jacket water. The temperature may vary according to the load. The temperature should never be allowed to exceed the boiling temperature of the pressurized cooling system. The operating range is 88 to 98 °C (190 to 205 °F). Higher temperatures may occur under certain conditions.

The engine should operate within the normal temperature range. The sensor for jacket water coolant temperature must be fully submerged in order to detect the temperature correctly. If the engine is operating above the normal temperature range, perform the following procedure:

1. Reduce the load and/or the engine rpm.
2. Inspect the cooling system for leaks.
3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load and/or rpm.



Inlet Manifold Air Temperature – This gauge indicates the inlet manifold air temperature to the cylinders.

NOTICE

High inlet manifold air temperature increases the risk of detonation. Detonation can cause damage to the engine. Ensure that the aftercooling system is operating properly.

The inlet manifold air temperature depends on the engine's aspiration and the water temperature regulator for the separate circuit aftercooler (if equipped). If the maximum temperature is exceeded, the engine will be unable to provide rated power. Derating occurs at temperatures that are greater than the maximum. See Table 4 for maximum temperatures of different engines.

Table 4

Maximum Inlet Manifold Air Temperatures for G3300 Engines		
Aspiration	Water Temperature Regulator	Maximum Inlet Manifold Air Temperature
Naturally aspirated	n/a	25 °C (77 °F) ⁽¹⁾
Air-To-Air Aftercooling	n/a	49 °C (120 °F)
Separate Circuit Aftercooling	32 °C (90 °F) ⁽²⁾	43 °C (110 °F)
Separate Circuit Aftercooling	54 °C (130 °F) ⁽²⁾	65 °C (150 °F)

⁽¹⁾ This temperature is for an engine at an altitude of 152 m (500 ft) above sea level. A greater temperature or a higher altitude requires derating.

⁽²⁾ Water inlet to the aftercooler



Inlet Manifold Air Pressure (TA Engines) and Inlet Manifold Vacuum (NA Engines) –

For TA engines, this gauge indicates the air pressure (turbocharger boost pressure) in the air plenum (air inlet manifold) after the aftercooler. For NA engines, this gauge is the pressure of the inlet manifold vacuum. For all engines, this pressure is relative to the load. This pressure may be used for estimating power output. Several factors affect the inlet manifold air pressure. All of these factors must be accounted for when power is estimated from inlet manifold air pressure: air restriction, exhaust restriction, jacket water coolant temperature, ambient air temperature, variation of the fuel, air/fuel ratio, ignition timing, and condition of the valves.

For more information, see the performance curves in the Engine Performance manual. The manual is available from your Caterpillar dealer.



Tachometer – This gauge indicates the engine rpm.

NOTICE

An overspeed can result in serious damage to the engine. To help prevent engine damage, never allow the engine to exceed the rated rpm.

Note: The rated rpm is stamped on the engine Information Plate.



Service Hour Meter – This meter shows the total number of service meter units that the engine has operated. Table 5 lists the factors for converting service meter units to clock hours.

Table 5

Factors for Converting Service Meter Units to Clock Hours	
Operating Speed	Factor
Engines That Are Rated From 1000 RPM to 1400 RPM	
1000 rpm	1.200
1200 rpm	1.000
1400 rpm	0.857
Engines That Are Rated From 1500 RPM to 1800 RPM	
1500 rpm	1.200
1600 rpm	1.125
1800 rpm	1.000

For example, an engine that is rated at 1800 rpm has been operating at 1500 rpm. To determine the number of clock hours, multiply the number of service meter units by the correct factor. In this example, one service meter unit is equivalent to 1.2 clock hours.



Fuel Filter Differential Pressure – This gauge is provided by the customer. This gauge indicates the difference in fuel pressure between the inlet side and the outlet side of the fuel filter. As the fuel filter element becomes plugged, the difference in pressure between the two sides of the fuel filter increases.

Service the fuel filter when the fuel filter differential pressure reaches 34 kPa (5 psi).



Air Cleaner Differential Pressure – This gauge indicates the difference in air pressure between the inlet side and the engine side of the air filter element. The pressure is measured from the turbocharger air inlet. As the air filter element becomes plugged, the difference in pressure between the two sides of the air cleaner element will increase. For optimum engine performance, replace the air cleaner elements when the air cleaner differential pressure reaches 4 kPa (15 inches of H₂O). Maximum air cleaner differential pressure is 7.5 kPa (30 inches of H₂O).



Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of "0"(zero).



Engine Oil Temperature – This gauge indicates the engine oil temperature after the oil has passed through the oil cooler. The maximum oil temperature at rated rpm and rated load is 110 °C (230 °F).

The engine oil is cooled by the jacket water. If the cooling system cannot remove the heat from the jacket water, the oil will not cool properly. Oil will degrade rapidly at temperatures above 99 °C (210 °F). Oil temperatures that are higher than normal indicate a problem in the lubrication system and/or in the cooling system. This can damage these components: cylinder heads, cylinder liners, pistons, and crankshaft bearings.

Features and Controls

i02061013

Performance Parameters

SMCS Code: 1000

Note: Refer to the Service Manual, “Systems Operation/Testing and Adjusting” or Special Instruction, REHS0371, “Installation and Initial Start-Up Procedure for G3300 & G3400 Engines” for information on the following topics:

- Adjusting the carburetor
- Adjusting the control linkage for the carburetor
- Adjusting the exhaust bypass

Consult your Caterpillar dealer for assistance.

Air/Fuel Ratio

The correct air/fuel ratio is very important for the following considerations:

- Margin of detonation
- Control of emissions
- Achieving optimum service life for the engine

If the air/fuel ratio is not appropriate for the fuel and the operating conditions, a failure of the engine may occur. The service life of the turbocharger, the valves, and other components may be reduced.

Fuel Supply Pressure

Fluctuations of the fuel pressure can change the air/fuel ratio. The maximum fluctuation that is allowed in the fuel pressure is 3.4 kPa (0.50 psi). Ensure a stable fuel pressure to the engine by installing a second gas pressure regulator prior to the gas pressure regulator on the engine.

Table 6 lists the fuel pressure that is required for the gas pressure regulator.

Table 6

Requirements for Fuel Pressure To the Gas Pressure Regulator	
Fuel System	Pressure
Low pressure gas	10.3 to 34 ± 2 kPa 1.50 to 5 ± 0.25 psi
High pressure gas	172 to 207 ± 7 kPa 25 to 30 ± 1 psi

Gas Pressure Regulator

The gas pressure regulator maintains a pressure differential between the air and the fuel that is supplied to the carburetor. Set the pressure of the fuel supply to a maximum of 1 to 1.2 kPa (4 to 4.5 inches of H₂O) higher than the pressure of the air supply. The gas pressure regulator will maintain the pressure differential in response to changes in the air pressure, if the gas pressure regulator is installed properly.

A water manometer is used to measure the pressure differential. This measurement is taken when the engine is operating at high idle rpm. After a load is applied, the fuel pressure will usually decrease by approximately 0.1 to 0.25 kPa (0.50 to 1 inches of H₂O). If the performance of the gas pressure regulator is erratic, the gas pressure regulator may require service.

Temperature of the Fuel Supply

Changes in the temperature of the fuel supply affects the air/fuel ratio. Warmer fuel is less dense than cold fuel. This results in a leaner mixture that causes a noticeable reduction of power.

Temperature of the Air Supply

Changes in the temperature of the air supply affects the air/fuel ratio. In addition to seasonal changes, the air temperature changes overnight. Control of the temperature in the engine room will help to maintain the air/fuel ratio.

To optimize the inlet air temperature, use ducting and a heat exchanger. This will help to avoid exposure to hot air from a generator. For more information, refer to Application and Installation Guide, LEKQ7250, “Air Intake”. Consult your Caterpillar dealer for assistance.

Angle of the Throttle Plate

On turbocharged engines, the angle of the throttle plate is adjusted for full load operation. The angle is adjusted by changing the setting of the exhaust bypass valve, if equipped. The proper angle at full load is 70 degrees.

The following factors affect the angle of the throttle:

- LHV of the fuel
- Setting of the air/fuel ratio (inlet manifold air pressure)
- Setting of the exhaust bypass (if equipped)

- Altitude

Ensure that the angle of the throttle plate is properly set. This will maintain the margin for detonation. This will also enable the engine to accept load changes without lugging.

Exhaust Bypass (Wastegate)

Some turbocharged engines are equipped with exhaust bypass valves that are adjustable. This enables the throttle position to be correctly set for the application. Adjustments must be made for the following variables:

- Altitude
- Setting of the air/fuel ratio
- Methane number of the fuel

The exhaust bypass is adjusted in order to achieve the proper angle of the throttle plate when the engine is operating under a rated load. The exhaust bypass will also limit the power output if the exhaust bypass is set properly for the given ambient conditions.

Some engines only have a boost limit valve that is not adjustable.

Oil Consumption

Low loads will cause the engine to consume more oil.

The rate of oil consumption is called the Brake Specific Oil Consumption (BSOC). The unit of measure is grams per brake kilowatt hour or pounds per brake horsepower hour. The BSOC depends on the following factors: engine model, aspiration, and operating load.

Consult your Caterpillar dealer for information on your engine's BSOC.

i02155496

Alarms and Shutoffs

SMCS Code: 7400

This section contains some general information about typical engine protective devices.

The operation of all alarms and shutoffs utilize components which are actuated by a sensing unit. The alarms and shutoffs are set at critical operating temperatures, pressures, or speeds in order to protect the engine from damage.

Alarms function in order to warn the operator when an abnormal operating condition occurs. Shutoffs function in order to shut down the engine when a more critical abnormal operating condition occurs. The shutoffs help to prevent damage to the equipment.

If an engine protective device shuts off the engine, always determine the cause of the shutoff. Make the necessary repairs before attempting to start the engine.

Shutoffs may cause unburned gas to remain in the air inlet and in the exhaust manifold.

WARNING

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the “Starting the Engine” section.

Become familiar with the following information:

- Types of the alarm and shutoff controls
- Locations of the alarm and shutoff controls
- Conditions which cause each control to function
- Resetting procedure that is required before starting the engine

On G3300 Engines, protective devices are available for the following conditions:

- Low oil pressure
- High coolant temperature
- Overspeed
- Low coolant level

Further protection is supplied by an emergency stop button.

Three basic protection systems are available:

- Self-powered shutoff
- Automatic start/stop system
- Customer supplied shutoff

Note: For an energize-to-shutoff system, the gas shutoff valve must be energized to shut off gas to the engine. For an energize-to-run system, the gas shutoff valve must be energized in order to supply gas to the engine.

Power for the self-powered system is supplied by the magneto. The self-powered system can be used with an air starting motor or an electric starting motor. An energize-to-shutoff gas valve and an instrument panel are required for this system.

Power for the automatic start/stop system is supplied by an external 24 volt electrical source. The automatic start/stop system can be used with an air starting motor or an electric starting motor. An energize-to-run gas valve and one of these controls are required:

- Automatic start/stop switchgear
- Engine Control Logic

For the customer supplied shutoff system, the customer must supply all of the wiring and the shutoffs. This includes the emergency stop button and wiring.

The features of the shutoff systems are listed in Table 7.

Table 7

G3300 Engine Protective Systems			
Item	Type of System		
	Self-Powered	Automatic Start/Stop	Customer Supplied ⁽¹⁾
High coolant temperature	Yes	Yes	Yes
Low oil pressure	Yes	Yes	Yes
Overspeed	No ⁽²⁾	Yes	Yes
High inlet manifold air temperature	No	No	Yes ⁽³⁾
High aftercooler water temperature	No	No	Yes ⁽³⁾
Emergency stop	Yes	Yes	Yes

(1) The customer is responsible for supplying the shutoffs and the wiring.
 (2) Overspeed protection is available as an option.
 (3) The customer is responsible for supplying the protection for either high inlet manifold temperature or high aftercooler water temperature.

Sensing Devices

The sensing devices that are described in this section are typical. The devices may be in different locations for different applications. Also, different applications may have different devices.

Engines that use different generator set control panels will have different sensing devices.

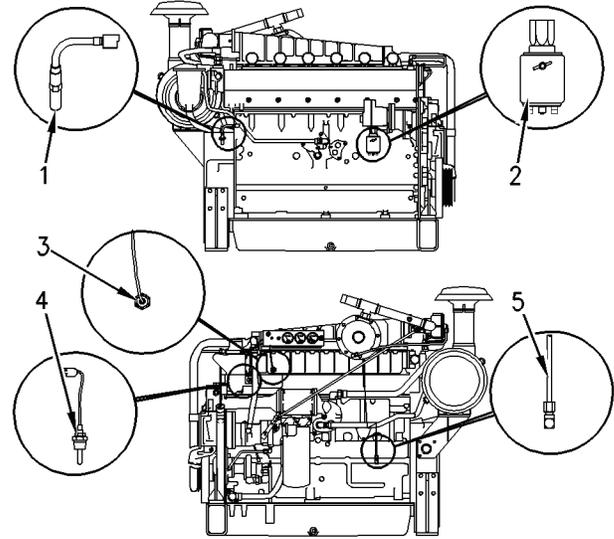


Illustration 18

g00788382

- (1) Speed sensor
- (2) Overspeed contactor
- (3) Air temperature switch (aftercooler)
- (4) Coolant temperature switch
- (5) Oil line

Overspeed

Speed sensor (1) (Illustration 18) helps to monitor the engine rpm. The speed sensor senses the motion of the flywheel ring gear. The speed sensor is used with a tachometer in order to display the engine rpm.

The speed sensor can also be used with an electrical overspeed switch. An external power source of 24 volts DC is required.

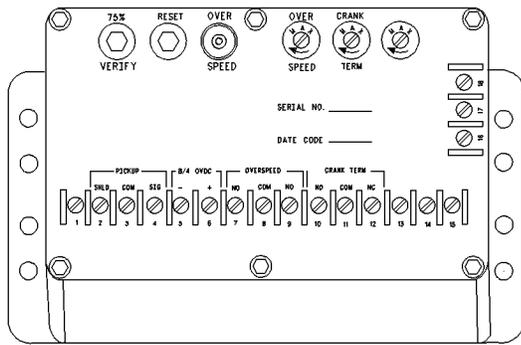


Illustration 19
Overspeed switch

The overspeed switch is mounted in the junction box. The recommended setpoint is 110 percent of the rated rpm. If an overspeed occurs, the “RESET” button on the switch must be reset before the engine can be started.

The switch also has a “VERIFY” button. The button enables the operation of the switch to be tested at 75 percent of the rated rpm.

Overspeed contactor (2) (Illustration 18) can be installed behind the magneto on the tachometer drive. The overspeed contactor is a mechanical device. Excessive engine rpm activates the contactor with centrifugal force.

Temperature

Air temperature switch (3) (Illustration 18) for the aftercooler is installed in the housing of the aftercooler. The shutoff is supplied by the customer.

Coolant temperature switch (4) (Illustration 18) is located next to the housing for the water temperature regulator. An excessive water temperature will activate a shutdown. The setpoint that is recommended for a high coolant temperature shutdown is 104 °C (220 °F).

Oil Pressure

Oil lines (5) (Illustration 18) for sending oil pressure can be located in various places on the side of the engine block. The oil lines are connected to the bearing oil gallery. The oil lines can be connected to these different components:

- Instrument panel
- Junction box
- Oil pressure switch

Low oil pressure will activate a shutoff. The recommended setpoint for low oil pressure is 55 kPa (8 psi).

Coolant Level

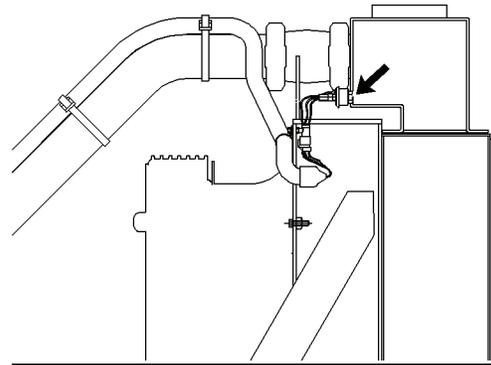


Illustration 20
Coolant loss sensor

The coolant loss sensor is an optional feature. The sensor is usually mounted near the top of the radiator. A lack of sufficient coolant can activate an alarm or a shutoff. Coolant must be added to the cooling system in order to correct the condition.

i02061020

Governors and Actuators

SMCS Code: 1264

Isochronous – The engine rpm remains constant from high idle at no load to full load operation. This is known as zero percent droop.

Droop – Droop represents a decrease in rpm from high idle at no load to full load operation.

The governor controls the engine rpm. For detailed information on governor operation, see the Service Manual, “Systems Operation/Testing and Adjusting” module.

Woodward PSG Governor

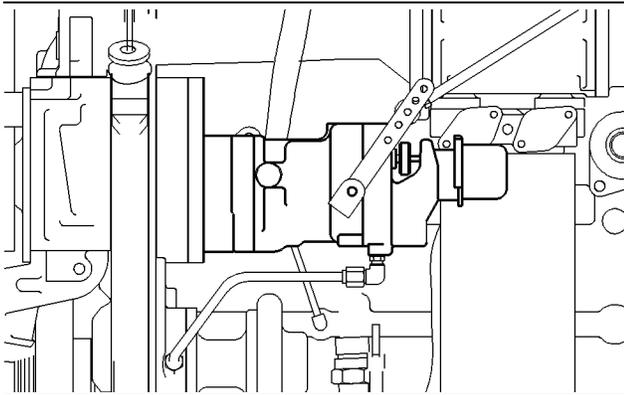


Illustration 21

g00521307

Woodward PSG Governor

The Woodward PSG Governor is the standard governor for G3306 Generator Set Engines. This hydraulic governor can be used in the droop mode or in the isochronous mode. A 24 volt DC motor is optional for remote speed control. The governor is lubricated with oil from the engine lubrication system.

Mechanical governor

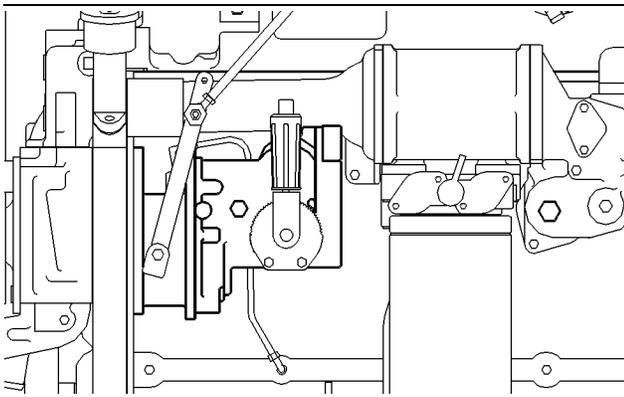


Illustration 22

g00521306

Mechanical governor with manual control

The mechanical governor is the standard governor for G3304 and G3306 Industrial Engines. This governor is manually operated. The governor has approximately seven percent droop at 1800 rpm. Springs can be ordered in order to reduce the droop, if necessary. The governor cannot be used for isochronous operation. The governor is lubricated with oil from the engine lubrication system.

Engine Starting

i02155494

Before Starting Engine

SMCS Code: 1000; 1400; 1450

Note: Certain procedures are required before an engine is started for the first time. Refer to the Special Instruction, REHS0371, "Installation and Initial Start-Up Procedure for G3300 and G3400 Engines".

Perform the required daily maintenance and other periodic maintenance before starting the engine. This can prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

Walk-Around Inspection

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

To obtain maximum service life for your engine, make a thorough inspection before starting the engine. Make a walk-around inspection of the installation. Look for items such as oil or coolant leaks, loose bolts and trash buildup. Remove any trash. Make repairs, if necessary.

- Inspect the drive belts for cracks and wear.
- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Ensure that the areas around the rotating parts are clear.

Air Inlet System

WARNING

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the "Starting the Engine" section.

- Ensure that the air inlet piping and the air filters are in place.
- Ensure that all clamps and connections are secure.
- Inspect the air cleaner service indicator (if equipped). Service the air cleaner filter element when the yellow diaphragm enters the red zone, or the red piston locks in the visible position.
- Inspect flexible piping for cracks and leaks.

Cooling System

- Inspect the cooling system for leaks or loose connections. Inspect the condition of all the hoses and pipes for the cooling system. Ensure that the connections are properly clamped.
- Inspect the water pumps for evidence of leaks.
- Check the coolant level. Add coolant, if necessary. For information on the proper coolant to use, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).
- For engines with separate circuit aftercooling, open the water supply.

Driven Equipment

- Check the oil levels of the driven equipment. Perform any maintenance that is required for the driven equipment. Refer to the literature that is provided by the OEM of the driven equipment.
- If the engine is equipped with a clutch, ensure that the clutch is disengaged.
- For generator set engines, ensure that the main circuit breaker is open.

Electrical System

Inspect the wiring for the following conditions:

- Loose connections
- Wiring that is worn or frayed

Inspect the gauge panel and the control panel for good condition. Reset any shutoff or alarm components.

Fuel System

WARNING

NEVER use a flame to check for gas leaks. Use a gas detector.

An open flame can ignite mixtures of air and fuel. This will cause explosion and/or fire which could result in severe personal injury or death.

- Check the fuel system for leaks with a gas detector.
- Inspect the fuel lines for loose fittings. Ensure that the fuel lines are properly clamped.
- Ensure that the fuel is supplied to the engine at the correct pressure for the engine.

Lubrication System

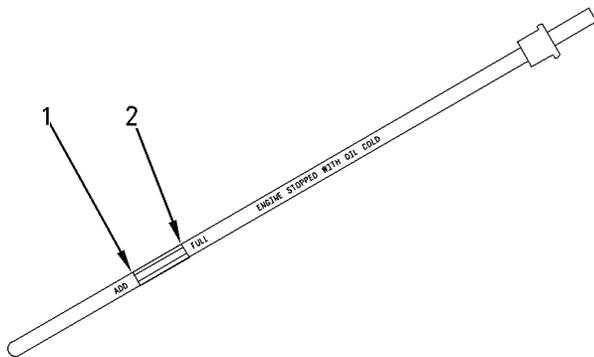


Illustration 23

g00760044

Oil level gauge (dipstick)

- (1) "ADD" mark
(2) "FULL" mark

NOTICE

Excessive engine oil will increase oil consumption and result in excessive deposits in the combustion chamber. Do not overfill the engine with oil.

- Check the engine crankcase oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge. For information on the proper oil to use, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).
- Check for leaks at the following components: crankshaft seals, crankcase, oil filters, oil gallery plugs, sensors, and valve cover.
- Inspect the tubes, and the clamps on the crankcase breathers.

Starting System

Note: If the engine is equipped with a system for external support, prepare the system before starting the engine. Ensure that all of the systems for engine support are enabled. Perform all prestart checks for the control system.

Air Starting Motor

- Drain moisture and sediment from the air tank and from any other air piping.
- Check the oil level in the lubricator. Keep the lubricator at least half full. Add oil, if necessary. For temperatures above 0 °C (32 °F), use a nondetergent 10W oil. For temperatures below 0 °C (32 °F), use air tool oil.
- Check the air pressure for starting. The air starting motor requires a minimum of 690 kPa (100 psi). The maximum allowable air pressure is 1030 kPa (150 psi). Open the air supply valve.

Electric Starting Motor

- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor engages.

Inspect the wiring, the electrical cables, and the battery for the following conditions:

- Loose connections
- Wires that are worn or frayed
- Corrosion

i01857649

Cold Weather Starting

SMCS Code: 1000; 1250; 1450; 1453; 1456; 1900

Note: Oil pan immersion heaters are not recommended for heating the lube oil. To ensure the compatibility of the components, only use equipment that is recommended by Caterpillar.

A jacket water heater is required for starting in temperatures as low as 0 °C (32 °F). The jacket water heater can maintain the water temperature at approximately 32 °C (90 °F). The heated water will help to keep the oil in the engine block warm enough to flow when the engine is started. A jacket water heater is required for starting when the temperature is less than 16 °C (60 °F).

For air starting motors, a larger volume of starting air and/or a higher air pressure may be necessary in order to start the engine at colder temperatures.

For electric starting, extra battery capacity may be necessary.

Consult your Caterpillar dealer for more information on the starting aids that are available for cold weather starting.

i02141975

Starting the Engine

SMCS Code: 1000; 1450

WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the fuel supply and/or the ignition to the engine.

WARNING

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the “Starting the Engine” section.

Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.

Ensure that no one will be endangered before the engine is started and when the engine is started.

Perform the procedures that are described in this Operation and Maintenance Manual, “Before Starting Engine” (Operation Section).

Purging Unburned Gas

The following events cause unburned gas to remain in the air inlet and in the exhaust manifold:

- Emergency stop
- Engine overspeed
- Unsuccessful successive attempts to start the engine

Unburned gas may remain in the air inlet and exhaust system after several unsuccessful attempts to start the engine. The unburned gas may increase to a concentration that may ignite during a successive attempt to start the engine.

Perform the following procedure in order to purge the unburned gas:

1. Turn the manual gas shutoff valve to the CLOSED position.
2. Disable the ignition by grounding the G lead on the ignition harness.
3. Turn the engine control switch to the START position. Crank the engine for one full crank cycle in order to purge the unburned gas.
4. Turn the engine control switch to the OFF/RESET position.
5. Enable the ignition by disconnecting the “G” lead from ground.

6. Turn the manual gas shutoff valve to the OPEN position.
7. Continue with your previous procedure.

Operation of the Generator Set Control Panel

For information on operation for a specific generator set control panel, refer to the Operation and Maintenance Manual for the generator and the control panel.

Automatic Starting

WARNING

When the engine is in the AUTOMATIC mode, the engine can start at any moment. To avoid personal injury, always remain clear of the engine when the engine is in the AUTOMATIC mode.

If the engine control switch is in the "AUTO" position, the engine will automatically start when the remote start/stop initiate contact closes. The engine will accelerate to rated rpm when the oil pressure is sufficient.

Manual Starting

1. Ensure that fuel is supplied to the engine. Ensure that no gas is leaking.
2. Ensure that the driven equipment is unloaded.
 - a. For generator set engines, open the main circuit breaker.
 - b. For industrial engines, unload the compressor or pump. Disengage the clutch (if equipped). Place the transmission and/or other attachments for the power take-off in NEUTRAL.

Note: Before starting an industrial engine, move the governor control lever to the position for 1/2 of rated rpm.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

3. The method that is used for starting depends on the equipment:

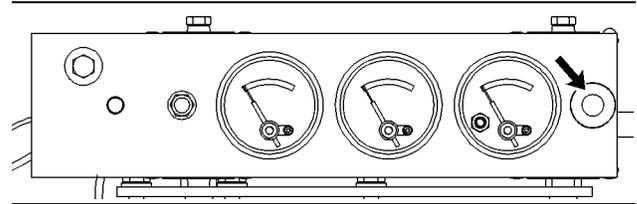


Illustration 24

g00523542

Typical "START" button on an instrument panel

- a. For electric starting, press the "START" button or turn the start/stop switch to the "START" position.

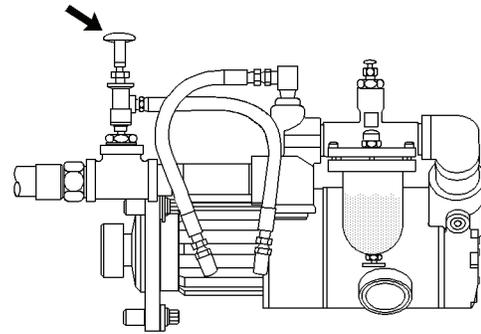


Illustration 25

g00523569

"START" valve on an air starting motor

- b. For starting with air, push the "START" valve. Release the valve as soon as the engine starts. Shut off the air supply to the starting motor.

Note: After starting an industrial engine, move the governor control lever to the position for low idle rpm.

4. Allow the engine to idle for three to five minutes. The engine speed should stabilize at low idle rpm. Check all of the pressure gauges. Inspect the engine for leaks and listen for unusual noises. When all systems are normal, the rpm may be increased.

Starting Failure

If the engine fails to start after cranking for 30 seconds, stop cranking. Perform the following procedure:

1. Turn the start switch to the "OFF" position.
2. Turn the gas supply OFF.

3. Allow the starting motor to cool for two minutes. Crank the engine for approximately 15 seconds in order to disperse any unburned gas from the engine and the exhaust system.
4. Allow the starting motor to cool for two minutes. Turn the gas supply ON. Repeat the starting procedure.

i02308903

Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

For information on troubleshooting the charging system, refer to Special Instruction, REHS0354, "Charging System Troubleshooting".

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, "Battery Test Procedure".

NOTICE

Using a battery source with the same voltage as the electric starting motor. Use **ONLY** equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

When using an external electrical source to start the engine, turn the generator set control switch to the "OFF" position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all accessories.
2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the electrical source.
3. Connect one negative end of the jump start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting combustible gases that are produced by some batteries.
4. Charge the batteries. The engine will not continue to run after starting if the batteries have not been charged.
5. Start the engine.
6. Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

Refer to the Electrical Schematic for your engine. Consult your Caterpillar dealer for more information.

i01028507

After Starting Engine

SMCS Code: 1000

For new installations and engines that are recently rebuilt, carefully monitor the engine in order to detect any unusual engine performance.

The engine rpm can be increased from low idle rpm to rated rpm after one minute.

It may be necessary to apply some load in order to attain normal operating temperatures. The operator can ramp the load manually. For automatic loading, programmable logic control can be used.

Engaging the Driven Equipment

Generator Set Engines

1. Increase the engine speed to rated rpm.
2. Ensure that the gauges are in the normal ranges for the engine rpm.
3. Close the main circuit breaker in order to apply the load.

Industrial Engines

1. Increase the engine rpm. Ensure that the gauges are in the normal ranges for the engine rpm.
2. Engage the driven equipment with no load on the driven equipment.
3. Increase the engine rpm and the load, as needed.

Engine Operation

i02061036

Engine Operation

SMCS Code: 1000

Proper operation and maintenance are key factors in attaining the maximum service life and economy for the engine. Follow the instructions in this Operation and Maintenance Manual in order to minimize operating costs and maximize the service life of the engine.

Observe the gauges frequently while the engine is operating. Record the data from the gauges in a log regularly. Compare the data to the specifications for normal engine operation. Comparing the data over time will help to detect changes in engine performance.

Investigate any significant change in the gauge readings. Monitor the engine operation and take action when discrepancies are found.

Operating the Engine and the Driven Equipment

Check the gauges and the driven equipment frequently while the engine is operating under a load. The engine can be operated for extended periods of time at full load.

Partial Load Operation

Extended operation at low idle or at a reduced load will cause increased oil consumption and carbon buildup in the cylinders. Carbon buildup results in the following effects:

- Power loss
- Poor performance
- Accelerated wear of components

Caterpillar Engines can be operated at very light loads (torques) for limited times with no harmful effects. Table 8 lists the limits for hours of operation at various torques.

After the time limit for reduced load operation has expired, operate the engine for a minimum of two hours at a torque that is more than 70 percent.

For example, an engine is operating at 20 percent of the rated torque. The engine may be operated at this load factor for a maximum of one-half hour. After the one-half hour, operate this engine for at least two hours at a load factor of more than 70 percent.

To keep engine maintenance at a minimum, follow the guidelines that are listed in Table 8.

Table 8

Time Limits For Low Load Operation		
Engine Torque	NA Engines	TA Engines
0 to 30%	1/2 hour	1/2 hour
31 to 60%	2 hours	2 hours
61 to 70%	24 hours	Continuous ⁽¹⁾
71 to 100%	Continuous	Continuous ⁽¹⁾

⁽¹⁾ For continuous operation of TA engines, the manifold air pressure should be greater than the atmospheric pressure.

Engine Stopping

i02155498

Emergency Stopping

SMCS Code: 1000; 7418

NOTICE

Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

Ensure that any system that provides external support to the engine is secured after the engine is stopped.

NOTICE

Do not start the engine until the problem necessitating the emergency stop has been located and corrected.

Pressing the Emergency Stop Button may cause unburned gas to remain in the air inlet and in the exhaust manifold.

WARNING

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the “Starting the Engine” section.

Emergency Stop Button

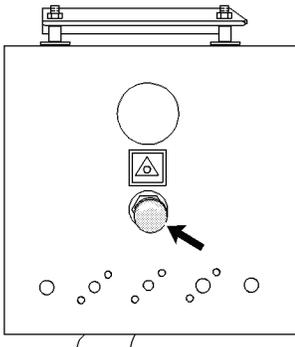


Illustration 26

g00520710

Emergency stop button on the junction box

For the junction box, the emergency stop button is in the OUT position for normal engine operation. For an emergency stop, push the emergency stop button. The button must be reset before the engine can be started.

To reset the button, turn the button clockwise. The spring-loaded button will return to the OUT position.

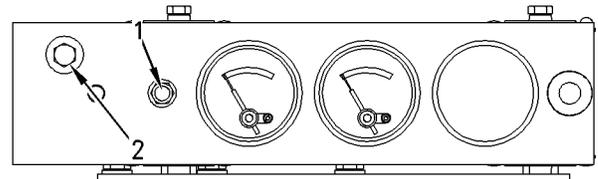


Illustration 27

g00841956

Emergency stop button on the instrument panel

- (1) “STOP” button
- (2) “RESET” button

For the instrument panel, push the “STOP” button in order to perform an emergency stop.

The instrument panel must be reset before the engine can be started. To reset the instrument panel, press the “RESET” button.

i01020551

i02508920

Manual Stop Procedure

SMCS Code: 1000; 7418

NOTICE

Stopping the engine immediately after the engine has been operating under a load can result in overheating and accelerated wear of the engine components.

Allow the engine to gradually cool before stopping the engine.

Note: Remove the load at a rate that will avoid detonation.

1. Disengage the driven equipment.
 - a. For generator set engines, open the main circuit breaker.
 - b. For industrial engines, unload the compressor or pump. Disengage the clutch (if equipped). Place the transmission and/or other attachments for the power take-off in NEUTRAL.

Note: Extended idling can cause excessive oil consumption and related problems. See this Operation and Maintenance Manual, "Engine Operation" topic (Operation Section).

2. Reduce the engine rpm to low idle.
3. Operate the engine at low idle rpm for a cool down period.

If the engine has been operated at a low load, operate the engine at low idle for approximately 30 seconds before stopping the engine.

If the engine has been operated at a high load, operate the engine at low idle for three to five minutes before stopping the engine.

4. To stop the engine, shut off the fuel supply.

The engine will coast to a stop. Ensure that any system that provides external support to the engine is secured after the engine is stopped.

After Stopping Engine

SMCS Code: 1000

- Check the engine crankcase oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten loose bolts.
- Note the service hour reading. Perform the maintenance that is scheduled in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

NOTICE

Only use antifreeze/coolant mixtures recommended in the Refill Capacities and Recommendations section of this manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
- If freezing temperatures are expected, check the coolant for protection against freezing. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. Refer to the instructions that are provided by the OEM of the driven equipment.

Maintenance Section

Refill Capacities

Refill Capacities and Recommendations

SMCS Code: 1348; 1395; 7560

Lubrication System

Lubricant Recommendations

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- Caterpillar Natural Gas Engine Oil (NGEO)
- Caterpillar EL250 Natural Gas Engine Oil (NGEO)
- Caterpillar EL350 Natural Gas Engine Oil (NGEO)

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation. To determine the oil viscosity that is required for starting a cold soaked engine, refer to the minimum temperature in Table 9. To select the oil viscosity for operation at the highest anticipated ambient temperature, refer to the maximum temperature in the Table. Use the highest oil viscosity that is available in order to meet the required temperature during start-up.

Table 9

Engine Oil Viscosity		
Caterpillar NGEO Grade of Viscosity	Ambient Temperature	
	Minimum	Maximum
SAE 30 ⁽¹⁾	0 °C (32 °F)	40 °C (104 °F)
SAE 40 ⁽¹⁾	5 °C (41 °F)	50 °C (122 °F)

⁽¹⁾ Caterpillar NGEO is available in these grades only. Multigrade oils are NOT recommended for use in Caterpillar Gas Engines. If other grades of viscosity are selected, ensure that the oil meets the requirements for Caterpillar Gas Engines.

For further information about oils, see Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations".

Lubricant Capacities

The capacity of the engine crankcase includes the capacity of the oil filters that are installed at the factory.

Table 10

Approximate Refill Capacities for the G3304 Engine Lubrication System		
Engine Serial Number	Liters	Quarts
(S/N: 37Y1-1017) (S/N: N4F1-Up)	19	20
(S/N: 37Y1018-Up)	31	33

Table 11

Approximate Refill Capacities for the G3306 Engine Lubrication System		
Engine Serial Number	Liters	Quarts
(S/N: 07Y1-1833) (S/N: G6X1-Up)	27.5	29
(S/N: 07Y1834-Up)	44.5	47

Fuel

Fuel Recommendations

Caterpillar gas engines will operate successfully on a broad range of gaseous fuels. Pipeline natural gas has been used for many years. Commercial fuel gases are mixtures of gases. These fuels consist primarily of hydrocarbons (combinations of hydrogen and carbon) and some inert gases. The compositions of these gas mixtures have extreme variations. Fuels such as wellhead gas, bio-gas, and manufactured gas need to be reviewed for acceptability. Analyze the fuel in order to determine the following characteristics:

- Composition
- Contaminants
- Heat value
- Methane number
- Specific gravity

Field gas can have varying characteristics of combustion. Field gas can contain numerous harmful impurities. The impurities can alter the BTU content. The impurities can also alter the methane number. The impurities include everything from water up to complex hydrocarbons that can lead to detonation and severe engine damage. To minimize these effects, Caterpillar recommends the following guidelines:

1. Evaluate the fuel with the Caterpillar Methane Number Program, LEKQ6378.

Methane values below 30 are not recommended for use in a Caterpillar engine. Fuels with a methane number that is below 30 must first be processed in order to remove harmful impurities in the fuel and raising the methane number into the acceptable range.

2. If necessary, use an engine that is configured for a fuel that has a high energy. Consult your local Caterpillar Dealer in order to determine the recommended engine timing.
3. Reduce the oil change interval according to the results of the oil analysis.

For further information on fuels, see Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations".

Cooling System

Coolant Recommendations

During shipping and storage, the engine must be protected from damage that can be caused by freezing of the cooling system. If the engine is shipped to a site with freezing temperatures and/or if the engine is stored in a location with freezing temperatures, the cooling system must contain antifreeze that will withstand the lowest ambient temperature. Frequently check the concentration of glycol in the coolant/antifreeze. Make sure that the concentration is adequate in order to prevent freezing. Otherwise, the cooling system must be completely drained.

Coolant/antifreeze is normally composed of three elements: water, glycol, and additives. Each element must meet specific guidelines.

Water

Deionized water or distilled water is recommended for use in engine cooling systems. If distilled water or deionized water is not available, use water with the properties that are listed in Table 12.

Table 12

Caterpillar Minimum Acceptable Water Requirements		
Property	Maximum Limit	ASTM Test
Chloride (Cl)	40 mg/L (2.4 grains per US gal)	"D512", "D4327"
Sulfate (SO ₄)	100 mg/L (5.9 grains per US gal)	"D516"
Total Hardness	170 mg/L (10 grains per US gal)	"D1126"
Total Solids	340 mg/L (20 grains per US gal)	"D1888"
Acidity	pH of 5.5 to 9.0	"D1293"

NOTICE

Use of water that does not meet the recommendations for the cooling system will damage the cooling system.

Do not use these types of water in the cooling system: sea water, softened water that has been conditioned with salt, hard water, and tap water.

Only use water that meets the recommendations for the cooling system.

If you are not sure about the properties of your water, consult one of the following sources for a water analysis:

- Caterpillar dealer
- Local water utility company
- Agricultural agent
- Independent laboratory

Glycol

NOTICE

Do not use Extended Life Coolant (ELC) with Caterpillar Gas Engines.

ELC was not formulated for use in Caterpillar Gas Engines.

Use only the coolant/antifreeze that is recommended.

Preferred – Caterpillar Natural Gas Engine Coolant (NGEC)

Alternatively, use Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty coolant/antifreeze that meets "ASTM D6210" or "ASTM D4985" specifications.

NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM “D3306” specification. This type of coolant/antifreeze is made for light duty automotive applications.

Use only the coolant/antifreeze that is recommended.

Acceptable – In applications that do not require protection from boiling or from freezing, a mixture of Caterpillar SCA and water that meets the properties that are listed in Table 12 is acceptable.

Note: The preferred coolant/antifreeze and the acceptable mixture of SCA and water require different concentrations of SCA. Refer to the Special Publication, SEBU6400, “Supplemental Coolant Additive (SCA)” topic.

Table 13 is a list of the coolant/antifreeze that is recommended for Caterpillar Gas Engines. The service life of the coolant/antifreeze that is used in Caterpillar Gas Engines is also listed. **To achieve this service life, the coolants must be properly maintained. The maintenance program includes S·O·S coolant analysis.**

Table 13

Recommended Coolant/Antifreeze and Service Life of the Coolant/Antifreeze	
Coolant/Antifreeze	Service Life ⁽¹⁾
Caterpillar NGEC	Three Years
Caterpillar DEAC	
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D6210”	Two Years
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D4985”	One Year
Caterpillar SCA and Water	Two Years
Commercial SCA and Water	One Year

⁽¹⁾ The service life of coolant is also limited by use (service hours). Refer to the specific engine’s Operation and Maintenance Manual, “Maintenance Interval Schedule”.

Additives

Preferred – Caterpillar Supplemental Coolant Additive (SCA)

Acceptable – A commercial SCA that provides 1200 mg/L (70 grains per US gal) or 1200 ppm of nitrites in the final mixture of coolant/antifreeze

Note: A 50/50 concentration of Caterpillar NGEC or of Caterpillar DEAC does not require a treatment with an SCA at the initial fill. Commercial heavy-duty coolant/antifreeze that meets “ASTM D6210” or “ASTM D4985” specifications may require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

To ensure that the correct amount of SCA is in the cooling system, the concentration of SCA must be tested on a scheduled basis. Obtain an S·O·S coolant analysis (Level 1) or use a test kit to check the concentration of the SCA according to this Operation and Maintenance Manual, “Maintenance Interval Schedule”.

For further information on coolant, see Special Publication, SEBU6400, “Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations”.

Coolant Capacities

To properly maintain the cooling system, the Total Cooling System capacity must be determined. The Total Cooling System capacity will vary between individual installations. The External System capacity includes the following components: engine, expansion tank, heat exchanger, radiator, and piping. Refer to the specifications that are provided by Caterpillar or by the OEM of the equipment. Record the Total Cooling System capacity in the following Table:

Table 14

Approximate Refill Capacities for the G3304 Engine Cooling System		
Compartment or System	Liters	Quart
Jacket Water	16	18
External System		
Total Cooling System		

Table 15

Approximate Refill Capacities for the G3306 Engine Cooling System		
Compartment or System	Liters	Quarts
Jacket Water	20	21
External System		
Total Cooling System		

i03246620

Maintenance Interval Schedule ((Standby Generator Set Engines))

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

Every Week

Air Starting Motor Lubricator Oil Level - Check	50
Air Tank Moisture and Sediment - Drain	51
Automatic Start/Stop - Inspect	51
Battery Charger - Check	52
Battery Electrolyte Level - Check	53
Control Panel - Inspect	55
Cooling System Coolant Level - Check	58
Engine Air Cleaner Service Indicator - Inspect	65
Engine Air Precleaner - Clean	66
Engine Oil Level - Check	67
Fuel System Fuel Filter Differential Pressure - Check	73
Instrument Panel - Inspect	79
Jacket Water Heater - Check	80
Standby Generator Set Maintenance Recommendations	86
Walk-Around Inspection	91

Every 250 Service Hours or 1 Year

Engine Oil and Filter - Change	69
--------------------------------	----

Every 500 Service Hours

Cooling System Coolant Analysis (Level I) - Obtain	57
---	----

Every Year

Actuator Control Linkage - Lubricate	49
Aftercooler Core - Clean/Test	49
Air Starting Motor Lubricator Bowl - Clean	50
Alternator - Inspect	51
Belts - Inspect/Adjust/Replace	53
Carburetor Air/Fuel Ratio - Check/Adjust	55
Cooling System Coolant Analysis (Level II) - Obtain	58
Cooling System Supplemental Coolant Additive (SCA) - Test/Add	59
Crankcase Blowby - Measure/Record	60
Crankshaft Vibration Damper - Inspect	60
Cylinder Pressure - Measure/Record	61
Engine - Clean	62
Engine Air Cleaner Element - Replace	63
Engine Crankcase Breather - Clean	66
Engine Mounts - Check	67
Engine Oil Sample - Obtain	68
Engine Performance - Test	71
Engine Protective Devices - Check	71
Engine Valve Lash - Inspect/Adjust	72
Engine Valve Rotators - Inspect	72
Gas Pressure Regulator - Check	74
Hoses and Clamps - Inspect/Replace	74
Ignition System Spark Plugs - Inspect/Replace	76
Ignition System Timing - Check/Adjust	79
Inlet Air System - Inspect	79
Radiator - Clean	86
Speed Sensor - Clean/Inspect	86
Starting Motor - Inspect	87
Turbocharger - Inspect	88
Water Pump - Inspect	92

Every 3 Years

Batteries - Replace	52
Belts - Replace	54
Carburetor - Inspect/Recondition	54
Cooling System Coolant (DEAC) - Change	55
Cooling System Coolant (NGEC) - Change	57
Exhaust Bypass - Inspect	72
Exhaust Piping - Inspect	73
Governor - Inspect	74
Hoses and Clamps - Replace	75
Ignition System Spark Plug Wires - Replace	75
Ignition System Transformer Resistance - Test	79

i03246601

Maintenance Interval Schedule (Naturally Aspirated Engines)

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

When Required

Engine Air Cleaner Element - Replace	63
Overhaul Considerations	84
Valve Stem Projection - Measure/Record	89

Daily

Air Starting Motor Lubricator Oil Level - Check	50
Air Tank Moisture and Sediment - Drain	51
Control Panel - Inspect	55
Cooling System Coolant Level - Check	58
Driven Equipment - Inspect/Replace/Lubricate ...	62
Engine Air Cleaner Service Indicator - Inspect	65
Engine Air Precleaner - Clean	66
Engine Oil Level - Check	67
Fuel System Fuel Filter Differential Pressure - Check	73
Instrument Panel - Inspect	79
Power Take-Off Clutch - Check/Adjust/Lubricate ..	85
Walk-Around Inspection	90

Every 250 Service Hours

Cooling System Supplemental Coolant Additive (SCA) - Test/Add	59
Engine Oil Sample - Obtain	68

Every 500 Service Hours

Cooling System Coolant Analysis (Level I) - Obtain	57
---	----

Every 750 Service Hours

Battery Electrolyte Level - Check	53
Belts - Inspect/Adjust/Replace	53
Crankshaft Vibration Damper - Inspect	60
Engine - Clean	62
Engine Crankcase Breather - Clean	66
Engine Oil and Filter - Change	69
Exhaust Piping - Inspect	73
Hoses and Clamps - Inspect/Replace	74
Ignition System Spark Plugs - Inspect/Replace ...	76
Ignition System Timing - Check/Adjust	79
Inlet Air System - Inspect	79

Initial 750 Service Hours

Engine Valve Lash - Inspect/Adjust	72
Engine Valve Rotators - Inspect	72
Gas Pressure Regulator - Check	74
Valve Stem Projection - Measure/Record	89

Initial 1500 Service Hours

Valve Stem Projection - Measure/Record	89
--	----

Every 1500 Service Hours

Actuator Control Linkage - Lubricate	49
Carburetor Air/Fuel Ratio - Check/Adjust	55
Crankcase Blowby - Measure/Record	60
Cylinder Pressure - Measure/Record	61
Engine Protective Devices - Check	71
Engine Valve Lash - Inspect/Adjust	72
Engine Valve Rotators - Inspect	72
Gas Pressure Regulator - Check	74
Speed Sensor - Clean/Inspect	86

Every Year

Cooling System Coolant Analysis (Level II) - Obtain	58
--	----

Every 3000 Service Hours

Air Starting Motor Lubricator Bowl - Clean	50
Alternator - Inspect	51
Driven Equipment - Check	62
Engine Mounts - Check	67
Ignition System Transformer Resistance - Test	79
Starting Motor - Inspect	87
Water Pump - Inspect	92

Every 3 Years

Cooling System Coolant (DEAC) - Change	55
Cooling System Coolant (NGEC) - Change	57

Between 12 000 and 16 000 Service Hours

Overhaul (Top End)	82
--------------------------	----

Between 36 000 and 44 000 Service Hours

Overhaul (Major) 80

i03246660

Maintenance Interval Schedule (Turbocharged Engines)

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

When Required

Engine Air Cleaner Element - Replace	63
Overhaul Considerations	84
Valve Stem Projection - Measure/Record	89

Daily

Air Starting Motor Lubricator Oil Level - Check	50
Air Tank Moisture and Sediment - Drain	51
Control Panel - Inspect	55
Cooling System Coolant Level - Check	58
Driven Equipment - Inspect/Replace/Lubricate ...	62
Engine Air Cleaner Service Indicator - Inspect	65
Engine Air Precleaner - Clean	66
Engine Oil Level - Check	67
Fuel System Fuel Filter Differential Pressure - Check	73
Instrument Panel - Inspect	79
Power Take-Off Clutch - Check/Adjust/Lubricate ..	85
Walk-Around Inspection	90

Every 250 Service Hours

Cooling System Supplemental Coolant Additive (SCA) - Test/Add	59
Engine Oil Sample - Obtain	68

Every 500 Service Hours

Cooling System Coolant Analysis (Level I) - Obtain	57
---	----

Every 750 Service Hours

Aftercooler Core - Clean/Test	49
Battery Electrolyte Level - Check	53
Belts - Inspect/Adjust/Replace	53
Crankshaft Vibration Damper - Inspect	60
Engine - Clean	62
Engine Crankcase Breather - Clean	66
Engine Oil and Filter - Change	69
Engine Valve Lash - Inspect/Adjust	72
Engine Valve Rotators - Inspect	72
Exhaust Piping - Inspect	73
Gas Pressure Regulator - Check	74
Hoses and Clamps - Inspect/Replace	74
Ignition System Spark Plugs - Inspect/Replace	76
Ignition System Timing - Check/Adjust	79
Inlet Air System - Inspect	79
Radiator - Clean	86

Initial 750 Service Hours

Valve Stem Projection - Measure/Record	89
--	----

Every 1500 Service Hours

Actuator Control Linkage - Lubricate	49
Carburetor Air/Fuel Ratio - Check/Adjust	55
Crankcase Blowby - Measure/Record	60
Cylinder Pressure - Measure/Record	61
Engine Protective Devices - Check	71
Speed Sensor - Clean/Inspect	86

Every Year

Cooling System Coolant Analysis (Level II) - Obtain	58
--	----

Every 3000 Service Hours

Air Starting Motor Lubricator Bowl - Clean	50
Driven Equipment - Check	62
Engine Mounts - Check	67
Ignition System Transformer Resistance - Test	79
Starting Motor - Inspect	87
Water Pump - Inspect	92

Every 3 Years

Cooling System Coolant (DEAC) - Change	55
Cooling System Coolant (NGEC) - Change	57

Every 4000 Service Hours

Alternator - Inspect	51
Exhaust Bypass - Inspect	72

Every 8000 Service Hours

Turbocharger - Inspect	88
------------------------------	----

Between 9000 and 12 000 Service Hours

Overhaul (Top End)	82
--------------------------	----

Between 18 000 and 24 000 Service Hours

Overhaul (Major) 80

i01519288

Actuator Control Linkage - Lubricate

SMCS Code: 1265-086

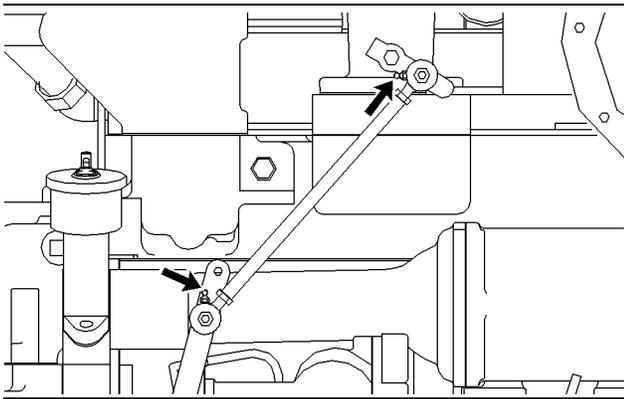


Illustration 28
Grease fittings

g00788799

Apply grease to the grease fittings. Use a hand grease gun and lubricate the grease fittings with MPGM.

Check the Linkage

Check the linkage for proper operation. Adjust the linkage, if necessary. For the adjustment procedure, see the Service Manual, "Systems Operation/Testing and Adjusting" module.

i02708645

Aftercooler Core - Clean/Test (Air-To-Air Aftercooler)

SMCS Code: 1064-070; 1064-081; 1064

S/N: H4D1-Up

S/N: H6D1-Up

S/N: G6X1-Up

S/N: 07Y1-Up

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi) when the air nozzle is deadheaded. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb".

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

i02654935

Air Starting Motor Lubricator Bowl - Clean

SMCS Code: 1451-070

If the engine is equipped with an air starting motor, use the following procedure:

WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

1. Ensure that the air supply to the lubricator is OFF.

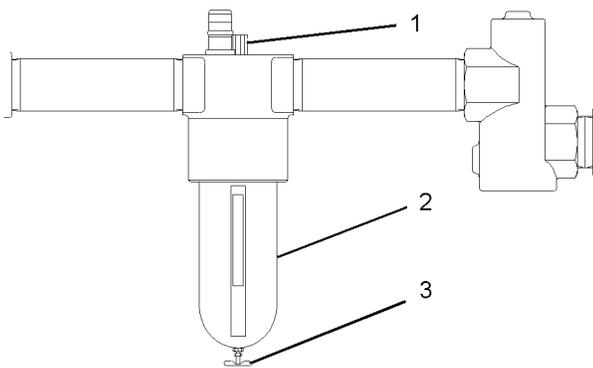


Illustration 29

g01333332

- (1) Filler plug
- (2) Bowl
- (3) Drain valve

2. Slowly loosen filler plug (1) in order to release the pressure from the lubricator.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

3. Place a suitable container under bowl (2) and open drain valve (3) in order to drain the oil from the bowl.
4. Remove bowl (2). Clean the bowl with warm water.
5. Dry the bowl. Inspect the bowl for cracks. If the bowl is cracked, replace the damaged bowl with a new bowl. Inspect the gasket. If the gasket is damaged, replace the gasket.
6. Install the bowl.
7. Make sure that drain valve (3) is closed.
8. For instructions on filling the lubricator, see this Operation and Maintenance Manual, "Air Starting Motor Lubricator Oil Level - Check" topic.

i02654969

Air Starting Motor Lubricator Oil Level - Check

SMCS Code: 1451-535

NOTICE

Never allow the lubricator bowl to become empty. The air starting motor will be damaged by a lack of lubrication. Ensure that sufficient oil is in the lubricator bowl.

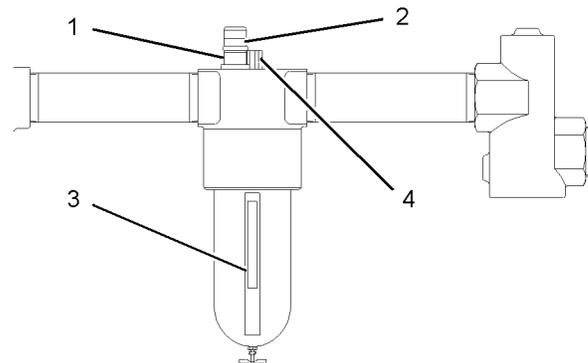


Illustration 30

g01333366

1. Observe the oil level in sight gauge (3). If the oil level is less than 1/2, add oil to the lubricator bowl.

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

2. Ensure that the air supply to the lubricator is OFF. Slowly loosen filler plug (4) in order to release pressure from the lubricator bowl.
3. Remove filler plug (4). Pour oil into the lubricator bowl. Use nondetergent SAE 10W oil for temperatures that are greater than 0 °C (32 °F). Use air tool oil for temperatures that are below 0 °C (32 °F).
4. Install filler plug (4).

Adjust the Lubricator

Note: Adjust the lubricator with a constant rate of air flow. After the adjustment, the lubricator will release oil in proportion to variations of the air flow.

1. Ensure that the fuel supply to the engine is OFF.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

2. Operate the air starting motor. Observe the drops of oil that are released in dome (1).

Note: Some lubricators have an adjustment screw rather than a knob.

3. If necessary, adjust the lubricator in order to release from one to three drops of oil per second. To increase the rate, turn knob (2) counterclockwise. To decrease the rate, turn the knob clockwise.

i00351324

Air Tank Moisture and Sediment - Drain

SMCS Code: 1466-543-M&S

Moisture and sediment in the air starting system can cause the following conditions:

- Freezing
- Corrosion of internal parts
- Malfunction of the air starting system

⚠ WARNING

When opening the drain valve, wear protective gloves, a protective face shield, protective clothing, and protective shoes. Pressurized air could cause debris to be blown and result in personal injury.

1. Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.
2. Close the drain valve.

i02084374

Alternator - Inspect

SMCS Code: 1405-040

Inspect the alternator for the following conditions:

- Proper connections
- Clean ports for cooling airflow
- Proper charging of the battery

Observe the ammeter during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system.

Make repairs, if necessary. See the Service Manual for service procedures. Consult your Caterpillar dealer for assistance.

i01039675

Automatic Start/Stop - Inspect (Generator Set)

SMCS Code: 4462

The generator set must be ready to operate under a load at any time. After performing maintenance on the generator set, inspect the position of the control switches. Ensure the following conditions:

- The starting system is enabled.
- The control switches are in the correct position for automatic starting.

- The switchgear and the automatic transfer switches that are associated with the generator are enabled.

For more information, see the Operation and Maintenance Manual for the generator and the control panel.

i01041029

Batteries - Replace

SMCS Code: 1401-510

WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

Note: Before connecting the cables, ensure that the key start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
8. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

i01039758

Battery Charger - Check

SMCS Code: 1401-535

Checking Before Start-Up

Check the battery charger for proper operation. If the batteries are properly charged, the needle of the ammeter will register near “0” (zero).

The battery charger must not produce excessive current during start-up. Alternatively, the charger must be automatically disconnected for start-up. If the engine has an alternator, the charger must be automatically disconnected during start-up and during engine operation.

Charging the Battery

WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

Perform the following procedure to charge the battery:

1. Ensure that the charger is turned OFF.
2. Adjust the voltage of the charger in order to match the voltage of the battery.
3. Connect the POSITIVE “+” lead of the charger to the POSITIVE “+” battery terminal. Connect the NEGATIVE “-” lead of the charger to the NEGATIVE “-” battery terminal.
4. Turn ON the battery charger.

Overcharging of Batteries

Overcharging reduces the service life of batteries. Use a battery charger that will not overcharge the battery. DO NOT charge the battery if the meter of the battery charger is in the RED zone.

Overcharging is indicated by the following symptoms:

- The battery is very warm to the touch.
- A strong odor of acid is present.
- The battery emits smoke or a dense vapor (gas).

Perform one of the following procedures if the battery shows symptoms of overcharging:

- Reduce the rate of charging by a significant amount. Complete the charging at the reduced rate.
- Turn OFF the charger.

Table 16 describes the effects of overcharging on different types of batteries.

Table 16

Effects of Overcharging Batteries	
Type of Battery	Effect
Caterpillar General Service Batteries Caterpillar Premium High Output Batteries	All of the battery cells have a low level of electrolyte.
	When the plates of the battery are inspected through the filler holes, the plates may appear to be warped. This is caused by an excessive temperature.
	The battery may not pass a load test.
Caterpillar Maintenance Free Batteries	The battery may not accept a charging current.
	The battery may not pass a load test.

Checking After Stopping

Ensure that the battery charger is connected properly. Observe the meter of the charger. Record the amperage.

i02601752

Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing.

WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the "FULL" mark on the battery.
2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.
3. Keep the batteries clean.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

Clean the battery case with one of the following cleaning solutions:

- A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. **DO NOT** remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

i02042962

Belts - Inspect/Adjust/Replace

SMCS Code: 1357-025; 1357-040; 1357-510

Inspection

Inspect the alternator belt and the fan drive belts for wear and for cracking. Replace the belts if the belts are not in good condition.

Check the belt tension according to the information in the Service Manual, "Specifications".

Slippage of loose belts can reduce the efficiency of the driven components. Vibration of loose belts can cause unnecessary wear on the following components:

- Belts

- Pulleys
- Bearings

If the belts are too tight, unnecessary stress is placed on the components. This reduces the service life of the components.

Replacement

For applications that require multiple drive belts, replace the drive belts in matched sets. Replacing one drive belt of a matched set will cause the new drive belt to carry more load because the older drive belts are stretched. The additional load on the new drive belt could cause the new drive belt to fail.

Alternator Belt Adjustment

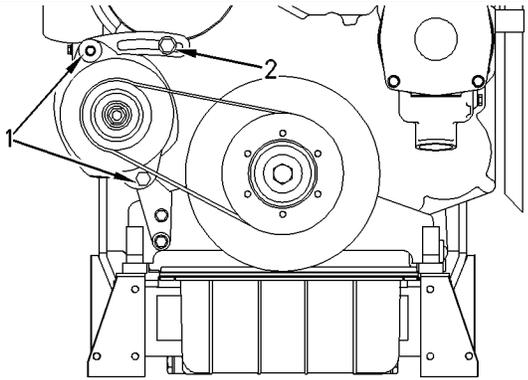


Illustration 31

g00788814

1. Remove the belt guard.
2. Loosen mounting bolts (1) and adjusting bolt (2).
3. Move the assembly in order to increase or decrease the belt tension.
4. Tighten adjusting bolt (2). Tighten mounting bolts (1).
5. Reinstall the belt guard.

If new drive belts are installed, check the drive belt tension again after 30 minutes of engine operation at the rated rpm.

Adjustment of the Fan Drive Belt

1. Remove the belt guard.
2. Loosen the mounting bolt for the pulley.
3. Loosen the adjusting nut for the pulley.
4. Move the pulley in order to adjust the belt tension.

5. Tighten the adjusting nut.
6. Tighten the mounting bolt.
7. Reinstall the belt guard.

If new drive belts are installed, check the drive belt tension again after 30 minutes of engine operation at the rated rpm.

i01041135

Belts - Replace

SMCS Code: 1357-510

Remove the used fan drive belt and the accessory drive belt. Install new belts.

For applications that require multiple drive belts, replace the belts in matched sets. Used belts are stretched. Replacing only one belt of a matched set will cause the new belt to carry an excessive load. The additional load on the new belt could cause the new belt to break.

Check the belt tension according to the information in the Service Manual, "Specifications" module. To adjust the belt tension, see this Operation and Maintenance Manual, "Alternator and Fan Belts - Inspect/Adjust/Replace" topic (Maintenance Section).

After new belts are installed, check the belt tension again after 30 minutes of engine operation at rated rpm.

i01519364

Carburetor - Inspect/Recondition

SMCS Code: 1512-020

Note: See the Service Manual, "Disassembly and Assembly" module for information on these topics: removal, disassembly, assembly, and installation.

1. Remove the carburetor.
2. Disassemble the carburetor.

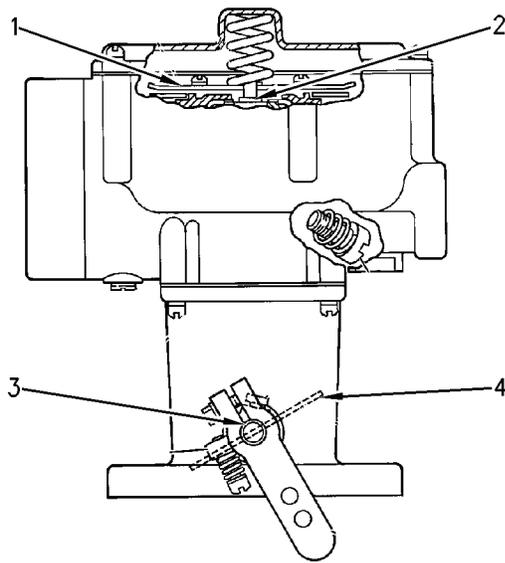


Illustration 32

g00788856

3. Inspect diaphragm (1). If the diaphragm is worn or damaged, replace the diaphragm.
4. Inspect piston (2). If the piston is excessively worn, replace the carburetor body and the diaphragm assembly.
5. Inspect throttle shaft (3) for wear near the bearing. Inspect throttle plate (4) and the throttle body for wear and/or damage. Replace any component that is worn or damaged.
6. Assemble the carburetor. Use new gaskets for assembly.
7. Install the carburetor.
8. Adjust the carburetor according to Special Instruction, REHS0371, "Installation and Initial Start-Up Procedure for G3300 and G3400 Engines".

i01005891

Carburetor Air/Fuel Ratio - Check/Adjust

SMCS Code: 1266-535; 1266

An engine failure may occur if the air/fuel ratio is not appropriate for the fuel and for the operating conditions. The service life of the turbocharger, of the valves, and of the other components may be reduced.

Ensure that the carburetor is adjusted properly so that the air/fuel ratio is correct.

For information on adjusting the carburetor, refer to the Service Manual, "Systems Operation/Testing and Adjusting", or refer to the Special Instruction, "Installation and Initial Start-Up Procedure".

i01762721

Control Panel - Inspect

SMCS Code: 4490-040; 7451-040

Inspect the condition of the panel. If a component is damaged, ensure that the component is repaired or that the component is replaced. If equipped, ensure that the electronic displays are operating properly.

Inspect the wiring for good condition. Ensure that the wiring connections are secure.

Record the Data and Review the Data

If equipped, check the gauges and check the indicators frequently during normal operation. Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will establish the normal gauge readings for the engine. A gauge reading that is abnormal may indicate a problem with operation or with the gauge.

i02155505

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-044

Clean the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- Oil has entered the cooling system and the coolant is contaminated.

Drain the Cooling System

1. Stop the engine and allow the engine to cool. Ensure that the engine will not start when the cooling system is drained.

Note: When maintenance for the jacket water system is performed, perform the same maintenance for the aftercooler's cooling system (if equipped).

- Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

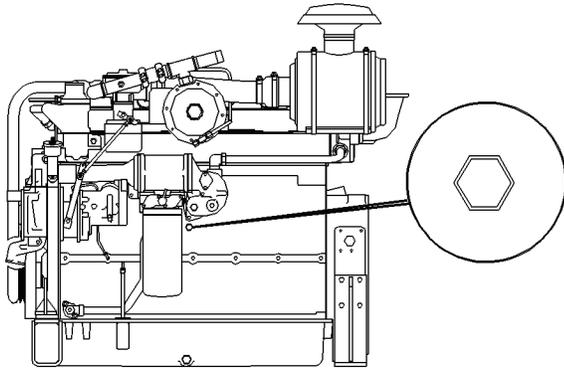


Illustration 33

g00518449

Engine block drain plug

- Open the cooling system drain valve. Remove the engine block drain plug.

NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Clean the Cooling System

- After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.
- Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

NOTICE

Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

- Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.
- Start the engine. Operate the engine for a minimum of 30 minutes with a coolant temperature of at least 82 °C (180 °F).
- Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valve. Remove the engine block drain plug.

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

- Allow the water to drain. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

Cleaning a Cooling System that has Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be an active flow through the cooling system components.

- After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.
- Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

NOTICE

Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap. Install vent plug (4).
4. Start the engine. Operate the engine for a minimum of 90 minutes with a coolant temperature of at least 82 °C (180 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valve. Remove the engine block drain plug. Allow the water to drain.

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

6. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

Fill the Cooling System

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

Note: For information about the proper coolant to use and the capacity of the cooling system, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).

1. Fill the cooling system with coolant/antifreeze. Do not install the cooling system filler cap.
2. Start the engine. Operate the engine in order to purge the air from the cavities of the engine block. Allow the coolant to warm and allow the coolant level to stabilize. Stop the engine.
3. Check the coolant level. Maintain the coolant to the proper level on the sight gauge (if equipped). If a sight gauge is not equipped, maintain the coolant within 13 mm (0.5 inch) below the bottom of the filler pipe.

4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets of the cooling system filler cap are damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gaskets of the cooling system filler cap are not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not maintain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02068741

Cooling System Coolant (NGEC) - Change

SMCS Code: 1350-044

The procedure that is used to change Natural Gas Engine Coolant (NGEC) is identical to the procedure that is used to change Diesel Engine Antifreeze/Coolant (DEAC). Refer to Operation and Maintenance Manual, "Cooling System Coolant (DEAC) - Change" for the proper procedure.

i01934272

Cooling System Coolant Analysis (Level I) - Obtain

SMCS Code: 1350

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Note: Level 1 results may indicate a need for Level 2 Analysis.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" or consult your Caterpillar dealer.

i01934327

Cooling System Coolant Analysis (Level II) - Obtain

SMCS Code: 1350

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Refer to Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 1) - Obtain" for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations" or consult your Caterpillar dealer.

i01197583

Cooling System Coolant Level - Check

SMCS Code: 1350-535-FLV

Check the coolant level when the engine is stopped and cool.

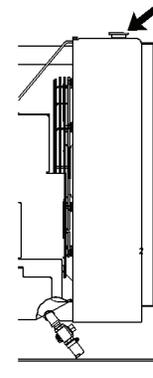


Illustration 34
Cooling system filler cap

g00285520

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

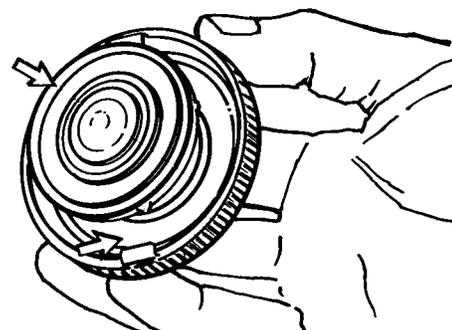


Illustration 35
Typical filler cap gaskets

g00103639

- Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
- Inspect the cooling system for leaks.

i02017557

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and eyes. Do not drink cooling system coolant additive.

Note: Caterpillar recommends an S·O·S coolant analysis (Level 1).

Test the Concentration of the SCA

Coolant/Antifreeze and SCA

NOTICE

Do not exceed the recommended six percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Follow the instructions that are provided in the kit.

Water and SCA

NOTICE

Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Use the instructions that follow:

- Fill the syringe to the "1.0 ml" mark with the coolant.
- Dispense the 1.0 mL coolant sample from the syringe into the empty mixing bottle.
- Add tap water to the mixing bottle in order to bring the level up to the "10 ml" mark. Place the cap on the bottle and shake the bottle.
- Add 2 to 3 drops of the "NITRITE INDICATOR SOLUTION B" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
- Add 1 drop of "NITRITE TEST SOLUTION A" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
- Repeat 5 until the solution changes color from red to light gray, green, or blue. Record the number of drops of "NITRITE TEST SOLUTION A" that were required to cause the color change.
- Use Table 17 to interpret the results.

Table 17

Number of Drops	Concentration of SCA	Maintenance Required
Less than 25	Less than the recommended concentration of SCA	Add SCA. Retest the coolant.
25 to 30	The recommended concentration of SCA	None
More than 30	More than the recommended concentration of SCA	Remove the coolant. Replace with water only. Retest the coolant.

Add the SCA, If Necessary

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

- Remove the cooling system filler cap slowly.

Note: Always dispose of fluids according to local regulations.

- If necessary, drain some coolant in order to allow space for the addition of the SCA.

NOTICE

Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components.

Excessive supplemental coolant additive concentration could also result in blockage of the heat exchanger, overheating, and/or accelerated wear of the water pump seal.

Do not exceed the recommended amount of supplemental coolant additive concentration.

3. Add the proper amount of SCA. The concentration of the SCA depends on the type of coolant that is used. To determine the proper amount, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic.
4. Clean the cooling system filler cap. Install the cooling system filler cap.

i01012683

Crankcase Blowby - Measure/Record

SMCS Code: 1317

Note: For a new G3304 Engine that is operating at 1800 rpm, the typical range for crankcase blowby is approximately 30 to 45 L/min (1 to 1.5 ft³/min). For a new G3306 Engine that is operating at 1800 rpm, the typical range for crankcase blowby is approximately 60 to 120 L/min (2 to 4 ft³/min).

Measure the crankcase blowby of new engines. Record the data. Continue to periodically measure the blowby. Comparing the recorded data to the new data provides information about the condition of the engine.

Note: Crankcase blowby is one of the three factors that help to determine the major overhaul interval. For more information, see this Operation and Maintenance manual, "Overhaul (Major)" topic (Maintenance Section).

After a new engine is used for a short time, the blowby can decrease as the piston rings are seated. The blowby will gradually increase as the following components show wear:

- piston rings
- cylinder liners

Note: A problem with the piston rings causes the oil to deteriorate rapidly. Information regarding the condition of the piston rings can be obtained from the measurement of the blowby and the results of oil analysis.

The blowby of a worn engine may exceed the blowby of a new engine by two times or more.

A sudden increase in blowby could indicate a broken piston ring. The following conditions are other potential sources of blowby:

- Worn valve guides
- A turbocharger seal that leaks

A rebuilt engine can have a high blowby due to the following factors:

- The piston rings are not seated properly.
- Worn parts such as valve guides were not replaced.

Excessive blowby may indicate the need for an overhaul. By keeping a record of the results, a gradual increase in the amount of the blowby will be noted until the amount has become excessive.

To measure the blowby, use the 8T - 2700 Blowby/Air Flow Indicator. Refer to Special Instruction, SEHS8712, "Using the 8T-2700 Blowby/Airflow Indicator Group". The instruction is provided with the tool.

Keep a record of the results.

For more information, see the Service Manual, "Systems Operation/Testing and Adjusting". For assistance, consult your Caterpillar dealer.

i00894991

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

Rubber Damper

Your engine may be equipped with a rubber damper. The rubber damper uses a ring which is mounted in rubber in order to reduce vibrations in the crankshaft.

Inspect the damper and repair or replace the damper for any of the following reasons:

- There is deterioration and cracking of the rubber.
- There is slippage of the outer ring from the original position.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

Visconic Damper

Your engine may be equipped with a visconic damper. The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration.

Inspect the damper for evidence of fluid leaks. If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and difficult to remove from surfaces.

If the fluid leak is oil, inspect the crankshaft seals for leaks. If a leak is observed, replace the crankshaft seals.

Inspect the damper and repair or replace the damper for any of the following reasons:

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

i01519864

Cylinder Pressure - Measure/Record

SMCS Code: 1223-082-CC; 1223; 7450-082

Measure the cylinder pressure of new engines. Record the data. Continue to periodically measure the cylinder pressure. Comparing the recorded data to the new data provides information about the condition of the engine.

Note: Cylinder pressure is one of the three factors that help to determine the major overhaul interval. For more information, see this Operation and Maintenance manual, "Overhaul (Major)" (Maintenance Section).

Cylinder pressure can be measured during inspection of the spark plugs. Use the following guidelines for checking the cylinder pressure:

- Remove all of the spark plugs.
- Fully open the throttle plate.
- Minimize the cranking time. This will enable a maximum consistent cranking speed for the check. Also, the battery power will be conserved.

A loss of cylinder pressure or a change of pressure in one or more cylinders may indicate the following conditions. These conditions may indicate a problem with lubrication:

- Excessive deposits
- Guttering of valves
- A broken valve
- A piston ring that sticks
- A broken piston ring
- Worn piston rings
- Worn cylinder liners

If the cylinder pressure has risen by one or more compression ratios, the engine needs a top end overhaul in order to remove deposits. Failure to remove the deposits will increase the chance for detonation. Severe guttering of the valves will occur.

To measure the cylinder pressure, use the 193 - 5859 Cylinder Pressure Gauge Gp. Follow the procedure in the Special Instruction, NEHS0798 that is included with the gauge group. Record the pressure for each cylinder. Use the Operation and Maintenance Manual, "Valve Data Sheet" (Reference Materials Section).

Illustration 36 is a graph of typical cylinder pressures for engines with different compression ratios.

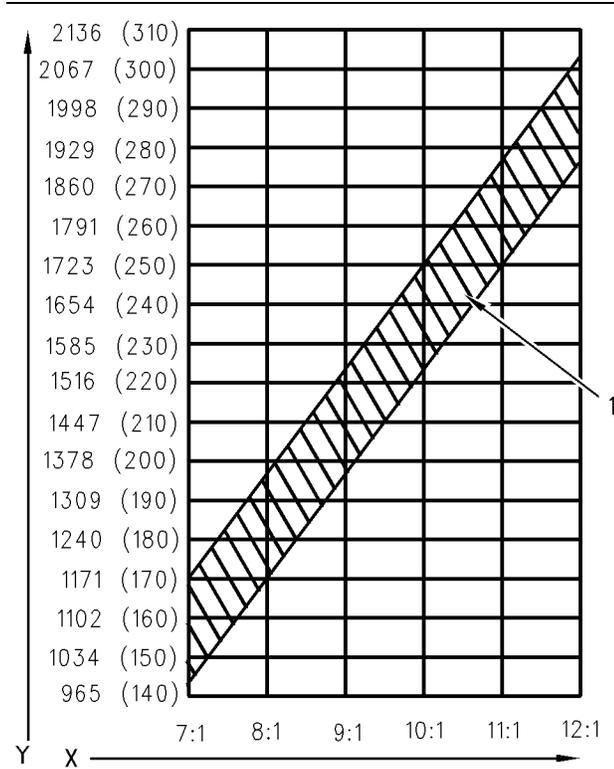


Illustration 36
g00760309
(Y) Cylinder pressure in kPa (psi)
(X) Compression ratio
(1) Normal range for cylinder pressure

Driven Equipment - Check

SMCS Code: 3279-535

To minimize bearing problems and vibration of the engine crankshaft and the driven equipment, the alignment between the engine and driven equipment must be maintained properly.

Check the alignment according to the instructions that are provided by the following manufacturers:

- Caterpillar
- OEM of the coupling

- OEM of the driven equipment

i00935098

Driven Equipment - Inspect/Replace/Lubricate

SMCS Code: 3279-040

Observe the driven equipment during operation. Look for the following items:

- Unusual noise and vibration
- Loose connections
- Damaged parts

Perform any maintenance that is recommended by the OEM of the driven equipment. Refer to the literature of the OEM of the driven equipment for the following service instructions.

- Inspection
- Lubricating grease and lubricating oil requirements
- Specifications for adjustment
- Replacement of components
- Requirements for ventilation

i02062908

Engine - Clean

SMCS Code: 1000-070



Personal injury or death can result from high voltage.

Moisture could create paths of electrical conductivity.

Make sure the unit is off line (disconnected from utility and/or other generators), locked out and tagged "Do Not Operate".

NOTICE

Water or condensation can cause damage to generator components. Protect all electrical components from exposure to water.

NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

NOTICE

Water and/or condensation can cause damage to electrical components. Protect all electrical components from exposure to water.

Note: For more information on cleaning and drying electric generators, refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".

i01749609

Engine Air Cleaner Element - Replace

SMCS Code: 1051-510; 1054-510

NOTICE

Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent air-borne debris from entering the air inlet.

NOTICE

Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

If the air cleaner element becomes plugged, the air pressure can split the filter material of the element. Unfiltered air will drastically accelerate internal engine wear. Your Caterpillar dealer has the proper air cleaner elements for your application.

The air cleaner may be mounted high above the engine. If necessary, use a ladder or a platform to reach the air cleaner.

- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element may be cleaned up to six times if the element is properly cleaned and inspected.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty paper elements with clean elements. Before installation, thoroughly inspect the element for tears and/or holes in the filter material. Inspect the gasket or the seal of the element for damage. Maintain a supply of suitable elements for replacement purposes.

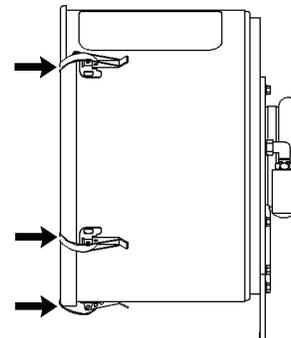


Illustration 37

g00317608

Fasteners for the air cleaner cover

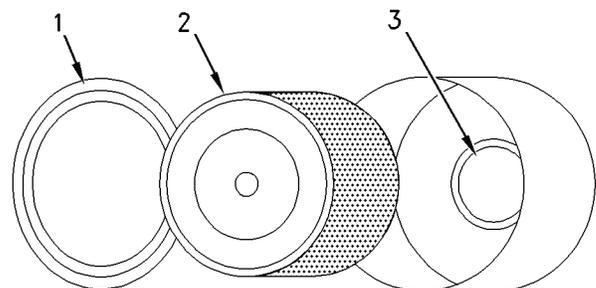


Illustration 38

g00781084

- (1) Cover
- (2) Element
- (3) Air inlet

1. Release the fasteners for cover (1).
2. Remove the cover and element (2).
3. Cover air inlet (3) with tape in order to keep dirt out.
4. Clean the inside of the cover and the body with a clean, dry cloth.
5. Remove the tape for the air inlet. Install a new element or a clean element.
6. Install the cover.
7. If necessary, reset the air cleaner service indicator.

Cleaning the Primary Air Cleaner Elements

The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. When the element is cleaned, check the filter material for rips or tears. Replace the element at least one time per year regardless of the number of cleanings.

Use clean elements while dirty elements are being cleaned.

NOTICE

Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the elements before cleaning. Inspect the elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged elements.

Air cleaner elements can be cleaned with pressurized air and with a vacuum.

Pressurized Air

Pressurized air can be used to clean elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

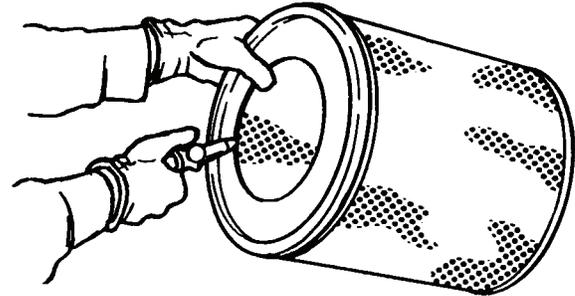


Illustration 39

g00281692

Note: When the elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the primary air cleaner element. Dirt could be forced into the pleats.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Inspecting the Primary Air Cleaner Elements

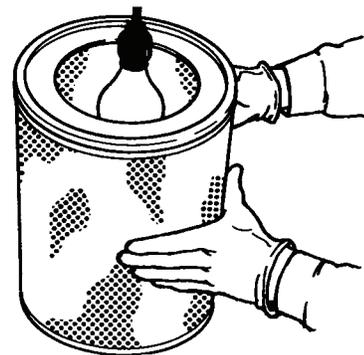


Illustration 40

g00281693

i01505252

Inspect the clean, dry element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the element. Rotate the element. Inspect the element for tears and/or holes. Inspect the element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the element to a new element that has the same part number.

Do not use an element that has any tears and/or holes in the filter material. Do not use an element with damaged pleats, gaskets or seals. Discard damaged elements.

Storing Primary Air Cleaner Elements

If an element that passes inspection will not be used immediately, store the element for future use.

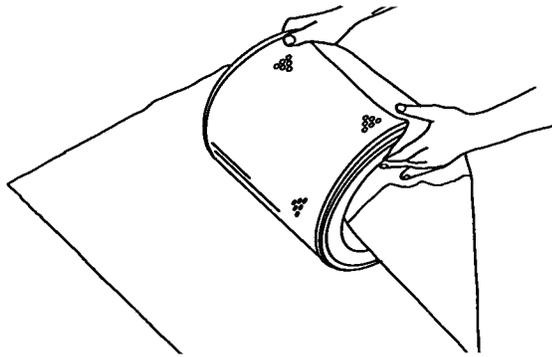


Illustration 41

g00281694

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. Restricted air flow may result. To protect against dirt and damage, wrap the elements in Volatile Corrosion Inhibited (VCI) paper.

Place the element into a cardboard box for storage. For identification, mark the outside of the container and mark the element. Include the following information:

- Date of cleaning
- Number of cleanings

Store the container in a dry location.

For more detailed information on cleaning the primary air cleaner element, refer to Special Publication, SEBF8062, "Procedure to Inspect and Clean Air Filters".

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

A service indicator may be mounted on the air cleaner element or in a remote location.

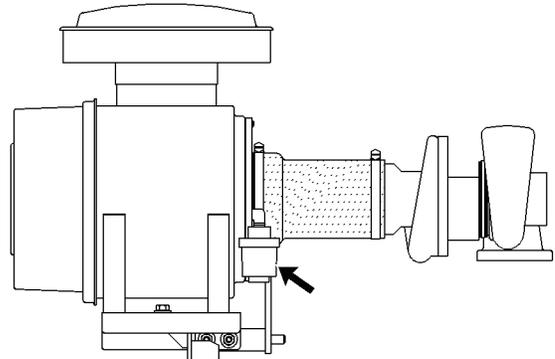


Illustration 42

g00517797

Service indicator

Some engines may be equipped with a different service indicator.

Observe the service indicator. Clean the air cleaner element or replace the element when the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.
- The air restriction reaches 3.7 kPa (15 inches of H₂O).

Inspect the service indicator daily for cracks, holes, or loose fittings. If any of these conditions are present, repair the service indicator or replace the service indicator.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated rpm. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, replace the service indicator. If the new service indicator will not reset, the fitting for the service indicator may be plugged.

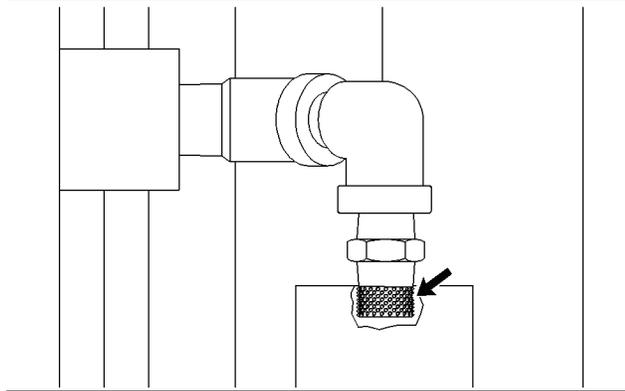


Illustration 43

g00351792

Porous filter

A porous filter is part of a fitting that is used for mounting of the service indicator. Inspect the filter for cleanliness. Clean the filter, if necessary. Use compressed air or a clean, nonflammable solvent.

The service indicator may need to be replaced frequently in environments that are severely dusty. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

Note: When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i01397717

Engine Air Precleaner - Clean

SMCS Code: 1055-070

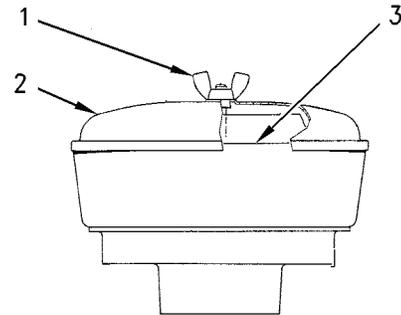


Illustration 44

g00736588

Typical precleaner

- (1) Wing nut
- (2) Cover
- (3) Body

Remove wing nut (1) and cover (2). Check for an accumulation of dirt and debris in body (3). Clean the body, if necessary.

After cleaning the pre-cleaner, install cover (2) and wing nut (1).

Note: When the engine is operated in dusty applications, more frequent cleaning is required.

i01519474

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.

Perform this maintenance when the engine is stopped.

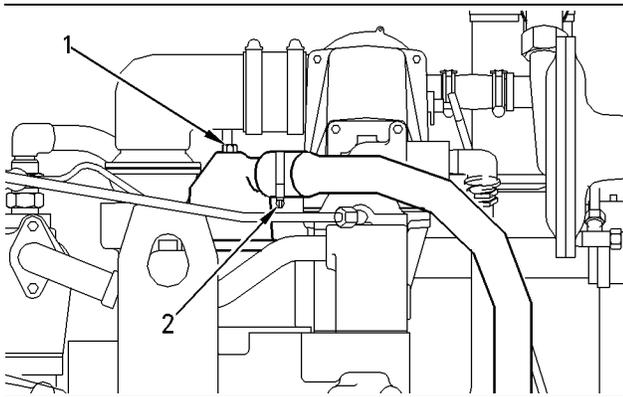


Illustration 45

g00788947

- (1) Retaining bolt
(2) Hose clamp

1. Loosen retaining bolt (1).
 2. Loosen hose clamp (2). Remove the breather assembly and the seal.
 3. Wash the breather in clean nonflammable solvent. Allow the breather to dry.
 4. Inspect the seal for good condition. Obtain a new seal, if necessary.
- Note:** Coat the rubber parts with clean engine oil or petroleum jelly in order to make installation easier.
5. Install the seal and the breather in the original position.

Tighten the hose clamp. For the proper torque, see this Operation and Maintenance Manual, "Torque Specifications" (Maintenance Section).

Install the retaining bolt. For the proper torque, see the Service Manual, "Specifications" module.

i03214182

Engine Mounts - Check

SMCS Code: 1152-535

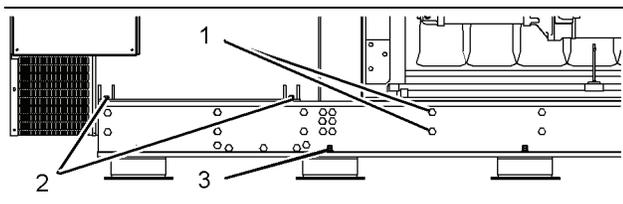


Illustration 46

g01340704

Typical configuration of mounting bolts for a Caterpillar genset

- (1) Mounting bolts for the engine
(2) Mounting bolts for the generator
(3) Levelling bolts for the isolators

Misalignment of the engine and the driven equipment will cause extensive damage. Excessive vibration can lead to misalignment. Excessive vibration of the engine and the driven equipment can be caused by the following conditions:

- Improper mounting
- Misalignment of driven equipment
- Loose bolts
- Deterioration of the isolators

Ensure that the mounting bolts are tightened to the proper torque. For standard torques, see Specifications, SENR3130, "Torque Specifications".

Ensure that the isolators are free of oil and contamination. Inspect the isolators for deterioration. Ensure that the bolts for adjusting the isolator are correctly adjusted and secured with the locking nut. Correctly adjusted isolators provide even support for the engine base. Each isolator should impose nearly identical force on the base rail. Each isolator should bear the same portion of the weight of the genset.

Replace any isolator that shows deterioration. For more information, see the literature that is provided by the OEM of the isolators. Also see the Application and Installation Guide for the engine. Consult your Caterpillar dealer for assistance.

i02150939

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

The most accurate check of the oil level is performed when the engine is stopped. Perform this maintenance on a surface that is as level as possible.

