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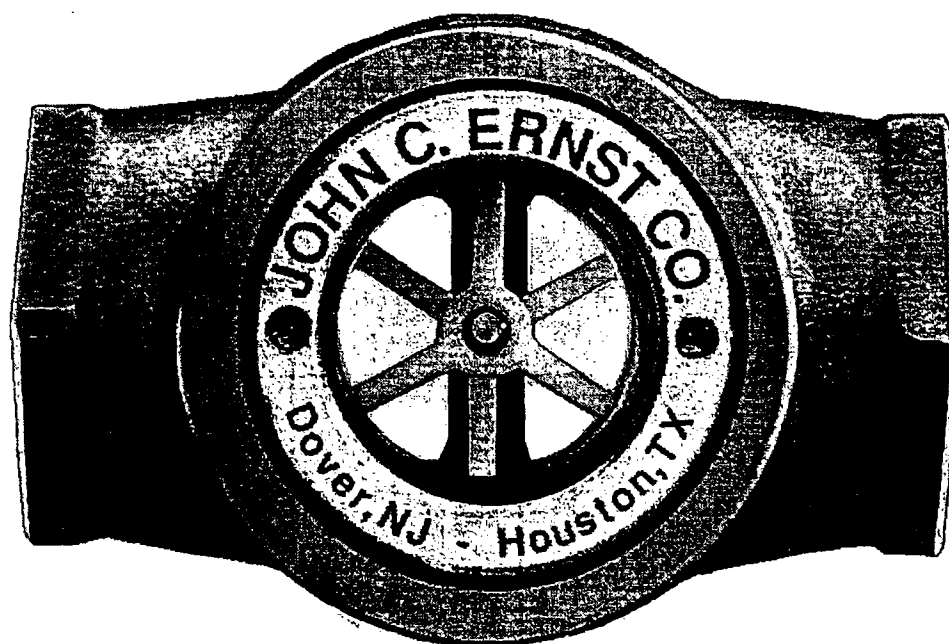
JOHN C. ERNST CO., INC. P.O. BOX 1500 Dover, New Jersey 07802		Title: Sight Flow Indicator - Threaded Window IOM		Drawing No. E10024	Rev D
Date: 19-Jul-00	Dr. by: DMF	Size:	Tolerances, unless otherwise specified: Fraction Decimal Angle ⊥ ⊥ ⊥		
Scale: 3962-993	App. by: JCW	Sheet: 1 of 7			

Sight Flow Indicator

Threaded Window

Includes Model #'s

100	101	102	103
140	141	142	143
160	161	162	163
190	191	192	193



Installation/Operation/Maintenance Instructions

Installation/Operation/Maintenance Instructions For Sight Flow Indicator, Threaded Window

This manual has been prepared as an aid and guide for personnel involved in installation and maintenance. All instructions must be read and understood thoroughly before attempting any installation, operation and maintenance. All instructions must be read and understood thoroughly before attempting any installation, operation, or maintenance.

WARNING: Failure to follow instructions could result in a malfunction or breakage of the indicator, resulting in fluid escaping from the unit and fragmenting glass. Always wear safety glasses when installing, servicing or operating a sight flow indicator. Failure to follow precautions can result in personal injury and property damage.

I. INTRODUCTION:

John C. Ernst Co. Threaded Window Sight Flow Indicators have been designed to enhance the visibility of process media as they pass by the glass window. The glass window assists the operations manager by creating a window to the fluid process volumes, directions, and reactions without interrupting the process flow. The process flow stream can be monitored in many orientations with a variety of indication devices. John C. Ernst Co. models are available in a variety of materials and sizes.

At a glance, the Threaded Window sight Flow Indicators allow for monitoring of:

- Liquid interfaces - change in level or evidence of liquid in the viewing area
- Foam interfaces - change in level or evidence of foam in the viewing area
- Fluid movement - change in direction or volume
- Color - change in tint or hue
- Clarity - change in opacity, brightness or purity

A. System Description

The John C. Ernst Co. Threaded Window Sight Flow Indicator consists of four basic components. Each component may vary slightly, depending on the desired physical and mechanical properties for the indicator. Use the exploded parts view in Section 10 as additional reference material.

Body - the threaded style connector ends provide rigid in-line attachment capability for the Threaded Window Sight Flow Indicator. In addition, the body provides a flat, machined cavity in which the retaining ring compresses the cushion and glass.

Glass - the glass disk is positioned between the gaskets and cushions to provide a window for observation of the media flowing through the body.

Gaskets - the gaskets are covers to tightly seal the gap between the body and to prevent leaks. Gaskets are standard with all 316 STS, which are Teflon®.

Covers - the covers provide a machined surface in which the glass and cushion are positively seated. The threaded cover provides an effective means of "screw" compressing the glass between the cushions, gasket and body on either side of the sight flow indicator.

II. Available Models:

John C. Ernst Co. offers five standard Threaded Window Sight Flow Indicator models. Standard materials of construction are ductile iron, bronze, carbon steel and 316 STS. Threaded Window Sight Flow Indicators are divided into the following models:

TABLE 1 - Model Numbers				
Carbon Steel	Bronze	Stainless Steel	Iron	Description (NPT)
100	140	160	190	Plain
101	141	161	191	Rotator
102	142	162	192	Flapper
103	143	163	193	Drip Tube

Covers are available in brass and 316 stainless steel. Spanner wrenches for retaining cover removal, installation, and torquing are available from John C. Ernst Co.

A. Indicator Pressure and Temperature Specifications

WARNING: Exceeding the design ratings or application's data limits can cause the glass to break, the unit to leak or sudden release of pressure. Do not exceed the design ratings for each particular unit. Failure to keep operations below design ratings may result in serious personal injury and property damage.

Maximum Design Ratings for Units with Tempered Glass

Body Material	Temp. Rating	Gasket Material						
		Teflon®	Asbestos	Grafoil®	Viton®	Kel-F®	Neoprene	Buna N
Iron	-20°F to 150°F	175	175	175	175	175	175	175
	At 250°F							150
	At 300°F						140	
	At 350°F	125	125	125	125	125		
Bronze	-20°F to 150°F	225	225	225	225	225	225	225
	At 250°F							205
	At 300°F						190	
	At 400°F	150	150	150	150	150		
Carbon Steel	-20°F to 100°F	285	285	285	285	285	285	285
	At 250°F							245
	At 300°F						230	
	At 400°F				200	200		
	At 500°F	170	170	170				
316 STS	-20°F to 100°F				275			
	-65°F to 100°F						275	275
	-120°F to 100°F	275						
	-150°F to 100°F		275					
	-300°F to 100°F			275		275		
	At 250°F							230
	At 300°F						215	
	At 400°F				195	195		
	At 500°F	170	170	170				

III. ASSEMBLY:

Upon receipt of a John C. Ernst Co. sight flow indicator, check all components carefully for damage, which may have been, incurred during shipping. **IMPORTANT:** If damage is evident or suspected, do not attempt installation. Notify your carrier immediately and request a damage inspection.

John C. Ernst Co. standard Threaded Window Sight Flow Indicator unit is comprised of (1) body, (2) gaskets, (2) cushions, (2) glass disks, (2) covers, and (1) identification nameplate.

Confirm that the information on the identification nameplate conforms to the size, model, and performance data on the purchase order and the actual operating conditions at the installation sight.

A. Assembling Indicators

Refer to the exploded view in Section 10 for component identification assistance and position.

1. Carefully remove the glass disks from the shipping package, examine the glass to ensure that it is free of scratches and other imperfections, and place in a safe area.
2. Clean any material from gasket and cushion seating cavity.

3. Place body on a clean flat surface and place gasket in one side.
4. Place glass on top of the gasket on the body.
5. Place cushion on top of the glass and thread the cover clockwise until it is finger tight.
6. Turn assembly over and repeat steps 2 through 6.
7. Using a spanner wrench, hand torque covers to the values in tables below:

WARNING: Torquing under pressure increases the likelihood of glass breakage and contents spraying out of the indicator, than if sight flow were de-pressurized. A sight flow indicator in service must be freed of all pressure or vacuum, allowed to reach ambient temperature and drained or purged of all fluids before re-torquing. Failure to follow this procedure could result in serious personal injury and property damage.

IV. INSTALLATION:

CAUTION: Only qualified experienced personnel who are familiar with sight flow indicator equipment and thoroughly understand the implications of the tables and all the instructions should assemble the sight flow indicator. Failure to read and comply with the following instructions could result in personal injury or property damage.

Unit Ratings and Torque Values

Gasket Material		Viton, Buna N, Butyl, Neoprene, EPR	
Unit Rating and Torque Value (ft. lbs.)		150 PSIG Torque (ft. lbs.)	150 ANSI Torque (ft. lbs.)
Unit Size	1/4", 3/8"	3 to 4	5 to 6
	1/2", 3/4"	6 to 7	10 to 12
	1"	7 to 8	13 to 15
	1 1/4", 1 1/2"	16 to 18	29 to 33
	2"	23 to 27	44 to 48

Table 3

Unit Ratings and Torque Values

Gasket Material		Teflon®, Asbestos, Kel-F®, Grafoil®, Durabala®, Nobestos, Garlock®, Gylon®	
Unit Rating and Torque Value (ft. lbs.)		150 PSIG Torque (ft. lbs.)	150 ANSI Torque (ft. lbs.)
Unit Size	1/4", 3/8"	7 to 8	8 to 9
	1/2", 3/4"	15 to 17	16 to 18
	1"	20 to 24	22 to 26
	1 1/4", 1 1/2"	35 to 39	44 to 48
	2"	53 to 57	65 to 69

Table 4

A. Inspection

1. Examine the glass to see that it is free of scratches, chips or other imperfections.
2. Ensure that the connections and inside of the sight flow have been cleaned and are free of any foreign material.