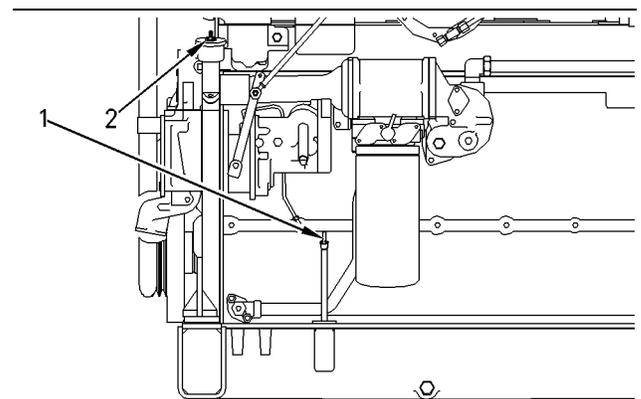


Illustration 47

g00788953

- (1) Oil level gauge (dipstick)
(2) Oil filler

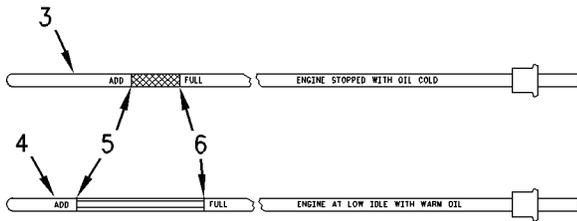


Illustration 48

g00735162

- (3) "ENGINE STOPPED" side
- (4) "LOW IDLE" side
- (5) "ADD" mark
- (6) "FULL" mark

1. Ensure that oil level gauge (1) is seated.
 - a. If the engine is stopped, remove oil level gauge (1). Observe the oil level on "ENGINE STOPPED" side (3).
 - b. If the engine is operating, reduce the engine speed to low idle. Remove oil level gauge (1) and observe the oil level on "LOW IDLE" side (4).

The oil level should be between "ADD" mark (5) and "FULL" mark (6).

NOTICE

Engine damage can occur if the crankcase is filled above the "FULL" mark on the oil level gauge (dipstick).

An overfull crankcase can cause the crankshaft to dip into the oil. This will reduce the power that is developed and also force air bubbles into the oil. These bubbles (foam) can cause the following problems: reduction of the oil's ability to lubricate, reduction of oil pressure, inadequate cooling, oil blowing out of the crankcase breathers, and excessive oil consumption.

Excessive oil consumption will cause deposits to form on the pistons and in the combustion chamber. Deposits in the combustion chamber lead to the following problems: guttering of the valves, packing of carbon under the piston rings, and wear of the cylinder liner.

If the oil level is above the "FULL" mark on the oil level gauge, drain some of the oil immediately.

2. If necessary, remove oil filler cap (2) and add oil. For the correct oil to use, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section). Do not fill the crankcase above "FULL" mark (6). Clean the oil filler cap. Install the oil filler cap.
3. Record the amount of oil that is added. For the next oil sample and analysis, include the total amount of oil that has been added since the previous oil sample. This will help to provide the most accurate oil analysis.

i01004097

Engine Oil Sample - Obtain

SMCS Code: 1348-554-SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine.

Obtain the Sample and the Analysis

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before taking the sample, complete the Label, PEEP5031 for identification of the sample. To help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The oil's hours of use
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

i02155500

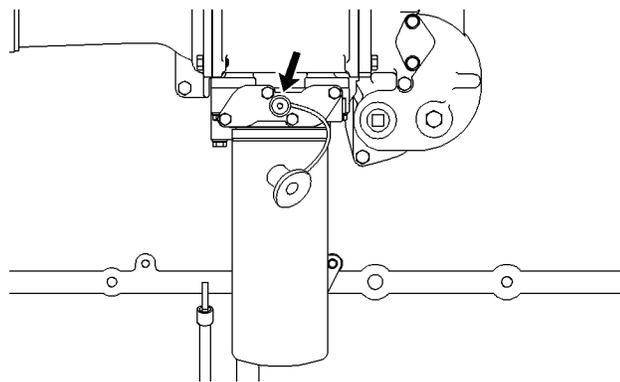


Illustration 49

g00403338

Oil sampling valve

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples is better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 8T-9190 Fluid Sampling Bottle Group is recommended for use with the sampling valve. The bottle group includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEHP6001, "How To Take A Good Oil Sample". Consult your Caterpillar dealer for complete information and assistance in establishing an S-O-S program for your engine.

Engine Oil and Filter - Change

SMCS Code: 1318-510

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

NOTICE

Ensure that the engine is stopped before performing this procedure. Attach a DO NOT OPERATE tag to the starting controls.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed when the cold oil is drained. Drain the crankcase with the oil warm, immediately after the engine is stopped. This method of draining allows the waste particles that are suspended in the oil to be drained.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

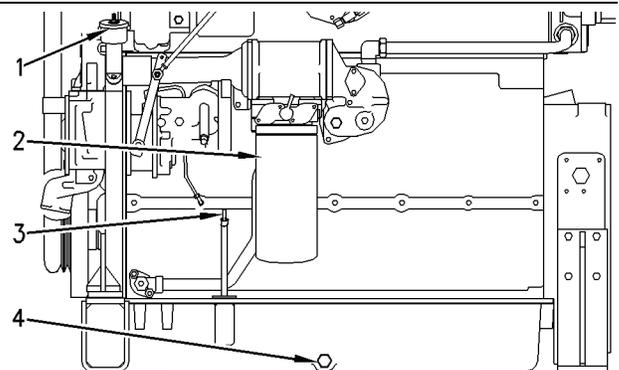


Illustration 50

g00788965

- (1) Oil filler
- (2) Oil filter
- (3) Oil level gauge (dipstick)
- (4) Oil drain plug

Drain the Engine Oil

1. After the engine has been operated at normal operating temperature, STOP the engine.

Note: Drain the oil into a suitable container. Dispose of fluids according to local regulations.

2. Drain the oil.

- a. If the engine has an oil drain valve, open the valve in order to drain the oil. After the oil has drained, close the valve.
- b. If the engine does not have a drain valve, remove an oil drain plug. Allow the oil to drain.

After the oil has drained, install the oil drain plug and tighten the plug according to the engine's Specifications.

Replace the Oil Filter

1. Remove the oil filter with a 1U-8760 Chain Wrench.
2. Cut the oil filter open with a 4C-5084 Oil Filter Cutter. Break apart the pleats and inspect the oil filter for metal debris.

An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Aluminum debris may indicate problems with the bearings of the front gears. If you find aluminum debris, inspect the vibration damper and the bearings of the front idler gear.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter element. If an excessive amount of debris is found in the oil filter element, consult your Caterpillar dealer in order to arrange for further oil analysis.



Illustration 51

g00103713

Typical filter mounting base and filter gasket

3. Clean the sealing surface of the filter mounting base. Ensure that all of the old oil filter gasket is removed.

NOTICE

Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

4. Apply clean engine oil to the new oil filter gasket.

NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the oil filter. Tighten the oil filter until the oil filter gasket contacts the base. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Fill the Engine Crankcase

NOTICE

Only use oils that are recommended by Caterpillar. For the proper oil to use, refer to this Operation and Maintenance Manual, "Engine Oil" topic (Maintenance Section).

NOTICE

Engine damage can occur if the crankcase is filled above the "FULL" mark on the oil level gauge (dipstick).

An overfull crankcase can cause the crankshaft to dip into the oil. This will reduce the power that is developed and also force air bubbles into the oil. These bubbles (foam) can cause the following problems: reduction of the oil's ability to lubricate, reduction of oil pressure, inadequate cooling, oil blowing out of the crankcase breathers, and excessive oil consumption.

Excessive oil consumption will cause deposits to form on the pistons and in the combustion chamber. Deposits in the combustion chamber lead to the following problems: guttering of the valves, packing of carbon under the piston rings, and wear of the cylinder liner.

If the oil level is above the "FULL" mark on the oil level gauge, drain some of the oil immediately.

1. Remove the oil filler cap. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section).

NOTICE

To prevent crankshaft damage or bearing damage, crank the engine with the fuel supply line closed. This will ensure that all of the oil filters are filled with oil before the engine is started. Do not crank the engine for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking again.

2. Close the fuel supply line. Crank the engine until normal oil pressure shows on the oil pressure gauge. Open the fuel supply line.
3. Start the engine according to this Operating and Maintenance Manual, "Starting the Engine" procedure (Operation Section). Operate the engine at low idle rpm for two minutes.

This will ensure that the lubrication system has oil and that the oil filters are filled. Inspect the engine for oil leaks.

4. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
5. Remove the oil level gauge and check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge.

i01042067

Engine Performance - Test**SMCS Code:** 1000-081

Operate the engine for a minimum of two hours at a minimum load of 60 percent.

- Monitor the operation of the generator set.
- Observe the gauges. Ensure that the gauges are in the normal ranges.
- Record the data. Maintain a record of the data for the engine performance.

i00626013

Engine Protective Devices - Check**SMCS Code:** 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE

During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i01626234

i01765711

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

WARNING

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring during operation.

For procedures on adjusting the engine valve lash, refer to the engine's Service Manual, "Systems Operation/Testing and Adjusting" .

Consult your Caterpillar dealer for assistance.

NOTICE

Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

If the valve lash is within the tolerance, an adjustment of the valve lash is NOT necessary.

Perform the valve lash adjustment if the dimension is not within the tolerance.

Perform the valve lash setting when the engine is cold. After the engine has been shut down and the valve covers are removed, the engine is considered cold.

Before performing maintenance, prevent the entry of foreign matter into the top of the cylinder head and the valve mechanism. Thoroughly clean the area around the valve mechanism covers.

For the valve lash setting, refer to the Operation and Maintenance Manual, "Engine Description" topic (Product Information Section).

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

NOTICE

A valve rotator which does not operate properly will accelerate valve face wear and valve seat wear and shorten valve life. If a damaged rotator is not replaced, valve face guttering could result and cause pieces of the valve to fall into the cylinder. This can cause piston and cylinder head damage.

Note: Use of a platform may be necessary to reach the engine valve rotators.

Perform this procedure after the valve lash has been set.

1. Mark the tops of the valve rotators with a permanent marker. Note the position of the marks.
2. Install the valve covers. See the Service Manual for the procedure.
3. Start the engine. Operate the engine for 5 minutes. Stop the engine.
4. Remove the valve covers. Observe the position of the marks that are on the valve rotators.

If a valve fails to rotate, consult your Caterpillar dealer.

i01505507

Exhaust Bypass - Inspect

SMCS Code: 1057-040

S/N: H4D1-Up

S/N: H6D1-Up

S/N: G6X1-Up

S/N: 07Y1-Up

For instructions on removal and installation, see the Service Manual, "Disassembly and Assembly".

1. Remove the exhaust bypass valve.

WARNING

The exhaust bypass valve cover is under spring compression. To prevent personal injury, use caution when removing the cover.

2. Disassemble the valve.

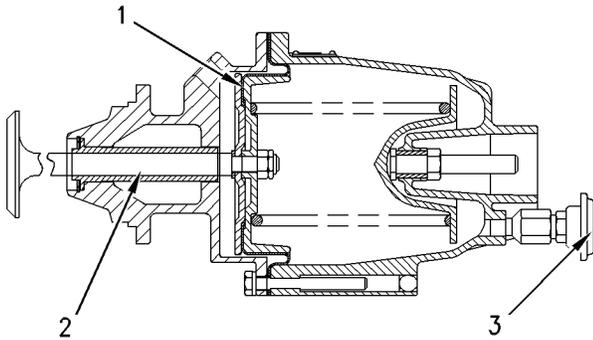


Illustration 52

g00781274

Exhaust bypass valve

- (1) Diaphragm
- (2) Valve stem
- (3) Breather

3. Inspect diaphragm (1). If the diaphragm is worn or cracked, replace the diaphragm.
4. Inspect valve stem (2) and the valve guide. If the parts are excessively worn, replace the parts.
5. Clean breather (3).
6. Assemble the valve.
7. Install the valve.

i00721010

Exhaust Piping - Inspect

SMCS Code: 1061-040

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

Inspect the components of the exhaust system. Repair the components or replace the components if any of the following conditions occur:

- Damage
- Cracks
- Leaks
- Loose connections

Consult your Caterpillar dealer for assistance.

Water Cooled Exhaust Manifolds

The water cooled exhaust manifolds do not require maintenance unless excessive deposits build up in the exhaust passages. Buildup of deposits cause an increase in back pressure that will cause the following conditions:

- Increased fuel consumption
- Reduced boost pressure

If excessive deposits build up in the exhaust passages, clean the passages in order to remove the deposits.

i01505536

Fuel System Fuel Filter Differential Pressure - Check

SMCS Code: 1261-535

A fuel filter differential pressure gauge must be installed in order to determine when the fuel filter requires service. This gauge and the fuel filter are supplied by the customer.

A fuel filter differential pressure gauge indicates the difference in fuel pressure between the inlet side and the outlet side of the fuel filter. The differential pressure increases as the fuel filter becomes plugged.

Operate the engine at the rated speed and at the normal operating temperature. Check the fuel filter differential pressure. Service of the fuel filter depends on the pressure of the fuel system:

- For low pressure gas fuel systems, service the fuel filter when the fuel filter differential pressure reaches 1.7 kPa (0.25 psi).
- For high pressure gas fuel systems, service the fuel filter when the fuel filter differential pressure reaches 34 kPa (5 psi).

For instructions, see Special Instruction, SEHS9298, "Installation and Maintenance of Gaseous Fuel Filters". Consult your Caterpillar dealer for assistance.

i02062420

i01041704

Gas Pressure Regulator - Check

SMCS Code: 1270-535

Check the fuel pressure before the gas pressure regulator and after the gas pressure regulator. Table 18 lists the fuel pressure that is required for the gas pressure regulator.

Table 18

Requirements for Fuel Pressure To the Gas Pressure Regulator	
Fuel System	Pressure
Low pressure gas for naturally aspirated engines	10.3 to 34 ± 2 kPa (1.50 to 5 ± 0.25 psi)
High pressure gas for turbocharged engines	172 to 207 ± 7 kPa (25 to 30 ± 1 psi)

Pressure of the Fuel Supply To the Carburetor

The gas pressure regulator maintains a pressure differential between the air and the fuel that is supplied to the carburetor. After setting, the gas pressure regulator will maintain the pressure differential in response to changes in the air pressure.

Use a water manometer for measuring the pressure differential. Obtain the measurement when the engine is operating at high idle rpm. After a load is applied, the fuel pressure will usually decrease by approximately 0.1 to 0.25 kPa (0.50 to 1 inches of H₂O). If the performance of the gas pressure regulator is erratic, the gas pressure regulator may require service.

Natural Gas

Set the pressure of the fuel supply to a maximum of 1 to 1.2 kPa (4 to 4.5 inches of H₂O) HIGHER than the ambient air pressure.

Propane

Set the pressure of the fuel supply to -0.37 ± -0.06 kPa (-1.5 ± 0.250 inches of H₂O) LOWER than the ambient air pressure. Refer to Special Instruction, REHS0371, "Installation And Initial Start Up Procedures For G3300 And G3400 Engines".

Governor - Inspect

SMCS Code: 1264-040

Inspect the governor for oil leaks.

For service information, see the literature that is provided by the OEM of the governor.

i02121526

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: Refer to the Specifications, SENR3130, "Torque Specifications" in order to locate the proper torques.

8. Refill the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

10. Start the engine. Inspect the cooling system for leaks.

i02164888

Hoses and Clamps - Replace

SMCS Code: 1380-510

Note: For instructions on draining the cooling system and filling the cooling system, see this Operation and Maintenance Manual, "Cooling System Coolant (DEAC) - Change" topic or see the Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change" topic (Maintenance Section).

1. Drain the cooling system.
2. Remove the used hoses and clamps. Discard the items.
3. Install new hoses and clamps. For the correct torque to use on the hose clamps, see the Specifications, SENR3130, "Torque Specifications", "Hose Clamps" topic.
4. Fill the cooling system.
5. Start the engine. Inspect the hose connections for leaks.

i01042052

Ignition System Spark Plug Wires - Replace (Standard Ignition Systems)

SMCS Code: 1558-510

WARNING

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring during operation.

NOTICE

Pulling on the wiring harness may break the wires. Do not pull on the wiring harness.

1. Disconnect the spark plug wire assembly from the transformer.
2. Disconnect the wire assembly from the spark plug. Discard the wire assembly.
3. Connect the new wire assembly to the spark plug.
4. Connect the wire assembly to the transformer.

i01626118

Ignition System Spark Plugs - Inspect/Replace

SMCS Code: 1555-535

WARNING

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring during operation.

Maintenance of the spark plugs is required in order to achieve the following benefits:

- Normal fuel consumption
- Normal level of emissions
- Maximum service life of the spark plugs

The service life of the spark plugs is affected by fouling due to deposits from the oil and by peak voltage. Maintenance of the ignition system is also affected by voltage. Higher voltage is required by higher inlet manifold air pressure and a higher compression ratio. Higher voltage reduces the service life of components such as spark plugs, wires, and transformers.

Remove the Spark Plug

NOTICE

Pulling on the wiring harness may break the wires. Do not pull on the wiring harness.

Standard Ignition System

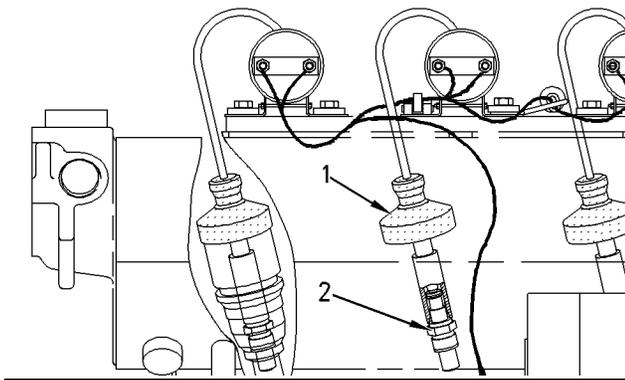


Illustration 53

g00842026

Standard ignition system

- (1) Cover
- (2) Spark plug

1. Remove cover (1).

Ignition Systems With Integral Transformers

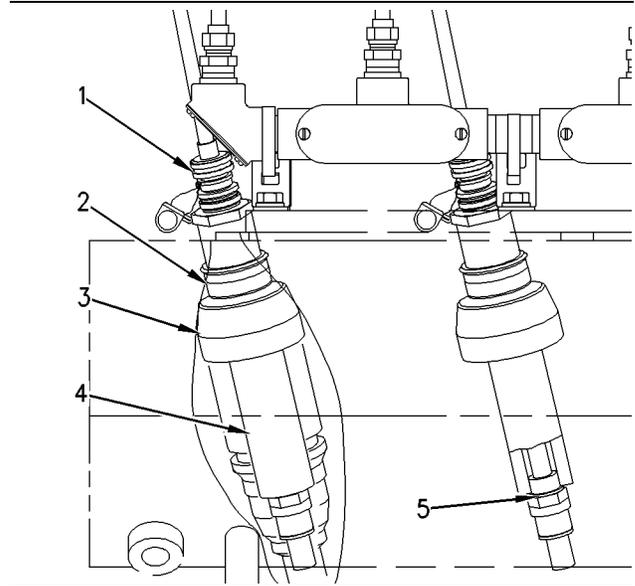


Illustration 54

g00842035

Ignition system with integral transformers

- (1) Connector
- (2) Clamp
- (3) Boot
- (4) Transformer
- (5) Gasket

1. Loosen connector (1).
2. Loosen clamp (2).
3. Remove boot (3).
4. Unscrew transformer (4).
5. Remove gasket (5). Discard the gasket.

Removing the Spark Plug

WARNING

Pressurized air can cause personal injury. When pressurized air is used for cleaning, wear a protective face shield, protective clothing, and protective shoes.

1. Debris may have collected in the spark plug well. Thoroughly remove any debris. Use compressed air. The maximum air pressure for cleaning purposes must be below 207 kPa (30 psi). Ensure that the area around the spark plug is clean and free of dirt and debris.

- To loosen the spark plug, use a 2P-5481 Deep Well Socket. After the spark plug has been loosened, remove the spark plug by hand in order to detect problems with the threads. After the spark plug has been removed, discard the used spark plug gasket.

NOTICE

The use of a thread tap will remove metal unnecessarily. This will also reduce the heat transfer for the spark plug. This can result in a reduction of the spark plug service life and a reduction of the detonation margin.

If the spark plug resists removal by hand, apply penetrating oil to the threads. Use the wrench and apply steady pressure to the spark plug until the spark plug is loose.

If the spark plug can not be removed by hand, clean the threads with a 154-9521 Spark Plug Seat Cleaner. This tool scrapes debris from the seat and from the threads in the cylinder head.

Inspecting the Spark Plug

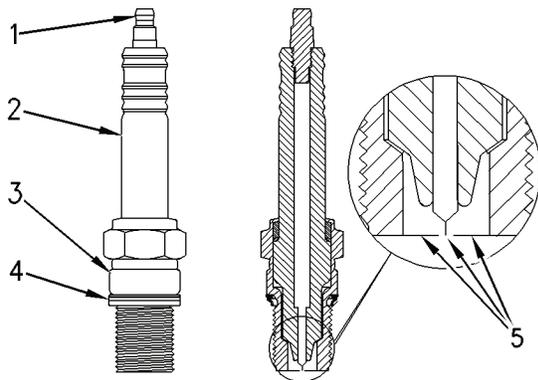


Illustration 55

g00842036

- (1) Terminal post
- (2) Insulator
- (3) Shell
- (4) Gasket
- (5) Electrode and ground straps

Inspect the spark plug closely for damage. The condition of the spark plug can indicate the operating condition of the engine.

Terminal post (1) must not move. If the terminal post can be moved by hand, discard the spark plug.

Inspect insulator (2) for cracks. If a crack is found, discard the spark plug.

Faint marks may extend from shell (3) onto the insulator. The marks may be a result of corona that forms at the top of the shell. The conductor will develop a corona when a very high voltage ionizes the air. This is a normal condition. This is not an indication of leakage between the shell and the insulator.

Inspect shell (3) for damage. Cracks can be caused by overtightening the spark plug. Overtightening can also loosen the shell. Discard any spark plug that has a shell that is cracked or loose.

Inspect the electrode and ground straps (5) for excessive wear. Flat surfaces with sharp edges provide the best conditions for creating a spark. An electrode will become worn from use. The surfaces erode. A higher voltage is required in order to produce a spark.

Caterpillar spark plugs have precious metal tips on the electrode and the ground straps. This material will gradually erode. Use extreme care for setting the electrode gap. Maintain even spacing between the two ground straps and the electrode.

Replace the spark plug if the precious metal is worn off.

Normal operation will produce a light brown deposit around the electrode.

White deposits or gray deposits may be caused by the following substances:

- Excessive oil
- Use of the wrong oil
- A substance that is introduced through the fuel system or the air system

A spark plug can operate despite a buildup of ash. However, a buildup of ash can cover the electrode gap. This will cause misfire. Large deposits may retain heat which can cause premature fuel ignition. This can lead to uncontrollable detonation.

Cleaning the Spark Plug

Thoroughly clean the spark plug. Do not use a wire brush. Glass beads are the preferred method for cleaning.

Follow these guidelines for using glass beads:

- Always use clean glass beads.
- Use care in order to clean only the electrode and the insulator near the electrode.

- Do not use glass beads on the outside of the shell or on the upper part of the insulator.

Installing the Spark Plug

Note: Do not use a flat feeler gauge for measuring the electrode gap of used spark plugs. A feeler gauge will falsely measure the actual electrode gap. This is due to the curvature of the used precious metal surfaces.

1. Before installing the spark plug, set the electrode gap to 0.635 ± 0.025 mm ($.0250 \pm .0010$ inch). Use the 9U-7516 Spark Plug Gauge.

Adjust the electrode gap in order to achieve proper alignment and even spacing between the precious metal surfaces. Measure the electrode gap after the alignment. Correct the electrode gap, if necessary.

Note: Do not use anti-seize compound on spark plugs. Most of the heat is transferred through the threads and the seat area of the spark plug. The surfaces must be in contact in order to provide the heat transfer that is required.

2. Ensure that the spark plug is clean and free of dirt and oil.
3. **Always use a new gasket when a spark plug is installed.** If a used spark plug is installed, place a new 108-3515 Plug Gasket on the spark plug. Orient the tabs of the gasket toward the electrode. Otherwise, the gasket may not seat properly. If a gasket for a spark plug is installed incorrectly, do not increase the torque on the spark plug in order to improve the seal. Do not reuse the gasket. Install a new gasket.

NOTICE

Do not overtighten the spark plug. The shell can be cracked and the gasket can be deformed. The metal can deform and the gasket can be damaged. The shell can be stretched. This will loosen the seal that is between the shell and the insulator, allowing combustion pressure to blow past the seal. Serious damage to the engine can occur.

Use the proper torque.

4. Install the spark plug by hand until the spark plug bottoms out. Tighten the spark plug to 30 ± 4 N·m (22 ± 3 lb ft).
5. Ensure that the cover is clean and free from dirt and oil. Inspect the connector for cleanliness.
6. Install the cover. Ensure a good connection for the connector and the spark plug.

Installing the Spark Plugs and the Integral Transformer

1. Follow Steps 1 through 4 from the “Installing the Spark Plug” instructions.

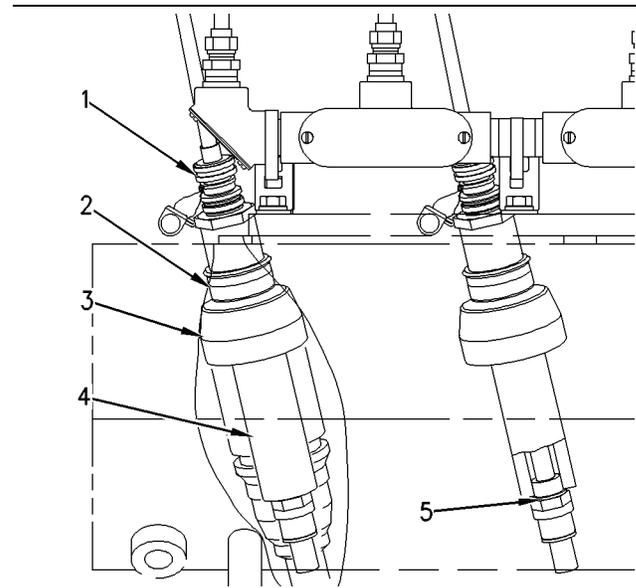


Illustration 56

g00842035

Ignition system with integral transformers

- (1) Connector
- (2) Clamp
- (3) Boot
- (4) Transformer
- (5) Gasket

2. Install new 108-6561 Gasket (5) on the spark plug.

The gasket is copper. **Whenever the transformer is removed, always install a new gasket.**

3. Ensure that transformer (4) is clean and free from dirt and oil. Screw the transformer by hand onto the spark plug.

Tighten the transformer until the transformer bottoms out on the copper gasket. Tighten the transformer for an additional 1/8 of a turn (45 degrees). Do not overtighten the transformer.

4. Inspect boot (3) for cleanliness and good condition. Install the boot.

5. Tighten clamp (2).

6. Inspect connector (1) for cleanliness and good condition. Reconnect the connector. Align the threads properly. For a correctly fastened connector, very little thread or no thread is visible.

i01005974

i01113853

Ignition System Timing - Check/Adjust

SMCS Code: 1550-025; 1550-535

After maintenance has been performed on the ignition system, check the timing of the ignition system. Adjust the timing, if necessary.

The optimum ignition timing for a gas engine varies according to several factors:

- Compression ratio of the engine
- Inlet air temperature
- Methane number of the gas

For the proper timing, see the Engine Performance publication for the engine.

Adjust the timing according to the Service Manual, "Systems Operation/Testing and Adjusting" module. Consult your Caterpillar dealer for assistance.

i00682407

Ignition System Transformer Resistance - Test

SMCS Code: 1550-081

The transformers produce a voltage increase. For good operation, the connections must be clean and secure. Inspect the transformers for the following conditions. If any of the conditions are found, correct the condition:

- Corrosion
- Dirty insulator
- Loose connections
- Moisture
- Open circuits
- Short circuits

Test the resistance of the transformers. Test each transformer at both the side with high voltage and the side with low voltage. See the Service Manual, "Specifications" module for the procedure. Consult your Caterpillar dealer for assistance.

Inlet Air System - Inspect

SMCS Code: 1058-040; 1071-040; 1087-040

Inspect the components of the air inlet system for the following conditions:

- Cracks
- Leaks
- Loose connections

Inspect the following components:

- Piping between the air cleaner and the turbocharger
- Turbocharger
- Piping between the turbocharger and the aftercooler
- Aftercooler
- Connection of the aftercooler to the air plenum
- Connection of the air plenum to the cylinder head

Ensure that all of the connections are secure. Ensure that the components are in good condition.

Make repairs, if necessary. For information regarding removal and installation of the components, see the Service Manual, "Disassembly and Assembly" module. Consult your Caterpillar dealer for assistance.

i01021379

Instrument Panel - Inspect

SMCS Code: 7451-040

Inspect the instrument panel for good condition. Check the condition of all of the gauges. If a gauge is broken, repair the gauge or replace the gauge immediately.

Frequently monitor the following parameters during normal operation:

- Fuel filter differential pressure
- Inlet air restriction
- Inlet manifold air temperature
- Jacket water temperature

- Oil filter differential pressure
- Oil pressure

Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will establish the normal gauge readings for the engine. A gauge reading that is abnormal may indicate a problem with operation or a problem with the gauge.

i03230758

Jacket Water Heater - Check

SMCS Code: 1383-535

Jacket water heaters help to improve startability in ambient temperatures that are below 21 °C (70 °F). All installations that require automatic starting should have jacket water heaters.

Check the operation of the jacket water heater. Check the operation of the circulation pump, if equipped. For an ambient temperature of 0 °C (32 °F), the heater should maintain the jacket water coolant temperature at approximately 32 °C (90 °F).

i02049014

Overhaul (Major)

SMCS Code: 7595-020-MJ

Scheduling a Major Overhaul

The need for a major overhaul is determined by several factors.

- An increase of oil consumption
- An increase of crankcase blowby
- A decrease and variation of cylinder compression

The following changes in the three conditions normally require a scheduled overhaul:

- A 300 percent increase in oil consumption
- A 200 percent increase in crankcase blowby
- A 20 percent loss of cylinder compression

Note: These indications do not require an engine to be shut down for service. These indications only mean that an engine should be scheduled for service in the near future. If the engine operation is satisfactory, an immediate overhaul is not a requirement.

The engine does not require an overhaul if the engine is operating within acceptable limits for oil consumption, crankcase blowby, and cylinder compression.

Other factors must also be considered for determining a major overhaul:

- The service hours of the engine
- The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

An increase of wear metals in the lube oil indicates that the bearings and the surfaces that wear may need to be serviced. An increase in the levels of noise and vibration indicates that rotating parts require service.

Note: It is possible for oil analysis to indicate a decrease of wear metals in the lube oil. The cylinder liners may be worn so that polishing of the bore occurs. Also, the increased use of lube oil will dilute the wear metals.

Monitor the engine as the engine accumulates service hours. Consult your Caterpillar dealer about scheduling a major overhaul.

Note: The driven equipment may also require service when the engine is overhauled. Refer to the literature that is provided by the OEM of the driven equipment.

Major Overhaul Information

A major overhaul includes all of the work that is done for top end overhauls. A major overhaul includes additional parts and labor. Additional parts and labor are required in order to completely rebuild the engine. In some cases, the engine is relocated for disassembly.

For the major overhaul, all of the bearings, seals, gaskets, and components that wear are disassembled. The parts are cleaned and the parts are inspected. If necessary, the parts are replaced. The crankshaft is measured for wear. The crankshaft may require regrinding. Alternatively, the crankshaft may be replaced with a Caterpillar replacement part.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the following recommendations.

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component may be reconditioned in order to comply with reusability guidelines. If the component cannot be rebuilt, replace the component.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer. Consult your Caterpillar dealer about repair options for your engine.

Table 19

Major Overhaul	
Inspect	Aftercooler
	Alternator
	Camshafts
	Camshaft followers
	Connecting rods
	Crankshaft
	Gear train
	Governor
	Inlet air piping
	Oil cooler
	Oil pump
	Pistons
	Transformers

(continued)

(Table 19, contd)

Major Overhaul	
Rebuild	Carburetor
	Cylinder packs
	Exhaust bypass (if equipped)
	Gas regulator
	Inlet air piping
	Oil pump
	Starting motor
	Turbocharger
	Water pumps
Replace	Alternator and fan drive belts
	Camshaft bearings
	Connecting rod bearings
	Crankshaft bearings
	Crankshaft seals
	Crankshaft vibration damper
	Cylinder liners
	Cylinder head and gaskets
	Exhaust manifold
	Gaskets and seals
	Gear train bearings
	Governor
	Hoses and clamps
	Piston rings
	Rod ends
	Spark plugs
	Spark plug wires
	Transformers
	Water temperature regulators
	Wiring harnesses

i02049048

Overhaul (Top End)

SMCS Code: 7595-020-TE

Scheduling a Top End Overhaul

Top end overhauls are scheduled according to the recession of the exhaust valve stems. This measurement provides an accurate indication of the rate of valve wear. This measurement can be used to predict when a cylinder head requires replacement. For more information, see this Operation and Maintenance Manual, "Valve Stem Projection - Measure/Record" topic.

Note: The generator or the driven equipment may also require service when the engine overhaul is performed.

Top End Overhaul Information

A top end overhaul involves servicing the cylinder heads and turbochargers. Also, some other engine components are inspected.

Top end overhauls require more tools than preventive maintenance. The following tools are needed for restoring the engine to factory specifications:

- Torque wrenches
- Dial indicators
- Accurate measurement tools
- Cleaning equipment
- Rebuilding equipment

Caterpillar dealers are equipped with these tools. Caterpillar dealers can provide a flat rate price for a top end overhaul.

Unexpected problems may be found during a top end overhaul. Plan to correct these problems, if necessary.

- Buildup in the cylinders from excessive oil consumption
- Buildup in the cylinders from contamination of the fuel
- Plugging of the aftercooler from coolant that is poorly maintained
- Plugging of the aftercooler from contamination of the inlet air

- Degradation of the oil cooler from hydrogen sulfide in the fuel

Inspect the following components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, "Index of Publications on Reusability or Salvage of Used Parts".

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the following recommendations.

Replacing of Components

Note: The cylinder head may be rebuilt, when possible.

Replace the following components during a top end overhaul.

- Alternator and fan drive belts
- Cylinder heads and gaskets
- Hoses and clamps
- Rod ends for the control linkage of the actuator
- Spark plugs
- Spark plug wires
- Water temperature regulator

Rebuilding of Components

Rebuild the following components during a top end overhaul:

- Carburetor
- Gas regulator
- Magneto
- Starting motor
- Turbocharger
- Water pumps

Note: Periodic inspection of the turbocharger is recommended for determining when the turbocharger will require an overhaul. In a few applications, the turbocharger may require rebuilding prior to the top end overhaul. An example is an application with loads that vary frequently. In these cases, rebuilding the turbocharger normally occurs separately from rebuilding the cylinder heads. Some applications can operate longer before the turbocharger requires rebuilding. Only experience can determine the actual need.

Inspecting of Components

Clean the following components. Pressure test the components. Replace the components, if necessary:

- Aftercooler core (if equipped)
- Oil cooler core

Note: If proper maintenance of the cooling system is not performed, the aftercooler core can be very difficult to clean.

Note: This procedure may be used for cleaning both the aftercooler core and the oil cooler core.

1. Remove the core. For the procedure, see the Service Manual, "Disassembly and Assembly" module.
2. Turn the core upside-down in order to remove debris.

NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

NOTICE

Do not use a high pressure spray for cleaning the fins of the core. A high pressure spray can damage the surface of the fins and reduce the flow of air through the core.

3. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Use a two to five percent concentration of the cleaner at temperatures up to 93 °C (200 °F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

4. Steam clean the core in order to remove any residue. Flush the fins of the core. Remove any other trapped debris.

5. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.

Note: The test pressure for the oil cooler is 790 kPa (115 psi). The maximum differential pressure of water for the aftercooler is 44 kPa (6 psi). The maximum differential pressure of air for the aftercooler is 5.1 kPa (.74 psi).

7. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.
8. Install the core. For the procedure, see the Service Manual, "Disassembly and Assembly" module.

For more information on cleaning the cores, consult your Caterpillar dealer.

Exhaust Bypass

Inspect the condition of the exhaust bypass (if equipped). Recondition the component, if necessary. See this Operation and Maintenance Manual, "Exhaust Bypass - Inspect" topic (Maintenance Section).

Governor

Inspect the governor for proper operation. Make any repairs that are necessary.

Transformers

The transformers produce a voltage increase. For good operation, the connections must be clean and secure. Inspect the transformers for the following conditions:

- Dirty insulator
- Loose connections
- Loose connector

- Moisture

Test the resistance of the transformers according to the Service Manual, "Specifications" module. Consult your Caterpillar dealer for assistance.

i02049051

Overhaul Considerations

SMCS Code: 7595-043

Overhaul Information

An overhaul is replacing the major worn components of the engine. An overhaul is a maintenance interval that is planned. The engine is rebuilt with certain rebuilt parts or new parts that replace the worn parts.

An overhaul also includes the following maintenance:

- Inspection of all the parts that are visible during the disassembly
- Replacement of the seals and gaskets that are removed
- Cleaning of the internal passages of the engine and the engine block

Most owners will save money by overhauling the engine at the intervals that are recommended in this Operation and Maintenance Manual. It is not practical to wait until the engine exhibits symptoms of excessive wear or failure. It is not less costly to wait. A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the guidelines for reusable parts.
- The service life of the engine can be extended without the risk of a major catastrophe due to engine failure.
- Achieve the best cost/value relationship per hour of extended service life.

Overhaul Intervals

Top end overhauls are determined by the projection of exhaust valve stems. Major overhauls are determined by cylinder compression, crankcase blowby, oil consumption, and results of S-O-S oil analysis.

Some other factors that are important for determining the overhaul intervals include the following considerations:

- Performance of preventive maintenance
- Use of recommended lubricants
- Use of recommended coolants
- Use of recommended fuels
- Proper installation
- Operating conditions
- Operation within acceptable limits
- Engine load
- Engine speed

Note: To avoid oil problems, engines that are turbocharged and aftercooled must be operated at a minimum of 60 percent of rated load.

Generally, engines that are operated at a reduced load and/or speed achieve more service life before an overhaul. However, this is for engines that are properly adjusted, operated and maintained.

Overhaul Inspection

Refer to the Service Manual for the disassembly and assembly procedures that are necessary in order to perform the required maintenance on the items that are listed. Consult your Caterpillar dealer for assistance.

To determine the reusability publications that are needed to inspect the engine, refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, "Index of Publications on Reusability or Salvage of Used Parts".

The Guidelines For Reusable Parts and Salvage Operations is part of an established Caterpillar parts reusability program. These guidelines were developed in order to assist Caterpillar dealers and customers reduce costs by avoiding unnecessary expenditures for new parts. If the engine parts comply with the established inspection specifications, the parts can be reused. New parts are not necessary if the old parts can be reused, repaired, or salvaged.

If the parts are not within the inspection specifications, the parts should be salvaged, repaired, replaced, or exchanged. The use of out-of-spec parts could result in unscheduled downtime and/or costly repairs. The use of out-of-spec parts can also contribute to increased fuel consumption and reduction of engine efficiency.

101506009

Your Caterpillar dealer can provide the parts that are needed to rebuild the engine at the least possible cost.

Overhaul Programs

An economical way to obtain most of the parts that are needed for overhauls is to use Caterpillar remanufactured parts. Caterpillar remanufactured parts are available at a fraction of the cost of new parts. These parts have been rebuilt by Caterpillar and certified for use. The following components are examples of the remanufactured parts:

- Alternators
- Connecting rods
- Crankshafts
- Cylinder heads
- Oil Pumps
- Starting motors
- Turbochargers
- Water pumps

Consult your Caterpillar dealer for details and for a list of the remanufactured parts that are available.

Your Caterpillar dealer may be offering a variety of overhaul options.

A Flat Rate Overhaul guarantees the maximum price that you will pay for an overhaul. Flat rate prices on preventive maintenance programs or major repair options are available from many servicing dealers for all Caterpillar Engines. Consult your Caterpillar dealer in order to schedule a before failure overhaul.

Overhaul Recommendation

Caterpillar recommends a scheduled overhaul in order to minimize downtime. A scheduled overhaul will provide the lowest cost and the greatest value. Schedule an overhaul with your Caterpillar dealer.

Overhaul programs vary between dealers. To obtain specific information about the types of overhaul programs and services, consult your Caterpillar dealer.

Power Take-Off Clutch - Check/Adjust/Lubricate

SMCS Code: 3055-036; 3055-086

NOTICE

New power take-offs should have the clutch adjustment checked before being placed into service. The clutch adjustment should be checked again after the first ten hours of operation. New clutch plates have a "wear in" period, and the clutch may require several adjustments until the new plates are "worn in".

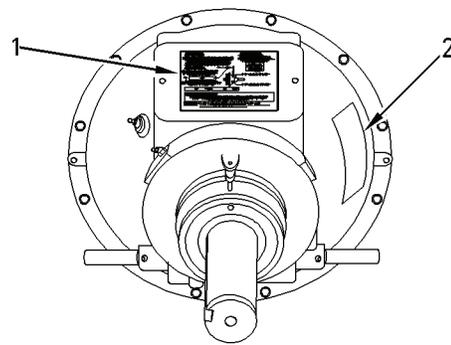


Illustration 57

g00781502

- (1) Instruction plate
(2) Serial number plate

Check the clutch adjustment regularly after "wear in". Heavy-duty applications which have engagements that are frequent and relatively long periods of clutch slippage require more frequent adjustment than light-duty applications. The operating torque should be measured in order to determine if a clutch adjustment is required.

Refer to the OEM information and instruction plate (1) for instructions on lubrication, adjustment, and other recommendations for service. Perform the maintenance that is specified on the instruction plate.

WARNING

Do not operate the engine with the Instruction Plate cover removed from the clutch. Personal injury may result.

If the clutch is damaged to the point of burst failure, expelled pieces can cause personal injury to anyone in the immediate area. Proper safeguards must be followed to help prevent accidents.

i02559063

i01511915

Radiator - Clean

SMCS Code: 1353-070

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, refer to Special Publication, SEBD0518, "Know Your Cooling System".

Speed Sensor - Clean/Inspect

SMCS Code: 1907-040; 1907-070

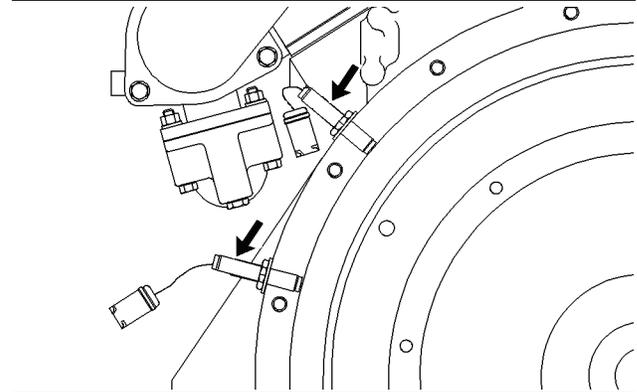


Illustration 58

g00784740

Speed sensors

1. Remove the speed sensor from the flywheel housing. Check the condition of the end of the magnet. Check for signs of wear and contaminants.
2. Clean the metal shavings and other debris from the face of the magnet.
3. Install the speed sensor and adjust the speed sensor according to the engine's Specifications module.

i01038735

Standby Generator Set Maintenance Recommendations

SMCS Code: 4450-041

A standby generator set may not need to be used very often. However, the generator set is usually needed for operation in an emergency situation. Maintenance of the standby generator set is very important for the following reasons:

- The generator set must always be in excellent operating condition.
- The generator set must be ready to work under load at any time.

Establishing a Preventive Maintenance Program will provide these benefits:

- Maximum availability of the standby generator set

- Longer service life for the generator set
- Minimum of expensive repairs

Your Caterpillar dealer can help you to establish an effective Preventive Maintenance Program for your generator set. Consult your Caterpillar dealer for details.

Maintenance and Operation Procedures

WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the “OFF” position. Attach “DO NOT OPERATE” tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

The recommended maintenance for the engine is listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule (Standby Generator Set Engines)” (Maintenance Section).

For the recommended generator maintenance, see the Operation and Maintenance Manual for the generator and the control panel.

Maintenance and Repair

The maintenance that is recommended for Every Week can be performed by an authorized operator. The maintenance that is recommended for the subsequent maintenance intervals must be performed by an authorized service technician or by your Caterpillar dealer.

Unless other instructions are provided, perform maintenance and repairs under the following conditions:

- The engine is stopped.
- The starting system is disabled.
- The generator does not pose an electrical shock hazard.

Operation

To ensure proper operation, the generator set must be exercised regularly. For instructions on operating the generator set, see the Operation and Maintenance Manual for the generator set control panel.

For these operation procedures, follow the instructions that are provided in this Operation and Maintenance Manual, “Operation Section”: starting the engine, engine operation, and stopping the engine.

Record Keeping

Maintain a record in order to document these items: gauge readings, maintenance that is performed, problems, and repairs.

Space Heaters

Moisture causes damage to generators and other electrical equipment. Make every effort to keep the generator set as dry as possible.

Generators can operate without problems in humid environments. However, problems can occur when the generator is inactive. Moisture can condense on the windings. This can result in poor performance. Also, damage to the windings can occur.

Use space heaters in order to help keep the windings dry. When the generator is not active, ensure that the space heaters are operating. When the generator is operating, turn OFF the space heaters.

i01113939

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

If the starting motor fails, the engine may not start in an emergency situation. A scheduled inspection of the starting motor is recommended.

The starting motor pinion and the flywheel ring gear must be in good condition in order for the engine to start properly. The engine will not start if the starting motor pinion does not engage the flywheel ring gear. The teeth of the starting motor pinion and the flywheel ring gear can be damaged because of irregular engagement.

Inspect the starting motor for proper operation. Listen for grinding when the engine is started. Inspect the teeth of the starting motor pinion and the flywheel ring gear. Look for patterns of wear on the teeth. Look for teeth that are broken or chipped. If damaged teeth are found, the starting motor pinion and the flywheel ring gear must be replaced.

Electric Starting Motor

i01012850

Note: Problems with the electric starting motor can be caused by the following conditions: malfunction of the solenoid and malfunction of the electric starting system.

Inspect the electrical system for the following conditions:

- Loose connections
- Corrosion
- Wires that are worn or frayed
- Cleanliness

Make repairs, if necessary.

Air Starting Motor

WARNING

Personal injury or death can result from improperly checking for a leak.

Always use a board or cardboard when checking for a leak. Escaping air or fluid under pressure, even a pin-hole size leak, can penetrate body tissue causing serious injury, and possible death.

If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Inspect all of the components in the air circuit for the starting motor. Inspect all of the air lines and connections for leaks.

If the teeth of the starting motor pinion and/or the flywheel ring gear are damaged, the air circuit for the starting motor must be examined in order to determine the cause of the problem.

Removal and Installation of the Starting Motor

Refer to the Service Manual, "Disassembly and Assembly" module for information on removing the starting motor and installing the starting motor.

Consult your Caterpillar dealer for assistance.

Turbocharger - Inspect

SMCS Code: 1052-040

S/N: H4D1-Up

S/N: H6D1-Up

S/N: G6X1-Up

S/N: 07Y1-Up

Periodic inspection and cleaning is recommended for the turbocharger.

Fouling of the turbine wheels can contribute to loss of engine power and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel could allow parts from the compressor wheel to enter an engine cylinder. This can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. Also, the chance for potential damage to other engine parts is reduced.

Note: Turbocharger components require clearances that are precise. The turbocharger cartridge must be balanced due to high rpm.

The following conditions can cause the turbocharger to be out-of-balance:

- The buildup of deposits
- Chipping and/or flaking of deposits

If the turbocharger must be removed for inspection, use caution. Do not break deposits from the turbine wheel. Do not attempt to clean the turbine wheel. For options regarding removal, installation, repair and replacement, see the Service Manual or consult your Caterpillar dealer.

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.
2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger should be reconditioned.
3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

Note: Deposits can accumulate on the turbine wheel. The turbine wheel will become unbalanced when the deposits flake off. The turbocharger cartridge must be replaced when this occurs. However, remove deposits from the housing. This will prevent wear on the blades of the turbine wheel.

4. Inspect the turbine wheel for deposits. If deposits of 25 mm (1/16 inch) thickness are found or if the turbine is in contact with the housing, the turbocharger must be disassembled and cleaned. The deposits can be very difficult to remove.
5. Inspect the bore of the turbine housing for corrosion and deposits.
6. Clean the turbocharger compressor housing with standard shop solvents and a soft bristle brush.
7. Check the clearances of the turbocharger bearing. Compare the clearances to the Service Manual, "Specifications". If the clearances are not within the specifications, the turbocharger must be repaired.

8. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i01360109

Valve Stem Projection - Measure/Record

SMCS Code: 1105-082

Valve Recession – The valves and the valve seats are worn over time. This causes the valves to recede into the cylinder head. This condition is called "valve recession".

The exhaust valves and valve seats show the greatest wear due to high operating temperatures. The top end overhaul is normally scheduled according to the exhaust valve recession.

It is difficult to obtain an accurate measurement of valve recession inside the cylinder head. Use the following method in order to determine the valve recession:

1. Remove the valve cover. For instructions, see the Service Manual, "Disassembly and Assembly" module.
2. Move the rocker arm from the top of the valve stem.
3. Use a depth micrometer. Obtain the measurement from the tip of the valve stem to the cylinder head. Obtain this measurement for each exhaust valve.

Make several copies of this Operation and Maintenance Manual, "Valve Data Sheet" (Reference Materials Section). Record the measurements on the sheets.

- The projection of the exhaust valve stems should be measured after completion of the initial start-up tests and the engine commissioning. This measurement is the baseline. The baseline is a reference for subsequent measurements.
- Measure the projection of the exhaust valve rotators at the first oil change interval. Illustration 59 shows schedules for determining subsequent intervals.

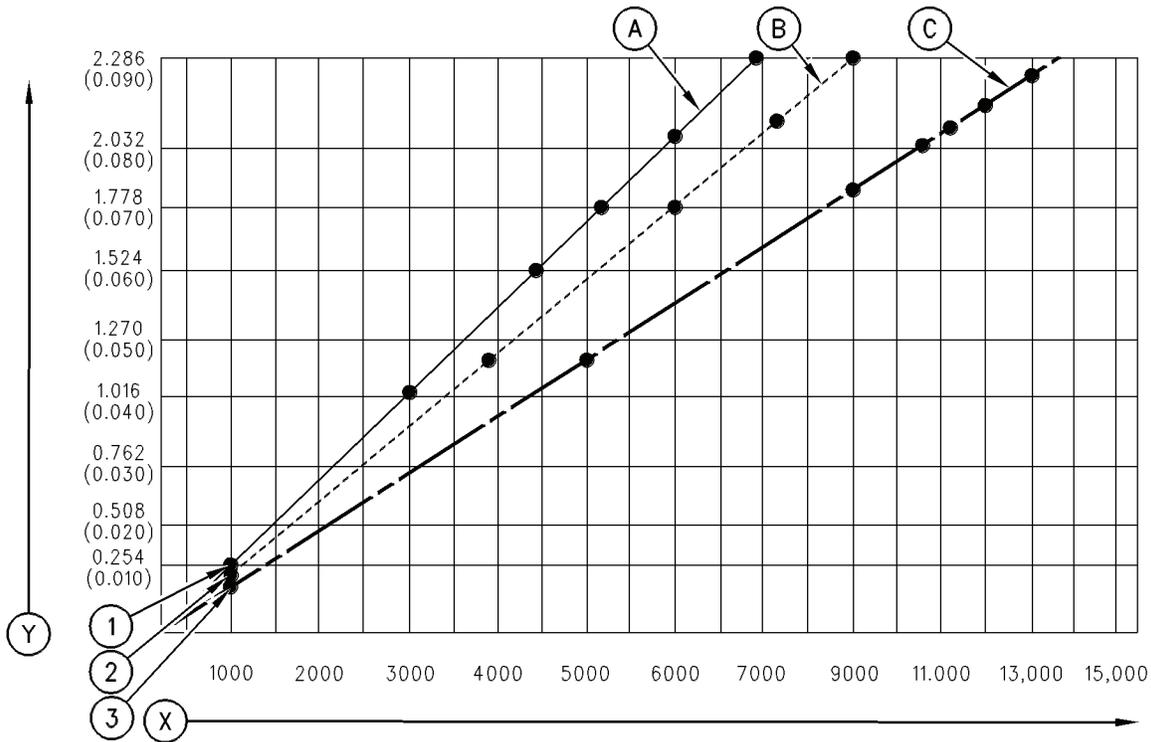


Illustration 59

g00320513

(A) Schedule
(B) Schedule
(C) Schedule

(Y) Valve recession in millimeters (inches)
(X) Hours of operation
(1) 0.254 mm (0.0100 inch)

(2) 0.218 mm (0.0086 inch)
(3) 0.152 mm (0.0060 inch)

To determine intervals, use the point on the graph in Illustration 59 that is closest to the measurement for each cylinder.

Consult your Caterpillar dealer for assistance.

For example, suppose that the measurement that was obtained at the initial oil change shows a valve recession of approximately 0.152 mm (0.0060 inch). According to Schedule (C), the next interval for measuring that cylinder is at 5000 service hours. Another cylinder may have a valve recession of approximately 0.254 mm (0.0100 inch). According to Schedule (A), the next interval for measuring that cylinder is at 3000 service hours.

- After 70 percent of the maximum limit has been reached, measure the projection of the exhaust valve stems at every 750 hours of operation (turbocharged engines). For Naturally aspirated engines, perform the measurement at every 1500 hours of operation.
- Plan for the top end overhaul as the valve stem projection approaches the maximum limit. Perform the top end overhaul when the valve stem projection has increased by a total of 2.3 mm (0.09 inch). **Do not allow the valve recession to exceed this limit.** The valve head can break. This will cause severe damage in the combustion chamber and the turbocharger.

i01492446

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, thoroughly inspect the engine room before starting the engine. Look for items such as leaks, loose bolts, loose connections and trash buildup. Make repairs, as needed.

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE

For any type of leak, clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that cooling lines are properly clamped. Check for leaks. Check the condition of all pipes.
- Inspect the water pumps for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur when the engine cools and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For instructions on removal and installation of water pumps and/or seals, refer to the Service Manual, "Disassembly and Assembly" module for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve covers.

 **WARNING**

NEVER use a flame to check for gas leaks. Use a gas detector.

An open flame can ignite mixtures of air and fuel. This will cause explosion and/or fire which could result in severe personal injury or death.

- Check the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground straps for good connections and for good condition.
- Check the condition of the gauges. Replace any gauge that is damaged. Replace any gauge that can not be calibrated.

- Inspect the exhaust system for leaks. If a leak is found, make repairs.

i01041757

Walk-Around Inspection (Exercise Inspection of Standby Generator Set Engines)

SMCS Code: 1000-040

 **WARNING**

NEVER use a flame to check for gas leaks. Use a gas detector.

An open flame can ignite mixtures of air and fuel. This will cause explosion and/or fire which could result in severe personal injury or death.

1. Perform the procedures that are described in this Operation and Maintenance Manual, "Before Starting Engine" topic (Operation Section).
 2. Start the engine according to the instructions in this Operation and Maintenance Manual, "Engine Starting" topic (Operation Section).
-

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

3. Perform an inspection of the installation after the engine is started. Look for leaks. Listen for unusual noises.
 - Check the engine oil level when the engine is operating at low idle rpm. Observe the oil level on the "LOW IDLE" side of the oil level gauge (dipstick).
 - Inspect the lubrication system for leaks at the oil pan, the oil filter, and the valve covers.
 - Inspect the cooling system for leaks at the hose connections.
 - Check the fuel system for leaks with a gas detector.
 - Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.

-
- Inspect the exhaust system for leaks.
 - If the enclosure has louvers, inspect the louvers for proper operation.
 - Observe the gauges. Ensure the correct readings for the engine rpm. Record the engine oil pressure and the jacket water temperature.
 - Record the data for the performance of the generator. See the Operation and Maintenance Manual for the generator and the control panel.
4. After exercising the generator set, stop the engine according to this Operation and Maintenance Manual, "Engine Stopping" topic (Operation Section).
 5. Perform the procedures that are described in this Operation and Maintenance Manual, "After Stopping Engine" topic (Operation Section).
 6. Ensure that the control switches are in the correct position for automatic starting of the generator set.

i02624237

Water Pump - Inspect

SMCS Code: 1361-040

A failed water pump might cause severe engine overheating problems that could result in cracks in the cylinder head, a piston seizure or other potential damage to the engine.

Visually inspect the water pump for leaks. If leaking of the water pump seals is observed, replace all of the water pump seals. Refer to two articles in the Disassembly and Assembly Manual, "Water Pump - Disassemble and Water Pump - Assemble" for the disassembly and assembly procedure. If it is necessary to remove the water pump, refer to two articles in the Disassembly and Assembly Manual, "Water Pump - Remove and Water Pump - Install".

Inspect the water pump for wear, cracks, pin holes and proper operation. Refer to the Parts Manual for the correct part numbers for your engine or consult your Caterpillar dealer if repair is needed or replacement is needed.

Reference Information Section

Customer Service

i01028392

Ordering Replacement Parts

SMCS Code: 4450; 7567

 **WARNING**

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

i00912149

i02408969

Maintenance Records

SMCS Code: 1000; 4450

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.
- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owner's repair costs
- Owner's receipts

- Maintenance log

Maintenance Records

SMCS Code: 1000; 4450

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Demonstration of compliance with the required maintenance practices and maintenance intervals
- Determination of operating costs
- Establishment of maintenance schedules for other engines that are operated in the same environment

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Keep records for the following items:

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. Keep the following documents as proof of maintenance or repair for warranty:

- Dealer work orders and itemized bills
- Logs of engine performance
- Maintenance logs
- Owner's repair costs
- Owner's receipts
- Trend charts

i01006031

Valve Data Sheet

SMCS Code: 1000

Table 22

Engine Model		Serial Number	Service Hours		Operator	
Cylinder	Cylinder Pressure	Valve Location	Current Measure	Stem Baseline	Rotator Baseline	Wear
1		Pushrod Side				
		Exhaust Manifold				
2		Pushrod Side				
		Exhaust Manifold				
3		Pushrod Side				
		Exhaust Manifold				
4		Pushrod Side				
		Exhaust Manifold				
5		Pushrod Side				
		Exhaust Manifold				
6		Pushrod Side				
		Exhaust Manifold				

i02156058

Reference Material

SMCS Code: 1000; 4450

The following literature can be obtained through any Caterpillar dealer.

Lubricants

- Data Sheet, PEHP0002, "Multipurpose Lithium Complex Grease with Molybdenum (MPGM)"
- Data Sheet, PEHP0003, "Multipurpose Lithium Complex Grease (MPG)"
- Data Sheet, PEHP0017, "Special Purpose Grease (SPG) Bearing Lubricant"
- Data Sheet, PECP0004, "Natural Gas Engine Oil"
- Special Publication, PECP6026, "One Safe Source (NACD)"
- Special Publication, PECP6027, "One Safe Source (COSA)"
- Special Publication, PECP6028, "One Safe Source"

- Special Publication, PEDP7036, "S·O·S Fluid Analysis"
- Special Publication, SEBD0640, "Oil and Your Engine"
- Special Publication, PEWP9733, "Caterpillar Fluids Selector Dial"
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"

Fuels

- Data Sheet, LEKQ9360, "Internal Combustion Engine Fuel Gases"
- Data Sheet, LEKQ2364, "US Stationary Engine Regulations/Spark Ignited Emissions"
- Data Sheet, LEKQ5404, "Fuels Specifications Changes"
- Application and Installation Guide, LEKQ7256, "Fuels, Fuel Systems"
- Application and Installation Guide, LEKQ7260, "Low Energy Fuels"

- Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations"

Coolants

- Data Sheet, PEHP7057, "Coolant Analysis"
- Special Publication, PEDP7036, "S-O-S Fluid Analysis"
- Special Publication, SEBD0518, "Know Your Cooling System"
- Special Publication, SEBD0970, "Coolant and Your Engine"
- Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations"
- Special Instruction, SEHS7633, "Battery Test Procedure"
- Special Instruction, SEHS7768, "Use of the 6V-2150 Starting/Charging Analyzer"
- Special Instruction, SEHS8622, "Using the FT-1984 Air-To-Air Aftercooler Leak Test Group"
- Special Instruction, SEHS8712, "Using the 8T-2700 Blowby/Airflow Indicator Group"
- Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products"
- Special Instruction, SEHS9298, "Installation and Maintenance of Gaseous Fuel Filters"
- Special Instruction, REHS0371, "Installation and Initial Start-Up Procedure for G3300 and G3400 Engines"

Miscellaneous

- Service Manual, RENR5965, "G3304 & G3306 Engines"
- Specifications, SENR7938, "G3304 & G3306 Engines"
- Systems Operation/Testing and Adjusting, SENR7939, "G3304 & G3306 Engines"
- Disassembly and Assembly, RENR5965, "G3304 & G3306 Engines"
- Schematic, RENR5962, "G3304 & G3306 Engines"
- Application and Installation Guide, LEKQ7250, "Air Intake"
- Service Manual, REG1139F, "Service Manual Contents Microfiche"
- Engine Performance, LEBQ4197, "G3300 Gas"
- Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations"
- Software Program, LEKQ6378, "Methane Number Program"
- Specifications, SENR3130, "Torque Specifications"
- Special Instruction, GMG00694, "Analyzing Cylinder Condition By Measuring Air Flow"
- Special Instruction, SEHS7332, "Do Not Operate Tag"
- Special Publication, NEHS0526, "Service Technician Application Guide"
- Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide"
- Special Publication, SEBF8029, "Index to Guidelines for Reusable Parts and Salvage Operations"
- Special Publication, SEBF8062, "Procedure to Inspect and Clean Air Filters"

i02780825

Additional Reference Material

SMCS Code: 1000; 4450

The "Society of Automotive Engineers (SAE) Specifications" can be found in your SAE handbook. This publication can also be obtained from the following locations: local technological society, local library, and local college. If necessary, consult SAE at the following address:

SAE International
400 Commonwealth Drive
Warrendale, PA, USA 15096-0001
Telephone: (724) 776-4841

The "American Petroleum Institute Publication No. 1509" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult API at the following address:

American Petroleum Institute
1220 L St. N.W.
Washington, DC, USA 20005
Telephone: (202) 682-8000

The International Organization for Standardization (ISO) offers information and customer service regarding international standards and standardizing activities. ISO can also supply information on the following subjects that are not controlled by ISO: national standards, regional standards, regulations, certification, and related activities. Consult the member of ISO in your country.

International Organization for Standardization (ISO)
1, rue de Varembé
Case postale 56
CH-1211 Genève 20
Switzerland
Telephone: +41 22 749 01 11
Facsimile: +41 22 733 34 30
E-mail: central@iso.ch
Web site: <http://www.iso.ch>

European classifications are established by the Conseil International Des Machines a Combustion (CIMAC) (International Council on Combustion Engines).

CIMAC Central Secretariat
Lyoner Strasse 18
60528 Frankfurt
Germany
Telephone: +49 69 6603 1567
Facsimile: +49 69 6603 1566

i00382622

Warranty Information

SMCS Code: 1000

Engine Protection Plans

Extended Warranties and Service Contracts

A wide variety of protection plans are available for Caterpillar Engines. Consult your Caterpillar dealer for detailed information on the specific programs and coverages that are available.

Consult your Caterpillar dealer for information on a plan that is tailored in order to fit your requirements.

Index

A

Actuator Control Linkage - Lubricate	49
Check the Linkage	49
Additional Reference Material	98
After Starting Engine	37
Engaging the Driven Equipment	37
After Stopping Engine.....	40
Aftercooler Core - Clean/Test (Air-To-Air Aftercooler).....	49
Air Starting Motor Lubricator Bowl - Clean	50
Air Starting Motor Lubricator Oil Level - Check	50
Adjust the Lubricator	51
Air Tank Moisture and Sediment - Drain.....	51
Alarms and Shutoffs	28
Sensing Devices	29
Alternator - Inspect	51
Automatic Start/Stop - Inspect (Generator Set).....	51

B

Batteries - Replace	52
Battery Charger - Check.....	52
Checking After Stopping	53
Checking Before Start-Up	52
Battery Electrolyte Level - Check	53
Before Starting Engine	14, 32
Air Inlet System.....	32
Cooling System.....	32
Driven Equipment	32
Electrical System	32
Fuel System.....	33
Lubrication System	33
Starting System.....	33
Walk-Around Inspection.....	32
Belts - Inspect/Adjust/Replace.....	53
Adjustment of the Fan Drive Belt	54
Alternator Belt Adjustment	54
Inspection.....	53
Replacement.....	54
Belts - Replace	54
Burn Prevention.....	11
Batteries.....	11
Coolant.....	11
Oils.....	11

C

Carburetor - Inspect/Recondition.....	54
Carburetor Air/Fuel Ratio - Check/Adjust	55
Cold Weather Starting	34
Control Panel - Inspect.....	55
Record the Data and Review the Data	55

Cooling System Coolant (DEAC) - Change.....	55
Clean the Cooling System	56
Cleaning a Cooling System that has Heavy Deposits or Plugging	56
Drain the Cooling System	55
Fill the Cooling System	57
Cooling System Coolant (NGEC) - Change	57
Cooling System Coolant Analysis (Level I) - Obtain	57
Cooling System Coolant Analysis (Level II) - Obtain	58
Cooling System Coolant Level - Check.....	58
Cooling System Supplemental Coolant Additive (SCA) - Test/Add.....	59
Add the SCA, If Necessary	59
Test the Concentration of the SCA.....	59
Crankcase Blowby - Measure/Record	60
Crankshaft Vibration Damper - Inspect	60
Rubber Damper	61
Visconic Damper.....	61
Crushing Prevention and Cutting Prevention	13
Customer Service	93
Cylinder Pressure - Measure/Record	61

D

Driven Equipment - Check.....	62
Driven Equipment - Inspect/Replace/Lubricate	62

E

Electrical System	15
Grounding Practices	15
Emergency Stopping	39
Emergency Stop Button	39
Engine - Clean.....	62
Engine Air Cleaner Element - Replace.....	63
Cleaning the Primary Air Cleaner Elements	64
Servicing the Air Cleaner Elements	63
Engine Air Cleaner Service Indicator - Inspect.....	65
Test the Service Indicator.....	65
Engine Air Precleaner - Clean	66
Engine Crankcase Breather - Clean.....	66
Engine Mounts - Check	67
Engine Oil and Filter - Change	69
Drain the Engine Oil.....	69
Fill the Engine Crankcase	70
Replace the Oil Filter	70
Engine Oil Level - Check.....	67
Engine Oil Sample - Obtain	68
Obtain the Sample and the Analysis.....	68
Engine Operation.....	38
Operating the Engine and the Driven Equipment.....	38
Partial Load Operation.....	38
Engine Performance - Test.....	71

Engine Protective Devices - Check	71	Ignition System Spark Plugs - Inspect/Replace.....	76
Visual Inspection	71	Cleaning the Spark Plug	77
Engine Starting	14, 32	Inspecting the Spark Plug	77
Engine Stopping	14, 39	Installing the Spark Plug	78
Engine Valve Lash - Inspect/Adjust	72	Remove the Spark Plug	76
Engine Valve Rotators - Inspect	72	Ignition System Timing - Check/Adjust.....	79
Exhaust Bypass - Inspect	72	Ignition System Transformer Resistance - Test.....	79
Exhaust Piping - Inspect.....	73	Ignition Systems	13
Water Cooled Exhaust Manifolds.....	73	Magneto	13
F		Important Safety Information	2
Features and Controls	27	Inlet Air System - Inspect.....	79
Fire Prevention and Explosion Prevention	11	Instrument Panel - Inspect.....	79
Fire Extinguisher	12		
Lines, Tubes and Hoses	13	J	
Foreword	5	Jacket Water Heater - Check	80
California Proposition 65 Warning	4		
Literature Information.....	4	L	
Maintenance	4	Lifting and Storage	22
Maintenance Intervals.....	4		
Operation	4	M	
Overhaul	5	Maintenance Interval Schedule ((Naturally Aspirated Engines))	45
Safety.....	4	Maintenance Interval Schedule ((Standby Generator Set Engines)).....	44
Fuel System Fuel Filter Differential Pressure - Check.....	73	Maintenance Interval Schedule ((Turbocharged Engines))	47
		Maintenance Log	95-96
G		Maintenance Records.....	94
Gas Pressure Regulator - Check.....	74	Maintenance Section	41
Pressure of the Fuel Supply To the Carburetor..	74	Manual Stop Procedure.....	40
Gauges and Indicators	24	Model View Illustrations.....	16
General Hazard Information	9	Model Views and Specifications	16
Asbestos Information	10	Mounting and Dismounting.....	13
Containing Fluid Spillage	10		
Dispose of Waste Properly	11	O	
Fluid Penetration.....	10	Operation Section.....	22
Pressurized Air and Water	10	Ordering Replacement Parts	93
Governor - Inspect.....	74	Overhaul (Major).....	80
Governors and Actuators.....	30	Major Overhaul Information	80
Mechanical governor.....	31	Scheduling a Major Overhaul.....	80
Woodward PSG Governor	31	Overhaul (Top End)	82
		Scheduling a Top End Overhaul	82
H		Top End Overhaul Information	82
Hoses and Clamps - Inspect/Replace	74	Overhaul Considerations.....	84
Replace the Hoses and the Clamps	75	Overhaul Information	84
Hoses and Clamps - Replace.....	75		
I			
Ignition System Spark Plug Wires - Replace (Standard Ignition Systems)	75		

P

Performance Parameters 27
 Air/Fuel Ratio 27
 Angle of the Throttle Plate 27
 Exhaust Bypass (Wastegate)..... 28
 Oil Consumption 28
Plate Locations and Film Locations..... 20
 Engine Identification..... 20
 Information Plate 20
 Serial Number Plate..... 20
Power Take-Off Clutch - Check/Adjust/Lubricate .. 85
Product Description 17
 Cooling System..... 18
 Engine Service Life 18
 Ignition System 17
 Inlet Air and Fuel System..... 17
 Lubrication System 18
Product Identification Information 20
Product Information Section 16
Product Lifting..... 22
 Engine Lifting with a Generator..... 22
Product Storage..... 23
 Generator Storage 23

R

Radiator - Clean 86
Reference Information 21
Reference Information Section 93
Reference Material 97
 Coolants..... 98
 Fuels 97
 Lubricants 97
 Miscellaneous 98
Reference Materials 94
Refill Capacities..... 41
Refill Capacities and Recommendations..... 41
 Cooling System..... 42
 Fuel..... 41
 Lubrication System 41

S

Safety Messages 6
Safety Section 6
Specifications 18
Speed Sensor - Clean/Inspect..... 86
Standby Generator Set Maintenance
 Recommendations..... 86
 Maintenance and Operation Procedures 87
Starting Motor - Inspect 87
 Air Starting Motor 88
 Electric Starting Motor..... 88
 Removal and Installation of the Starting Motor .. 88

Starting the Engine 34
 Automatic Starting..... 35
 Manual Starting..... 35
 Operation of the Generator Set Control Panel... 35
 Purging Unburned Gas 34
Starting with Jump Start Cables 36

T

Table of Contents..... 3
Turbocharger - Inspect 88

V

Valve Data Sheet..... 97
Valve Stem Projection - Measure/Record..... 89

W

Walk-Around Inspection 90
 Inspect the Engine for Leaks and for Loose
 Connections 90
Walk-Around Inspection (Exercise Inspection of
Standby Generator Set Engines)..... 91
Warranty Information 99
 Engine Protection Plans..... 99
Water Pump - Inspect..... 92

Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

Dealer Contact

Phone Number

Hours

Sales: _____

Parts: _____

Service: _____

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

2230 East 49th Street, Tulsa, Oklahoma 74105
(918) 712-8268 Fax (918) 712-8269
airxhemphill.com

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

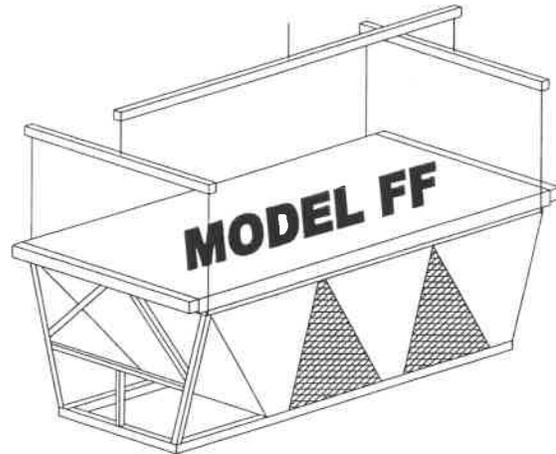
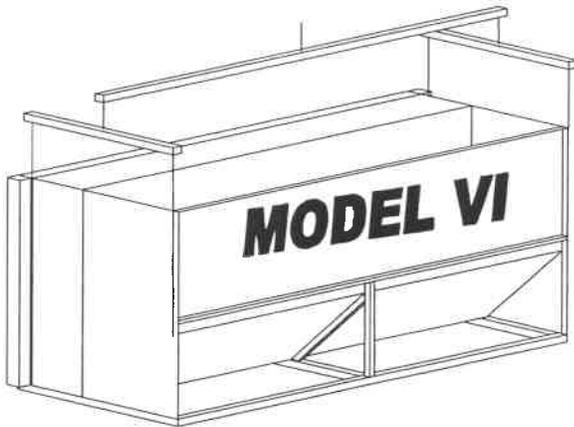
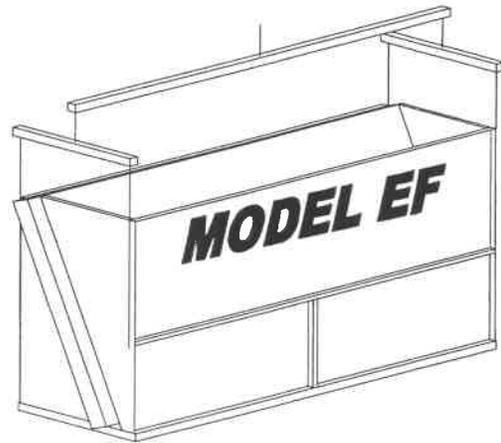
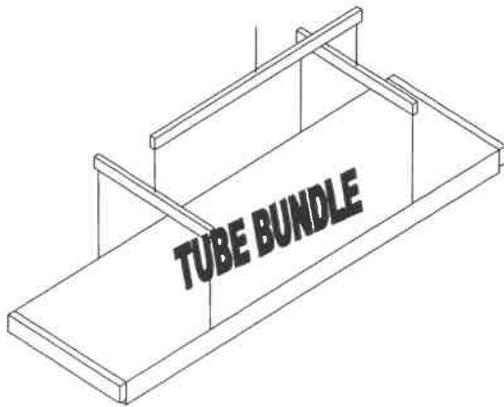
Upon arrival at site, the cooler should be inspected thoroughly by receiving personnel. Damage in transit could be the result of dropping or being struck by heavy objects or equipment. Observe the sub-skid, flanges, plenum side panels and coil sections for any apparent physical damage. Dents, bent flanges, 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:

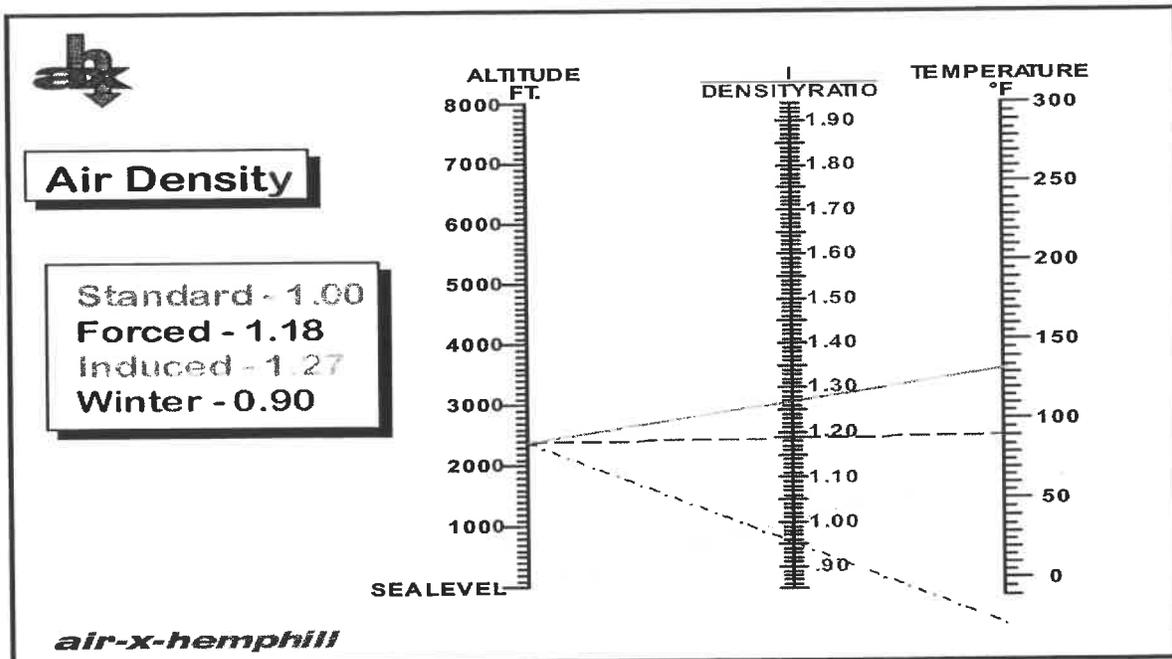
1. It significantly reduces the parasite fan hp and enables more hp to be used for compression.
2. It will result in much improved temperature control for process services and will reduce the chance for over cooling and potential hydrate formation (freeze up).
3. It will significantly reduce stress and 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.

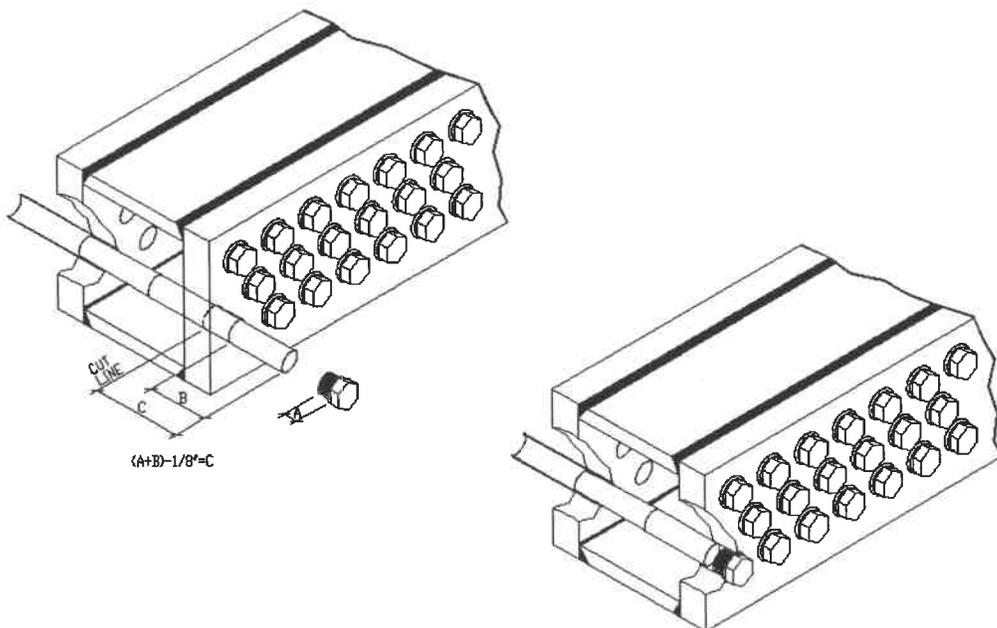
LEAKING TUBES

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

2230 East 49th Street, Tulsa, Oklahoma 74105
(918) 712-8268 Fax (918) 712-8269
airxhemphill.com

CC90-G1

- **Murphy**
 - **Flatplate**
 - **Catadyne Heater**
 - **TB Woods**
 - **TDI**
 - **Penberthy**
 - **Fisher**
 - **Control Valve – D2**
 - **Pressure Regulator – 627**
 - **Fairchild**
 - **Fisher**
 - **Pressure Control Valve – Y600**
 - **FPE**
-
- **Any Additional Options**

TTDJ Series Fully-Configurable Fault Annunciator Installation and Operations Manual

TTDJ-99062N
Revised 01-02
Section 50
(00-02-0412)



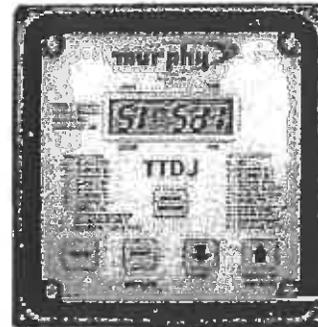
Please read the following information before installing. This installation information is intended for all TTDJ Series models. A visual inspection of this product before installation for any damage during shipping is recommended.

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 6,144,118
(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 0" 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.4, 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)

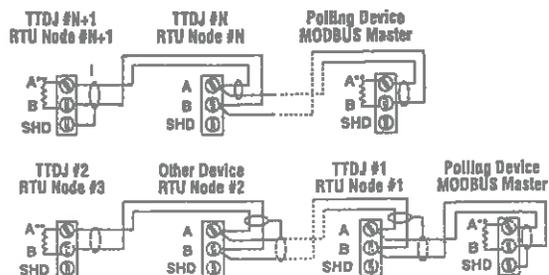
The RS485 serial port (MODBUS RTU slave) on the back of the module is provided for communicating with micro-controllers, PC's, PLC's and SCADA systems (see RS485 Typical Connections, below). It is recommended that a termination resistor** (customer supplied) be used on the first and last device connected 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).

*Alarm Before Shutdown is a function that causes annunciation and the alarm output, but will not cause a shutdown.

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.

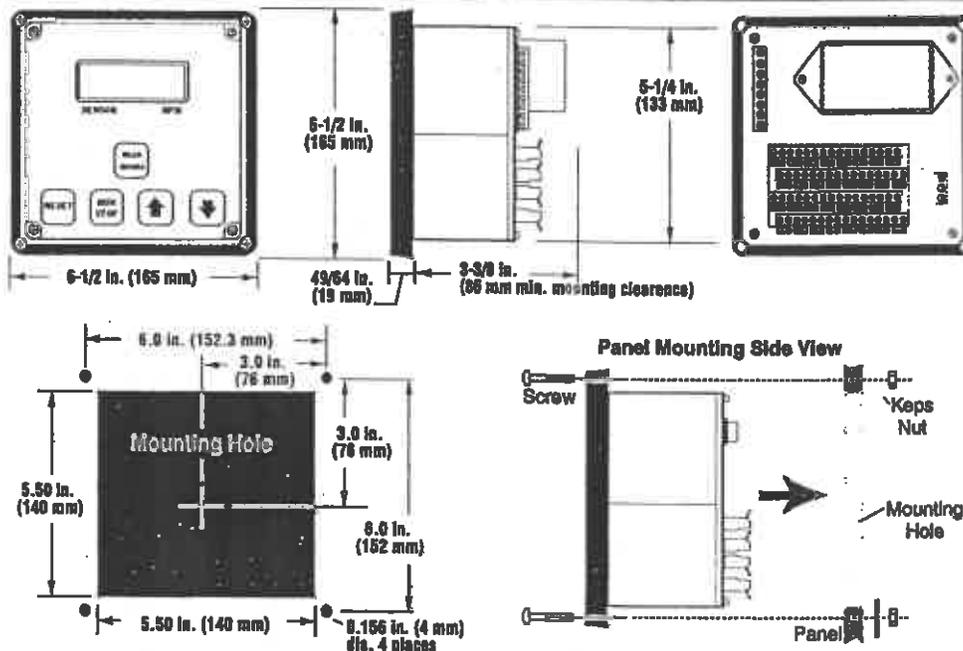
Hourmeter Range: 0 to 65535 hrs.

Hourmeter Accuracy: ±15 minutes per year.

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:

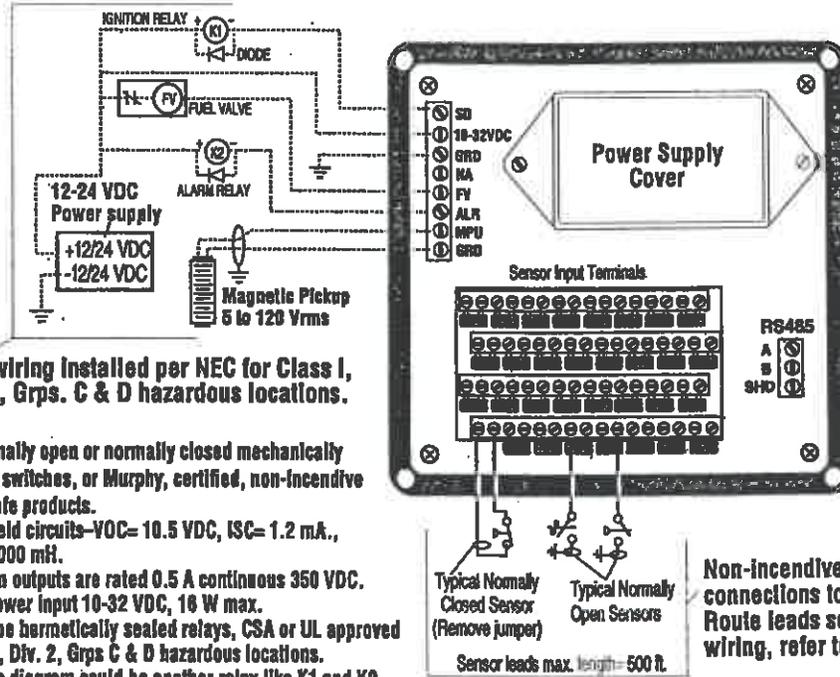
1. Make sure the area is made Non-Hazardous and shut down the System (remove power).
2. Using extreme caution remove the Power Supply Cover Screws (located on the back of the TTDJ module).
3. Gently pull the Power Supply Cover away from the back of the TTDJ to have access to the old Backup Battery.
4. 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.

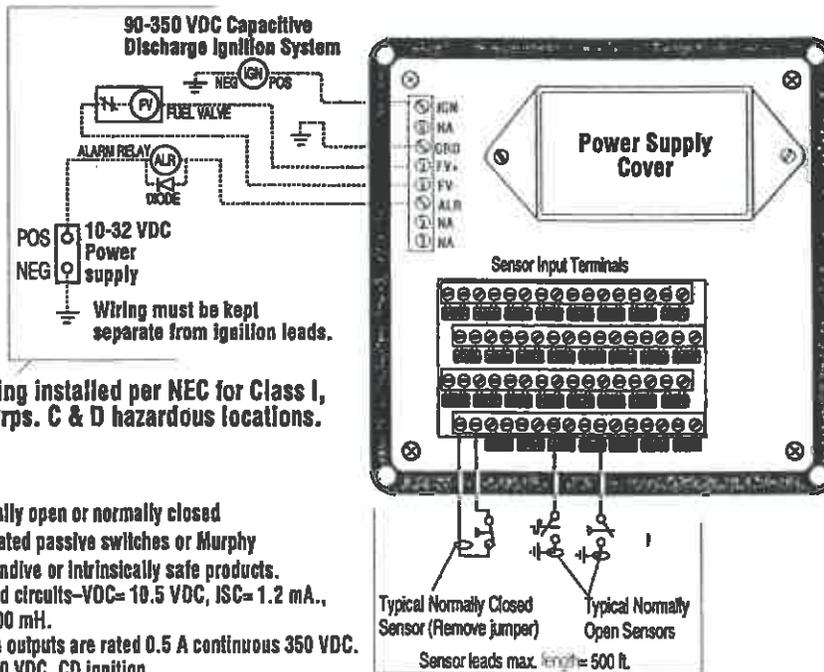
NOTES:

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, 10 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

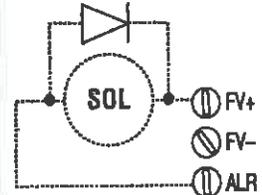


User wiring installed per NEC for Class I, Div. 2, Grps. C & D hazardous locations.

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.

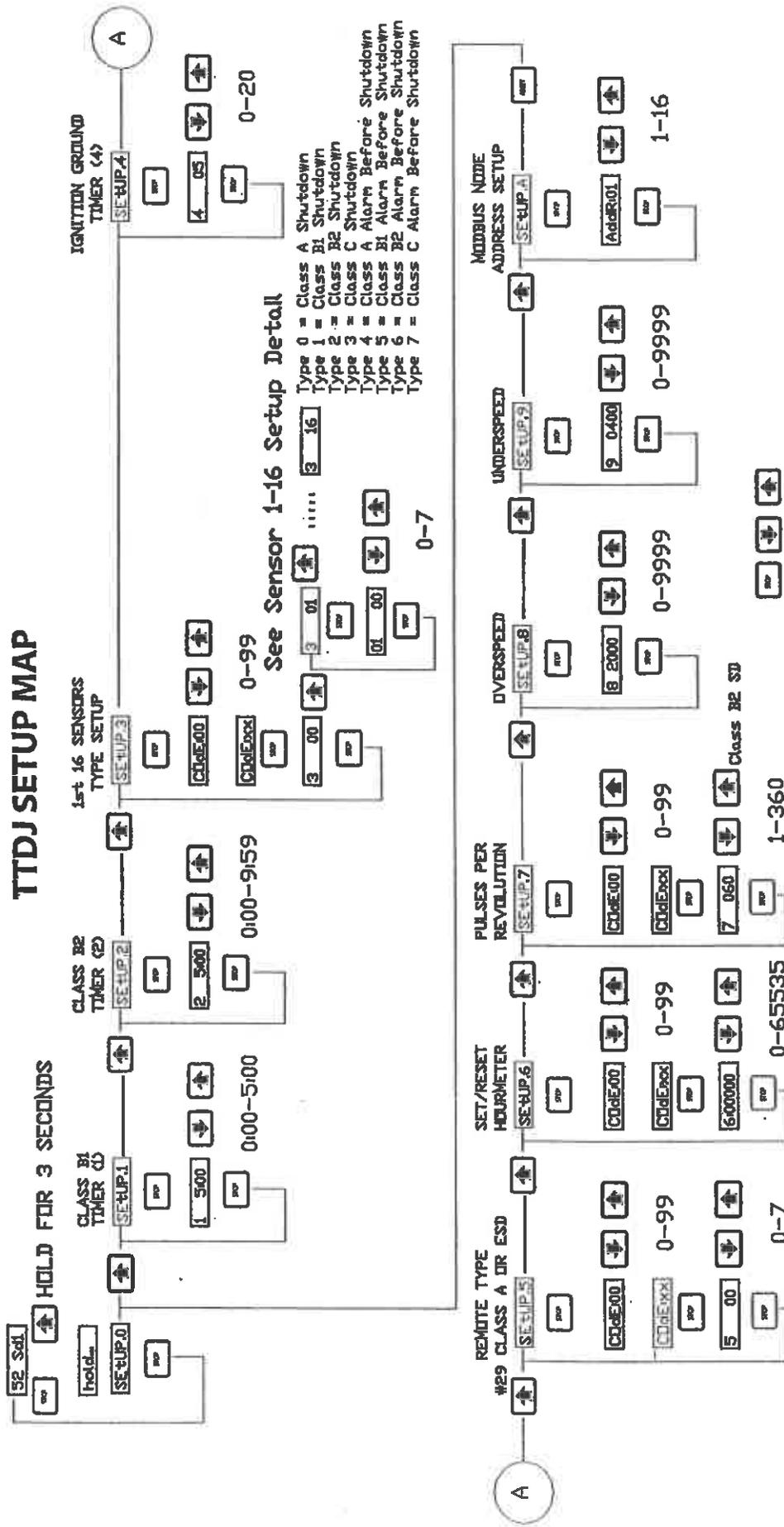
Alternate hook-up for using latching 48 VDC coil solenoid for alarm air horn.



NOTE: FV- terminal cannot be used with this hook-up for a CD fuel valve.

Non-incendive field wiring connections to passive switches. Route leads separate from other wiring. Refer to Notes (1,2).

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.

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.

SEQUENCE OF OPERATIONS

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:

	(t0): Class "A" Shutdown
	(t1): Class "B1" Shutdown
	(t2): Class "B2" Shutdown
	(t3): Class "C" Shutdown
	(t4): Class "A" Alarm
	(t5): Class "B1" Alarm
	(t6): Class "B2" Alarm
	(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.



FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74117 USA
(918) 317-4100
fax (918) 317-4266
e-mail sales@fwmurphy.com
www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
(281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Racho Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-444-8206264 Fax +52-444-8206336
e-mail ventas@murphydex.com.mx
www.murphydex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Loverslock, Salisbury SP110Z; U.K.
+44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Hume Highway
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@macquarrie.com.au





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)



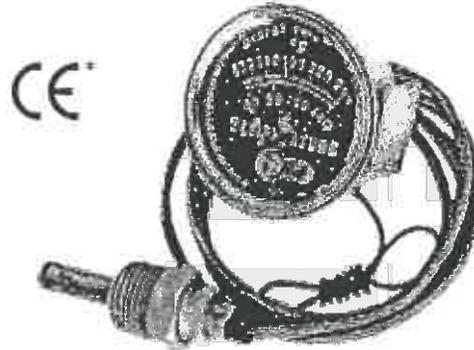
Please read the following information before installing. A visual inspection of this product for damage during shipping is recommended before mounting. General information and these installation instructions are intended for all 20T, 25T, A20T, and A25T series models.

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

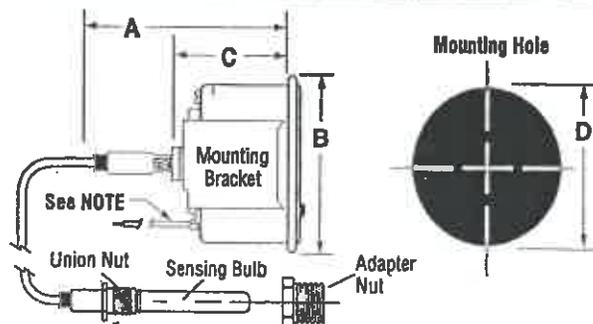
Murphy manufactures several, patented Magnetic Switches for protection of the light duty SWICHGAGE® contacts and to ensure positive shut-down of equipment. There are Magnetic Switches for Capacitor Discharge ignition, Magneto, or Battery systems, and models for electric motor driven equipment. TATTLETALE® 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 pigtails. 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.

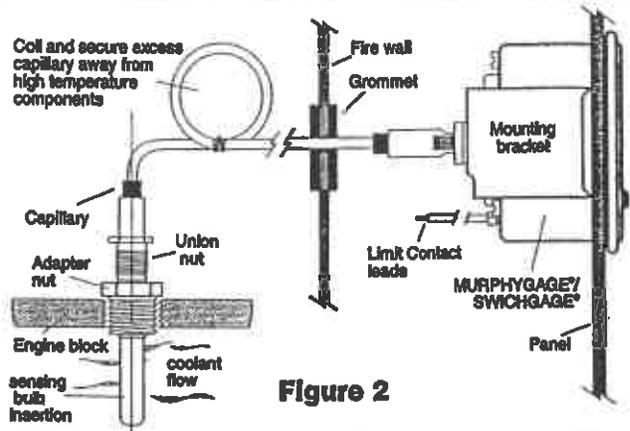


Figure 2

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.



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.

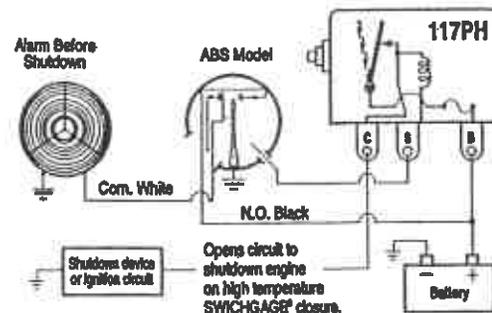
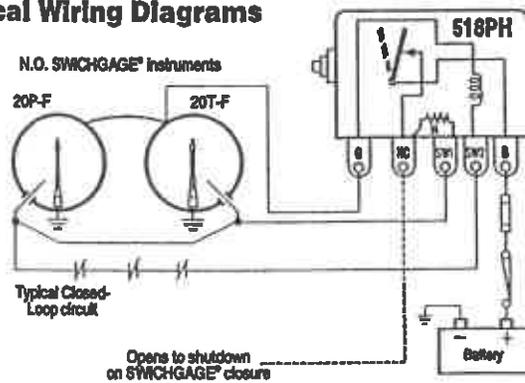
1. **Oil Temperature**
 - a. The SWICHGAGE® sensing probe must be fully immersed in the oil pan, oil filter housing, oil cooler, etc. depending on engine model and configuration.
 - b. Observe all precautions for liquid cooled engines.
2. **Cylinder Head Temperature**
 - a. Generally the cylinder head 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.

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®.

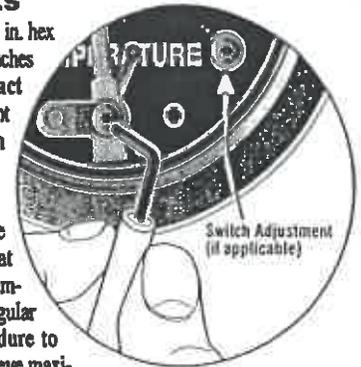


Figure 3

TYPICAL WIRING DIAGRAMS



WARNING: DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING INSTALLATION

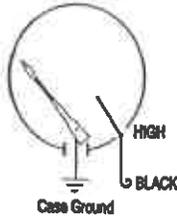
20 and 25 Series models

These diagrams are shown with the pointer in the at rest (shelf) position.

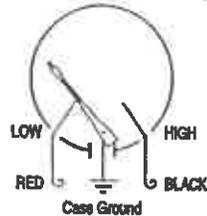
Pointer contact rating: pilot duty 2 A @ 30 VAC/DC.

Snap-switch rating: 3 A @ 30 VDC, 4 A @ 125 VAC.

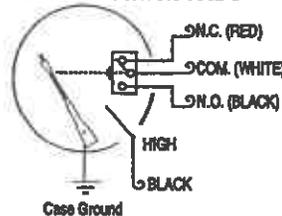
20T and 25T



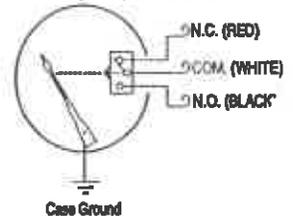
20T-HL and 25T-HL



20TABS and 25TABS



20TE and 25TE



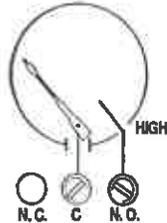
A20 Series models

These diagrams are shown with the pointer in the at rest (shelf) position.

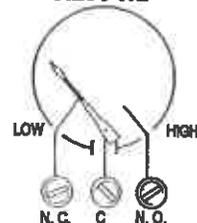
Pointer contact rating: pilot duty 2 A @ 30 VAC/DC.

Snap-switch rating: 3 A @ 30 VDC, 4 A @ 125 VAC.

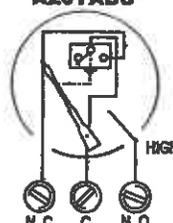
A20T



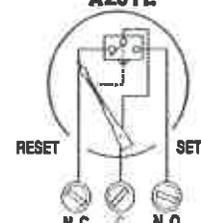
A20T-HL



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.

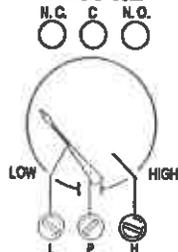
Pointer contact rating: pilot duty 2 A @ 30 VAC/DC.

Snap-switch rating: 3 A @ 30 VDC, 4 A @ 125 VAC.

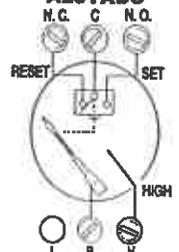
A25T



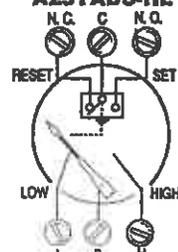
A25T-HL



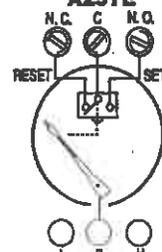
A25TABS



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.



FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74147 USA
(918) 317-4100
fax (918) 317-4266
e-mail sales@fwmurphy.com
www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 181F; Rosenberg, Texas 77471; USA
(281) 342-0297 Fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Rocho Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-444-8206264 fax +52-444-8206336
e-mail ventas@murphymex.com.mx
www.murphymex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Lavenock, Salisbury SP1 1QZ; U.K.
+44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1628 Hanna Highway
Campbellfield, Vic. 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@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.

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.

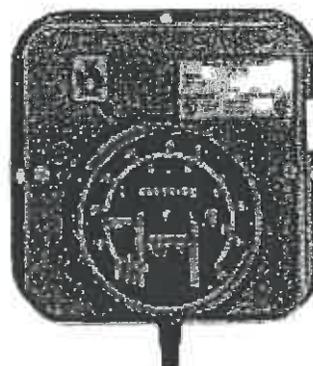
GENERAL INFORMATION



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 NPTF 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.

Dope or 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.

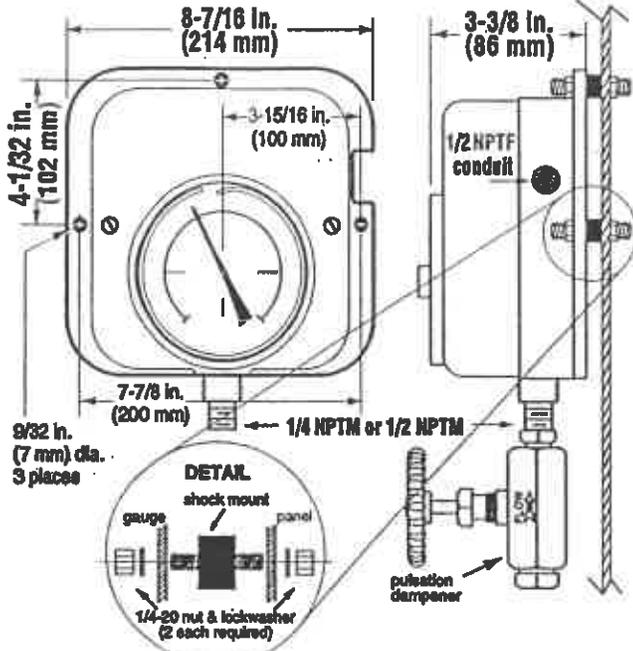
*Selected configurations are third party listed. Consult factory for details.

**Products covered by this bulletin comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted. Does not cover “BP” models.

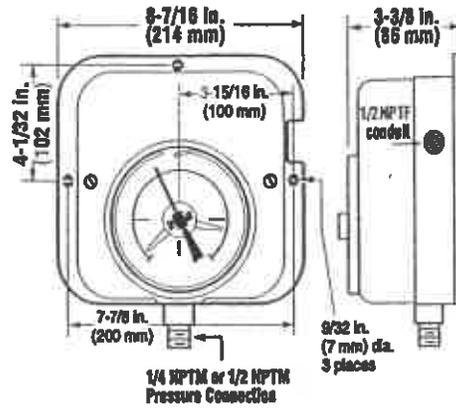
CASE MOUNTING

OPL Series Wall Mount

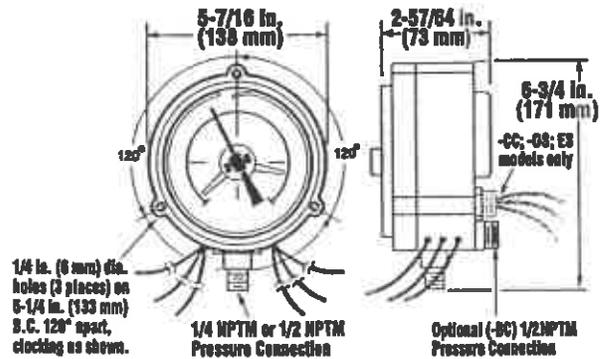
Flanged case design intended for wall mount, it can also be direct mounted. Shown with shock mounts and pulsation dampener.



45APE Series Wall Mount

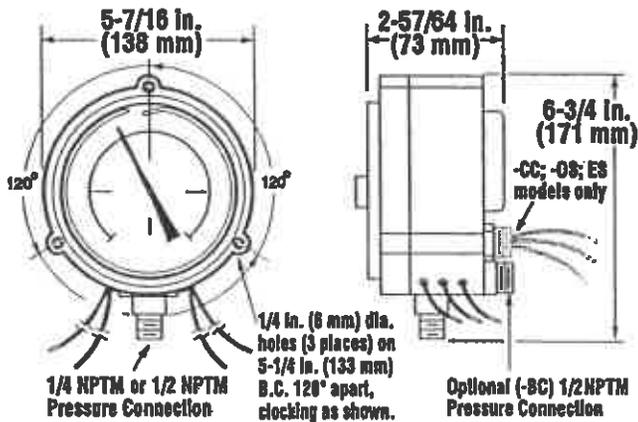


45APE Series Flush Mount

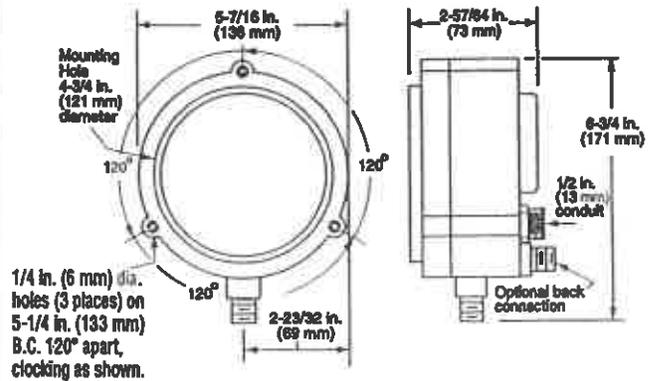


OPL Series Flush Mount

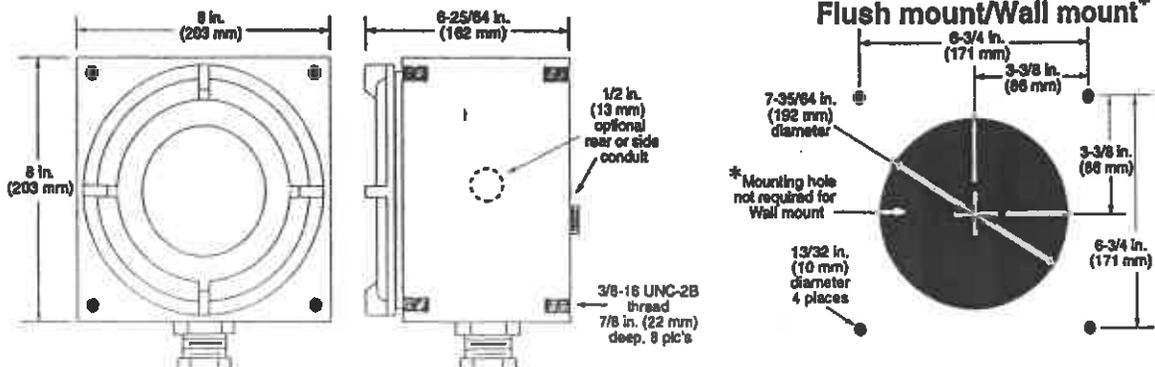
Round case design to be mounted in a panel from 1/32 in. (1 mm) to 1/8 in. (mm) thick. It can also be direct mounted. Shown with pulsation dampener.



Options "OS" and "ES" (flush mount case)



Explosion-proof Case Mount Explosion-proof case can be mounted from face or rear.



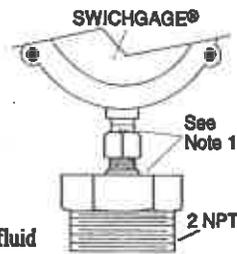
OPTIONS

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.

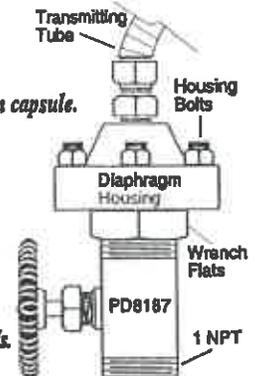
CAUTION: Do Not unscrew the green diaphragm capsule.

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.

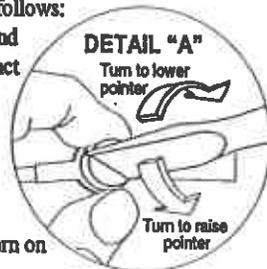
45APE Series Trip Point Adjustments

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:

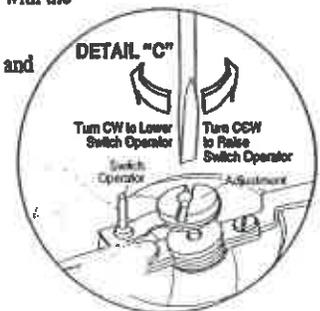
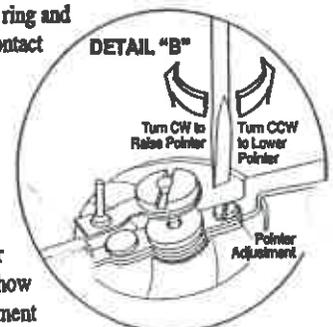
1. Turn off power. Remove the snap ring and very carefully remove the lens and contact assembly (or open hinged cover).
2. Hold the pointer hub with thumb and forefinger then turn screw to desired point. See DETAIL "A".
3. Replace lens and contact assembly and snap ring (or close hinged cover), and turn 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.

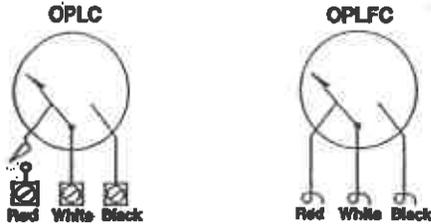
TYPICAL ELECTRICAL DIAGRAMS



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

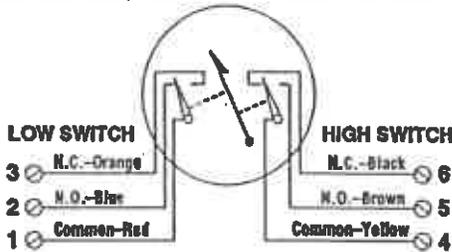
Contact Rating: 1 SPDT, Center Off; 2 A, 30 VDC, 1 A, 125 VAC pilot duty.



NOTE: Diagrams above show the pointer in the at rest (shelf) position.

45APE and 45APEF

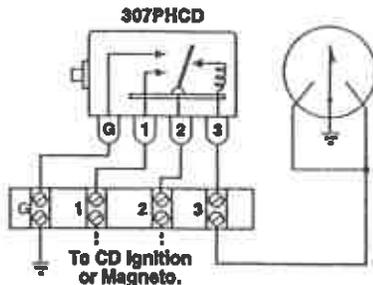
Contact Rating: 2-SPDT snap-switches (one for high and low pressure), 4 A inductive, 250 VAC each switch. *NOTE: Diagram below shows the pointer in the at rest (shelf) position. Low setpoint should be limited to the lower 1/2 scale and upper setpoint should be limited to the upper 1/2 scale.*



45 Series with 307PHCD

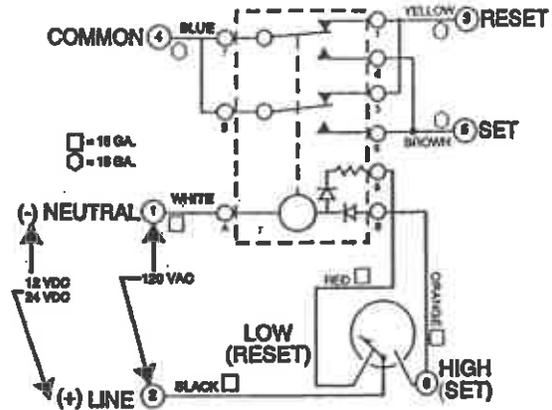
Contact Rating: 12/32 VDC coil, 10 A, 32 VDC battery ignition contacts; Magneto ignition coil, 10 A magneto ignitions contacts; CD ignition coil, 10 A CD ignition contacts; 120 VAC coil, 10 A, 120 VAC contacts. *NOTE: Diagram below shows the pointer in the operating position.*

IMPORTANT:
Use with 110/120 VAC requires isolated ground SWITCHGAGE® instruments.



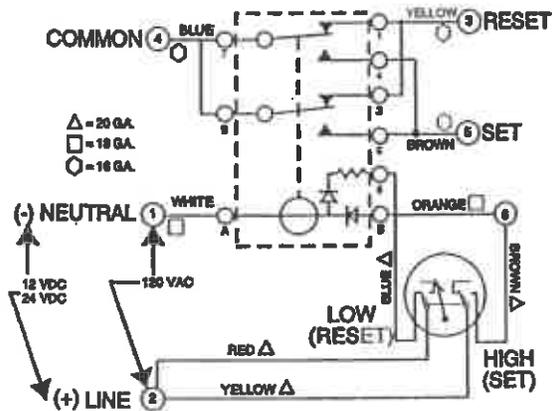
OPLBP

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®



FWMurphy

P.O. Box 470248

Tulsa, Oklahoma 74147 USA

(918) 427-3550

Fax (918) 464-6146

e-mail sales@fwmurphy.com

www.fwmurphy.com



Printed in U.S.A.

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
(281) 342-0297 Fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Bvd. Antonio Rocha Cordaro 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-48-206264 Fax +52-48-206336
e-mail ventasmex@murphycom.mx

FRANK W. MURPHY, LTD.
Church Rd.; Laverstock, Salisbury SP1 1QZ; U.K.
+44 1722 410055 Fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

For Service in French:
Pow service en français:
+44 1722 410697 Fax +44 1722 410088
e-mail franco@fwmurphy.co.uk
www.fwmurphy.co.uk/francais.htm

MURPHY SWITCH OF CALIFORNIA
41943 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 Fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Home Highway;
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 Fax +61 3 9358-5558
e-mail murphy@macquarrie.com.au

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.

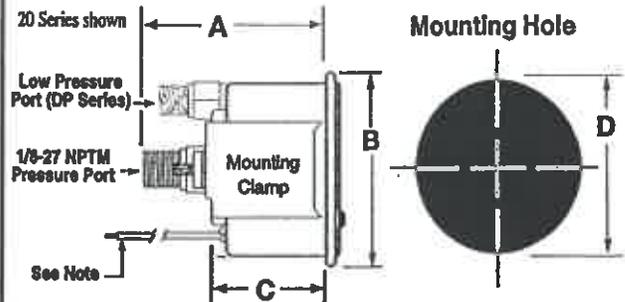
NOTE: Face contact shut-down limit setting and snap switch low point are factory-set; specify when ordering if setting is other than standard.

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: At 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®.

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	2-15/64 (57)	2-1/4 (57)	3-1/8 (79)	2-29/32 (74)
C	1-5/16 (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.

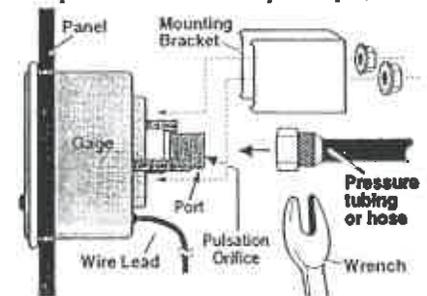


Figure 2

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/worn 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.



Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted.

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.)	
							psi	Bar	psi	Bar	psi	Bar	psi	Bar	psi	Bar
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.

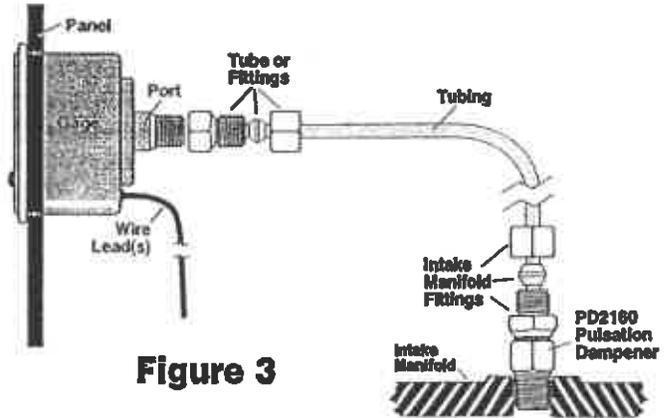


Figure 3

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.

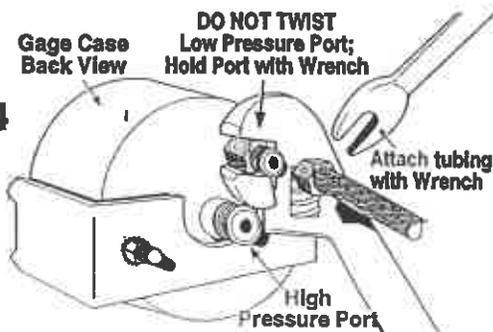
1. To connect the high pressure tubing use at least 3/16 in. (5 mm) LD. flexible pressure tubing/hose and fittings. If using copper or rigid tubing, install at least 12 in. (305 mm) flexible hose from the gage to the rigid tubing (to prevent damaging vibration to the gage, see Figure 2).



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



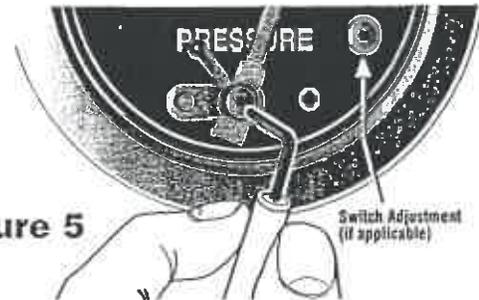
IMPORTANT: If the SWICHGAGE® has a lockout push button on the face, a contact setting higher than the factory setting will make the lockout device inoperative.

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 it touches the pointer. Do NOT force contact against the gage point. 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®.



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.

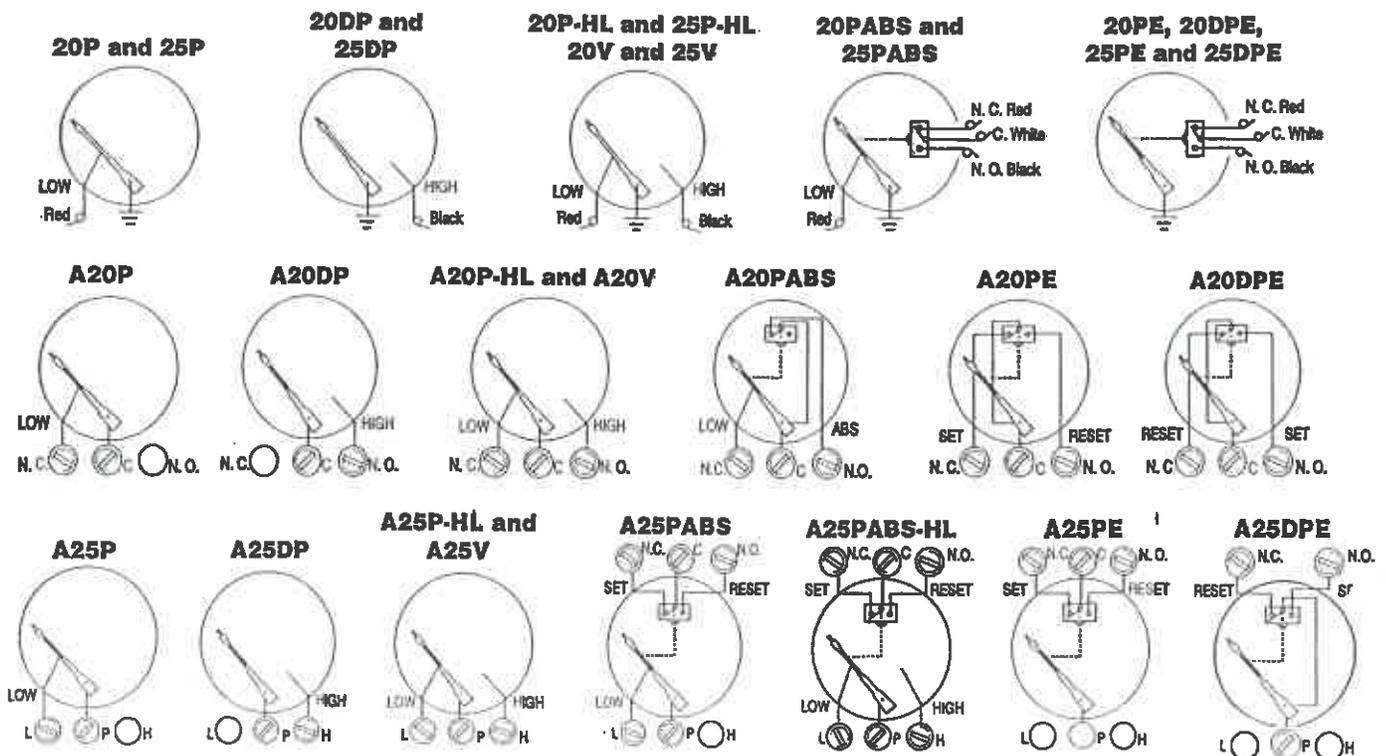
When installing the SWICHGAGE® on a ungrounded panel, you **MUST** provide a ground wire from the SWICHGAGE® to a common ground. Install **ONLY** in a 12 or 24 V system. Warning lights or audible signal **MUST** be of the same voltage as the battery. Current draw should **NEVER** exceed SWICHGAGE® contact 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.



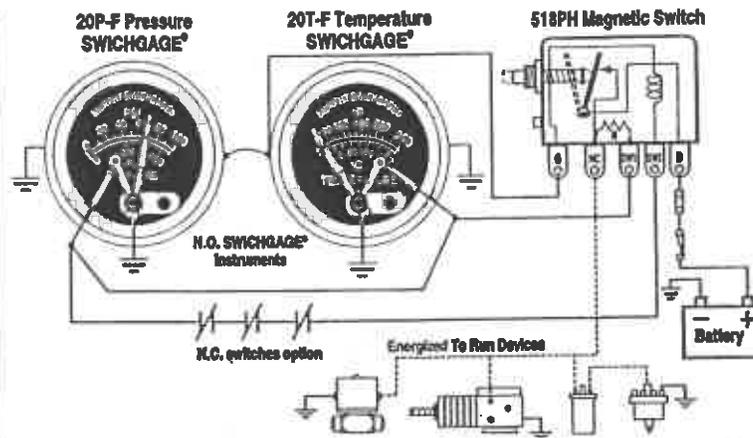
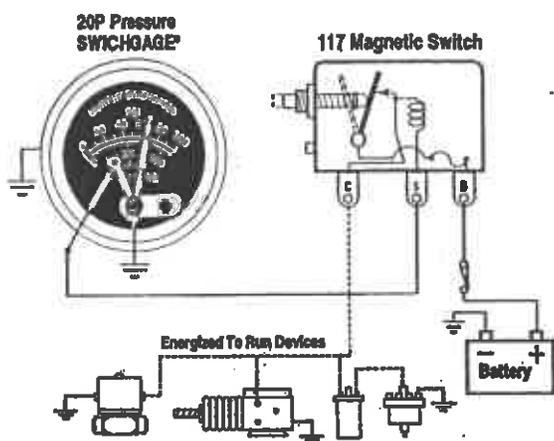
Installing The Magnetic Switch



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). Rewire 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.



FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74147 USA
(918) 317-4100
fax (918) 317-4266
e-mail sales@fwmurphy.com
www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819, Rosenberg, Texas 77471; USA
(281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Bvd. Antonio Rocha Cordero 300, Frecdén del Aguaje
San Luis Potosí, S.L.P.; México 78304
+52-444-8206264 fax +52-444-8206336
e-mail ventas@murphydex.com.mx
www.murphydex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Leverstock, Salisbury SP1 1QZ; U.K.
+44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Hume Highway
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@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.

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)

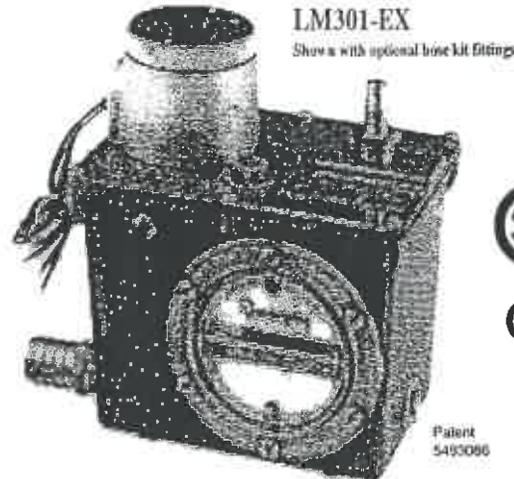
with 1/4 in. (6 mm) orifice.

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)



LM301-EX

Show with optional hose kit fittings



Patent
5495086

Outlet Connection: 3/4-14 NPT left side, right side, and bottom.

Crankcase Balance Vent Fitting: 1/2-14 NPT.

Mounting: Accepts Murphy 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

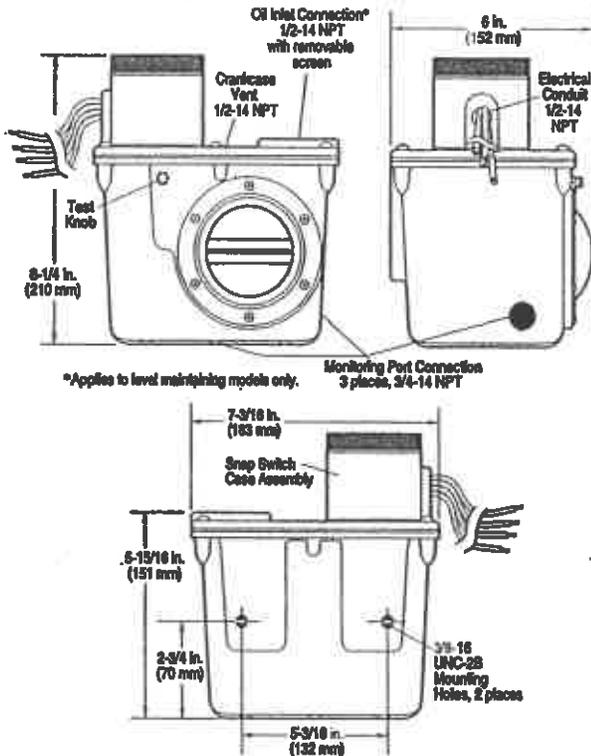
^{††}CSA certified with switch contacts rated at 10 A @ 250 VAC (standard).

^{**} Products covered by this bulletin comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted.

DIMENSIONS

LM300 Series Enclosures

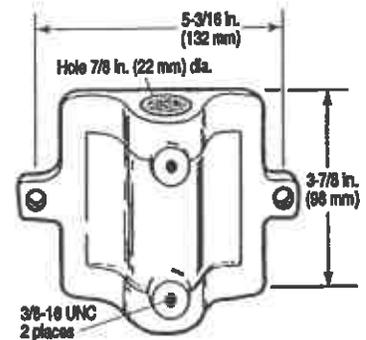
The dimensions below are for the optional -EX model enclosure. The standard model enclosure dimensions are the same except the height and width which are: 7 in. (178 mm) H, 7-7/8 in. (200 mm) W.



Mounting Brackets with Hardware

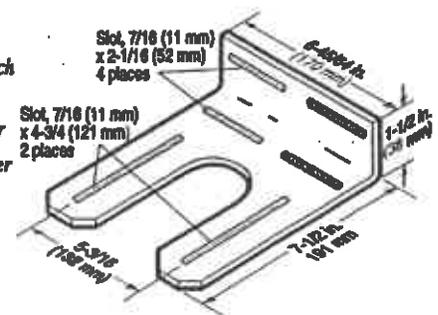
15000371 pipe bracket

- 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.

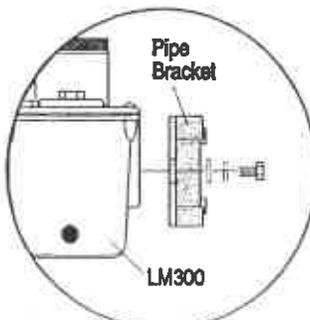


Figure 1A

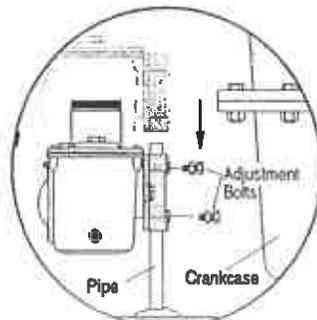


Figure 1B

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).

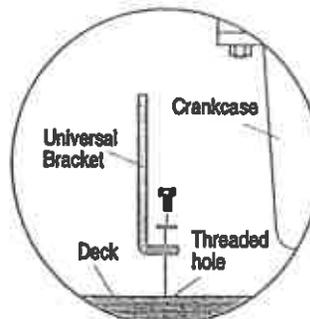


Figure 2A

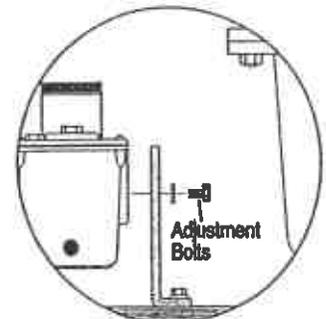


Figure 2B

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).

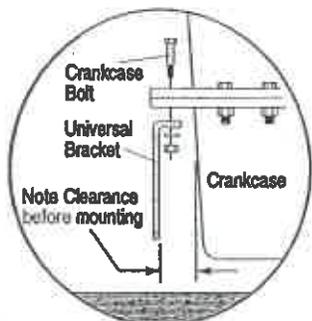


Figure 3A

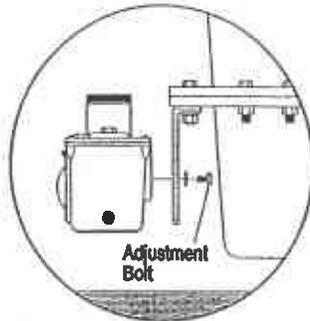


Figure 3B

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. The vent connection on the crankcase must be well above the regulated oil level. All hoses must be clear of obstructions.

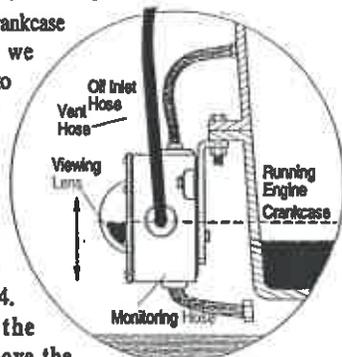


Figure 4

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.

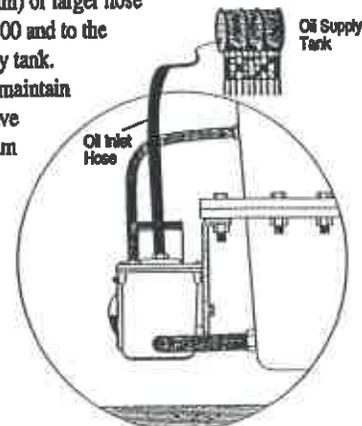


Figure 5

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.**

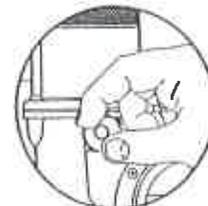


Figure 6

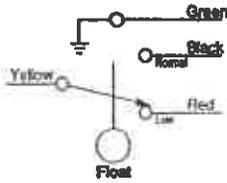
NOTE: After the engine shuts down, you will notice that the oil in the sight gauge glass will rise above normal running level, possibly showing an overfill condition. This is a result of "drain-back" to the engine crankcase and it is normal. Therefore, on models LM302 and LM303 it may be necessary to 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

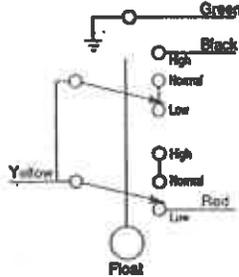


WARNING: DISCONNECT ALL ELECTRICAL POWER BEFORE CONNECTING ANY WIRES.

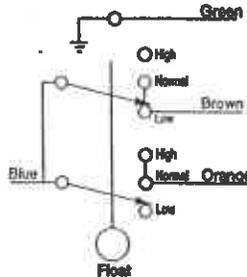
LM301
SPDT



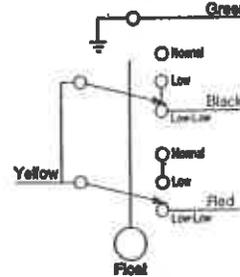
LM302
High/Low N.O.
DPST



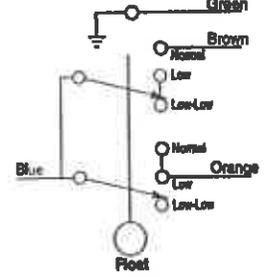
LM303
High/Low N.C.
DPST



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.

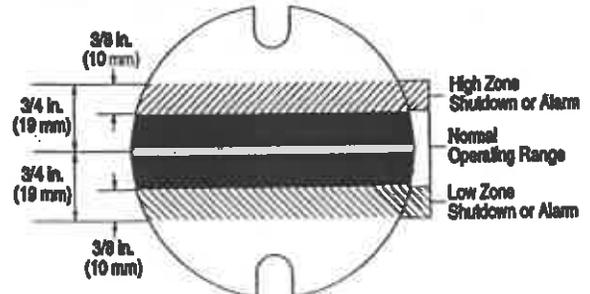


Figure 8: LM302/LM303

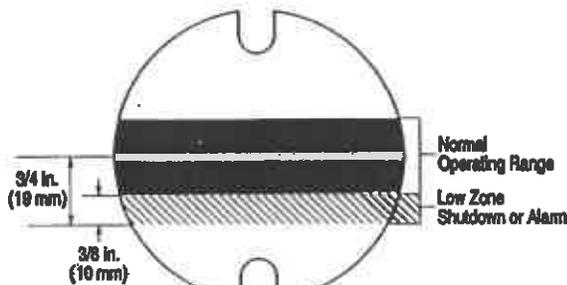


Figure 7: LM301

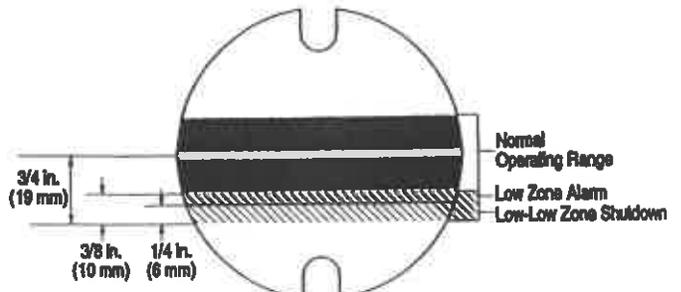


Figure 9: LM304/LM305

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.



FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74147 USA
(918) 317-4100
fax (918) 317-4266
e-mail sales@fwmurphy.com
www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
(281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Rocha Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-444-8206264 fax +52-444-8206336
e-mail ventas@murphymex.com.mx
www.murphymex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Loversock, Salisbury SP1 1QZ; U.K.
+44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Home Highway
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@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.

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 OP14762.

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.



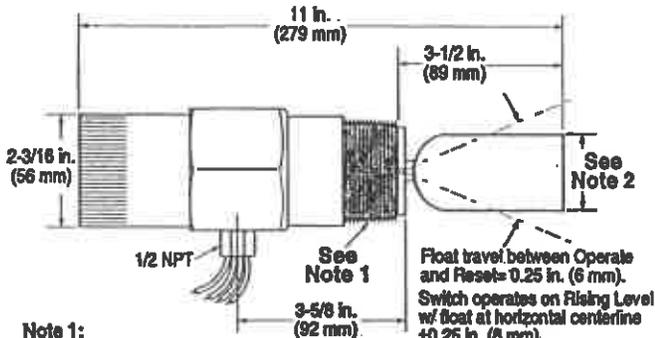
Specifications	L1100	L1111	L1150	L1200	L1250	L1200N	L1200NDVO	L1200NDVOR
Body								
• Standard: Electroless Nickel plated steel	x ^A	x ^A	x ^A	x ^B				
• Optional: 316 Stainless Steel†	x ^A	x ^A	x ^A	x ^B				
Pressure Rating								
• 15 psi (103 kPa) [1.03 bar] Polyethylene Float			x		x			
• 1500 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 mm² 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.

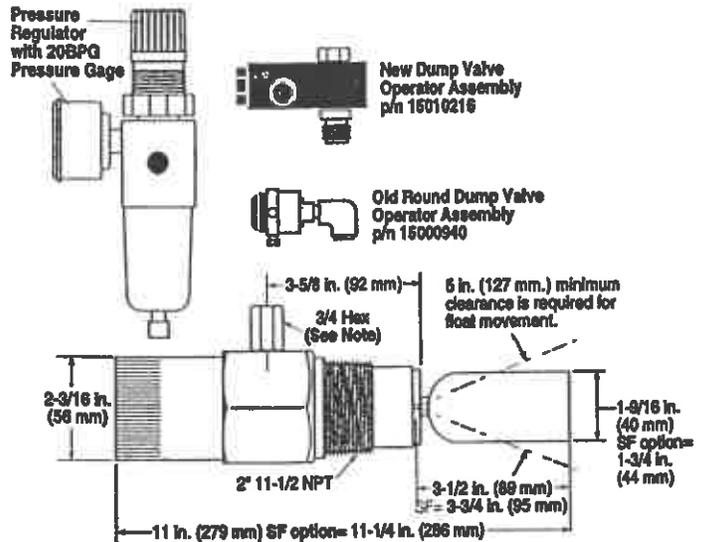
DIMENSIONS

L1100 and L1200



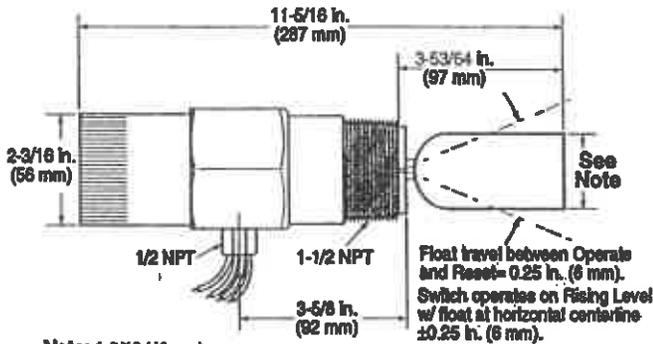
Note 1:
 L1100: 1-1/2 NPT
 L1200: 2 NPT
Note 2: 1-9/16 (40 mm)
 SF option:
 L1100: 1-1/2 (38 mm)
 L1200: 1-3/4 (44 mm)

L1200N, L1200NDVO and L1200NDVOR with Dump Valve Operator, Pressure Regulator and Gage



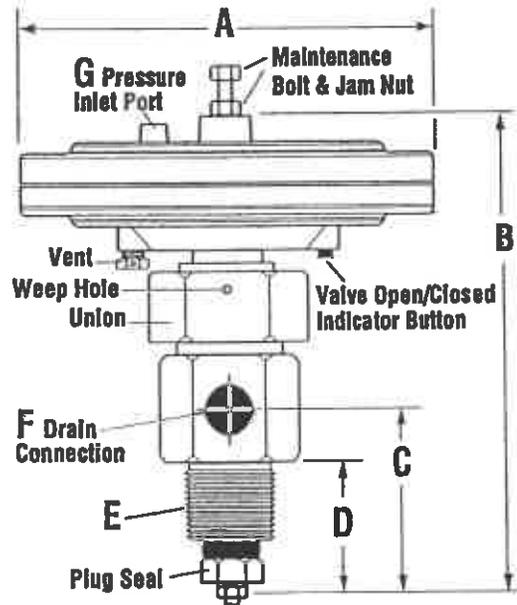
Note: For use only with Old Round Dump Valve Operator Assembly (15000940).

L1111



Note: 1-9/16 (40 mm)

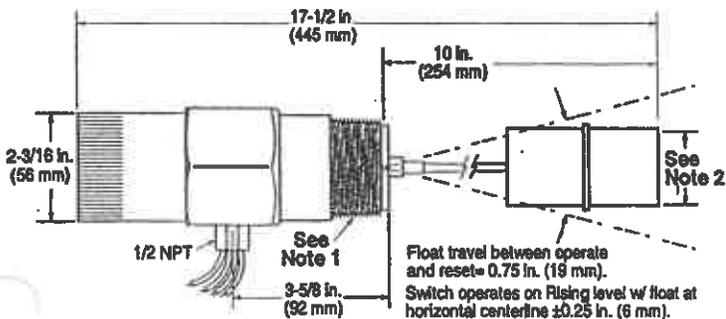
DVU150, DVU175, DVU2105/2115/2120 Series Dump Valves



	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)	1.96 (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				

NOTE: Dimensions are in inches and (millimeters)

L1150 and L1250



Note 1:
 L1150: 1-1/2 NPT
 L1250: 2 NPT

Note 2:
 L1150: 1-1/2 in. (38 mm)
 L1250: 2 in. (51 mm)

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 tightened. 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.

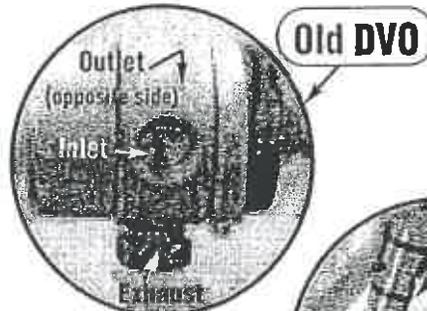


Figure 1



Figure 2

New DVOA



Figure 3



Figure 4

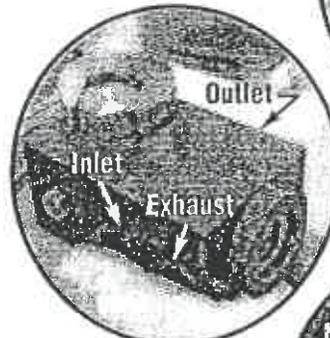


Figure 5

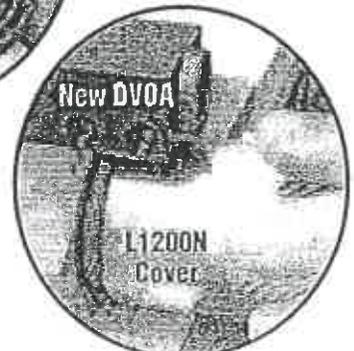
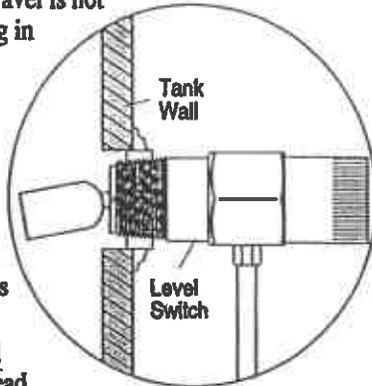


Figure 6

PRESSURE VESSEL INSTALLATION: L1100, L1200, and L1200N

Direct Installation into the Wall of the Pressure Vessel

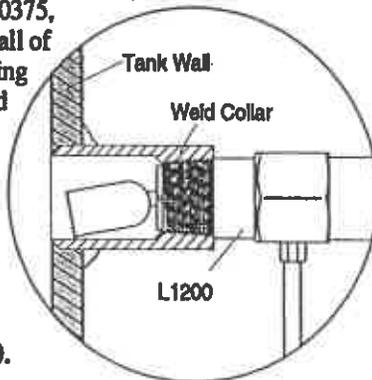
1. Determine that the float travel is not obstructed by the coupling in the vessel wall, internal baffles, etc.
Do NOT use more than one arm extension P/N 15050395.



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

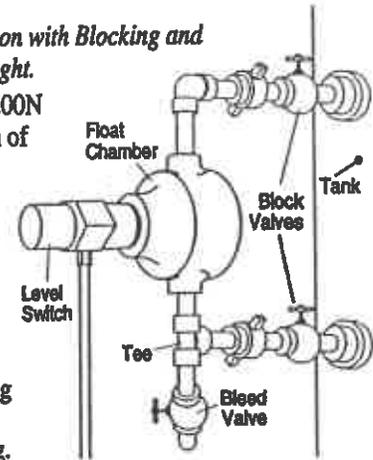
CAUTION: USE "NON SPARKING TOOLING".

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.

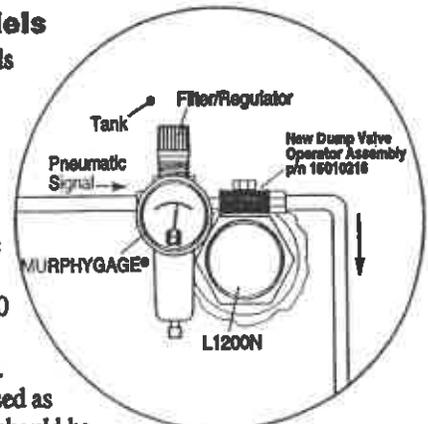
NOTE: A typical installation with Blocking and Bleed valves is shown at right.

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.

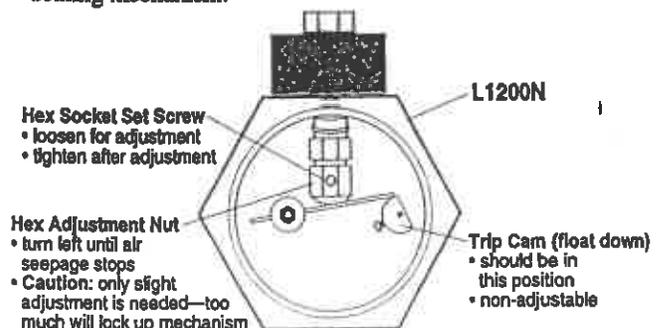


Pneumatic Models

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

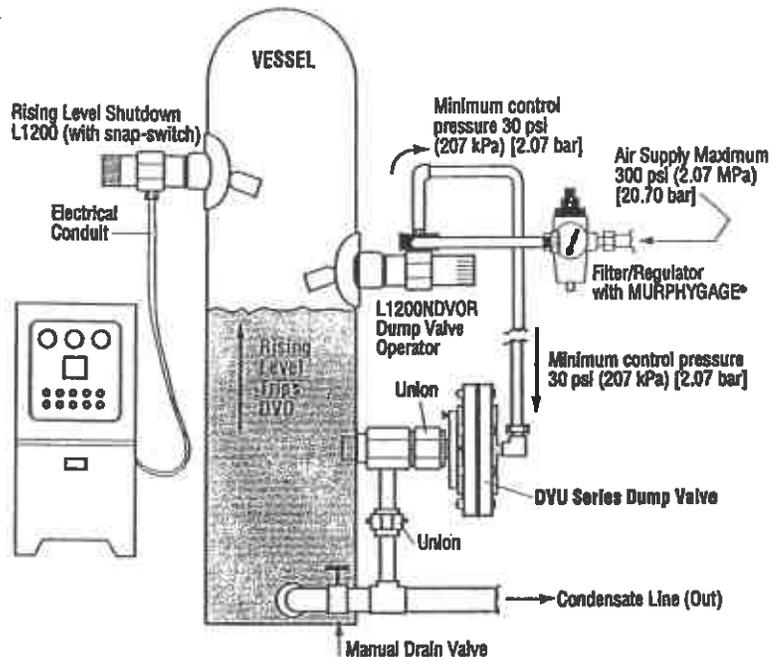
Basic Operation

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.

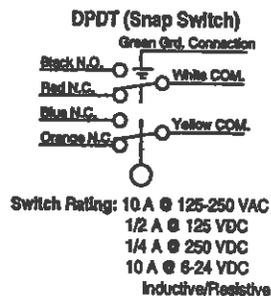
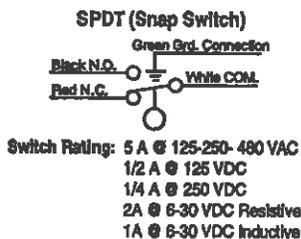
If for any reason the condensate continues to rise beyond normal dump levels, model L1200 operates the alarm and/or shuts down the equipment.

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: BUOYGLAST™ 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: BUOYGLAST™ float
- 15000894: Stainless Steel float for L1200N
- 15050453: Valve stem
- 15010189: Counter balance assembly

L1200NDVO and L1200NDVOR

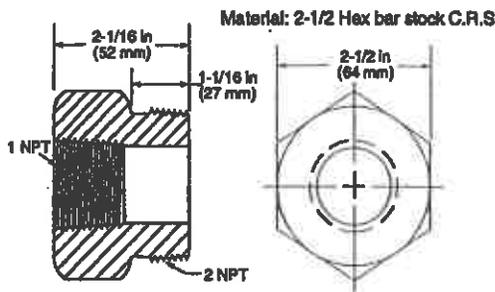
- 55050621: Regulator only
- 05706499: 20BPG-D-75 Pressure MURPHYGAGE®
0-75 psi (517 kPa) [5.17 bar]
- 15010216: DVOA assembly (New rectangular style)
- 15000940: DVO assembly (Old round style)

*To maintain hazardous location listings, all other repairs must be made by the factory.

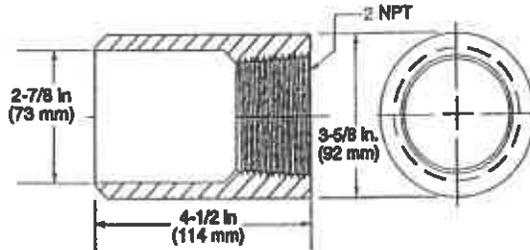
ACCESSORIES

Order by part number designation.

55050617: DVU150/DVU175 Adapter Bushing

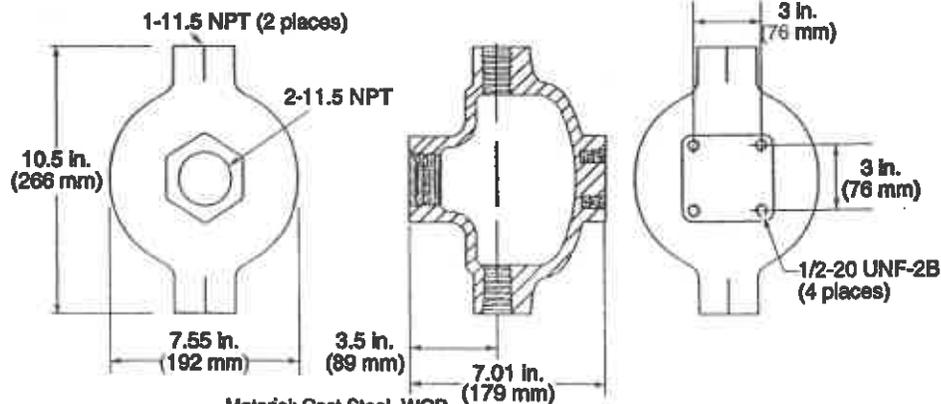


15050375: Weld Collar



Operating Pressure: 2000 psi (13.8 MPa) [138 bar].
Operating Temperature: 400°F (204°C).

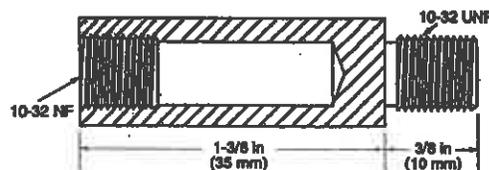
15051098: External Float Chamber



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.



FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74147 USA
(918) 317-4100
fax (918) 317-4266
e-mail sales@fwmurphy.com
www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819, Rosenberg, Texas 77471; USA
(281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Rocha Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-444-8206264 fax +52-444-8206336
Villahermosa Office +52-993-3162117
e-mail ventas@murphymex.com.mx
www.murphymex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Laverstock, Salisbury SP1 1QZ; U.K.
+44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Hume Highway
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@mequanrie.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.

M2582, M5081, and M5180 Series Electromechanical and Pneumatic, Fuel Gas Shut- off Valves Installation and Operation Instructions



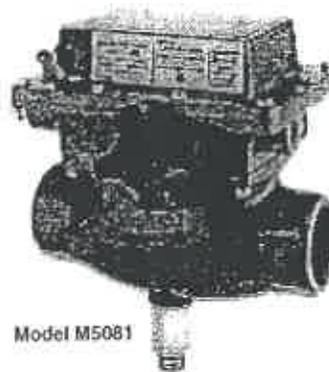
Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit and make sure installation conforms with NEC and local codes.

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 electromagnet 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

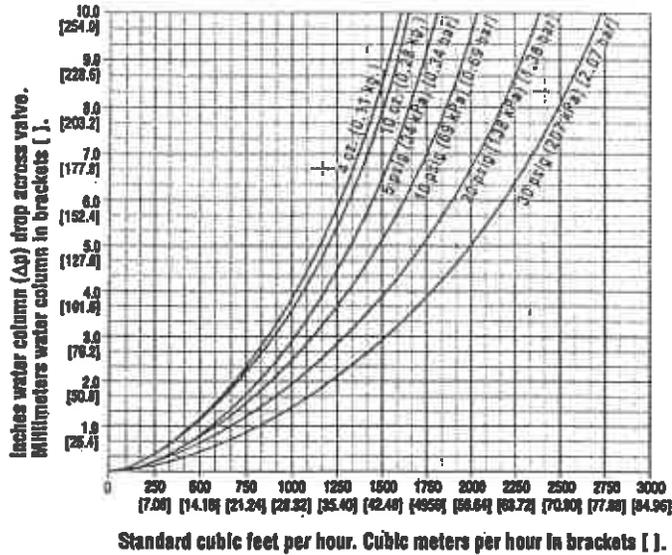
The Murphy diode package (65010065) is designed to allow the fuel shut-off valve to be used with dual Magneto Ignition systems.

NOTE: All aluminum versions of the M5081 Series Fuel Valve carry Canadian Registration Number OC1476.2.

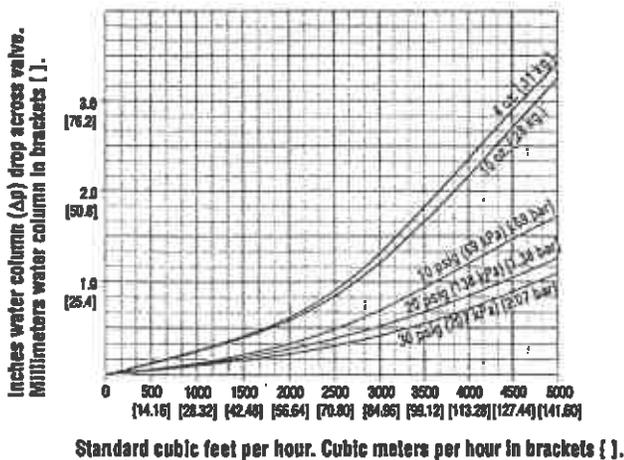
* M5081 model is CSA approved for Class I, Division I, Groups C and D. See Specifications on page 12.

FLOW CHARACTERISTICS

M2582 Series



M5081 and M5180 Series



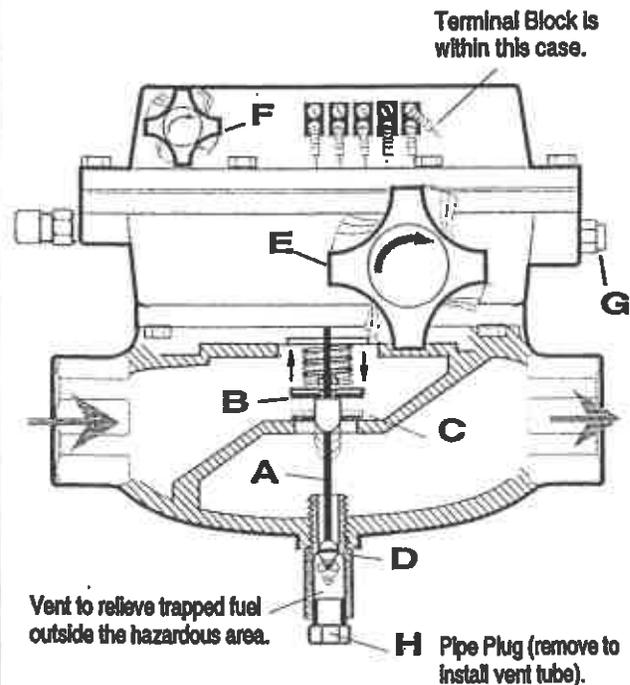
VALVE CUT-OUT

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.

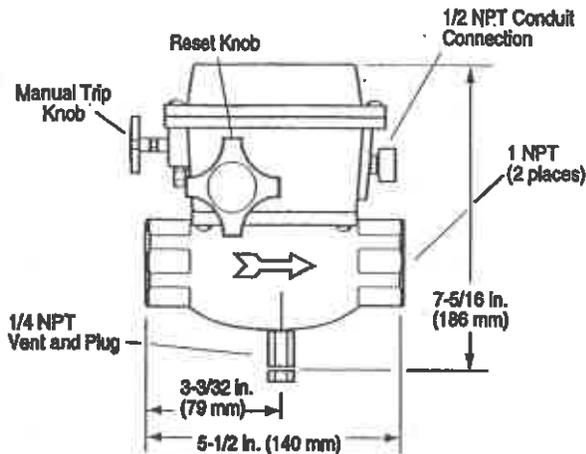
Be sure to replace Pipe Plug (H) and to clean vent periodically.

DIMENSIONS

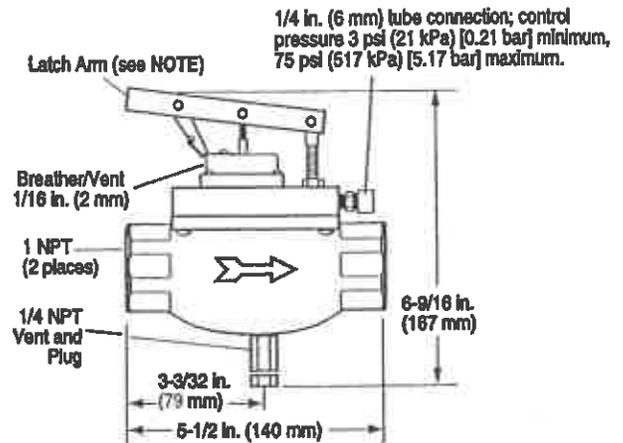


CAUTION: THE ARROW ON THE SIDE OF THE FUEL VALVE **MUST** POINT TO THE CORRECT DIRECTION OF THE FLOW, FROM FUEL SOURCE TO THE ENGINE. APPLY PIPE DOPE **ONLY** TO FUEL PIPE, **NOT** TO THE FUEL VALVE.

M2582

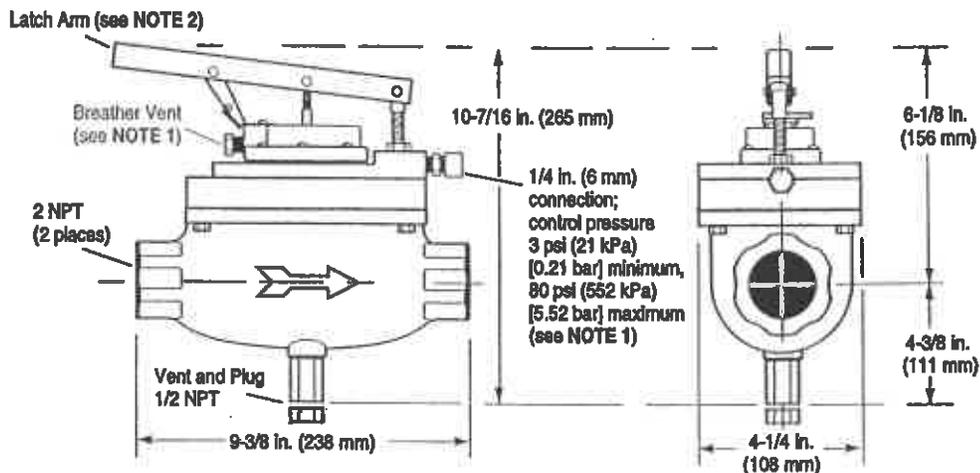


M2582-P



NOTE: Thumb operated opening latch (2.5 psi [17 kPa] [0.17 bar] required to release cocking latch)

M5180-P

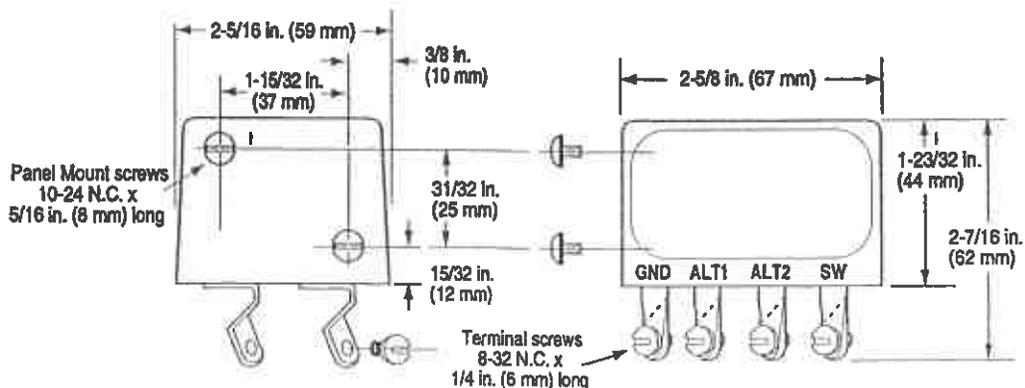


NOTE 1: Control pressure connection fitting and breather vent fitting can be swapped to convert to vacuum control.

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)

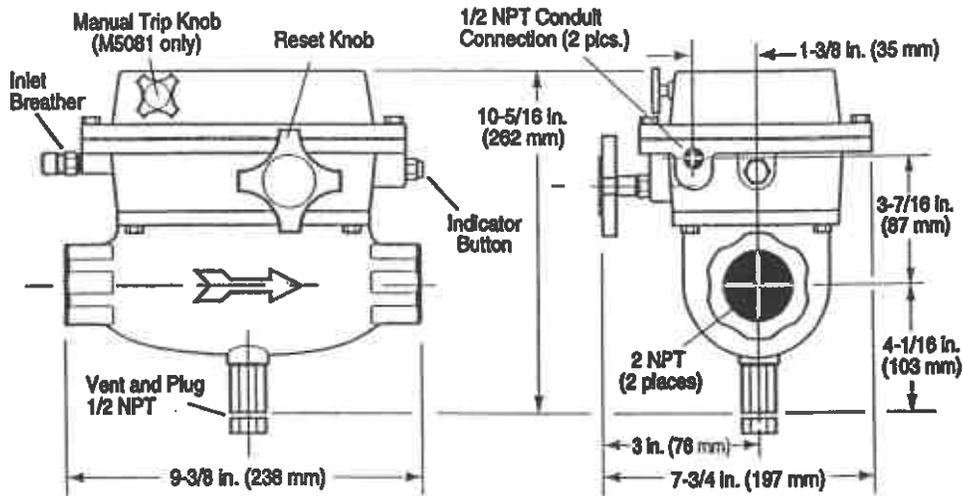


DIMENSIONS *continued*

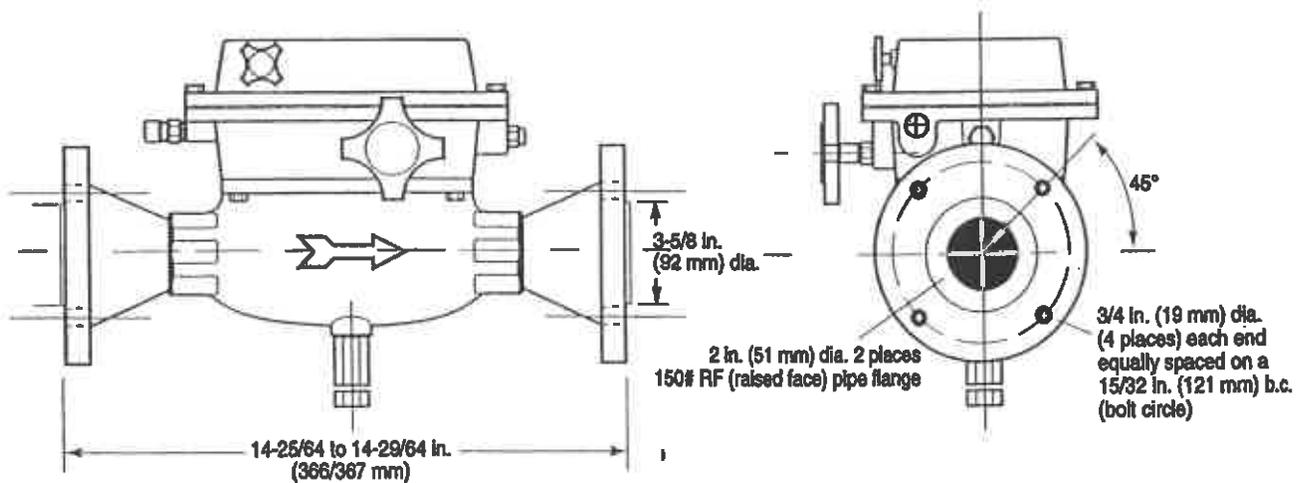


CAUTION: THE ARROW ON THE SIDE OF THE FUEL VALVE **MUST** POINT TO THE CORRECT DIRECTION OF THE FLOW, FROM FUEL SOURCE TO THE ENGINE. APPLY PIPE DOPE **ONLY** TO FUEL PIPE, **NOT** TO THE FUEL VALVE.

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)

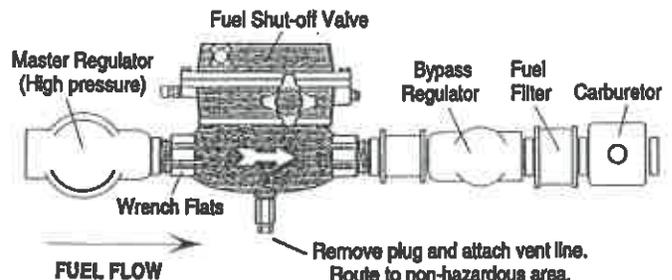
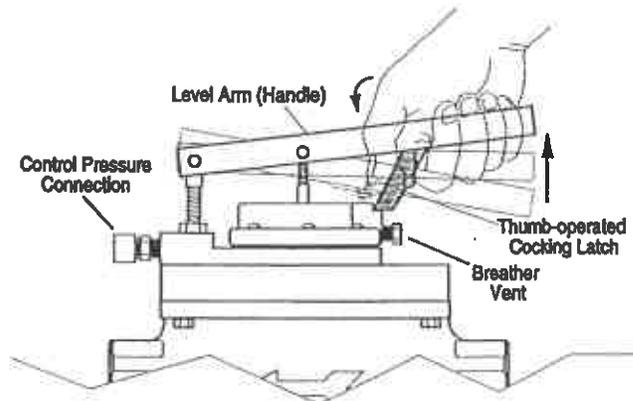


Figure 2
Pull the lever up, and press the latch down into ridge with thumb.



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

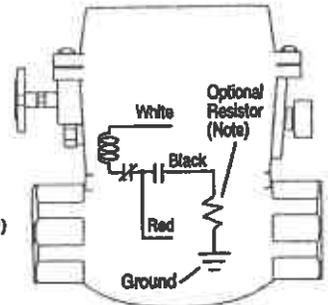
Install a 1/2 NPT conduit from the M2582 conduit connection to the power source. See M2582 Dimensions (page 3) for location.

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

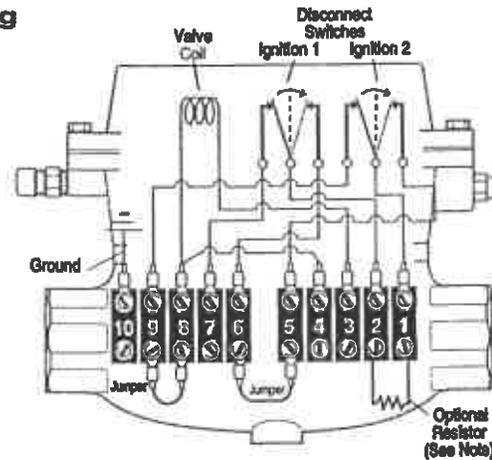
Conduit Installation

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.

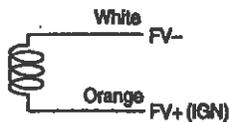
For wiring the M5081 fuel valves to Solid-State TATTLETALE[®] annunciators, refer to pages 9, 10, and 11.

M5081 Internal Wiring

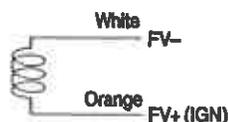


NOTE: For grounding the ignition (CD models only) through the fuel valve snap-switches, use a Magnetic Switch Adapter, see Magnetic Switch Adapter, below and the "TO CLOSE THE FUEL VALVE and GROUND THE IGNITION" attachment, and install a 100 ohm; 2 watt resistor (included with your attachment).

M2582-C-LS Wiring



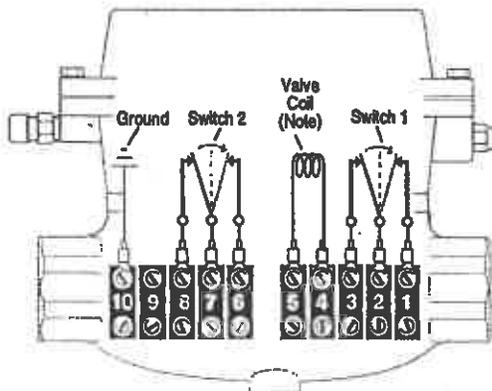
M5081-C-LS Wiring



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.

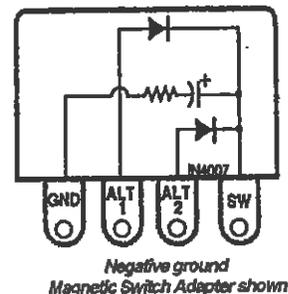
Magnetic Switch Adapters for Use with Capacitor Discharge Ignitions

Connect the Magnetic Switch Adapter between the fuel Valve terminal 1 and the CD Ignition. See wiring diagrams (pages 7 and 11).

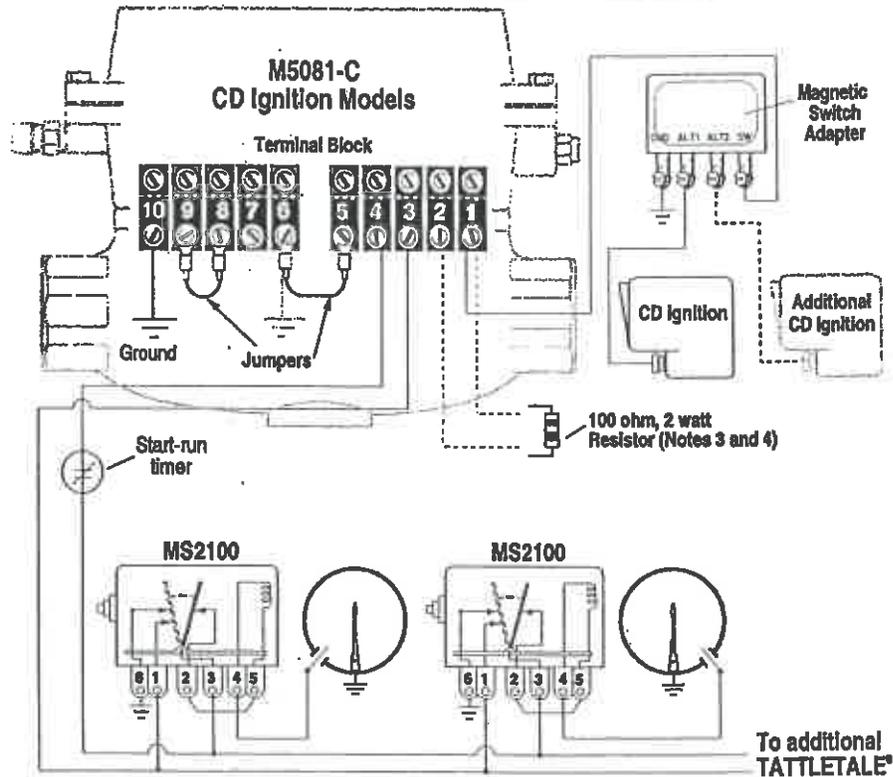
65700053 (was 65020126): For use with negative ground ignitions up to 240 VDC.

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.

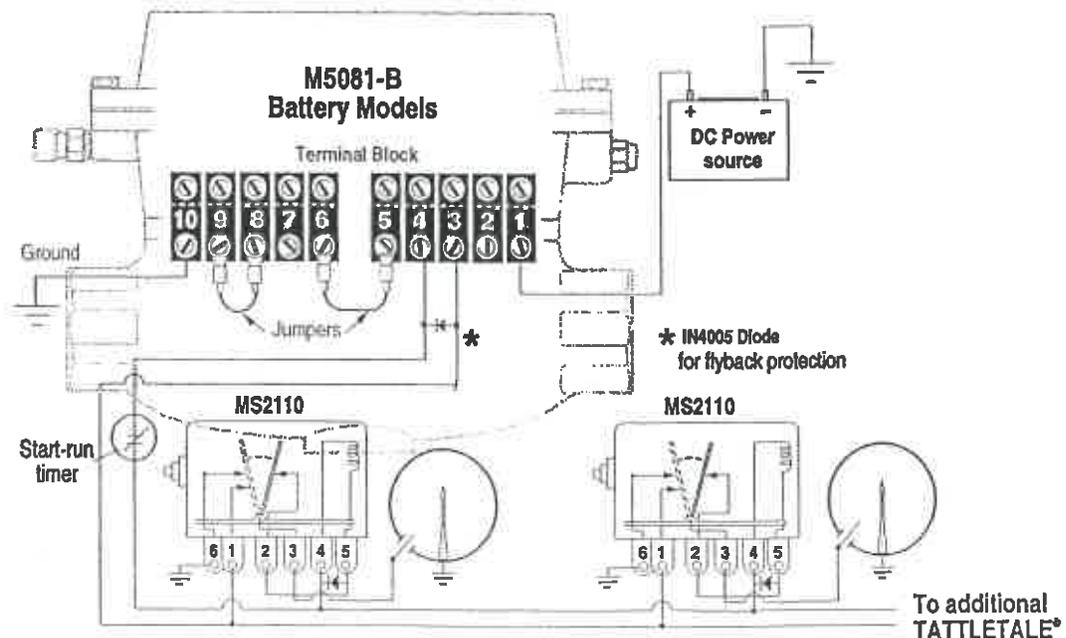


TYPICAL WIRING for M5081-C (CD IGNITION MODELS)

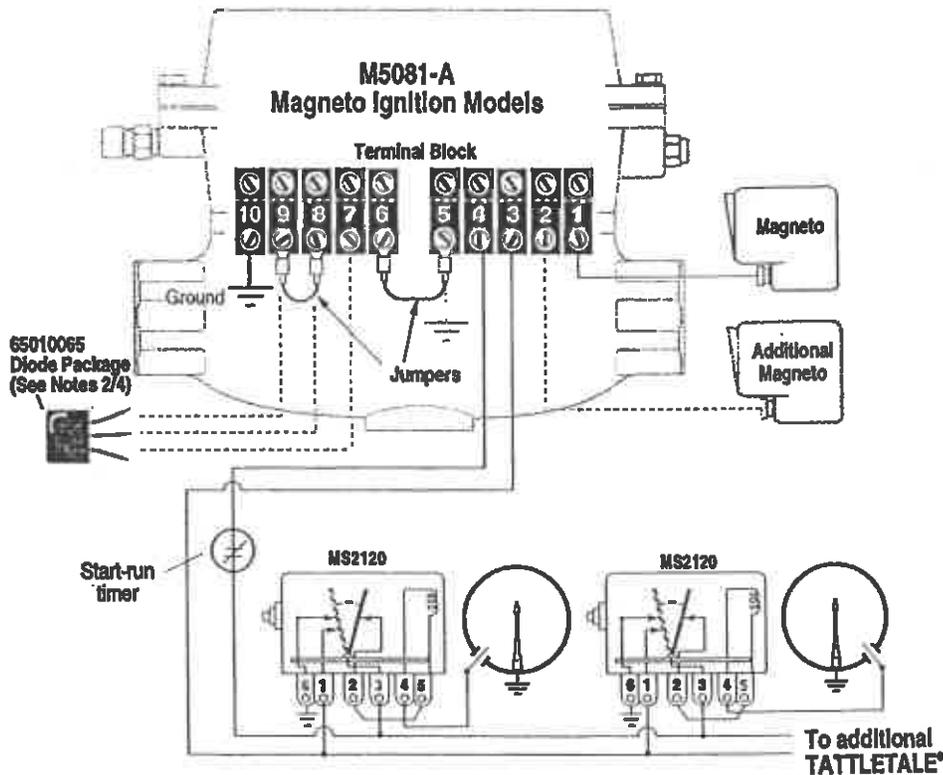


- NOTE 1:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITION (Single CD Ignition Systems) Remove the factory-installed jumper on terminals 6-5. Do NOT ground terminal 6.
- NOTE 2:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITIONS (Dual CD Ignition Systems) Remove the jumper on terminals 6-5. Connect second 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)



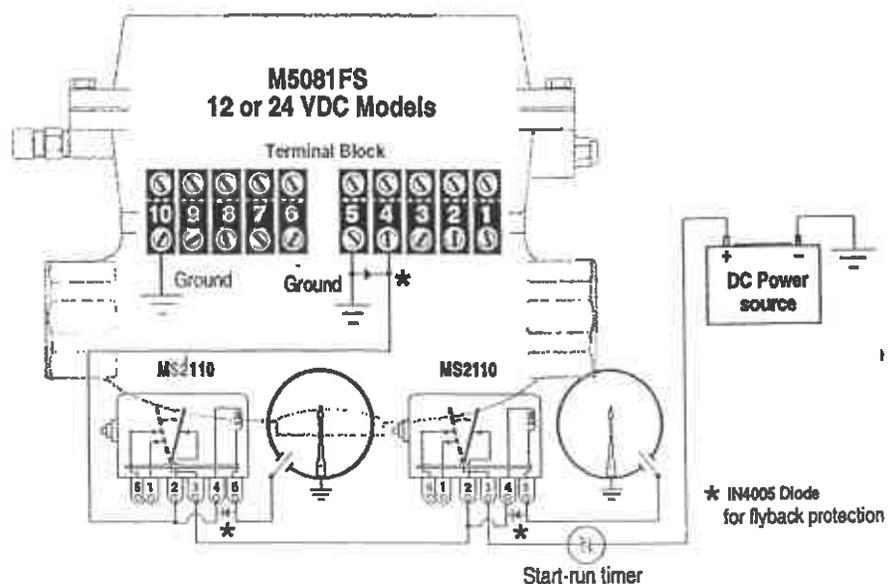
NOTE 1: To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITION (Single Magneto Systems) Remove the factory-installed jumper on terminals 6-5. Do NOT ground terminal 5.