B. Location Precautions

DO NOT impose system piping loads on the Threaded Window Sight Flow Indicator. The sight flow indicator is not designed to be a load bearing component. Piping must be supported and aligned with the sight flow indicator end connections to reduce the possibility of load or torsional stresses.

Locate the Threaded Window Sight Flow Indicator:

1. Where it can be easily seen.
2. Away from areas where objects may be dropped, thrown or generally allowed to contact the glass.
3. So that it is protected from dust, grit or other objects that could damage the glass.
4. So it is protected from external thermal shock such as high a temperature application being exposed to a cold air blast or cold water wash.

C. Cover Torque Check

Cover torque is vital to the proper operation of a Threaded Window Sight Flow Indicator. Torque values should be checked after initial installation, and periodically thereafter, to ensure that the unit is in compliance with the torque values described in Section 4.1.

WARNING: Failure to inspect, locate and check the sight flow indicator as described above within the Inspection, Loading Precautions, and Cover Torque Sections could result in serious personal injury and property damage.

V. OPERATION:

Before initializing sight flow operation, check that all installation procedures have been completed. Use only qualified, experienced personnel who are familiar with sight flow indicator equipment and thoroughly understand the implications of the tables and all the instructions. Check that the covers have been torqued to their proper limits as stated in Section 4. Check that all connections are pressure tight and the glass is clean and free of any damage.

CAUTION: Sight flow indicator installations should be brought into service slowly to avoid excessive shock or stress on the glass. Rapid pressurization of a sight flow indicator can cause glass breakage/fragmentation and fluid leakage. Hydrostatically pressure test the Threaded Window Sight Flow Indicator to at least 50 psig and correct any leakage to help avoid personal or property damage.

VI. MAINTENANCE:

Use only qualified, experienced personnel who are familiar with sight flow indicator equipment and thoroughly understand the implications of the tables and all the instructions.

WARNING: Torquing under pressure increases the likelihood of glass breakage and contents spraying out of the indicator, than if sight flow were depressurized. A sight flow indicator in service must be freed of all pressure or vacuum, allowed to reach ambient temperature and drained or purged of all fluids before re-torquing. Failure to follow this procedure could result in serious personal injury and property damage.

Create a maintenance schedule for each specific installation of a Threaded Window Sight Flow Indicator. On all inspections, regularly check the following items:

1. Glass for cleanliness and signs of damage or wear.
2. Sight flow indicator for signs of leakage at gaskets or connections.
3. Sight flow indicator for signs of internal or external corrosion.
4. Cover torque values (see Section 4)

A. Maintenance Procedures

1. GLASS should be given regular and careful attention. Keep glass clean using a commercial glass cleaner and a soft cloth. Inspect the surface of the glass for any clouding, etching or scratching or physical damage such as bruises, checks or corrosion. Glass that is damaged is weakened and may break under pressure. Shining a light at approximately a 45° angle will aid in detecting some of these conditions. Typical damaged areas will glisten more brightly than the surrounding glass because the light is reflected.

Detection of any damage, problem areas or surface wear is sufficient evidence to take the sight flow indicator out of service. DO NOT proceed with operation of the sight flow indicator until the glass has been replaced by following the assembly instructions in Section 4.

2. GASKET LEAKS must be repaired immediately. DO NOT proceed with operation of a sight flow indicator until gaskets have been replaced by following the assembly instructions in Section 4.

3. CONNECTION LEAKS at a threaded connection should be corrected by tightening the NPT connection, or by taking the sight flow indicator out of service and wrapping the connection threads with Teflon® tape on all male pipe threads.

4. CORROSION may occur if the user has selected an improper material for the Threaded Window Sight Flow Indicator application. It is the responsibility of the user to choose a material of construction compatible with the contained fluid and the surrounding environment. If internal or external corrosion are present, an investigation must immediately be performed by the user. It may be necessary to contact an authorized John C. Ernst Co. distributor to better determine the origin of the corrosion.

B. Troubleshooting

Problem

Glass becomes etched or clouded in service.

Cause

Cure

Fluid being handled is not compatible with the glass

Replace the glass.

Problem

Glass continually breaks in service.

Cause

Cure

Warped body as a result of mechanical or thermal stresses.

Reduce the stress and replace sight flow indicator

VII. REMOVAL/DISASSEMBLY/REASSEMBLY:

WARNING: DO NOT remove sight flow indicator while it is under pressure. A pressurized sight flow indicator fragments the glass and sprays contents in a more violent manner than if it were de-pressurized. A sight flow indicator in service must be freed of all pressure or vacuum, allowed to reach ambient temperature and drained or purged of all fluids before re-torquing. Failure to follow this procedure could result in serious personal injury and property damage.

A. Disassembly

Threaded Window Sight Flow Indicators should be by placing the sight flow indicator on a clean, level table surface. Ensure that the unit is stable and secure, hold the sight flow indicator firmly, and loosen the covers with a spanner wrench. Remove the cushions, glass and gaskets from the indicator using the appropriate safety precautions. Once a sight flow indicator has been disassembled, all glass must be disposed of because of wear, and, all gaskets must be disposed of since they are permanently deformed by compression during service.

WARNING: DO NOT under any circumstances reuse glass or gasketing items previously in service, since they can cause leaks or high stress points resulting in glass breakage and serious personal injury and property damage.

Glass that is broke or damaged in any way is dangerous and should be disposed of in a safe manner determined by the user.

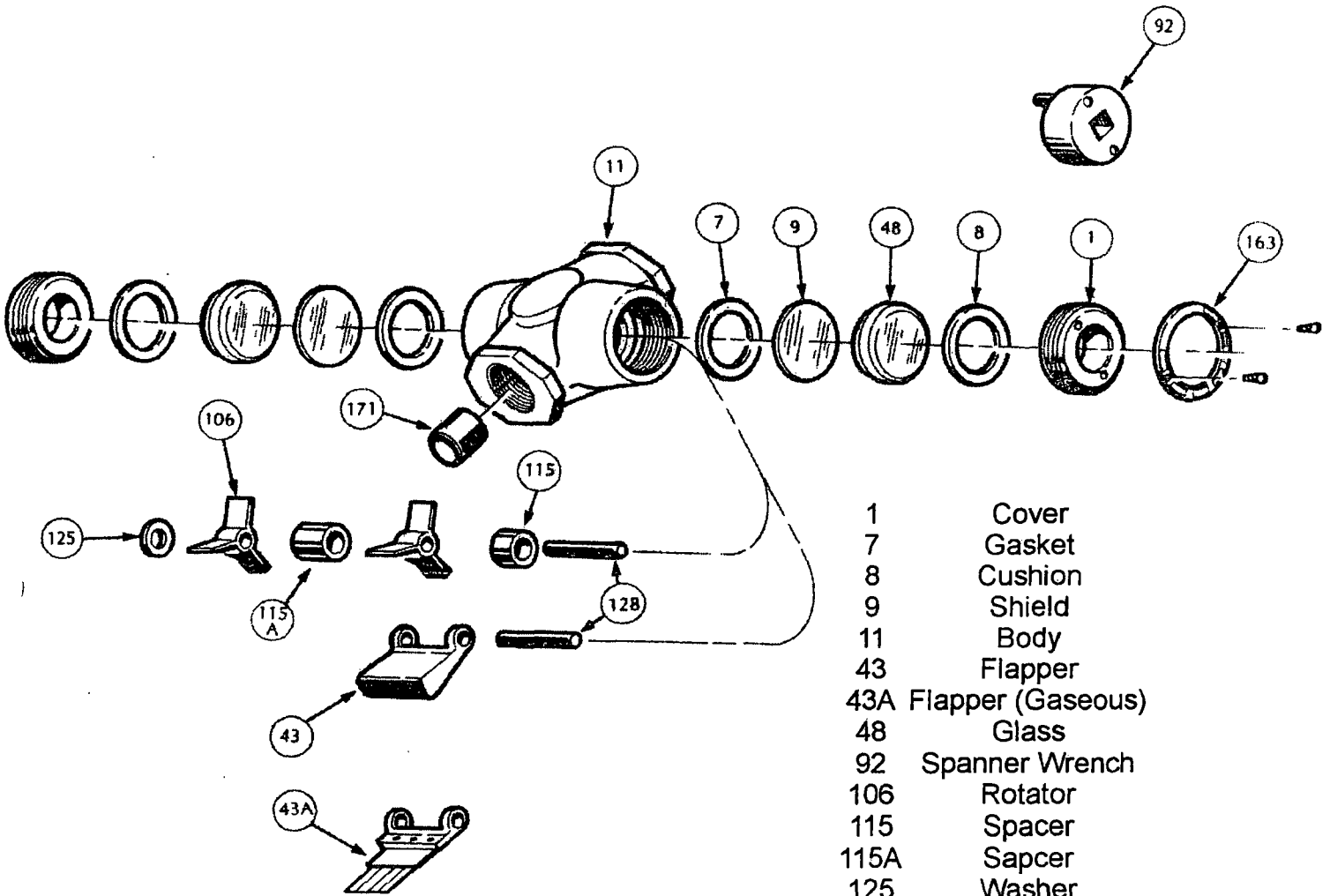
B. Reassembly

To prepare for installation of new glass, clean the gasket seating surfaces on the body and cushion seating surface of cover. This should be done using a soft metal scraper (preferably brass) to remove all burrs, rust and remnants of the previous gasket or cushion. Exercise extreme care to avoid gouging or scarring gasket seating surfaces. Failure to prepare the gasket surfaces will result in leaks and/or glass breakage.

Before installation, inspect the replacement glass for imperfections. During inspection, and during any subsequent handling of the glass, keep the glass from contacting other surfaces. Bumping or sliding of glass against other surfaces can result in glass breaking, scratching or chipping. Install the new glass disks by following the procedure in Section 4.