NOTE 2: To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITIONS (Dual Magneto Systems) Remove the factory-installed jumpers on terminals 6-5 and 8-9. 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 8-9) 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)

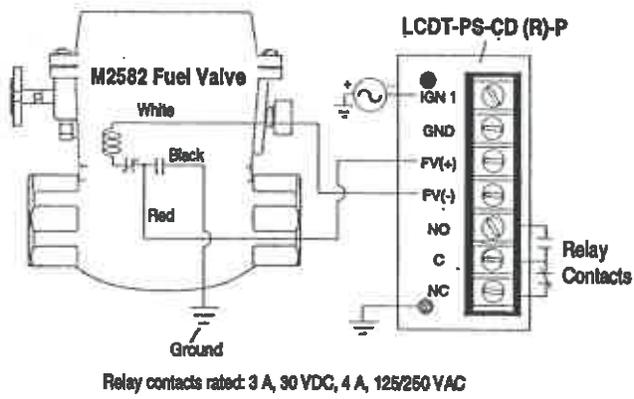


TYPICAL WIRING to SOLID-STATE TATTLETALE® Annunciators

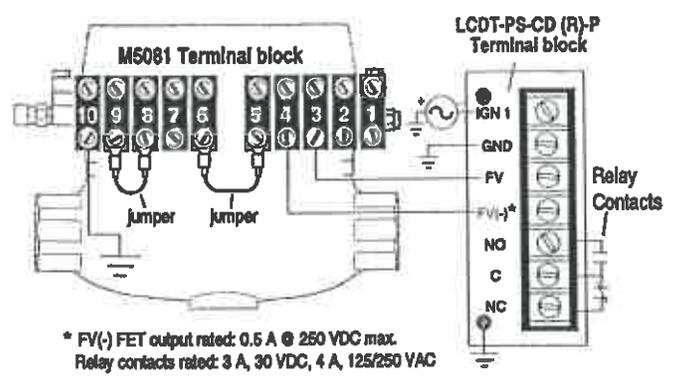


WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

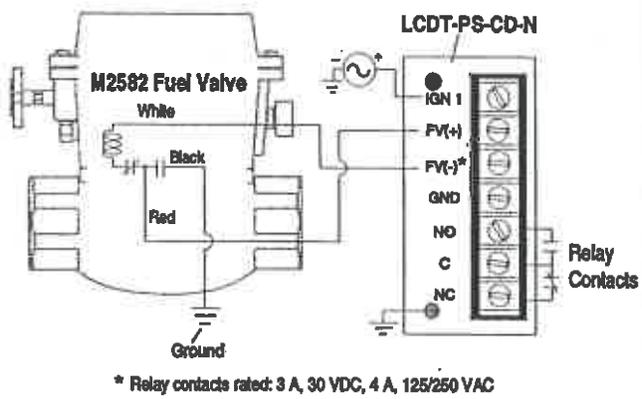
M2582-C to LCDT-PS-CD (R)-P (positive ground)



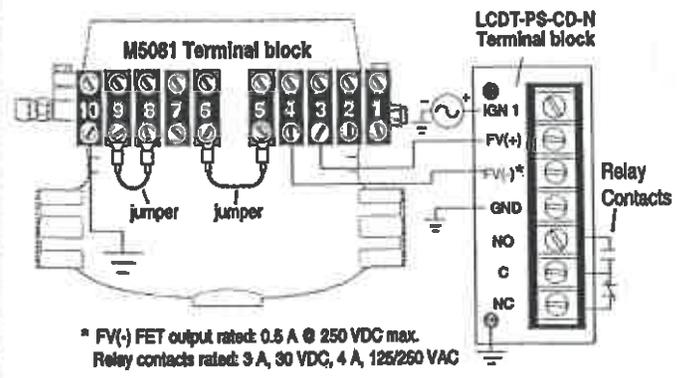
M5081-C to LCDT-PS-CD (R)-P (positive ground)



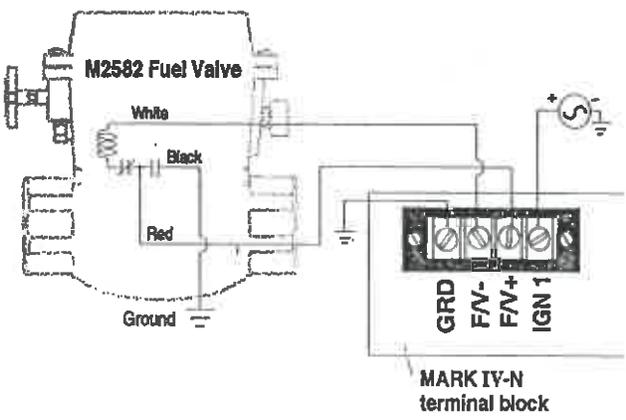
M2582-C to LCDT-PS-CD-N (negative ground)



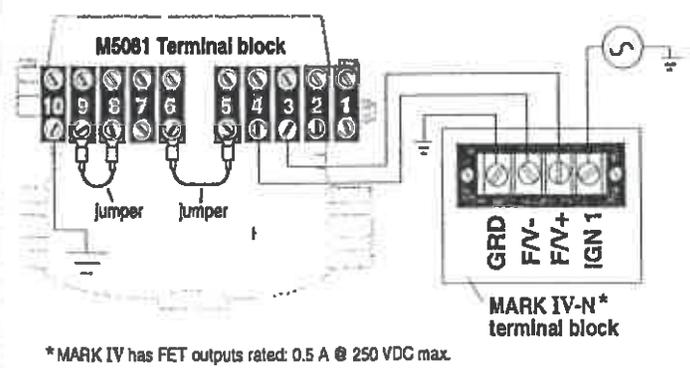
M5081-C to LCDT-PS-CD-N (negative ground)



M2582-C to MARK IV-N (negative ground)



M5081-C to MARK IV-N (negative ground)

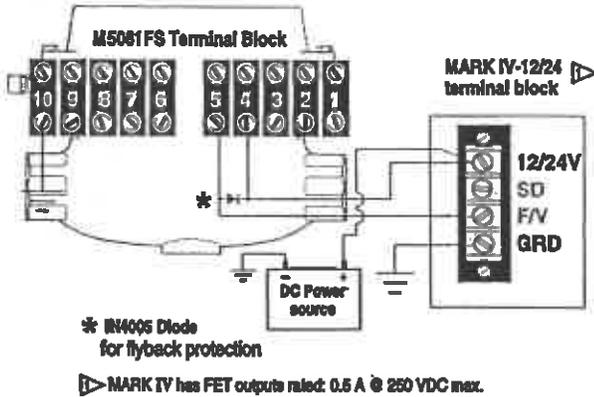


TYPICAL WIRING to SOLID-STATE TATTLETALE® Annunciators

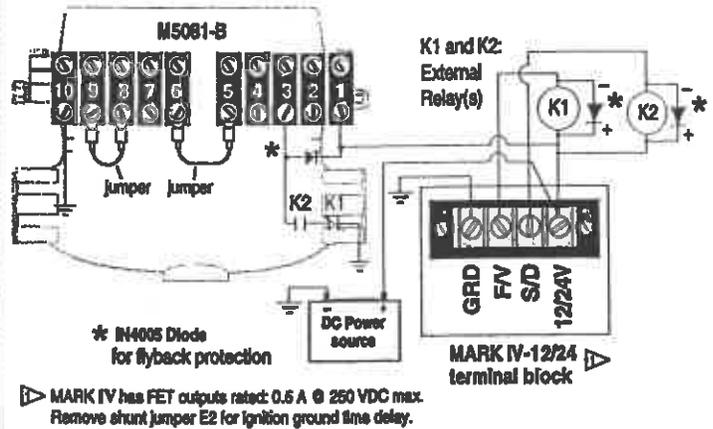


WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

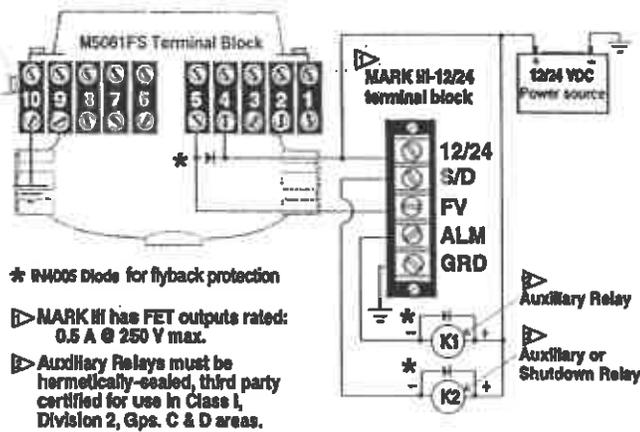
M5081 FS to MARK IV-12/24



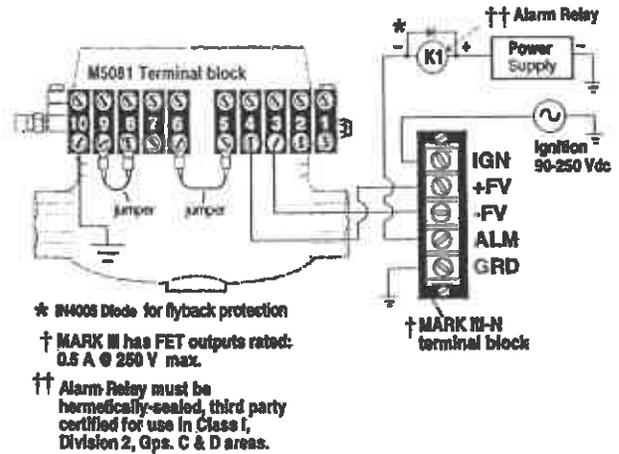
M5081-B to MARK IV-12/24



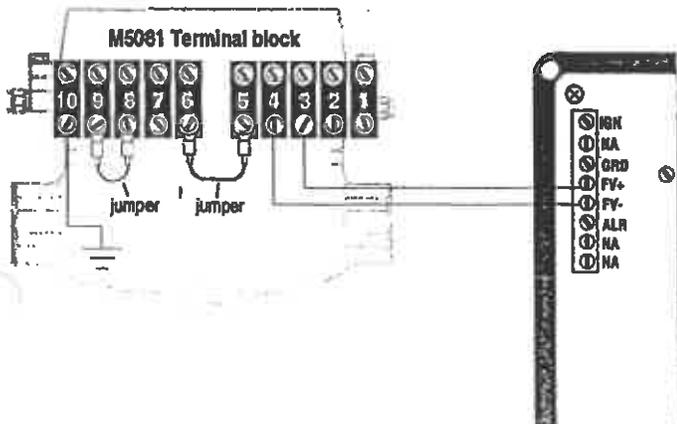
M5081 FS to MARK III-12/24



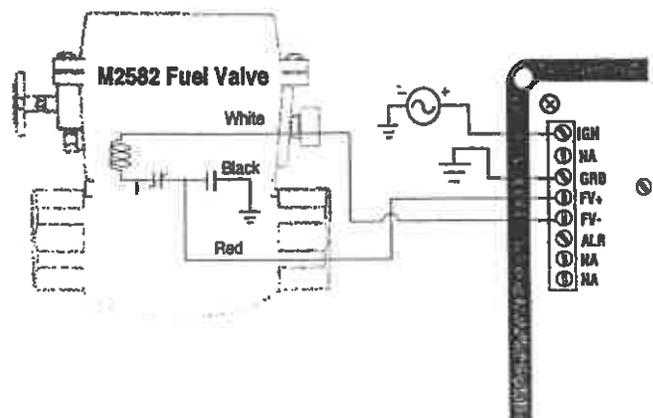
M5081-C to MARK III-N



M5081-C to TTDJ-IGN-(T)



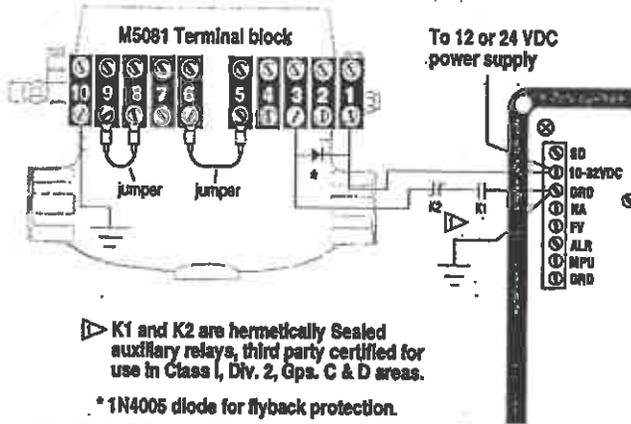
M2582-C to TTDJ-IGN-(T)



TYPICAL WIRING to SOLID-STATE TATTLETALE® Annunciators continued

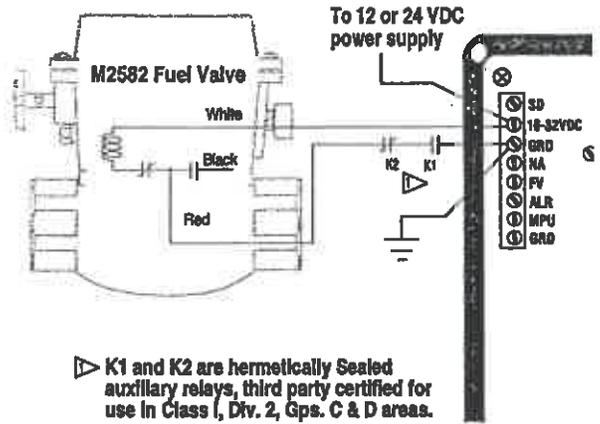
WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

(A) M5081-B to TTDJ-DC-(T)



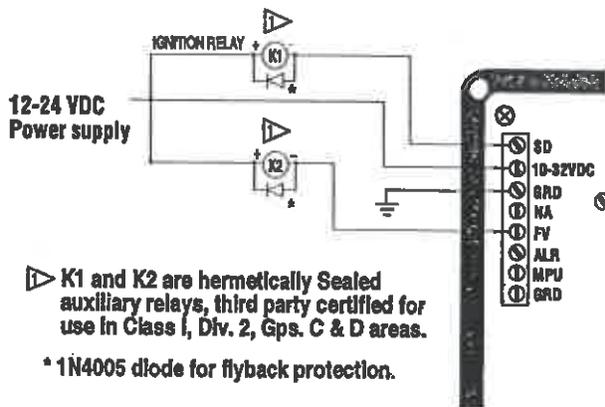
▷ K1 and K2 are hermetically Sealed auxiliary relays, third party certified for use in Class I, Div. 2, Gps. C & D areas.
* 1N4005 diode for flyback protection.

(B) M2582-B to TTDJ-DC-(T)



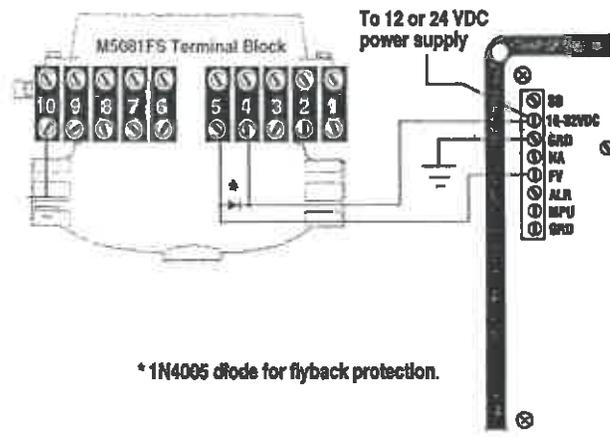
▷ K1 and K2 are hermetically Sealed auxiliary relays, third party certified for use in Class I, Div. 2, Gps. C & D areas.

TTDJ-DC-(T) to Relays
Connections Shown for Use with
Diagrams (A), (B), (C), and (D) on this page.



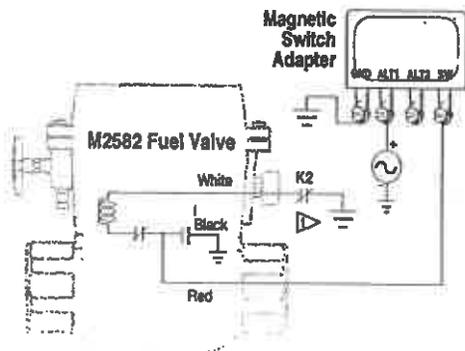
▷ K1 and K2 are hermetically Sealed auxiliary relays, third party certified for use in Class I, Div. 2, Gps. C & D areas.
* 1N4005 diode for flyback protection.

M5081FS to TTDJ-DC-(T)



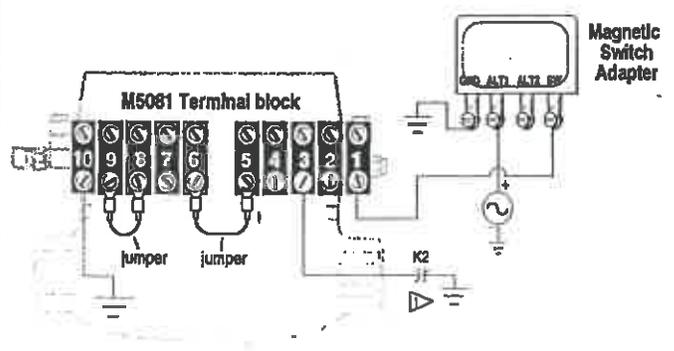
* 1N4005 diode for flyback protection.

(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	55000128	-----	-----	-----
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	55000097	55000137	-----	-----	-----
Soap Switch Assembly	55000098	55000072	55000160	-----	-----
Close/Open Indicator Assembly	-----	55000138	55000138	-----	-----
Stem and Seat Kit	55000093	55000075	55000135	55000147	55000135
Top Works Complete Valve Less Body and Vent	55000146	55000131	55000161	55000150	55000155
Vent Bushing Assembly	55000143	55000132	55000132	55000143	55000132
Diaphragm Assembly	-----	-----	-----	55000184	55000153
Pilot Diaphragm	-----	-----	-----	00007908	55050420
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.



FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74147 USA
(918) 317-4100
fax (918) 317-4266
e-mail sales@fwmurphy.com
www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
(281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Rocha Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-444-8206264 fax +52-444-8206336
Villa Hermosa Office +52-993-3162117
e-mail ventas@murphymex.com.mx
www.murphymex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Lymington, Salisbury SP1 1QZ; U.K.
+44 1722 410055 fax +44 1722 410888
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Hume Highway
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@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.

Installation Instructions for L150, EL150K1, and EL150 EX Level SWICHGAGE®s for Engine Liquids

L-7768N
Revised 08-00
Section 15
(00-02-0171)



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.

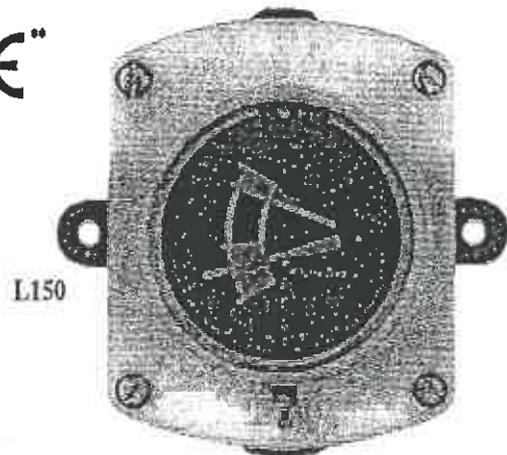
Applications

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[™]



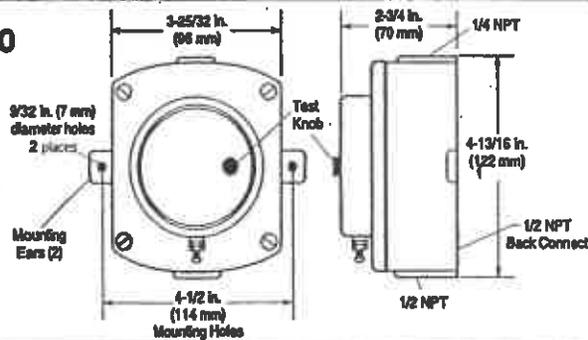
L150

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 psi (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.			•

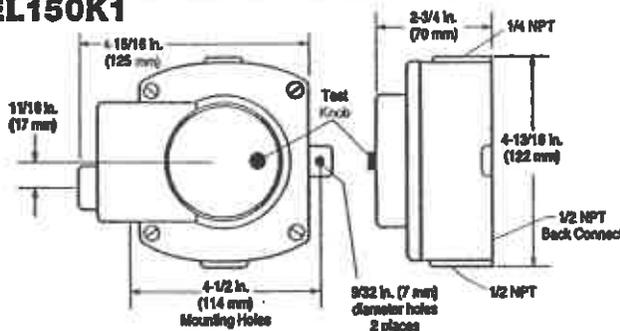
**Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted.

DIMENSIONS

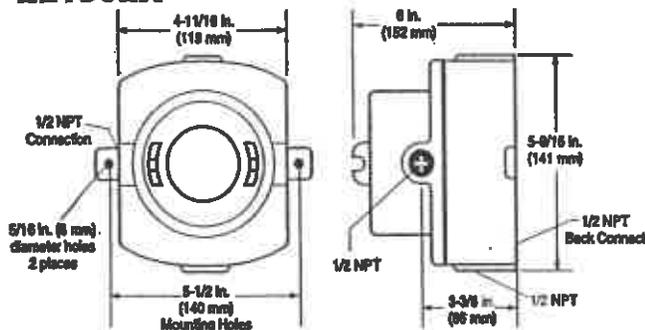
L150



EL150K1



EL150EX



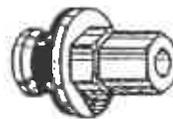
PS FITTINGS INSTALLATION

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®.

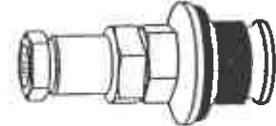
- P/N 15-00-0107 (PS) Accepts 1/4 in. (6 mm) O.D. copper tubing.
- P/N 15-01-0167 (PS Barbed) Barbed fitting accepts 1/4 in. (6 mm) I.D. flexible tubing and hose clamp.
- P/N 15-01-0202 (PS-D) Accepts 1/2 in. (13 mm) I.D. hose; 1/4 in. (6 mm) copper tube.

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.

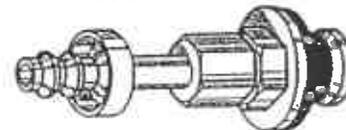
15-00-0107



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.

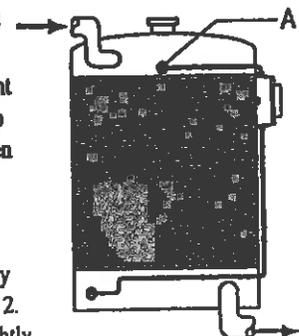
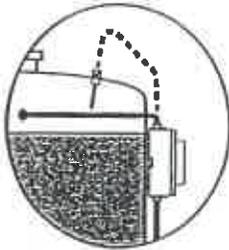


Figure 1: Pressurized System

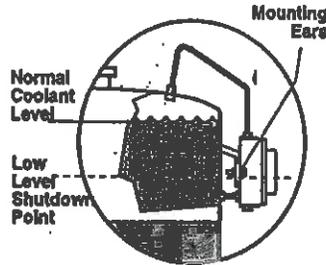
LEVEL SWITCHGAGE[®] INSTALLATION (continued)

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.

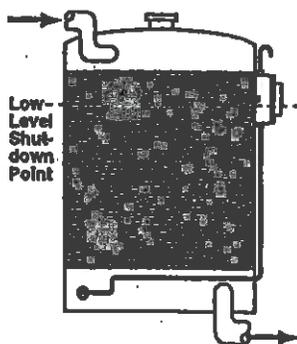
5. For an **ATMOSPHERIC SYSTEM** a tube connection in the top tank may not be required. Determine the lowest desired level of coolant in the top tank. Mount the L150/EL150K1 so that the mounting ears are approximately 1/4 in. (6 mm) above that level (Figure 3). A back mounting option is available for 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).

Condenser/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.

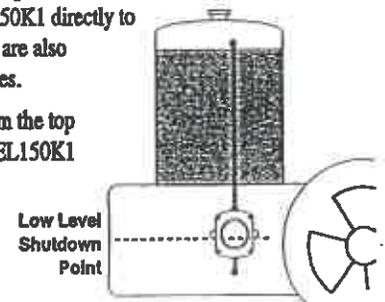
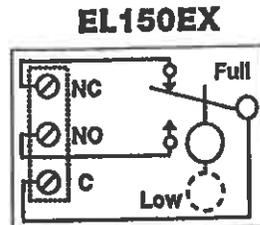
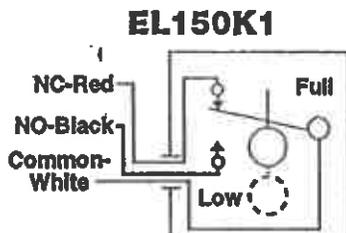
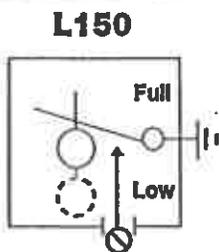


Figure 5:
Condenser/Radiator System

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.

1. As applicable, shut off liquid to the SWICHGAGE® or drain the system level below the SWICHGAGE®.
2. Disconnect electrical lead(s), one at a time and tag for reinstallation.
3. Disconnect conduit on EL150K1.

4. Remove the four screws that secure the float and glass assembly to the case.
5. Remove and discard the old float and cover assembly.
6. Remove and discard the old gasket.
7. Install the new gasket.
8. Install the new float and cover assembly and secure it with four screws.
9. Re-connect the conduit on EL150K1.
10. Re-connect the electrical lead(s).
11. As applicable, open valves to the SWICHGAGE® or refill the system to proper level.
12. Check the SWICHGAGE® for proper operation at the full indicating position. (Alarm not operated/engine continues to operate.)
13. 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.
14. Check for unrestricted float movement by rotating the switch test knob.
15. 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

FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74147 USA
(918) 627-3550
fax (918) 664-6146
e-mail sales@fwmurphy.com
www.fwmurphy.com



CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
(281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Rocha Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-48-206264 fax +52-48-206336
e-mail ventasmx@murphymex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Lyverslock, Salisbury SP1 1QZ; U.K.
+44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

For Service in France:
Pour service en français:
+44 1722 410697 fax +44 1722 410088
e-mail france@fwmurphy.co.uk
www.fwmurphy.co.uk/francais.htm

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 272-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Hume Highway;
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@macquarrie.com.au

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.

FRANK W. MURPHY MANUFACTURER P.O. Box 479248; Tulsa, Oklahoma 74147; USA tel. (918) 627-3550 fax (918) 664-6146 e-mail sales@fwmurphy.com <http://www.fwmurphy.com>



USA-350 0001 FIM 29221
UK-550 0002 FIM 23422

Printed in U.S.A.

FRANK W. MURPHY SOUTHERN DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
tel. (281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

FRANK W. MURPHY, LTD.
Church Rd.; Laverstock, Salisbury SP1 1QZ; U.K.
tel. +44 1722 410055 fax +44 1722 410081
e-mail sales@fwmurphy.co.uk
<http://www.fwmurphy.co.uk>

FRANK W. MURPHY FRANCE
tel. +33 1 30 762626 fax +33 1 30 763189

MURPHY DE MEXICO, S.A. DE C.V.
 Blvd. Antonio Lacho Cardero 300, Fracción del Agrícola
 San Luis Potosí, S.L.P.; México 78304.
 tel. +52-48-206264 fax +52-48-206336
 e-mail murmex@sanluis.poder.net.mx

FRANK W. MURPHY PTE., LTD.
 No. 2 Teas South Street 2,
 Sprincocks Bldg., #02-01/02
 Singapore 630042
 tel. +65 863-1398 fax +65 863-0200
 e-mail fwsales@fwmurphy.com.sg

MURPHY SWITCH OF CALIFORNIA
 41343 12th Street West
 Palmdale, California 93551-1442; USA
 tel. (661) 272-4700 fax (661) 947-7570
 e-mail sales@murphyswitch.com
<http://www.murphyswitch.com>

MACQUARRIE CORPORATION
 1620 Hume Highway;
 Campbellfield, Vic 3061; Australia
 tel. +61 3 9358-5555 fax +61 3 9358-5558
 e-mail murphy@macquarrie.com.au

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®, TATTLETALE® 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 regresada 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 consecuentes o indirectos.

Usted ha adquirido instrumentación confiable, y bajo cuidado normal le proporcionará 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 subsiguientes a la fecha de entrega o de la fecha de facturación.

FRANK W. MURPHY MANUFACTURER P.O. Box 470248; Tulsa, Oklahoma 74147; USA



USA-350 9001 FM 28221
UK-450 5002 FM 28422

Printed in U.S.A.

FRANK W. MURPHY SOUTHERN DIVISION
P.O. Box 1119; Houston, Texas 77471; USA
Tel. (281) 342-8297 fax (281) 341-6006
e-mail sales@fwmurphy.com

FRANK W. MURPHY, LTD.
Church Hill; Lymington, Salisbury SP1 1QZ; U.K.
Tel. +44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
http://www.fwmurphy.co.uk

FRANK W. MURPHY FRANCE
Tel. +33 1 30 762626 fax +33 1 30 763989

tel. (918) 627-3550 fax (918) 644-6146 e-mail sales@fwmurphy.com http://www.fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
 Blvd. Antonio Roda Cardeza 308, Fracción del Agrupado
 San Luis Potosí, S.L.P.; México 78384
 Tel. +52-48-204264 fax +52-48-204336
 e-mail murmex@satelnet.com.mx

FRANK W. MURPHY PTE., LTD.
 No. 2 Teas South Street 2,
 Singapore 638042
 Tel. +65 663-1398 fax +65 663-0208
 e-mail fwmexales@fwmurphy.com.sg

MURPHY SWITCH OF CALIFORNIA
 41943 12th Street West
 Palmdale, California 93551-1442; USA
 Tel. (661) 272-4700 fax (661) 947-3570
 e-mail sales@murphyswitch.com
 http://www.murphyswitch.com

MACQUARRIE CORPORATION
 1628 Home Highway,
 Campbellfield, Vic 3061; Australia
 Tel. +61 3 9358-5555 fax +61 3 9358-5558
 e-mail murphy@macquarrie.com.au

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 máquinas 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 periódicamente 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 estén 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 cuestión debe ser regresada a la fábrica 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.

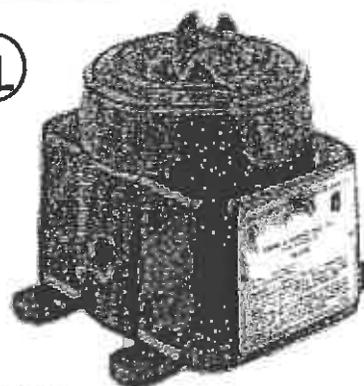
Shock/Vibration Control Switches Installation Instructions

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



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

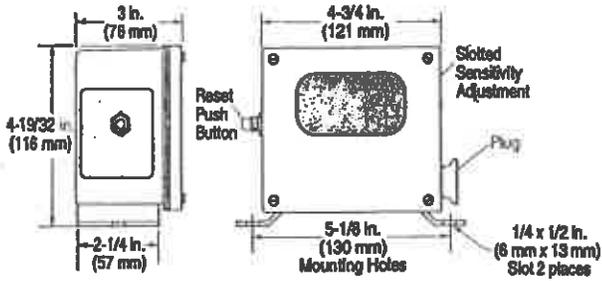
-H24: Space heater for 24 VDC

Warranty

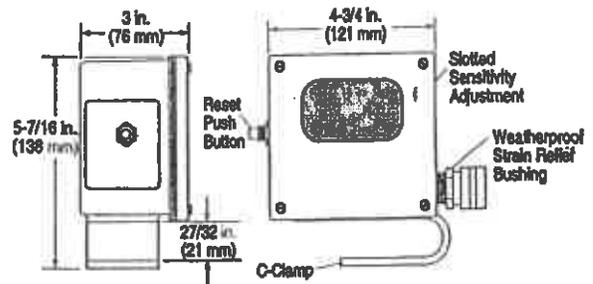
A two-year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.

DIMENSIONS

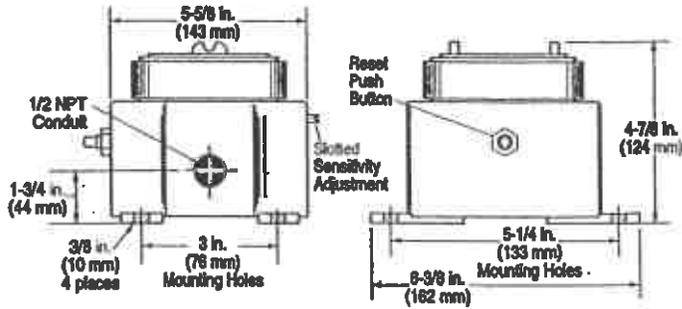
VS2



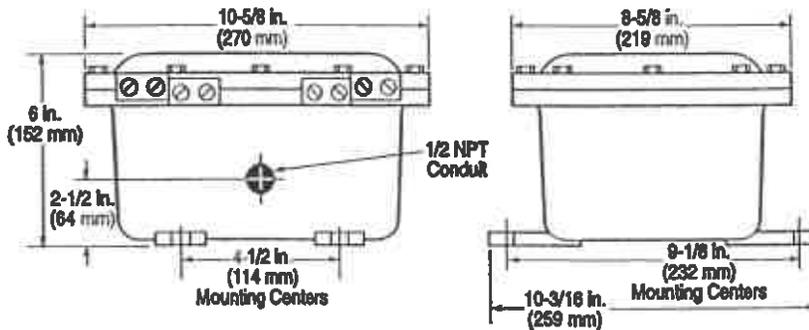
VS2C



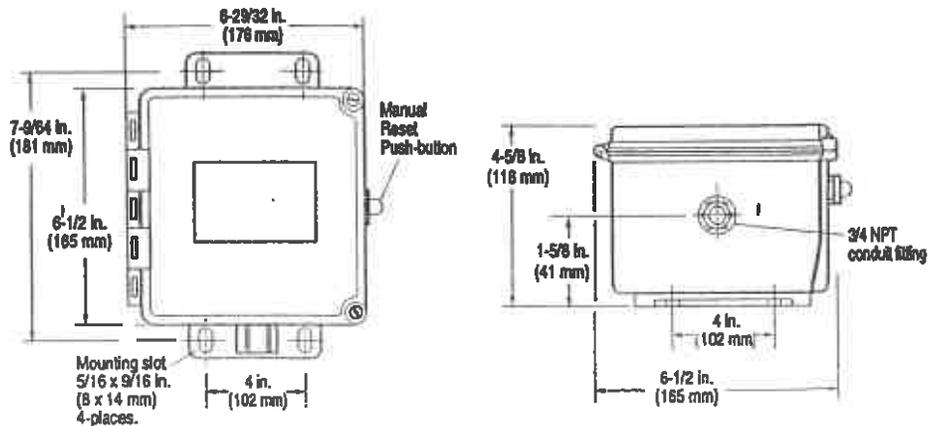
VS2EX and VS2EXR



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.



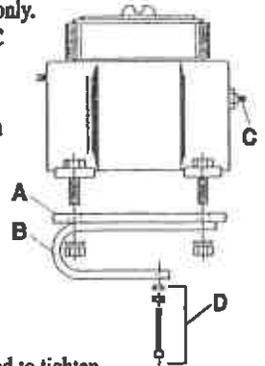
CAUTION: A dust boot is provided on the reset pushbutton for all series to prevent moisture or dust intrusion. The sensitivity adjustment for model VS2EX is not sealed; therefore, mounting

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"



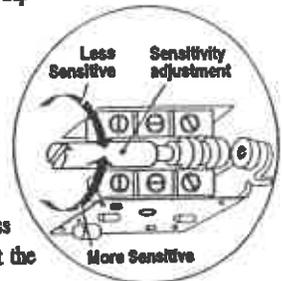
allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL "B").



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.

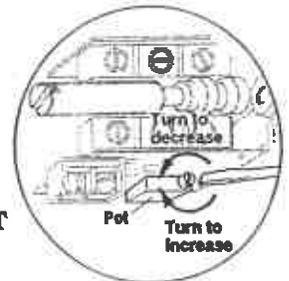
VS94 Time Delay Adjustment



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.

DETAIL "C"



NOTE: Allow 30 seconds bleed-time between turning the power "OFF" and "ON."

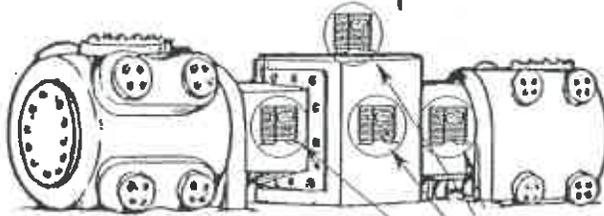
4. Locate the time adjustment pot (DETAIL "C"). The time is factory-set at the lowest setting (5 seconds approximately). To increase time, rotate the 20-turn pot clockwise as needed (15 seconds per turn approximately).
5. Repeat the above steps as necessary to obtain desired time delay.

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

TYPICAL MOUNTING LOCATIONS

NOTE: These are typical mounting locations for best operation. Other mountings are possible. See *Installation* section on page 3.

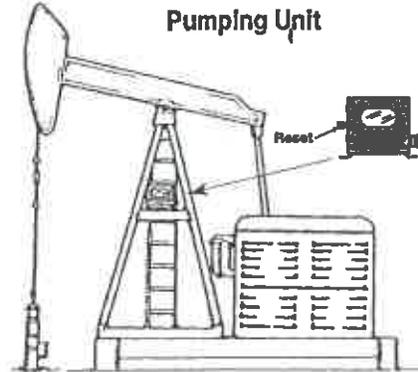
2-Throw Balance-Opposed Compressor



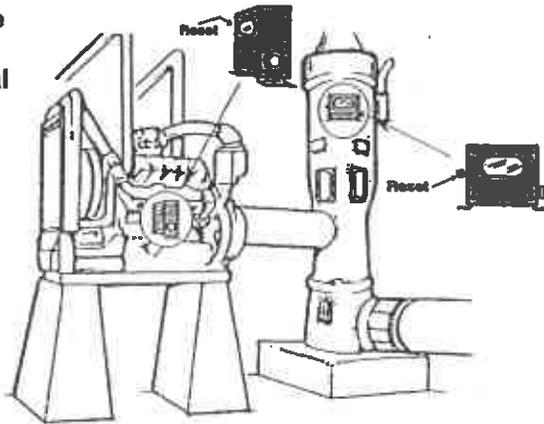
NOTE: If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.



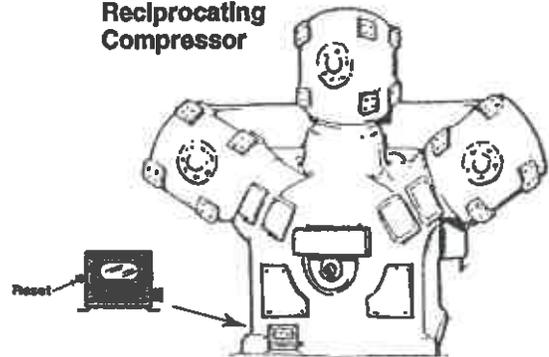
Pumping Unit



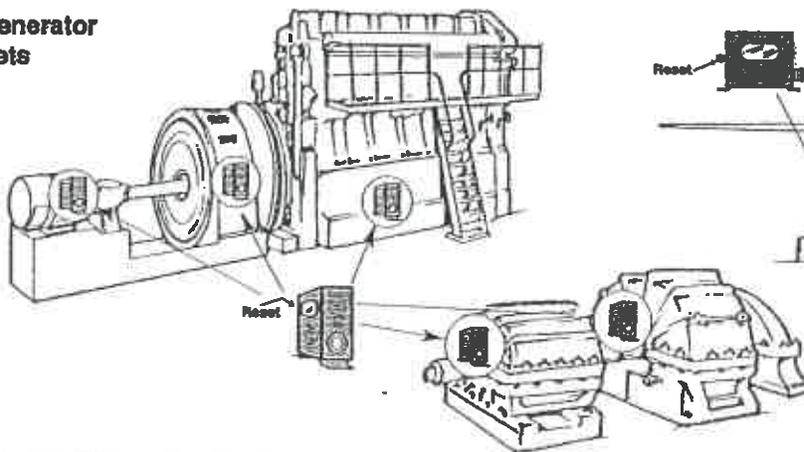
Engine and Vertical Shaft Pump



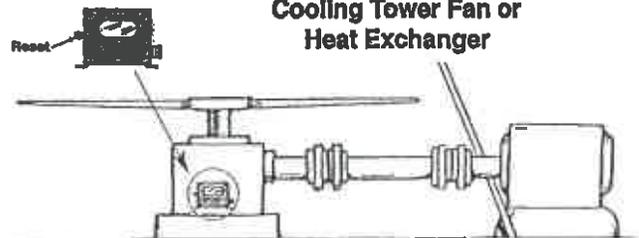
"Y" Type Reciprocating Compressor



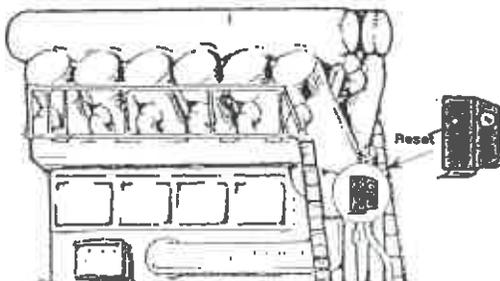
Generator Sets



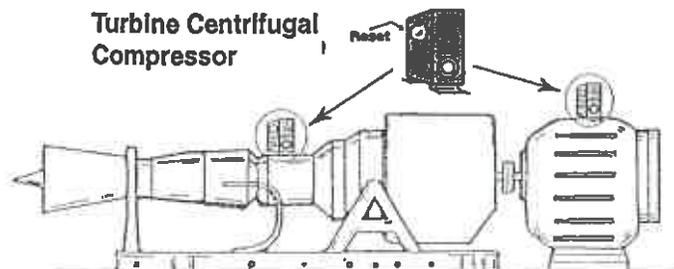
Cooling Tower Fan or Heat Exchanger



Engine Compressor

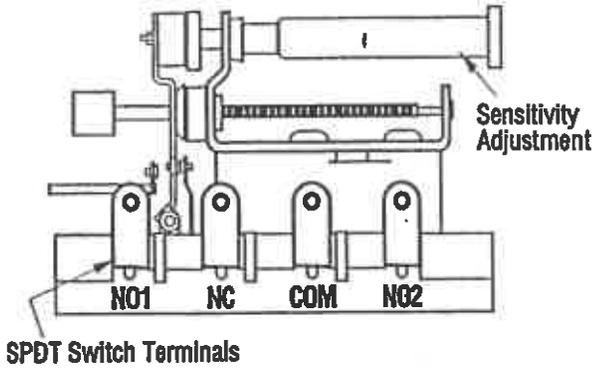


Turbine Centrifugal Compressor

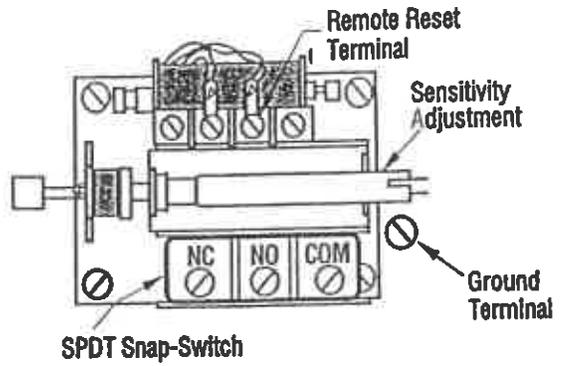


INTERNAL SWITCHES

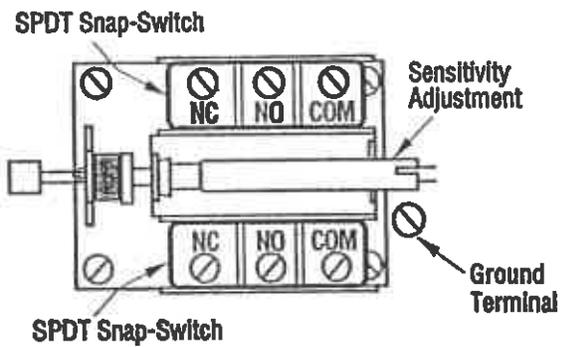
VS2 and VS2C



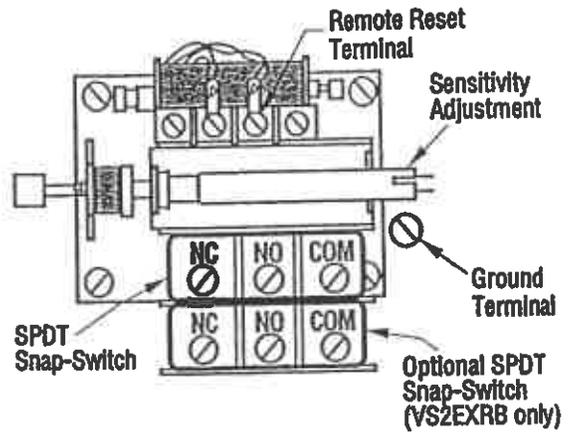
VS2EXR



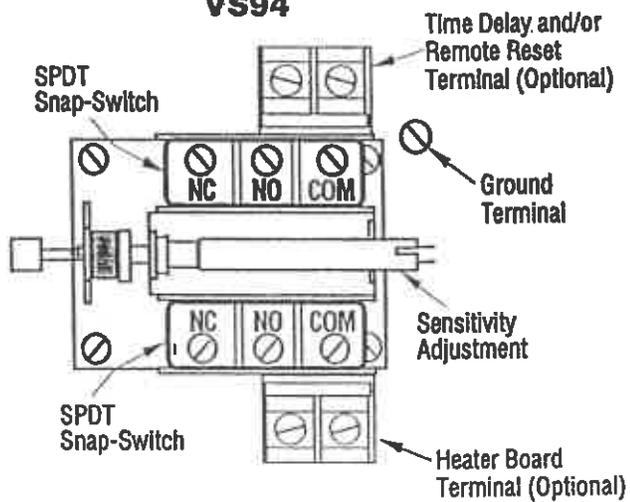
VS2EX



VS2EXB and VS2EXRB



VS94

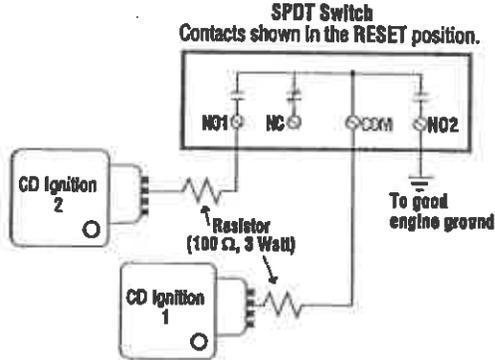


ELECTRICAL

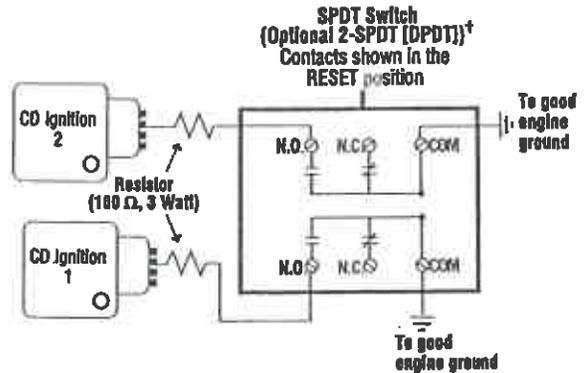


WARNING: REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.

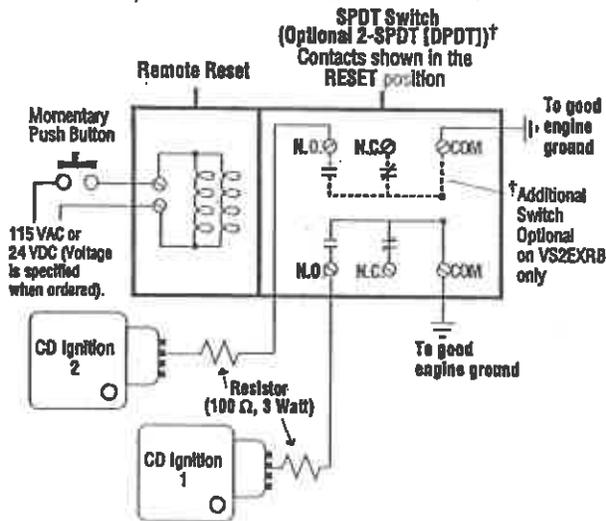
VS2 and VS2C
Typical Wiring Diagram for Single or Dual CD Ignition



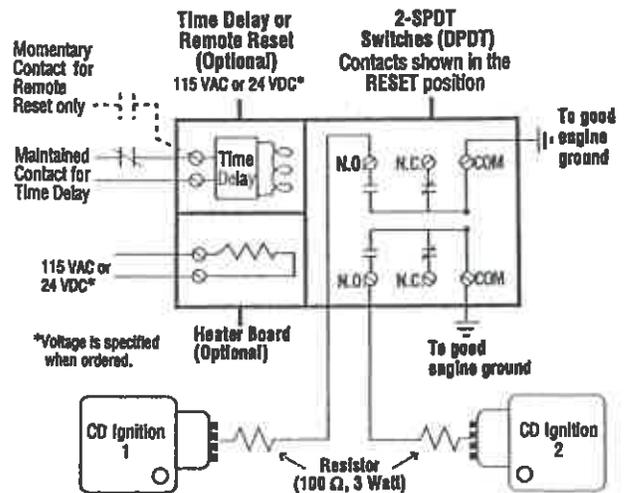
VS2EX
Typical Wiring Diagram for Single or Dual CD Ignitions



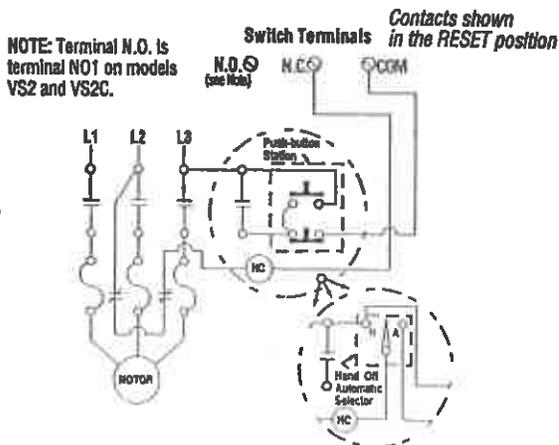
VS2EXR and VS2EXRB
Typical Wiring Diagram for Single or Dual CD Ignitions



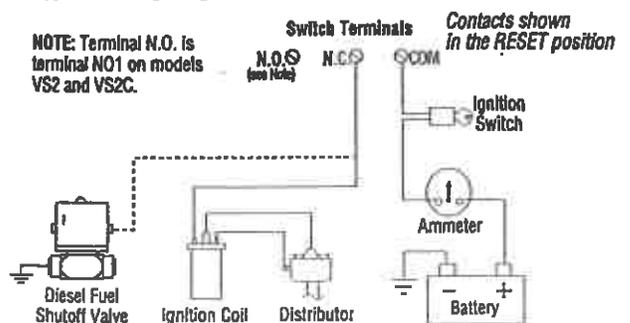
VS94
Typical Wiring Diagram for Single or Dual CD Ignitions



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).



FWMurphy

P.O. Box 470248
 Tulsa, Oklahoma 74147 USA
 (918) 317-4100
 Fax: (918) 317-4266
 e-mail sales@fwmurphy.com
 www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
 P.O. Box 1819; Rosenberg, Texas 77471; USA
 (281) 633-4500 Fax: (281) 633-4588
 e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
 Blvd. Antonio Rocha Cordero 300, Fracción del Aguaje
 San Luis Potosí, S.L.P.; México 78384
 +52-444-8206264 Fax +52-444-8206336
 Villahermosa Office +52-993-3162117
 e-mail ventas@murphydex.com.mx
 www.murphydex.com.mx

FRANK W. MURPHY, LTD.
 Church Rd.; Lavenock, Salisbury SP1 1QZ; U.K.
 +44 1722 410055 Fax +44 1722 410088
 e-mail sales@fwmurphy.co.uk
 www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
 41343 12th Street West
 Palmdale, California 93551-1442; USA
 (661) 272-4700 Fax: (661) 947-7570
 e-mail sales@murphyswitch.com
 www.murphyswitch.com

MACQUARRIE CORPORATION
 1620 Home Highway
 Campbellfield, Vic 3061; Australia
 +61 3 9358-5555 Fax +61 3 9358-5558
 e-mail murphy@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.



FP Series HEAT EXCHANGER

FlatPlate's FP Series is rugged and reliable representing the latest technology in high performance brazed plate heat exchangers. Designed for a wide range of applications including industrial process heating and cooling, shell/tube replacement, hydronic heating, boiler applications, domestic water heating, snow melt, and fluid to fluid applications.

Simple Design

The FP Series Brazed Plate Heat Exchanger consists of stainless steel plates with a special high efficient heat transfer surface. The plates are then copper brazed together at high temperature, allowing the heat exchanger to be leak tight and rugged.

The FP Series differs significantly from other types of plate heat exchangers in that a wider range of applications, connection sizes, and features can be provided for single quantity units, and for high volume production. Because of this the FP Series is very cost effective for a wide range of applications.

Compact

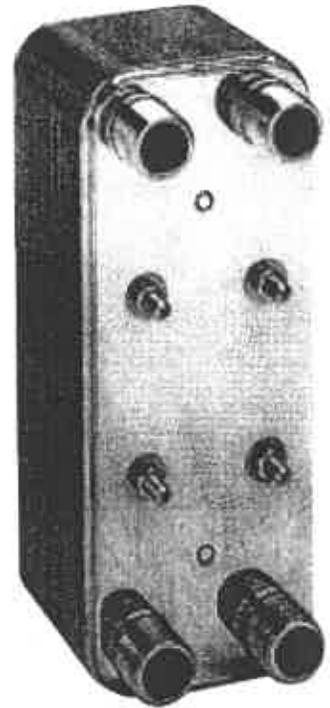
Light weight and compact, the FP Series can be up to 50% to 80% smaller size than other types of heat exchangers. This allows for smaller equipment packages, simplified installation and lower shipping costs.

High Efficiency

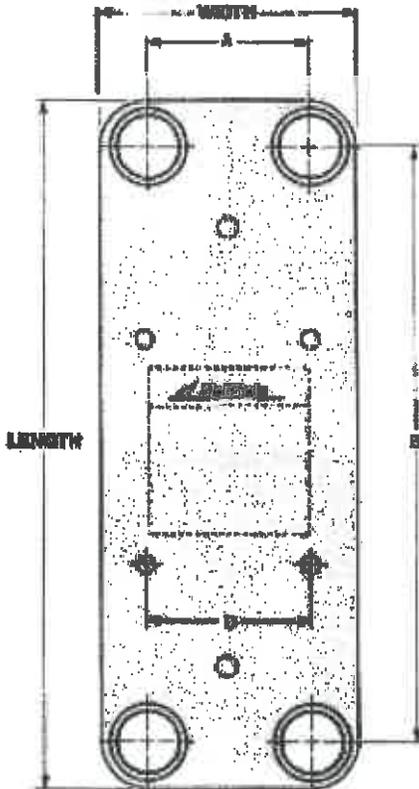
Like all FlatPlate heat exchangers, the FP Series uses a highly efficient heat transfer surface with excellent turbulence, moderate to low pressure drops and lower fouling rates. Heat Transfer coefficients up to 1200 BTU/H²F-sq ft for fluid to fluid applications are typical.

Proven Performance

FlatPlate heat exchanger designs have been tested for performance under a wide range of operating conditions. From this test data, all applications are computer modeled and selected for optimum performance. And all units are Helium leak tested for assured quality.



 **FlatPlate**[®]



		Connections (a)		C
		# of Plates	Standard Threaded (MPT)	
5X12	4 thru 16		3/4	1.125
	20 thru 30, 36 thru 40, 50		1	1.250
	30, 40		1-1/4	1.375
10X20	50 thru 80		1-1/2	1.500
	20 thru 40		2	1.750
	90 thru 200		2-1/2	2.000

- (a) Connections the same on both sides
- (b) Heat exchanger may be installed in vertical or horizontal position
- (c) Heat exchanger must be piped in counterflow arrangement
- (d) A water strainer MUST be installed in the water inlet circuit (16-20 mesh minimum, 20-40 mesh recommended)
- (e) Water quality should be maintained at a PH of 7.4 (8.5 to 8.0)
- (f) Use MP Series version for sea water, chlorinated water and pool water applications
- (g) Use FPN Series version for de-ionized water applications

- Stud Bolts:**
- 3/8-24 x 1"L. on all 5 x 12 Models
 - 1/2-20 x 1-1/2"L. standard on all 10 x 20 Models

Model	Dimensions (in.)							Approx. Wt. (lbs.)
	L	W	Depth	A	B	D	E	
FP5x12	12.2	4.9	.094 x #plates + .36	2.7	9.9	2.5	3.5	.328 x #plates + 3.1
FP10x20	20.3	9.8	.094 x #plates + .36	6.5	17.0	4.0	5.5	1.1 x #plates + 10.7

Specifications

Plate Material:	316L Stainless Steel
Braze Material:	Copper
Maximum Working Temperature:	350°F
Maximum Working Pressure:	450 psi

UL LISTED

- Approvals:
 - U.L. (Underwriters Laboratory), US and Canada
 - ASME Code Stamped (optional)
 - Canadian CRN
 - European TÜV
- Optional Floor Mount Bracket
- Standard and Custom units available including FPN Nickel brazed versions and MP Series Marine versions.

Application Support
 FlatPlate provides support for
 all applications, large or small.....Please call or fax us.

Ph: 717-767-9060
 Fax: 717-767-9160



Manufactured 100% In the U.S.A.

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	0.293 kW	WX 18 x 24	12,000 Btu/hr	3.514 kW
WX 6 x 12	2,000 Btu/hr	0.586 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 6 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	11.716 kW
WX 12 x 72	24,000 Btu/hr	7.029 kW	WX 24 x 72	48,000 Btu/hr	14.058 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 6 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/CSA

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

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 CSA/CAN – B149.1-00, Natural Gas and Propane Installation Code	NFPA 70, National Electrical 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).

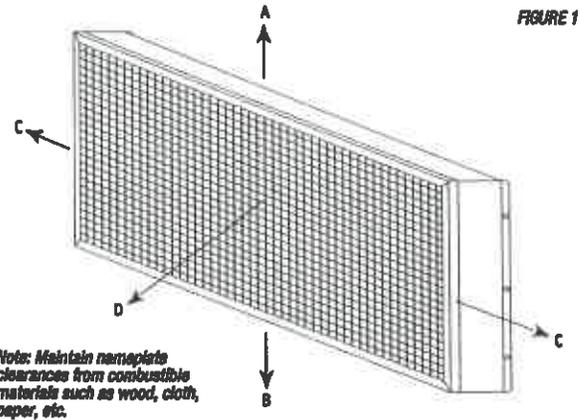


FIGURE 1

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).

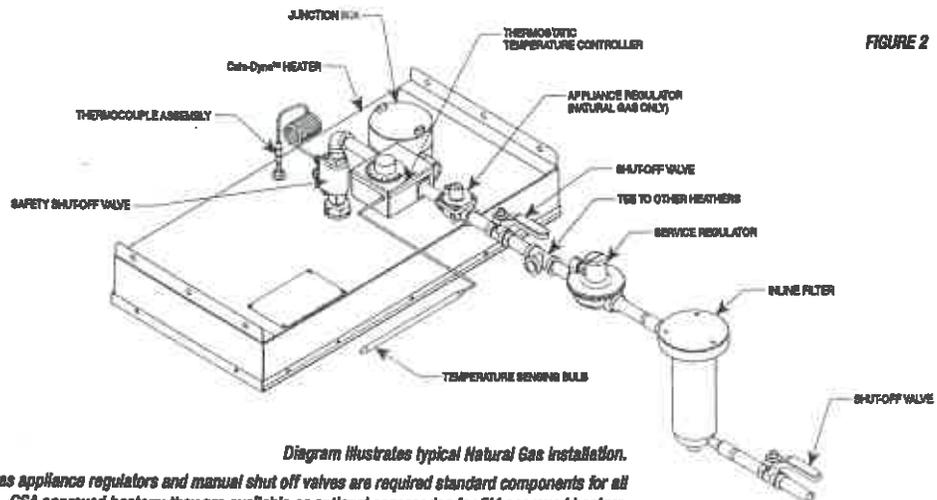


FIGURE 2

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

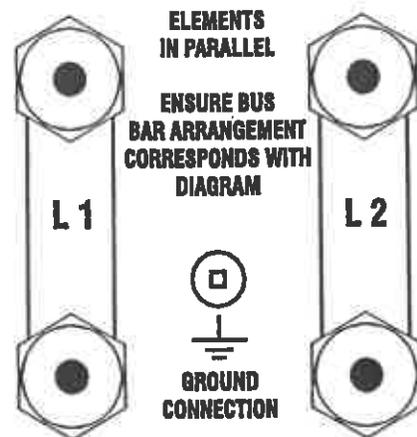


FIGURE 5

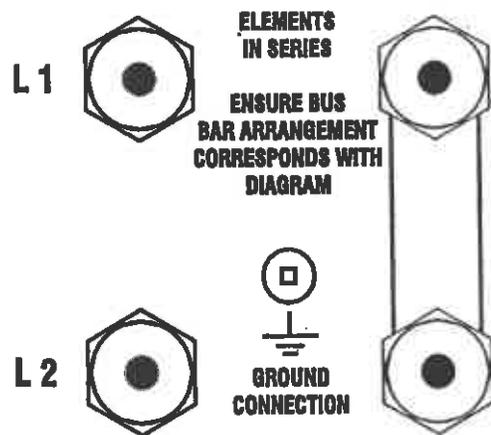


FIGURE 3

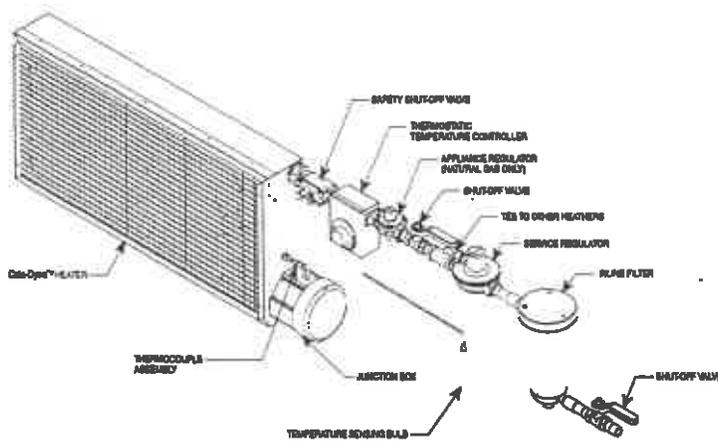
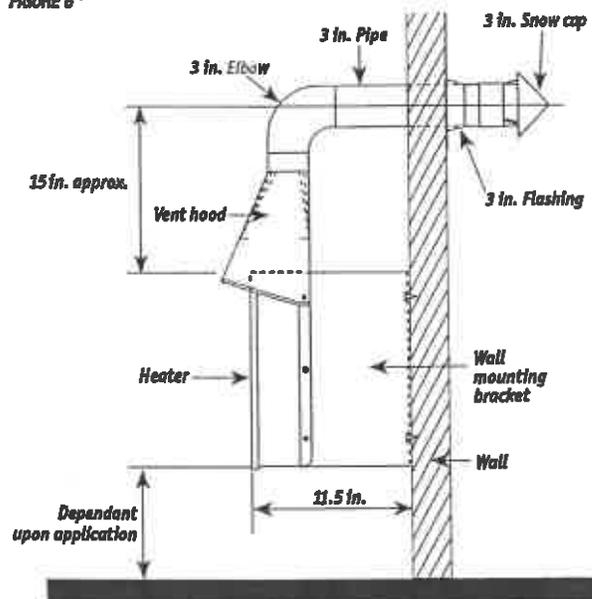


Diagram illustrates typical Natural Gas installation.

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.

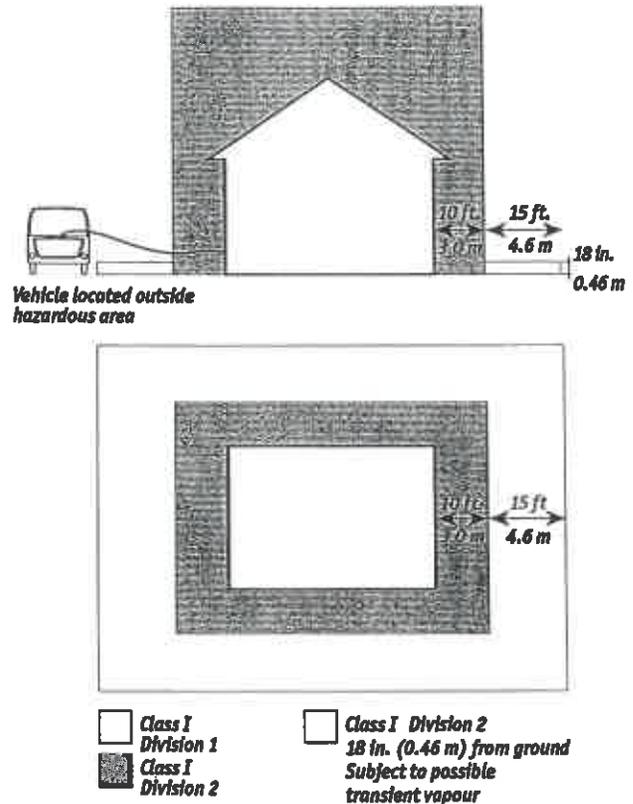
Shut down

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.

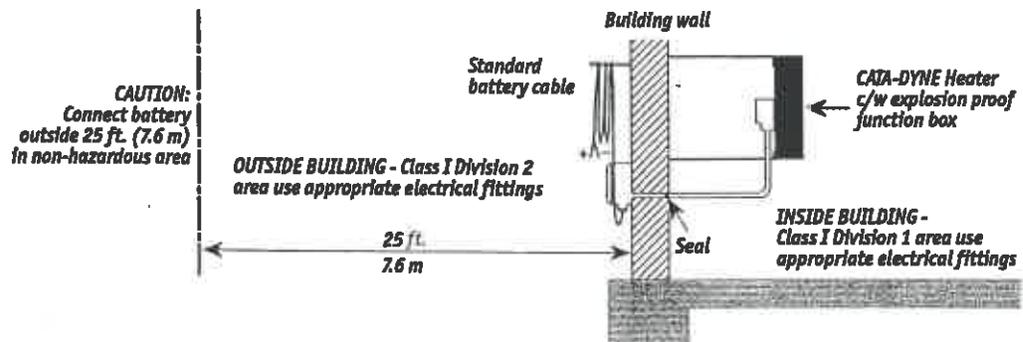
12 V HAZARDOUS ELECTRICAL INSTALLATIONS



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.

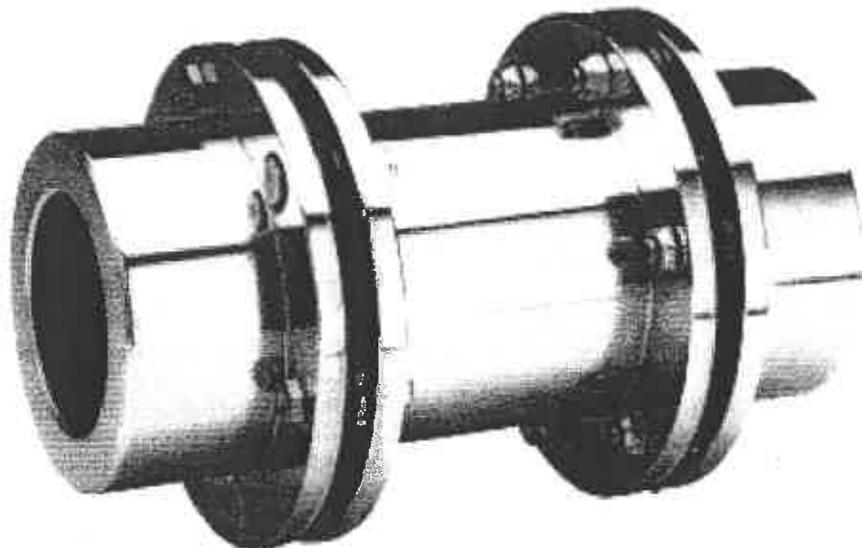
Separate Installation and Operation Instructions are available for oven and Industrial heating applications.

FORM-FLEX[®]

FLEXIBLE DISC

COUPLINGS

- **Long Life**
- **Low Maintenance**
- **Design Flexibility**

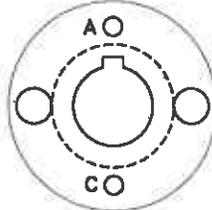
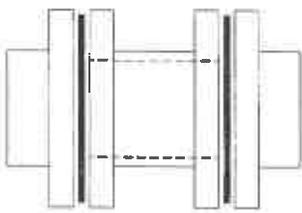




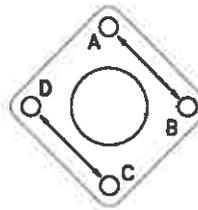
FORM-FLEX METAL DISC FLEXIBLE COUPLINGS

Form-Flex couplings transmit torque while compensating for angular, parallel and axial misalignment between two connected shafts. Flexible disc couplings minimize the misalignment forces on the connected equipment.

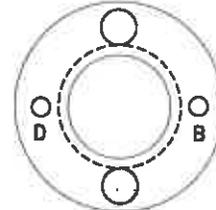
The Basic flex coupling consists of two hubs, a spacer and two flexible discs. The flex disc is an assembly of thin metal laminations. In figure shown below, flex disc holes A & C are bolted to the hub and holes B & D are bolted to the spacer. Torque is transmitted in direct tensions from A to B and from C to D through the flex disc. Misalignment is taken through bending in the link between the bolt holes.



HUB



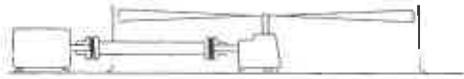
FLEX DISC



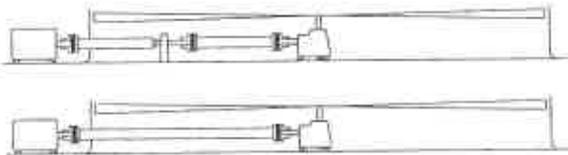
SPACER

COOLING TOWER DRIVES

Form-Flex metal disc couplings are widely used in cooling fan drive applications. Form-Flex 4 bolt disc couplings offer more misalignment capacity than any competing metal disc design.

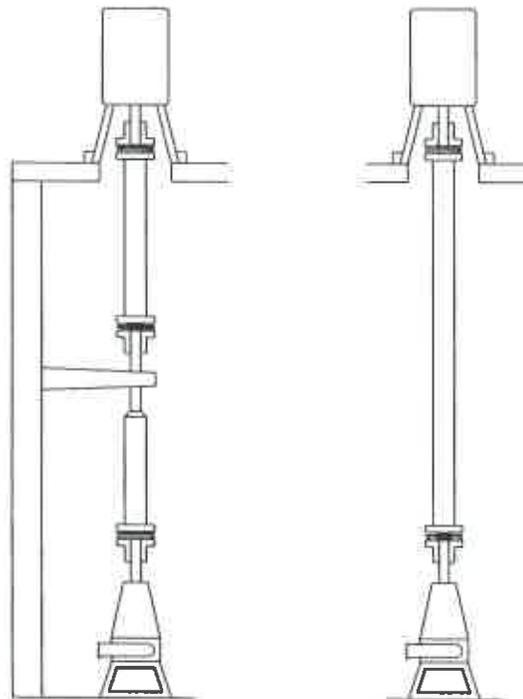


For smaller towers up to about 100 inches DBSE, TB Wood's offers steel and composite spacer tubing options. TrueTube composite torque tubes are lighter than steel and eliminate thermal growth and vibration problems.



Form-Flex composite floating shaft couplings are recommended as a replacement for older multi-section drivelines. Composite couplings can span up to 240 inches without high maintenance center support bearings.

VERTICAL PUMP DRIVES



Form-Flex floating shaft couplings are a cost-effective, maintenance free alternative to cardan U-joints for vertical pump drivelines. Form-Flex couplings are available with either steel or composite spacer tubing. Composite spacer tubing can reduce total cost by eliminating the need for bearings and support structures.

FORM-FLEX METAL DISC FLEXIBLE COUPLINGS



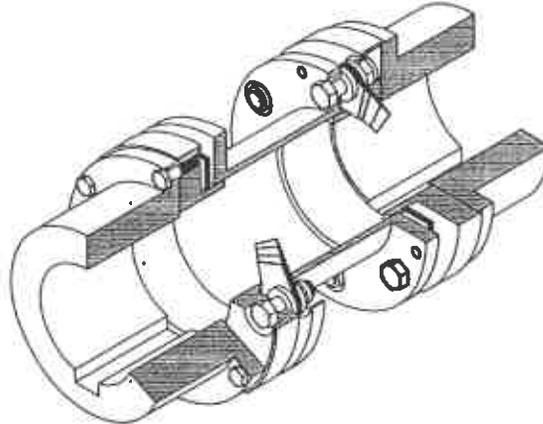
COMPLETE PRODUCT OFFERING

- TORQUE CAPACITY TO 3175 HP/100 RPM
- CLOSE COUPLE, SPACER AND FLOATING SHAFT DESIGNS

HIGH STRENGTH STEEL FASTENERS

- NO MOVING PARTS
- ZERO BACKLASH

OVER 30 YEARS EXPERIENCE IN METAL DISC COUPLINGS



HIGH STRENGTH STAINLESS STEEL FLEX DISCS

- HIGH TORSIONAL STIFFNESS
- NO LUBRICATION REQUIRED

APPLICATIONS

- PUMPS
- COMPRESSORS
- PRINTING

- FANS AND BLOWERS
- FOOD PROCESSING
- MACHINE TOOLS

ALL METAL CONSTRUCTION

- WIDE TEMPERATURE RANGE
- AVAILABLE IN CARBON OR STAINLESS STEEL
- COMPOSITE MATERIALS NOW AVAILABLE

TYPICAL APPLICATIONS

• PUMPS

Form-Flex spacer and close couple designs are ideally suited for all types of pump applications

• ENGINE DRIVEN EQUIPMENT

Form-Flex heavy duty FSH series couplings are commonly used to drive reciprocating compressors and other engine driven equipment

• PRINTING

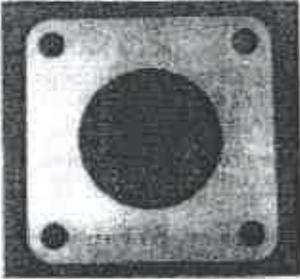
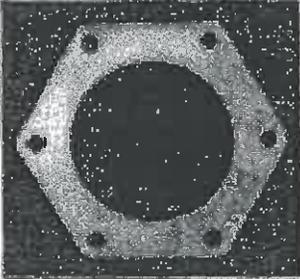
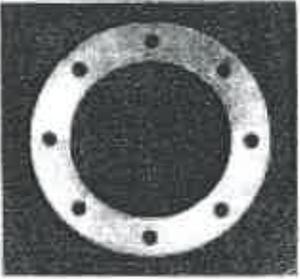
Form-Flex couplings' high torsional stiffness allows precise registration for high quality printing in shaft applications

• POSITIONING SYSTEMS

Zero backlash and high torsional stiffness make Form-Flex the first choice for servo and stepper drives



Form-Flex Flex Disc Designs

DISC STYLE	DESIGN FEATURES	WHERE USED
4 BOLT (A, M SERIES) 	Straight sided flex disc. 1 degree angular misalignment. Torque range: 35 LB. IN. to 30,240 LB. IN. Zero backlash. All machined steel construction. Stainless steel flex discs. Steel or stainless steel materials. Minimum reaction forces.	Ideal for general industrial applications with motor or turbine drivers and smooth to moderate load conditions. Low to moderate speed ranges. Serve or stepper driven positioning systems. Applications where misalignment may be a problem. 4 bolt designs offer the highest misalignment capacity of any metal disc design. Not recommended for engine driven applications.
6 BOLT (B SERIES) 	Straight sided disc. 0.7 degree angular misalignment. Torque range: 3050 LB. IN. to 233,000 LB. IN. Suitable for precision balancing. Zero backlash. All machined steel construction. Stainless steel flex discs. Steel or stainless steel materials.	Ideal for motor or turbine drivers with any load conditions. Use for reversing, reciprocating or other rough load conditions. May be used with industrial engines driving smooth loads. Moderate to high speed ranges and applications where dynamic balancing is required. Consider 6 bolt where 4 bolt size requires increasing coupling size to meet bore size requirements.
8 BOLT (D, F, H SERIES) 	Round disc design. 0.3 degree angular misalignment. Torque range: 9500 LB. IN. to 2,000,000 LB. IN. Zero backlash. Heavy duty cast construction. Alloy or stainless steel flex discs. Flywheel mount designs.	High torque-low speed applications. Industrial engines driving reciprocating equipment. Heavy-duty reversing applications. Custom designs for high torque applications.

MATERIAL CLASSES APPLIES TO 4 AND 6 BOLT DESIGNS

MATERIAL CLASS BY COMPONENT				DESCRIPTION
COUPLING	HUB	SPACER ASSY	REPAIR KIT	
A	A	A	A	Mild steel hubs and spacer, alloy steel hardware, 300 series SS flex disc
B	B	B	A	Zinc plated steel hubs and spacer, alloy steel hardware, 300 series SS flex disc
C	B	C	E	Zinc plated steel hubs and spacer, 300 series SS flex disc and hardware
E	E	E	E	All 300 series stainless steel construction

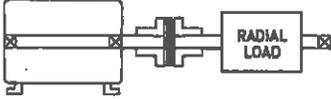
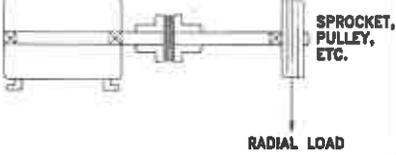
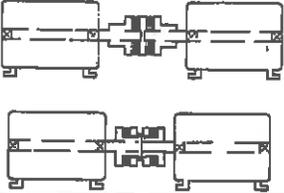
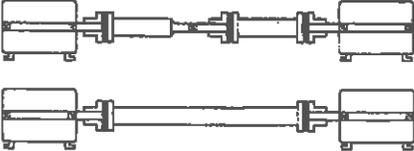
PRODUCT FEATURES AND OPTIONS

FEATURE	AR, AK, AP AX, AY	BH, BP, BY DP*	BF	BA, DA*	A5, A7	B5	HFTH	HH, HSH, FSH
STANDARD BORE FIT	CLEARANCE	INTERFERENCE			CLEARANCE	INTERFERENCE		
SET SCREWS	STANDARD	OPTIONAL			STANDARD	OPTIONAL		
PULLER HOLES	OPTIONAL	STANDARD			OPTIONAL	STANDARD	OPTIONAL	
STANDARD FLEX DISCS	300 SERIES STAINLESS STEEL*						ALLOY STEEL	
BALANCE CLASS	AGMA 7	AGMA 8	AGMA 9	AGMA 7	N/A			N/A
DYNAMIC BALANCE	OPTIONAL				PER TBW COMMERCIAL STANDARD			N/A

*Alloy steel flex disc is standard for DA and DP series. Stainless steel is optional.

COUPLING/APPLICATION TYPES



COUPLING TYPE	TYPICAL APPLICATIONS	PAGES		
		SERIES	PAGE	
SINGLE FLEX	<p>Single flexing couplings compensate for angular and axial misalignment only. Single couplings should only be used in a three bearing system with a self-aligning bearing as shown in the illustration.</p> <p>Single couplings may also be used in pairs to support a clutch, transducer or other system component. These arrangements are double flexing and must be used with two fully supported shafts as described below.</p>		<p>AR BH HH</p>	<p>F5-10 F5-11 F5-12</p>
				
CLOSE COUPLE DOUBLE FLEX	<p>Close couple designs accommodate angular, parallel and axial misalignment types where two fully supported shafts are located very close together. Close shaft separations are generally in the range of 1/8 to 2 inches.</p>		<p>AX AA AY BY BA DA</p>	<p>F5-13 F5-14 F5-15 F5-16 F5-17 F5-17</p>
SPACER COUPLINGS DOUBLE FLEX	<p>Spacer couplings are used to connect fully supported shafts with wider separations than can be reached with a close couple design. Spacer couplings allow room for installation and maintenance without moving the connected equipment. Shaft separations are generally in the range of 3 to 12 inches. These couplings accommodate angular, parallel and axial misalignment.</p>		<p>AK AP BP BF DP HSH FSH</p>	<p>F5-18 F5-18 F5-19 F5-20 F5-21 F5-22 F5-23</p>
FLOATING SHAFT COUPLINGS	<p>Floating shaft couplings are spacer style couplings which are designed to connect widely separated shafts. The coupling spacers are fabricated. Both steel and TrueTube composite tubing options are available.</p>		<p>A5 A7 B5 HFTH C/S</p>	<p>F5-24 F5-25 F5-26 F5-27 F5-29</p>
	<p>Semi-floating shaft couplings are a special single flex version of the floating shaft coupling. These may be used alone for some applications or in combination with floating shaft couplings and pillow block bearings to span long distances.</p> <p>Composite floating shaft couplings should be considered as an alternative to multiple span applications with center bearings.</p>			
MICRO COUPLINGS DOUBLE FLEX	<p>Form-Flex Micro Couplings are used for precision low torque applications. They are a smaller version of our 4 bolt line. Micro Couplings are constructed of aluminum for reduced inertia. Close couple and spacer designs are available.</p>		<p>MA MB MC</p>	<p>F5-31 F5-31 F5-31</p>



SELECTING AND ORDERING FORM-FLEX COUPLINGS

- 1) Select correct service factor from the chart below.
- 2) Calculate HP @ 100 or Design Torque (in lbs).

$$\text{HP @ 100} = \frac{\text{HP} \times \text{service factor} \times 100}{\text{coupling RPM}}$$

OR

$$\text{Design Torque (in lbs)} = \frac{63025 \times \text{HP} \times \text{service factor}}{\text{coupling RPM}}$$

OR

$$\text{Design Torque} = \text{Torque (in lbs)} \times \text{Service Factor}$$

- 3) Compare this to the HP @ 100 column or the Rated Torque column.
- 4) Check other limiting factors such as bores and overall dimensions.
- 5) Standard Four or Six bolt couplings can be ordered as hubs and a center assembly.
All other couplings should be ordered by description.

SERVICE FACTOR TABLE

These service factors assume a smooth motor or turbine type driver. The adders listed for other driver types must be added to the service factor shown for the driven equipment.

ADDERS FOR DRIVER TYPE		DRIVEN EQUIPMENT	S.F.	DRIVEN EQUIPMENT	S.F.	DRIVEN EQUIPMENT	S.F.
DRIVER	ADD	CONVEYORS-Uniform load (Cont.)		FANS		PAPER MILLS-(Cont.)	
TURBINE	0	Flight	1.25	Centrifugal	1.00	Couch	1.75
AC MOTORS		Oven	1.50	Cooling Tower	2.00	Cutters, Platers	2.00
With Soft Start	0	Screw	1.25	FEEDERS		Cylinders	1.75
NEMA A or B	0	CONVEYORS-Non-Uniform Load		Apron	1.25	Dryers	1.75
NEMA C or D	1	Apron	1.50	Belt	1.25	Felt Stretchers	1.25
DC MOTORS		Assembly	1.25	Disc	1.25	Felt Whipper	2.00
Shunt Type	0	Belt	1.25	Reciprocating	2.50	Presses	2.00
Series or Compound	1	Bucket	1.50	Screw	1.25	Reel	1.50
I/C ENGINES		Chain	1.50	FOOD INDUSTRY		Stock Chests	1.50
8 or More Cylinders	1	Flight	1.50	Cereal Cookers	1.25	Suction Roll	1.75
4-6 Cylinders	1.5	Oven	1.50	Dough Mixers	1.75	Washers and Thickeners	1.50
1-3 Cylinders	2	Reciprocating	2.50	Meat Grinders	1.75	Winders	1.50
DRIVEN EQUIPMENT	S.F.	Screw	1.50	Slicers	1.75	PRINTING PRESSES	1.50
AGITATORS		Shaker	2.50	LUMBER INDUSTRY		PUMPS	
Pure Liquids	1.00	CRANES AND HOISTS		Barkers-Drum Type	2.00	Centrifugal	1.00
Liquids and Solids	1.25	Main Cranes	2.00	Edger Feeders	2.00	Reciprocating	
Liquids-Variable Density	1.25	Reversing	2.00	Live Rolls	2.00	Double Acting	2.00
BLOWERS		Skip Hoists	1.75	Log Haul	2.00	Single Acting 1-2 Cylinders	2.25
Centrifugal	1.00	Trolley Drive	1.75	Off Bearing Rolls	2.00	Single Acting 3+ Cylinders	1.75
Lobe	1.50	Bridge Drive	1.75	Planers	1.75	Rotary-Gear, Lobe, Vane	1.50
Vane	1.25	Slope	1.50	Slab Conveyors	1.50	TEXTILE INDUSTRY	
BRIQUETTER MACHINE	1.00	DREDGES		Sorting Table	1.50	Batchers	1.25
CAN FILLING MACHINE	1.00	Cable Reels	1.75	Trimmer Feed	1.75	Calenders	1.75
COMPRESSORS		Conveyors	1.50	MACHINE TOOLS		Card Machines	1.50
Centrifugal	1.25	Maneuvering Winches	1.75	Bending Roll	2.00	Cloth Finishing Machines	1.50
Lobe	1.50	Pumps	1.75	Plate Planer	1.50	Dry Cans	1.75
Reciprocating	C/F	Screen Drives	1.75	Spindle Drives	1.50	Dryers	1.50
CONVEYORS-Uniform Load		Stracers	1.75	Table/Axis Drives	1.25	Dyeing Machinery	1.25
Apron	1.25	Utility Winches	1.50	Tapping Machines	2.50	Looms	1.50
Assembly	1.00	ELEVATORS		PAPER MILLS		Mangles	1.25
Belt	1.00	Bucket	1.75	Beater & Pulper	1.75	Nappers	1.25
Bucket	1.25	Centrifugal Discharge	1.50	Bleacher	1.00	Soapers	1.25
Chain	1.25	Freight	2.00	Calendars	2.00	Spinners	1.50
		Gravity Discharge	1.50	Converting Machines	1.50	Tinter Frames	1.50

COUPLING SELECTION GUIDE



- 1) CONSULT FACTORY FOR APPLICATIONS IN SHADED AREAS.
- 2) TORQUE RATINGS MAY VARY BY COUPLING SERIES.
- 3) USE THE 1.0 SERVICE FACTOR COLUMN IF A SERVICE FACTOR WAS USED IN THE HP/100 RPM CALCULATION.

TYPICAL APPLICATION CONDITIONS						
SMOOTH MOTOR OR TURBINE DRIVEN	STEADY MOTOR OR TURBINE DRIVEN	MODERATE MOTOR OR TURBINE DRIVEN	MEDIUM MOTOR OR TURBINE DRIVEN	HEAVY-HIGH TQ. MOTOR OR ENGINE DRIVEN	EXTRA HEAVY ENGINE DRIVEN	EXTREMELY HEAVY ENGINE DRIVEN
SOFT START WITH STEADY LOAD	AVERAGE STARTING LOADS AND SLIGHT TORQUE VARIATIONS	ABOVE AVERAGE STARTING LOADS AND MODERATE LOAD VARIATIONS	HIGH STARTING TORQUES AND MEDIUM TO HEAVY LOAD VARIATIONS	MILD SHOCK LOADING ENGINES. DRIVING SMOOTH LOADS. EXTREME RELIABILITY	HEAVY SHOCK LOADING OR LIGHT REVERSING	EXTREME SHOCK LOADING. FREQUENT WIDE TORQUE VARIATIONS

TYPE/SIZE	RATED TORQUE LB*IN	MAX RPM	O.D.	MAX BORE	SERVICE FACTOR										
					1.0	1.5	2.0	2.5	3.0	3.25	4.0				
					RATED HP/100 RPM AT SERVICE FACTOR SHOWN										
MICRO 4 BOLT	01	9	20,000	1.02	0.38	0.01	0.01	0.01	NOT RECOMMENDED FOR THESE APPLICATIONS						
	02	17	20,000	1.28	0.59	0.03	0.02	0.01							
	03	35	20,000	1.65	0.79	0.06	0.04	0.03							
	04	87	20,000	2.24	0.79	0.14	0.09	0.07							
A SERIES 4 BOLT	05	300	8,500	2.85	0.87	0.48	0.32	0.24					0.19		
	10	800	7,500	3.19	1.25	1.27	0.85	0.63					0.51		
	15	1,575	6,700	3.65	1.37	2.50	1.87	1.25					1.00		
	20	2,200	6,200	4.08	1.82	3.49	2.33	1.75					1.40		
	25	3,800	5,500	4.95	2.00	6.03	4.02	3.02					2.41		
	30	6,930	5,000	5.63	2.37	11.00	7.33	5.50					4.40		
	35	11,340	4,400	6.63	2.87	18.00	12.00	9.00	7.20						
	40	18,270	4,000	7.64	3.25	29.00	19.33	14.50	11.60						
45	30,240	3,700	8.43	3.75	48.00	32.00	24.00	19.20							
B SERIES 6 BOLT	33	3,050	17,400	4.89	2.50	4.84	3.23	2.42	1.94	1.61	1.49				
	38	6,860	14,300	5.87	3.25	10.89	7.26	5.44	4.36	3.63	3.35				
	43	13,500	12,700	6.7	3.75	21.43	14.29	10.71	8.57	7.14	6.59				
	48	18,400	11,000	7.5	4.38	29.21	19.47	14.60	11.88	9.74	8.99				
	53	24,000	10,700	7.87	4.50	38.10	25.40	19.05	15.24	12.70	11.72				
	58	41,000	9,475	9	5.13	65.08	43.39	32.54	26.03	21.69	20.02				
	63	48,000	8,590	10	5.50	78.19	50.79	38.10	30.48	25.40	23.44				
	68	72,000	7,800	10.75	6.00	114.29	78.19	57.14	45.71	38.10	35.16				
	73	125,000	6,740	12.5	6.50	198.41	132.28	99.21	79.37	66.14	61.05				
	78	233,000	5,800	15.05	7.50	369.84	248.56	184.92	147.94	123.28	113.80				
D SERIES 8 BOLT	22	9,500	3,800	6.00	2.25	15.08	10.05	7.54	6.03	5.03	4.64	3.77			
	26	16,000	3,300	6.88	2.63	25.40	16.93	12.70	10.16	8.47	7.81	6.35			
	31	24,000	2,800	8.13	3.13	38.10	25.40	19.05	15.24	12.70	11.72	9.52			
	35	44,000	2,600	9.13	3.63	69.84	48.56	34.92	27.94	23.28	21.49	17.46			
	37	60,000	2,500	10.06	3.75	95.24	63.49	47.82	38.10	31.75	29.30	23.81			
	42	73,000	2,400	11.00	4.50	115.87	77.25	57.94	48.35	38.82	35.65	28.97			
	45	99,000	2,250	11.88	4.75	157.14	104.76	78.57	62.86	52.38	48.35	39.29			
	50	128,000	2,000	13.44	5.50	203.17	135.45	101.59	81.27	67.72	62.52	50.79			
	55	189,000	1,800	15.00	6.25	300.00	200.00	150.00	120.00	100.00	92.31	75.00			
	60	281,000	1,800	16.75	7.12	414.29	276.19	207.14	165.71	139.10	127.47	103.57			
	70	415,000	1,400	18.94	7.87	658.73	439.15	329.37	263.49	219.58	202.69	164.68			
	75	533,000	1,300	20.83	8.75	846.03	584.02	423.02	338.41	282.01	260.32	211.51			
	80	685,000	1,200	22.38	9.12	1,087.30	724.87	543.65	434.92	362.43	334.55	271.83			
	85	829,000	1,100	23.75	9.82	1,315.87	877.25	657.94	526.35	438.82	404.88	328.97			
	92	1,040,000	1,000	25.75	11.00	1,650.79	1,100.53	825.40	660.32	550.28	507.94	412.70			
105	1,250,000	1,000	29.25	12.00	1,984.13	1,322.75	992.06	793.65	661.38	610.50	496.03				
160	2,000,000	900	33.50	17.00	3,174.80	2,116.40	1,587.30	1,289.84	1,058.20	976.80	783.65				

CONSULT WOOD'S SAN MARCOS

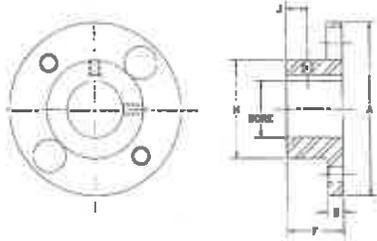


4 BOLT COUPLING HUB OPTIONS

TO ORDER A COMPLETE COUPLING, ORDER TWO HUBS OF ANY TYPE AND A COUPLING (SPACER) SUB ASSEMBLY FOR THE REQUIRED COUPLING TYPE. ALL DIMENSIONS SHOWN IN INCHES.