Recommended Spare Parts

Ref. #	Item	Quantity
7	Gasket	2
48	Glass	2



- 1 Cover
- 7 Gasket
- 8 Cushion
- 9 Shield
- 11 Body
- 43 Flapper
- 43A Flapper (Gaseous)
- 48 Glass
- 92 Spanner Wrench
- 106 Rotator
- 115 Spacer
- 115A Sapcer
- 125 Washer
- 128 Pin
- 163 Nameplate
- 171 Drip Tube
- 331 Band

Installation for L1100, L1200, L1200N Series

Liquid Level Switches and DV850, DV875, and DV2100 Series Dump Valves

DV models are Patent pending.

LDV-92151N
Revised 1201
Section 15
(00-02-075)



Please read the following instructions before installing. A visual inspection for damage during shipping is recommended before mounting.

GENERAL INFORMATION

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ Disconnect all electrical power to the machine.
- ✓ Make sure the machine cannot operate during installation.
- ✓ Follow all safety warnings of the machine manufacturer.
- ✓ Read and follow all installation instructions.
- ✓ OBSERVE all pressure and electrical ratings and requirements for the devices and the operating environment.
- ✓ BE SURE all pressure HAS BEEN REMOVED from the vessel before opening any pressure connections.

Description

Series L1100 and L1200 Liquid Level Switches are float activated to operate an electrical SPDT snap switch (optional DPDT on some models) for alarm or shutdown of an engine or electric motor. They screw directly into the wall of the vessel. Series L1200 can also be used with a weld collar or external float chamber.

Series L1200N is a float-activated, pneumatic-vent level device used to operate dump valves or similar devices. This model screws directly into the vessel or can be mounted via an external float chamber. It cannot be used with weld collar 15050375. Model variations include a dump valve operator with or without a filter/pressure regulator and indicating pressure gauge.

NOTE: All stainless steel versions of L1100, L1200, L1200N, L1200NDVO, and L1200NDVOR series carry Canadian Registration Number OF1476.2.

Series DV850, DV875 & DV2100 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. **NOTE:** All stainless steel versions of DV850, DV875, and DV2100 series carry Canadian Registration Number OC1476.2.

Specifications

	L1100	L1111	L1150	L1200	L1250	L1200N	L1200NDVO	L1200NDVOR
Body								
• Standard: Electroless Nickel plated steel	X ^A	X ^A	X ^A	X ^B	X ^B	X ^B	X ^B	X ^B
• Optional: 316 Stainless Steel†	X ^A	X ^A	X ^A	X ^B	X ^B	X ^B	X ^B	X ^B
Pressure Rating								
• 15 psi (103 kPa) [1.03 bar] Polyethylene Float			X		X			
• 1500 psi (10.3 MPa) [103.42 bar] Stainless Float	X	X		X		X	X	X
• 2000 psi (13.8 MPa) [138 bar] BUOYGLAS™ Float	X	X		X		X	X	X
Temperature Rating								
• Standard: -20/175°F (-29/79°C)			X		X			
• Standard: -20/300°F (-29/149°C)	X	X		X		X	X	X
• Optional: -20/400°F (-29/204°C)*	X	X		X		X	X	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	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

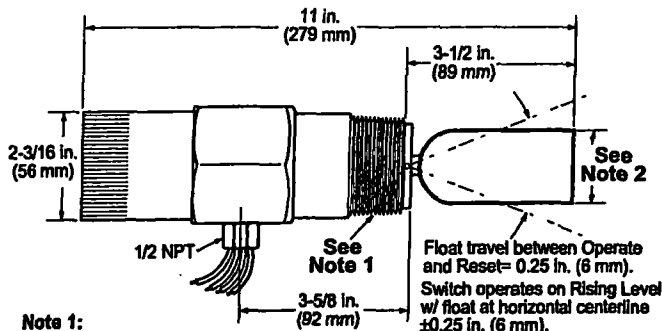
A=1-1/2 NPT B=2 NPT †Meets NACE standard MR-01-75 for direct exposure to H₂S service.

*Not available with DPDT snap-switch.

**Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility.

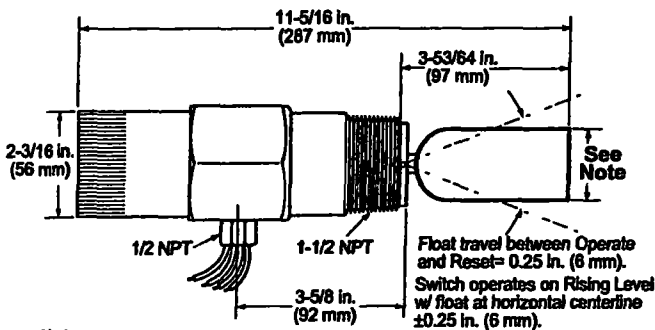
DIMENSIONS

L1100 and L1200



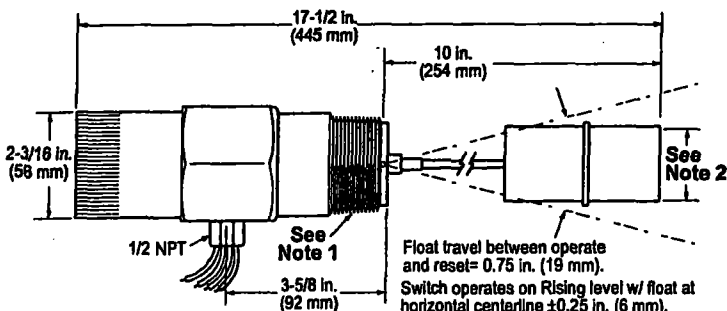
Note 1:
L1100: 1-1/2 NPT
L1200: 2 NPT
Note 2: 1-9/16 (40 mm)
SF option:
L1100: 1-1/2 (38 mm)
L1200: 1-3/4 (44 mm)

L1111



Note: 1-9/16 (40 mm)
SF option: 1-1/2 (38 mm)

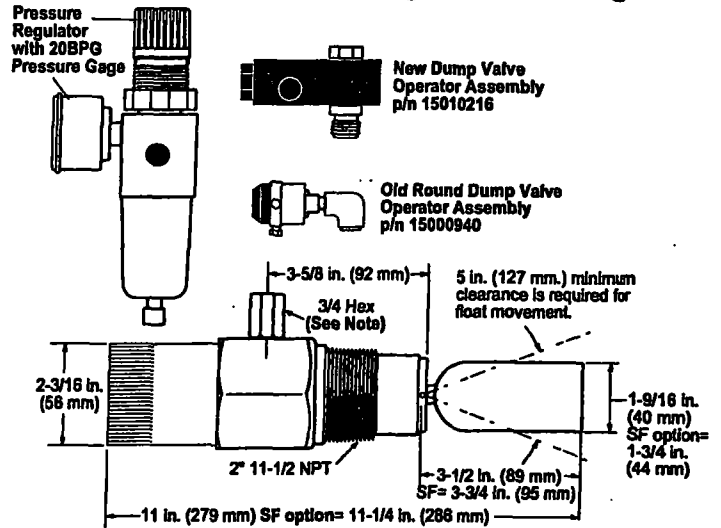
L1150 and L1250



Note 1:
L1150: 1-1/2 NPT
L1250: 2 NPT

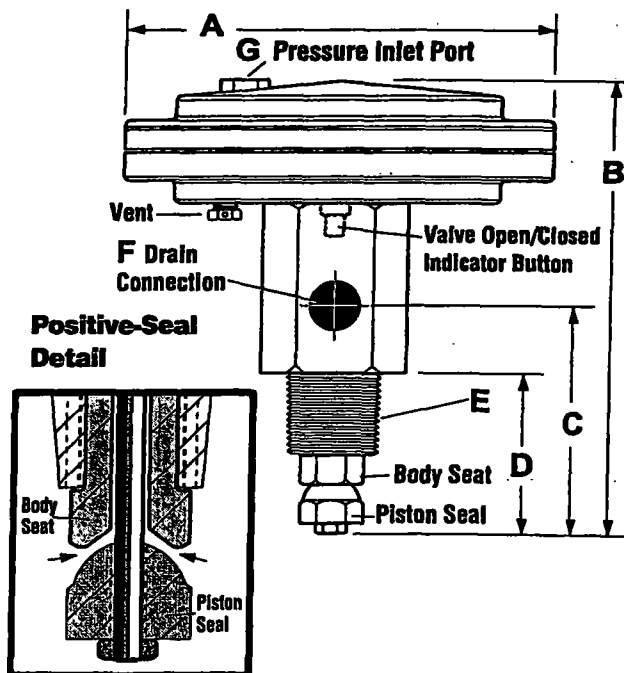
Note 2:
L1150: 1-1/2 in. (38 mm)
L1250: 2 in. (51 mm)

L1200N, L1200NDVO and L1200NDVOR with Dump Valve Operator, Pressure Regulator and Gage



Note: For use only with Old Round Dump Valve Operator Assembly (15000940).

DV850, DV875, and DV2100 Series Dump Valves



	DV850/SS	DV875/SS	DV2100/SS
A	6-3/4 (171)	6-3/4 (171)	6-3/4 (171)
B	7-9/64 (181)	7-9/64 (181)	7-59/64 (201)
C	3-9/32 (83)	3-9/32 (83)	3-63/64 (101)
D	2-19/64 (58)	2-19/64 (58)	2-5/32 (55)
E	1 NPT	1 NPT	2 NPT
F	1/2 NPT	3/4 NPT	1 NPT
G	1/8 NPT	1/8 NPT	1/8 NPT

NOTE: Dimensions are in inches and (millimeters)

REPLACING AND INSTALLING THE DVOA ASSEMBLY

When replacing/installing the old style DVO assembly with the new style (DVOA), tubing and fitting modifications are required. We suggest removing the L1200NDVO/DVOR from the vessel. Relieve pressure from the vessel or use block valves before removing the L1200NDVO/DVOR.

Replacing and Installing the DVOA Assembly For Models L1200NDVO & L1200NDVOR

Tools Needed: Strap or pipe wrench; 3/4" Hex wrench; 9/16" hex wrench; needle nose pliers; tubing cutters and benders and the appropriate tools for the fittings.

1. Block off and bleed the instrument gas pressure supply to the L1200NDVO.
2. Remove the tubing between the L1200NDVO and the separator dump valve, and remove the supply gas tubing (regulator [-R] if used).
3. Remove the L1200NDVO from the vessel (optional).
4. If the L1200N was removed from the vessel, mount it in a suitable vise on a work bench (if possible).
5. Using the proper tools, disconnect the Inlet, Outlet and Exhaust fittings from the existing DVO (see fig. 1). You will re-connect these to the new DVOA in a later step.

NOTE: The following steps must be done with the DVO in the upright position (on top of the L1200N).

6. Remove the L1200N cover (this will aid with the alignment of the new DVOA Valve Bushing). The use of a strap wrench or a pipe wrench may be needed.
7. Insert the new Valve Bushing through the new DVOA (see fig. 2). The markings on top of the DVOA must be facing up. This will be needed in step 9.
8. With a 3/4" hex wrench loosen the existing DVO, valve stem, and static seal (see fig. 3). Once the assembly is loosened, VERY CAREFULLY use needle nose pliers to hold the Valve Seat Assembly in place. Remove the existing DVO making sure the Valve Seat Assembly inside the L1200NDVO is aligned and straight (see fig. 4).



CAUTION: MAKE SURE the Valve Seat Assembly inside the L1200N remains in place after removing the DVO.

9. Holding the Seat Assembly up with the needle nose pliers inside the L1200NDVO body, place the tip of the new DVOA valve bushing through the spring and into the hole in the center of the valve seat, and tighten the valve bushing. The Valve Seat Assembly should be able to move freely up and down after the bushing has been tighten. The DVO red button must face away from the vessel.
10. With the new DVOA aligned over the hex on the L1200NDVO body, tighten the Valve Bushing using the 9/16" hex wrench. You may need to hold the DVOA while tightening the Valve Bushing to keep it from rotating (see fig. 5).
11. If the L1200N is in the vise, operate the float and inspect for smooth and proper operation of the Valve Seat Assembly.
12. Replace the L1200NDVO cover (see fig. 6).
13. Using the appropriate tools re-install the Inlet, the Outlet and the Exhaust fittings to the new DVOA (see fig. 5).
14. If the L1200N was removed from the vessel re-install it at this time.
15. Modify existing or install new tubing to connect the Inlet, the Outlet and Exhaust fittings.

NOTE: Clean, dry instrument quality gas should be used. Use of filters will improve service life and reliability.



Figure 1

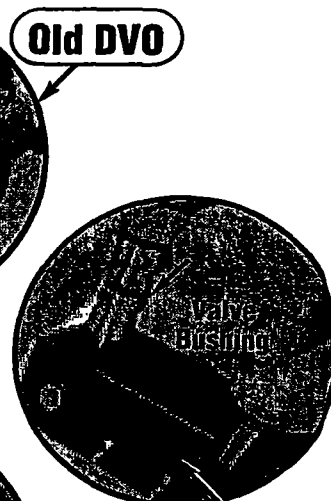


Figure 2 New DVOA



Figure 3

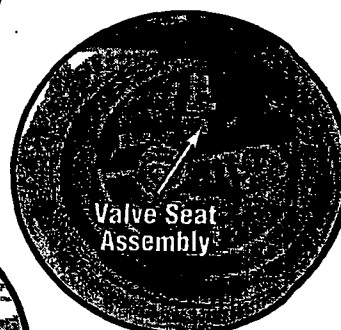


Figure 4

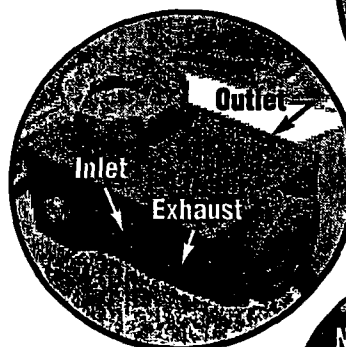


Figure 5

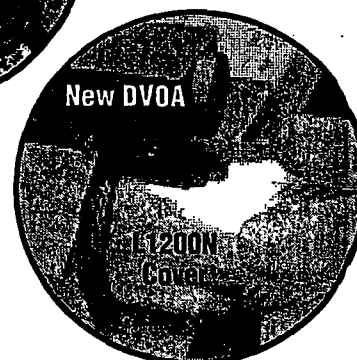
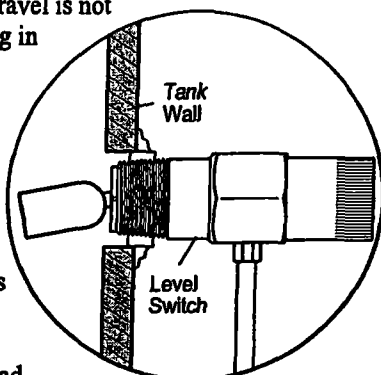


Figure 6

PRESSURE VESSEL INSTALLATION: L1100, L1200, and L1200N

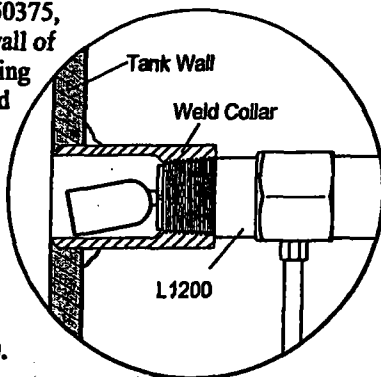
Direct Installation into the Wall of the Pressure Vessel

1. Determine that the float travel is not obstructed by the coupling in the vessel wall, internal baffles, etc.
Do NOT use more than one arm extension P/N 15050395.
2. BE SURE that the float and extension are tight and that the lock washer is in place.
3. Before installing the level switch a suitable pipe thread sealant is recommended. Screw the unit directly into the threaded connection in the wall of the pressure vessel.
4. Be sure that the electrical connection is positioned at the bottom. For L1200N the 1/8 NPT pneumatic connection should be on top (the 1/4 NPT vent connection should be on the bottom). See "Pneumatic models" section for further instructions for the L1200N.
5. Make the electrical wiring connections according to appropriate wiring diagrams for the alarm or shutdown system to be used. The electrical connection is 1/2-14 NPT.
6. BE SURE all electrical connections are insulated and the cover is fully installed before reconnecting electrical power.
7. BE SURE all pressure connections are tight before pressurizing the system.



Installation with a Weld Collar

1. The weld collar, P/N 15050375, must be welded into the wall of the pressure vessel according to code standards and good welding practices.
2. Follow above instructions for installation directly into the wall of the pressure vessel.
3. NOTE: Weld collar 15050375 can be used ONLY with model L1200.



Installation Using External Float Chamber 15050697



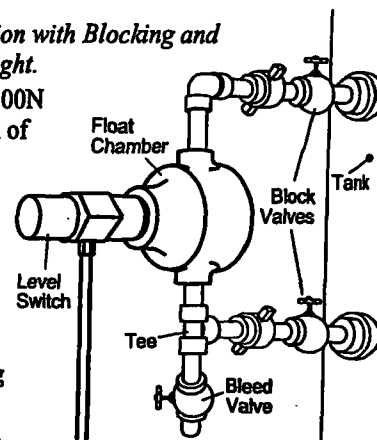
CAUTION: USE "NON SPARKING TOOLING".

1. Install the float chamber 15050697 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

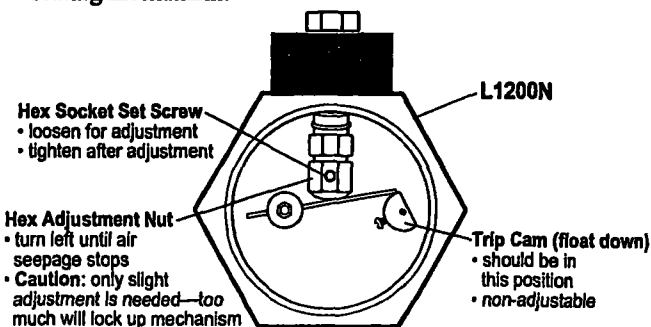
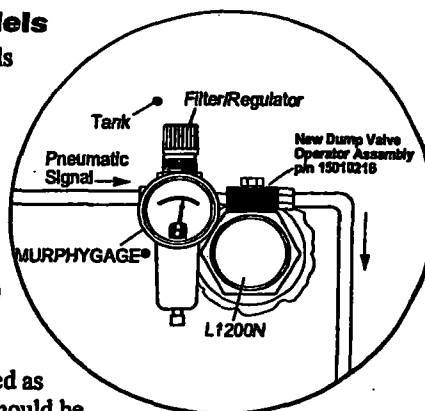
1. All pneumatic models operate on the vent principle. The pneumatic signal source MUST BE CLEAN AND DRY. The input pneumatic signal must be regulated between 30 and 70 psi (207-483 kPa) [2.07-4.83 bar].

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.