AJ STANDARD HUBS

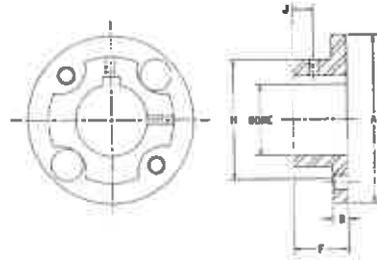
PROVIDED WITH STRAIGHT BORE AND KEYWAY
SOLID HUBS AVAILABLE FROM STOCK



SIZE	MAX BORE	A	B	F	H	J	STD SET SCREW SIZE
05	0.87	2.65	0.25	1.00	1.30	0.38	10-24 UNC
10	1.25	3.19	0.30	1.00	1.30	0.38	1/4-20 UNC
15	1.37	3.65	0.35	1.13	2.00	0.41	1/4-20 UNC
20	1.62	4.08	0.35	1.32	2.40	0.50	1/4-20 UNC
25	2.00	4.95	0.45	1.62	2.80	0.63	5/16-18 UNC
30	2.38	5.63	0.55	1.86	3.30	0.69	5/16-18 UNC
35	2.88	6.83	0.55	2.25	4.15	0.88	1/2-13 UNC
40	3.25	7.64	0.65	2.50	4.65	0.94	1/2-13 UNC
45	3.75	8.43	0.65	3.00	5.40	1.20	1/2-13 UNC

AZ OVERSIZE BORE HUBS

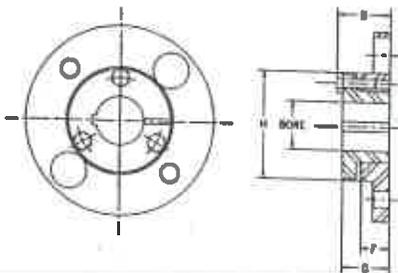
PROVIDED WITH STRAIGHT BORE AND KEYWAY



SIZE	MAX BORE	A	B	F	H	J	STD SET SCREW SIZE
05	1.13	2.65	0.25	1.00	1.68	0.38	10-24 UNC
10	1.63	3.19	0.30	1.00	2.37	0.38	1/4-20 UNC
15	1.88	3.65	0.35	1.13	2.69	0.41	1/4-20 UNC
20	2.13	4.08	0.35	1.32	3.13	0.50	1/4-20 UNC
25	2.38	4.95	0.45	1.62	3.75	0.63	5/16-18 UNC
30	2.88	5.63	0.55	1.86	4.25	0.69	5/16-18 UNC
35	3.75	6.83	0.55	2.25	5.25	0.88	1/2-13 UNC
40	4.00	7.64	0.65	2.50	6.02	0.94	1/2-13 UNC
45	4.83	8.43	0.65	3.00	6.75	1.20	1/2-13 UNC

QD BORED HUBS

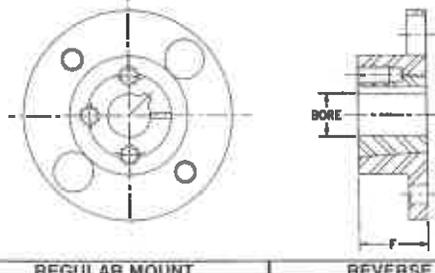
MATERIAL CLASS A OR B ONLY - CLASS A AVAILABLE FROM STOCK



CPLG SIZE	BUSH. SIZE	BUSH. TQ. LB*IN	MAX BORE	B	C	F	H	BOLT SIZE UNC
15	JA	1000	1-1/4	1.17	1.00	.56	2.00	#10
20	JA	1000	1-1/4	1.17	1.00	.56	2.40	#10
25	SH	3500	1-11/16	1.50	1.25	.75	2.80	1/4
30	SD	5000	2	2.08	1.81	1.25	3.30	1/4
35	SK	7000	2-5/8	2.19	1.87	1.25	4.15	5/16
40	SF	11000	2-15/16	2.38	2.08	1.37	4.65	3/8

HUBS FOR TAPER LOCK BUSHINGS

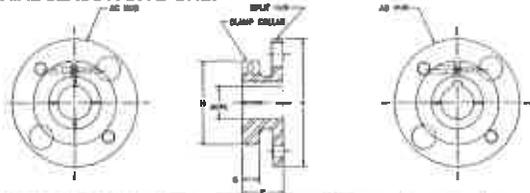
AVAILABLE MTO ONLY



CPLG SIZE	REGULAR MOUNT				REVERSE MOUNT			
	BUSH SIZE	BUSH TQ LB*IN	MAX BORE	F	BUSH SIZE	BUSH TQ LB*IN	MAX BORE	F
15	N/A	1108	1300	1.12	0.87
20	1108	1300	1.12	0.87	1215	3550	1.25	1.50
25	1215	3550	1.25	1.50	1310	3850	1.37	1.00
30	1310	3850	1.37	1.00	1615	4300	1.62	1.50
35	2012	7150	2.00	1.25	2517	11600	2.50	1.75
40	2525	11300	2.50	2.50	2525	11300	2.50	2.50

AC/AD CLAMPING HUBS

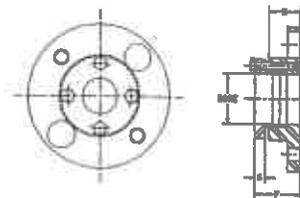
AC HUBS PROVIDED WITHOUT KEYWAY
AD HUBS PROVIDED WITH KEYWAY
MATERIAL CLASS A OR B ONLY



SIZE	MAX BORE		A	F	G	H	SCREW SIZE
	AC	AD					
05	1.00	0.87	2.65	1.13	.50	2.08	1/4-20 UNC
10	1.00	0.87	3.19	1.18	.50	2.08	1/4-20 UNC
	1.50	1.25		1.36	.69	2.75	5/16-18 UNC
15	1.00	0.87	3.65	1.27	.50	2.08	1/4-20 UNC
	1.75	1.37		1.46	.69	3.00	5/16-18 UNC
20	1.31	1.00	4.08	1.32	.55	2.38	1/4-20 UNC
	2.12	1.62		1.52	.75	3.50	3/8-16 UNC
25	2.13	1.62	4.95	1.62	.84	3.50	5/16-18 UNC
	2.50	1.67		1.88	.88	4.00	3/8-18 UNC

AL LOCK ELEMENT HUBS

THESE HUBS USE RINGFEDER TAPERED LOCKING ELEMENTS
MATERIAL CLASS A OR B ONLY



SIZE	HUB TYPE	BORE SIZE-mm		B	F	G	SCREW SIZE
		MIN	MAX				
05	AJ	6	13	1.00	1.32	.32	10-32 UNF
	AZ	14	19	1.00	1.42	.42	1/4-28 UNF
10	AJ	12	18	1.00	1.42	.42	1/4-28 UNF
	AZ	19	30	1.00	1.42	.42	1/4-28 UNF
15	AJ	12	22	1.13	1.65	.42	1/4-28 UNF
	AZ	24	35	1.13	1.55	.42	1/4-28 UNF
20	AJ	22	30	1.32	1.78	.42	1/4-28 UNF
	AZ	32	42	1.32	1.83	.51	5/16-24 UNF
25	AJ	22	32	1.63	2.05	.42	1/4-28 UNF
	AZ	35	50	1.63	2.23	.60	3/8-24 UNF

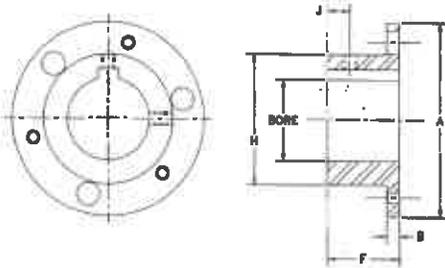
NOTE: AC and AL Hubs do not carry full torque capacity. Please consult engineering.

COUPLING HUB OPTIONS



6 BOLT COUPLING HUBS

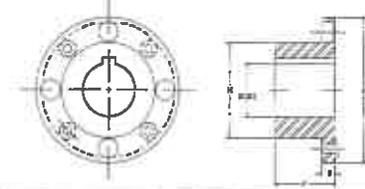
BH SERIES—USED ON BH, BP, BS, BY SERIES
PROVIDED WITH STRAIGHT BORE AND KEYWAY
INTERFERENCE FIT WITHOUT SETSCREWS IS RECOMMENDED



SIZE	MAX BORE	A	B	F	H	J	OPTIONAL SET SCREW SIZE
33	2.25	4.69	0.30	1.75	3.14	0.88	1/4-20 UNC
36	3.00	5.87	0.35	2.25	4.13	1.13	3/8-16 UNC
43	3.25	6.70	0.42	2.50	4.83	1.25	3/8-16 UNC
48	3.75	7.50	0.40	2.75	5.40	1.50	1/2-13 UNC
53	3.88	7.87	0.55	2.88	5.65	1.44	1/2-13 UNC
58	4.25	9.00	0.65	3.25	6.22	1.63	1/2-13 UNC
63	4.88	10.00	0.85	3.38	7.14	1.89	3/4-10 UNC
68	5.00	10.75	0.75	3.75	7.33	1.88	3/4-10 UNC
73	5.25	12.50	1.00	5.13	7.80	2.50	3/4-10 UNC
78	6.50	15.05	1.15	6.38	9.50	3.12	3/4-10 UNC

8 BOLT COUPLING HUBS

Dxx-3 CAST IRON MATERIAL, Dxx-3ST CAST STEEL MATERIAL
USED ON HH, HSH, FSH, HFTH SERIES
INTERFERENCE FIT WITHOUT SETSCREWS IS RECOMMENDED



SIZE	MAX BORE		A	B	F	H
	IRON	STEEL				
22	2.25	—	6.00	0.53	2.50	3.88
26	2.62	—	6.87	0.62	2.88	4.50
31	3.12	—	8.12	0.69	3.38	5.50
35	3.62	—	9.12	0.88	3.75	6.12
37	3.75	—	10.08	0.88	4.00	6.50
42	4.25	4.50	11.00	1.00	4.25	7.00
45	4.50	4.75	11.87	1.13	4.50	7.43
50	5.12	5.50	13.43	1.25	5.00	8.50
55	5.62	6.25	15.00	1.25	5.50	9.50
60	6.50	7.12	16.75	1.44	6.25	10.50
70	7.00	7.87	18.93	1.75	7.00	11.75
75	7.75	8.75	20.82	1.75	7.25	13.00
80	8.00	9.12	22.37	2.09	7.75	13.75
85	8.50	9.82	23.75	2.13	8.25	14.80
92	10.00	11.00	25.75	2.82	9.00	15.87

FORM-FLEX DISC IDENTIFICATION CHART

ALL DIMENSIONS ARE ROUNDED TO THE NEAREST FRACTIONAL SIZE FOR IDENTIFICATION PURPOSES. NO TOLERANCES ARE SPECIFIED OR IMPLIED.
DISC SET THICKNESS VARIES FOR TYPE BA AND DA

4 BOLT DISCS		SIZE	WIDTH	I.D.	HOLE DIA	B.C. DIA	CHORD	DISC SET THICKNESS
	5	1-13/16	1	1/4	1-7/8	1-5/16	0.08	
	10	2-3/16	1-3/16	1/4	2-3/8	1-5/8	0.09	
	15	2-9/16	1-1/4	5/16	2-5/8	1-7/8	0.12	
	20	2-13/16	1-5/8	5/16	3-1/8	2-3/16	0.14	
	25	3-9/16	1-3/4	7/16	3-3/4	2-5/8	0.15	
	30	4	2-1/16	1/2	4-1/4	3	0.18	
	35	4-3/4	2-3/4	1/2	6-1/4	3-3/4	0.28	
	40	5-1/2	3	5/8	6	4-1/4	0.30	
	45	6-1/16	3-1/2	5/8	6-3/4	4-3/4	0.40	
	50	7	4	3/4	7-3/4	5-1/2	0.43	
55	7-3/4	4-1/4	1	8-1/2	6	0.51		
6 BOLT DISCS		SIZE	WIDTH	I.D.	HOLE DIA	B.C. DIA	CHORD	DISC SET THICKNESS
	33	3-3/4	2-3/4	1/4	3-3/4	1-7/8	0.10	
	36	4-13/16	3-9/16	5/16	4-7/8	2-7/16	0.13	
	43	5-11/8	3-15/16	7/16	5-9/16	2-7/8	0.16	
	48	6-3/8	4-5/8	7/16	6-3/8	3-3/16	0.19	
	53	6-3/4	4-3/4	1/2	6-5/8	3-5/16	0.24	
	58	7-3/4	5-1/4	5/8	7-7/16	3-3/4	0.25	
	63	8-1/2	6	5/8	8-3/8	4-3/16	0.30	
	68	9-1/4	6-1/4	3/4	9-15/16	5	0.34	
	73	10-5/8	6-5/8	1	10	5	0.44	
	78	13-9/16	7-7/8	1-1/4	12	6	0.54	
8 BOLT DISCS		SIZE	WIDTH	I.D.	HOLE DIA	B.C. DIA	CHORD	DISC SET THICKNESS
	22	5-5/8	3-7/8	5/16	4-3/4	1-13/16	0.17	
	26	6-9/16	4-7/16	13/32	5-1/2	2-1/8	0.23	
	31	7-3/4	5-1/4	15/32	6-1/2	2-1/2	0.25	
	35	8-5/8	5-3/4	17/32	7-1/4	2-3/4	0.29	
	37	9-5/8	6-5/16	5/8	8	3-1/16	0.31	
	42	10-1/2	6-3/4	11/16	8-5/8	3-5/16	0.31	
	45	11-1/4	7-1/4	3/4	9-1/4	3-1/2	0.37	
	50	12-13/16	8-1/2	7/8	10-1/2	4	0.48	
	55	14-3/8	9	1	11-3/4	4-1/2	0.54	
	60	15-15/16	9-15/16	1-1/8	13	5	0.59	
	70	18-7/8	11-1/8	1-5/16	14-3/4	5-5/8	0.78	
	75	19-3/4	12	1-7/16	16	6-1/8	0.80	
	80	21-7/16	13-1/8	1-9/16	17-3/8	6-5/8	0.81	
	85	22-7/8	14	1-3/4	18-1/2	7-1/8	0.87	
	92	24-7/8	15	1-7/8	20	7-5/8	1.00	



ENGINEERING STANDARDS FORM - FLEX COUPLINGS

INDUSTRY STANDARDS REFERENCED

AGMA 9002-A86—BORES AND KEYWAYS FOR FLEXIBLE COUPLINGS

AGMA 9000-C90—FLEXIBLE COUPLINGS - POTENTIAL UNBALANCED CLASSIFICATION

AGMA 514.02—LOAD CLASSIFICATION AND SERVICE FACTORS FOR FLEXIBLE COUPLINGS

API610—CENTRIFUGAL PUMPS FOR GENERAL REFINERY SERVICE, 7th Edition—BF and BP series meet the requirements of API610, 7th Edition when supplied with interference fit bores. Other coupling series can be altered to comply with API610.

NEMA MG1-14.37 AND MG1-21.81—All Form-Flex metal disc couplings meet these standards without limited end float devices

Certain tables and data in this catalog were extracted from the reference AGMA standards with the permission of the publisher, the American Gear Manufacturers Association, 1901 North Meyer Drive, Arlington, VA 22209.

MATERIAL CLASSES APPLICABLE TO 4 AND 6 BOLT DESIGNS

CLASS A—	Mild steel hubs and spacer, alloy steel hardware, 300 series stainless steel flex discs.
CLASS B—	Zinc plated mild steel hubs and spacer, alloy steel hardware, 300 series stainless steel flex discs.
CLASS C—	Zinc plated mild steel hubs and spacer, 300 series stainless steel hardware and flex discs.
CLASS E—	All 300 series stainless steel construction.

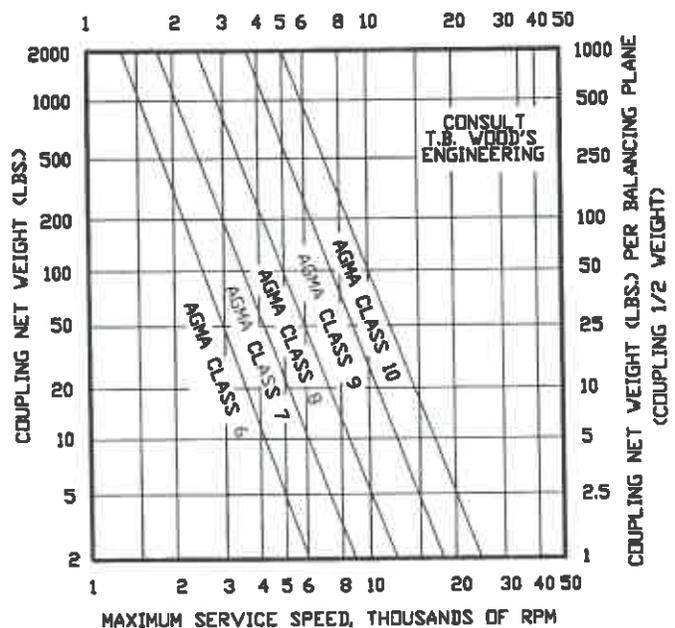
DYNAMIC BALANCING RECOMMENDATIONS

Use this graph to determine the appropriate balance class based on coupling weight and operating speed. The balance classes listed on the graph are for equipment with average sensitivity to coupling unbalance. The user should determine how sensitive the equipment train is to coupling unbalance. Use one balance class higher if your system has higher than average sensitivity to unbalance. Use one balance class lower if your system has lower than average sensitivity to unbalance. Use this guide to check your coupling selection against the recommended balance class for your operating conditions.

The following factors should be considered when determining a machine's sensitivity to coupling unbalance.

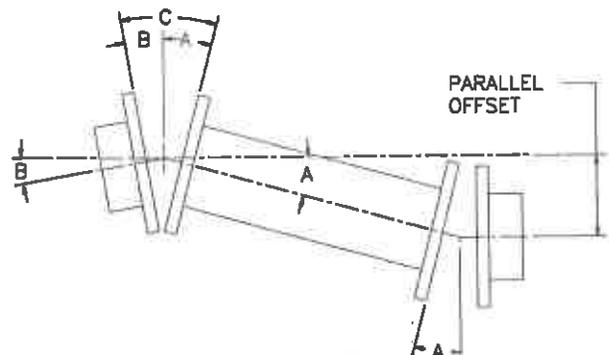
- 1) Shaft End Deflection: Machines having flexible shaft extensions are relatively sensitive to coupling unbalance.
- 2) Bearing Load Due to Coupling Weight Relative to Total Bearing Load: Machines having lightly loaded bearings, bearings that are primarily loaded by the weight of the coupling or other overhung weight are relatively sensitive to coupling unbalance.
- 3) Bearing, Bearing Support and Foundation Flexibility: Machines or systems with flexible foundations for supports for the rotating elements are relatively sensitive to coupling unbalance.
- 4) System Natural Frequencies: Machines operating at or near natural frequencies are sensitive to coupling unbalance.
- 5) Machine Separation: System having widely separated machines are relatively sensitive to coupling unbalance.
- 6) Shaft Extension Relative to Bearing Span: Machines having a short bearing span relative to their shaft extensions are sensitive to static unbalance.

BALANCE CLASS SELECTION CHART



HOW FORM-FLEX COUPLINGS ACCOMMODATE MISALIGNMENT

Double flexing metal disc couplings may be used to accommodate angular, parallel and axial misalignment. Single flexing couplings may only be used to accommodate angular and axial misalignment. A metal disc type coupling uses a double hinge effect through two flexible discs and the spacer to compensate for parallel offset misalignment between shafts. Parallel misalignment imposes the same angular deflection (A) on each flex disc. Angular misalignment of either connected shaft, (B), creates additional angular deflections which are added to the angular offset due to parallel misalignment. The total misalignment angle, (C), at the flex disc is equal to the angular offset due to parallel misalignment (A) plus the angular offset due to angular misalignment (B). The maximum misalignment angle (C) should never exceed the rated misalignment capacity of the coupling type being used. Machinery equipment changes in actual operation and over the life of the equipment. We recommend that the machinery misalignment be set as close to zero as possible when a coupling is installed. We recommend keeping the measured misalignment below 25% of the rated misalignment capacity of the coupling type used when the machinery is installed and aligned. The remaining coupling misalignment capacity will then be available to accommodate additional misalignment caused by foundation shifts, vibrations, thermal growth or other causes.



ENGINEERING STANDARDS FORM-FLEX COUPLINGS



PRODUCT FEATURES AND OPTIONS

FEATURE	AR, AK, AP AX, AY	BH, BP, BY DP*	BF	BA, DA*	A5, A7	B6	HFTH	HH, HSH, FSH
STANDARD BORE FIT	CLEARANCE	INTERFERENCE			CLEARANCE	INTERFERENCE		
SET SCREWS	STANDARD	OPTIONAL			STANDARD	OPTIONAL		
PULLER HOLES	OPTIONAL	STANDARD			OPTIONAL	STANDARD	OPTIONAL	
STANDARD FLEX DISCS	300 SERIES STAINLESS STEEL*						ALLOY STEEL	
BALANCE CLASS	AGMA 7	AGMA 8	AGMA 9	AGMA 7	N/A			N/A
DYNAMIC BALANCE	OPTIONAL				PER TBW COMMERCIAL STANDARD			N/A

*Alloy steel flex disc is standard for DA and DP series. Stainless steel is optional.

STANDARD BORE TOLERANCES

INCH SIZE	SIZE	KEYWAY SIZE	BORE TOLERANCE	
			CLEARANCE FIT	INTERFERENCE FIT
1/2	12	1/8 X 1/16	.500/.501	...
5/8	58	3/16 X 3/32	.625/.626	...
3/4	34	3/16 X 3/32	.750/.751	.7490/.7495
7/8	78	3/16 X 3/32	.875/.876	.8740/.8745
15/16	1516	1/4 X 1/8	.9375/.9385	.9365/.9370
1	1	1/4 X 1/8	1.000/1.001	.9990/.9995
1-1/8	118	1/4 X 1/8	1.125/1.126	1.1240/1.1245
1-3/16	1316	1/4 X 1/8	1.1875/1.1885	1.1865/1.1870
1-1/4	114	1/4 X 1/8	1.250/1.251	1.2490/1.2495
1-3/8	138	5/16 X 5/32	1.375/1.376	1.3740/1.3745
1-7/16	1716	3/8 X 3/16	1.4375/1.4385	1.4365/1.4370
1-1/2	112	3/8 X 3/16	1.500/1.501	1.4990/1.4995
1-5/8	158	3/8 X 3/16	1.625/1.626	1.623/1.624
1-3/4	134	3/8 X 3/16	1.750/1.751	1.749/1.749
1-7/8	178	1/2 X 1/4	1.875/1.876	1.873/1.874
1-15/16	11516	1/2 X 1/4	1.9375/1.9385	1.9355/1.9365
2	2	1/2 X 1/4	2.000/2.001	1.999/1.999
2-1/8	218	1/2 X 1/4	2.1250/2.1265	2.123/2.124
2-1/4	214	1/2 X 1/4	2.2500/2.2515	2.248/2.249
2-3/8	238	5/8 X 5/16	2.3750/2.3765	2.373/2.374
2-7/16	2716	5/8 X 5/16	2.4375/2.4390	2.4355/2.4365
2-1/2	212	5/8 X 5/16	2.5000/2.5015	2.498/2.499
2-5/8	258	5/8 X 5/16	2.6250/2.6265	2.623/2.624
2-3/4	234	5/8 X 5/16	2.7500/2.7515	2.748/2.749
2-7/8	278	3/4 X 3/8	2.8750/2.8765	2.873/2.874
2-15/16	21516	3/4 X 3/8	2.9375/2.9390	2.9355/2.9365
3	3	3/4 X 3/8	3.000/3.0015	2.998/2.999
3-1/4	314	3/4 X 3/8	3.2500/3.2515	3.2470/3.2485
3-3/8	338	7/8 X 7/16	3.3750/3.3765	3.3720/3.3735
3-1/2	312	7/8 X 7/16	3.5000/3.5015	3.4970/3.4985
3-5/8	358	7/8 X 7/16	3.6250/3.6265	3.6220/3.6235
3-3/4	334	7/8 X 7/16	3.7500/3.7515	3.7470/3.7485
4	4	1 X 1/2	4.0000/4.0015	3.9970/3.9985
4-1/4	414	1 X 1/2	4.2500/4.2515	4.2465/4.2480
4-1/2	412	1 X 1/2	4.5000/4.5015	4.4965/4.4980
4-3/4	434	1-1/4 X 5/8	4.7500/4.7515	4.7465/4.7480
5	5	1-1/4 X 5/8	...	4.9965/4.9980
5-1/4	514	1-1/4 X 5/8	...	5.2460/5.2475
5-1/2	512	1-1/4 X 5/8	...	5.4960/5.4975
5-3/4	534	1-1/2 X 3/4	...	5.7460/5.7475

METRIC SIZE	SIZE CODE	KEYWAY SIZE	BORE TOLERANCE
			CLEARANCE FIT
6	6MM	2 X 1	.238/.237
8	8MM	2 X 1	.315/.316
10	10MM	3 X 1.4	.394/.395
12	12MM	4 X 1.8	.4725/.4735
13	13MM	5 X 2.3	.512/.513
14	14MM	5 X 2.3	.551/.552
15	15MM	5 X 2.3	.591/.592
16	16MM	5 X 2.3	.630/.631
18	18MM	6 X 2.8	.709/.710
20	20MM	6 X 2.8	.7875/.7885
22	22MM	6 X 2.8	.866/.867
24	24MM	8 X 3.3	.945/.946
25	25MM	8 X 3.3	.984/.985
28	28MM	8 X 3.3	1.1025/1.1035
30	30MM	8 X 3.3	1.181/1.182
32	32MM	10 X 3.3	1.260/1.261
35	35MM	10 X 3.3	1.378/1.379
38	38MM	10 X 3.3	1.496/1.497
40	40MM	12 X 3.3	1.575/1.576
45	45MM	14 X 3.8	1.772/1.773
48	48MM	14 X 3.8	1.890/1.891
50	50MM	14 X 3.8	1.969/1.970
55	55MM	16 X 4.3	2.1655/2.1670
60	60MM	18 X 4.4	2.3620/2.3635
65	65MM	18 X 4.4	2.5590/2.5605
70	70MM	20 X 4.9	2.7560/2.7575
75	75MM	20 X 4.9	2.9530/2.9545
80	80MM	22 X 5.4	3.1500/3.1515
85	85MM	22 X 5.4	3.3465/3.3480
90	90MM	25 X 5.4	3.5435/3.5450
95	95MM	25 X 5.4	3.7400/3.7415
100	100MM	28 X 6.4	3.9370/3.9385
110	110MM	28 X 6.4	4.3310/4.3325

BORE TOLERANCES IN INCHES
KEYWAY SIZES IN MM

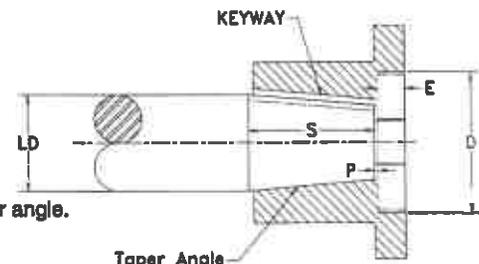
KEYWAY TOLERANCES

WIDTH	ENGLISH	+ .002"/ -0.000"
	METRIC	+ .001"/ -0.000"
HEIGHT AT SIDE OF KW	BORE <= 3.375"	+ .015"/ -0.000"
	BORE > 3.375"	+ .020"/ -0.000"

SPECIFYING TAPERED BORES

Please provide the following information for taper bore hubs:

- Drawing of HUB showing bore and keyway details.
OR
- Drawing of shaft showing:
 - (LD) Large diameter, specify with tolerance.
 - (S) Length of taper, measure parallel to shaft centerline.
 - (T) Taper angle. Specify as degrees, taper per foot or a percentage.
 - (P) Desired pull-up of hub on shaft.
 - (D) Counterbore diameter as required.
 - (E) Counterbore depth as required.
 Keyway or shaft keyseat dimensions. Specify width, depth and keyway taper angle.
-AND OPTIONALLY-
- Drawing or sketch of equipment layout in order to determine correct spacer length.



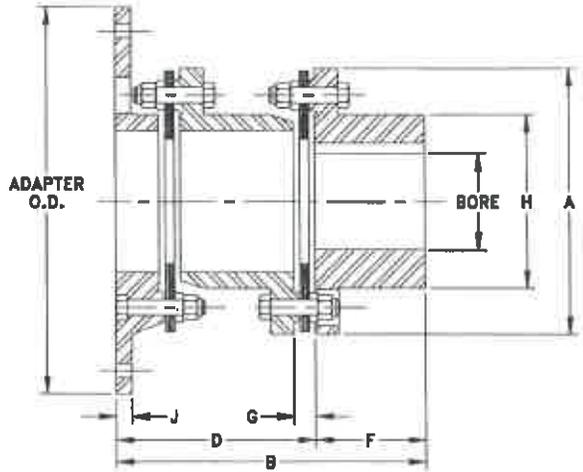
SPACER - FSH SERIES 8 BOLT FLYWHEEL MOUNT COUPLINGS



The FSH series is designed for high torque, low speed applications. Hubs and spacers are cast of iron or steel. Adapter plates are cast grey or ductile iron. Flex discs are high strength alloy steel. Stainless flex discs are optional. Dynamic balancing for higher speed operation is not recommended. Single plane balancing of flywheel adapters, hubs and spacers is available.

HUB TYPES	SIZES
C.I.	31-105
STL	31-105
SEE PAGE F5-9	

ORDERING: FSH Series couplings are sold as complete assemblies. Please specify hub type, bore sizes, and flex disc materials. A coupling will be configured to meet your specifications.



RATED MISALIGNMENT: 0.3 DEG/DISC

SIZE	OD	STANDARD ADAPTER SIZES					
		SAE BOLTING			HD BOLTING		
		BC	HOLE QTY	HOLE SIZE	BC	HOLE QTY	HOLE SIZE
10	10.375	9.625	8	13/32	9.500	8	15/32
12	12.375	11.625	8	13/32	11.500	8	17/32
14	13.875	13.125	8	13/32	12.500	8	21/32
18	18.375	17.250	8	17/32	16.750	8	25/32
20	20.375	19.250	8	17/32	18.500	8	29/32
22	22.500	21.375	6	21/32	20.500	8	1-1/32
26	26.500	25.250	12	21/32	24.500	12	1-1/32
28	28.875	27.250	12	25/32	26.875	12	1-1/32

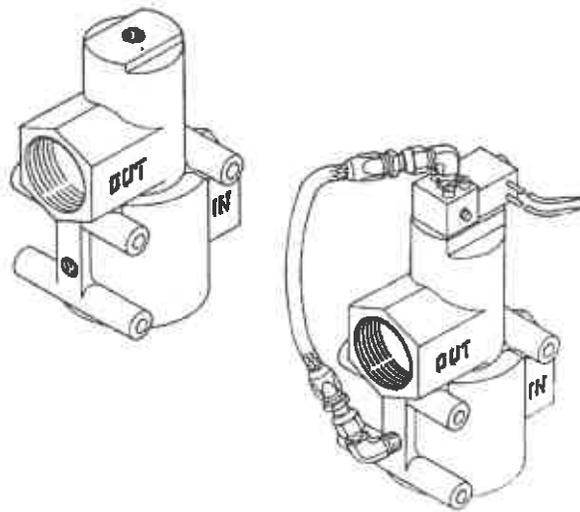
SIZE	DIMENSIONS IN INCHES									AVAILABLE ADAPTER SIZES								
	MAX BORE		A	B	D BORE	F	G	H	J	X = STOCK SIZE O = M								
	IRON	STEEL								10	12	14	18	20	22	26		
31	3.12	3.25	8.12	8.68	5.31	3.37	0.82	5.50	0.50	O	O	X	X	O	O			
36	3.62	3.81	9.12	9.62	5.87	3.75	0.86	6.12	0.50	O	O	X	X	O	X			
37	3.75	4.19	10.06	10.62	6.62	4.00	0.81	6.50	0.56			O	O	O	O			
42	4.25	4.50	11.00	11.37	7.12	4.25	0.81	7.00	0.63			O	X	O	X	X	X	X
45	4.50	4.75	11.87	12.00	7.50	4.50	0.87	7.43	0.69			O	X	O	X	X	X	X
50	5.12	5.50	13.43	13.75	8.75	5.00	1.06	8.37	0.75				X	O	X	X	X	X
55	5.62	6.25	15.00	15.38	9.87	5.50	1.25	9.50	0.88				X	O	X	X	X	X
60	6.50	7.12	16.75	17.12	10.87	6.25	1.34	10.50	1.00				X	O	X	X	X	X
70	7.00	7.87	18.93	19.43	12.43	7.00	1.50	11.75	1.00					O	X	X	X	X
75	7.75	8.75	20.62	20.75	13.60	7.25	1.53	13.00	1.13						O	O	O	X
80	8.00	9.12	22.37	22.50	14.75	7.75	1.56	13.75	1.25						O	O		X
85	8.50	9.62	23.75	23.93	15.68	8.25	1.62	14.50	1.26									X
92	10.00	11.00	25.75	26.25	17.25	9.00	1.75	16.87	1.38									X
105	10.50	12.00	29.25	27.77	17.27	10.50	1.75	20.00	1.75									X

SIZE	HP PER 100 RPM	RATED TORQUE (lb. in.)	PEAK O/L TORQUE (lb. in.)	MAX RPM (2)	WEIGHT (lbs.) (1)	WR ² (lb. in. ²) (1)	TQ/RAD X10 ⁴ (1) (lb. in./rad)	FREE END FLOAT +/- Inch
	1.0S.F							
31	38.10	24,000	36,000	2,800	48	442	2.95	0.052
35	69.84	44,000	66,000	2,600	64	661	6.69	0.056
37	95.24	60,000	90,000	2,500	87	1,170	10.3	0.062
42	115.9	73,000	109,500	2,400	115	1,860	7.03	0.067
45	157.1	99,000	148,500	2,250	138	2,500	15.4	0.072
50	203.2	128,000	192,000	2,000	202	5,550	48.8	0.082
55	300.0	169,000	283,500	1,800	263	8,000	58.6	0.092
60	414.3	261,000	391,500	1,600	359	12,700	86.5	0.102
70	658.7	415,000	622,500	1,400	559	26,200	161	0.115
75	846.0	533,000	799,500	1,300	766	43,600	180	0.125
80	1087	665,000	1,027,500	1,200	930	60,100	225	0.136
85	1316	829,000	1,243,500	1,100	1,110	83,000	222	0.140
92	1651	1,040,000	1,560,000	1,000	1,460	124,000	433	0.156
105	1984	1,250,000	1,875,000	1,000	C/F	C/F	C/F	0.170

1) WEIGHT, WR² AND TORSIONAL STIFFNESS VALUES SHOWN ARE FOR CAST IRON HUBS AT MAXIMUM BORE SIZE AND MINIMUM AVAILABLE ADAPTER O.D.

2) MAX RPM LISTED IS FOR SMALLEST ADAPTER SIZE. CONSULT FACTORY FOR SPEED RATINGS BY ADAPTER SIZE.

OPERATING & SERVICE MANUAL



TURBOVALVE

TABLE OF CONTENTS

SECTION	SUBJECT	PAGE
1.0	General Information.....	1
2.0	<i>TURBOVALVE</i> Operation.....	1
3.0	<i>TURBOVALVE</i> Installation.....	2
4.0	<i>TURBOVALVE</i> Disassembly.....	2
5.0	<i>TURBOVALVE</i> Assembly.....	3
6.0	Disassembly/Assembly (Electrical).....	3

LIST OF ILLUSTRATIONS

FIGURES	TITLE	PAGE
1	<i>TURBOVALVE</i> (Pneumatically Controlled).....	1
2	<i>TURBOVALVE</i> (Electrically Controlled).....	2
3	Opening Pressure vs. Supply.....	2
4	Piston Removal.....	3
5	<i>TURBOVALVE</i> Dimensional Data.....	4
6	T30-I Installation Diagram (Electrical).....	5
7	T50-P Installation Diagram.....	6
8	T100 Series Installation Diagram.....	7
9	T100-V Installation Diagram.....	8
10	<i>TURBOVALVE</i> (Pneumatically Controlled).....	10
11	<i>TURBOVALVE</i> (Electrically Controlled).....	12

TDI *TURBOTWIN*TM

FROM TECH DEVELOPMENT, INC.

1.0 GENERAL INFORMATION

The TDI *TURBOVALVE* is a versatile starting air or control relay valve available in a pilot operated version or with an integrated solenoid that eliminates extra plumbing. Its high flow capacity reduces pressure drop through the valve, providing for a broad range of applications.

An auxiliary port provides a convenient point for accessing the pressure at the supply (IN port) ... using it for indication, control or pilot actuation.

FEATURES

- Low pressure pilot
- Optional integrated solenoid versions
- 450 psig Rating (Pneumatically controlled version only)
- High flow capacity
- Replaceable O-Rings
- 1-1/4" or 1-1/2" pipe sizes
- 3-Point mounting for secure attachment
- Replaces Sealco (P/N: 10900, 11900, 14900, and 110250) and Ingersoll-Rand (P/N:SRV125 and SRV150) relay valves

SPECIFICATIONS

- Valve Housing: Aluminum (Nickel plated for corrosion resistance).
- Internal Parts: Aluminum
- O-Rings: VITON or Buna N
- Operating Temperature: -20 to 200°F (-29° to 93°C)
- Valve Working Pressure Rating: 450 psig (31 Bar) (Pneumatically controlled version only)
- Weight: 2.9 pounds (1.3 kg)
- Optional Solenoid Voltages: 12, 24, 48, 110 VDC/120 or VAC/60-Hz
- Cv = 41

2.0 OPERATION

2.1 Pneumatically controlled *TURBOVALVE*

- a. Air is supplied to the Applied Pressure Port (APP), which forces the piston to the open position. The pressure required to open the relay valve is based on the supply pressure. See figure 3.
- b. The main ports (IN and OUT) open to allow flow through the valve.
- c. When the pilot pressure is released, the spring allows the piston to retract, closing the main port.

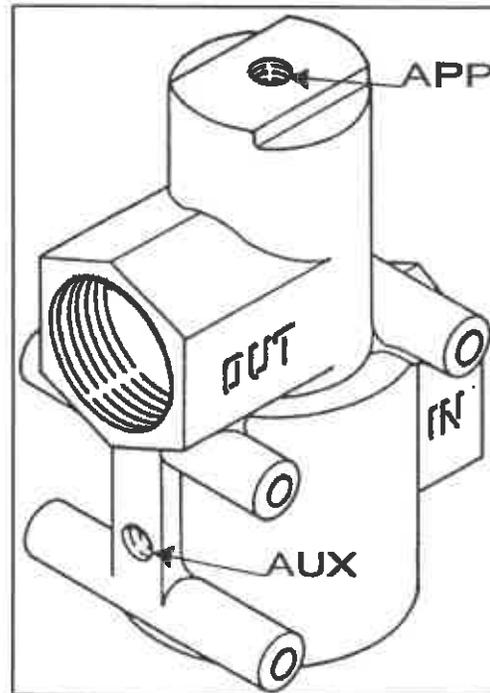


Figure 1. TurboValve-Pneumatically Controlled

2.2 Electrically controlled *TURBOVALVE*

- a. Electricity is applied to the solenoid valve allowing air to access the relay valve via the APP.

TDI TURBOTWIN™

FROM TECH DEVELOPMENT, INC.

- b. The main ports (IN and OUT) are opened to allow flow through the valve.
- c. When the start button is released, the electric solenoid vents, allowing the relay valve piston to retract, closing the main port.

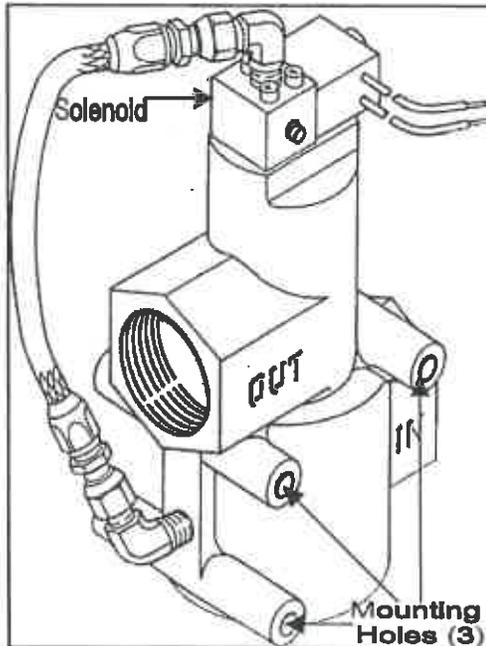


Figure 2. TurboValve-Electrically Controlled

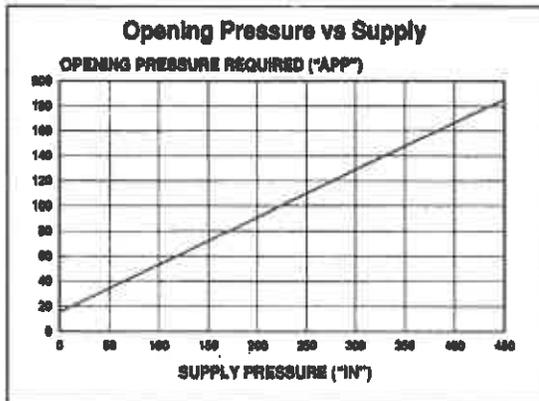


Figure 3. Opening Pressure vs. Supply

3.0 INSTALLATION

The valve may be mounted in any position using the three holes located

on the relay valve body as shown in figure 2. The air to the Applied Pressure Port (APP) should be clean and dry. Connection piping to the APP and IN ports should be cleaned to remove excess thread sealant, chips, and other foreign matter that could get trapped in the valve or the pilot chamber and cause seals to fail.

The TURBOVALVE may be ordered using the full description as shown or by specifying a Part Number using the Model Code System. Example: the Part Number for a standard pneumatic valve with a 1-1/2\" NPT threads and Buna N O-Ring is RLVA-25683-001-1-01. (Please Note: TDI RLVA-25683-001-2-00 replaces TDI 42-23356, and TDI RLVA-25683-001-1-01 replaces TDI 52-93503.)

4.0 DISASSEMBLY

WARNING

Never attempt to remove the starter relay valve or retainer snap-ring from bottom side of valve until the air pressure has been bled off. Failure to do this could result in internal parts being blown out with considerable force.

Carefully remove retaining ring (11) from relay valve housing (1).

Remove end cap (9), spring (7), and piston (4) from relay valve housing.

WARNING

If necessary, apply low pressure air to the relay valve APP to disengage the piston from valve housing. The aft end of valve must be positioned toward workbench surface to block piston as shown in figure 4.

TDI TURBOTWIN™

FROM TECH DEVELOPMENT, INC.

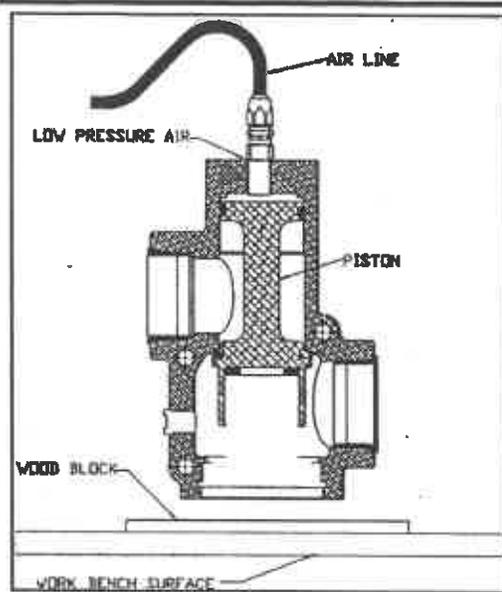


Figure 4. Piston Removal

Remove O-Rings (8,10) from end cap.

Remove O-Ring cap (6), shock dampener (5) and O-Rings (2,3) from piston (4).

5.0 ASSEMBLY

Use either 2-26119-001 (Buna N) or 2-26119-002 (Viton) repair kit to rebuild the TURBOVALVE.

Coat all O-Rings, end cap, piston, and bore of relay valve housing with a good grade of silicon based grease (TDI P/N 9-94082-001).

Place O-Rings (8,10) on end cap (9) and O-Rings (2,3) on piston (4).

Install shock dampener (5) into piston housing (4) bore.

Install O-Ring cap (6) onto piston (4) and seat over O-Ring (3).

Hand press piston assembly into relay valve housing (1) until seated.

Install spring (7) into bore of valve housing (1).

Install end cap assembly (8,9,10) into valve bore and secure with retainer ring (11).

6.0 DISASSEMBLY / ASSEMBLY (RELAY VALVE – ELECTRICALLY CONTROLLED)

Follow the above procedure to remove and install the internal parts in electrically controlled relay valve.

If necessary, rotate the connectors on the ends of the hose assembly (5) counter-clockwise to remove from relay valve assembly.

Rotate 90° elbows (4,6) counter-clockwise to remove from relay valve assembly.

Remove the screws (2) to separate the solenoid valve (1) from the relay valve housing (7).

TDI TURBOTWIN™
 FROM TECH DEVELOPMENT, INC.

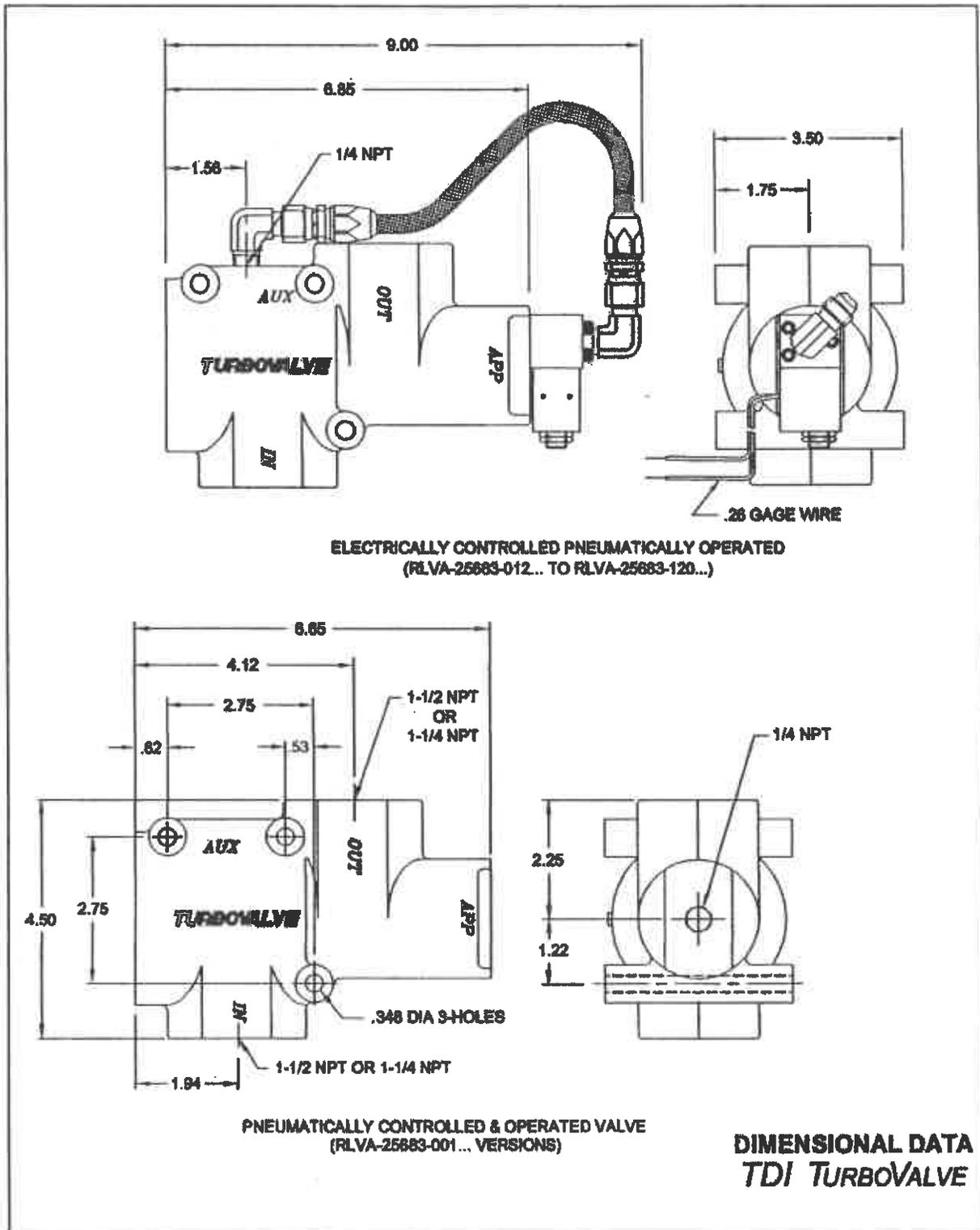


Figure 5. TURBOVALVE Dimensional Data

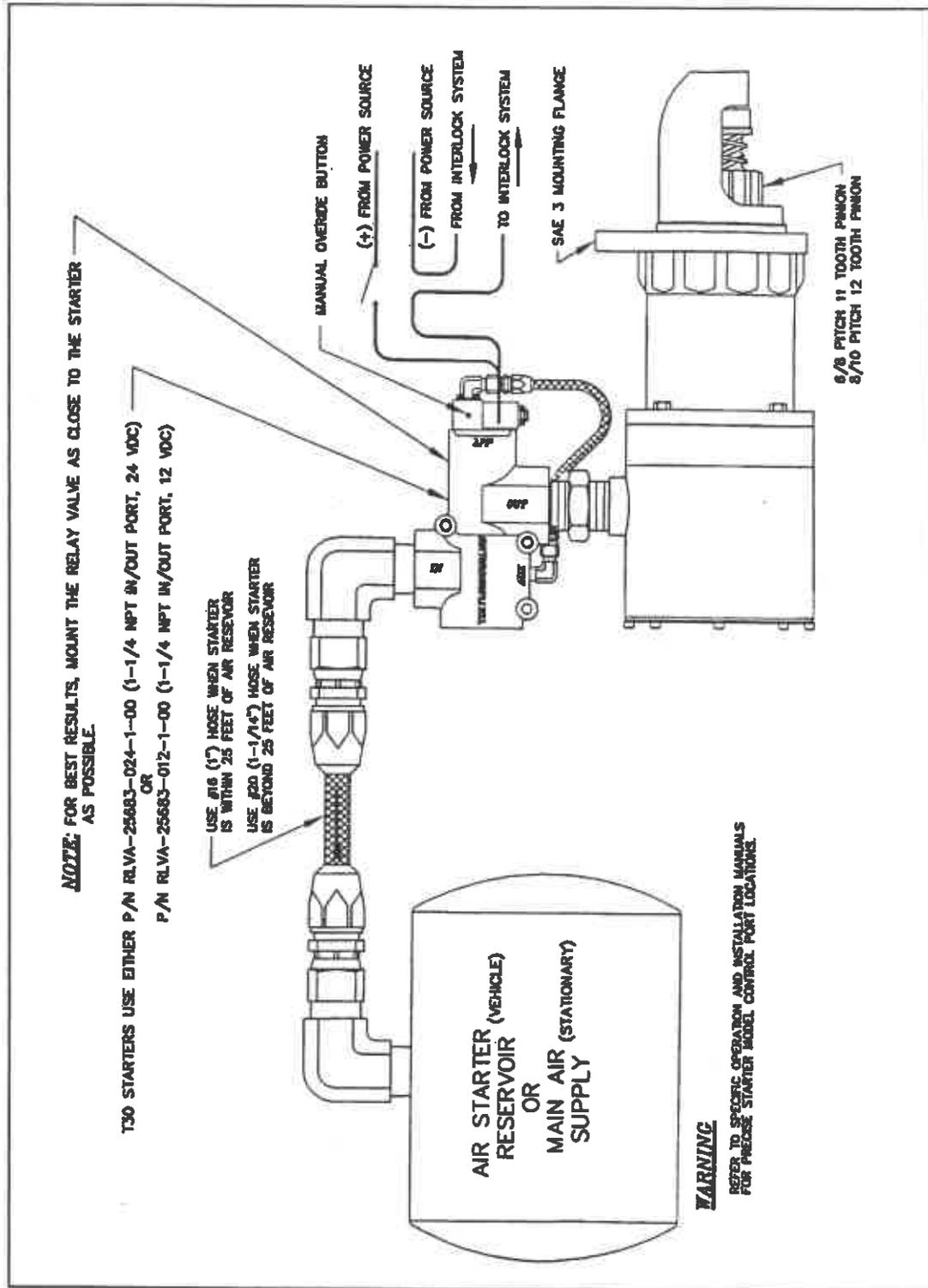


Figure 6. T30-I TURBOTWIN Air Starter Installation Diagram (Electrical)

TDI TURBOTWIN™

FROM TECH DEVELOPMENT, INC.

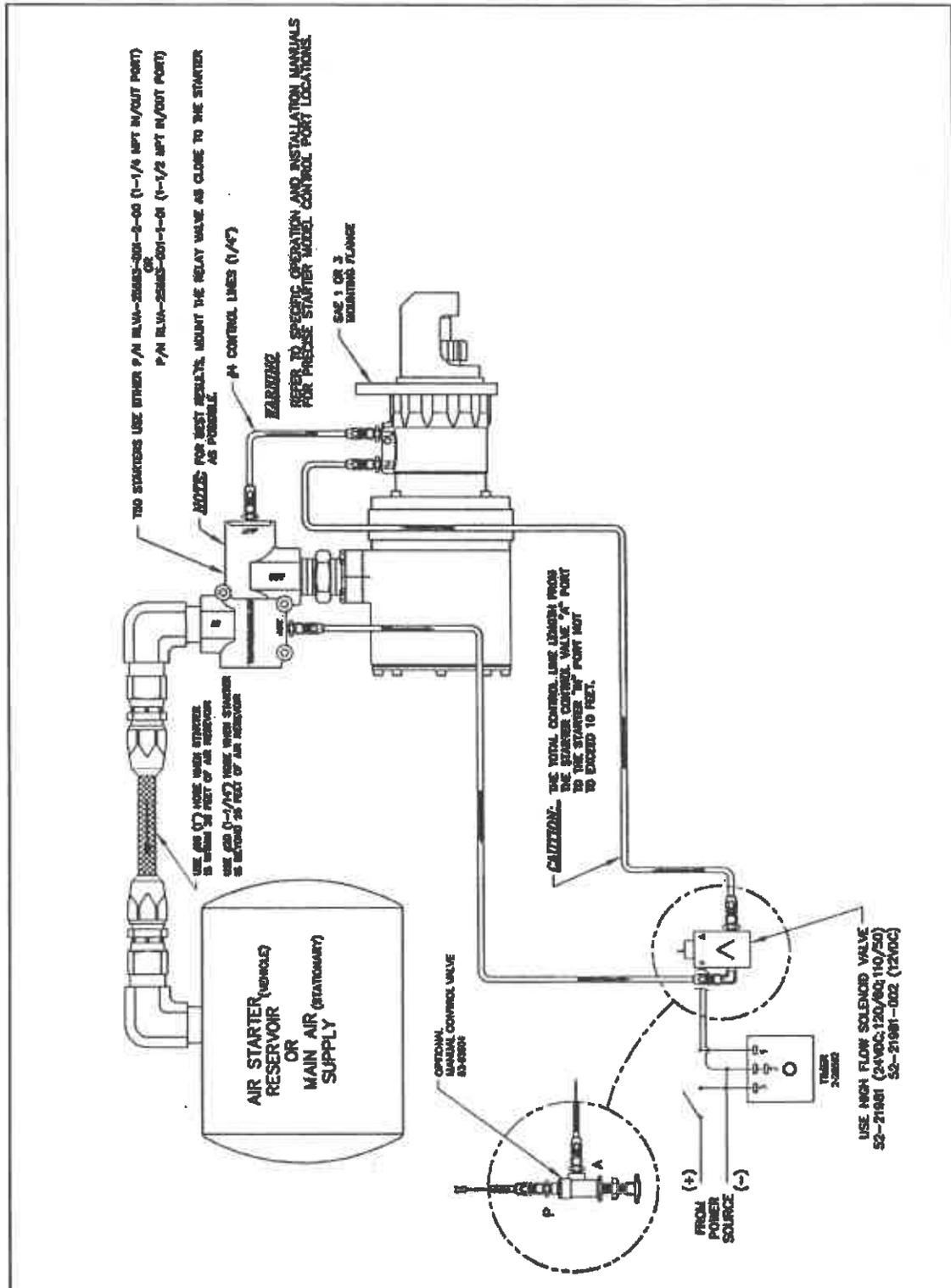


Figure 7. T50-P TURBOTWIN Air Starter Installation Diagram

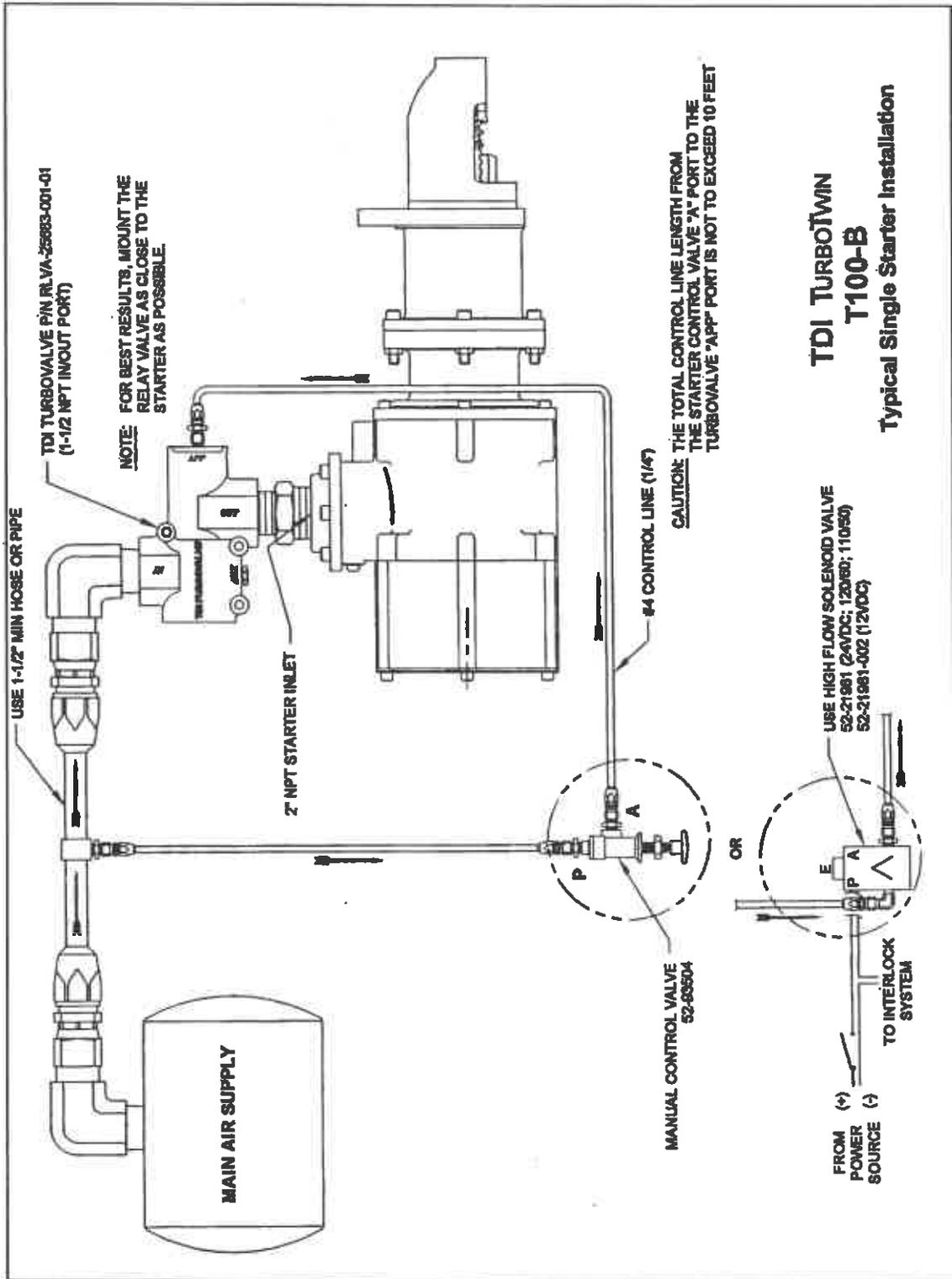


Figure 8. T100 Series *TURBOTWIN* Air Starter Installation Diagram

TDI TURBOTWIN™
FROM TECH DEVELOPMENT, INC.

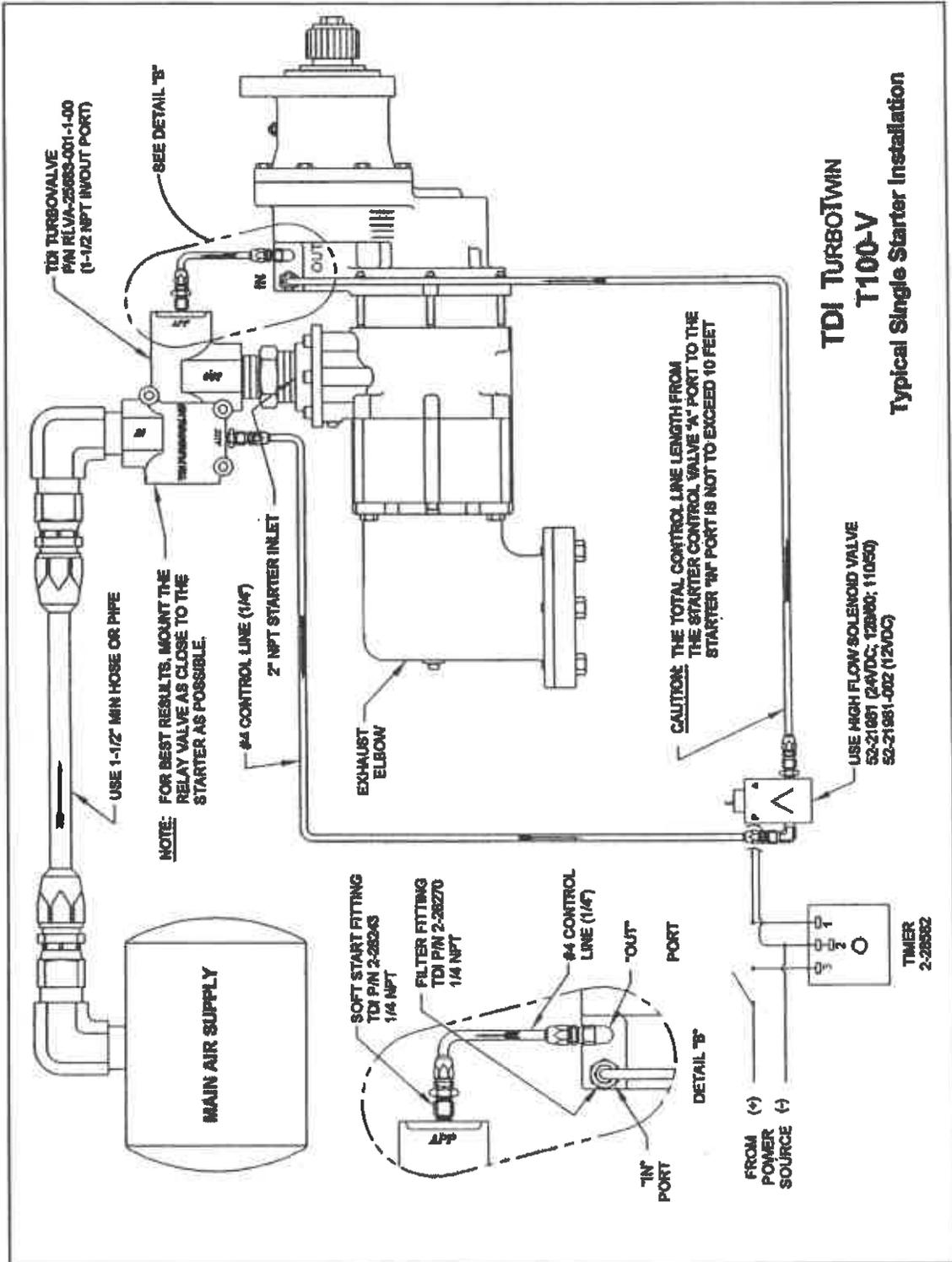


Figure 9. T100-V TURBOTWIN Air Starter Installation Diagram

6.0 ILLUSTRATED PARTS BREAKDOWN (Pneumatically Controlled)

PART NUMBER	IN PORT	OUT PORT	O-RINGS	OVERHAUL KIT
RLVA-25683-001-1	1 ¼"	1 ¼"	Buna-N	2-26119-001
RLVA-25683-001-2	1 ¼"	1 ¼"	Viton	2-26119-002
RLVA-25683-001-1-01	1 ½"	1 ½"	Buna-N	2-26119-001
RLVA-25683-001-2-01	1 ½"	1 ½"	Viton	2-26119-002

KEY NO.	DESCRIPTION	PART NUMBER
1	Housing, Relay Valve (1 ¼" NPT)	2-25764
1	Housing, Relay Valve (1 ½" NPT)	2-25764-001
2	O-Ring, Buna - N	9-90001-221
2	O-Ring, Viton	9-90002-221
3	O-Ring, Buna - N	9-90031-324
3	O-Ring, Viton	9-90030-324
4	Piston	2-25694
5	Dampener, Shock	2-25107
6	Cap, O-Ring	2-25106
7	Spring, Compression	9-90435
8	O-Ring, Buna - N	9-90001-218
8	O-Ring, Viton	9-90002-218
9	End Cap	2-25693
10	O-Ring, Buna - N	9-90001-035
10	O-Ring, Viton	9-90002-035
11	Ring, Retaining	9-92001-016

TDI TURBOTWIN™
FROM TECH DEVELOPMENT, INC.

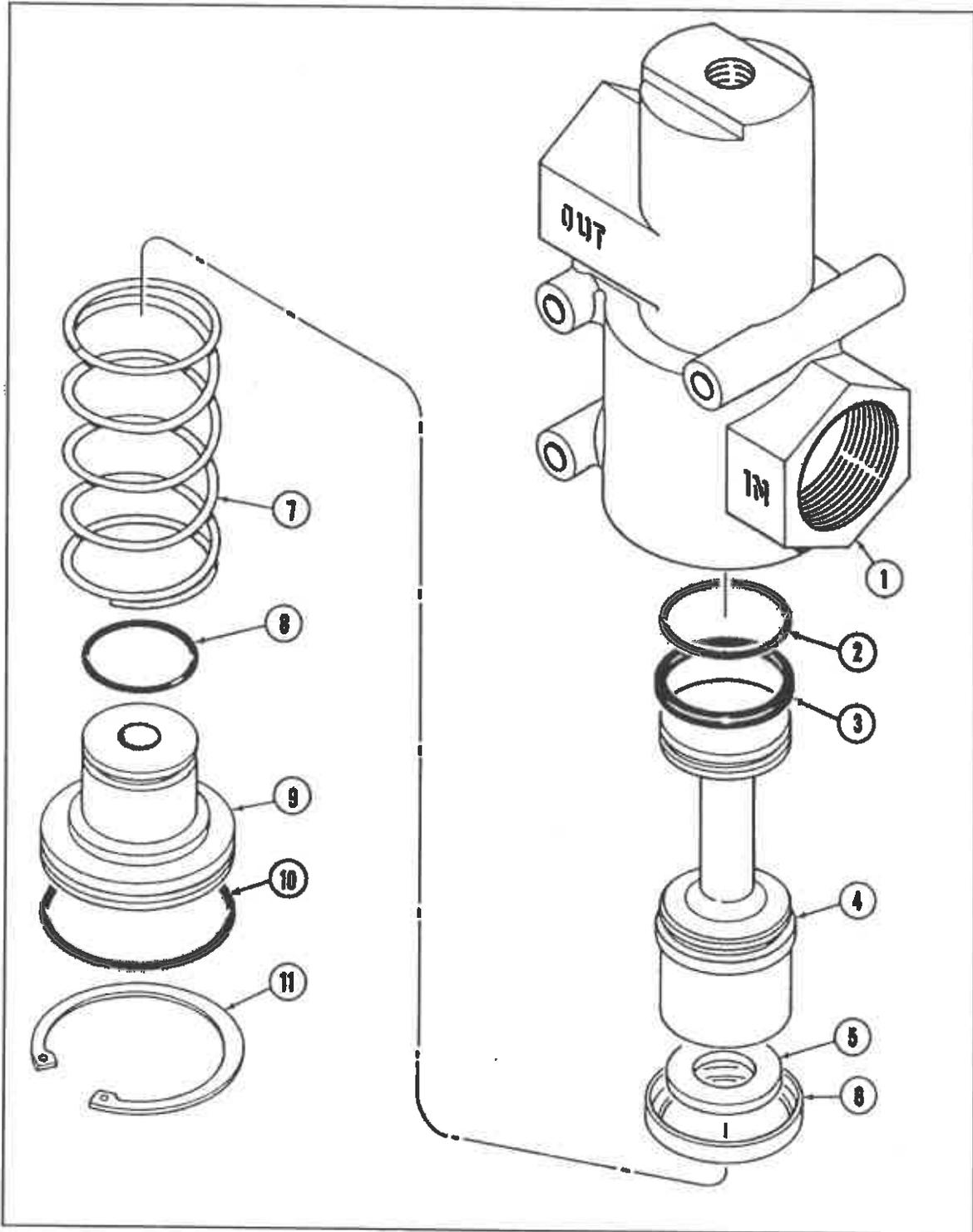


Figure 10. Exploded View of *TURBOVALVE* (Pneumatically Controlled)

7.0 ILLUSTRATED PARTS BREAKDOWN (Electrically Controlled)

PART NUMBER	IN PORT	OUT PORT	O-RINGS	VOLTAGE	VALVE PART NUMBER	OVERHAUL KIT
RLVA-25683-012-1	1 ¼"	1 ¼"	Buna-N	12 VDC	2-26324-001	2-26119-001
RLVA-25683-012-2	1 ¼"	1 ¼"	Viton	12 VDC	2-26324-001	2-26119-002
RLVA-25683-012-1-01	1 ½"	1 ½"	Buna-N	12 VDC	2-26324-001	2-26119-001
RLVA-25683-012-2-01	1 ½"	1 ½"	Viton	12 VDC	2-26324-001	2-26119-002
RLVA-25683-024-1	1 ¼"	1 ¼"	Buna-N	24 VDC	2-26324-010	2-26119-001
RLVA-25683-024-2	1 ¼"	1 ¼"	Viton	24 VDC	2-26324-010	2-26119-002
RLVA-25683-024-1-01	1 ½"	1 ½"	Buna-N	24 VDC	2-26324-010	2-26119-001
RLVA-25683-024-2-01	1 ½"	1 ½"	Viton	24 VDC	2-26324-010	2-26119-002
RLVA-25683-110-2-01	1 ½"	1 ½"	Viton	110 VDC	2-26324-003	2-26119-002
RLVA-25683-120-2-01	1 ½"	1 ½"	Viton	120 VAC	2-26324-004	2-26119-002

KEY NO.	DESCRIPTION	PART NUMBER
1	Valve (12VDC)	2-26324-001
2	Screw (3)	11F-19024-020
3	O-Ring, Buna - N	9-90001-010
3	O-Ring, Viton	9-90002-010
4	Elbow, 90° Male	9-93565-001
5	Hose Assembly	1P-23448-001
6	Elbow, 90° Male	9-93565-002
7	Housing, Relay Valve (1 ¼" NPT)	2-25692
7	Housing, Relay Valve (1 ½" NPT)	2-25692-001
8	O-Ring, Buna - N	9-90001-221
8	O-Ring, Viton	9-90002-221
9	O-Ring, Buna - N	9-90031-324
9	O-Ring, Viton	9-90030-324
10	Piston	2-25694
11	Dampener, Shock	2-25107
12	Cap, O-Ring	2-25106
13	Spring, Compression	9-90435
14	O-Ring, Buna - N	9-90001-218
14	O-Ring, Viton	9-90002-218
15	End Cap	2-25693
16	O-Ring, Buna - N	9-90001-035
16	O-Ring, Viton	9-90002-035
17	Ring, Retaining	9-92001-016

TDI TURBOTWIN™
FROM TECH DEVELOPMENT, INC.

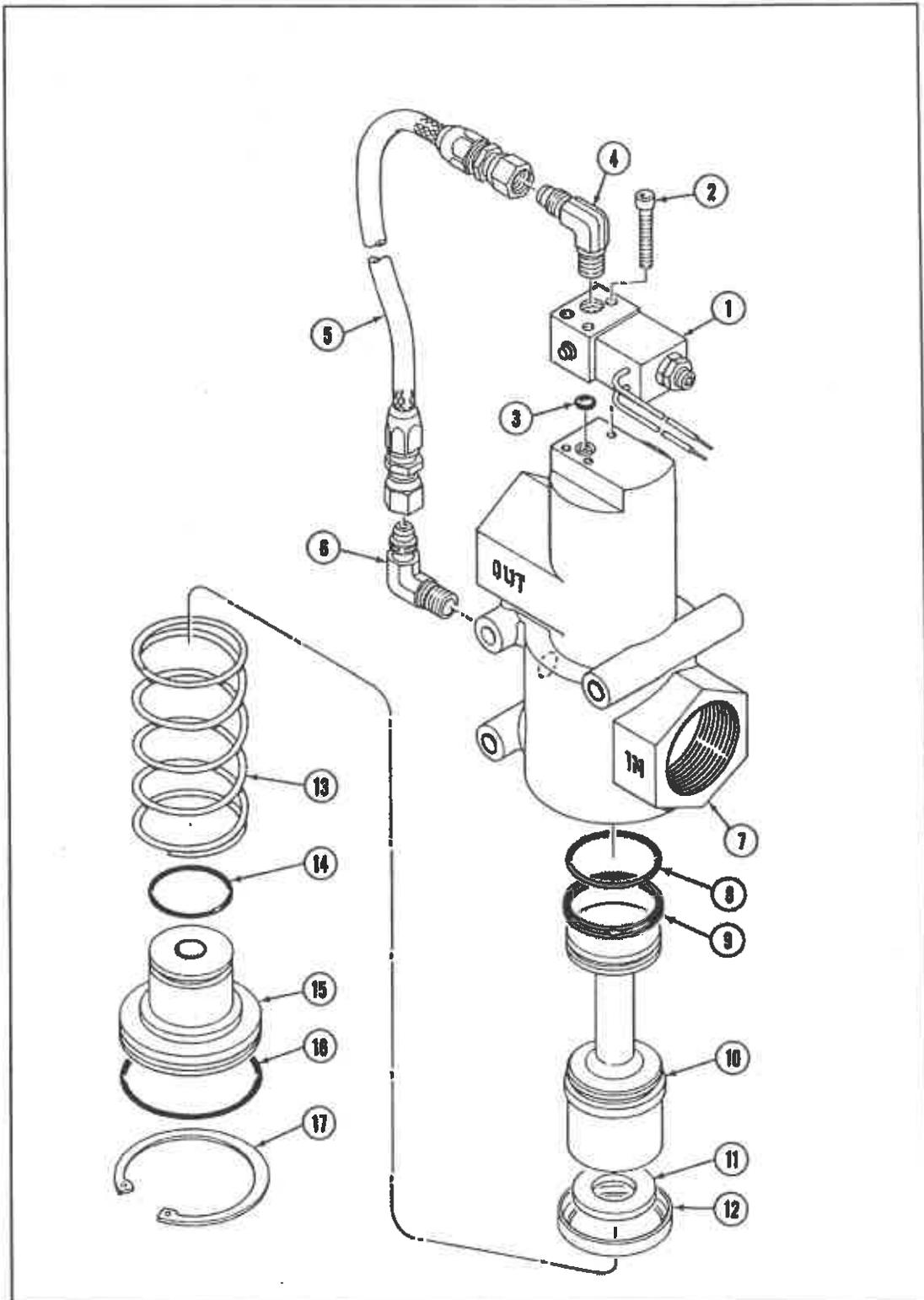


Figure 11. Exploded View of *TURBOVALVE* (Electrically Controlled)



Series Q20 Liquid Level Gauges

Standard construction includes a solid one-piece chamber machined from bar, machined steel covers, tempered glass, alloy steel bolts and nuts. Recessed gasket seats prevent gasket movement. Series Q20 gauges are available in a variety of materials to meet specific corrosive conditions. All standard chamber materials (carbon and stainless steels) are NACE MR-01-75 acceptable materials. Non-frost extensions, illuminators, support brackets, Kel-F shields, mica shields and special alloys are available.

- Temperature range to 600°F
- Recessed gasket seats in both chamber and cover.
- Visible length from 3 3/4" up
- Quality Liquid level Gauges Comply with all requirements of ASME B16.34
- A rugged flat glass gauge for medium pressure applications

PRESSURE / TEMPERATURE RATINGS
(Flanged gauges take flanged rating when lower)

TRANSPARENT GLASS SIZE									
Deg.°F	1	2	3	4	5	6	7	8	9
100	2000	1875	1760	1625	1500	1375	1250	1125	1000
200	1825	1710	1595	1480	1370	1255	1140	1025	910
300	1775	1665	1555	1445	1335	1220	1110	995	885
400	1715	1610	1500	1395	1285	1180	1070	960	855
500	1620	1520	1415	1315	1215	1115	1010	910	810
600	1480	1385	1295	1200	1110	1015	925	830	735
SATURATED STEAM USING MICA									
600	600	600	600	550	500	450	400	350	

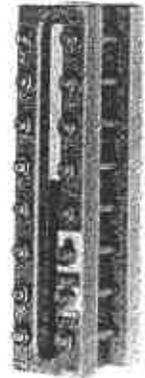
REFLEX GAUGE GLASS SIZE									
Deg.°F	1	2	3	4	5	6	7	8	9
100	3000	2875	2750	2625	2500	2375	2250	2125	2000
200	2735	2620	2505	2395	2280	2165	2050	1940	1825
300	2660	2550	2440	2325	2215	2105	1995	1885	1775
400	2565	2460	2355	2245	2140	2035	1925	1820	1715
500	2425	2325	2225	2120	2020	1920	1820	1720	1620
600	2215	2125	2030	1940	1845	1755	1660	1570	1480
SATURATED STEAM RATING 300 WSP									

% of Rating	100%	90%	50%
CHAMBER MATERIAL	CARBON STEEL, STAINLESS STEEL	MONEL	BRASS
GASKETING	SERIES 300 OR 300L BONDED COMPRESSED FIBERS OR TEFLON GLASS FILLED		PURE TEFLON KEL-F (SHIELDS)

TEST PRESSURE: All gauges are hydrostatically tested by Quality prior to shipment @ 1-1/2 times the design pressure rating at 100°F

SERIES Q 20

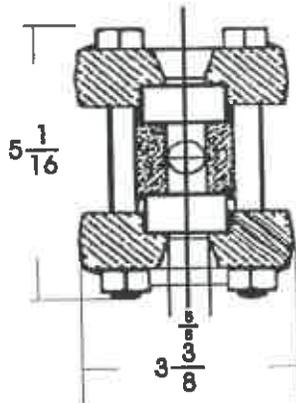
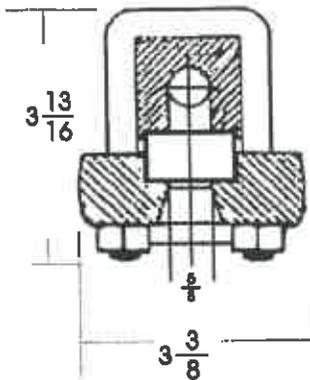
Pressures up to 3000psi@ 100°F
CRN ØC4222.52 / ØF4223.52



Q19-T-20



Q19-R-20



Series Q20 Gauge Specifications

Lengths

Series Q20 gauges are available in nine standard visible glass lengths. Multiples of the same size windows (up to nine sections) in a single place bar stock liquid chamber are used for longer lengths.

Connections

Standard Series Q20 Gauges are furnished with 1/2 or 3/4 inch NPT female end connections. Other connections available: 1/2 or 3/4 inch NPT female or male, side or back, flanged ends, side or back to suit mating connections.

Liquid Chambers

Machined from bar stock with recessed gasket seats.

Covers

All covers are manufactured to be interchangeable.

Bolt & Nuts

Alloy steel to ASTM Standards.

Glass

The tempered glass must be protected from corrosive substances such as caustic acid and hydrofluoric acid. Only transparent glass with mica or Kel-f shields must be used in these applications.

Gaskets

Precision die cut from the highest quality materials.

Protection

All carbon steel parts are coated both externally and internally with a high quality rust inhibitor. This coating serves as a superior bonding base for paint. It is recommended that all Q20 Gauges be installed with Quality Gauge Valves, having safety ball checks, which help provide protection against physical injury and loss of product should glass breakage occur.

Single Section Reflex Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q11-R-20	3 3/8	5 1/4	3 1/2	3 7/8	8
Q12-R-20	4 3/4	6 3/4	4 1/2	4 7/8	9
Q13-R-20	5 3/4	7 3/4	5 1/2	5 7/8	11
Q14-R-20	6 3/4	8 3/4	6 1/2	6 7/8	12
Q15-R-20	7 7/8	9 3/8	7 1/2	8	14
Q16-R-20	9 1/8	10 5/8	8 1/2	9 1/4	16
Q17-R-20	10 3/4	11 3/4	10	10 3/8	18
Q18-R-20	11 7/8	13 3/8	11 1/2	12	20
Q19-R-20	12 5/8	14 1/8	12 3/8	12 1/2	21

Single Section Transparent Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q11-T-20	3 3/4	5 1/4	3 1/2	3 7/8	8
Q12-T-20	4 3/4	6 1/4	4 1/2	4 7/8	14
Q13-T-20	5 3/4	7 1/4	5 1/2	5 7/8	17
Q14-T-20	6 3/4	8 1/4	6 1/2	6 7/8	19
Q16-T-20	7 7/8	9 3/8	7 1/2	8	23
Q16-T-20	9 1/8	10 5/8	8 1/2	9 1/4	24
Q17-T-20	10 3/4	11 3/4	10	10 3/8	27
Q18-T-20	11 7/8	13 3/8	11 1/2	12	30
Q19-T-20	12 5/8	14 1/8	12 3/8	12 1/2	32

Two Section Reflex Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q23-R-20	13	14 1/2	12 3/4	13 1/8	22
Q24-R-20	15	16 1/2	14 3/4	15 1/8	25
Q25-R-20	17 1/4	18 3/4	17	17 3/8	28
Q26-R-20	19 3/4	21 1/4	19 1/2	19 7/8	32
Q27-R-20	22	23 1/2	21 3/4	22 1/8	35
Q28-R-20	25 1/4	26 3/4	25	26 3/8	40
Q29-R-20	26 1/2	28 1/4	26 1/2	26 7/8	43

Two Section Transparent Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q23-T-20	13	14 1/2	12 3/4	13 1/8	33
Q24-T-20	15	16 1/2	14 3/4	15 1/8	38
Q25-T-20	17 3/4	18 3/4	17	17 3/8	43
Q26-T-20	19 3/4	21 1/4	19 1/2	19 7/8	49
Q27-T-20	22	23 1/2	21 3/4	22 1/8	54
Q28-T-20	26 1/4	26 3/4	25	26 3/8	61
Q29-T-20	26 1/2	28 1/4	26 1/2	26 7/8	64

Three Section Reflex Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q36-R-20	30 1/8	31 7/8	30 1/2	30 1/2	48
Q37-R-20	33 3/4	36 1/4	33 3/8	33 7/8	63
Q38-R-20	38 5/8	40 1/8	38 3/8	38 3/4	60
Q39-R-20	40 1/8	42 3/8	40 5/8	41	64

Three Section Transparent Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q36-T-20	30 3/8	31 7/8	30 1/2	30 1/2	73
Q37-T-20	33 3/4	36 1/4	33 3/8	33 7/8	80
Q38-T-20	38 5/8	40 1/8	38 3/8	38 3/4	92
Q39-T-20	40 7/8	42 3/8	40 5/8	41	97

Four Section Reflex Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q47-R-20	45 1/2	47	45 1/4	45 5/8	71
Q48-R-20	52	53 1/2	51 3/4	52 1/8	80
Q49-R-20	55	56 1/2	54 1/4	55 1/8	85

Four Section Transparent Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q47-T-20	45 1/2	47	45 1/4	45 5/8	107
Q48-T-20	52	53 1/2	51 3/4	52 1/8	122
Q49-T-20	55	56 1/2	54 1/4	55 1/8	129

Five Section Reflex Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q57-R-20	57 1/2	58 1/2	57	57 3/8	88
Q58-R-20	65 3/8	66 7/8	65 1/8	66 1/2	100
Q59-R-20	69 1/8	70 5/8	68 7/8	69 1/4	106

Five Section Transparent Gauges					
Model No.	Visible Glass Inch	Overall Length Inch.	Minimum Centres Side Connections 1/2 Inch 3/4 inch	Approx. Weight lb.	
Q57-T-20	57 1/2	58 1/2	57	57 3/8	134
Q58-T-20	65 3/8	66 7/8	65 1/8	66 1/2	162
Q59-T-20	69 1/8	70 5/8	68 7/8	69 1/4	161

Type D2 FloPro™ Control Valve

Contents

Introduction	1
Scope of Manual	1
Description	1
Specifications	1
Installation	3
Setting Valve Flow Rate	4
Changing Actuator Action from (Spring-to-Close) to (Spring-to-Open)	4
Maintenance	5
Valve Trim Maintenance	5
Packing and Valve Trim Maintenance	6
Parts Kits	13
Parts List	13



Figure 1. Type D2 FloPro Control Valve

Introduction

Scope of Manual

This instruction manual provides installation, maintenance, and parts information for the 1-inch Type D2 FloPro control valve and actuator.

No person may install, operate, or maintain a Type D2 FloPro control valve without first (1) being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance, and (2) carefully reading and understanding the contents of this manual. If you have any questions about these instructions, contact your Fisher sales office before proceeding.

Description

The Type D2 FloPro control valve (patents pending) (figures 1 and 2) is a compact, rugged valve

designed for on-off control of a variety of fluids at pressures up to 155 bar (2250 psig). This valve is ideal for use as a dump valve on gas separators and scrubbers. It is also well suited for other high pressure applications in natural gas production, compression, and processing. The Type D2 FloPro valve has threaded end connections and is available in a 1-inch globe style body.

Specifications

Table 1 lists specifications for the Type D2 FloPro control valve. Some of the specifications for a given control valve as it originally comes from the factory are stamped on a nameplate (figure 2) located on the upper diaphragm casing flange.



Table 1. Specifications

<p>Valve Assembly Pressure Class ASME B16.34 Class 900</p> <p>Maximum Inlet Pressure and Temperature⁽¹⁾ 155 bar from -46 to 93°C, and 150 bar at 149°C. (2250 psig from -50 to 200°F, and 2185 psig at 300°F)</p> <p>Maximum Pressure Drop 155 bar (2250 psig)</p> <p>Maximum Downstream Pressure Spring-to-Close: 82 bar (1200 psig) Spring-to-Open: 103 bar (1500 psig)</p> <p>Shutoff Classification ANSI Class IV ANSI/FCI 70-2 and IEC 60534-4</p> <p>Construction Materials Valve Body and Bonnet: ASME SA 352 LCC Stress relieved Valve Plug and Seat: (R0006) Alloy 6 Valve Stem: (S31600) 316 SST O-Rings: (HNBR) Hydrogenated Nitrile Packing: PTFE/Carbon PTFE Packing Springs: (N07718) Inconel 718 Stem Bushing: (Ryton) PPS Actuator Diaphragm: Nitrile/Polyester Actuator Springs: Zinc-plated steel</p> <p>Flow Characteristic FloPro Characterized</p> <p>Flow Direction Flow down</p>	<p>Port Diameter 13 mm (1/2 inch)</p> <p>Maximum Travel 13 mm (1/2 inch)</p> <p>Approximate Weight 7.7 kg (17 lb)</p> <p>Material Temperature Capabilities Valve Body Assembly: -46 to 149°C (-50 to 300°F) Actuator Assembly: -46 to 93°C (-50 to 200°F)</p> <p>Bonnet/Body Connection Threaded with leakoff bleed</p> <p>Actuator Configuration The D2 FloPro actuator is an on-off spring-and-diaphragm. Actuator action is Spring-to-Close from the factory. For Spring-to-Open actuator action, a Spring-to-Open Spring Kit (10C1998X012) must be used</p> <p>Maximum Actuator Casing Pressure 2.4 bar (35 psig)</p> <p>Minimum Required Actuator Casing Pressure 2.1 to 2.4 bar (30 to 35 psig)</p> <p>Actuator Diaphragm Effective Area 194 cm² (30 square inches)</p> <p>Actuator Pressure Connections 1/4 inch NPT female</p>
--	---

1. The pressure and temperature limitations in this manual, and any applicable code limitation, should not be exceeded.

Installation

WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for overpressure protection as required by accepted industry or local, state, and Federal codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user.

Fisher does not assume responsibility for the selection, use, or maintenance of any product. Responsibility for proper selection, use, and maintenance of any Fisher product remains solely with the purchaser and end-user.

1. Before installing the valve, inspect it to be certain that the valve body cavity is free of foreign material. Clean out all pipelines to remove scale, welding slag, and other foreign materials.

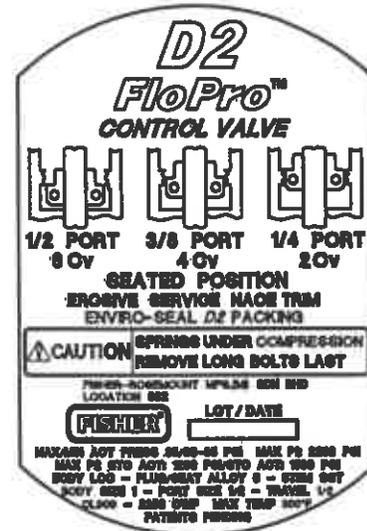


Figure 2. Nameplate

2. The control valve assembly may be installed in any orientation unless limited by seismic criteria. However, the normal method is with the actuator vertical above the valve body.

Flow through the valve body must be in the direction indicated by the arrow on the valve body.

3. Use accepted piping practices when installing the valve in the pipeline.
4. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the control valve assembly.

Note

The 1-inch Type D2 FloPro valve is equipped with ENVIRO-SEAL® D2 packing.

The actuator, as shipped from the factory, is spring-to-close. If spring-to-open action is required, see the *Changing Actuator Action* section in this manual.

Additionally, the actuator as shipped from the factory, has the FloPro flow adjuster set at a 3/8 inch port flow rate position. If some other flow rate is desired, see the *Setting Valve Flow Rate* section in this manual.

Setting Valve Flow Rate

Spring-to-Close Actuator Action

1. To change the valve flow rate, loosen the flow adjuster socket head cap screws (key 29), and reposition the flow adjuster halves (key 14 and 15) to the desired flow rate position. See figure 5 for flow rate settings.

Spring-to-Open Actuator Action

1. Attach a pressure line to the actuator. Supply pressure to the actuator to seat the plug in the seat ring.

2. To change the valve flow rate, loosen the flow adjuster socket head cap screws (key 29), and reposition the flow adjuster halves (key 14 and 15) to the desired flow rate position. See figure 5 for flow rate settings.

Changing Actuator Action from (Spring-to-Close) to (Spring-to-Open)

Note

The following procedure requires use of Spring Kit 10C1998X012.

1. Remove the six short actuator casing cap screws (key 22) first. Once these have been removed from the actuator assembly, carefully remove the two long actuator cap screws (key 30).

Note

Be aware as you loosen and remove the actuator cap screws that the actuator springs are under compression.

2. Remove the upper casing (key 21) and the springs (key 27).

3. Do not turn the valve stem (key 4) while removing the diaphragm hex nut (key 26). Use an appropriate tool on the machined flats located on the valve stem

above the flow adjuster for this procedure. Continue the actuator disassembly by removing the washer (key 24) diaphragm plate (key 25), diaphragm (key 19), and washer (key 24). Inspect the diaphragm for any wear or damage. Replace with a new one if necessary.

4. Unscrew the socket head cap screws (key 29), and remove the flow adjuster halves (key 14 and 15). Position the stem (key 4) to its most upward position.

5. Place the 3 springs (key 27) from the Spring Kit in their approximate, equally spaced, locations in the bottom casing (key 20). Place the washer (key 24) over the valve stem. Then install the diaphragm plate (key 25) and, using the diaphragm plate, correctly position the actuator springs.

6. Place the diaphragm (key 19) over the stem, along with washer (key 24). Position the diaphragm so the holes in the diaphragm align with the holes in the bottom casing.

7. Insert a 1/8 inch diameter drift punch, or other suitable device through the 5/32 diameter hole in the valve stem located below the bottom of the flow adjuster. Install hex nut (key 26) and tighten to 11 N•m (95 lbf•in). Remove the 1/8 inch drift punch or other holding device.

8. Attach the upper casing by first installing the two long cap screws (key 30) opposite one another. Begin tightening the two long screws evenly until the remaining six shorter cap screws (key 22) can be installed with their hex nuts. Continue tightening the actuator casing cap screws evenly using a cross-tightening procedure. Torque to 14 N•m (10 lbf•ft).

9. Connect a pressure line to the top actuator pressure connection, and apply pressure to the actuator. Stroke the actuator until the valve plug is seated on the seat ring. Install the flow adjuster, positioning it to the desired travel. Tighten the flow adjuster socket head cap screws to 3 N•m (26 lbf•in).