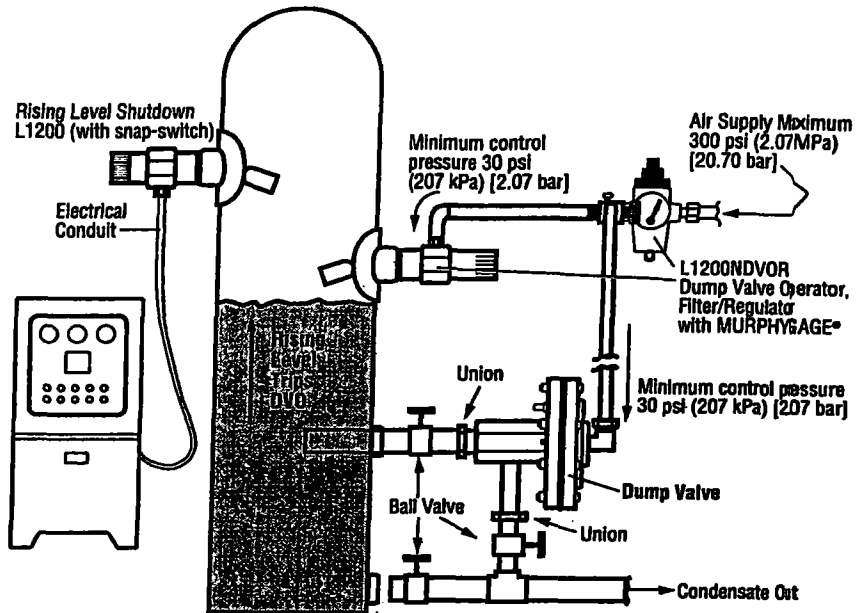
TYPICAL INSTALLATION ON GAS COMPRESSORS

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.



DUMP VALVE INSTALLATION

DV850 - DV875 - DV2100



CAUTION: USE "NON SPARKING TOOLING".

The following steps describe the "Block and Bleed" method for installing the dump valve. The "Direct Mounting" method to the tank wall is also accepted.

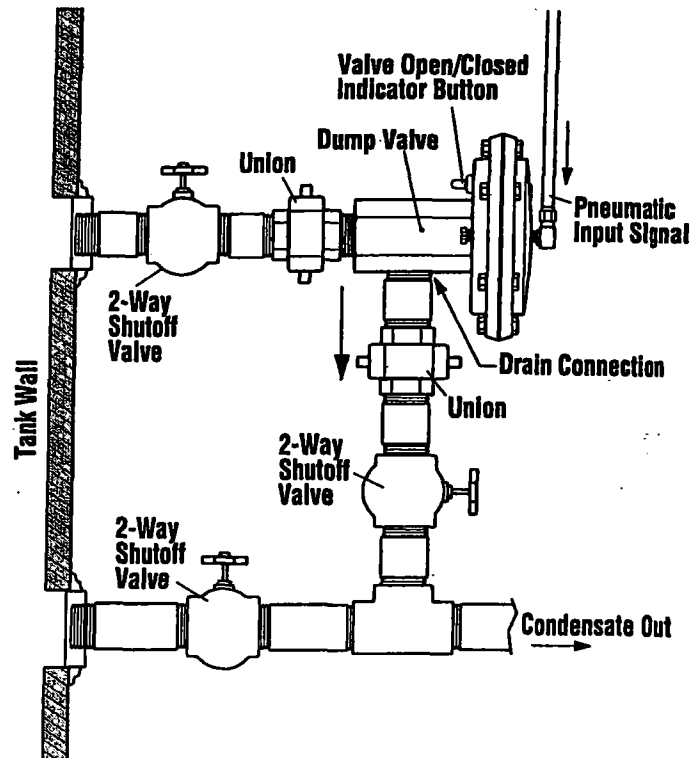
1. Install a manual shutoff (2-way) valve and a union between the DV valve and the vessel to facilitate valve repair or replacement.
2. Position the DV valve drain connection so it is on the bottom.
3. Install a 2-way valve to the drain line between the lower vessel entry and the condensate out line.
4. Be sure the unit is screwed tight and does not leak liquid.
5. Install the piping for the pneumatic input signal into the 1/8 NPT threaded connection of the pressure inlet port (on top of the DV valve).
6. Install a 2-way valve and union between the DV drain connection and the condensate out line.

NOTE: The typical procedure to remove the valve should be:

1. Close the shutoff valve between the scrubber and the DV valve.
2. Operate the dump valve to equalize pressure to the drain (condensate out) line.
3. Close the shutoff valve downstream of the drain.

Be Careful, pressure will still be in the system at the drain pressure when the unions are loosened.

Typical Dump Valve installation



REPLACING THE DUMP VALVE SEAT KIT

Replacing the Seat Kit on the Dump Valves

Tools needed: 7/8" hex wrench, 7/16" hex wrench, 1-1/8" hex wrench, and thread sealer; optional pressure source.

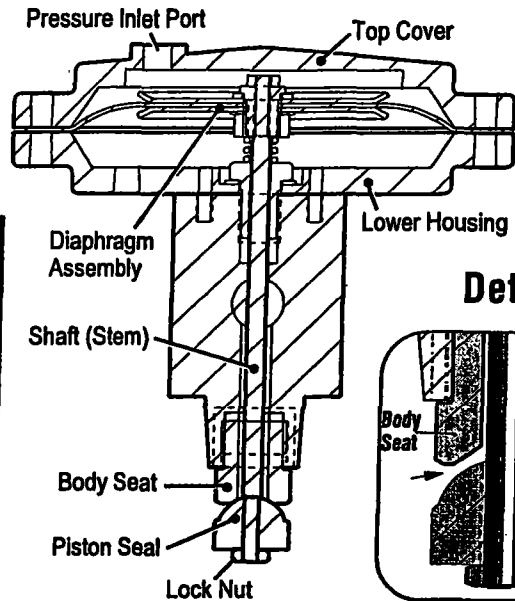
NOTE: Relieve pressure from scrubber or use the block valves before removing the DV dump valve.

1. Remove the valve from the Scrubber.



CAUTION: THE BODY SEAT AND PISTON SEAL WILL BE DAMAGED IF ALLOWED TO TURN AGAINST EACH OTHER. THE PREFERRED METHOD IS TO USE AIR TO KEEP THE VALVE OPEN. IF AIR IS NOT AVAILABLE, CAREFULLY FOLLOW THE ALTERNATE INSTRUCTIONS (STEPS 2A & 8A).

ALSO, DO NOT GRIP THE OPERATING STEM WITH ANY TOOLS. IF STEM NEEDS TO BE HELD, USE THE NUT ON THE BACK OF THE DIAPHRAGM.



2. Apply 30 psi to the pressure inlet port (top of valve). The Shaft and Piston Seal will extend.
- 2A. **IF AIR IS NOT AVAILABLE DO THE FOLLOWING:** Remove the valve Top Cover (bolts/nuts). Note the orientation of the Top Cover to the bottom. Mark both sides of the Diaphragm Housing before dis-assembly. Once the Top Cover is removed, carefully turn the valve upside down with the Piston Seal pointing up. Clamp the bottom housing down, or secure it against a flat surface to compress the spring and open the Piston Seal and Body Seat. Be careful not to damage the diaphragm. The valve must be kept in this fashion, with this much clearance throughout the following operations.
3. Hold the Piston Seal with the 7/8" hex wrench, and remove the Locknut with 7/16" hex wrench.
4. Unscrew the Piston Seal with the 7/8" hex wrench. Now, unscrew the Body Seat (use 7/8" hex wrench for DV850 and DV875 models). Use the 1-1/8" hex wrench for the DV2100 Series models.

5. Apply thread sealer to new Body Seat, and screw it in place tightening with the wrench until it stops. **NOTE:** Clean the female threads in the body before inserting the new Body Seat to facilitate threading.
6. Apply thread sealer to the shaft (stem), and screw the new Piston Seal on to the shaft (stem).
7. Hold the Piston Seal with the 7/8" hex wrench and screw the Locknut in place.
8. Remove the 30 psi pressure to the pressure inlet port, and re-install the valve into the scrubber.
- 8A. Re-install the Top Cover, paying attention to the alignment marks made in step 2A. Re-install the DV into the scrubber.

REPLACING THE DUMP VALVE DIAPHRAGM ASSEMBLY

Replacing the Diaphragm Assembly for all DV models (Refer to the Illustration above)

Tools needed: 7/8" hex wrench, 7/16" hex wrench, 5/8" hex wrench or socket, and thread sealer.

NOTE: Relieve pressure from scrubber or use the block valves before removing the DV dump valve.

1. Remove the valve from the Scrubber.
2. Remove the valve Top Cover (bolts/nuts). Note the orientation of the Top Cover to the bottom. Mark both sides of the Diaphragm Housing before dis-assembly.



CAUTION: MAKE SURE TO USE A 7/8" HEX WRENCH TO HOLD THE PISTON SEAL WHILE REMOVING THE DIAPHRAGM ASSEMBLY. DO NOT GRIP THE DIAPHRAGM (BLACK RUBBER) WITH ANY TOOLS.

3. Hold the Piston Seal with a 7/8" hex wrench making sure to keep the shaft (stem) from turning, and remove the nut on the back of the diaphragm assembly with the 7/16" wrench.
4. While holding the piston seal with the 7/8" wrench, proceed to remove the diaphragm assembly by hand.

NOTE: You will be turning the assembly against the spring when unscrewing the diaphragm assembly.

5. To re-assemble the assembly, apply thread sealer to the shaft/stem threads and hold the Piston Seal with a 7/8" hex wrench.
6. Keep holding the Piston Seal with 7/8" hex wrench. Make sure the 3/4" nut side of the new diaphragm assembly is toward the shaft. Press the diaphragm assembly into the shaft threads and tighten it on to the shaft threads by hand.
7. Keep holding the Piston Seal with 7/8" hex wrench. Apply thread sealer to 7/16" nut, and screw it on to the shaft threads to lock the diaphragm assembly in place, tighten the nut with the 7/16" wrench.
8. Press down the diaphragm assembly with your hands to open the valve, and **very carefully** turn to align the diaphragm holes with the lower housing bolt holes.

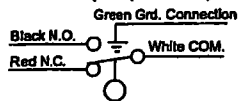


CAUTION: THE BODY SEAT AND PISTON SEAL WILL BE DAMAGED IF ALLOWED TO TURN AGAINST EACH OTHER.