10. Release the actuator pressure, and install the vent plug (key 28) into the bottom casing pressure connection.

Maintenance

WARNING

Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.
- 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 parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing and trim maintenance, reversing the action, and replacing actuator parts.

All maintenance operations can be performed with the valve in the line.

Note

Whenever a gasket seal or O-ring is disturbed by removing or shifting gasketed parts, a new gasket should be installed upon reassembly. This is necessary to ensure a good gasket seal, since the used gasket or O-ring will not seal properly.

Valve Trim Maintenance

Note

The following maintenance procedures apply to both spring-to-close and spring-to-open actuator configurations, except for steps 2 and 8 as noted.

Key numbers are referenced in figures 7 and 8.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve.
2. For spring-to-close actuator action only, apply pressure to the actuator to fully stroke it open. This will raise the plug off its seat so that the valve stem serrations are visible inside the flow adjuster window (see figure 6). Loosen the socket head screws (key 29) and lower the flow adjuster (key 14 and 15) to its lowest position on the valve stem. Retighten the socket head screws (key 29) to 3 N•m (26 lbf•in). Relieve pressure to the actuator, shut off all pressure lines to the actuator, and disconnect. Use lockout procedures to be sure that the above measures stay in effect while you work on the equipment.

Note

The preceding step ensures that, during the removal of the bonnet and actuator, the valve plug (key 3) and seat ring (key 5) are not damaged.

3. Unscrew the bonnet from the valve body.

 **WARNING**

Avoid personal injury from sudden release of process pressure. If the process media starts to escape from the safety vent (see figure 5) located in the bonnet neck of the valve body,

STOP DISASSEMBLY IMMEDIATELY!

The escape of process media indicates that the valve has NOT been isolated from the process media, or process pressure is trapped in the valve body.

4. Once the bonnet has been removed from the valve body, inspect the seat ring (key 5) for wear or damage. If the seating surface has been damaged, remove it from the valve body. Also remove the seat ring gasket (key 6). Clean and inspect the valve body gasket surface for damage. Visually inspect the valve body interior below the seat ring for erosion. Replace the valve body if necessary.

To replace the seat ring, first install a new seat ring gasket. Install the new seat ring and tighten to 230 N•m (170 lbf•ft).

Cover the opening in the valve body to prevent foreign material from getting into the valve body cavity.

5. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.
6. If the valve plug requires replacement, use an appropriate tool on the machined flats located on the valve stem above the flow adjuster and unscrew the valve plug from the valve stem. Replace it with a new valve plug. Screw the valve plug into the valve stem, being careful not to damage the plug seat or plug contour. Tighten to 18 N•m (13 lbf•ft).
7. Lubricate a new O-ring (key 13) with Dow Corning 111 compound or equivalent and place it into the valve body as shown in figure 7 or 8. Ensure that no foreign material blocks the safety vent hole.

Screw the bonnet into the valve body, and torque to a range of 542.3 to 677.9 N•m (400 to 500 lbf•ft).

8. For spring-to-close actuator action only, attach the pressure line to the actuator, and supply pressure to the actuator. Move the flow adjuster to approximately midpoint on the valve stem serration. Release the pressure to the actuator. This allows the plug to find its seated position.

9. Set the flow adjuster to the desired travel position (see figure 5), and tighten the flow adjuster socket head cap screws to 3 N•m (26 lbf•in).

Packing and Valve Trim Maintenance

Note

The following maintenance procedures apply to both spring-to-close and spring-to-open actuator configurations, except for steps 2, 23, and 26 as noted.

Key numbers are referenced in figures 7 and 8.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve.
2. For spring-to-close actuator action only, apply pressure to the actuator to fully stroke it open. This will raise the plug off its seat so that the valve stem serrations are visible inside the flow adjuster window (see figure 6). Loosen the socket head screws (key 29) and lower the flow adjuster (key 14 and 15) to its lowest position on the valve stem. Retighten the socket head screws (key 29) to 3 N•m (26 lbf•in). Relieve pressure to the actuator, shut off all pressure lines to actuator, and disconnect. Use lockout procedures to be sure that the above measures stay in effect while you work on the equipment.

Note

The preceding step ensures that, during the removal of the bonnet and actuator, the valve plug (key 3) and seat ring (key 5) are not damaged.

3. Unscrew the bonnet from the valve body.

WARNING

Avoid personal injury from sudden release of process pressure. If the process media starts to escape from the safety vent (see figure 5) located in the bonnet neck of the valve body,

STOP DISASSEMBLY IMMEDIATELY!

The escape of process media indicates that the valve has NOT been isolated from the process media, or process pressure is trapped in the valve body.

4. Once the bonnet has been removed from the valve body, inspect the valve seat (key 5) for wear or damage. If the seating surface has been damaged, remove it from the valve body. Also remove the seat ring gasket (key 6). Clean and inspect the valve body gasket surface for damage. Visually inspect the valve body interior below the seat ring for erosion. Replace the valve body if necessary.

To replace the seat ring, first install a new seat ring gasket. Install the new seat ring and tighten to 230 N•m (170 lbf•ft).

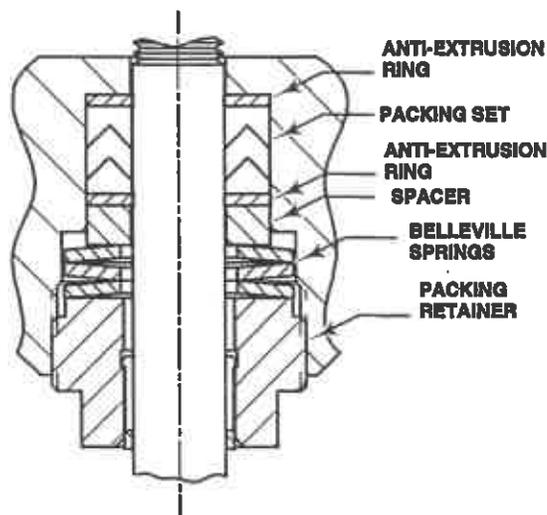
Cover the opening in the valve body to prevent foreign material from getting into the valve body cavity.

5. Remove the six short actuator casing cap screws (key 22) first. Once these have been removed from the actuator assembly, carefully remove the two long actuator cap screws (key 30).

Note

Be aware as you loosen and remove the actuator cap screws that the actuator springs are under compression.

6. Remove the upper casing (key 21) and the springs (key 27).
7. Do not turn the valve stem (key 4) while removing the diaphragm hex nut (key 26). Use an appropriate tool on the machined flats located on the valve stem above the flow adjuster for this procedure. Continue the actuator disassembly by removing the washer (key 24) diaphragm plate (key 25), diaphragm (key 19), and washer (key 24). Inspect the diaphragm for



80764

Figure 3. Packing and Belleville Spring Stacking Order

any wear or damage. Replace with a new one if necessary.

If you wish to inspect/replace the bonnet to actuator casing O-ring (key 16), mark the orientation of the actuator pressure connection to the bonnet for later reference (see figure 6). Unscrew the hex nut (key 18) from the bonnet. Remove the bottom casing (key 20).

8. Unscrew the flow adjuster socket head cap screws (key 29), and remove the flow adjuster halves.
9. Unscrew the packing retainer (key 7) from the bonnet (key 2). After the packing retainer has been unscrewed from the bonnet, pull the valve stem out of the bonnet.
10. Remove the three Belleville springs (key 9), packing spacer (key 10), packing (key 11), and two anti-extrusion rings (key 12) from the bonnet. See figure 3.
11. 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 Fisher sales office.
12. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.
13. If the valve plug requires replacement, use an appropriate tool on the machined flats located on the valve stem above the flow adjuster and unscrew the valve plug from the valve stem. Replace it with a new valve plug. Screw the valve plug into the valve

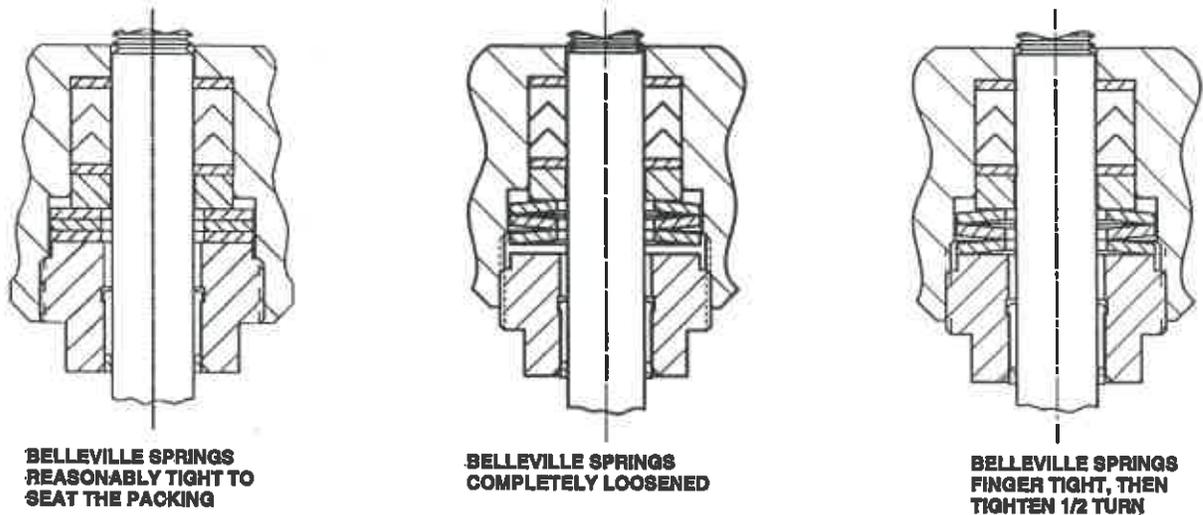


Figure 4. Belleville Spring Procedure

stem, being careful not to damage the plug seat or plug contour. Tighten to 18 N•m (13 lbf•ft).

14. Inspect the valve stem bushings (key 8) located in the lower end of the packing retainer and in the upper end of the bonnet. If damaged, remove and replace it with new bushings (key 8). Replace the valve stem bushing by inserting the bushing, flange end first, into the bore opposite the threaded end of the packing retainer or into the bore located at the top of the bonnet flow adjuster window. Insert until the flange snaps into the groove provided for it.

15. Remove the O-ring (key 17) from the upper end of the bonnet. Replace it with a new one, and lubricate it with Dow Corning 111 compound or equivalent.

16. Install new packing according to the packing arrangement shown in figure 3. Slide the valve stem through the packing retainer. Place the Belleville springs over the valve stem, positioned as shown in figure 3. Carefully slide the stem through the packing to a point where the serration extends completely into the flow adjuster window of the bonnet (see figure 6).

17. Apply a light film of Dow Corning 111 lubricant or equivalent (key 33) to the threads of the packing retainer (key 7).

18. Install the packing retainer into the bonnet and tighten until the Belleville springs (key 9) are reasonably tight to seat the packing. See figure 4.

19. Completely loosen the packing retainer to relieve all Belleville spring compression. See figure 4.

20. Retighten the packing retainer with your fingers until the packing retainer contacts the Belleville springs. See figure 4.

21. Tighten the packing retainer 1/2 turn clockwise. See figure 4.

22. If the bottom casing (key 20) has been removed, place O-ring (key 16) into the groove provided in the top of the bonnet. Place the bottom casing on the bonnet, oriented in the same position as marked in step 7 on page 7. Screw the hex nut (key 18) onto the bonnet, and tighten to 203 N•m (150 lbf•ft).

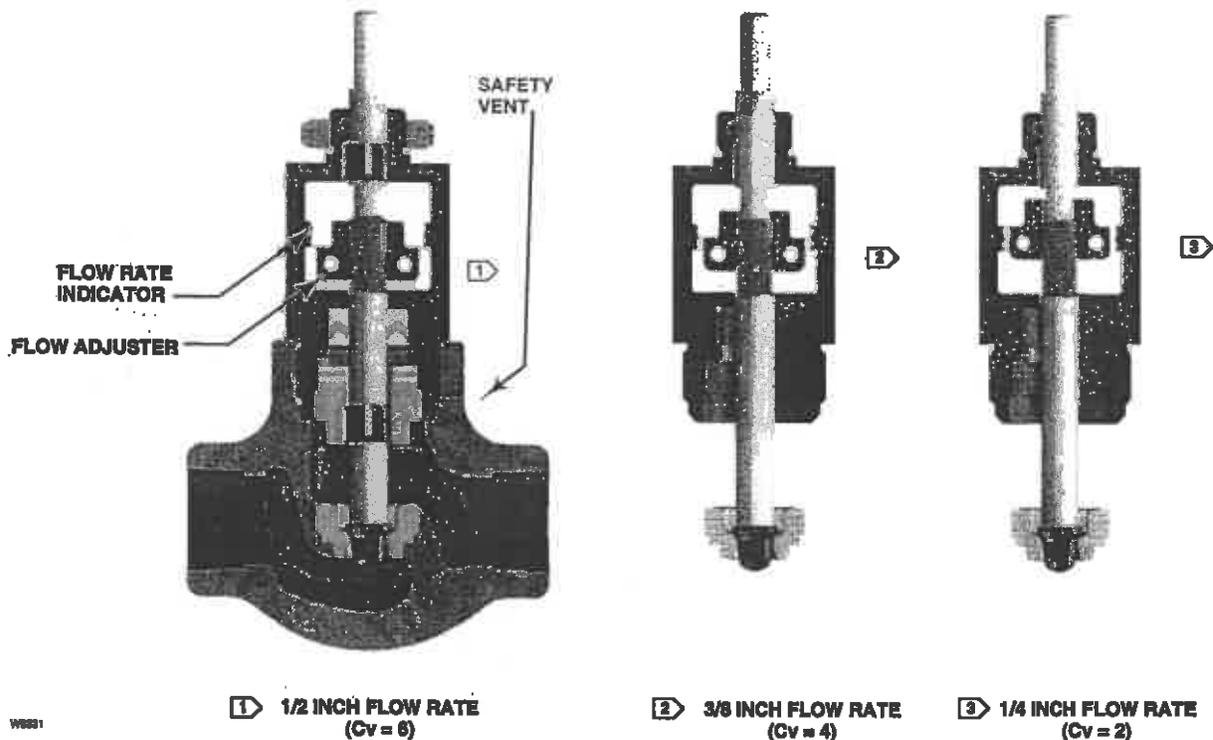


Figure 5. Flow Rate Adjustments

23. For spring-to-close actuator action only, assemble the actuator by first placing the washer (key 24) over the valve stem. Then place the diaphragm (key 19) over the valve stem, and position it so the holes in the diaphragm match the holes in the casing. Place the diaphragm plate (key 25) over the valve stem. Install the washer (key 24), diaphragm hex nut (key 26). Tighten the diaphragm hex nut to 11 N•m (95 lbf•in). Install the springs (key 27) and attach the upper casing (key 21) by first installing the two long cap screws (key 30) opposite one another.

24. Begin tightening the two long screws evenly until the remaining six shorter cap screws (key 22) can be installed with their hex nuts. Continue tightening the actuator casing cap screws evenly using a cross-tightening procedure. Torque to 14 N•m (10 lbf•ft).

25. Lubricate a new O-ring (key 13) with Dow Corning 111 compound or equivalent and place it into the valve body as shown in figure 7 or 8. Ensure that no foreign material blocks the safety vent hole. Screw the bonnet into the valve body, and torque to a range of 542 to 678 N•m (400 to 500 lbf•ft).

26. For spring-to-close actuator action only, attach the pressure line to the actuator, and supply pressure to the actuator. Move the flow adjuster to approximately midpoint on the valve stem serration. Release the pressure to the actuator. This allows the plug to find its seated position.

27. Set the flow adjuster to the desired travel position (see figure 5), and tighten the flow adjuster socket head cap screws to 3 N•m (26 lbf•in).

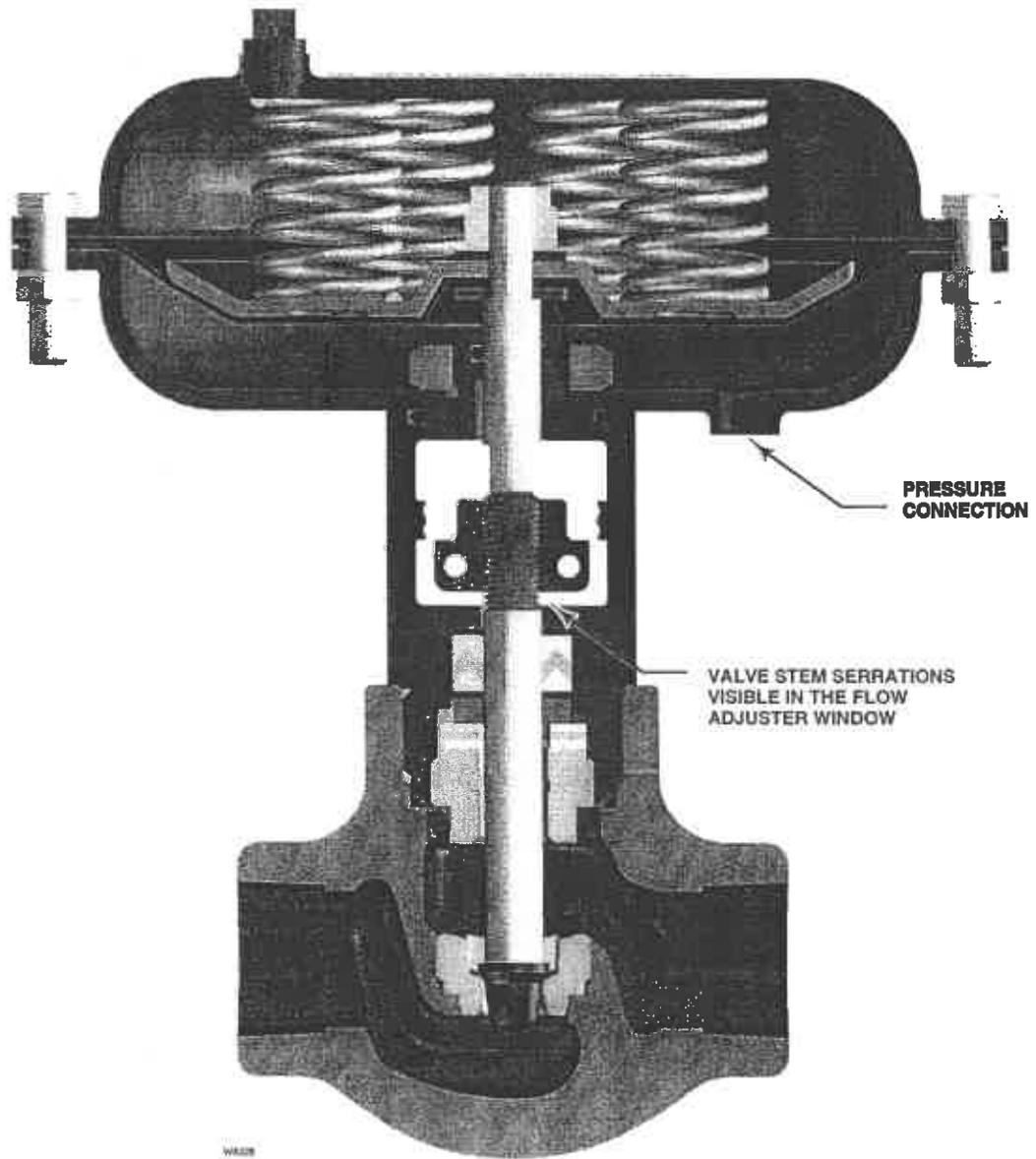
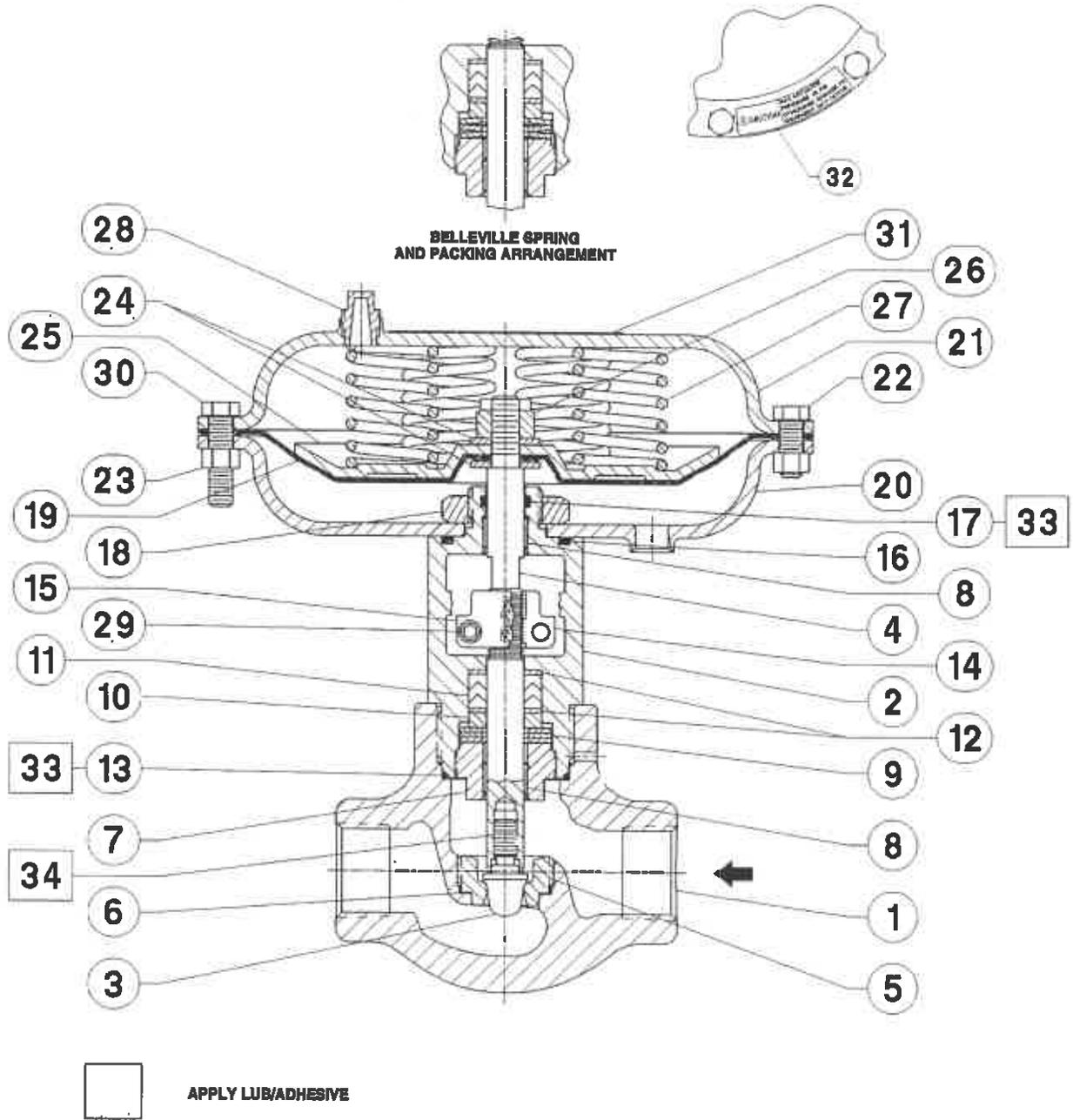
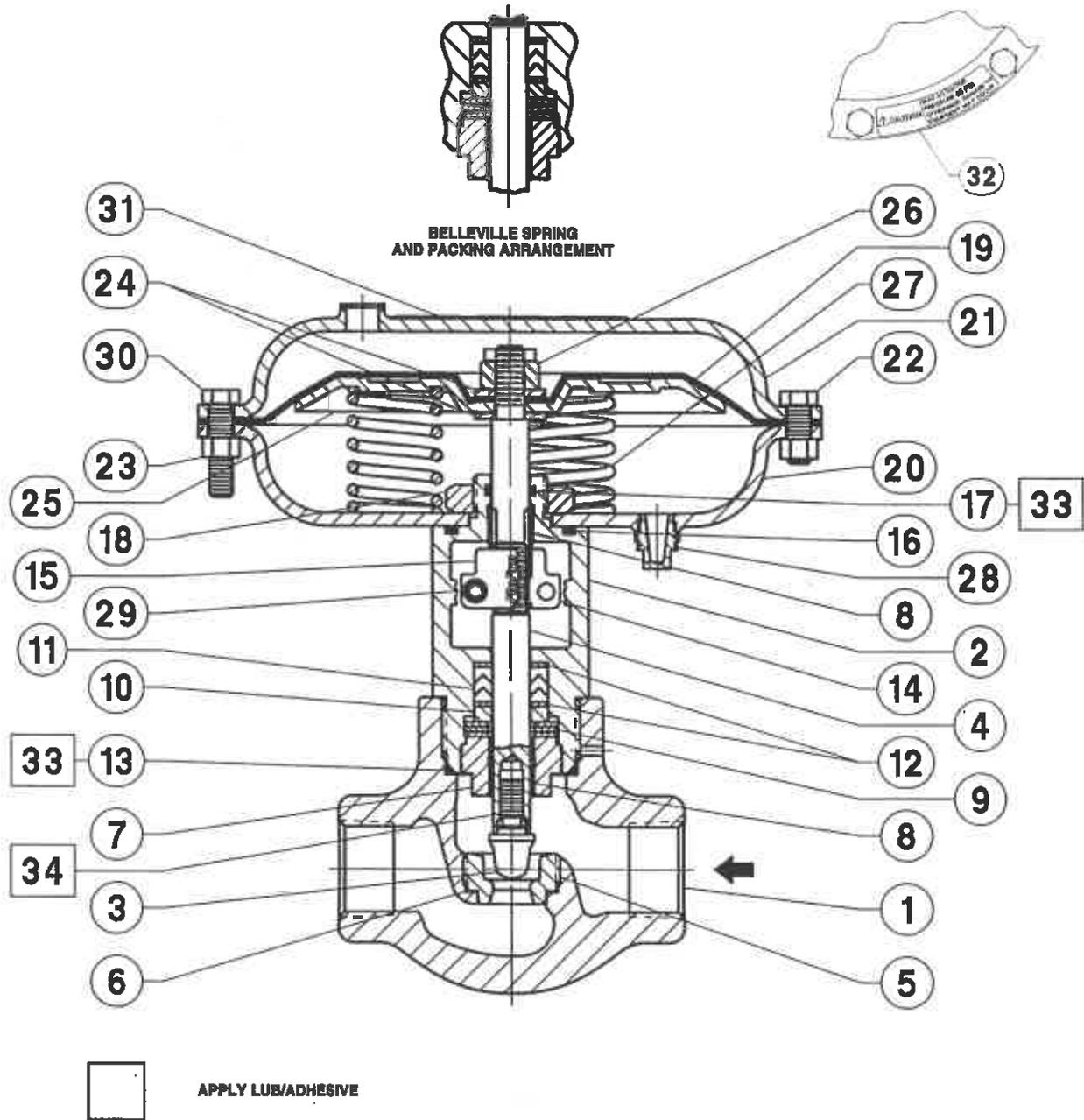


Figure 6. Type D2 FloPro Interior Detail



8805885-C

Figure 7. Type D2 FloPro Assembly—Spring-to-Close



2000-000-1

Figure 8. Type D2 FloPro Assembly—Spring-to-Open

Parts Ordering

Components that are not manufactured by Fisher should not, under any circumstances, be used in any Fisher valve. The use of parts not manufactured by Fisher may adversely affect the performance of the valve as well as worker and workplace safety.

Note

Fisher does not assume responsibility for the selection, use, or maintenance of any product. Responsibility for proper selection, use, and maintenance of any Fisher product remains solely with the purchaser and end-user.

Parts Kits

Description	Part Number
* Valve Trim Kit Includes key numbers 3, 5, 6, and 13	19B8485X012
* Valve Packing Kit Includes key numbers 8 (2 req'd), 11, 12 (2 req'd), 13, 16, and 17	19B8486X012
* Spring-to-Open Spring Kit Includes key number 27 (3 springs)	10C1998X012

Parts List

Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Fisher sales office.

Key	Description	Part Number
1	Valve Body	
2	Bonnet	
3	Valve Plug	
4*	Valve Stem	39B5914X012
5	Seat Ring	
6	Seat Ring Gasket	
7	Packing Retainer	
8	Valve Stem Bushing (2 req'd)	
9	Belleville Springs (3 req'd)	
10	Packing Spacer	
11	ENVIRO-SEAL B2 Packing Set	
12	Anti-Extrusion Ring (2 req'd)	
13	Valve Body O-ring	
14	Flow Adjuster Half	
15	Flow Adjuster Half	
16	Casing O-ring	
17	Valve Stem O-ring	
18	Hex Nut	
19*	Diaphragm	39B3848X012
20	Bottom Casing	
21	Upper Casing	
22	Short Actuator Casing Cap Screws (6 req'd)	
23	Nut	
24	Washer (2 req'd)	
25	Diaphragm Plate	
26	Diaphragm Hex Nut	
27	Springs Spring-to-Close (6 springs) Spring-to-Open (Spring Kit, 3 springs included)	
28	Vent Plug	
29	Flow Adjuster Socket Head Cap Screws (2 req'd)	
30	Long Actuator Casing Cap Screws (2 req'd)	
31	Nameplate	
32	Caution Label	
33	Lubricant, Dow Corning 111 Compound or equivalent	

*Recommended spare parts

ENVIRO-SEAL, FloPro, and Fisher are marks owned by Fisher Controls International, Inc., a business of Emerson Process Management. The Emerson logo is a trademark and service mark of Emerson Electric Co. All other marks are the property of their respective owners. This product may be covered by one or more of the following patents: 5,129,625; 5,131,666; 5,056,757; 5,230,498; and 5,299,812 or under pending patents

The contents of this publication are presented for informational purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. We reserve the right to modify or improve the designs or specifications of such products at any time without notice.

Fisher does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Fisher product remains solely with the purchaser and end-user.

Emerson Process Management

Fisher

Marshalltown, Iowa 50158 USA
Cernay 68700 France
Sao Paulo 05424 Brazil
Singapore 128461

www.Fisher.com

627 Series Pressure Reducing Regulators

Introduction

Scope of Manual

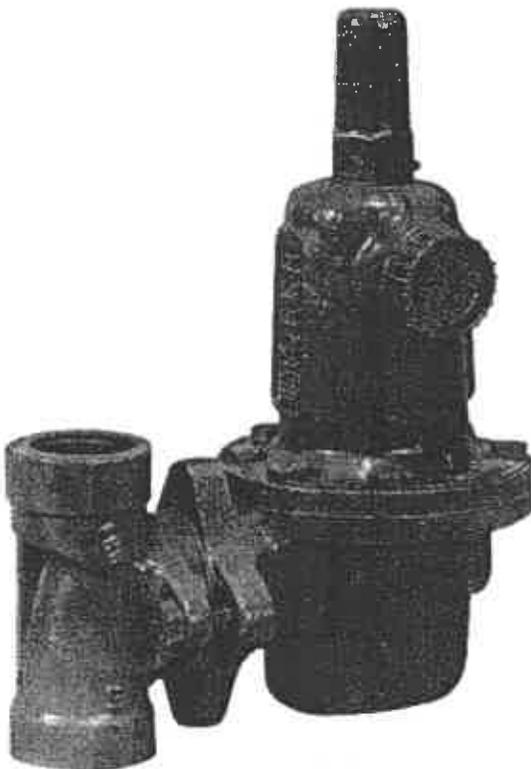
This manual provides instructions for the installation, adjustment, maintenance, and parts ordering for the 627 Series regulators. These regulators usually are shipped separate for line installation, although sometimes they are shipped installed on other equipment. Refer to the instruction manual for the other equipment for installation and operating instructions.

Description

The 627 Series self-operated pressure reducing regulators (figure 1) are for high and low pressure systems. These regulators can be used with natural gas, air, or a variety of other gases. Performance characteristics vary according to construction (see the AVAILABLE CONFIGURATIONS specification in table 1).

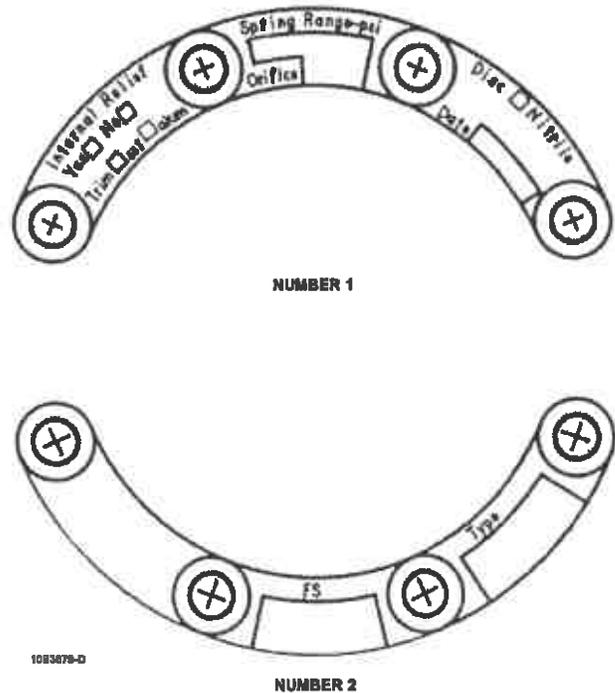
Specifications

Table 1 gives some general specifications for the 627 Series regulators. The nameplates (figure 2) gives detailed information for a particular regulator as it comes from the factory.



101728

Figure 1. Typical 627 Series Self-Operated Pressure Reducing Regulator



1013678-D

Figure 2. Nameplates



627 Series

Table 1. Specifications

Available Constructions

Type 627: Self-operated pressure reducing regulator equipped with a pitot tube for greater regulated capacities (figure 7)

Type 627R: Type 627 with internal relief and with an open throat (figure 8)

Type 627M: Type 627 with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4-inch NPT downstream control line connection (figure 9)

Type 627MR: Type 627M with internal relief (figure 10)

Type 627H: Type 627 with a diaphragm limiter to deliver a higher outlet pressure (figure 11)

Type 627HM: Type 627H with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through two 1/4-inch NPT downstream control line connections (figure 12)

Body Sizes

3/4, 1, or 2-inch

End Connection Styles

3/4, 1, or 2-inch body sizes: NPT

1 or 2-inch body sizes: ANSI Class 300 or 600 RF flanged

Maximum Inlet Pressure⁽¹⁾ (Body Rating)

2000 psig (138 bar) for NPT steel, 1480 psig (102 bar) for RF flanged steel, or 1000 psig (69 bar) for ductile iron

Maximum Valve Disk Inlet Pressure Rating⁽¹⁾

2000 psig (138 bar) for nylon disk or 1000 psig (69 bar) for nitrile disk

Maximum Operating Inlet Pressure, Pressure Differential, and Outlet Pressure Ranges⁽¹⁾

See table 2 for pressures by port and spring range

Maximum Spring and Diaphragm Casing Pressure⁽¹⁾

See table 3

Maximum Body Outlet Pressure⁽¹⁾ (Type 627M, 627MR, and 627HM Only)

2000 psig (138 bar) for screwed steel, 1480 psig (102 bar) for RF flanged steel, or 1000 psig (69 bar) for ductile iron. (Type 627 and 627R are limited by maximum diaphragm casing pressure)

Port Diameters

See table 2

Internal Relief Performance

Type 627R: See table 4

Type 627MR: Limited by field-installed control line piping

Temperature Capabilities⁽¹⁾

-20 to 180°F (-29 to 82°C)

Pressure Registration

Type 627, 627H or 627R: Internal

Type 627M, 627HM or 627MR: External through 1/4-inch NPT control line connection in the diaphragm casing

De-icer System

See figure 3 and Type 627M Regulator De-icer System Application section

Relief Indicator

For 627R and 627MR (see figures 8 and 9)

Spring Case Vent Connection

3/4-inch NPT female with removable screened vent assembly

Control Line Connection (Type 627M, 627HM or 627MR Only)

1/4-inch NPT female

Approximate Weight

Ductile Iron or Steel Casings: 10 pounds (4,5 kg)

Aluminum Casings: 6.3 pounds (2.8 kg)

1. The pressure/temperature limits in this instruction manual or any applicable standard limitation should not be exceeded.

Table 2. Maximum Inlet Pressures, Differential Pressures, and Outlet Pressure Ranges

TYPE NUMBER	OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	ORIFICE SIZE, INCHES (mm)	MAXIMUM INLET PRESSURE, PSIG (bar)	MAXIMUM DIFFERENTIAL PRESSURE, PSID (bar)
627 and 627M ⁽³⁾	5(2) to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/16 (4,8)	750 (51,7)	750 (51,7)
		1/4 (6,4)	500 (34,5)	500 (34,5)
		3/8 (9,5)	300 (20,7)	300 (20,7)
	15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1500 (103) ⁽¹⁾	1500 (103) ⁽¹⁾
		3/16 (4,8)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		1/4 (6,4)	750 (51,7)	750 (51,7)
		3/8 (9,5)	500 (34,5)	500 (34,5)
	35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
3/16 (4,8)		1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾	
1/4 (6,4)		1500 (103) ⁽¹⁾	1500 (103) ⁽¹⁾	
3/8 (9,5)		1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾	
70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾	
	1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾	
	3/16 (4,8)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾	
	1/4 (6,4)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾	
	3/8 (9,5)	1250 (86,2) ⁽¹⁾	1250 (86,2) ⁽¹⁾	
627R and 627MR	5(2) to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/16 (4,8)	750 (51,7)	750 (51,7)
		1/4 (6,4)	500 (34,5)	500 (34,5)
		3/8 (9,5)	300 (20,7)	300 (20,7)
	15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1500 (103) ⁽¹⁾	1500 (103) ⁽¹⁾
		3/16 (4,8)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		1/4 (6,4)	750 (51,7)	750 (51,7)
		3/8 (9,5)	300 (20,7)	300 (20,7)
	35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾
		3/16 (4,8)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		1/4 (6,4)	750 (51,7)	750 (51,7)
		3/8 (9,5)	300 (20,7)	300 (20,7)
	70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/16 (4,8)	500 (34,5)	500 (34,5)
		1/4 (6,4)	300 (20,7)	300 (20,7)
		3/8 (9,5)	200 (13,8)	200 (13,8)
627H and 627MH ⁽³⁾	140 to 250 psig (9,7 to 17,2 bar) 10B3078X012 Blue	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		3/16 (4,8)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾
		1/4 (6,4)	1500 (103) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/8 (9,5)	1000 (69) ⁽¹⁾	500 (34,5)
	240 to 500 psig (16,5 to 34,5 bar) 10B3079X012 Red	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		3/16 (4,8)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾
		1/4 (6,4)	1500 (103) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/8 (9,5)	1000 (69) ⁽¹⁾	500 (34,5)

1. For inlet pressure in excess of 1000 psig (69 bar), refer to the maximum body and disk pressure ratings in the specification table.
2. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.
3. The unbalance forces change from the wide-open monitor mode to an active regulator mode such that the Type 627M or 627MH should have a 3/8-inch (9,5 mm) or larger orifice when used as a wide-open monitor.

627 Series

Table 3. Maximum Spring and Diaphragm Casing Pressure(1)

MAXIMUM PRESSURE DESCRIPTION	SPRING AND DIAPHRAGM CASING STYLE	TYPE 627, PSIG (bar)	TYPE 627R, PSIG (bar)	TYPE 627M, PSIG (bar)	TYPE 627MR, PSIG (bar)	TYPE 627H AND 627HM, PSIG (bar)
Maximum pressure to spring and diaphragm casings to prevent leak to atmosphere other than relief action (internal parts damage may occur)	Die cast aluminum	250 (17,2)	250 (17,2)	Not Available	Not Available	Not Available
	Die cast aluminum	250 (17,2)	250 (17,2)	250 (17,2)	Not Available	Not Available
	Steel	250 (17,2)	250 (17,2)	250 (17,2)	250 (17,2)	800 (55,2)
Maximum pressure to spring and diaphragm casings to prevent burst of casings during abnormal operation (leak to atmosphere and internal parts damage may occur)	Die cast aluminum	375 (25,9)	375 (25,9)	Not Available	Not Available	Not Available
	Ductile Iron	465 (32)	465 (32)	465 (32)	465 (32)	Not Available
	Steel	1500 (103)	1500 (103)	1500 (103)	1500 (103)	1500 (103)
Maximum diaphragm casing overpressure (above setpoint) to prevent damage to internal parts	All styles	60 (4,1)	120 (8,3)	60 (4,1)	120 (8,3)	120 (8,3)

1. If the spring case is pressurized, a metal adjusting screw cap is required. Contact your Fisher Sales Representative.

WARNING

Personal Injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is over-pressured or is installed where service conditions could exceed the limits given in tables 1, 2, 3, and 4, or where conditions exceed any ratings of the adjacent piping or piping connections.

To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits. The Type 627R or 627MR regulator with internal relief will provide downstream overpressure protection within the limits given in tables 1, 2, 3 and 4. If these limits are exceeded additional downstream overpressure protection must be provided by the user.

Additionally, physical damage to the regulator could cause personal injury or property damage due to escaping gas. To avoid such injury or damage, install the regulator in a safe location.

Installation

Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. A regulator should be inspected for damage periodically and after any overpressure condition. Key numbers referenced in this section are shown in figures 7 through 12. Ensure that the operating temperature capabilities listed in table 1 are not exceeded.

Like most regulators, 627 Series regulators have outlet pressure ratings that are lower than their inlet pressure ratings. A pressure relieving or pressure limiting device must be provided by the user for the Type 627, 627H, 627M, and 627HM regulators if the inlet pressure can exceed the outlet pressure rating, since these regulators do not have internal relief.

Type 627R regulators provide internal relief which limits the total outlet pressure buildup over setpoint. Use table 4 to determine the total outlet pressure. This internal relief may be adequate for the application, if not, provide additional pressure relief or a pressure limiting device downstream.

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate instruction manual.

Perform steps 1 through 6 for all types of regulators:

1. Only personnel qualified through training and experience should install, operate, or maintain this regulator.
2. For a regulator that is shipped separately, make sure that there is no damage to, or foreign material in, the regulator.
3. Ensure that all tubing and piping have been blown free of foreign debris.
4. The regulator may be installed in any position as long as the flow through the body is in the direction indicated by the arrow cast on the body.
5. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the regulator.

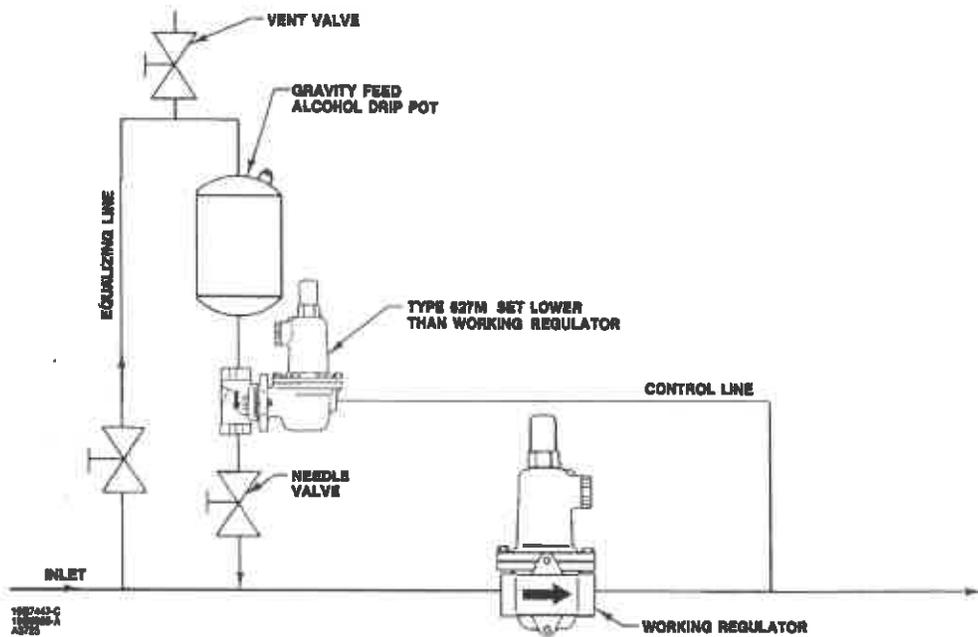


Figure 3. Schematic of De-Icer System

WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

6. Position the body (key 1) and/or diaphragm spring case (key 29) so it will not collect moisture or debris into the screened vent. If the regulator requires repositioning, refer to the body area maintenance procedures and/or the diaphragm case area maintenance procedures in the Maintenance section to reposition the screened vent for the application.

Perform steps 7 through 9 for Types 627M, 627HM, and 627MR regulators only:

7. A Type 627M, 627HM, or 627MR regulator requires a downstream control line. Install the control line before putting the regulator into operation.

8. Ensure that the downstream control line piping is at least 3/8-inch or larger outside diameter tubing and

connected to a straight section of outlet piping 10 diameters downstream of the regulator.

9. A hand valve should be installed in the control line. This hand valve can be used to throttle down and dampen outlet pulsations in control pressure which may cause instability or cycling of the regulator.

Remote Vent Line Installation

All 627 series regulators have a vent assembly installed in the 3/4-inch NPT spring case vent opening. The vent assembly can be removed to install a remote vent line if necessary. Remote vent lines must have the largest practical diameter. The vent line should be as short as possible with a minimum number of bends or elbows.

Protect the remote vent opening against entrance of rain, snow, or any other foreign material that may plug the vent or vent line and prevent proper operation of the regulator. Periodically check the vent opening to be sure it is not plugged with foreign debris.

Type 627M or 627HM Regulator De-Icer System Application

For the Type 627M or 627HM regulator de-icer system, refer to the application shown in figure 3. With a large pressure drop across the working regulator, ice can

627 Series

Table 4. Type 627R Internal Relief Performance⁽¹⁾

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	OUTLET PRESSURE SETTING, PSIG (bar)	MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE, PSIG (bar)	MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED, PSIG (bar) ⁽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 (12,7)
5 ⁽³⁾ to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	10 (0,69)	60 (4,1)	1250 (86,2)	740 (51,1)	320 (22,1)	190 (13,1)	95 (6,56)	75 (5,18)
		100 (6,9)	2000 (138)	1500 (103)	620 (42,7)	390 (26,9)	180 (12,4)	130 (8,97)
		125 (8,6)	2000 (138)	1900 (131)	830 (57,2)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1160 (79,8)	520 (36,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1360 (94,8)	770 (53,1)	380 (26,3)	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)	810 (56,2)	370 (25,5)	170 (11,7)	130 (8,97)
		125 (8,6)	2000 (138)	1900 (131)	970 (66,9)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1160 (79,8)	570 (39,8)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (90,8)	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 (5,52)	65 (4,49)	
	100 (6,9)	2000 (138)	1300 (89,6)	600 (41,4)	360 (24,8)	170 (11,7)	120 (8,28)	
	125 (8,6)	2000 (138)	1800 (124)	750 (51,8)	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 (90,8)	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 (8,97)	80 (5,5)	65 (4,49)
		100 (6,9)	2000 (138)	1300 (89,6)	590 (40,7)	350 (24,1)	170 (11,7)	120 (8,28)
		125 (8,6)	2000 (138)	1800 (124)	800 (55,2)	470 (32,4)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	640 (44,1)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	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)	630 (43,4)	200 (13,8)	150 (10,3)	100 (6,9)	70 (4,83)	65 (4,49)
		100 (6,9)	2000 (138)	1200 (82,7)	550 (37,9)	330 (22,8)	160 (11,0)	120 (8,28)
		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)	450 (31,7)	320 (22,1)	
	30 (2,1)	100 (6,9)	2000 (138)	950 (65,5)	450 (31,1)	260 (17,9)	140 (9,66)	110 (7,59)
		125 (8,6)	2000 (138)	1500 (103)	670 (46,2)	400 (27,6)	190 (13,1)	150 (10,3)
		175 (12,1)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	300 (20,7)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	760 (52,4)	360 (24,8)	260 (17,9)
250 (17,2)		2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)	
40 (2,8)	100 (6,9)	1500 (103)	700 (48,3)	330 (22,8)	200 (13,8)	120 (8,28)	108 (7,45)	
	125 (8,6)	2000 (138)	1300 (89,6)	560 (38,6)	340 (23,4)	180 (12,4)	140 (9,66)	
	175 (12,1)	2000 (138)	1800 (124)	1000 (69,0)	550 (37,9)	290 (20,0)	220 (15,2)	
	200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	730 (50,3)	360 (24,1)	260 (17,2)	
	250 (17,2)	2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)	

form with in this regulator. The formation of ice decreases the size of the port opening, so the regulator is unable to supply enough flow to satisfy the downstream demand. When the downstream pressure falls below the outlet pressure setting of the Type 627M or 627HM regulator, the disk assembly of the Type 627Mor 627HMregulator moves off its seat ring, permitting alcohol to flow into the main gas line. The alcohol carried to the main regulator by the flow stream prevents additional ice from forming on the seat ring. When normal flow resumes, and as pressure in the downstream system is restored, the Type 627M or 627HM regulator shuts off.

Startup and Adjustment

Startup



WARNING

To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during startup, release downstream pressure to prevent an overpressure condition on the diaphragm of the regulator.

Table 4. Type 627R Internal Relief Performance⁽¹⁾ (continued)

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	OUTLET PRESSURE SETTING, PSIG (bar)	MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE, PSIG (bar)	MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED, PSIG (bar) ⁽²⁾					
			Orifice Size, Inches (mm)					
			3/32 (2,4)	1/8 (3,2)	3/16 (4,8)	1/4 (6,4)	5/8 (9,5)	1/2 (12,7)
35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	40 (2,8)	125 (8,6)	2000 (138)	1100 (75,8)	500 (34,5)	300 (20,7)	170 (11,7)	140 (9,66)
		150 (10,3)	2000 (138)	1800 (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)
	50 (3,4)	125 (8,6)	1400 (96,5)	820 (56,5)	400 (27,6)	230 (15,9)	150 (10,3)	140 (9,66)
		150 (10,3)	2000 (138)	1400 (96,5)	650 (44,8)	370 (25,5)	210 (14,5)	170 (11,7)
		175 (12,1)	2000 (138)	1900 (131)	700 (48,3)	530 (36,5)	270 (18,6)	210 (14,5)
		200 (13,8)	2000 (138)	2000 (138)	1100 (75,8)	670 (48,2)	360 (22,8)	240 (16,5)
	60 (4,1)	125 (8,6)	900 (62,1)	450 (31,1)	270 (18,6)	190 (13,1)	140 (9,66)	130 (8,97)
		150 (10,3)	1700 (117)	1100 (75,8)	540 (37,2)	300 (20,7)	190 (13,1)	160 (11,0)
		175 (12,1)	2000 (138)	1700 (117)	780 (53,8)	470 (32,4)	250 (17,2)	200 (13,8)
		200 (13,8)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	310 (21,4)	230 (15,9)
	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)	300 (19,3)	230 (15,9)
		250 (17,2)	2000 (138)	2000 (138)	1300 (89,6)	830 (57,2)	460 (27,6)	310 (21,4)
	80 (5,5)	150 (10,3)	800 (55,2)	500 (34,5)	300 (20,7)	200 (13,8)	160 (11,0)	150 (10,3)
		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)
70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	70 (4,8)	175 (12,1)	1900 (131)	800 (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)
		250 (17,2)	2000 (138)	2000 (138)	1100 (75,8)	680 (46,9)	360 (24,8)	290 (20,0)
	80 (5,5)	175 (12,1)	1400 (96,5)	250 (17,2)	240 (16,5)	200 (13,8)	180 (13,1)	175 (12,1)
		200 (13,8)	2000 (138)	960 (66,2)	520 (36,9)	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)
		250 (17,2)	2000 (138)	1800 (110)	770 (53,1)	520 (36,9)	320 (22,1)	270 (18,6)
	125 (8,8)	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)
		250 (17,2)	1200 (82,7)	260 (17,9)	260 (17,9)	260 (17,9)	260 (17,9)	260 (17,9)

1. The internal relief performance values are obtained by removing the disk assembly.
 2. For inlet pressures in excess of 1000 psig (69 bar), refer to the maximum body and disk pressure ratings in the specifications table.
 3. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.
 Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 6 gives the maximum inlet pressure for normal regulator operation.

In order to avoid an overpressure condition and possible equipment damage, pressure gauges should always be used to monitor pressures during startup.

1. Slowly open the upstream shutoff valve.
2. Slowly open the downstream shutoff valve.
3. Check all connections for leaks.
4. Make final control spring adjustments according to the adjustment procedures.

Adjustment

The range of allowable pressure settings is marked on the nameplate (figure 2). If a pressure setting beyond this range is necessary, substitute the appropriate regulator control spring. Change the nameplate to indicate the new pressure range.

Before increasing the setting, refer to tables 2, 3, or 4. Review the pressure limits for the control spring range being used and be certain that the new pressure setting will not result in an overpressure condition.

627 Series

Table 5. Maximum Torque Values

KEY NUMBER ⁽¹⁾	DESCRIPTION	MAXIMUM TORQUE, FOOT-POUNDS (N•m)
2	Seat ring	25 (34)
3	Cap screw (w/ aluminum diaphragm casing)	18 (22)
	Cap screw (w/ ductile iron or steel diaphragm casing)	25 (34)
18	Lever cap screw	7 (9)
22	Diaphragm connector nut	17 (23)
26	Guide retainer (for Type 627R and 627MR only)	3 (4)
37	Spring case cap screw (w/ aluminum or ductile iron diaphragm casing)	7 (9)
	Spring case cap screw (w/ steel diaphragm casing)	35 (47)
46	Diaphragm cap screw (w/Type 627 or 627M)	7 (9)
	Diaphragm cap screw (w/Type 627H or 627MH)	14 (19)

1. Refer to figures 7 through 10 for key number locations.

Note

Always use a pressure gauge to monitor pressure when making adjustments.

Refer to figures 7 through 12 for key number locations.

1. Remove the adjusting screw cap (key 36).
2. Loosen the locknut (key 34).
3. Increase the outlet pressure setting by turning the adjusting screw (key 35) clockwise. Decrease the outlet pressure setting by turning the adjusting screw counter-clockwise.
4. When the desired pressure is obtained, hold the adjusting screw (key 35) in place and tighten the locknut (key 34).

Shutdown



WARNING

To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during shutdown, release downstream pressure to prevent an overpressure condition on the diaphragm of the regulator.

1. Close the nearest upstream shutoff valve.
2. Close the nearest downstream shutoff valve.

3. Open the vent valve between the regulator and the downstream shutoff valve nearest to it.

4. For a Type 627, 627H, or 627R regulator, the regulator will open to release pressure between the upstream shutoff valve and the regulator.

5. A Type 627M, 627HM, or 627MR regulator requires venting the control line and downstream pressure from the regulator before maintenance. The pressure between these shutoff valves is released through the open regulator because the disk assembly remains open in response to the decrease in control line pressure.

Maintenance

Unless otherwise specified, the following maintenance procedures apply to all types of regulators. For a summary of maximum torque values required for all types of regulators, refer to table 5.

Due to normal wear, damage from external sources, or debris in the air or gas line, regulator parts such as the disk assembly, seat ring, and diaphragm must be inspected periodically and replaced as necessary to ensure correct performance. The frequency of inspection and replacement depends upon the severity of conditions and the requirements of state and federal laws. Normal wear of the seat ring and disk assembly is accelerated with high pressure drops and with large amounts of impurities in the flow stream. Instructions are given below for replacing the disk assembly, seat ring, diaphragm, and O-rings. These procedures may also be used for disassembly required for inspection and replacement of other parts.

Problem Indication for Type 627R and 627MR Regulators



WARNING

Isolate the regulator from all pressure to avoid personal injury and equipment damage due to explosion or sudden release of process pressure. Cautiously release pressure from the regulator before attempting disassembly.

The vent assembly is equipped with a relief indicator (key 49, figure 4). The cap for the relief indicator snaps over the vent assembly opening. If the relief valve opens wide, exhaust gas pops the cap off the screen vent assembly opening indicating a problem with the regulator. If the cap pops off, refer to the shutdown and to the body area maintenance procedures to inspect the disk assembly and seat ring.

If the disk assembly and seat ring are not damaged, refer to the diaphragm and spring case area maintenance procedures in this section.

The disk assembly and seat ring can be inspected, removed, and replaced without removing the regulator body from the line connections. Refer to the body area maintenance procedures.

Body Area Maintenance Procedures

These procedures are for gaining access to the disk assembly, seat ring, diaphragm casing O-ring and stem assembly. All pressure must be released from the diaphragm casing before the performing these steps.

While using the following procedures, refer to figures 7 through 12 for key number locations.

Replacing the Disk Assembly or Seat Ring

1. To inspect and replace the disk assembly (key 9) or seat ring (key 2), remove the cap screws (key 3, figure 5), and separate the diaphragm casing (key 5) from the body (key 1).
2. Inspect and, if necessary, remove the seat ring (key 2). If removed, coat the threads of the replacement seat ring with lubricant (key 38) and torque to 25 foot-pounds (34 N·m).
3. Inspect the disk assembly and, if necessary, remove the hair pin clip (key 13) that holds the disk assembly (key 9) in place. If replacing the disk assembly is the only maintenance required, skip to step 16.



Figure 4. Relief Indicator

Replacing the Stem Assembly

If it is necessary to perform maintenance on the stem assembly, continue with steps 4 through 8 and 15 through 19 for Type 627, 627H, and 627R regulators, or steps 9 through 19 for Type 627M, 627HM, and 627MR regulators.

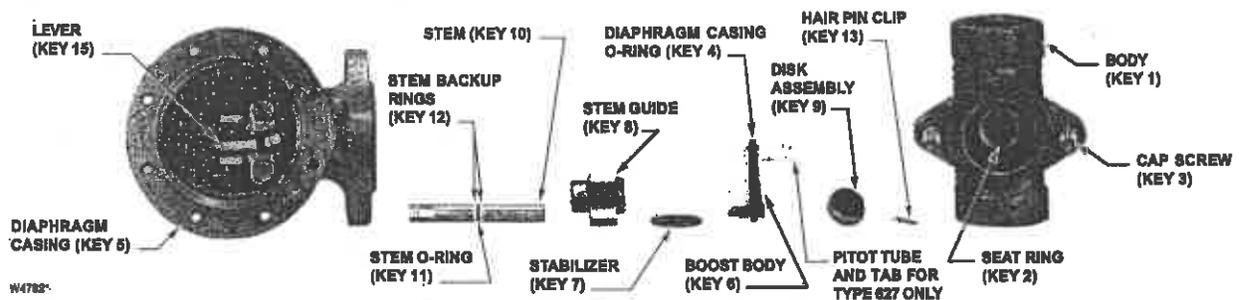
Perform steps 4 through 8 for Type 627, 627H, and 627R Regulators only:

4. For Type 627, 627H, and 627R regulators (figure 5), use steps 5 through 8 to remove and replace the stem assembly.
5. Remove the boost body (key 6), stabilizer (key 7), and stem guide (key 8) from the diaphragm casing (key 5). Unhook and remove the stem (key 10) from the diaphragm casing (key 5).
6. Remove and inspect the diaphragm casing O-ring (key 4, figure 7, 8, or 11) and replace it if necessary.
7. Apply lubricant (key 42) to a replacement diaphragm casing O-ring (key 4, figure 7, 8, or 11) and install it onto the boost body (key 6). Skip to step 14.
8. For the Type 627 or 627H regulators, be sure to insert the pitot tube (tab) into the outlet side of the body (see figure 7 or 11). Skip to step 14.

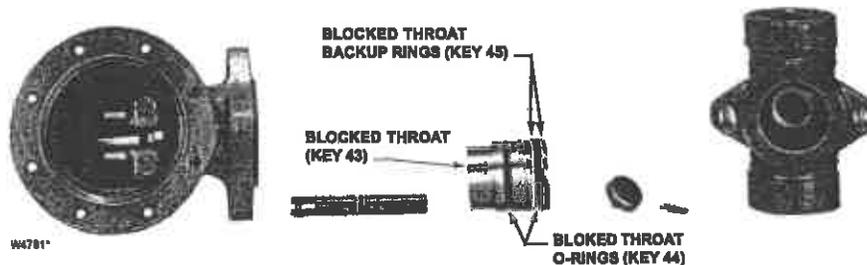
Perform steps 9 through 19 for Type 627M, 627HM, and 627MR Regulators only:

9. For Type 627M, 627HM, and 627MR regulators (figure 5), use steps 10 through 14 to remove and replace the stem assembly.
10. To remove the blocked throat (key 43), insert a screw driver blade into the groove provided in the throat and pry it out of the diaphragm casing (key 5). Inspect and replace parts as necessary.

627 Series



Type 627 and 627R



Type 627M and 627MR

Figure 5. Stem Assemblies

11. Inspect and, if necessary, replace the blocked throat O-rings (key 44, figure 5) and backup rings (key 45, figure 5).

12. Apply lubricant (key 42) to replacement blocked throat O-rings (key 44) and backup rings (key 45).

13. Apply lubricant (key 42) to the replacement stem O-ring (key 11) and stem backup rings (key 12) and install them on the stem (key 10).

14. For assembly, insert the stem (key 10) into the diaphragm casing (key 5) and hook it on the lever (key 15).

15. Insert parts into the diaphragm casing (key 5) that were removed in steps 5 and 6 or step 10 (see figure 5).

16. Install the the disk assembly (key 9), line up the hole in the disk assembly and stem (key 10) and insert the hair pin clip (key 13).

17. Position the diaphragm casing plus attached parts in relation to the body (key 1) so that they are correct for the application.

18. Secure the diaphragm casing to the body with the cap screws (key 3, figure 5). For an aluminum diaphragm casing (key 5), torque the cap screws (key 3) to 16 foot-pounds (22 N•m). For ductile iron or steel diaphragm casings, torque the cap screws (key 3) to 25 foot-pounds (34 N•m).

19. It may be necessary to reposition the diaphragm spring case to prevent rain, ice, and foreign debris from entering the spring case. Refer to the diaphragm and spring case area maintenance procedures, steps 1, 2, and 21 through 25.

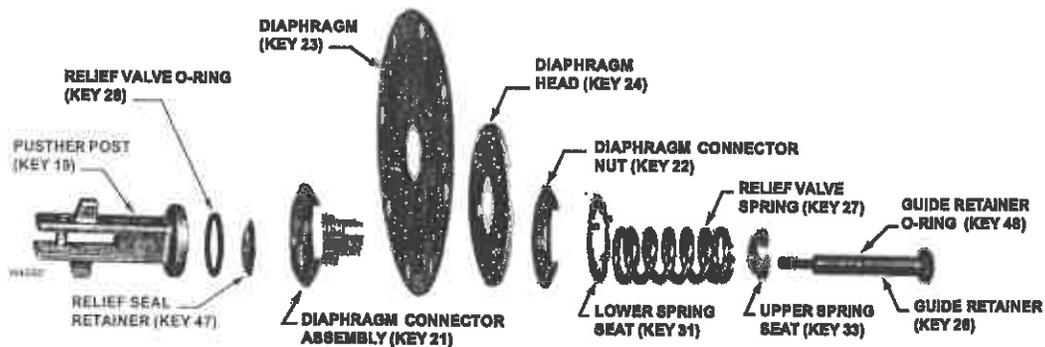
Diaphragm and Spring Case Area Maintenance Procedures

These procedures are for gaining access to the control spring, diaphragm assembly, and lever assembly. All spring pressure must be released from the diaphragm casing before these steps can be performed.

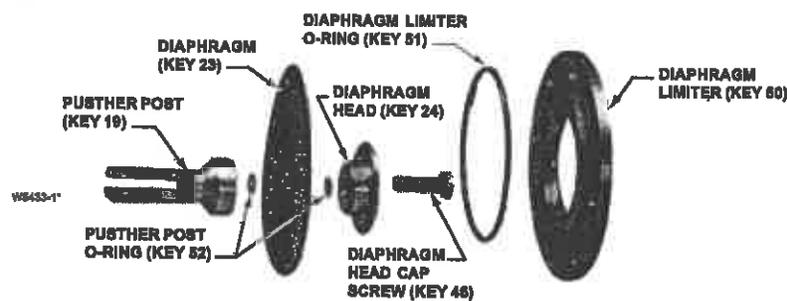
While using the following procedures, refer to figures 7 through 12 for key number locations.

1. Remove the adjusting screw cap (key 36), loosen the lock nut, and turn the adjusting screw (key 35) counterclockwise until all compression is removed from the control spring (key 32).

2. Remove the spring case cap screws (key 37), the nameplates, and lift off the spring case (key 29). If changing the control spring (key 32) or repositioning the spring case (key 29) is the only maintenance required, install the replacement control spring or rotate the spring case so it is correct for the application. Skip to step 21. For diaphragm area maintenance, continue with step 3.



Type 627, 627R, 627M, or 627MR



Type 627H and 627HM

Figure 6. Diaphragm Assemblies

3. Remove the diaphragm limiter and O-ring (keys 50 and 51, on the Type 627H or 627HM only). Remove the diaphragm assembly by tilting it so that the pusher post (key 19) slips off the lever (key 15).

4. If it is necessary to replace the lever assembly, remove the lever cap screws (key 18).

5. Install the replacement lever (key 15) into the lever retainer (key 16) by inserting the lever pin (key 17). Secure the lever assembly into the diaphragm casing with the cap screws (key 18) and torque the cap screws to 7 foot-pounds (9 N·m).

If it is necessary to perform maintenance on the diaphragm assembly, continue with steps 6 through 11 and step 20 for Type 627, 627H, 627M, and 627HM regulators, or steps 12 through 19 for Type 627R and 627MR regulators.

Perform steps 6 through 11 for Type 627, 627H, 627M, and 627HM Regulators only:

6. For Type 627, 627H, 627M, and 627HM regulators (figures 5 & 6), use steps 7 through 11 to disassemble and reassemble the diaphragm assembly.

7. Remove the diaphragm head cap screw (key 46), lower spring seat (key 31, Type 627 or 627M only), and diaphragm head (key 24). On the Type 627H or 627HM, remove the diaphragm cap screw O-rings (key 52). Separate the diaphragm (key 23) from the pusher post (key 19).

8. Install the diaphragm (key 23), in reverse order in step 7, on the pusher post (key 19), insert and finger tighten the diaphragm head cap screw (key 46).

9. Hook the pusher post on the lever (key 15), then turn the diaphragm (key 23) to match the holes in the diaphragm with the holes in the spring casing.

10. Unhook the pusher post from the lever and torque the diaphragm head cap screw (key 46) to 7 foot-pounds (9 N·m) for the Type 627 or 627M. On the Type 627H or 627HM torque the diaphragm head cap screw to 14 foot-pounds (18 N·m).

11. Hook the pusher post on the lever (key 15) and check the hole alignment. If necessary, loosen the cap screw (key 46) and reposition the diaphragm (key 23) on the pusher post (key 19). Retorque the screw (see step 10). Skip to step 20.

627 Series

Perform steps 12 through 19 for Type 627R and 627MR Regulators only:

12. For Type 627R and 627MR regulators (figure 6), use steps 13 through 19 to disassemble and reassemble the diaphragm assembly:

13. Remove the guide retainer (key 26) and separate the diaphragm parts. Refer to figure 6 for the sequence of parts.

14. To remove the diaphragm (key 23), remove the diaphragm connector nut (key 22) and lift off the diaphragm head (key 24) and diaphragm (key 23) from the connector assembly (key 21). Do not attempt to disassemble the connector assembly (key 21).

15. Position the replacement diaphragm (key 23) on the connector assembly (key 21), install the diaphragm head (key 24) and connector nut (key 22), then torque to 17 foot-pounds (32 N•m).

16. If necessary, replace the guide retainer O-ring (key 48) and, set the guide retainer (key 26) aside, ready for assembly.

17. On the pusher post (key 19) install the relief seal O-ring (key 28) and lubricate (key 42). Also, install the relief seal retainer (key 47), diaphragm connector assembly (key 21, with attached parts) relief spring (key 27), upper relief spring seat (key 33), and guide retainer (key 26). Torque the guide retainer (key 26) to 3 foot-pounds (4 N•m).

18. Hook the pusher post (with attached parts) on the lever (key 15) to check the alignment of the holes in the diaphragm with the holes in the spring casing. If the holes do not line up, unhook the pusher post from the lever, hold the pusher post, and rotate the diaphragm to the correct position.

19. Install the lower spring seat (key 31) over the relief spring so it rests flat on the connector nut (key 22).

20. Insert the diaphragm assembly into the diaphragm casing (key 5) and hook the pusher post on the lever (key 15).

21. Install the control spring (key 32) and upper spring seat (key 33), and apply lubricant (key 38) to the upper spring seat (key 33).

22. Install the spring case (key 29) so that the screened vent assembly (key 30) is in the correct position for the application. Place the nameplates (key 39) over the screw holes, insert the spring case cap screws (key 37), and finger tighten.

23. Screw in the adjustment screw to put slack into the diaphragm (key 23).

24. Using a crisscross pattern, finish tightening the spring case cap screws (key 37) to 7 foot-pounds (9 N•m) of torque.

25. If necessary, refer to the installation and/or the startup and adjustment procedures.

26. Install the adjusting screw cap (key 34) after regulator adjustment.

Parts Ordering

When corresponding with your Fisher sales office or sales representative about this regulator, always reference the type number which is found on the nameplate (key 39, figures 7 through 12).

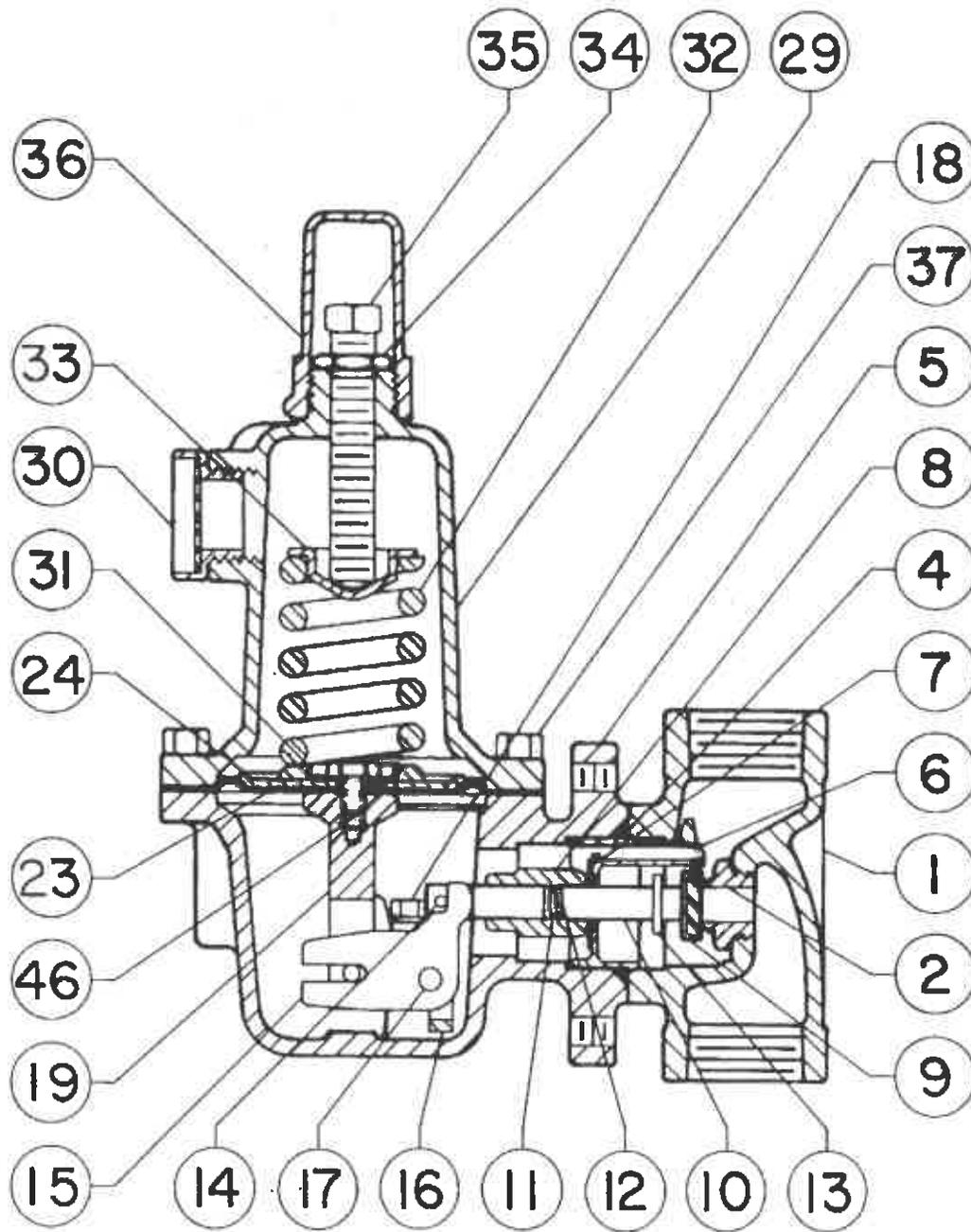
When ordering replacement parts, reference the key number of each needed part as found in the following parts list.

Parts List

Key	Description	Part Number
	Type 627 Parts Kit with aluminum/nitrile trim (includes keys 4, 9, 11, 12, and 23)	R627X000A12
	Type 627 Parts Kit with stainless steel/nitrile trim (includes keys 4, 9, 11, 12, and 23)	R627X000S12
	Type 627R Parts Kit with aluminum/nitrile trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00A12
	Type 627R Parts Kit with stainless steel/nitrile trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00S12
1	Body	
	Ductile Iron	
	1000 psig (69 bar) max inlet pressure	
	3/4-inch NPT size	30B3046X012
	1-inch NPT size	30B3048X012
	2-inch NPT size	30B3096X012
	Steel	
	2000 psig (138 bar) max inlet pressure	
	3/4-inch NPT size	30B3050X012
	1-inch NPT size	30B3051X012
	2-inch NPT size	30B7452X012
	Steel, ANSI Class 800 RF flanged	
	1480 psig (102 bar) max inlet pressure	
	1-inch size	40B6754X012
	2-inch size	40B6756X012
2*	Seat ring	
	Aluminum	
	3/32-inch (2.4 mm) port diameter	0R044109022
	1/8-inch (3.2 mm) port diameter	1A936709012
	3/16-inch (4.8 mm) port diameter	00991209012
	1/4-inch (6.4 mm) port diameter	0B042009012
	3/8-inch (9.5 mm) port diameter	0B042209012
	1/2-inch (12.7 mm) port diameter	1A928809012
	303 Stainless steel	
	3/32-inch (2.4 mm) port diameter	0R044135032
	1/8-inch (3.2 mm) port diameter	1A936735032
	3/16-inch (4.8 mm) port diameter	00991235032
	1/4-inch (6.4 mm) port diameter	0B042035032
	3/8-inch (9.5 mm) port diameter	0B042235032
	1/2-inch (12.7 mm) port diameter	1A928835032

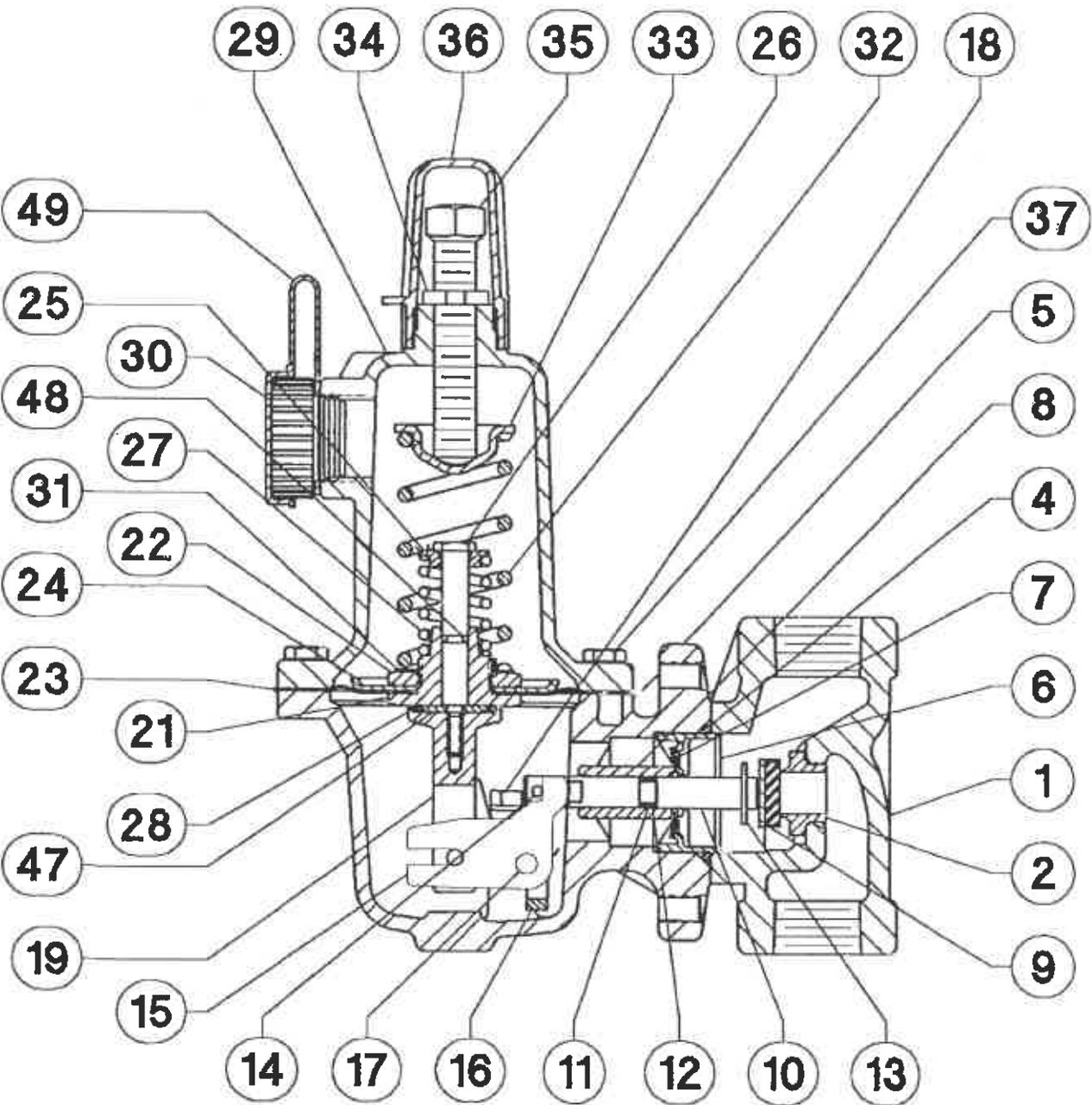
*Recommended spare part.

Key	Description	Part Number	Key	Description	Part Number
2*	Seat ring (continued)		23*	Diaphragm, nitrile (continued)	
	316 Stainless steel, NACE ⁽¹⁾ construction only			For Type 627 or 627M w/steel diaphragm case	10B8735X012
	3/32-inch (2.4 mm) port diameter	0R0441X0012		For Type 627R or 627MR w/aluminum or ductile iron diaphragm case	10B3088X012
	1/8-inch (3.2 mm) port diameter	1A9387X0022		For Type 627R or 627MR w/steel diaphragm case	10B8736X012
	3/16-inch (4.8 mm) port diameter	009912X0012		For Type 627H or 627HM w/steel diaphragm case (diaphragm is neoprene with nylon fabric)	12B0178X012
	1/4-inch (6.4 mm) port diameter	0B0420X0012	24	Diaphragm Head, plated steel	
	3/8-inch (9.5 mm) port diameter	0B0422X0012		For Type 627 or 627M, plated steel	1D866428982
	1/2-inch (12.7 mm) port diameter	1A9288X0012		For Type 627R or 627MR, plated steel	10B3071X012
3	Cap Screw (not shown), (2 req'd)			For Type 627H or 627HM, 416 stainless steel	12B0175X012
	Type 627 and 627R w/aluminum diaphragm case, pl steel	18A1087X012	25	Relief Spring Seat (for Type 627R or 627MR only), steel	10B7448X012
	All Types w/ductile iron diaphragm case, pl steel	1C403824052	26	Guide Retainer (for Type 627R or 627MR only), stainless steel	10B7450X012
	or steel diaphragm case, pl steel	1C403024052	27	Relief Spring (for Type 627R or 627MR only), plated steel	10B6757X012
4*	Diaphragm Case O-Ring (Type 627, 627H, or 627R only), nitrile	17A2325X022	28*	Relief Seal O-Ring (for Type 627R or 627MR only), nitrile	1J108506992
5	Diaphragm Case		29	Spring Case	
	For Type 627 or 627R			For Type 627 or 627R	
	Aluminum w/o 1/8-inch gauge tap	40B3084X012		Aluminum	40B3088X012
	Aluminum with 1/8-inch gauge tap			Ductile iron	30B3055X012
	for Type 627 only	11B5380X012		Steel	30B3102X012
	Ductile iron w/o 1/8-inch gauge tap	30B3053X012		For Type 627M or 627MR	
	Ductile iron with 1/8-inch gauge tap			Ductile iron	30B3055X012
	for Type 627 only	31B0641X012		Steel	30B3102X012
	Steel	30B3104X012		For Type 627H or 627HM	
	For Type 627M or 627MR			Steel	30B3102X012
	Ductile iron	39A5987X012	30	Screened Vent Assembly, plastic	10B3093X012
	Steel	30B8734X012	31	Lower Spring Seat, plated steel	
	For Type 627H, steel	30B3104X012		For Type 627 or 627M	1D666625072
	For Type 627HM, steel	30B8734X012		For Type 627R or 627MR	20B3073X012
6	Boost Body (not for Type 627M, 627HM, or 627MR), Delrin ⁽²⁾		32	Control Spring, pl steel	
	For Type 627 or 627H	30B3056X012		5 to 20 psig (0.34 to 1.4 bar), yellow	10B3078X012
	For Type 627R	30B3057X012		15 to 40 psig (1.0 to 2.8 bar), green	10B3077X012
7	Stabilizer (for Type 627, 627H, and 627R only), nitrile	10B3060X012		35 to 80 psig (2.4 to 5.5 bar), blue	10B3078X012
8	Stem Guide (for Type 627, 627H, and 627R only), powdered metal	20B3061X012		70 to 150 psig (4.8 to 10.3 bar), red	10B3079X012
9*	Disk Assembly (for all port diameters)			140 to 250 psig range (9.6 to 17.2 bar), blue, used in a Type 627H or 627HM	10B3078X012
	Aluminum holder and nitrile disk	1C4248X0212		240 to 500 psig range (16.5 to 34.5 bar), red, used in a Type 627H or 627HM	10B3079X012
	303 Stainless steel holder and nitrile disk	1C4248X0202	33	Upper Spring Seat, plated steel	1D867125072
	Aluminum holder and nylon disk	1C4248X00A2	34	Locknut, plated steel	1D867728982
	303 Stainless steel holder and nylon disk	1C4248X00B2	35	Adjusting Screw, pl steel	
	NACE construction only			For Type 627 or 627M	10B3081X012
	Aluminum holder and nitrile disk	1C4248X0212		For Type 627H or 627HM	10B3081X012
	316 Stainless steel holder and nitrile disk	1C4248X02B2		For Type 627R or 627MR	10B3080X012
	Aluminum holder and nylon disk	1C4248X00A2	36	Adjusting Screw Cap, plastic	20B3082X012
	316 Stainless steel holder and nylon disk	1C4248X02B2	37	Spring Case Cap Screw, pl steel (8 required)	
10	Stem			For aluminum or ductile iron diaphragm case	1A391724052
	303 stainless steel	10B3059X012		For steel diaphragm case	10B8737X012
	316 stainless steel (NACE)	10B3059X022		For Type 627H/HM, steel diaphragm case	1A346424052
11*	Stem O-Ring, nitrile	1D887506992	39	Nameplate	-----
12	Stem Backup Ring, TFE (2 required)	1K786806992	43	Blocked Throat (for Type 627M, 627HM or 627MR only), stainless steel	10B3085X012
13	Hair Pin Clip, stainless steel	10B3058X012	44	Blocked Throat O-Ring (for Type 627M, 627HM, or 627MR only), nitrile (2 required)	1E264306992
14	Drive Pin, plated steel	1A953228982	45	Blocked Throat Backup Ring (for Type 627M, 627HM, or 627MR only), TFE (2 required)	10B3108X012
15	Lever, plated steel	20B3063X012	46	Diaphragm Head Cap Screw, steel	
16	Lever Retainer, plated steel	30B3087X012		For Type 627 or 627M	1K920724052
17	Lever Pin			For Type 627H or 627HM	1C379124052
	Stainless steel	10B3083X012	47	Relief Seal Retainer (for Type 627R or 627MR only), stainless steel	10B7445X012
	316 stainless steel (NACE)	10B3083X022	48*	Guide Retainer O-Ring (for Type 627R or 627MR only), nitrile	1D882506992
18	Lever Cap Screw (2 required)		49	Relief Indicator (for Type 627R or 627MR only), rubber (not shown)	30B3100X012
	Plated steel	10B7454X012	50	Diaphragm Limiter	22B0176X012
	316 stainless steel (NACE)	10B7454X022	51*	Diaphragm Limiter O-Ring	1K877806992
19	Pusher Post, aluminum		52*	Pusher Post O-Ring (2 required)	1C853806992
	For Type 627 or 627M	10B3098 X012			
	For Type 627R or 627MR	10B3098 X022			
	For Type 627H or 627HM, 416 stainless steel	10B3098 X032			
21	Diaphragm Connector (for Type 627R or 627MR only), stainless steel	10B6758X012			
22	Diaphragm Connector Nut (for Type 627R or 627MR only), stainless steel	10B7449X012			
23*	Diaphragm, nitrile				
	For Type 627 or 627M w/aluminum or ductile iron diaphragm case	10B3069X012			



3093062-D

Figure 7. Type 627 Regulator Components



3083008-D

Figure 8. Type 627R Regulator Components

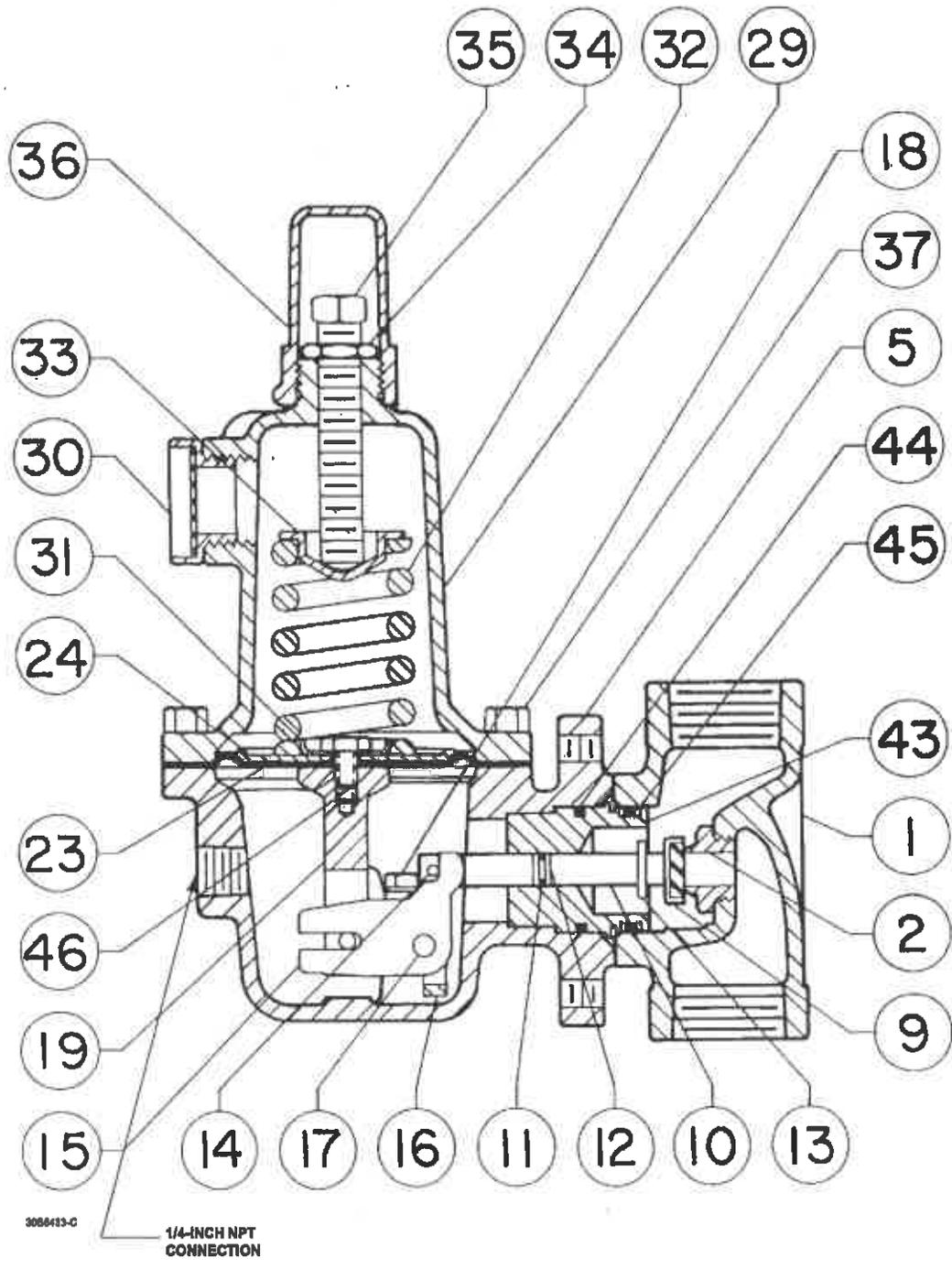


Figure 9. Type 627M Regulator Components

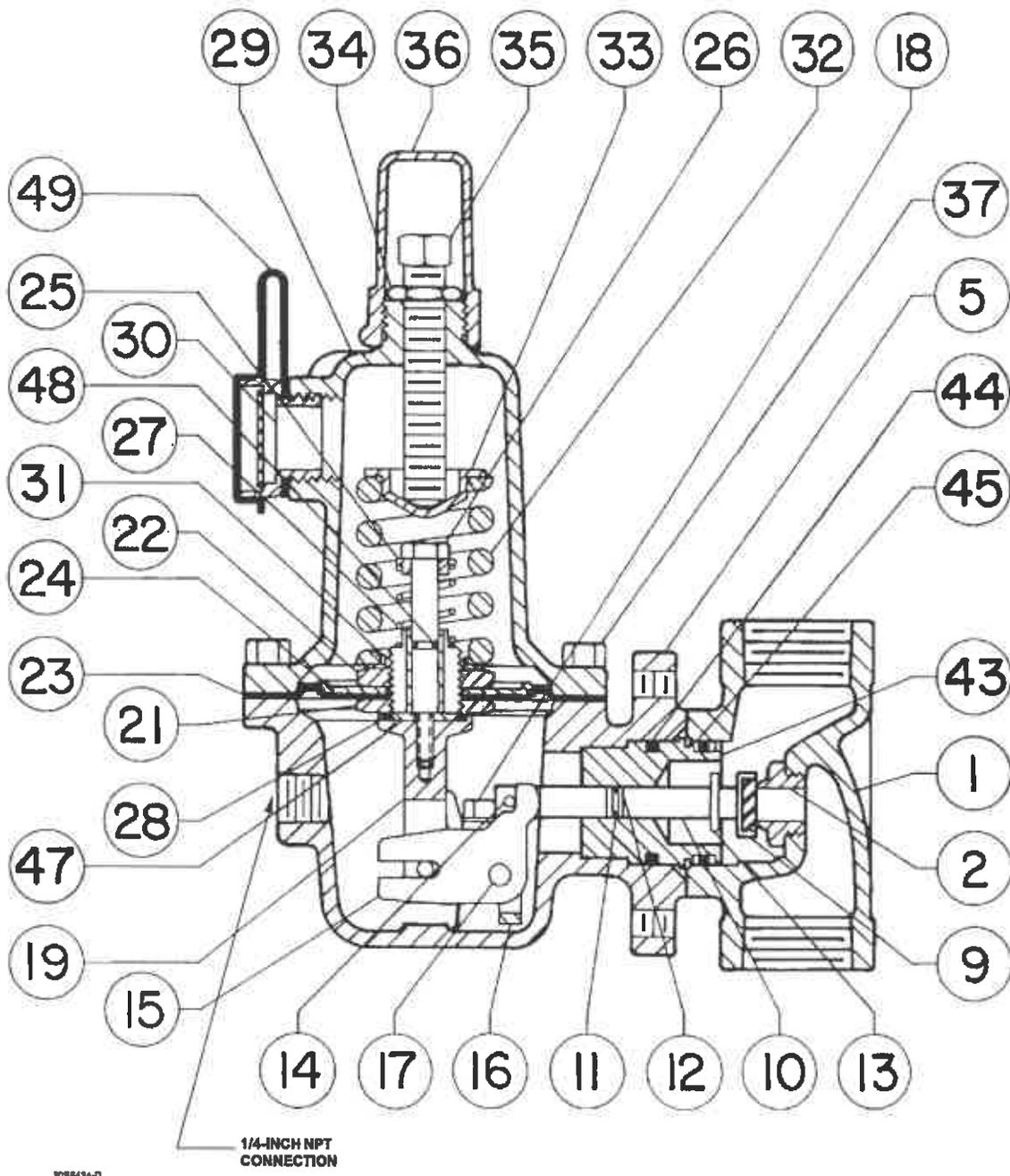


Figure 10. Type 627MR Regulator Components

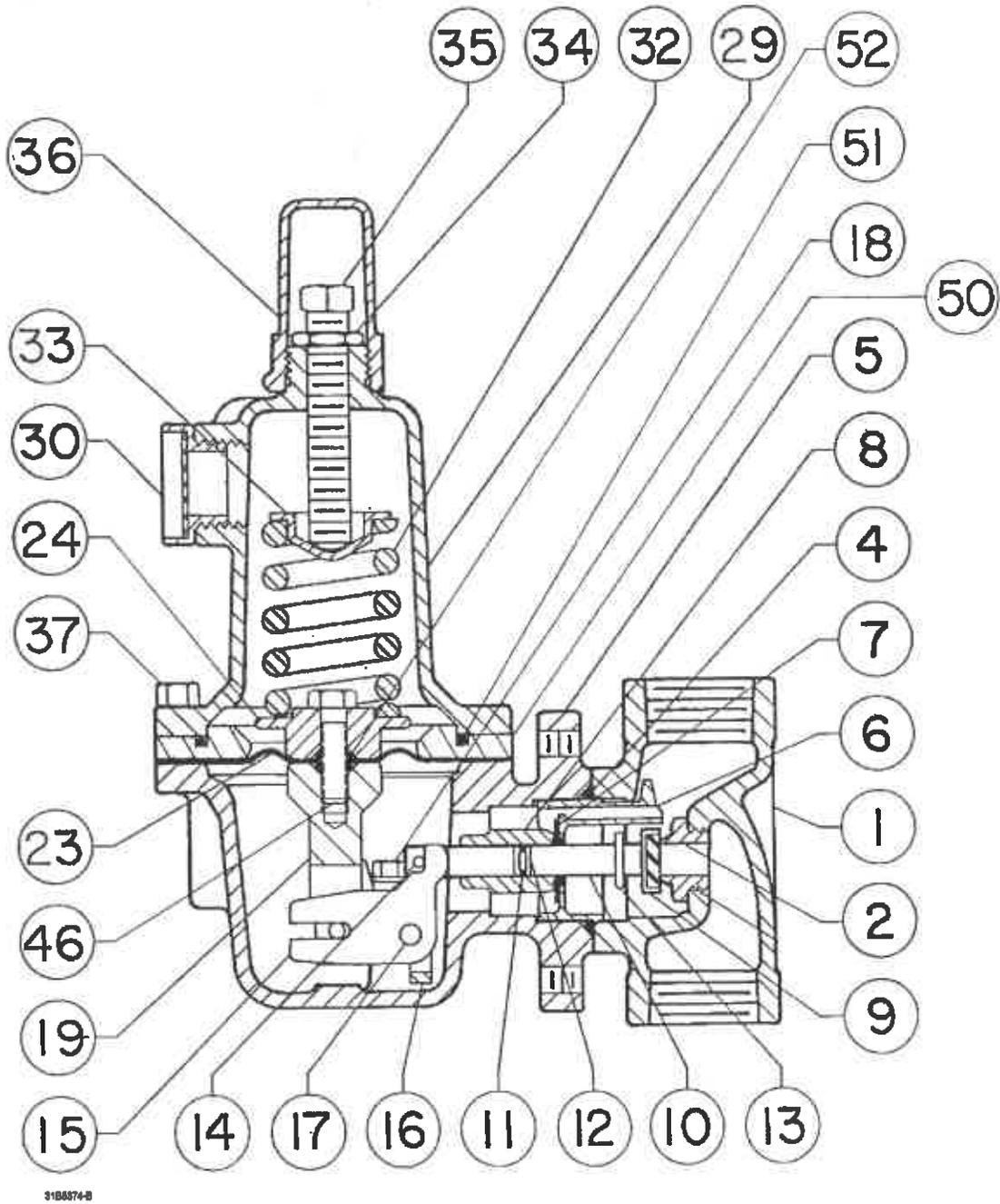
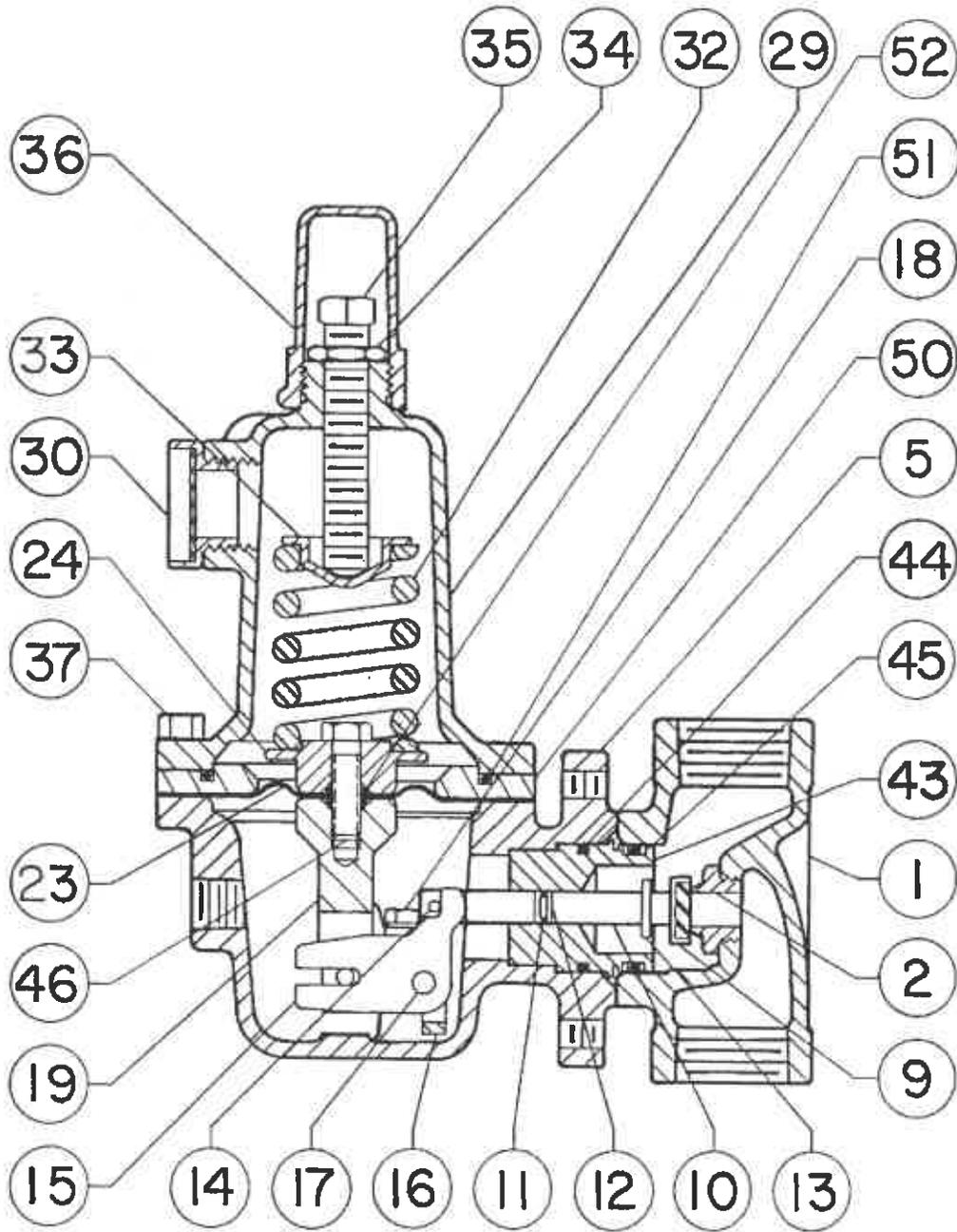


Figure 11. Type 627H Regulator Components



3188022-0

Figure 12. Type 627HM Regulator Components

Errata Sheet for

627 Series
Form 5252, July 1989

This errata sheet includes information covering the Type 627LB extended body regulator. This new body style is available on all 627 Series configurations and will be an addition to key 1 in the Parts List. The pressure ratings on the Type 627LB bodies will be identical to the existing specifications stated in the current 627 Series Instruction Manual. Each bullet on this errata sheet refers to a section of the 627 Series Instruction Manual (form 5252) where this information needs to be added.