9. Re-install the Top Cover, paying attention to the alignment marks made in step 2. Be sure to tighten the bolts and nuts evenly. Re-install the DV into the scrubber.

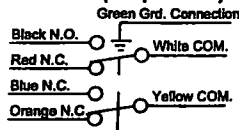
ELECTRICAL INFORMATION

SPDT (Snap Switch)



Switch Rating: 5 A @ 125-250- 480 VAC
 1/2 A @ 125 VDC
 1/4 A @ 250 VDC
 2A @ 6-30 VDC Resistive
 1A @ 6-30 VDC Inductive

DPDT (Snap Switch)



Switch Rating: 10 A @ 125-250 VAC
 1/2 A @ 125 VDC
 1/4 A @ 250 VDC
 10 A @ 6-24 VDC Inductive/Resistive

REPLACEMENT PARTS

Order by part number designation.

L1100/L1200*

15000893: *BUOYGLAS™ float*

15000894: *Stainless Steel float for L1200*

15000937: *Stainless Steel float for L1100/L111*

15000124: *SPDT snap switch assembly*

15010213: *L1100 counter balance assembly*

15010214: *L1200 counter balance assembly*

L1200N

15050420: *Cam spring return*

15050421: *Cam*

15000893: *BUOYGLAS™ float*

15000894: *Stainless Steel float for L1200N*

15050453: *Valve stem*

15010189: *Counter balance assembly*

L1200NDVO and L1200NDVOR

55050621: *Regulator only*

05706499: *20BPG-D-75 Pressure MURPHYGAGE®*

0-75 psi (517 kPa) [5.17 bar]

15010216: *DVOA assembly (New rectangular style)*

15000940: *DVO assembly (Old round style)*

00003341: *Filter for regulator*

00003340: *Regulator Diaphragm Kit*

DV850, DV850SS, DV875, DV875SS, DV2100 and DV2100SS

55000219: *Diaphragm Assembly (all models)*

55000224: *Seat Kit (DV850, DV850SS, DV875 and DV875SS)*

55000225: *Seat Kit (DV2100 and DV2100SS)*

55050617: *Optional Adapter Bushing 2 NPT to 1 NPT*

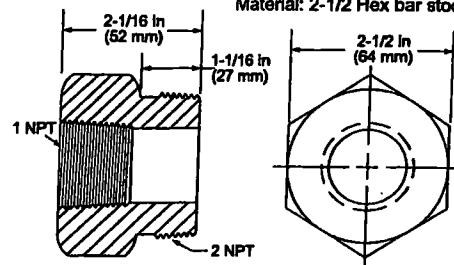
*To maintain hazardous location listings, all other repairs must be made by the factory.

ACCESSORIES

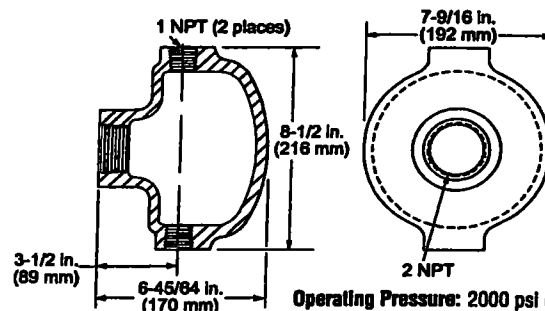
Order by part number designation.

55050617: DV850/DV875 Adapter Bushing

Material: 2-1/2 Hex bar stock C.R.S

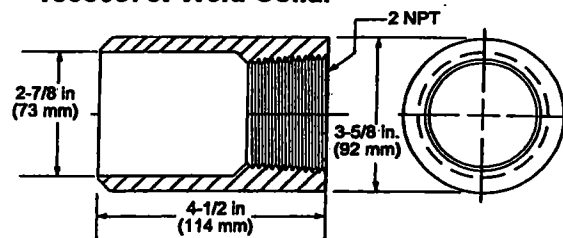


15050697: External Float Chamber



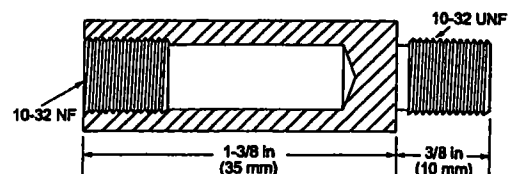
Operating Pressure: 2000 psi (13.8 MPa) [138 bar].
 Operating Temperature: 400°F (204°C).

15050375: Weld Collar



Operating Pressure: 2000 psi (13.8 MPa) [138 bar].
 Operating Temperature: 400°F (204°C).

15000892: Float Shaft Extension



LDV-92151N page 8 of 8

BETTIS

Actuators & Controls

A Daniel Industries Company

RPC-Series Rack and Pinion Pneumatic Actuators

BettisGuard

NAMUR / ISO

Bi-directional
Travel Adjustment

Extended Cycle Life

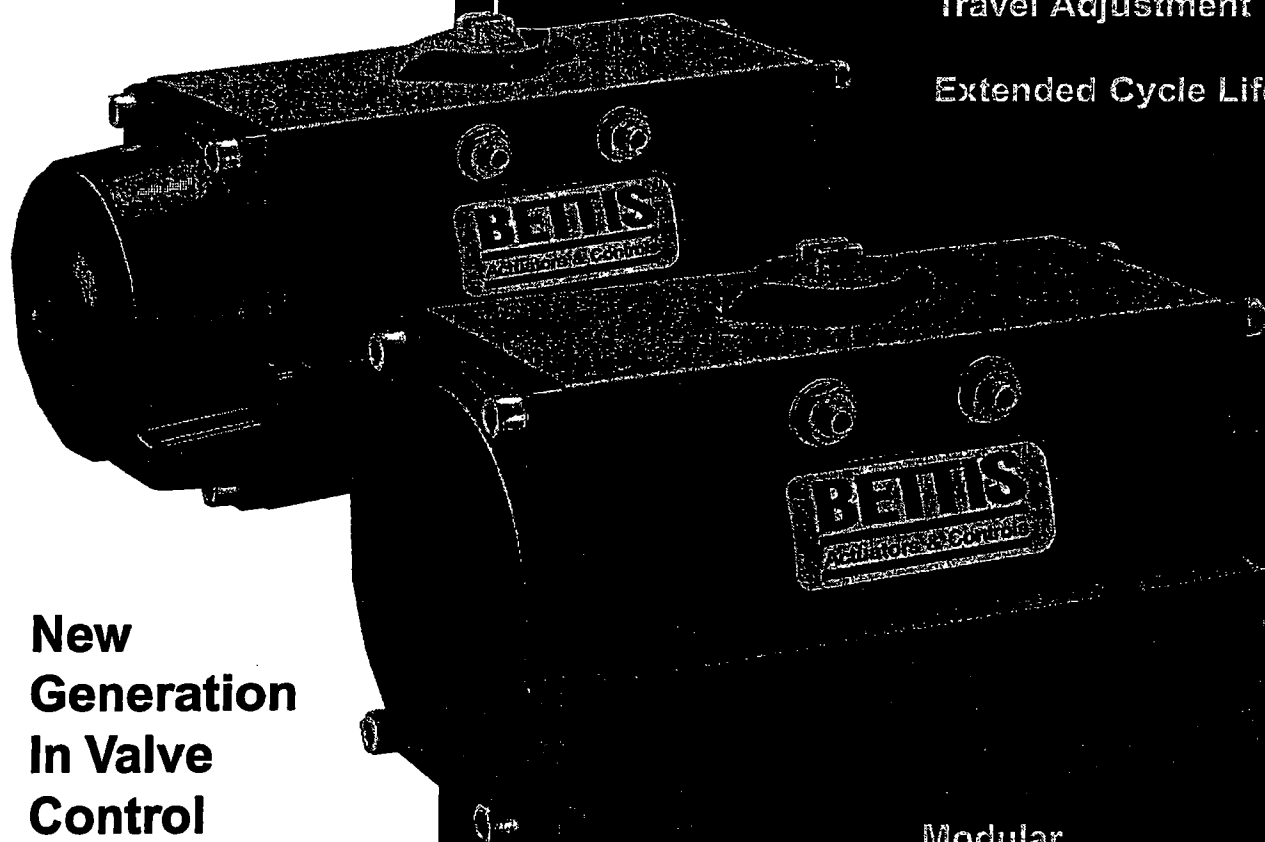
Modular

Internal Porting

Blow-out Proof
Pinion Gear

Replaceable Bearings

**New
Generation
In Valve
Control**



Design and Construction

Introduction

Bettis RPC-Series pneumatic rack and pinion actuators represent a new generation of valve control, incorporating the latest technologies and materials available to offer a reliable, economical and long lasting product. Specifically designed for quarter-turn applications, the RPC-Series is ideally suited for the operation of plug, butterfly, ball valves, dampers and other 90° turn devices.

Advantages

RPC-Series actuators offer many significant features and benefits, among these are:

- **BettisGuard** – An advanced, highly corrosion resistant surface conversion process which combines hard anodizing with fluoropolymer codeposition to protect the aluminum housing inside and out with an extremely hard wear resistant layer. This process, applied after finished machining, ensures that all housing surfaces are fully protected from hostile environments.

End caps are polyester powder coated, providing excellent corrosion protection.

All external metal fasteners are 300 series stainless steel.

- **NAMUR Mounting** – RPC-Series meets the latest NAMUR standards allowing direct or close coupling of NAMUR designed accessories. The pinion gear interface features a positive, international standard drive for positioners, switches and other accessories. The solenoid interface allows direct acceptance of any NAMUR designed control valves.
- **Bi-directional Travel Adjustment** – Bettis RPC-Series actuators feature bi-directional pinion travel stops. Side located stops allow a full $\pm 5^\circ$ of valve travel adjustment, giving a guaranteed range of

adjustment between 80° and 100° of actuator travel. These travel stops are designed to absorb the maximum rated torque of the actuator and the maximum impact loads associated with recommended stroke speed.

- **Extended Cycle Life** – Replaceable upper and lower pinion gear, piston head and heel bearings are made from an internally lubricated thermoplastic. This material contributes significantly to extended cycle life, wear resistance and efficiency.
- **Blow-out Proof Pinion Gear** – In addition to the stainless steel retaining ring, the RPC pinion gear features a unique internal safety ring.
- **Serviceability and Confidence** – Bettis rack and pinion actuators are designed to be safe, simple and rugged. Unlike other rack and pinion actuators, servicing the RPC actuator does not require special tools.
- **Modular** – The modular design of the RPC-Series simplifies the conversion from double-acting or spring-return configurations.
- **ISO/DIN Valve Interface** – The imperial and metric RPC output drive features a female, double square (eight point pattern) as standard. Optional output drive configurations are available. The ISO centering interface or female groove is standard on the metric models. The centering ring is available as an option. (See drawing on page 9.)
- **Operating Ranges** – RPC-Series double-acting actuators produce guaranteed minimum torque outputs up to 16,500 lb-in (1,865 Nm). The spring-return units produce spring ending torques up to 5,230 lb-in (591 Nm).*

RPC-Series pneumatic actuators are suitable for continuous opera-

tion at pressures ranging from 40 to 120 PSIG (3 to 8 BAR) while exposed to temperatures of -40°F to $+180^\circ\text{F}$ (-40°C to $+82^\circ\text{C}$). Optional temperature trims extend the range to 350°F (177°C).

Maximum width piston rack gear teeth provide optimum pinion gear tooth engagement; higher cycle life and accurate valve positioning in throttling applications.

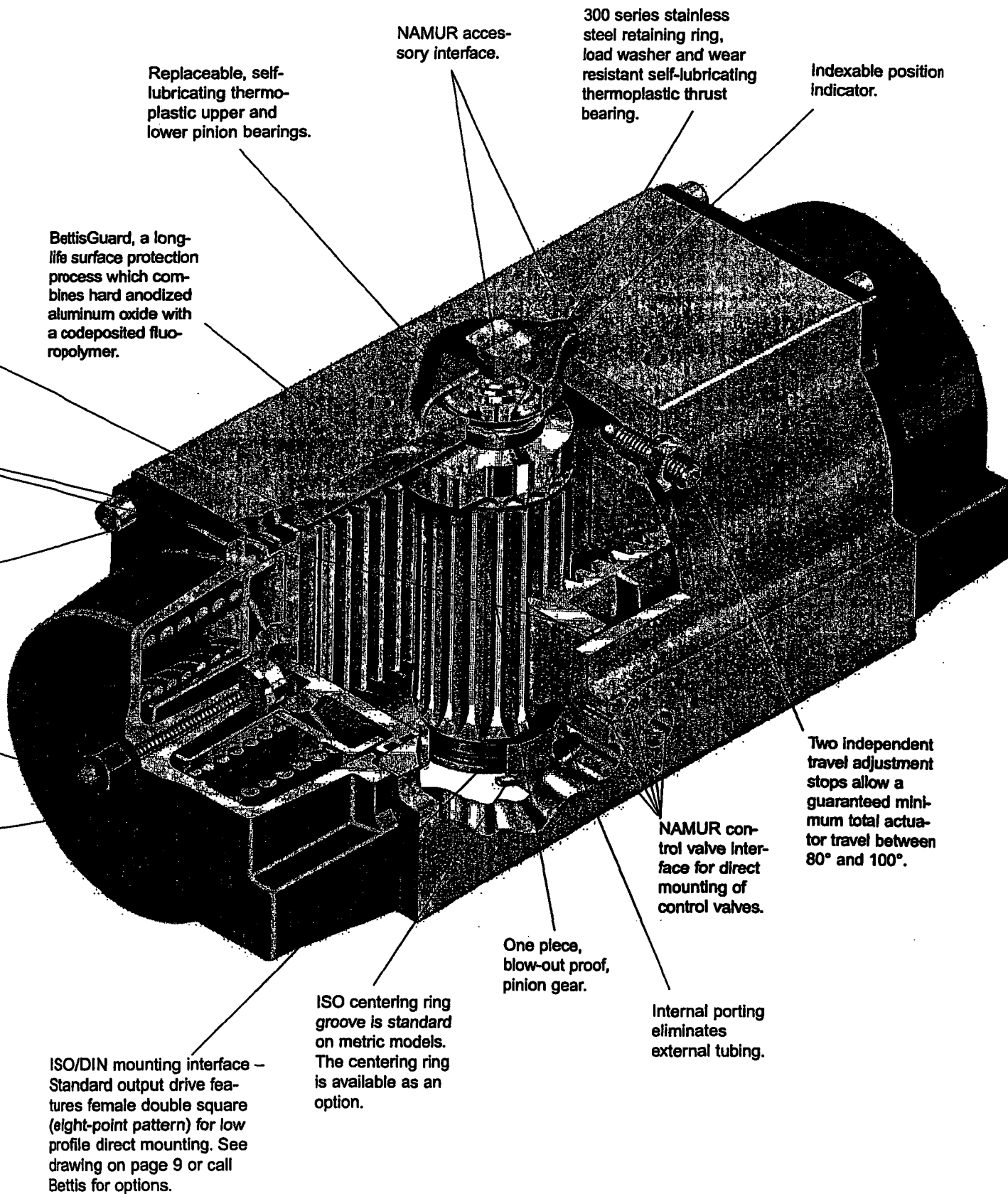
Replaceable low friction piston head and heel bearings.

300 series stainless steel metal fasteners.

Acorn nut and O-ring seal protects spring bolt threads.

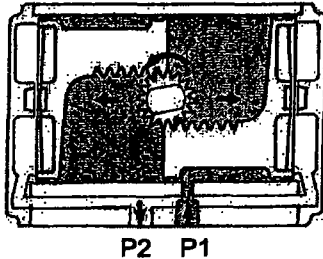
Polyester powder coating provides excellent corrosion protection and chip resistance of end caps.

* Double-acting models use pressure to rotate in both directions. Spring-return models use pressure for one direction of rotation and spring force for the reverse rotation.

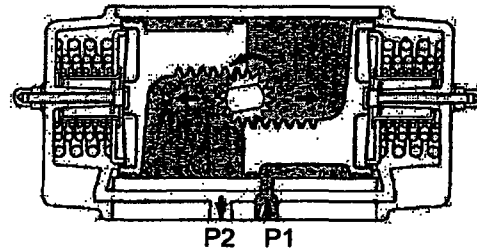


Operation

Double-Acting
(TOP View)



Spring-Return
(TOP View)



Double-Acting – Standard Configuration

For counterclockwise output rotation, apply pressure to Port 1, driving the pistons apart.

When required, the pistons can be inverted in the housing resulting in a clockwise rotation when pressure is applied to Port 1.

Spring-Return – Standard Configuration

Actuator to Fail Clockwise

For counterclockwise pressure rotation, apply pressure to Port 1, driving the pistons apart and compressing the springs. During this pressure stroke, the volume on the spring side of the pistons is vented/exhausted at Port 2.

Spring force rotates the actuator clockwise when the pressure is vented/exhausted at Port 1. The BettiSolenoid valve, when used, directs some of the exhaust gas to the spring side of the piston, creating a closed purge system. This helps to prevent corrosive outside contaminants from entering the spring chamber and can greatly extend the service life in hostile environments. See page 11 for schematics.

Actuator to Fail Counterclockwise

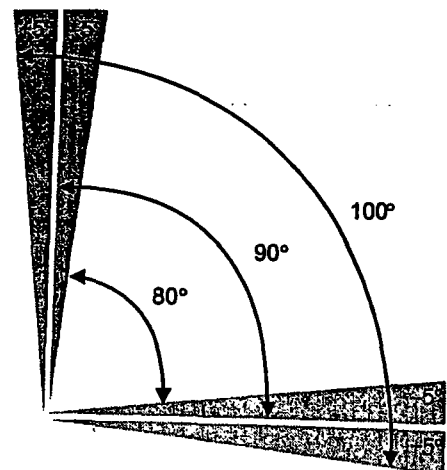
When fail counterclockwise is required, the pistons must be inverted in the housing.

Bi-directional Travel Stop Illustration

Bettis RPC-Series actuators feature bi-directional pinion travel stops. Side located stops allow a true $\pm 5^\circ$ of valve travel adjustment, giving a guaranteed range of adjustment between 80° and 100° of actuator travel. These travel stops are designed to absorb the maximum rated torque of the actuator and the maximum impact loads associated with recommended stroke speed.

Standard Assembly

Adjustment of the counterclockwise and clockwise rotation limits are accomplished by turning the respective left and right stop adjustment screws to reduce or increase output rotation.



Typical Specifications

The following information may be used as a guide to compile specifications for rack and pinion pneumatic actuators. Bettis RPC- Series actuators meet, or exceed these specifications.

1.0 Bettis RPC-Series Pneumatic Rack and Pinion Actuators

- 1.1 The pneumatic actuator shall be quarter-turn, opposed piston rack and pinion type of a totally enclosed design with no external moving linkages.
- 1.2 The actuator shall be capable of 100° rotation and shall include open and closed position stops with a minimum of 20° total travel adjustment.
- 1.3 The actuator shall be rated for continuous operation using dry or lubricated non-corrosive gas and be suitable for mounting in any position.
- 1.4 Trims shall be available for temperature ranges from -40°F to +350°F (-40°C to +177°C).