- Add the following to the Available Constructions section of Table 1. Specifications on page 2.
- Add the following figure to the end of page 18.

Type 627LB: A 627 Series construction with an extended NPT screwed body. Note: The pressure ratings and capacities for a Type 627LB depend on the 627 Series construction. See the above listed constructions for ratings and specifications.

- Add the following to the Parts List on page 12.

Key	Description	Part Number
1	Body	
	Type 627LB - Ductile Iron	
	1000 psig (69 bar) max Inlet pressure	
	3/4-inch NPT screwed body	39B2450X012
	1-inch NPT screwed body	39B2451X012
	2-inch NPT screwed body	39B0414X012
	Type 627LB - Steel	
	2000 psig (138 bar) max Inlet pressure	
	3/4-inch NPT screwed body	39B0411X012
	1-inch NPT screwed body	39B0412X012
2-inch NPT screwed body	39B0415X012	

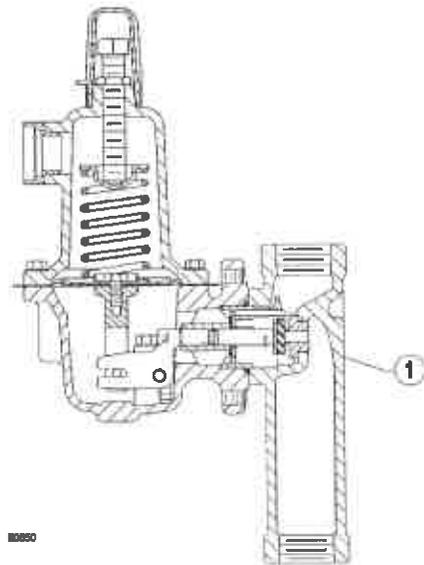


Figure 13. Type 627LB Regulator Body

Fisher is a mark owned by Fisher Controls International, Inc., a business of Emerson Process Management. The Emerson logo is a trademark and service mark of Emerson Electric Co. All other marks are the property of their respective owners.

The contents of this publication are presented for informational purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. We reserve the right to modify or improve the designs or specifications of such products at any time without notice.

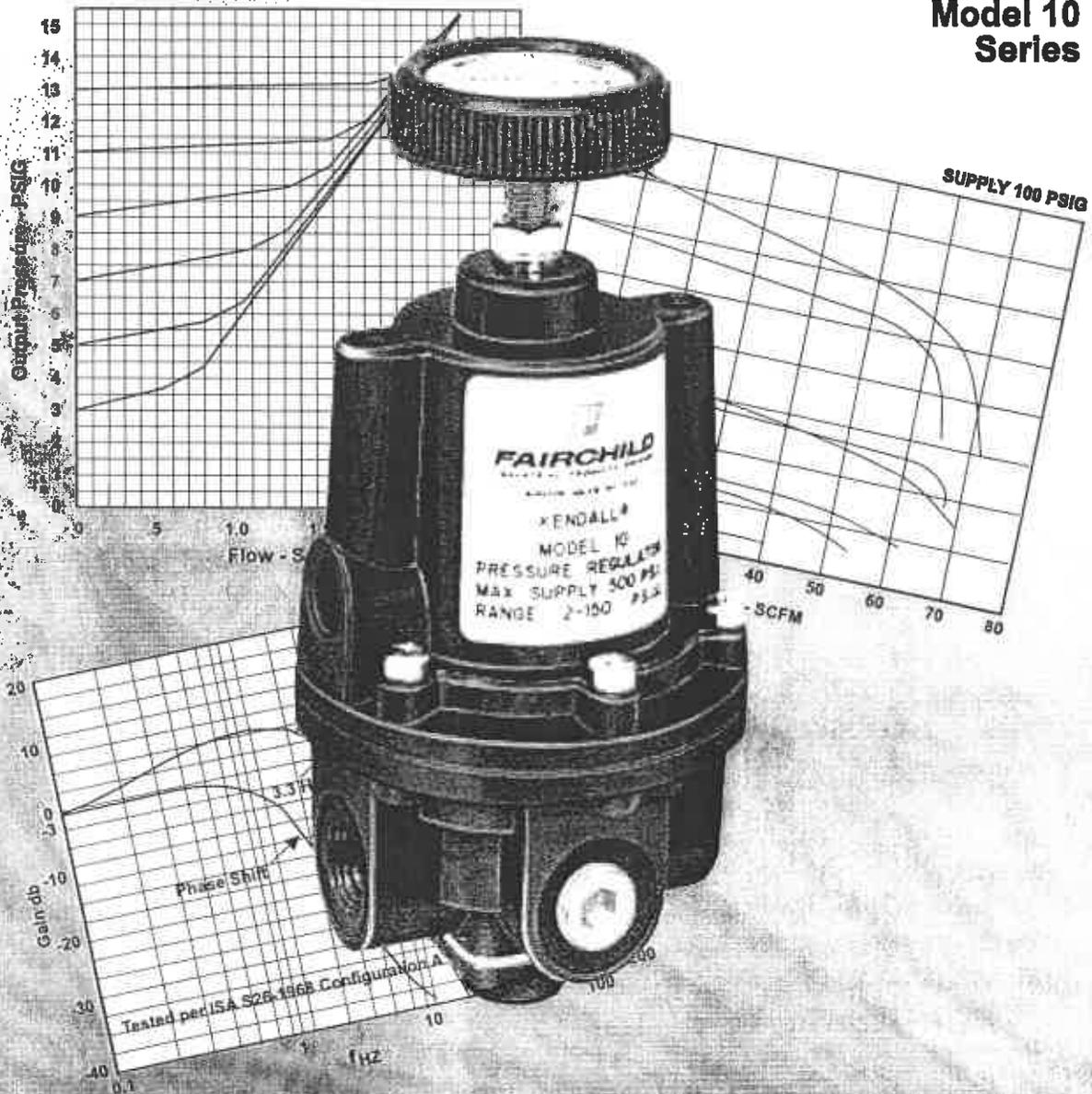
Fisher does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Fisher product remains solely with the purchaser.

For information, contact Fisher:
 Marshalltown, Iowa 50158 USA
 McKinney, Texas 75070 USA
 28320 Gallardon, France
 40013 Castel Maggiore (BO), Italy
 Sao Paulo 05424 Brazil
 Singapore 128461

FAIRCHILD

PNEUMATIC PRECISION REGULATOR

Model 10
Series



FAIRCHILD
INDUSTRIAL PRODUCTS COMPANY

GENERAL INFORMATION

MODEL 10 SERIES PNEUMATIC PRECISION REGULATOR

APPLICATIONS

The Model 10 Series is a high capacity regulator that provides a uniform output pressure independent of supply pressure variation.

The combination of high capacity and sensitivity make the Model 10 Series an excellent choice for a wide range of precision applications including: Dancer and Calendar Roll Loading, Cylinder Bucking Pressure Control, Manometer Reference Pressure, Supply for Carrier Gas, Web Tensioning Control, Pneumatic Control Valve Diaphragm Loading, Clutch and Brake Controls and Flapper Nozzle Supply.

FEATURES

Performance

- The Model 10 Series can be set to 1/8" Water Column which permits use in precision processes.
- A Compensating Diaphragm allows the regulator to remain unaffected by supply pressure changes.
- An Optional Check Valve permits dumping of downstream pressure when supply is opened to atmosphere.

Functional

- Flow of Up to 40 SCFM with 100 psig Supply allows use in applications with high flow requirements.

Physical

- A Separate Control Chamber and Aspirator Tube isolates the diaphragm from the main flow eliminating hunting and buzzing.
- Construction with Standard Removable Components allows in-line servicing.
- Mounting Bracket available.

OUTLINE DIMENSIONS

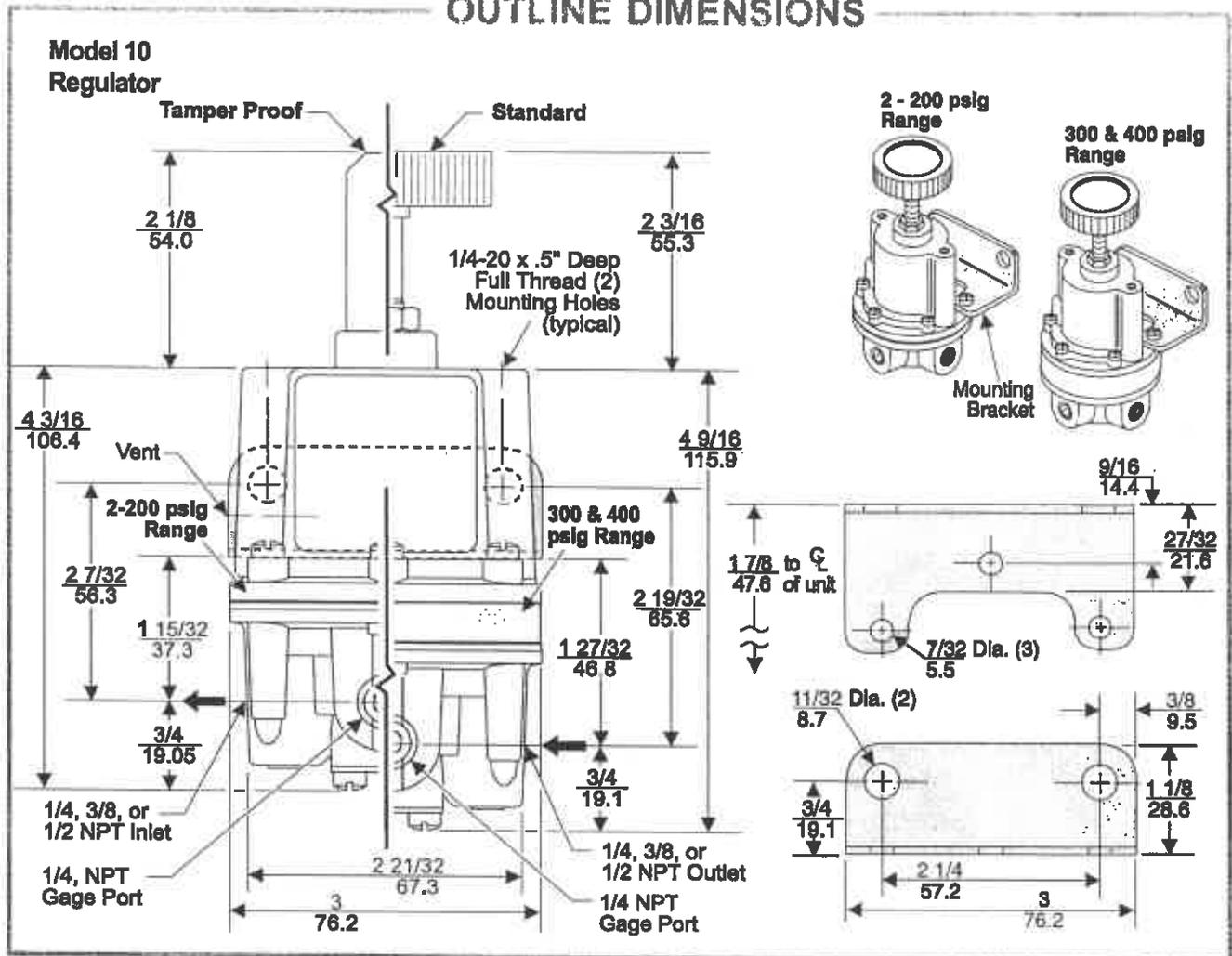


Figure 1. Outline Dimensions.

Figure 2. Mounting Bracket EB-09921. (Sold Separately)

SPECIFICATIONS

FUNCTIONAL SPECIFICATIONS

Supply Pressure	500 psig, [35.0 BAR] (3500 kPa) Maximum
Flow Capacity (SCFM)	40 (68 m ³ /HR) @ 100 psig, [7.0BAR], (700 kPa) supply & 20 psig, [1.5 BAR], (150 kPa) setpoint.
Exhaust Capacity (SCFM)	5.5 (9.35 m ³ /HR) where downstream pressure is 5 psig, [.35 BAR], (35 kPa) above 20 psig, [1.5 BAR], (150 kPa) setpoint.
Ambient Temperature	-40°F to +200°F (-40°C to +93°C)

PERFORMANCE SPECIFICATIONS

Sensitivity	Less than 1/8" (.32 cm) Water Column.
Supply Pressure Effect	Less than 0.1 psig, [.007 BAR], (.7 kPa) for 100 psig, [7.0 BAR], (700 kPa) change in supply pressure.
Materials of Construction	Body and Housing Aluminum Trim Stainless Steel, Brass, Zinc Plated Steel Diaphragms Buna N on Dacron (Std. Unit Only)

CROSS SECTION

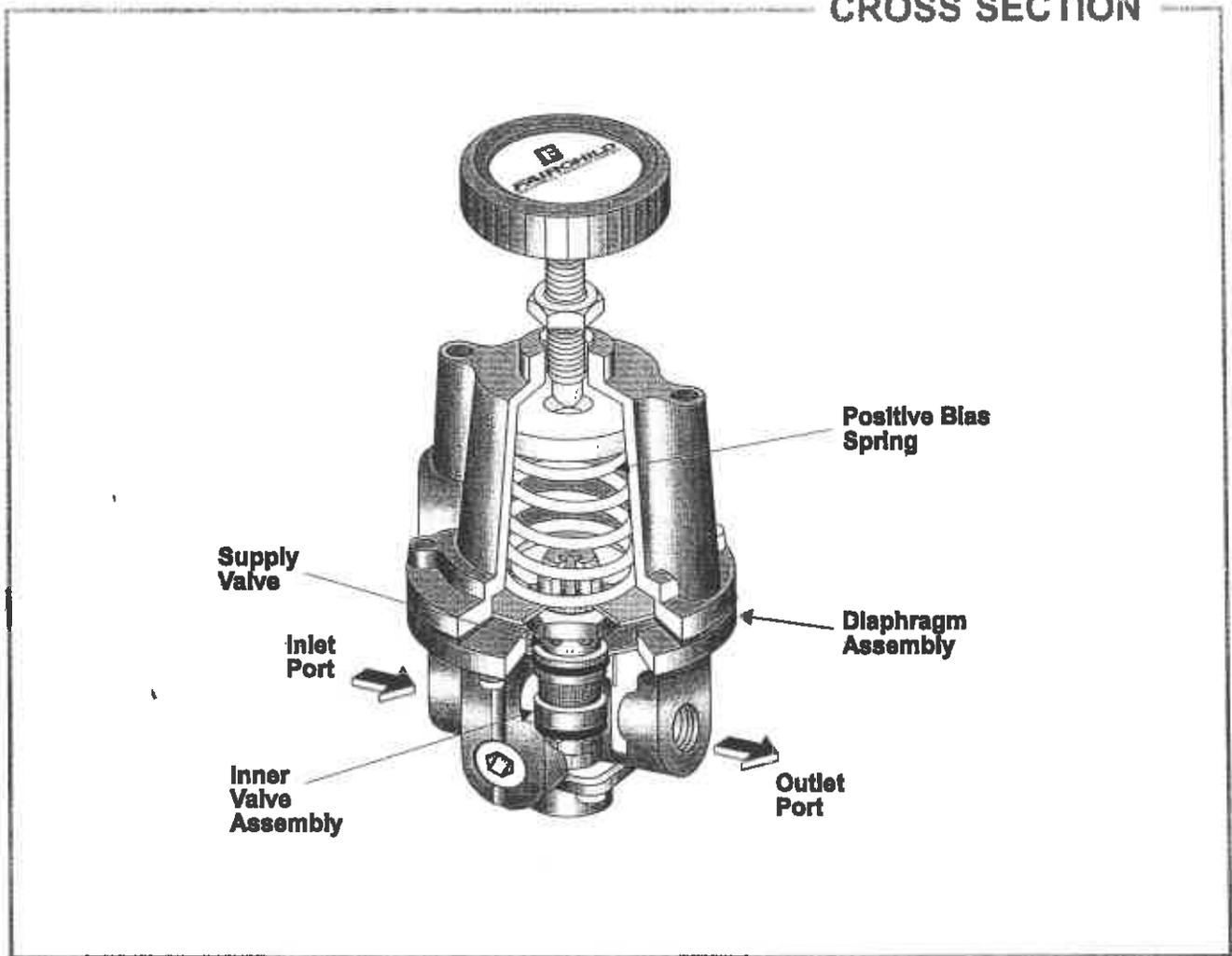


Figure 3. Model 10 Detail Drawing.

OPERATING PRINCIPLES

The Model 10 Regulator uses the force balance principal to control the movement of the Valve Assembly which in turn controls the output pressure. When the Model 10 Regulator is adjusted for a specific set point, the downward force of the Positive Bias Spring causes the Diaphragm Assembly to move downward. Then the Supply Valve opens and allows air to pass to the Outlet Port. As the set point is reached, the downward force exerted by the Positive Bias Spring is balanced by the force of the downstream pressure acting on the Diaphragm Assembly. The resultant force moves the Supply Valve upward to reduce the flow of air to the Outlet Port.

Outlet pressure is maintained as a result of balance between forces acting on the top and bottom of the Diaphragm Assembly. For more information, see Figure 3. "Model 10 Detail Drawing" above.

INSTALLATION

For Installation Instructions refer to the *Fairchild Model 10 Midget Precision Regulator IOM, IS-10000010*.

TYPICAL APPLICATIONS

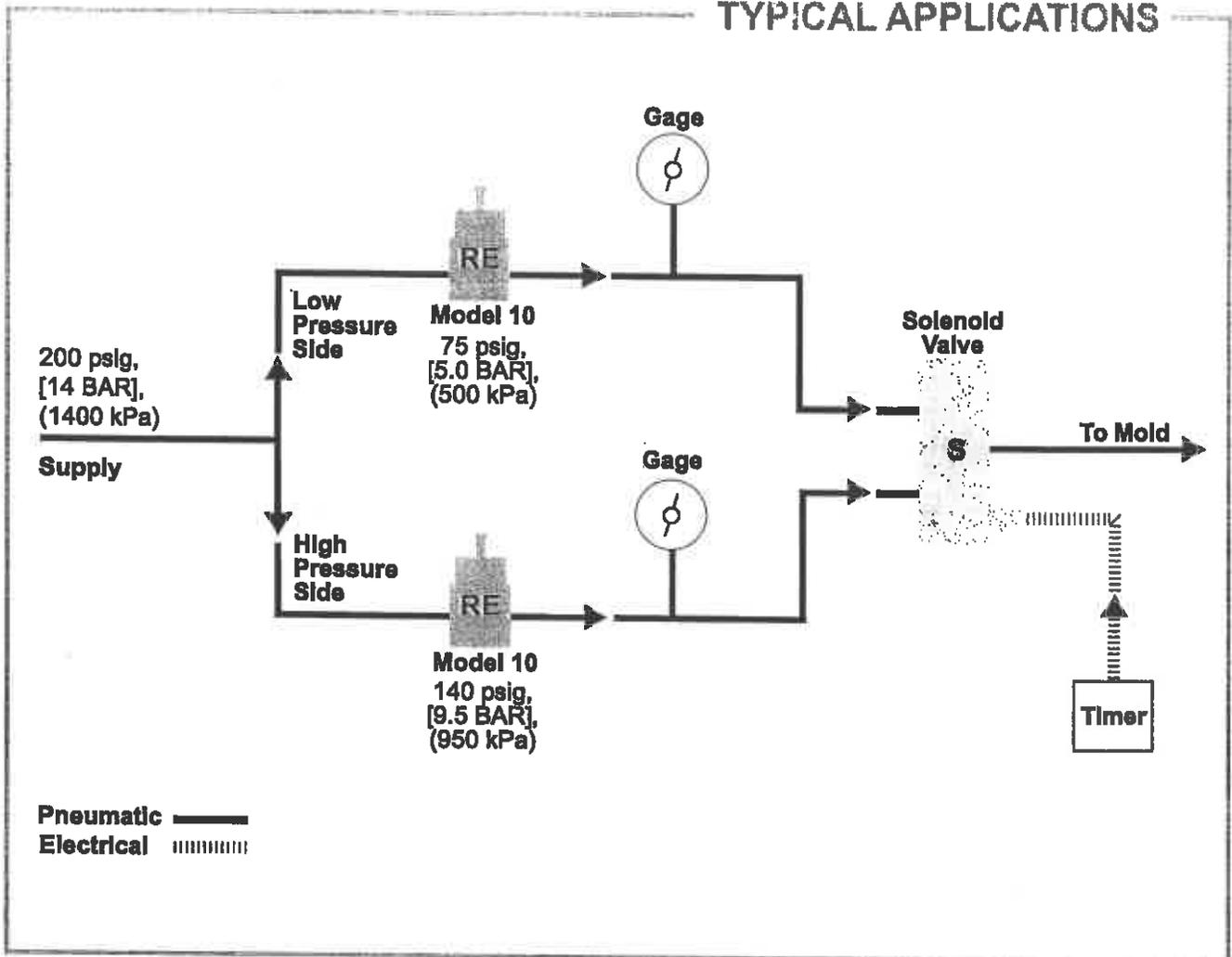


Figure 4. Tire Molding Process Application for the Model 10.

TYPICAL APPLICATIONS

The Model 10 Pneumatic Precision Regulator controls the air pressure in a tire molding process. During the process, initial low pressure is applied to the mold. As the process approaches the final stage, higher pressure is applied.

An automatic timer activates the solenoid valve and delivers low pressure to the mold. At a preset point in the cycle, the automatic timer transfers to the high pressure output of the

solenoid valve and turns off the low pressure output.

At the end of the cycle, the high pressure to the mold is turned off and the mold exhausts into the atmosphere. When the mold closes, the cycle repeats. Interlock switches prevent the mold from opening under high pressure. For more information, see Figure 4. "Tire Molding Process Application for the Model 10 Regulator".

— ORDERING INFORMATION —

Catalog Number 1 0 2

Pressure Range

psig	[BAR]	(kPa)	
0-2	[0-0.1]	(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	[0.1-4]	(10-400)	(4)
2-150	[0.1-10]	(15-1000)	(6)
3-200	[0.2-15]	(20-1500)	(7)
5-300	[0.3-21]	(35-2100)	(8)
5-400	[0.3-28]	(35-2800)	(9)

Pipe Size

1/4" NPT	(2)
3/8" NPT	(3)
1/2" NPT	(4)

Options

Table 1. Plunger Operated Regulator.

Range	Push Rod Travel (Inches)	Push Rod Thrust (lbs.)
0-2 psig	.560 ± 10%	6.28 ± 10%
0-10 psig	.668 ± 10%	31.4 ± 10%
0-20 psig	.668 ± 10%	62.8 ± 10%
.5-30 psig	.673 ± 10%	94.2 ± 10%
1-60 psig	.698 ± 10%	188.4 ± 10%
2-150 psig	.589 ± 10%	471.0 ± 10%
5-300 psig		
3-200 psig	.418 ± 10%	628.0 ± 10%
5-400 psig		

Compatibility

	T	E	L	R	N	B	C	A	J	U	H
Tamper Proof (T)	-	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Tapped Exhaust (E)	Y	-	Y	N	Y	Y	Y	Y	Y	Y	Y
Low Flow (L)	Y	Y	-	Y	N	N	Y	Y	Y	Y	Y
Plunger Operated ¹ (R)	N	N	Y	-	Y	Y	Y	Y	Y	Y	Y
Non-Relieving (N)	Y	Y	N	Y	-	N	N	Y	Y	Y	Y
Low Bleed (B)	Y	Y	N	Y	N	-	N	Y	Y	Y	Y
Check Valve ² (C)	Y	Y	Y	Y	N	N	-	Y	Y	Y	Y
Silicone Elastomers ³ (A)	Y	Y	Y	Y	Y	Y	Y	-	N	Y	Y
Viton Elastomers (J)	Y	Y	Y	Y	Y	Y	Y	N	-	Y	Y
BSPT (Tapered) (U)	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	N
BSPP (Parallel) ⁴ (H)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	-

¹ Refer to Table 1. for Push Rod Travel and Thrust.
² Maximum Supply Pressure - 250 psig, [35.0 BAR], (3500kPa)
³ Maximum Supply Pressure - 75 psig, [5.0 BAR], (500 kPa)
⁴ BSPP Threads in Inlet & Outlet Ports Only. Others BSPT.

ISO 9002
Certified



www.fairchildproducts.com

CS-1000010
Litho in USA
Rev. Y 8/02

April 1999

Y600A Series Pressure Reducing Regulators

Introduction

Scope of Manual

This manual describes and provides instructions and parts lists for Types Y600A, Y600AM, and Y600AR pressure regulators. Instructions and parts lists for other equipment used with these regulators are found in separate manuals.

Product Description

The Y600A Series pressure reducing regulators may be applied as switching valves, relay or pressure loading regulators, or monitoring regulator pilots, and are described as follows:

Type Y600A—Direct-operated regulator with internal registration requiring no downstream control line.

Type Y600AM—Direct-operated regulator with blocked throat, O-ring stem seal to prevent leakage around the stem, and diaphragm casing tapped 1/2-inch NPT for control line connection.

Type Y600AR—Type Y600A with internal relief valve.

Specifications

Ratings and specifications for the Y600A Series regulators are given in the Specifications section on page 2. Individual regulator data is stamped on the closing cap as it comes from the factory.

Installation

WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is over-

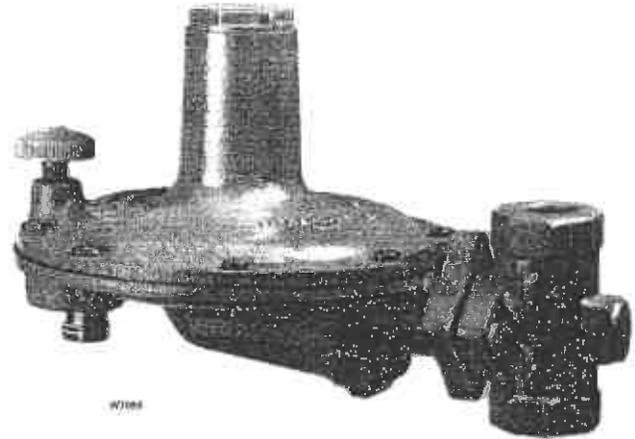


Figure 1. Type Y600A Pressure Regulator

pressured or is installed where service conditions could exceed the limits given in the Specifications section, or where conditions exceed any ratings of the adjacent piping or piping connections.

To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

Additionally, physical damage to the regulator could cause personal injury or property damage due to escaping gas. To avoid such injury or damage, install the regulator in a safe and well-ventilated location.

Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. A regulator should be inspected for damage periodically and after any overpressure condition. Key numbers referenced in this section are shown in figures 3 through 6.

FISHER

www.FISHERregulators.com


EMERSON
Process Management

Y600A Series

Specifications

<p>Body Sizes (Inlet x Outlet) and End Connection Style⁽¹⁾ 3/4 x 3/4 or 1 x 1-inch NPT screwed</p> <p>Maximum Inlet Pressure (Body Rating)⁽²⁾ 150 psig (10,3 bar)</p> <p>Maximum Outlet Pressure (Casing)⁽²⁾ 20 psig (1,4 bar)</p> <p>Maximum Operating Inlet Pressure See table 2</p> <p>Maximum Operating Outlet Pressure to Avoid Internal Parts Damage⁽²⁾ 2 psig (0,14 bar) above outlet pressure setting</p>	<p>Outlet Pressure Ranges⁽²⁾ See table 1</p> <p>Flow Coefficients See table 2</p> <p>Material Temperature Capabilities⁽²⁾ -20° to 180°F (-29° to 82°C)</p> <p>Spring Case Vent Connection 1/4-inch NPT</p> <p>Diaphragm Case Connection 1/2-inch NPT</p> <p>Approximate Weight 13 pounds (5,9 kg)</p>
--	---

1. End connections for other than U.S. standards can usually be provided; consult the Fisher Sales Office or Sales Representative.
2. The pressure/temperature limits in this instruction manual and any applicable standard or code limitation should not be exceeded.

Table 1. Outlet (Control) Pressure Ranges

TYPE NUMBER	SPRING COLOR	SPRING PART NUMBER	OUTLET PRESSURE RANGE WITH SPRING CASE ABOVE DIAPHRAGM	APPROXIMATE POINT ABOVE PRESSURE SETTING AT WHICH THE TYPE Y600AR INTERNAL RELIEF STARTS TO DISCHARGE
Y600A, Y600AM, Y600AR	Red	1B653827052	4 to 8-Inches w.c. (10 to 20 mbar)	10 to 24-Inches w.c. (25 to 60 mbar)
	Olive drab	1B653827022	7 to 16-Inches w.c. (17 to 40 mbar)	10 to 28-Inches w.c. (25 to 65 mbar)
	Yellow	1B637027052	15-Inches w.c. to 1.2 psig (37 to 83 mbar)	
	Light green	1B537127022	1.2 to 2.5 psig (0,083 to 0,17 bar)	0.5 to 2 psig (0,034 to 0,14 bar)
	Light blue	1B537227022	2.5 to 4.5 psig (0,17 to 0,31 bar)	0.5 to 3 psig (0,034 to 0,21 bar)
	Black	1B537327052	4.5 to 7 psig (0,31 to 0,52 bar)	1 to 4 psig (0,69 to 0,28 bar)

Table 2. Maximum Operating Inlet Pressures

ORIFICE SIZE, INCHES (mm)	MAXIMUM OPERATING INLET PRESSURE, PSIG (bar)					WIDE-OPEN C _g FOR EXTERNAL RELIEF SIZING	C ₁
	4 to 16-Inches w.c. (10 to 40 mbar)	15-Inches w.c. to 1.2 Psig (37 to 83 mbar)	1.2 to 2.5 Psig (0,08 to 0,17 bar)	2.5 to 4.5 Psig (0,17 to 0,31 bar)	4.5 to 7 Psig (0,31 to 0,52 bar)		
1/8 (3,2)	150 (10,3)	150 (10,3)	150 (10,3)	150 (10,3)	150 (10,3)	12.3	35
3/16 (4,8)	150 (10,3)	150 (10,3)	150 (10,3)	150 (10,3)	150 (10,3)	27.6	
1/4 (6,4)	75 (5,2)	60 (4,1)	150 (10,3)	150 (10,3)	150 (10,3)	50	
3/8 (9,5)	35 (2,4)	30 (2,1)	60 (4,1)	60 (4,1)	60 (4,1)	110	
1/2 (12,7)	8 (0,55)	6 (0,41)	10 (0,69)	12 (0,83)	12 (0,83)	200	
9/16 (14,3)	5 (0,34)	2 (0,14)	6 (0,41)	8 (0,55)	9 (0,62)	250	

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate instruction manual.

1. Only personnel qualified through training and experience should install, operate, and maintain a regulator. For a regulator that is shipped separately, make sure that there is no damage to, or foreign material in, the regulator. Also ensure that all tubing and piping are free of debris.

2. The regulator may be installed in any position as long as the flow through the body is in the direction indicated by the arrow cast on the body. 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.

3. Be certain that the vent (key 26) is not positioned so that it can collect moisture which may drain into the spring case. The diaphragm casing (key 4) may be rotated to any of four positions with respect to the body in order to obtain desired positioning. Perform Body Area Maintenance procedure steps 1 and 4 through 8 to rotate the diaphragm casing.

4. The Type Y600AM regulator requires a downstream control line. Be sure to install this control line before putting the regulator into operation. The downstream control line pipe should be at least 1/2-inch in diameter and connected to a straight section of outlet piping at least 5 to 10 pipe diameters downstream of the regulator. If instability due to turbulence exists, a hand valve can be installed in a straight section of the control line. This hand valve can be throttled down to dampen out pulsations.

Start-up and Adjustment

A Y600A Series regulator can be placed in operation by slowly introducing inlet pressure. The regulator takes control when downstream pressure is established.

The regulator has been adjusted at the factory to provide approximately the reduced pressure requested on the order. With a spring-loaded regulator, the pressure setting may be adjusted within the spring range shown in table 1. To adjust the pressure setting, perform the following steps (key numbers are referenced in figures 3 through 6):

1. Remove the closing cap (key 22).
2. Use a 1-inch hex rod or screwdriver to turn the adjusting screw (key 35) either clockwise to increase outlet pressure or counterclockwise to decrease outlet pressure.

WARNING

To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion

of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range according to the diaphragm and spring case area section of the maintenance procedure.

3. After making the adjustment and replacing the closing cap (key 22), the closing cap can be wired to the spring case (key 3) to discourage tampering.

Shutdown

First close the nearest upstream shutoff valve and then close the nearest downstream shutoff valve to vent the regulator properly. Next, open the vent valve between the regulator and the downstream shutoff valve closest to it. All pressure between these shutoff valves is released through the open vent valve, since a Y600A Series regulator remains open in response to the decreasing downstream pressure.

Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends on the severity of service conditions and upon applicable codes and government regulations. Key numbers are referenced in figures 3 through 5 unless otherwise noted.

WARNING

To avoid personal injury, property damage, or equipment damage caused by sudden release of pressure or explosion of accumulated gas, do not attempt any maintenance or disassembly without first isolating the regulator from system pressure and relieving all internal pressure from the regulator.

Body Area

This procedure is for gaining access to the disk assembly, orifice, body O-ring, and pitot tube if used. All pressure must be released from the diaphragm

Y600A Series

casing, and the disk assembly must be open, before these steps can be performed.

1. Remove the cap screws (key 2) and separate the diaphragm casing (key 4) from the body (key 1).
2. Remove and inspect the body seal O-ring (key 11) and the backup ring (key 48). See figure 2.
3. Inspect and replace the orifice (key 5) if necessary. Protect the orifice seating surface during disassembly and assembly. Lubricate the threads of the replacement orifice with a good grade of light grease and install with 29 to 37 foot-pounds (39 to 50 N·m) of torque.
4. To replace the disk assembly (key 13), remove the cotter pin (key 15). If not necessary, skip to step 7.
5. To replace the pitot tube (key 32, figures 3 and 6) on the Types Y600A and Y600AR, remove the machine screws (key 33), install the new pitot tube, and secure with the machine screws. Position the pitot tube so that it points into the outlet of the body (key 1) by rotating the guide insert (key 18).
6. Install the disk assembly (key 13) and secure it with the cotter pin (key 15).
7. Place backup ring (key 48) into the body (key 1). Then place the body seal O-ring (key 11) into the body. See figure 2.
8. Place the diaphragm casing (key 4) on the body (key 1). Secure the diaphragm casing to the body with the cap screws (key 2) using 7 to 9 foot-pounds (9 to 12 N·m).

Diaphragm and Spring Case Area

This procedure is for gaining access to the spring, diaphragm, lever assembly stem, and Type Y600AM stem O-ring. All pressure must be released from the diaphragm casing before performing these steps.

Note

Any Type 662 remote control drive unit used with a Y600A Series regulator must be removed from the spring case (key 3) before these steps can be performed.

1. Remove the closing cap (key 22), and turn the adjusting screw (key 35) counterclockwise to remove the compression from the spring (key 6).

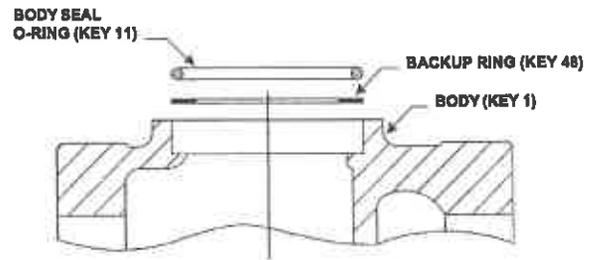


Figure 2. Expanded View of the Body Area Showing the Body Seal O-ring and Backup Ring Placement

2. If the only maintenance is to change the control spring, take out the control spring and replace with the desired spring. Turn the adjusting screw (key 35) clockwise to compress the spring to the desired outlet pressure setting. Skip to step 11.
3. If further maintenance to the internal diaphragm casing parts is required, remove the hex nuts (key 23, not shown) and cap screws (key 24). Remove the diaphragm (key 10) plus attached parts by tilting them so that the pusher post (key 8) slips off the lever assembly (key 16). To separate the diaphragm from the attached parts, unscrew the cap screw (key 38, figures 3 and 4) from the pusher post (key 8) for a Type Y600A or Y600AM, OR unscrew the relief valve spring holder (key 37, figure 6) from the pusher post (key 8) for a Type Y600AR. If the only further maintenance is to replace the diaphragm parts, skip to step 7.
4. To replace the lever assembly (key 16), remove the machine screws (key 17). To replace the stem (key 14) or the Type Y600AM stem O-ring (key 30, figure 4), also perform Body Area Maintenance procedure steps 1 and 4, and pull the stem (key 14) out of the diaphragm casing (key 4). With a Type Y600AM, grease the replacement stem O-ring (key 30, figure 4) with a good grade of lubricant and install it on the stem (key 14).
5. Install the stem (key 14) into the diaphragm casing (key 4) and perform Body Area Maintenance procedure steps 6 through 8 as necessary.
6. Install the lever assembly (key 16) into the stem (key 14) and secure the lever assembly with the machine screws (key 17).
7. For a Type Y600A or Y600AM (figures 3 and 4), hold the pusher post (key 8) and place diaphragm assembly parts on the pusher post in the following order: diaphragm (key 10), diaphragm head (key 7),

lower spring seat (key 50), and washer (key 36), and secure with diaphragm cap screw (key 38) using 7 to 9 foot-pounds (9 to 12 N·m) of torque OR for a Type Y600AR (figure 5), secure the pusher post (key 8) to the relief valve spring holder with 1 to 3 foot-pounds (1,4 to 4,1 N·m) of torque.

8. Install the pusher post (key 8) and attached parts onto the lever (key 16)

9. Install the control spring (key 6) and spring case (key 3) on the diaphragm casing (key 4) so that the vent assembly (key 26) is correctly oriented, and secure them with the cap screws (key 24) and hex nuts (key 23) to finger tightness only.

10. Turn the adjusting screw (key 35) clockwise until there is enough control spring (key 6) force to provide proper slack to the diaphragm (key 10). Using a crisscross pattern, finish tightening the cap screws (key 24) and hex nuts to 5 to 6 foot-pounds (6,8 to 8,1 N·m) of torque. Finish turning the adjusting screw to the desired outlet pressure setting.

11. Install the closing cap (key 22) or the Type 662 remote control drive unit, if used.

To Convert Constructions

The Type Y600A to the Type Y600AM:

New parts required: keys 30, 31, and 33

1. Remove pipe plug (key 27) from the diaphragm casing (key 4).

2. Refer to steps 1 and 5 in the Body Area Maintenance section to remove the four machine screws (key 33) and pitot tube (key 32, figure 3).

3. Insert the throat O-ring (key 31, figure 4) and one machine screw (key 33, figure 4).

4. Insert the stem O-ring (key 30, figure 4) by following steps 1 through 6 in the Diaphragm and Spring Case Area Maintenance section. Reassemble

The Type Y600AM to the Type Y600A:

New parts required: keys 27, 32, and 33

1. Insert pipe plug (key 27, figure 4) in the diaphragm casing (key 4).

2. Follow steps 1 through 4 in the Diaphragm and Spring Case Area Maintenance Section to remove one machine screw (key 33, figure 3), the stem seal O-ring

(key 30, figure 4), and the throat seal (key 31, figure 4) blocking the registration port.

3. Insert pitot tube (key 32) and four machine screws (key 33) as outlined in step 5 of the Body Area Maintenance section.

Parts Ordering

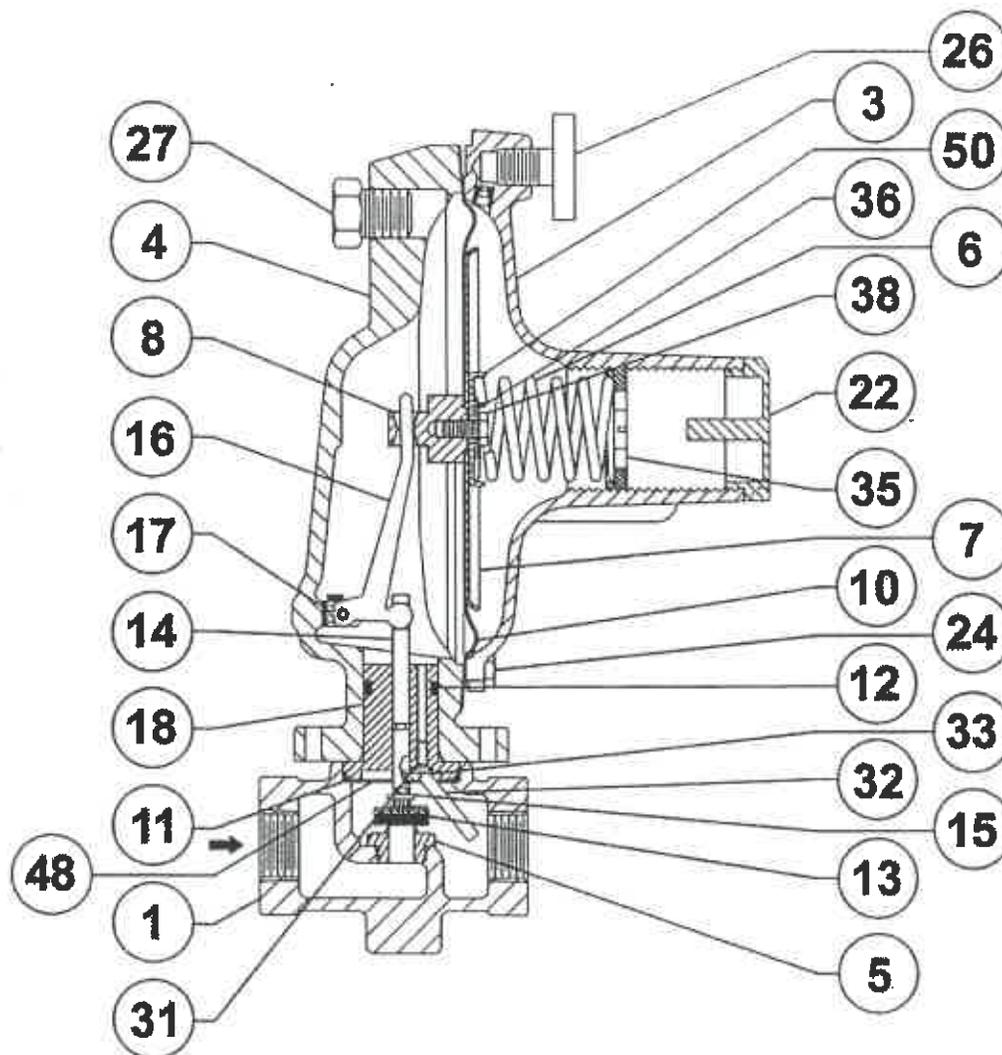
When corresponding with the Fisher Sales Office or Sales Representative about this regulator, include the type number and all other pertinent information stamped on the closing cap. Specify the eleven-character part number when ordering new parts from the following parts list.

Parts List (figures 3 through 6)

Key	Description	Part Number
	Parts Kit (keys 10, 11, 12, 13, 15, 30, and 31)	
	Type Y600A and Y600AM	RY600AX0012
	Type Y600AR	RY600ARX012
1	Body, Cast iron	
	3/4 x 3/4-inch	1E987119012
	1 x 1-inch	1E987319012
2	Cap Screw (2 required), Plated steel	1C856228992
3	Spring Case Assembly, Cast iron	1B8365X0342
4	Diaphragm Casing, Cast iron	47B2271X012
5	Orifice, Aluminum	
	1/8-inch (3,2 mm)	1A936709012
	3/16-inch (4,8 mm)	00991209012
	1/4-inch (6,4 mm)	0B042009012
	3/8-inch (9,5 mm)	0B042209012
	1/2-inch (12,7 mm)	1A928809012
	9/16-inch (14,3 mm)	1C4252X0012
6	Spring, Plated steel	
	4 to 8-inches w.c. (10 to 20 mbar)	1B653827052
	7 to 16-inches w.c. (17 to 40 mbar)	1B653927022
	15-inches w.c. to 1.2 psig (37 to 83 mbar)	1B537027052
	1.2 to 2.5 psig (0,083 to 0,17 bar)	1B537127022
	2.5 to 4.5 psig (0,17 to 0,31 bar)	1B537227022
	4.5 to 7 psig (0,31 to 0,52 bar)	1B537327052
7	Diaphragm Head	
	Type Y600A and Y600AM, 304 Stainless steel	17B9723X032
	Type Y600AR, Plated steel	1B541425072
8	Pusher Post	
	Type Y600A and Y600AM, Aluminum	17B9734X032
	Type Y600AR, Zinc	2B541944012
10*	Diaphragm, Nitrile	
	Type Y600A and Y600AM	17B9726X012
	Type Y600AR	1C942902072
11*	Body Seal O-ring, Nitrile	1H993808992
12*	Insert Seal O-ring, Nitrile	1B885508992
13*	Disk Assembly, Aluminum Disk Holder with Nitrile disk	1C4248X0212
14	Stem, Stainless Steel	17B3423X012
15*	Cotter Pin, Stainless steel	1A886537022
16	Lever Assembly, Plated steel	1B5375X0082
17	Machine Screw (2 required), Stainless steel	19A7151X022
18	Guide Insert, Delrin	27B4028X012

* Recommended spare part.

Y600A Series

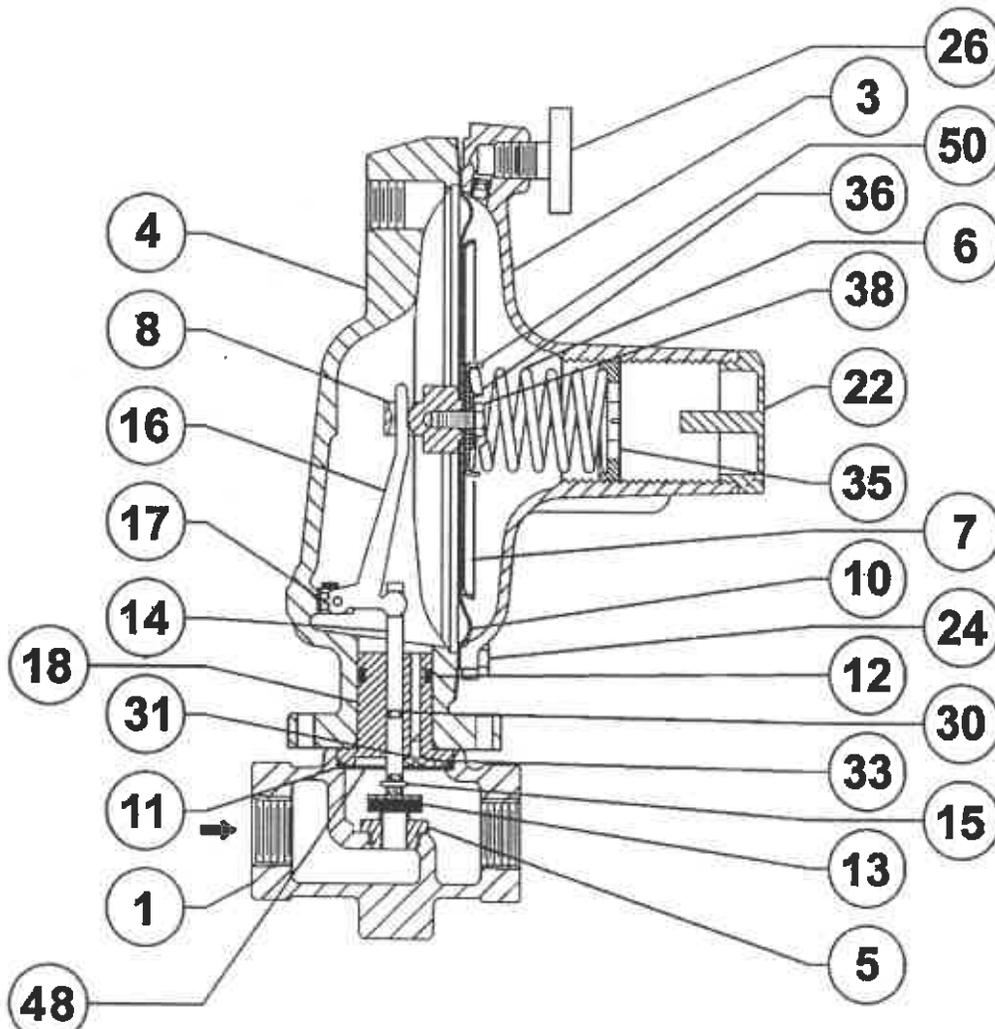


AT141_1

Figure 3. Type Y600A Regulator Assembly

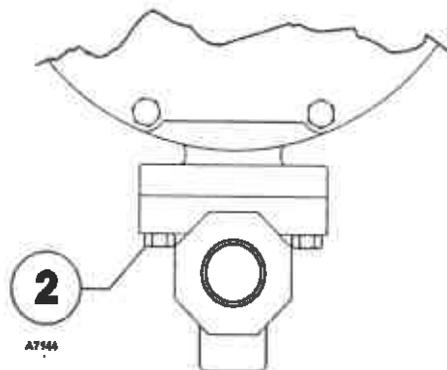
Key	Description	Part Number	Key	Description	Part Number
22	Closing Cap, Thermoplastic	T13524T0062	33	Machine Screw, Stainless steel	
23	Hex Nut, not shown (8 required), Plated steel	1E985324142		Type Y600AM (1 required)	18A0703X022
24	Cap Screw (8 required), Plated steel	T1070824912		Types Y600A and Y600AR (4 required)	19A7151X022
26	Type Y602 Vent Assembly		35	Adjusting Screw, Zinc	1B537944012
	Spring case up (standard)	17A5515X012	36	Washer	18B3440X012
	Spring case down	17A6570X012	37	Spring Holder (Type Y600AR only), Plated steel.	1C323114012
27	Pipe Plug, Plated steel (Types Y600A and Y600AR only)	1A369224492	38	Diaphragm Cap Screw (Types Y600A and Y600AM only), Plated steel	1B290524052
30*	Stem O-Ring (Type Y600AM only), Nitrile (NBR)	1H292606992	39	Relief Valve Spring(Y600AR only), Plated steel	1B541327022
31*	Throat Seal O-Ring (Type Y600AM only), Nitrile (NBR)	1D682506992	48	Back Up Ring, Stainless Steel	18B3446X012
32	Pitot Tube (Types Y600A and Y600AR only), 304 Stainless steel	17B4479X012	50	Lower Spring Seat (Types Y600A and Y600AM only), Plated steel	1B636325062

* Recommended spare part.



A7142_1

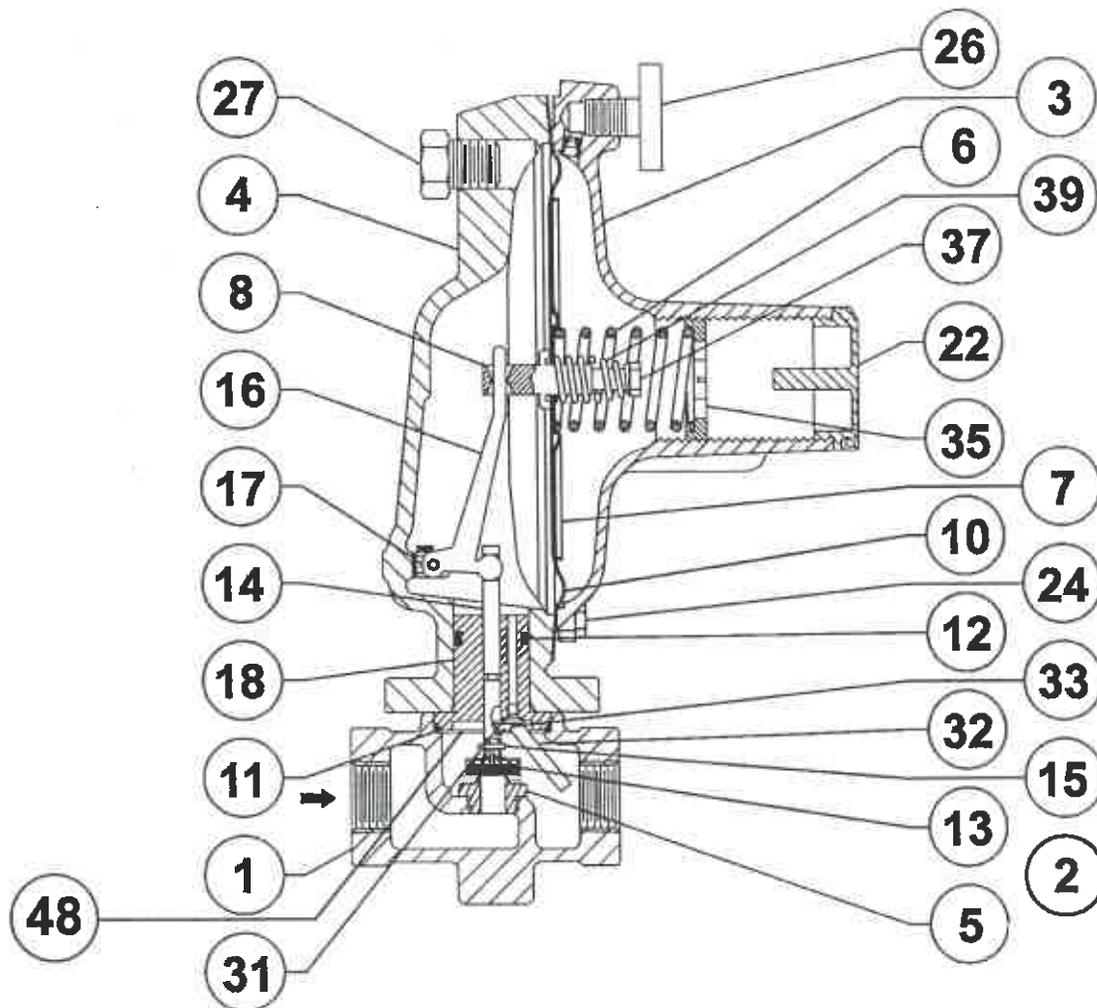
Figure 4. Type Y600AM Regulator Assembly



A7544

Figure 5. Diaphragm Casing Cap Screw Location

Y600A Series



A7143

Figure 6. Type Y600AR Regulator Assembly

Fisher is a mark owned by Fisher Controls International, Inc., a business of Emerson Process Management. The Emerson logo is a trademark and service mark of Emerson Electric Co. All other marks are the property of their respective owners.

The contents of this publication are presented for informational purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. We reserve the right to modify or improve the designs or specifications of such products at any time without notice.

Fisher does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Fisher product remains solely with the purchaser.

For information, contact Fisher:
 Marshalltown, Iowa 50158 USA
 McKinney, Texas 75070 USA
 28320 Gallardon, France
 40013 Castel Maggiore (BO), Italy
 Sao Paulo 05424 Brazil
 Singapore 128461

Model 1530

Three-Way Thermostatic Valve



1530	1 1/2" NPT
1530M	1 1/2" NPT with Manual Override
1530J16	1" SAE O-Ring
1530J20	1 1/4" SAE O-Ring
1530J24	1 1/2" SAE O-Ring
F1530	1 1/2" 125# FF Flange
SF1530	1 1/2" 150# RF Flange
SF1530X	1 1/2" 300# RF Flange

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 brass or nickel-plated sleeve, which directs flow. All FPE Thermostatic Valves are factory set at predetermined temperatures: no further adjustments are necessary. A wide range of temperatures are available for water and oil temperature control applications.

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.

In a mixing application, hot fluid enters the "B" port and colder fluid enters the "C" port. The flows mix and the thermostat adjusts 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, steel and stainless steel housings are available.

Available connections: NPT, SAE O-Ring, 125# FF Flange, 150# RF Flange, 300# RF Flange, Navy and Metric Flanges.

Optional Features: Manual Override, High Over Temp elements, Plated elements. Other options available upon request.

Features

Wide Range of Temperatures

Heavy Duty

Self-Contained

Replaceable Element

Non-Adjustable

Rugged Construction

Tamper-Proof

Operate in Any Position



FLUID POWER ENERGY, INC.

W229 N591 Foster Court • Waukesha, WI 53186

262 • 548 • 6220 Fax 262 • 548 • 6239

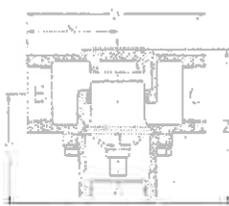
www.fpevalves.com



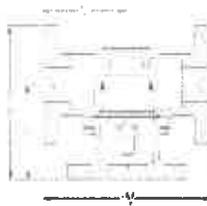
Model 1530

MODEL NUMBER	BODY MATERIAL (*)	NOMINAL PIPE SIZE	PRINCIPAL DIMENSIONS (UNITS In. & (mm))				MAX WIDTH IN THE OTHER PLANE	FLANGE DRILLING			NO. OF ELEMENTS	APPROX. SHIPPING WEIGHT	NOTES OR NUMBERED ENDNOTES
			"X"	"Y"	"W"	"Z"		NO. OF HOLES	DIA. OF HOLES	BOLT CIRCLE			
*1530	A, B, D S, SS	1 1/2" NPT	3 3/4 (95.25)	3 1/16 (77.78)	6 1/8 (155.58)	5 1/4 (133.35)	3 3/4 (95.25)	N/A	N/A	N/A	1	A & D=216, B=246 S & SS=178	
*1530J16	A, B, D S, SS	SAE 16 1"	3 3/4 (95.25)	3 1/16 (77.78)	6 1/8 (155.58)	5 1/4 (133.35)	3 3/4 (95.25)	N/A	N/A	N/A	1	A & D=216, B=246 S & SS=178	
*1530J20	A, B, D S, SS	SAE 20 1 1/4"	3 3/4 (95.25)	3 1/16 (77.78)	6 1/8 (155.58)	5 1/4 (133.35)	3 3/4 (95.25)	N/A	N/A	N/A	1	A & D=216, B=246 S & SS=178	
*1530J24	A, B, D S, SS	SAE 24 1 1/2"	3 3/4 (95.25)	3 1/16 (77.78)	6 1/8 (155.58)	5 1/4 (133.35)	3 3/4 (95.25)	N/A	N/A	N/A	1	A & D=216, B=246 S & SS=178	
*1530M	A, B, D S, SS	1 1/2" NPT	3 3/4 (95.25)	3 1/16 (77.78)	6 1/8 (155.58)	N/A	3 3/4 (95.25)	N/A	N/A	N/A	1	A & D=216, B=246 S & SS=178	Manual Override
*F1530	A, B, D	1 1/2" 128# RF FLANGE	4 (101.60)	3 1/2 (88.90)	7 (177.80)	6 1/2 (165.10)	5 (127.00)	4 (101.60)	5/8 (15.88)	3 7/8 (98.43)	1	A&D=178 B=166	
	S, SS	1 1/2" 150# RF FLANGE	4 (101.60)	3 1/2 (88.90)	7 (177.80)	N/A	5 (127.00)	4 (101.60)	5/8 (15.88)	3 7/8 (98.43)	1	S & SS=178	
*F1530M	A, B, D	1 1/2" 128# RF FLANGE	4 (101.60)	3 1/2 (88.90)	7 (177.80)	N/A	5 (127.00)	4 (101.60)	5/8 (15.88)	3 7/8 (98.43)	1	A&D=178 B=166	Manual Override
	S, SS	1 1/2" 150# RF FLANGE	4 (101.60)	3 1/2 (88.90)	7 (177.80)	N/A	5 (127.00)	4 (101.60)	5/8 (15.88)	3 7/8 (98.43)	1	S & SS=178	Manual Override
*F1530X	S, SS	1 1/2" 300# RF FLANGE	4 3/4 (120.65)	4 (101.60)	8 (203.20)	7 13/16 (195.44)	6 1/8 (158.08)	4 (101.60)	7/8 (22.23)	4 1/2 (114.30)	1	S & SS=206	
*F1530XM	S, SS	1 1/2" 300# RF FLANGE	4 3/4 (120.65)	4 (101.60)	8 (203.20)	7 13/16 (195.44)	6 1/8 (158.08)	4 (101.60)	7/8 (22.23)	4 1/2 (114.30)	1	S & SS=206	Manual Override

* (Replace * with body material type; A=Cast Iron, B=Bronze, D=Ductile Iron, S=Steel, SS=Stainless Steel)



*1530, *1530J



*F1530, *F1530X

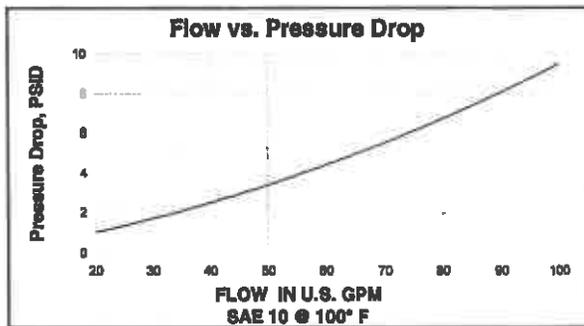


*1530M



*F1530M, *F1530XM

PRESSURE RATINGS	
MATERIAL	PSI
A, B	150
D	250
S, SS	500
SF, SSF	275
SFX, SSFX	720

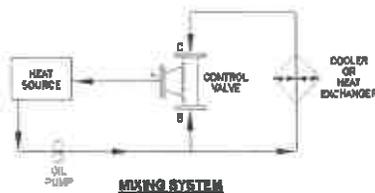


Recommended Pressure Drop is 2 to 7 PSI

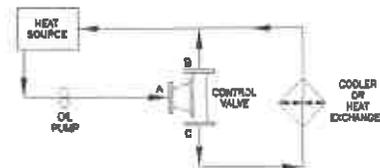
*1530	VALVE BODY (*See table for material)
1572**	O-RING (Standard material is Buna-N)
1580-Temp	THERMOSTAT (Temp to follow dash)
1601	LOCK WASHER
1572**	O-RING (Standard material is Buna-N)
1580-Temp	THERMOSTAT (Temp to follow dash)

Viton® is a registered trademark of DuPont Dow Elastomers

APPLICATION CHARTS



MIXING SYSTEM



DIVERTING SYSTEM



FPF1530-050R03

FLUID POWER ENERGY, INC.

W229 N591 Foster Court • Waukesha, WI 53186
262•548•6220 Fax 262•548•6239

www.fpevalves.com

To Order

Specify Model Number, nominal temperature desired, and housing material. For Model coding information, visit our website or consult your factory representative.



FLOTECT® Model V6 Flow Switch

Specifications - Installation and Operating Instructions



The FloTECT® Model V6 is an inexpensive, explosion-proof flow switch for use on air, water or other compatible gases and liquids. Three configurations are available - 1. Factory installed in a tee. 2. With a trimmable vane for field adjustment and installation in a suitable tee. 3. Low flow models with an integral tee and adjustable valve. All are available with an optional enclosure which is UL and CSA listed, or Directive 94/9/EC (ATEX) compliant for $\text{CE} \text{ II } 2 \text{ G EEx d IIC T6}$ Process Temp=75°C.

INSTALLATION

Unpack and remove any packing material found inside lower housing or tee.

Switch can be installed in any position but the actuation/deactuation flow rates in the charts are based on horizontal pipe runs and are nominal values. For more precise settings, units can be factory calibrated to specific flow rates.

V6 Models with Tee are supplied in 1/2" - 2" NPT sizes. Install in piping with arrow pointing in direction of flow.

V6 Low Flow Models have 1/2" NPT connections and are field adjustable. Install in piping with arrow pointing in direction of flow. To adjust, loosen the four socket head cap screws on bottom. The adjustment valve rotates 90° between "O" (open) and "C" (closed). See flow charts for approximate ranges. Tighten screws once the required flow rate has been set.

V6 with Field Trimmable Vane. These models enable the installer to choose approximate actuation/deactuation points by trimming the full size vane at appropriate letter-designated marks on a removable template. Flows are defined in the following charts. Note that the charts are based on either brass or cast iron reducing tees or stainless or forged steel straight tees with bushings where necessary. Install in piping with arrow pointing in direction of flow.

SPECIFICATIONS

Service: Gases or liquids compatible with wetted materials.

Wetted Materials: Standard V6 Models: Vane: 301 SS; Lower Body: brass or 303 SS; Magnet: ceramic; Other: 301, 302 SS; Tee: brass, iron, forged steel, or 304 SS.

V6 Low Flow Models: Lower Body: brass or 303 SS; Tee: brass or 304 SS; Magnet: ceramic; O-ring: Buna-N standard, Viton® optional; Other: 301, 302 SS.

Temperature Limits: -4 to 220°F (-20 to 105°C) Standard, MT high temperature option 400°F (205°C) [MT not UL, CSA or ATEX]. ATEX compliant AT option ambient temperature -4 to 167°F (-20 to 75°C), process temperature: -4 to 220°F (-20 to 105°C).

Pressure Limit: Brass lower body with no tee models 1000 psig (69 bar), 303 SS lower body with no tee models 2000 psig (138 bar). Brass tee models 250 psi (17.2 bar), iron tee models 1000 psi (69 bar), forged and stainless steel tee models 2000 psi (138 bar), low flow models 1450 psi (100 bar).

Enclosure Rating: Weatherproof and Explosion-proof. Listed with UL and CSA for Class I, Groups A, B, C and D; Class II, Groups E, F, and G. (Group A on stainless steel body models only).

$\text{CE} \text{ II } 2 \text{ G EEx d IIC T6}$ Process Temp=75°C.

EC-type Certificate No.: KEMA 04ATEX2128.

Switch Type: SPDT snap switch standard, DPDT snap switch optional.

Electrical Rating: UL models: 5A @ 125/250 VAC (V-), CSA and ATEX models: 5A @ 125/250 VAC (V-); 5A res., 3A Ind. @ 30 VDC (V=), MV option: 1A @ 125 VAC (V-), MT option: 5A @ 125/250 VAC (V-), [MT option not UL, CSA or ATEX].

Electrical Connections: UL models: 18 AWG, 18" (460 mm) long. ATEX/CSA models: terminal block.

Upper Body: Brass or 303 stainless steel.

Conduit Connections: 3/4" male NPT standard, 3/4" female NPT on junction box models.

Process Connection: 1/2" male NPT on models without a tee.

Mounting Orientation: Switch can be installed in any position but the actuation/deactuation flow rates in the charts are based on horizontal pipe runs and are nominal values.

Set Point Adjustment: Standard V6 models none. Without tee models vane is trimmable. Low flow models are field adjustable in the range shown. See set point charts on opposite page.

Weight: 2 to 6 lb (.9 to 2.7 kg) depending on construction.

When bushings are used, they must be back drilled to allow proper clearance for unrestricted vane travel. Bore the I.D. to 13/16" (20 mm) on 1/2" x 3/4" bushings or 1" (25 mm) on larger bushings. The depth of the bore must leave internal threads 9/16" (14 mm) high for proper engagement between the lower housing of the switch and the bushing. Check for proper vane travel and switch operation after installation.

ELECTRICAL CONNECTIONS

Connect wire leads in accordance with local electrical codes and switch action required. N.O. contacts will close and N.C. contacts will open when flow increases to the actuation point. They will return to "normal" condition when flow decreases to the deactuation point. Black = Common, Blue = Normally Open and Red = Normally Closed.

For units supplied with both internal and external grounds, the ground screw inside the housing must be used to ground the control. The external ground screw is for supplementary bonding when allowed or required by local code. Some CSA listed models are furnished with a separate green ground wire. Such units must be equipped with a junction box, not supplied but available on special order.

EC-Type Certificate Installation Instructions:

Cable Connection

The cable entry device shall be an EEx d certified cable gland suitable for conditions of use and correctly installed. The certified cable gland and cable shall be rated for a minimum temperature of 80°C.

Conduit Connection

An EEx d certified seal device such as a conduit seal with setting compound suitable for conditions of use and correctly installed shall be provided immediately to the entrance of the electrical housing. The certified conduit seal and setting compound and cable shall be rated for a minimum temperature of 80°C.

Note: ATEX units only: The temperature class is determined by the maximum ambient and or process temperature. Units are intended to be used in ambient of -20°C ≤ Tamb ≤ 75°C. Units may be used in process temperatures up to 105°C providing the enclosure and switch body temperature do not exceed 75°C. The standard Temperature Class is T6 Process Temp ≤ 75°C.

All wiring, conduit and enclosures must meet applicable codes for hazardous areas. Conduits and enclosures must be properly sealed. For outdoor or other locations where temperatures vary widely, precautions should be taken to prevent condensation inside switch or enclosure. Electrical components must be kept dry at all times.

CAUTION: To prevent ignition of hazardous atmospheres, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in use.

MAINTENANCE

Inspect and clean wetted parts at regular intervals. The cover should be in place at all times to protect the internal components from dirt, dust and weather and to maintain hazardous location ratings. Disconnect device from the supply circuit before opening to prevent ignition of hazardous atmosphere.

V6 With Tee

Cold Water - Factory Installed Tee

Approximate actuation/deactuation flow rates
GPM upper, LPM lower

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
1.5 1.0	2.0 1.25	3.0 1.75	4.0 3.0	6.0 5.0	10.0 8.5
6.7 3.8	7.6 4.7	11.4 6.6	15.1 11.4	22.7 18.9	37.9 32.2

Air-Factory Installed Tee

Approximate actuation/deactuation flow rates
SCFM upper, LPM lower

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
6.5 5.0	10.0 8.0	14 12	21 18	33 30	43 36
180 140	280 230	400 340	590 510	930 850	1220 1020

V6 Low Flow, Field Adjustable

Cold Water - Low Flow Models

Approximate actuation/deactuation flow rates
GPM upper, LPM lower

MINIMUM		MAXIMUM	
.04	.03	.75	0.60
.15	.11	2.8	2.3

Air - Low Flow Models

Approximate actuation/deactuation flow rates
SCFM upper, LPM lower

MINIMUM		MAXIMUM	
.18	.15	2.70	2.0
5.1	4.2	76	57

Example	V6	EF	R	R	S	T	B	MT	
Series	V6								V6EPB-B-S-2-B-MT flow switch: brass upper housing, brass lower housing, brass tee with 1/2" NPT connections, SPDT brass switch, and high temperature option
Construction		EP							Series V6 flow switch Explosion Proof and Weatherproof
Upper Body Material			H						Brass 303 Stainless Steel
Lower Body Material				B					Brass 303 Stainless Steel
Circuit (Switch)					S				SPDT DPDT
Process Connection Size						1 2 3 4 5 6 L.F.			1/2" NPT 3/4" NPT 1" NPT 1-1/4" NPT 1-1/2" NPT 2" NPT Low Flow Model (1/2" NPT connections)
Process Connection Type							O B FS MI PVC PVC/SW S S150		No tee, Male NPT Connection, Field Adjustable Vane Brass Tee Forged Steel Tee Iron Tee PVC Tee with NPT* PVC Tee with sweat joints* 304 Stainless Steel Tee 304 Stainless Steel 150# Tee
Switch Options								NV NT	(For L.F. Model no tee material chosen, tee material matches lower housing material) Solid Contacts on snap switch for dry circuits (see specifications for ratings) High Temperature wetted rated 300°F (200°C) (see specifications for ratings)*
Options									ATEX approved construction (with JCT option standard) CSA approved construction (with JCT option standard) Custom Vane Flow Test Report Ground Lead* Customer information on standard nameplate Weatherproof and explosion-proof junction box* Weatherproof and explosion-proof junction box, left side Orifice Brass Orifice Stainless Steel Reinforced Vane Terminal Block Connector* Viton® O-rings in place of Buna-N on low flow models .018 Spring .020 Spring .022 Spring .022 Spring with Alnico® magnet .031 Spring

* Options that do not have ATEX

Attention: Units without the "AT" suffix are not Directive 94/9/EC (ATEX) compliant. These units are not intended for use in potentially hazardous atmospheres in the EU. These units may be CE marked for other Directives of the EU.

V8 With Field Trimmable Vane
Cold Water - Brass or Cast Iron Reducing Tee
 Approximate actuation/deactuation flow rates
 GPM upper, LPM lower

Air - Brass or Cast Iron Reducing Tee
 Approximate actuation/deactuation flow rates
 SCFM upper, LPM lower

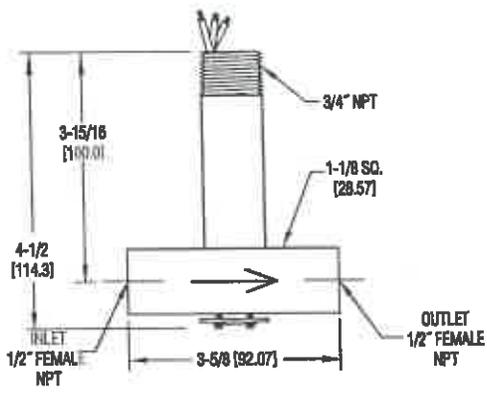
Vane	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
Full Size						9.0 8.5						39.0 37.0
a						34.1 32.2						1100 1050
b						9.5 9.0						40.0 38.0
c						36.0 34.1						1130 1080
d						10.0 9.3						42.0 40.0
e						37.9 35.2						1190 1130
f						11.0 10.0						50.0 44.0
g						41.6 37.9						1420 1250
h					6.2 5.5	12.0 10.0					27.0 25.0	55.0 46.0
i					23.5 20.8	45.4 37.9					780 710	1560 1300
j					7.0 6.5	13.0 11.0					30.0 28.0	
k					26.5 24.6	49.2 41.6					850 790	
l				4.3 3.9	7.6 7.1	14.0 12.0					20.0 18.0	32.0 30.0
m				16.3 14.8	26.8 26.9	53.0 45.4				20.0 18.0	32.0 30.0	
n				4.9 4.4	8.0 7.3					570 510	910 850	
o				18.5 16.7	30.3 27.6					590 540	960 910	
p				5.5 5.0	9.0 8.2					23.0 21.0	37.0 34.0	
q				20.8 18.9	34.1 31.0					650 590	1050 960	
r			3.5 3.1	6.0 5.6	10.0 9.0				16.0 15.0	24.0 22.0	39.0 36.0	
s			13.2 11.7	22.7 21.2	37.9 34.1				450 430	680 620	1100 1020	
t			4.0 3.5	7.0 6.6	13.0 11.0				18.0 16.0	28.0 25.0	61.0 45.0	
u			15.1 13.2	26.5 25.0	49.2 41.6				510 450	790 710	1440 1270	
v			4.8 4.2	8.0 7.6	15.0 13.0				19.0 17.0	33.0 30.0	69.0 57.0	
w			17.4 15.9	30.3 28.8	56.8 49.2				540 480	930 850	1950 1610	
x		2.5 2.3	5.6 5.2	10.0 9.0					13.0 12.0	22.0 20.0	38.0 35.0	
y		9.8 8.7	21.2 19.7	37.9 34.1					370 340	620 570	1080 990	
z	1.6 1.3	3.5 3.1	6.3 6.1	12.0 10.0			6.4 3.8	15.0 14.0	25.0 23.0	45.0 42.0		
aa	6.1 4.9	13.2 11.7	23.8 23.1	45.4 37.9			180 110	420 400	710 650	1270 1190		
ab	2.2 1.8	4.3 3.6	8.0 7.5				10.0 7.0	20.0 16.0	32.0 28.0			
ac	8.3 6.8	16.3 14.4	30.3 26.4				280 200	570 450	910 790			
ad	3.0 2.4						12.0 9.0					
ae	11.4 9.1						340 250					

Cold Water - Stainless or Forged Steel Straight Tee and Bushing
 Approximate actuation/deactuation flow rates
 GPM upper, LPM lower

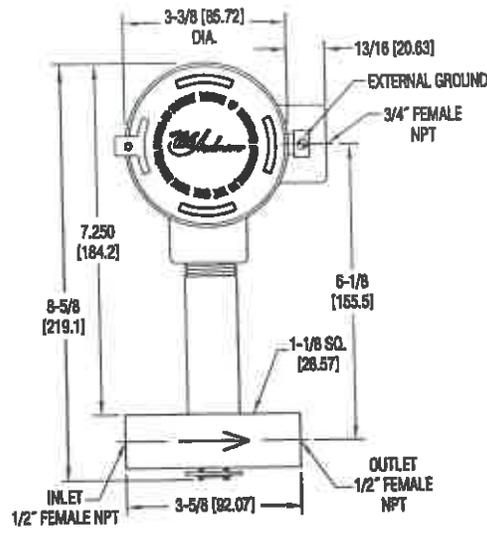
Air - Stainless or Forged Steel Straight Tee and Bushing
 Approximate actuation/deactuation flow rates
 SCFM upper, LPM lower

Vane	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
Full Size						5.0 4.5 8.5 7.8						21.0 18.0 33.0 30.0
a						18.9 17.0 32.2 29.5						590 510 930 850
b						5.5 5.0 9.2 8.6						22.0 20.0 39.0 36.0
c						20.8 18.9 34.8 32.6						620 570 1100 1020
d						6.2 5.7 9.8 9.0						24.0 22.0 42.0 38.0
e						23.5 21.6 37.1 34.1						680 620 1190 1080
f						6.8 6.3 12.0 10.0						28.0 26.0 51.0 46.0
g						25.7 23.8 45.4 37.9						790 740 1440 1300
h			2.8 2.4	8.5 7.8	13.0 11.0				12.0 10.0	33.0 30.0	55.0 50.0	
i			10.6 9.1	32.2 29.5	49.2 41.6				340 280	930 850	1560 1420	
j			3.4 3.0	10.0 9.2					14.0 12.0	37.0 34.0		
k			12.9 11.4	37.9 34.8					400 340	1050 960		
l			4.0 3.6	12.0 10.0					16.0 14.0	43.0 40.0		
m			15.1 13.6	45.4 37.9					450 400	1220 1150		
n		2.0 1.5	5.0 4.5				8.0 6.5	19.0 17.0				
o		7.6 5.7	18.9 17.0				230 180	540 480				
p		2.5 2.0	6.5 6.1				11.0 10.0	26.0 24.0				
q		9.5 7.6	24.5 23.1				310 280	740 680				
r		3.5 3.0	9.0 8.2				14.0 13.0	32.0 30.0				
s		13.2 11.4	34.1 31.0				400 370	910 850				
t		7.0 5.5					27.0 24.0					
u		26.5 20.8					760 680					
v		10.0 8.0					39.0 36.0					
w		37.9 30.3					1100 1020					

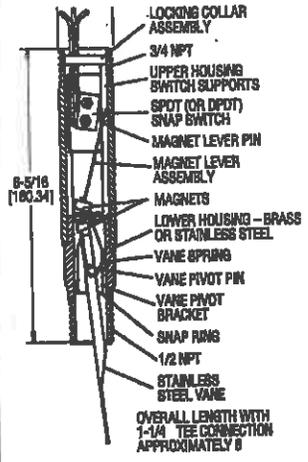
DIMENSIONS
FLOTECT® Model V6



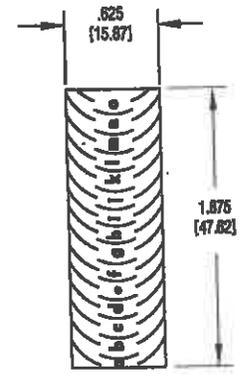
V6 Low Flow



V6 Low Flow with CSA, ATEX Conduit Enclosure

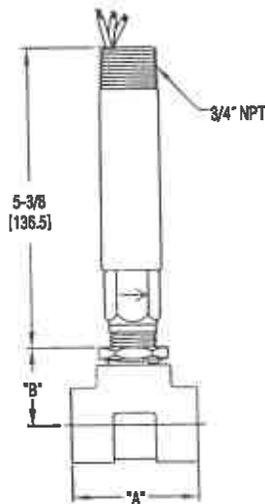


V6 with Field Trimmable Vane

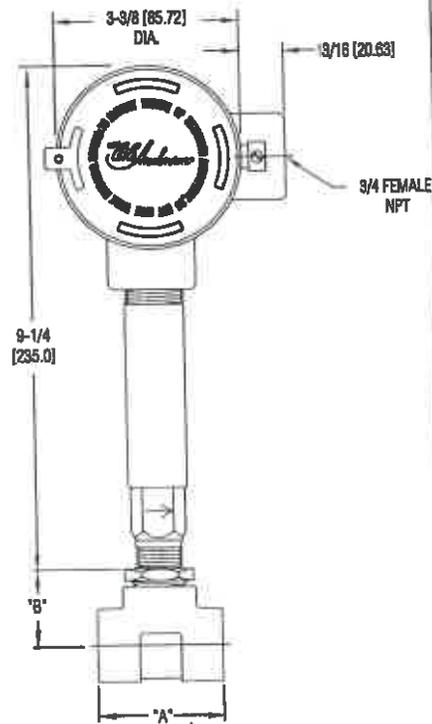


Trimmable Vane

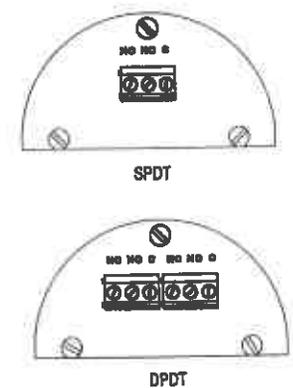
PIPE SIZE	BRASS/DUCTILE IRON		FORGED/STAINLESS STEEL		MALLEABLE IRON	
	DIM. A	DIM. B	DIM. A	DIM. B	DIM. A	DIM. B
1/2"	2-1/4 (57)	1-1/8 (29)	2-1/4 (57)	1-1/8 (29)	2-1/2 (64)	1-1/4 (32)
3/4"	2-3/8 (60)	1-1/4 (32)	2-5/8 (67)	1-7/8 (47)	2-5/8 (67)	1-3/8 (36)
1"	2-1/2 (64)	1-3/8 (35)	3 (76)	2-1/8 (54)	2-7/8 (73)	1-1/2 (38)
1-1/4"	2-5/8 (67)	1-1/2 (38)	3-1/2 (89)	2-1/2 (64)	3 (76)	1-3/4 (44)
1-1/2"	2-7/8 (73)	1-5/8 (41)	4 (102)	2-3/4 (70)	3-1/4 (83)	1-7/8 (48)
2"	3 (76)	1-7/8 (48)	4-3/4 (121)	3-1/8 (79)	3-1/2 (89)	2-1/8 (54)



V6 with Tee



V6 with Tee and CSA, ATEX Conduit Enclosure



Terminal Connections CSA, ATEX Enclosures



FLOTECT. Modell V6 Durchflußwächter,

Betriebsanleitung



Das Modell TMF-V6 ist ein kostengünstiger, explosionsgeschützter Durchflußwächter, der sich zur Überwachung von Luft, Wasser oder anderen kompatiblen Gasen und Flüssigkeiten eignet. Es sind 3 Konfigurationen möglich – 1. Werkseingestellt mit einem T-Stück, 2. Mit einem verstellbaren Paddel zur Feldjustage und Installation in einem T-Stück, 3. LF – Modelle mit einem integrierten T-Stück und einstellbarem Ventil. Alle Modelle sind verfügbar mit einem optionalen Gehäuse, das gemäß UL und CSA oder auch nach Direktive 94/9/EC (ATEX) gemäß II 2 G, EEx d IIC T6 process temp \leq 75°C.

INSTALLATION

Packen Sie das Gerät aus und entfernen sämtliches Verpackungsmaterial, das sich im Inneren des T-Stückes befinden kann.

Der Durchflußwächter kann in jeder Lage montiert werden, allerdings sind die Ein- und Ausschaltpunkte, die in der Tabelle aufgeführt sind, bei horizontalem Einbau gewährleistet. Diese Werte sind nur nominale Werte, bei genaueren Werten wird empfohlen, die Wächter im Werk einstellen zu lassen.

Die TMF-V6 mit T-Stücken haben Anschlußgrößen von 1/2" bis 2" NPT. Installieren Sie das Gerät so, dass der Pfeil in Richtung Durchfluß zeigt.

Die TMF-V6-LF Modelle haben einen 1/2" NPT Anschluss und sind feldjustierbar. Montieren Sie das Instrument so, dass der Pfeil in Richtung Durchfluß zeigt. Für die Einstellung lösen Sie die 4 Schrauben an der Unterseite. Das Einstellventil kann um 90° gedreht werden, zwischen „O“ (offen) und „C“ (geschlossen). Siehe Tabelle für die Bereiche. Befestigen Sie die Schrauben wieder, nachdem Sie den Bereich eingestellt haben.

Die TMF-V6 mit verstellbarem Paddel geben dem Anwender die Möglichkeit die ungefähren Ein- und Ausschaltpunkte zu wählen. Dies geschieht durch das Abnehmen von einzelnen Schichten des Paddels. Der Durchflußbereich wird in der belligenden Tabelle angezeigt. Bemerkung: Die Charts mit den Werten basieren auf Reduzier – T – Stücke aus Messing oder Eisen, auf geraden T-Stücken aus Edelstahl mit Rohrmuffen. Montieren Sie

TECHNISCHE DATEN

Medium: Flüssigkeiten, kompatibel zu den medienberührenden Teilen
Medienberührende Teile: Standard TMF-V6: Paddel: 301 Edelstahl; Unteres Gehäuse: Messing oder 303 Edelstahl; Magnet: Keramik; Andere: 301, 302 Edelstahl; T-Stück: Messing, Eisen, Stahl oder 304 Edelstahl
 Modell TMF-V6-LF: Unteres Gehäuse: Messing oder 303 Edelstahl; T-Stück: Messing oder 304 Edelstahl; Magnet: Keramik; O-Ring: Buna-N Standard, Option: Viton; Andere: 301, 302 Edelstahl

Temperaturbereich: -20°C bis 105°C Standard. MT Version bis 205°C (MT-Version nicht möglich mit Ex-geschützter Ausführung, ATEX – Ausführung: -20°C bis 75°C Umgebungstemperatur, -20°C bis 105°C Prozesstemperatur

Druckbereich: Messingkörper: 69 bar, 316 Edelstahlkörper: 138 bar, optional bis 345 bar nur verfügbar mit 316 Edelstahlkörper und 1 x SPDT Gehäuse: Wettergeschützt und Explosiongeschützt. Listed mit UL and CSA für Class I, Groups A, B, C and D; Class II, Groups E, F, and G. (Group A nur bei Modellen mit Edelstahlgehäuse) C E 0344 II 2 G - EEx d IIC T6, Prozess Temp \leq 75°C. EC-type Zertifikat Nr.: KEMA 04ATEX2128.

Mikroschalter: SPDT Standard, DPDT optional
Schaltleistung: UL Modelle: 5A @ 125/250 VAC (V-). CSA und ATEX Modelle: 5A @ 125/250 VAC (V-); 5A res., 3A ind. @ 30 VDC (V=). MV Option: .1A @ 125 VAC (V-). MT option: 5A @ 125/250 VAC (V-). [MT Option nicht möglich bei UL, CSA oder ATEX].

Elektrische Anschlüsse: UL Modelle: 18 AWG, 460 mm lang, ATEX und CSA Ausführung: Klemmleiste

Kabelgang: 3/4" NPTM Standard, 3/4" NPTF bei Modellen mit der Schutzbox

Prozessanschluss: 1/2" NPTM bei Modellen ohne T-Stück

Montagerichtung: in jeder Richtung, Ein- und Ausschaltpunkte, die in der Tabelle aufgeführt sind, nur bei horizontalem Einbau gewährleistet

Schaltpunkteinstellung: Standard nicht möglich, nur mit einstellbarem Paddel oder bei LF-Modellen

Gewicht: 0,9 bis 2,7 kg abhängig von der Konstruktion

die Geräte mit dem Pfeil in Durchflußrichtung. Wenn Sie Rohrmuffen verwenden müssen diese so gearbeitet sein, dass das Paddel frei schwingen kann. Der Innendurchmesser sollte bei 1/2"x3/4" Muffen ca. 20 mm sein oder 25 mm bei größeren Muffen. Die Tiefe der Muffe muss bei den internen Gewinden ca. 14 mm hoch sein (zwischen dem unteren Gehäuse und der Muffe). Nach der Installation

ELEKTRISCHE ANSCHLÜSSE

Verbinden Sie die Kabel entsprechend den örtlichen Regularien. Der Kontakt N.O. ist stromlos offen und der Kontakt N.C. ist stromlos geschlossen. Die Schaltpunkte kehren zur normalen Operation zurück, nachdem der Durchfluß wieder zu den normalen Bedingungen zurückgekehrt ist. Schließen Sie die Kabel wie folgt an:

Schwarz = Gemeinsamer Pol
 Blau = stromlos offen
 Rot = stromlos geschlossen

Bei Instrumenten, die mit zwei Erdungsschrauben geliefert werden (einer internen und einer externen Schraube), muss die innere Schraube zur Erdung des Signales verwendet werden. Die externe Schraube wird zur zusätzlichen Erdung verwendet. Einige CSA Modelle werden mit einem zusätzlichen grünen Erdungskabel geliefert. Einige Modelle benötigen eine zusätzliche Box, die zwar nicht automatisch mitgeliefert aber als Option verfügbar ist.

Kabelanschluss nach EC-Type:

Das Gerät ist zugelassen in der Explosionsschutzklasse „d“ einsetzbar in diesen Umgebungsbedingungen und korrekt installiert. Es sollten Kabel und Kabelverschraubungen eingesetzt werden, die bis mindestens 80°C zugelassen sind.

V6 mit T-Stueck

Gehäuseverschraubung:

Bei einem EEx d zertifiziertes Gerät muss unverzüglich Zugang zu dem Inneren des Gehäuses gewährleistet sein. Das Kabelmaterial und die Durchgangsdichtung sollten mindestens bis 80°C geeignet sein.

Bemerkung: ATEX-Geräte: Die Temperaturklasse wird entweder durch die max. Umgebungstemperatur oder durch die Prozesstemperatur bestimmt. Die Geräte sind für eine Umgebungstemperatur von $-20^{\circ}\text{C} < T_{\text{amb}} < 75^{\circ}\text{C}$ bestimmt. Die Instrumente können bis zu einer Prozesstemperatur von 105°C eingesetzt werden, vorausgesetzt das Gehäuse und der Schaltkörper erreichen keine Temperaturen über 75°C . Die Standardtemperaturklasse T6 ist bei einer Prozesstemperatur von $<75^{\circ}\text{C}$.

Alle Verdrahtungen und Gehäuse müssen den entsprechenden Regularien für explosionsgefährdete Umgebungen entsprechen. Die Gehäuse müssen entsprechend abgedichtet werden. Bei Aussenanwendungen oder anderen Anwendungen, bei denen die Temperaturen sehr schwanken, müssen Sie Vorkehrungen treffen, um Kondensation innerhalb des Gehäuses zu verhindern. Alle elektrische Komponenten müssen trocken gehalten werden.

ACHTUNG: Um Zündfunken explosionsgefährdeter Umgebung zu verhindern, unterbrechen Sie die Spannungsversorgung, bevor Sie den Durchflüßwächter öffnen. Halten Sie das Gerät beim Arbeiten immer geschlossen.

WARTUNG

Prüfen und reinigen Sie die medienberührenden Teile in regelmäßigen Intervallen. Die Abdeckung sollte immer zuverlässig verschlossen sein, um die internen Teile von Schmutz, Staub und Wetter zu schützen. Lösen Sie immer die Spannungsversorgung, bevor Sie den Schalter öffnen, um Arbeiten an der Elektrik vorzunehmen.

Kaltes Wasser - werkseitiges T-Stueck

Ungefährer Ein-/Ausschaltpunkt

GPM oben, LPM unten

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
1.5 1.0	2.0 1.25	3.0 1.75	4.0 3.0	6.0 5.0	10.0 8.5
5.7 3.8	7.8 4.7	11.4 6.8	15.1 11.4	22.7 18.9	37.9 32.2

Luft - werkseitiges T-Stueck

Ungefährer Ein-/Ausschaltpunkt

SCFM oben, LPM unten

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
6.5 5.0	10.0 8.0	14 12	21 18	33 30	43 36
180 140	260 230	400 340	590 510	930 850	1220 1020

V6 LF, Einstellbar

Kaltes Wasser - LF - Modelle

Ungefährer Ein-/Ausschaltpunkt

GPM oben, LPM unten

MINIMUM		MAXIMUM	
.04	.03	.75	0.60
.15	.11	2.8	2.3

Luft - LF - Modelle

Ungefährer Ein-/Ausschaltpunkt

SCFM oben, LPM unten

MINIMUM		MAXIMUM	
.18	.15	2.70	2.0
5.1	4.2	76	57

Beispiel	V6	EP	B	B	S	2	B	MT	
Serie	V6								V6EPB-S-2-B-MT Durchflüßwächter mit Messing Gehäuse u. Messing T-Stueck mit 3/4" NPT Anschluss, SPDT Schalter und Höchsttemperaturausführung
Konstruktion		EP							Serie V6 Durchflüßwächter
Obere Gehäusestück			B						Messing 303 Edelstahl
Untere Gehäusestück			S	B					Messing 303 Edelstahl
Schalter Typ					S	D			SPDT SPDT
Prozess Anschluss						1 2 3 4 5 6 F			1/2" NPT 3/4" NPT 1" NPT 1-1/4" NPT 1-1/2" NPT 2" NPT LF Modelle (1/2" NPT Anschluss)
Prozess Anschluss Typ							B FS MI PVC PVC/SW S S150		Kein T-Stueck NPT/M Anschluss, Padlock einstellbar Messing T-Stueck T-Stueck aus Schmiedeleisen Eisen T-Stueck PVC T-Stueck mit NPT Anschluss PVC T-Stueck* 304 Edelstahl T-Stueck 304 Edelstahl T-Stueck 150# T-Stueck (* LF Modelle kein Material wählbar, wird entsprechend dem unteren Gehäuse geliefert)
Schalteroptionen								MV MT	Gold Kontakte Hochtemperaturausführung bis 200°C*
Optionen								AT CSA CV FTR GL ID JCT JCTLH ORFB ORFS RV TBC VIT 018 020 022 022A 031	ATEX approved construction (mit JCT option standard) CSA approved construction (mit JCT option standard)* Kundenpadlock Flow Test Report Ground Lead* Kundeninformationen auf Platte Wetterschutzblech und Explosionsgeschützte Box Wetterschutzblech und Explosionsgeschützte Box, linke Seite Orifice Messing Orifice Edelstahl Verstärktes Padlock Schraubdemmenanschluss* Viton O-ringe anstatt Buna-N bei LF-Modellen .018 Feder .020 Feder .022 Feder .022 Feder mit Alnico magnet .031 Feder

* Optionen die keinen ATEX-Schutz haben

Achtung: Geräte ohne-AT Suffix sind nicht zertifiziert. Solche Geräte sind nicht für den Einsatz in explosionsgefährdeten Räumen geeignet.

V6 mit einstellbarem Paddel
Kaltes Wasser - Messing oder Stahl T-Stueck
 Ungefahrer Ein-/Aussschaltpunkt
 GPM oben, LPM unten

Luft - Messing oder Stahl T-Stueck
 Ungefahrer Ein-/Aussschaltpunkt
 SCFM oben, LPM unten

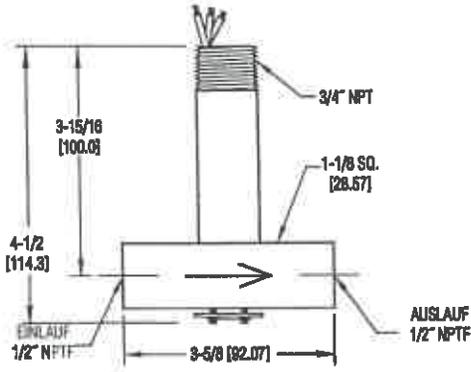
Pad	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
Full Size						9.0 8.5						38.0 37.0
a						34.1 32.2						1100 1050
b						9.5 9.0						40.0 38.0
c						38.0 34.1						1130 1080
d						10.0 9.3						42.0 40.0
e						37.9 35.2						1190 1130
f						11.0 10.0						50.0 44.0
g						41.5 37.9						1420 1250
h					6.2 5.5	12.0 10.0					27.0 25.0	55.0 46.0
i					23.5 20.8	45.4 37.9					760 710	1560 1300
j					7.0 6.5	13.0 11.0					30.0 28.0	
k					28.5 24.6	49.2 41.6					850 790	
l				4.3 3.9	7.6 7.1	14.0 12.0				20.0 18.0	32.0 30.0	
m				16.3 14.8	28.8 26.9	53.0 45.4				570 510	910 850	
n				4.9 4.4	8.0 7.3					21.0 19.0	34.0 32.0	
o				18.5 16.7	30.3 27.6					590 540	900 910	
p				5.5 5.0	9.0 8.2					23.0 21.0	37.0 34.0	
q				20.8 18.9	34.1 31.0					650 590	1050 960	
r			3.5 3.1	8.0 5.8	10.0 9.0				16.0 15.0	24.0 22.0	39.0 36.0	
s			13.2 11.7	22.7 21.2	37.9 34.1				450 430	680 620	1100 1020	
t			4.0 3.5	7.0 6.8	13.0 11.0				18.0 16.0	28.0 25.0	51.0 45.0	
u			15.1 13.2	26.5 25.0	49.2 41.6				510 450	790 710	1440 1270	
v			4.8 4.2	8.0 7.6	15.0 13.0				19.0 17.0	33.0 30.0	69.0 57.0	
w			17.4 15.9	30.3 28.8	58.8 49.2				540 480	930 850	1950 1610	
x		2.8 2.3	5.6 5.2	10.0 9.0					13.0 12.0	22.0 20.0	38.0 35.0	
y		9.8 8.7	21.2 19.7	37.9 34.1					370 340	620 570	1080 990	
z	1.6 1.3	3.5 3.1	6.3 6.1	12.0 10.0			6.4 3.8	15.0 14.0	25.0 23.0	45.0 42.0		
aa	6.1 4.9	13.2 11.7	23.8 23.1	45.4 37.9			180 110	420 400	710 650	1270 1190		
ab	2.2 1.8	4.3 3.8	8.0 7.5				10.0 7.0	20.0 16.0	32.0 28.0			
ac	8.3 6.8	16.3 14.4	30.3 28.4				280 200	570 450	910 790			
ad	3.0 2.4						12.0 9.0					
ae	11.4 9.1						340 250					

Kaltes Wasser - Edelstahl o. Schmiedest. gerades T-Stueck
 Ungefahrer Ein-/Aussschaltpunkt
 GPM oben, LPM unten

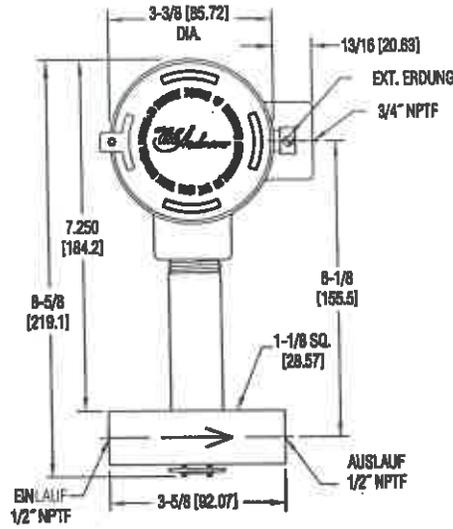
Luft - Edelstahl o. Schmiedest. gerades T-Stueck
 Ungefahrer Ein-/Aussschaltpunkt
 SCFM oben, LPM unten

Van	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
Full Size				5.0 4.5 8.5 7.8						21.0 18.0 33.0 30.0		
a				18.9 17.0 32.2 29.5						590 510 930 850		
b				5.6 5.0 9.2 8.6						22.0 20.0 39.0 36.0		
c				20.8 18.9 34.8 32.6						620 570 1100 1020		
d				6.2 5.7 9.8 9.0						24.0 22.0 42.0 38.0		
e				23.5 21.6 37.1 34.1						680 620 1190 1080		
f				6.8 6.3 12.0 10.0						28.0 26.0 51.0 46.0		
g				25.7 23.8 45.4 37.9						790 740 1440 1300		
h			2.8 2.4	8.5 7.8 13.0 11.0					12.0 10.0	33.0 30.0 55.0 50.0		
i			10.6 9.1	32.2 29.5 49.2 41.6					340 280	930 850 1560 1420		
j			3.4 3.0	10.0 9.2					14.0 12.0	37.0 34.0		
k			12.9 11.4	37.9 34.8					400 340	1050 960		
l			4.0 3.6	12.0 10.0					16.0 14.0	43.0 40.0		
m			15.1 13.6	45.4 37.9					450 400	1220 1130		
n		2.0 1.5	5.0 4.5					8.0 6.5	19.0 17.0			
o		7.6 5.7	18.9 17.0					230 180	540 480			
p		2.5 2.0	6.5 6.1					11.0 10.0	26.0 24.0			
q		9.5 7.6	24.6 23.1					310 280	740 680			
r		3.5 3.0	9.0 8.2					14.0 13.0	32.0 30.0			
s		13.2 11.4	34.1 31.0					400 370	910 850			
t		7.0 5.5						27.0 24.0				
u		26.5 20.8						760 680				
v		10.0 8.0						39.0 36.0				
w		37.9 30.3						1100 1020				

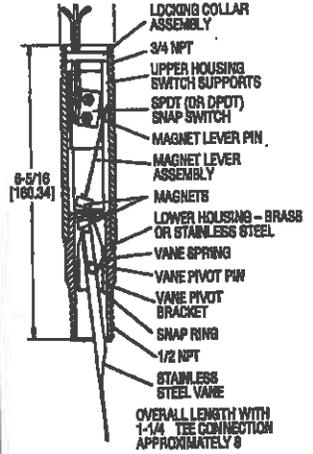
**ABMESSUNGEN
Modell V6**



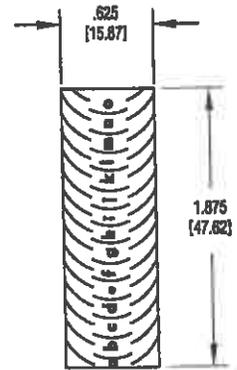
V6 LF



**V6 LF mit CSA,
ATEX Schutzgehäuse**

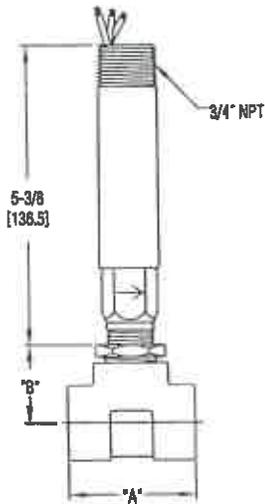


**V6 mit einstellbarem
Paddel**

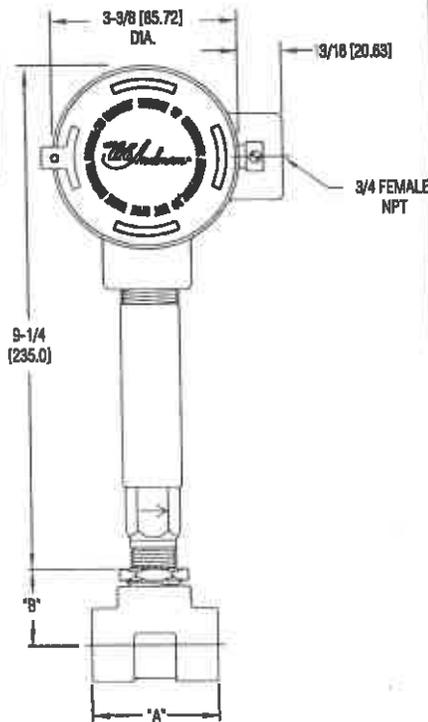


**Einstellbares
Paddel**

Rohr or	Mess. in mm		Edelstahl / Sinterdest.		Gussisen	
	DIM. A	DIM. B	DIM. A	DIM. B	DIM. A	DIM. B
1/2"	2-1/4 (57)	1-1/8 (29)	2-1/4 (57)	1-1/8 (29)	2-1/2 (64)	1-1/4 (32)
3/4"	2-3/8 (80)	1-1/4 (32)	2-5/8 (67)	1-7/8 (47)	2-5/8 (67)	1-3/8 (36)
1"	2-1/2 (64)	1-3/8 (35)	3 (76)	2-1/8 (54)	2-7/8 (73)	1-1/2 (38)
1-1/4"	2-5/8 (67)	1-1/2 (38)	3-1/2 (89)	2-1/2 (64)	3 (76)	1-3/4 (44)
1-1/2"	2-7/8 (73)	1-5/8 (41)	4 (102)	2-3/4 (70)	3-1/4 (83)	1-7/8 (48)
2"	3 (76)	1-7/8 (48)	4-3/4 (121)	3-1/8 (79)	3-1/2 (89)	2-1/8 (54)



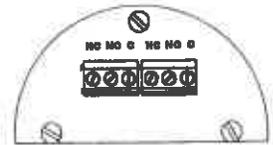
V6 mit T-Stueck



**V6 mit T-Stueck f r CSA,
ATEX Gehaeuse**



SPDT



DPDT

**Klemmleisten fr
CSA, ATEX Gehaeuse**

FLOTECT. Modèle V6 Détecteur de débit

Spécifications - Instructions d'installation et de fonctionnement



Le modèle V6 FLOTECT est un détecteur de débit anti-déflagrant à faible coût utilisé pour l'air, l'eau et autres gaz et liquides compatibles. Trois configurations sont proposées:

1. Installé avec un Té. 2. Avec une palette réglable pour ajustage du seuil et installation dans un Té approprié. 3. Modèles faible débit avec un Té intégré et clapet réglable. Tous sont disponibles avec un boîtier option UL et CSA ou homologué 94/9/EC (ATEX) conforme à CE II 2 G EEx d IIC T6 température $\leq 75^{\circ}\text{C}$.

INSTALLATION

Déballer le détecteur et enlever tous matériaux d'emballage trouvés à l'intérieur du boîtier inférieur ou du Té

Le détecteur peut être installé dans n'importe quelle position, mais l'enclenchement ou le désenclenchement des seuils de débit sont donnés dans le tableau pour un tuyau horizontal et des valeurs moyennes. Pour des seuils plus précis, la pièce peut être calibrée en usine selon le seuil spécifié.

Les modèles V6 avec Té sont fournis en tailles 1/2" à 2" NPT. Installation dans la tuyauterie avec la flèche dans le sens du débit.

Les modèles V6 faible débit ont des raccordements 1/2" NPT et sont réglables. Installation dans la tuyauterie avec la flèche dans la direction du débit. Pour régler, desserrer les quatre vis du couvercle du dessous. Le réglage de la valve se fait sur 90° entre "O" (ouvert) et "C" (fermé). Pour les seuils, voir le tableau des débits. Resserrer les vis une fois le seuil de débit réglé.

V6 avec palette ajustable par taillage de la lame. Ces modèles permettent à l'installateur de choisir le point approximatif d'enclenchement ou désenclenchement par taillage de la palette à la bonne dimension selon la lettre retenue sur le gabarit mobile. Le débit est défini dans le tableau. Les valeurs de celui-ci sont calculées en fonction de l'utilisation d'un Té en laiton ou en fonte, d'un Té en inox ou acier forgé avec filetage si nécessaire. Installation dans la tuyauterie avec la flèche dans le sens du débit.

SPECIFICATIONS

Utilisation: Gaz ou liquides compatibles avec les matériaux humidifiés.

Matériaux humidifiés: Modèles V6 standard: Palette en inox 301; corps inférieur: laiton ou inox 303; Aimant: céramique; autres pièces inox 301, 302; Té: laiton, acier, acier forgé ou inox 304. V6 faible débit: Corps inférieur: laiton ou inox 303; Té: laiton ou inox 304; Aimant: céramique; joint torique: Buna-N en standard, Viton en option, autres pièces inox 301, 302.

Températures limites: -20 à 105°C en standard, option MT haute température 205°C (MT n'est pas UL, CSA ou ATEX). Option ATEX. AT température ambiante -20 à 75°C, température de fonctionnement: -20 à 105°C.

Pression max: Modèle sans Té, corps inférieur en laiton 69 bar. Modèle sans Té corps inférieur en inox 303 138 bar. Modèle avec Té laiton 17,2 bar, avec Té acier 69 bar, avec Té en acier forgé et inox 138 bar, modèle faible débit 100 bar.

Boîtier électrique: Étanche et anti-déflagrant. Aux normes UL et CSA Classe I Groupe A, B, C et D; Classe II Groupe E, F et G (Groupe A seulement sur les modèles au corps en inox).

CE 0344 II 2 G EEx d IIC T6 Température de fonctionnement $\leq 75^{\circ}\text{C}$

Certificat CE n°: KEMA 04ATEX2128.

Micro-contact: Standard contact SPDT, option contact DPDT.

Pouvoir de coupure: Modèles UL: 5A-125/250 VCA (V~). Modèles CSA et ATEX: 5A-125/250 VCA (V~); 5A résistif, 3A inductif @ 30 VCC (V~). Option MV: 1A-125 VCA (V~). Option MT: 5A-125/250 VCA (V~). Option MT non normalisée UL, CSA ou ATEX.

Connexions électroniques: Modèles UL: Câble 18AWG, longueur 480 mm; Modèles ATEX et CSA: bornier.

Corps supérieur: Laiton ou inox 303.

Raccordement électrique: 3/4" NPTm en standard; 3/4" NPT sur modèle à bornier.

Raccordement tuyauterie: 1/2" NPTm sur modèles sans Té. (avec Té voir tableau)

Orientation de montage: Les détecteurs peuvent être installés dans n'importe quelle direction, mais les valeurs des vitesses de débit d'enclenchement et de désenclenchement du tableau sont nominales et basées sur les passages de tuyaux horizontaux.

Seuil de réglage: Aucun sur les modèles standards V6. La palette des modèles faibles débits sont réglables dans la gamme donnée. Voir le tableau des seuils page suivante.

Poids: 0,9 à 2,7 kg suivant construction.

Quand les filetages sont utilisés, ils doivent être situés à l'arrière du perçage pour permettre un dégagement approprié à un mouvement libre de la palette. Percer au diamètre intérieur de 20 mm sur filetage 1/2" x 3/4" ou 25 mm sur filetage plus grands. La profondeur de l'alésage doit permettre un filetage interne de 14 mm de haut pour un emmanchement approprié entre le boîtier inférieur du micro-contact et l'alésage.

RACCORDEMENTS ELECTRIQUES

Connecter les fils suivant les normes électriques en vigueur et l'action du micro-contact demandée, NO le contact se fermera, NC le contact s'ouvrira quand le débit augmentera vers le seuil de basculement. Ils reviendront en position normale quand le débit diminuera vers le point de basculement. Noir: commun; Bleu: normalement ouvert; Rouge: normalement fermé.

Pour les détecteurs fournis avec deux masses (interne et externe), la vis de masse externe est pour une seconde mise à la masse si les normes en vigueur le permettent ou le demandent. Quelques modèles CSA sont fournis avec un fil de masse vert. De tels appareils doivent être équipés avec une boîte de dérivation, non fournie mais disponible sur commande.

Modèles certifiés CE Instructions d'installation:

Raccordement du câble

L'entrée du câble doit être un presse-étoupe certifié EEx d approprié aux conditions d'utilisation et correctement installé. Le presse-étoupe certifié et le câble doivent tenir une température de 80°C minimum.

Raccordement système

Un scellement certifié EEx d approprié aux conditions d'utilisation et correctement installé doit être déposé sur l'entrée du presse étoupe. Le scellement et le câble doivent tenir une température de 80°C minimum.

Note: Matériel ATEX uniquement, la classe de température est déterminée par la température ambiante maximum et la température de l'ensemble de l'installation. Les matériels sont destinés à être utilisés à une température ambiante de -20°C Tamb. ± 75°C. Les matériels peuvent être utilisés à une température de l'installation de 105°C, à condition que le boîtier et le corps du détecteur ne dépasse pas 75°C. La classe de température est T6, la température de l'installation étant ≤75°C.

Tout câblage, tuyauterie et boîtier doivent être conformes aux normes applicables aux zones à risques. La tuyauterie et le boîtier doivent être correctement scellés. Pour les installations extérieures ou autre où les températures varient largement, des précautions doivent être prises pour éviter les condensations à l'intérieur des boîtiers électriques. Les composants électriques doivent rester secs à tous moments.

ATTENTION: Pour prévenir tout risque d'explosion, déconnecter l'appareil du circuit d'alimentation avant d'ouvrir. Garder l'appareil fermé en utilisation.

MAINTENANCE

Inspecter et nettoyer les parties humidifiées régulièrement. Le couvercle doit être maintenu en place tout le temps pour protéger les composants internes de la poussière et de l'impuretés et pour maintenir le niveau de protection de zones à risques. Déconnecter l'appareil pour prévenir tout risque d'explosion.

V6 avec T6

Eau froide - T6 installé en usine

Seuil approximatif d'enclenchement/désenclenchement
Unité ligne supérieure GPM ligne inférieur LPM

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
1.5 1.0	2.0 1.25	3.0 1.75	4.0 3.0	6.0 5.0	10.0 8.5
5.7 3.8	7.6 4.7	11.4 6.8	15.1 11.4	22.7 18.9	37.9 32.2

Air - T6 installé en usine

Seuil approximatif d'enclenchement/désenclenchement
Unité ligne supérieure GPM ligne inférieur LPM

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
6.5 5.0	10.0 8.0	14 12	21 18	33 30	43 38
180 140	280 230	400 340	690 510	930 850	1220 1020

V6 faible débit, seuil réglable

Eau froide - Modèle faible débit

Seuil approximatif d'enclenchement/désenclenchement
Unité ligne supérieure GPM ligne inférieur LPM

MINIMUM		MAXIMUM	
.04	.03	.75	0.60
.15	.11	2.8	2.3

Air - Modèle faible débit

Seuil approximatif d'enclenchement/désenclenchement
Unité ligne supérieure GPM ligne inférieur LPM

MINIMUM		MAXIMUM	
.18	.15	2.70	2.0
5.1	4.2	78	57

Exemple	V6	EP	B	B	S	Z	B	MT	
Modèle	V6								V6EPB-B-S-2-B-MT détecteur de débit, boîtier supérieur et inférieur en laiton, té laiton avec connexion 3/4" NPT, micro contact SPDT, option haute température
Construction		EP							Antidéflagrant et étanche
Matériau corps supérieure			303						Laiton inox 303
Matériau corps inférieure				303					Laiton inox 303
Micro contact					S D				SPDT DPDT
Taille des raccordements électriques						1 2 3 4 5 6 8 LF			1/2" NPT 3/4" NPT 1" NPT 1-1/4" NPT 1-1/2" NPT 2" NPT Modèle faible débit (1/2" NPT)
Type de raccordement fluide							O B FS MI PVC PVC/SW S S150		Pas de T6, connexion NPT mâle, palette ajustable Té en laiton Té acier forgé Té acier Té PVC avec NPT * Té PVC avec joint * Té inox 304 Té inox 304- #150 (Pour le modèle LF voir de matière choisie pour le T6, la matière du T6 est opposée à la matière du boîtier XXXXX)
Options Micro-contacts								MV MT	Contact doré pour circuit sec (voir spécification) Haute température 205°C voir spécification)
Options générales								AT CSA CV FTR GL ID JCT JCTLH ORFB ORFS RV TBC VT 018 020 022 022A 031	Homologué ATEX (avec bomier) Homologué CSA (avec bomier) Palette suivant spécification client P.V. de mesures de débit Fils de masse * Information client sur plaque signalétique Boîtier antidéflagrant et étanche * Boîtier antidéflagrant et étanche sortie gauche. Orifice laiton Orifice inox Palette renforcée Bomier * Joint torique Viton au lieu de BLINA-N sur modèle faible débit. Ressort 0.018 Ressort 0.020 Ressort 0.022 Ressort 0.022 avec aimant Alnico. Ressort 0.031

* Option non applicable pour version ATEX

Attention: Les modèles sans le suffixe AT ne sont pas conformes à la directive 84/9/EC(ATEX). Ces modèles ne sont pas destinés à un usage en zone à risque en Europe. Ils peuvent être marqués CE pour d'autres directives européennes.

V6 avec palette ajustable

Eau froide - Té réduit en laiton ou fonte

Seuil approximatif d'enclenchement/désenclenchement

Unité ligne supérieure GPM ligne inférieur LPM

Palette	1/4" NPT	1/2" NPT	1" NPT	1 1/2" NPT	1 3/4" NPT	2" NPT
Taille Complète				5.0 4.5 8.5 7.8		
				18.9 17.0 32.2 29.5		
a				5.5 5.0 9.2 8.6		
				20.8 18.9 34.8 32.6		
b				6.2 5.7 9.8 9.0		
				23.5 21.6 37.1 34.1		
c				6.8 6.3 12.0 10.0		
				25.7 23.8 45.4 37.9		
d			2.8 2.4 8.5 7.8 13.0 11.0			
			10.6 9.1 32.2 29.5 49.2 41.6			
e			3.4 3.0 10.0 9.2			
			12.9 11.4 37.9 34.8			
f			4.0 3.6 12.0 10.0			
			15.1 13.6 45.4 37.9			
g		2.0 1.5 5.0 4.5				
		7.6 5.7 18.9 17.0				
h	2.5 2.0 6.5 6.1					
	9.5 7.6 24.6 23.1					
i	3.5 3.0 9.0 8.2					
	13.2 11.4 34.1 31.0					
j	7.0 5.5					
	26.5 20.8					
k	10.0 8.0					
	37.9 30.3					

V6 avec palette ajustable

Air - Té réduit en laiton ou fonte

Seuil approximatif d'enclenchement/désenclenchement

Unité ligne supérieure GPM ligne inférieur LPM

Palette	1/4" NPT	1/2" NPT	1" NPT	1 1/2" NPT	1 3/4" NPT	2" NPT
Taille Complète						9.0 8.5
						34.1 32.2
a						9.5 9.0
						36.0 34.1
b						10.0 9.3
						37.9 35.2
c						11.0 10.0
						41.6 37.9
d				6.2 5.5 12.0 10.0		
				23.5 20.8 45.4 37.9		
e				7.0 6.5 13.0 11.0		
				26.5 24.6 49.2 41.6		
f				4.3 3.9 7.6 7.1 14.0 12.0		
				16.3 14.8 28.8 26.9 53.0 45.4		
g				4.9 4.4 8.0 7.3		
				18.5 16.7 30.3 27.6		
h				5.5 5.0 9.0 8.2		
				20.8 18.9 34.1 31.0		
i		3.5 3.1	6.0 5.6 10.0 9.0			
		13.2 11.7	22.7 21.2 37.9 34.1			
j		4.0 3.5	7.0 6.6 13.0 11.0			
		15.1 13.2	28.5 25.0 49.2 41.8			
k		4.6 4.2	8.0 7.6 15.0 13.0			
		17.4 15.9	30.3 28.8 58.8 49.2			
l		2.6 2.3	5.6 5.2 10.0 9.0			
		9.8 8.7	21.2 19.7 37.9 34.1			
m	1.6 1.3	3.5 3.1	6.3 6.1 12.0 10.0			
	6.1 4.9	13.2 11.7	23.8 23.1 45.4 37.9			
n	2.2 1.8	4.3 3.8	8.0 7.5			
	8.3 6.8	16.3 14.4	30.3 28.4			
o	3.0 2.4					
	11.4 9.1					

Eau froide- Té droit et filetage inox et acier forgé

Seuil approximatif d'enclenchement/désenclenchement

Unité ligne supérieure GPM ligne inférieur LPM

Palette	1/4" NPT	1/2" NPT	1" NPT	1 1/2" NPT	1 3/4" NPT	2" NPT
Taille Complète						
a						
b						
c						
d						
e						
f						
g						
h						
i						
j						
k						

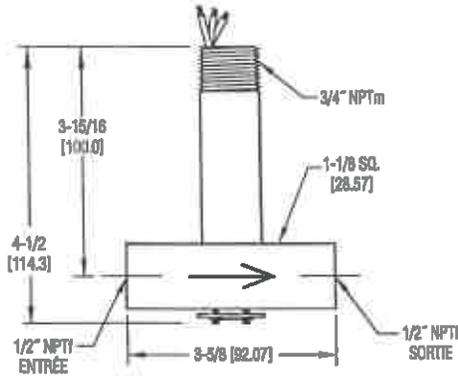
Air-Té droit et adaptateur fileté inox et acier forgé

Seuil approximatif d'enclenchement/désenclenchement

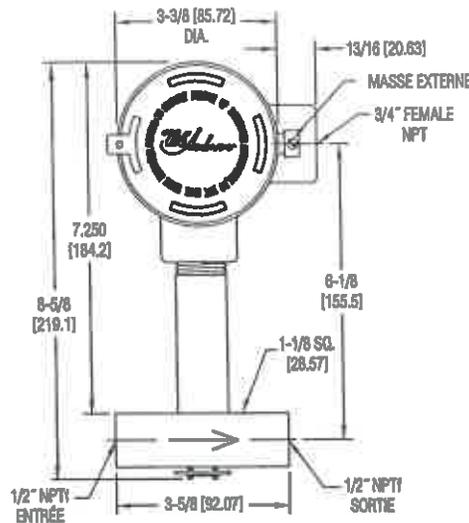
Unité ligne supérieure GPM ligne inférieur LPM

Palette	1/4" NPT	1/2" NPT	1" NPT	1 1/2" NPT	1 3/4" NPT	2" NPT
Taille Complète						
a						
b						
c						
d						
e						
f						
g						
h						
i						
j						
k						

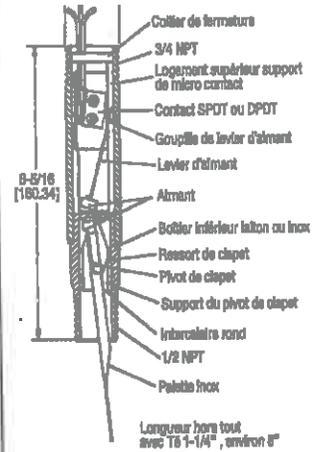
**Dimensions
Modèle V6 FLOTECT**



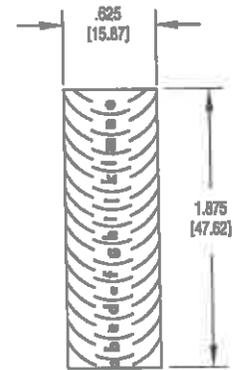
V6 faible Débit



**V6 faible débit avec Boîtier
CSA , ATEX**

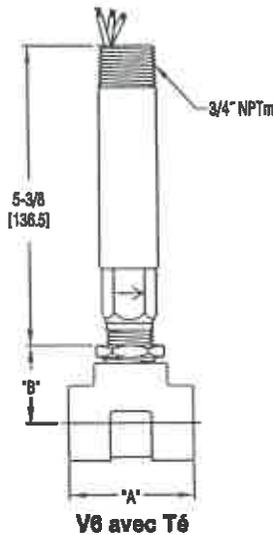


**V6 palette
ajustable**

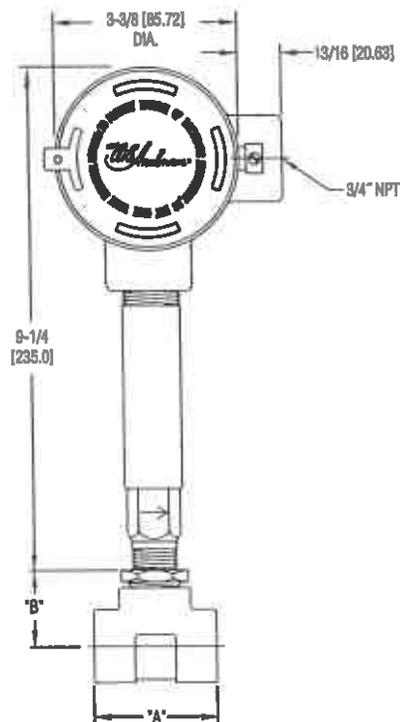


Palette ajustable

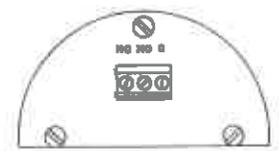
Taille Tuyau	Laiton / fer doux		Acier forgé / inox		Acier	
	DIM. A	DIM. B	DIM. A	DIM. B	DIM. A	DIM. B
1/2"	2-1/4 (57)	1-1/8 (29)	2-1/4 (57)	1-1/8 (29)	2-1/2 (64)	1-1/4 (32)
3/4"	2-3/8 (60)	1-1/4 (32)	2-5/8 (67)	1-7/8 (47)	2-5/8 (67)	1-3/8 (36)
1"	2-1/2 (64)	1-3/8 (36)	3 (78)	2-1/8 (54)	2-7/8 (73)	1-1/2 (38)
1-1/4"	2-5/8 (67)	1-1/2 (38)	3-1/2 (89)	2-1/2 (64)	3 (78)	1-3/4 (44)
1-1/2"	2-7/8 (73)	1-5/8 (41)	4 (102)	2-3/4 (70)	3-1/4 (83)	1-7/8 (48)
2"	3 (75)	1-7/8 (48)	4-3/4 (121)	3-1/8 (79)	3-1/2 (89)	2-1/8 (54)



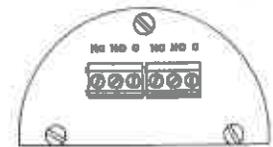
V6 avec Tè



V6 avec Tè et boîtier CSA ou ATEX



SPDT



DPDT

**Bornier pour boîtier CSA
et ATEX**

**Interruptor de Caudal FLOTECT, Mod. V6****Especificaciones – Instrucciones de instalación y operación**

El **FloTECT modelo V6** es un interruptor de caudal barato, anti-deflagrante, para uso en aire, gases y líquidos compatibles. Dispone de tres configuraciones: 1. Con "T" instalada en fábrica. 2. con paleta recortable para ajuste en campo e instalación en "T" con cabeza, opcional, UL y CSA o ATEX Directiva 94/9/EC cumpliendo para $\text{CE II 2 G EExd IIC T6}$ temperatura de proceso menor de 75°C.

INSTALACIÓN

Desempaquetar y quitar cualquier tipo de material de juntas que encuentre dentro de la caja inferior o de la "T".

El interruptor se puede instalar en cualquier posición pero los puntos de actuación/rearme de las tablas están basados en tuberías horizontales y son para valores nominales. Para ajustes más precisos se pueden calibrar para valores específicos de caudal en fábrica.

Los modelos V6 con "T" para tamaños de tubería desde 1/2" a 2" NPT. Instalar en la tubería con la flecha indicadora en la dirección del caudal.

Los modelos V6 de bajo caudal tienen conexiones de 1/2" NPT y son ajustables en campo. Instalar en la tubería con la flecha en la dirección del caudal. Para ajustar hay que aflojar los cuatro tornillos de la base del fondo. La válvula de ajuste gira 90° entre "O" (abierto) y "C" (cerrado). Ver las tablas de caudal para valores aproximados. Apretar los tornillos una vez ajustados los puntos de caudal.

V6 con paleta recortable en campo. Estos modelos permiten al instalador seleccionar los puntos de actuación/desactuación recortando los tramos de la paleta según las marcas con letras o plantillas. Los caudales están definidos en las tablas siguientes. Vea que las tablas están basadas en "Tees" reductoras de latón, fundición, acero inoxidable o rectas de acero forjado con casquillos donde sean necesarios. Instalar en la tubería con la flecha en la dirección del caudal.

ESPECIFICACIONES

Servicio: Gases y líquidos compatibles con los materiales de las partes mojad.

Materiales mojados: Modelos V6 estándar: Paleta en 301 SS; cuerpo inferior en latón o 303 SS; iman cerámico; Otros: 301 SS/302 SS; "T" en latón, hierro, acero forjado o 304 SS. Modelos V6 de bajo caudal: Cuerpo inferior en latón o 303 SS; "T" en latón o 304 SS; iman cerámico; junta en Buna-N (estándar) o Viton (opcional); otros: 301 SS/302 SS.

Límites de temperatura: -20 a 105°C estándar; MT opción de alta temperatura: 205°C (MT no cumple con UL, CSA ni ATEX). La opción "AT" de cumplimiento ATEX es para temperatura ambiente de -20 a 75°C, temperatura de proceso de -20 a 105°C.

Límites de presión: Para modelos de cuerpo inferior de latón sin "T" es 1000 psig (69 bar), para modelos de cuerpo inferior de 303 SS sin "T" es 2000 psig (138 bar). Los modelos con "T" de latón es 250 psig (17,2 bar), los de "T" de hierro es 1000 psig (69 bar), los de "T" de acero forjado e inoxidable es 2000 psig (138 bar) y los modelos de bajo caudal es 1450 psig (100 bar).

Ratificación de la caja: Estanca y anti-deflagrante. Listados con UL y CSA para Clase I, Grupos A, B, C y D; Clase II, Grupos E, F y G. (Grupo A únicamente en modelos de acero inoxidable). $\text{CE 0344 II 2 G EExd IIC T6}$ Temperatura de proceso menor de 75°C. EC-Certificado tipo N°.: KEMA 04ATE2128.

Tipo de contacto: Microcontacto SPDT estándar, opcional DPDT.

Poder de corte: Modelos UL: 5A @ 125/250 VAC (-); modelos CSA y ATEX: 5A @ 125/250 VAC (-); 5A res., 3A Ind. @ 30 VDC (=). Opción MV: 1A @ 125 VAC (-). Opción MT: 5A @ 125/250 VAC (-). (La opción MT no es UL, CSA ni ATEX).

Conexiones eléctricas: Modelos UL: 18 AWG, 18" (460 mm) de longitud de cables. Los modelos ATEX/CSA: bloque terminal.

Cuerpo superior: Latón o 303 SS.

Conducto eléctrico: 3/4" NPT-M estándar., 3/4" NPT-H en modelos en caja de unión.

Conexión a proceso: 1/2" NPT-M en modelos sin "T".

Posición de montaje: Los interruptores pueden ser montados en cualquier posición pero los caudales de actuación/desactuación de las tablas están basados en tuberías horizontales y son valores nominales.

Ajustes del punto de disparo: Los modelos V6 estándar no tienen. En los modelos sin "T" la paleta es recortable. Los modelos de bajo caudal son ajustables en campo para el caudal mostrado. Ver tablas de ajustes en la página siguiente.

Peso: De 0,9 a 2,7 Kg, dependiendo de la construcción.

Cuando se usen casquillos, se deben taladrar por detrás para permitir una holgura apropiada al libre movimiento de la paleta. Dejar un diámetro interior de 20 mm en casquillos de 1/2" x 3/4" y de 25 mm de diámetro en casquillos mayores. La profundidad del taladro debe dejar roscas internas de 14 mm de longitud para conseguir una unión apropiada entre el casquillo y la parte inferior del interruptor. Verificar el movimiento de la paleta y la operación del interruptor después de la instalación.

CONEXIONES ELECTRICAS

Conectar los cables de acuerdo a los códigos locales y el tipo de acción requerida. Los contactos abiertos (NO) cerrarán y los contactos cerrados (NC) abrirán el contacto en aumento de caudal. Volverán a la condición "normal" cuando el caudal pase por la posición de disparo en disminución. Negro=común, Azul=normalmente abierto y Rojo=normalmente cerrado.

Para equipos que se suministran con dos tomas de tierra (externa e interna), el tornillo interno de tierra se debe usar para la tierra del control y el tornillo externo de tierra se debe usar con un lazo suplementario o cuando los códigos locales lo requieran. Algunos modelos listados CSA se suministran con un cable de tierra verde por separado. Estas unidades se deben equipar con caja de unión, no suministrada pero disponible con un pedido especial.

Instrucciones de instalación para el Certificado Tipo EC:

Conexión del cableado

La entrada del cableado debe ser válida para uso con prensas certificadas "EEEx d" correctamente instaladas. Tanto el cable como el prensa certificado deben ser válidos para una temperatura mínima de 80°C.

Conexión eléctrica

La entrada eléctrica debe estar sellada con un componente certificado "EEEx d" válido para las condiciones de uso. Tanto el sello como su componente deben ser válidos para una temperatura mínima de 80°C.

Nota: Solo para unidades ATEX: La clase de temperatura está determinada por la temperatura máxima de ambiente y la temperatura del proceso. Deben ser válidas para temperaturas ambientales desde -20°C a +75°C. Pueden ser usadas en procesos de temperaturas hasta 105°C siendo la temperatura del cuerpo del interruptor y de la caja inferior a 75°C. El estándar de Temperatura Clase T6 es Temperatura de Proceso inferior a 75°C.

El cableado, la caja y el conducto eléctrico deben cumplir con los códigos aplicables para áreas peligrosas. El conducto eléctrico y la caja deben ser sellados apropiadamente. Para localizaciones exteriores u otras donde las temperaturas varíen ampliamente, se deben tomar precauciones para prevenir condensaciones en el interior del interruptor o de la caja. Los componentes eléctricos se deben mantener secos en todo momento.

ADVERTENCIA: Para prevenir fuego en atmósferas peligrosas, desconecte la unidad de la alimentación antes de abrir. Mantenerla cerrada cuando esté en uso.

MANTENIMIENTO

Inspeccione y limpie periódicamente las partes mojadas. La tapa debe estar puesta siempre para proteger los componentes internos de polvo, suciedad, atmósfera y mantener las normas de zonas peligrosas. Desconectar la alimentación antes de abrir el equipo.

V6 con "T"

Agua Fría - "T" instalada en fábrica

Valores aproximados de actuación/desactuación Superior en GPM, inferior en LPM

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
1.5 1.0	2.0 1.25	3.0 1.75	4.0 3.0	6.0 5.0	10.0 8.5
5.7 3.8	7.8 4.7	11.4 6.8	15.1 11.4	22.7 18.9	37.9 32.2

Aire - "T" instalada en fábrica

Valores aproximados de actuación/desactuación Superior en SCFM, inferior en LPM

1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
6.5 6.0	10.0 8.0	14 12	21 18	33 30	43 38
180 140	280 230	400 340	590 510	930 850	1220 1020

V6 Bajo Caudal, Ajustable en Campo

Agua Fría - Modelos de Bajo Caudal

Valores aproximados de actuación/desactuación Superior en GPM, inferior en LPM

MINIMO		MAXIMO	
.04	.03	.75	0.80
.15	.11	2.8	2.3

Aire - Modelos de Bajo Caudal

Valores aproximados de actuación/desactuación Superior en SCFM, inferior en LPM

MINIMO		MAXIMO	
.18	.15	2.70	2.0
6.1	4.2	76	57

Ejemplo	V6	FP	B	B	S	2	B	MT	
Serie	V6								V6EPB-B-S-2-B-MT Interruptor de caudal; caja superior en latón, Caja inferior en latón, "T" en latón con conexión de 3/4" NPT, microcontacto SPDT y conexión de alta temperatura
Construcción		FP							Interruptor serie V6
Superior			B						Antidiflagrante y estanco
Material del cuerpo inferior			S						Latón
Material del cuerpo superior				B					303 SS
Tipo de conexión				S					Latón
				D					303 SS
Tamaño de Conexión a Proceso						1 2 3 4 5 6 LF			SPDT DPDT
Tipo de Conexión a Proceso							0 B PS MI PVC PVC/SW S S150		1/2" NPT 3/4" NPT 1" NPT 1-1/4" NPT 1-1/2" NPT 2" NPT
Operación del micro								MV MT	Modelos de Bajo Caudal (conexiones de 1/2" NPT) Sin "T", conexión NPT-M, paleta recortable en campo
Opciones									"T" de latón "T" de acero forjado "T" de hierro "T" de PVC con NPT* "T" de PVC con juntas* "T" de 304 SS "T" de 304 SS de 150# (Para modelos de Bajo Caudal no se elija material de la "T", el material de la "T" es el del cuerpo inferior)
									Microcontacto dorado seco (ver ratings) Microcontacto de alta temperatura (350°C) (ver ratings)
									Aprobado ATEX (con opción estándar JCT) Aprobado CSA (con opción estándar JCT) Paleta a medida Informe de prueba de caudal Cable de tierra* Placa con información del cliente Caja de unión antidiflagrante y estanca* Caja de unión antidiflagrante y estanca a la izquierda Orificio de latón Orificio en acero inoxidable Paleta reforzada Conector de bloque terminal* Juntas de Vitón en lugar de Buna-N modelos de Bajo Caudal Resorte de 0,018 Resorte de 0,020 Resorte de 0,022 Resorte de 0,022 con Iman de Alnico Resorte de 0,031

* Opciones que no tienen ATEX

Atención: Las unidades sin el sufijo "AT" no cumplen con la Directiva 94/9/EC (ATEX). Estas unidades no son válidas para uso en atmósferas potencialmente peligrosas en Europa. Estas unidades pueden ser marcadas con "CE" para otras Directivas de Europa.

V6 con paleta recortable en campo

Agua Fría - "T" reductora de latón o hierro ductil

Valores aproximados de actuación/desactuación

Superior en GPM, inferior en LPM

Aire - "T" reductora de latón o hierro ductil

Valores aproximados de actuación/desactuación

Superior en SCFM, inferior en LPM

Paleta	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
Tamaño Total						9.0 8.5						39.0 37.0
a						34.1 32.2						1100 1050
b						9.5 9.0						40.0 38.0
c						36.0 34.1						1130 1080
d						10.0 9.3						42.0 40.0
e						37.9 35.2						1190 1130
f						11.0 10.0						50.0 44.0
g						41.6 37.9						1420 1250
h					6.2 5.5	12.0 10.0						27.0 25.0 55.0 48.0
i					23.5 20.8	45.4 37.9						780 710 1560 1300
j					7.0 6.5	13.0 11.0						30.0 28.0
k					26.5 24.6	49.2 41.6						850 790
l				4.3 3.9	7.6 7.1	14.0 12.0						20.0 18.0 32.0 30.0
m				16.3 14.8	28.6 26.9	53.0 45.4						570 510 910 850
n				4.9 4.4	8.0 7.3							21.0 19.0 34.0 32.0
o				18.5 16.7	30.3 27.6							590 540 960 910
p				5.5 5.0	9.0 8.2							23.0 21.0 37.0 34.0
q				20.8 18.9	34.1 31.0							650 590 1050 980
r			3.5 3.1	6.0 5.6	10.0 9.0							18.0 15.0 24.0 22.0 39.0 36.0
s			13.2 11.7	22.7 21.2	37.9 34.1							450 430 880 820 1100 1020
t			4.0 3.5	7.0 6.6	13.0 11.0							18.0 16.0 28.0 25.0 51.0 45.0
u			15.1 13.2	26.5 25.0	49.2 41.6							510 450 790 710 1440 1270
v			4.6 4.2	8.0 7.6	15.0 13.0							19.0 17.0 33.0 30.0 69.0 57.0
w			17.4 15.9	30.3 28.8	56.8 49.2							540 480 930 850 1950 1610
x		2.6 2.3	5.6 5.2	10.0 9.0								22.0 20.0 36.0 35.0
y		9.8 8.7	21.2 19.7	37.9 34.1								370 340 620 570 1080 990
z	1.6 1.3	3.5 3.1	6.3 6.1	12.0 10.0			6.4 3.8	15.0 14.0	25.0 23.0	45.0 42.0		180 110 420 400 710 650 1270 1190
aa	6.1 4.9	13.2 11.7	23.8 23.1	45.4 37.9			10.0 7.0	20.0 18.0	32.0 28.0			280 200 570 450 810 790
ab	2.2 1.8	4.3 3.8	8.0 7.5				12.0 9.0					340 250
ac	8.3 6.8	16.3 14.4	30.3 28.4									
ad	3.0 2.4											
ae	11.4 9.1											

Agua Fría - "T" recta y casquillo en acero inoxidable o acero forjado

Valores aproximados de actuación/desactuación

Superior en GPM, inferior en LPM

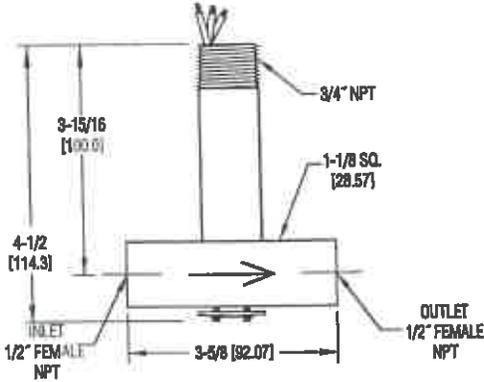
Aire - "T" recta y casquillo en acero inoxidable o acero forjado

Valores aproximados de actuación/desactuación

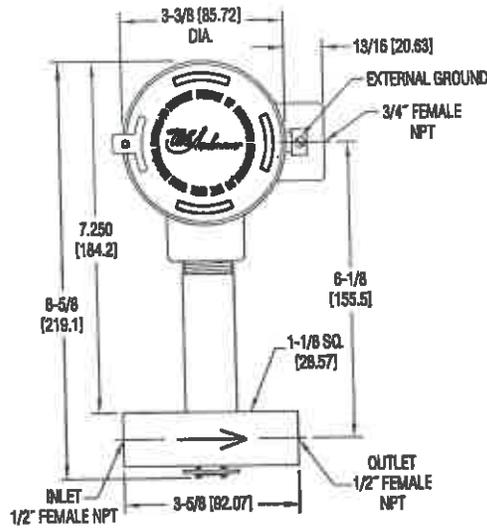
Superior en SCFM, inferior en LPM

Paleta	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	1/2" NPT	3/4" NPT	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT
Tamaño Total				5.0 4.5 8.5 7.8								
a				18.9 17.0 32.2 29.5						21.0 18.0 33.0 30.0		
b				5.5 5.0 9.2 8.6						59.0 51.0 93.0 85.0		
c				20.8 18.9 34.8 32.6						22.0 20.0 39.0 36.0		
d				6.2 5.7 9.8 9.0						82.0 57.0 110.0 102.0		
e				23.5 21.6 37.1 34.1						24.0 22.0 42.0 38.0		
f				6.8 6.3 12.0 10.0						88.0 62.0 119.0 108.0		
g				25.7 23.8 45.4 37.9						28.0 26.0 51.0 46.0		
h			2.8 2.4	8.5 7.8 13.0 11.0						79.0 74.0 144.0 130.0		
i			10.6 9.1	32.2 29.5 49.2 41.6						12.0 10.0 33.0 30.0 55.0 50.0		
j			3.4 3.0	10.0 9.2						34.0 28.0 93.0 85.0 156.0 142.0		
k			12.9 11.4	37.9 34.8						14.0 12.0 37.0 34.0		
l			4.0 3.6	12.0 10.0						40.0 34.0 105.0 96.0		
m			15.1 13.6	45.4 37.9						16.0 14.0 43.0 40.0		
n		2.0 1.5	5.0 4.5							45.0 40.0 122.0 113.0		
o		7.8 5.7	18.9 17.0							8.0 6.5 19.0 17.0		
p		2.5 2.0	6.5 6.1							23.0 18.0 54.0 48.0		
q		9.5 7.8	24.5 23.1							11.0 10.0 26.0 24.0		
r		3.5 3.0	9.0 8.2							31.0 25.0 74.0 68.0		
s		13.2 11.4	34.1 31.0							14.0 13.0 32.0 30.0		
t		7.0 5.5								40.0 37.0 91.0 85.0		
u		26.5 20.8								27.0 24.0		
v		10.0 8.0								79.0 68.0		
w		37.9 30.3								39.0 36.0		
x										110.0 102.0		

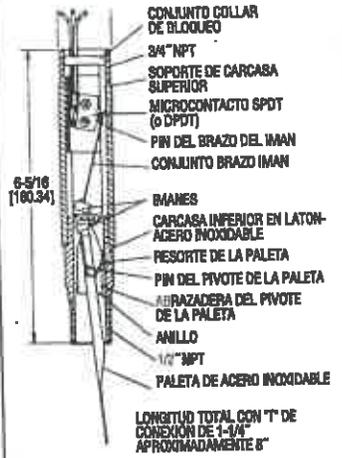
**DIMENSIONES
FLOTECT® Modelo V6**



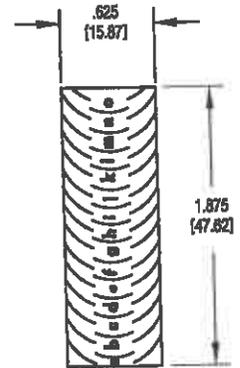
V6 de Bajo Caudal



V6 de Bajo Caudal con caja CSA, ATEX

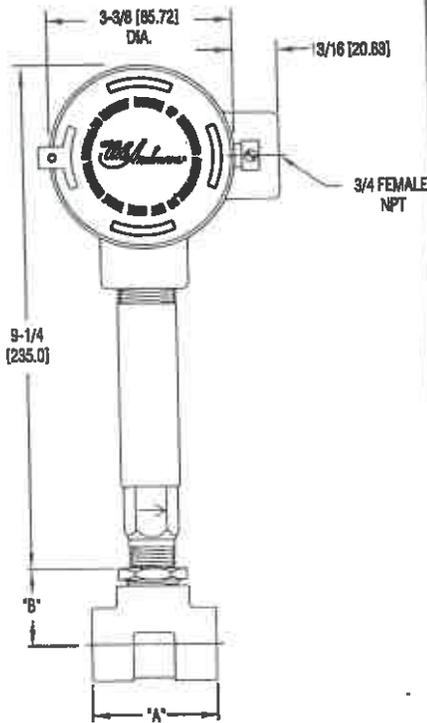


V6 con paleta recortable en campo

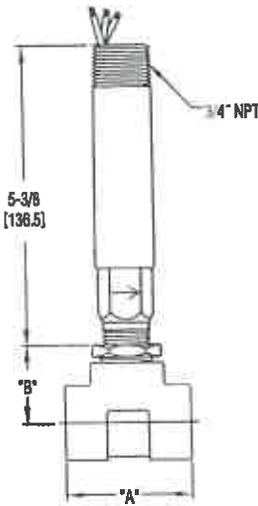


Paleta recortable

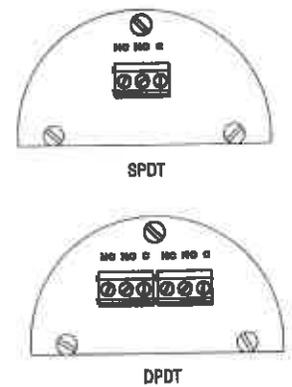
Diámetro	Latón o Hierro Ductil		Forjado Acero		Maleable Hierro	
	DIM. A	DIM. B	DIM. A	DIM. B	DIM. A	DIM. B
1/2"	2-1/4 (57)	1-1/8 (29)	2-1/4 (57)	1-1/8 (29)	2-1/2 (64)	1-1/4 (32)
3/4"	2-3/8 (60)	1-1/4 (32)	2-5/8 (67)	1-7/8 (47)	2-5/8 (67)	1-3/8 (35)
1"	2-1/2 (64)	1-3/8 (36)	3 (76)	2-1/8 (54)	2-7/8 (73)	1-1/2 (38)
1-1/4"	2-5/8 (67)	1-1/2 (38)	3-1/2 (86)	2-1/2 (64)	3 (76)	1-3/4 (44)
1-1/2"	2-7/8 (73)	1-5/8 (41)	4 (102)	2-3/4 (70)	3-1/4 (83)	1-7/8 (48)
2"	3 (76)	1-7/8 (48)	4-3/4 (121)	3-1/8 (79)	3-1/2 (89)	2-1/8 (54)



V6 con "T" y caja CSA, ATEX



V6 con "T"

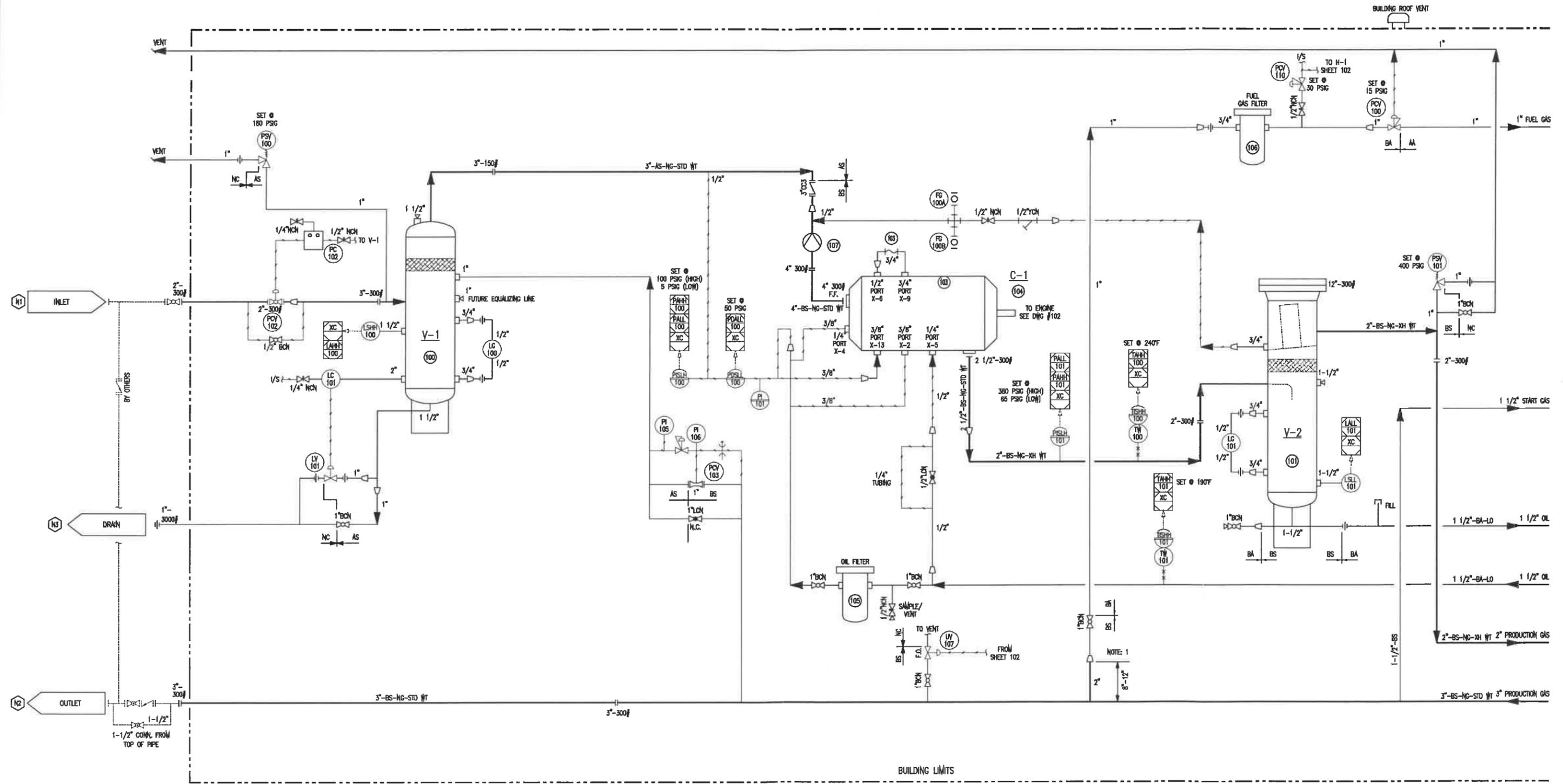


Conexiones del terminal de las cajas CSA/ATEX

V-1
INLET SEPARATOR
 SIZE: 14" O.D. x 59" S/S
 M.A.W.P.: 245 PSIG @ 250°F
 M.D.M.T.: -20/250°F
 C.A.: 0.125"
 WEIGHT: 575 LBS

C-1
GAS COMPRESSOR
 MANUFACTURER: SULLAR
 MODEL: PDM127-G1
 INPUT SPEED: 1800 RPM
 MAX PS: 140 PSIG
 MAX PD: 400 PSIG
 WEIGHT: 550 LBS

V-2
OIL SEPARATOR
 SIZE: 12 3/4" O.D. x 63.5" S/S
 M.A.W.P.: 450 PSIG @ 250°F
 M.D.M.T.: -20/250°F
 C.A.: 0.125"
 WEIGHT: 1250 LBS



THIS DRAWING IS THE EXCLUSIVE PROPERTY OF CONCEPT COMPRESSION CORP. AND CANNOT BE REPRODUCED WITHOUT THE PERMISSION OF CONCEPT COMPRESSION CORP.

SIZE	PIPE SPECIFICATION					
	NC	AA	BA	CA	AS	BS
1/2"	80	80	80	160	X0H	X0H
3/4"	80	80	80	160	160	X0H
1"	80	80	80	160	160	X0H
1 1/4"	80	80	80	160	160	X0H
1 1/2"	80	80	80	160	160	X0H
2"	80/STD	80/STD	80/STD	160/80	160/80	160/80

GENERAL NOTES

- ELECTRICAL CLASSIFICATION: CLASS 1, DIV. 2, GROUP D
- COMPRESSOR OIL TYPE: COGN1
- ENGINE OIL TYPE: ESSO GMA-40 OR EQUAL
- COOLANT TYPE: 50/50 EG
- LUBE OIL CAPACITIES: ENGINE: 2.5 GALLONS, COMPRESSOR: 10 GALLONS, SYSTEM TOTAL: 21 US GALLONS

GENERAL NOTES

- TUBING TO BE SS. FITTINGS TO BE CADMIUM PLATED #1/SS PRIMARY FERRULE & CS SECONDARY FERRULE.
- INTRINSICALLY SAFE WIRING TO BE TWO CONDUCTOR, 18 AWG, PVC COATED AND PVC SHEATH, TRIPLEX, SHIELD, #18L, STAINLESS STEEL Braid.
- ALL PROCESS PIPING TO COMPLY WITH ANSI B31.3
- (1X) 2"-300# & (1X) 3"-300# 25'-0" LG HOSE TO BE PROVIDED

NOTES

1. TAKE FROM TOP OF PIPE

REV	DESCRIPTION	DATE	BY	APPR
4	UPDATE CLIENT INFO & OPTIONS	DEC 12/08	T.K.	
3	AS-BUILT	JUNE 01/06	T.K.	
2	ADD ROOTS FUEL GAS METER	MAY 24/06	T.K.	
1	ADD OPTIONS AS PER CUSTOMER	MAY 23/06	T.K.	
0	ISSUED FOR CONSTRUCTION	MAR 02/06	J.H.	

NO.	DESCRIPTION	DATE	BY	APPR
1	ISSUED FOR CONSTRUCTION	MAR 02/06	J.H.	

P&ID
 CC90 G1 UNIT
 NGC JOB#
 16530

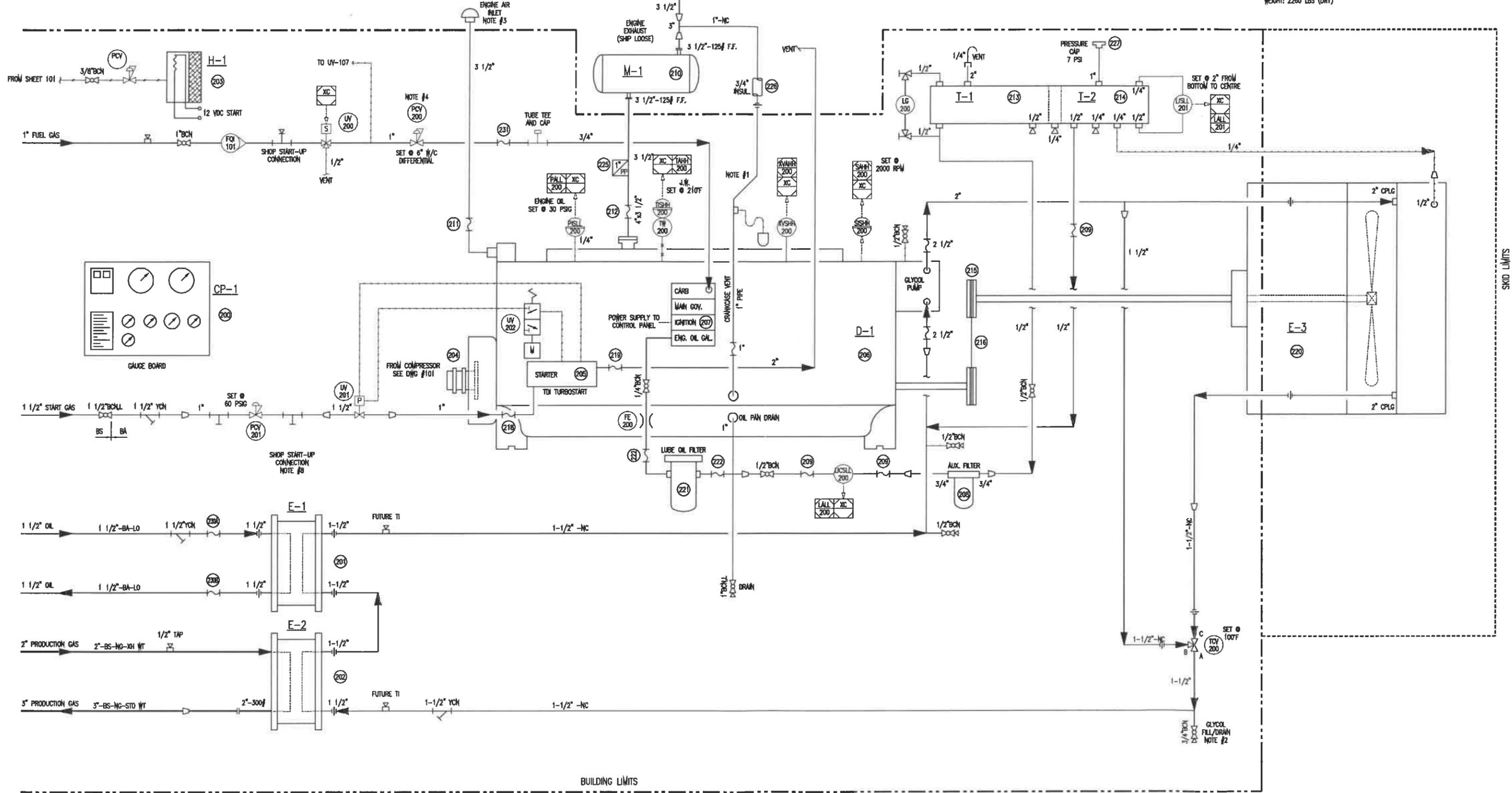
CONCEPT
 COMPRESSION CORP.

FOR NAVARONE ENERGY CORP.
 CC90 RENTAL
 LSD: 06-09-55-15-W5M

100495 100495-101 4

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF CONCEPT COMPRESSION CORP. AND CANNOT BE REPRODUCED WITHOUT THE PERMISSION OF CONCEPT COMPRESSION CORP.

- H-1**
BUILDING HEATER
CATALYTIC ROOM HEATER
MODEL: W24-24-000-1 12VDC
RATED INPUT: 16000 BTU/HR
MAKE: CIS-CAN
WEIGHT: 38 LBS
- E-1**
OIL COOLER
MODEL: FP 5x12-50
W.A.W.P.: 450 PSIG
SURFACE AREA: 18.4 SQ FT
WEIGHT: 19 LBS (DRY)
- E-2**
GAS COOLER
MODEL: FP 10x20L-24
W.A.W.P.: 400 PSIG
SURFACE AREA: 28.8 SQ FT
WEIGHT: 38 LBS (DRY)
- CP-1**
MURPHYMATIC CONTROL PANEL
MODEL: TTDJ-IGN-T
SELECTRONIC TATTLETALE
WEIGHT: 30 LBS
- M-1**
MUFFLER
MAKE: SILEX
MODEL: J00S-3.5-SI-AL-A
HOSPITAL GRADE
WEIGHT: 139 LBS
- D-1**
DRIVER
MAKE: CATERPILLAR
MODEL: 3304NA
POWER: 87 BHP @ 2500 F.A.S.L.
NO. CYLINDERS: INLINE 4
DESIGN SPEED: 1800
WEIGHT: 1630 LBS (DRY)
- T-1**
DAY TANK
SERVICE: ENGINE OIL
VOLUME: 16 GALLONS
8" x 6" x 60"
WEIGHT: 125 LBS
- T-2**
SURGE TANK
SERVICE: GLYCOL
VOLUME: 5.5 GALLONS
8" x 6" x 20"
- E-3**
AIR COOLER
MAKE: AIR-X-HEMPHILL
MODEL: 42M
SERVICE: E-GLYCOL
FAN: MOORE IK-10
FAN SPEED: 1040 RPM
FAN POWER: 3.5
WEIGHT: 2260 LBS (DRY)



SIZE	NPT/SW PIPE WT CHART						
	NC	AA	BA	CA	AS	BS	CS
1/2"	80	80	80	160	X0H	X0H	X0H
3/4"	80	80	80	160	160	160	X0H
1"	80	80	80	160	160	160	X0H
1 1/4"	80	80	80	160	160	160	X0H
1 1/2"	80	80	80	160	160	160	X0H
2"	80/STD	80/STD	80/STD	160/80	160/80	160/80	X0H/160

GENERAL NOTES

1. SLOPE, DO NOT TRAP. MAX. PRESSURE OF CRANKCASE +/- 0.5" W.C.
2. LOWEST POINT ON SYSTEM
3. RAIN CAP SUPPLIED WITH ENGINE
4. MOUNT AS CLOSE TO CARBURATOR AS OPERATIONALLY POSSIBLE

NOTES

1. TAKE OFF FOR STARTER TO BE AS CLOSE TO STARTER AS POSSIBLE

REV.	DESCRIPTION	DATE	BY	APPR.
3	UPDATE CLIENT INFO	DEC 12/08	T.K.	
2	AS-BUILT	JUNE 01/06	T.K.	
1	ADD OPTIONS AS PER CUSTOMER	MAY 23/06	T.K.	
0	ISSUED FOR CONSTRUCTION	MAR 02/06	J.H.	

REV.	DESCRIPTION	DATE	BY	APPR.
3	UPDATE CLIENT INFO	DEC 12/08	T.K.	
2	AS-BUILT	JUNE 01/06	T.K.	
1	ADD OPTIONS AS PER CUSTOMER	MAY 23/06	T.K.	
0	ISSUED FOR CONSTRUCTION	MAR 02/06	J.H.	

CONCEPT COMPRESSION CORP.

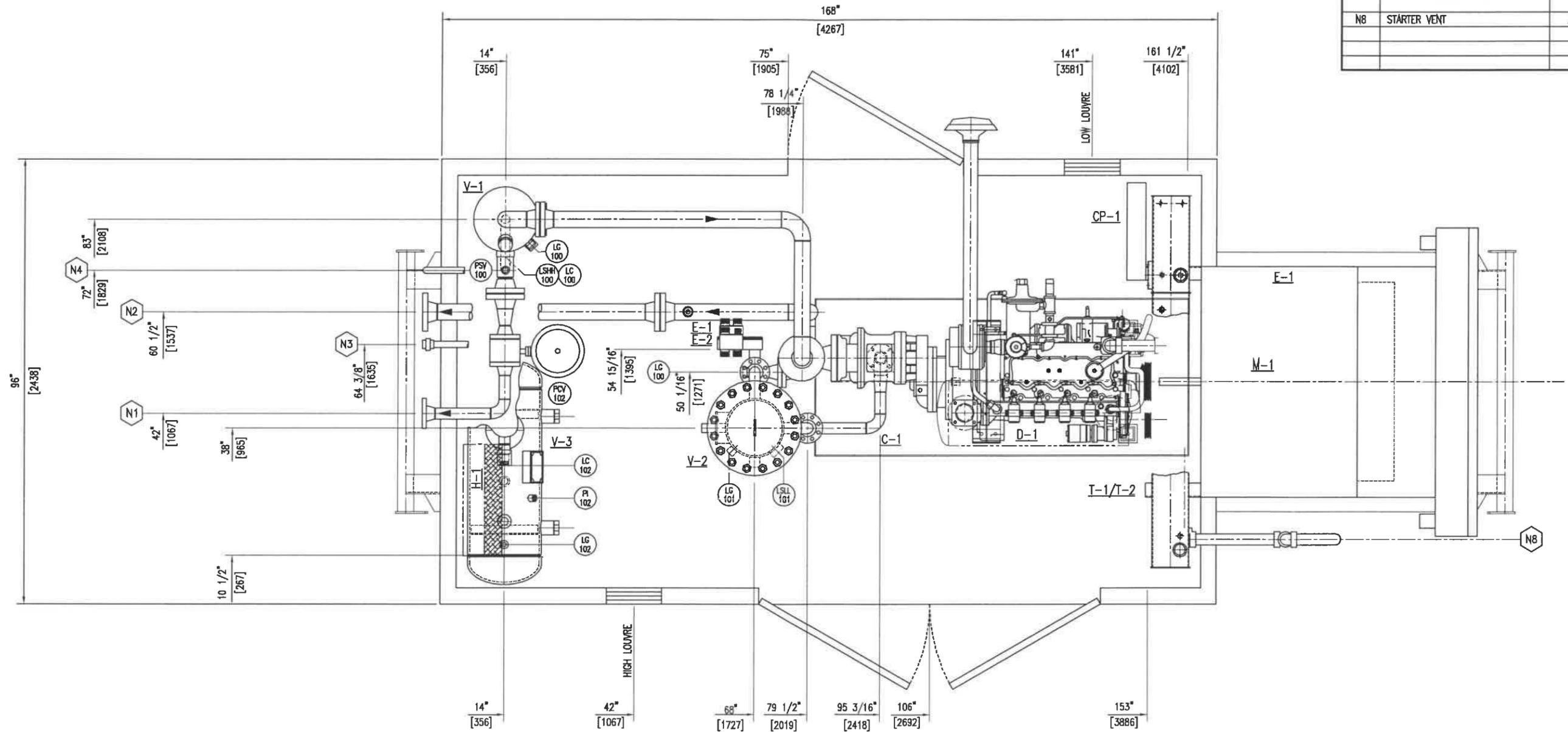
P&ID
CC90 G1 UNIT
NGC JOB#
16530

REV. B. RINEHART DATE DEC 9/04 FOR NAVARONE ENERGY CORP.
CC90 RENTAL
LSD: 06-09-55-15-W5M

100495 100495-102 2

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	2"	300#	RFWN
N2	GAS OUTLET	3"	300#	RFWN
N3	DRAIN	1"	3000#	NPT UNION
N4	PSV VENT	1"	3000#	NPT UNION
N8	STARTER VENT	2"	3000#	NPT UNION



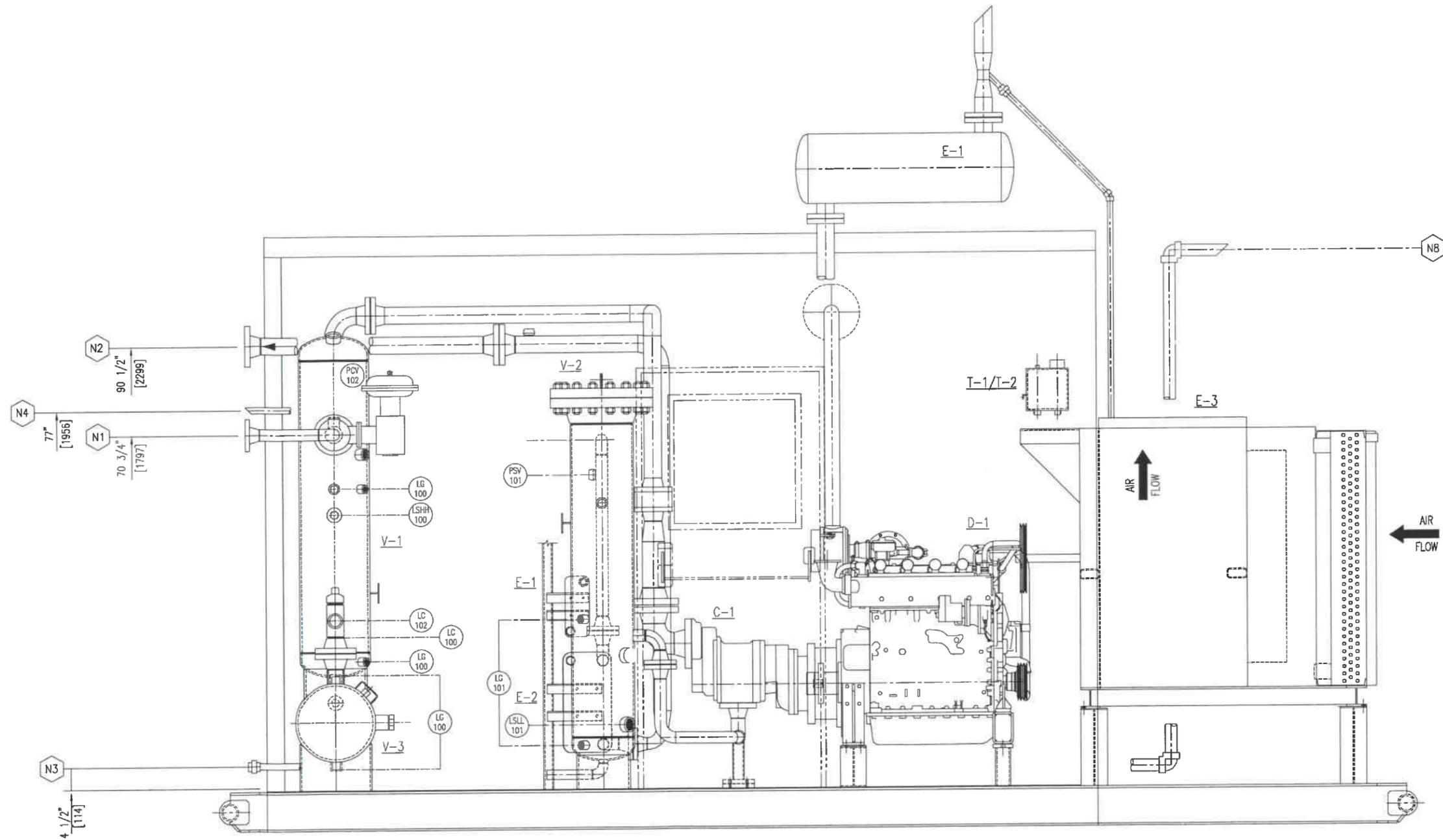
- GENERAL NOTES**
- ALL DIMENSIONS OUTSIDE OF BRACKETS ARE IN INCHES. ALL DIMENSIONS WITHIN [] ARE IN mm.
 - ALL TAIL DIMENSIONS ARE FROM DATUM.
 - ALL WELDED PIPING TO BE HYDROTESTED TO B31.3
 - ALL PROCESS PIPING TO BE LEAK TESTED TO B31.3
 - ALL PIPING TO BE SUBJECT TO 10% RADIOGRAPHY.
 - WELDING 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.
 - NO-NON CODE
 - AA-150 CLASS SHEET
 - BA-300 CLASS SHEET
 - 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, GLOSS URETHANE ENAMEL, CONCEPT TAN
 - SHIPPING WEIGHT IS APPROX.: 13,000 LBS (5897 KGS)
 - ROOF VENTS REMOVED FOR SHIPPING

REV	DESCRIPTION	DATE	BY	APPR
3	UPDATE CLIENT INFO	DEC 12/08	T.K.	
2	AS-BUILT	JUNE 01/08	T.K.	
1	ADD OPTIONS AS PER CUSTOMER	MAY 23/06	T.K.	
0	ISSUED FOR CONSTRUCTION	MAR 02/06	E.P.	

GENERAL ARRANGEMENT CC90 G1 UNIT NGC JOB# 16530			
DATE	SEP 26/05	FOR	NAVARONE ENERGY CORP.
DATE			CC90 RENTAL
DATE			LSD: 06-09-55-15-W5M
NO.	100495	NO.	100495-201
REV		REV	3

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF CONCEPT COMPRESSION CORP. AND CANNOT BE REPRODUCED WITHOUT THE PERMISSION OF CONCEPT COMPRESSION CORP.



- 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
 - MA-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, GLOSS URETHANE ENAMEL, CONCEPT TAN
 - SHIPPING WEIGHT IS APPROX.: 13,000 LBS (5897 KGS)
 - ROOF VENTS REMOVED FOR SHIPPING

REV.	DESCRIPTION	DATE	BY	APPR.
3	UPDATE CLIENT INFO	DEC 12/08	T.K.	
2	AS-BUILT	JUNE 01/08	T.K.	
1	ADD PER CUSTOMER	MAY 23/06	T.K.	
0	ISSUED FOR CONSTRUCTION	MAR 02/06	E.P.	

STAMPS			

GENERAL ARRANGEMENT CC90 G1 - PDH12 UNIT NGC JOB# 16530				
DRW. BY E.PETERS	DATE SEP 26/05	FOR NAVARONE ENERGY CORP. CC90 RENTAL LSD: 06-09-55-15-WSM		
DRW. NO. 100495	P.O. NO.	DRW. NO. 100495-202	REV. NO. 3	