2.0 Construction

- 2.1 Actuator body shall be precision-extruded aluminum alloy, hard anodized with fluoropolymer codeposition process inside and out after finished machining.
- 2.2 All metal fasteners shall be 300 series stainless steel.
- 2.3 The output shaft/pinion shall be one piece steel, bottom loaded, blow-out proof secured by a non-exposed, redundant stainless steel retaining ring for safety.
- 2.4 End caps shall be cast aluminum, UV and chip resistant polyester powder coated.
- 2.5 Actuator shall incorporate internal porting to permit use of either NAMUR direct mount or remote controls.
- 2.6 Actuator shall be provided with a mechanical indexable visual position indicator and NAMUR accessory drive.

3.0 Design

- 3.1 Double-acting and spring-return models shall be field convertible without the use of special tools.
- 3.2 All spring module assemblies shall be of self contained and service safe design.
- 3.3 All actuators shall be designed and manufactured in accordance with ISO 9001 quality standards to meet NAMUR and ISO/DIN dimensional standards.
- 3.4 Actuator shall have replaceable, self-lubricating thermoplastic upper and lower pinion, piston head and heel bearings.
- 3.5 Pressure containing seals shall be outboard of all bearings.
- 3.6 Use of self-threading thread forming fasteners and metal-to-metal pressure seals are strictly prohibited.
- 3.7 All spring designs shall be qualified by fatigue and load test.
- 3.8 Actuator shall include side located bi-directional pinion travel stops which provide a guaranteed $\pm 5^\circ$ of valve travel adjustment between 80° and 100° of actuator travel. Travel stops shall be designed to absorb the maximum rated torque of the actuator and the maximum impact loads associated with recommended maximum stroke speed.
- 3.9 Full tooth engagement, at the pitch line, shall be maintained throughout full range of travel.
- 3.10 Attachment of shaft driven accessories shall not require removal of the visual position indicator.
- 3.11 Actuator shall incorporate a one-piece blow-out proof pinion.
- 3.12 A secondary extended bolt pattern shall be provided to accommodate installation on non ISO/DIN valve designs.
- 3.13 Gear teeth shall be designed to AGMA specifications, minimizing back lash and suitable for throttling applications.

Materials of Construction

- A. **Body:** Precision-extruded aluminum alloy, hard anodized with fluoropolymer codeposition process inside and out after finished machining.
- B. **Pinion Gear:** Alloy steel, corrosion protected.
- C. **Pistons:** Cast aluminum alloy, dichromate dipped.
- D. **End Caps:** Cast aluminum alloy, polyester powder coated.
- E. **Fasteners:** 300 series stainless steel.
- F. **Seals:** Low temperature Nitrile is standard -40°F to +180°F (-40°C to +82°C). Options, Viton 0°F to +350°F (-18°C to +177°C).
- G. **Springs:** Carbon steel, shot peened, and corrosion protected by a pliable self-healing coating.
- H. **Heel Bearings:** Acetal, self lubricating.
- I. **Piston Bearings:** Acetal, self-lubricating.
- J. **Pinion Gear (output shaft) Bearings:** Standard trim; Upper – PEEK composite; Lower – Acetal; Thrust – Acetal. Optional high temperature trim has PEEK composite upper and lower bearings.

Torque Ratings — Imperial

Double-Acting Actuators

RPC-Series

Actuator Model	Operating Pressure (PSIG)					
	0	50	100	150	200	250
RPC 250	0	125	188	250	313	375
RPC 450	0	225	338	450	563	675
RPC 1000	0	500	750	1000	1250	1500
RPC 2250	0	1125	1687	2250	2812	3375
RPC 3650	0	1825	2738	3650	4563	5475
RPC 5000	0	2500	3750	5000	6250	7500
RPC 11000	0	5500	8250	11000	13750	16500

0 The torque output for double-acting rack & pinion actuators remains constant from start to end of stroke.

Spring-Return Actuators

RPC-Series

Actuator Model	Spring Set #	Operating Pressure (PSIG)											
		0	50	100	150	200	250	300	350	400	450	500	550
250	2	76	47	139	110	202	172	264	235	327	298		
	3	—	—	113	70	178	133	238	196	301	258		
	4	—	—	88	31	151	94	214	156	276	219		
	5	—	—	—	—	127	54	189	117	252	180		
	6	—	—	—	—	—	—	164	78	227	141		
450	2	137	84	250	188	364	311	477	424	590	538		
	3	—	—	205	126	318	240	432	353	545	466		
	4	—	—	159	55	273	168	386	282	499	395		
	5	—	—	—	—	228	97	341	210	455	324		
	6	—	—	—	—	—	—	298	139	409	252		
1000	2	301	184	550	434	800	683	1049	932	1298	1182		
	3	—	—	449	278	698	527	948	776	1197	1026		
	4	—	—	350	120	600	370	849	619	1098	868		
	5	—	—	—	—	501	213	750	462	999	711		
	6	—	—	—	—	—	—	651	305	901	554		
2250	2	702	403	1274	975	1846	1546	2417	2118	2989	2689		
	3	—	—	1051	603	1622	1174	2194	1746	2765	2317		
	4	—	—	829	232	1401	804	1973	1376	2544	1947		
	5	—	—	—	—	1182	434	1753	1006	2325	1577		
	6	—	—	—	—	—	—	1532	635	2103	1207		
3650	2	1152	659	2063	1570	2975	2482	3886	3393	4797	4305		
	3	—	—	1726	996	2637	1907	3549	2819	4460	3730		
	4	—	—	1388	423	2300	1335	3211	2246	4123	3157		
	5	—	—	—	—	1967	744	2878	1655	3789	2566		
	6	—	—	—	—	—	—	2540	1082	3452	1994		
5000	2	1625	750	2875	2000	4124	3249	5374	4499	6824	5749		
	3	—	—	2437	1125	3687	2375	4937	3624	6187	4874		
	4	—	—	2000	250	3249	1500	4499	2749	5749	3999		
	5	—	—	—	—	2812	625	4062	1874	5312	3124		
	6	—	—	—	—	—	—	3624	999	4874	2249		
11000	2	3576	1651	6327	4402	9078	7153	11829	9904	14580	12655		
	3	—	—	5363	2473	8114	5224	10865	7975	13616	10726		
	4	—	—	4398	547	7149	3298	9900	6049	12651	8800		
	5	—	—	—	—	6188	1372	8939	4123	11690	6874		
	6	—	—	—	—	—	—	7975	2197	10726	4949		

* Spring Set # x 20 = Nominal Operating Pressure

All Published Torques are Guaranteed Minimum Values.

Torque Ratings — Metric

Double-Acting Actuators RPC-Series

Model	Port 1 Pressure (MPa)	Port 2 Pressure (MPa)	Port 3 Pressure (MPa)	Port 4 Pressure (MPa)	Port 5 Pressure (MPa)	Port 6 Pressure (MPa)	Port 7 Pressure (MPa)	Port 8 Pressure (MPa)
RPC 251	0	15	20	26	28	31	36	41
RPC 451	0	28	37	46	51	55	65	74
RPC 1001	0	61	82	102	113	123	143	164
RPC 2251	0	138	184	230	253	277	323	369
RPC 3651	0	224	299	374	411	449	523	598
RPC 5001	0	307	410	512	563	615	717	819
RPC 11001	0	676	901	1127	1239	1352	1577	1803

† The torque output for double-acting rack & pinion actuators remains constant from start to end of stroke.

Spring-Return Actuators RPC-Series

Model	Port 1 Pressure (MPa)	Port 2 Pressure (MPa)	Port 3 Pressure (MPa)	Port 4 Pressure (MPa)	Port 5 Pressure (MPa)	Port 6 Pressure (MPa)	Port 7 Pressure (MPa)	Port 8 Pressure (MPa)	Port 9 Pressure (MPa)	Port 10 Pressure (MPa)	Port 11 Pressure (MPa)	Port 12 Pressure (MPa)	Port 13 Pressure (MPa)	Port 14 Pressure (MPa)	Port 15 Pressure (MPa)	Port 16 Pressure (MPa)
251	2	10	7	15	12	20	17	23	19	25	22	30	27	36	32	
	3	—	—	12	7	17	12	20	15	22	18	27	23	33	28	
	4	—	—	—	—	14	8	17	11	20	13	25	18	30	23	
	5	—	—	—	—	—	—	—	—	17	9	22	14	27	19	
	6	—	—	—	—	—	—	—	—	—	—	19	9	24	14	
	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
451	2	18	12	27	21	36	30	41	35	46	40	55	49	64	58	
	3	—	—	22	13	31	22	36	27	40	32	50	41	59	50	
	4	—	—	—	—	26	14	31	19	35	24	45	33	54	42	
	5	—	—	—	—	—	—	—	—	30	15	40	25	49	34	
	6	—	—	—	—	—	—	—	—	—	—	34	17	44	26	
	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1001	2	39	26	59	46	80	67	90	77	100	87	121	107	141	128	
	3	—	—	48	29	68	49	79	59	89	69	109	90	130	110	
	4	—	—	—	—	57	31	67	41	78	52	98	72	118	93	
	5	—	—	—	—	—	—	—	—	66	34	87	54	107	75	
	6	—	—	—	—	—	—	—	—	—	—	—	—	96	57	
	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
2251	2	91	57	138	104	184	151	208	174	231	197	278	244	325	291	
	3	—	—	112	62	159	108	183	132	208	155	253	202	300	249	
	4	—	—	—	—	134	67	158	90	181	114	228	160	275	207	
	5	—	—	—	—	—	—	—	—	156	72	203	119	250	165	
	6	—	—	—	—	—	—	—	—	—	—	178	77	225	124	
	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
3651	2	148	93	223	167	298	242	335	279	372	317	447	391	522	468	
	3	—	—	185	102	259	177	297	214	334	252	409	328	483	401	
	4	—	—	—	—	221	112	259	150	296	187	371	262	445	336	
	5	—	—	—	—	—	—	—	—	258	120	333	195	408	270	
	6	—	—	—	—	—	—	—	—	—	—	295	130	370	205	
	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
5001	2	208	109	311	212	413	314	464	366	516	417	618	519	720	622	
	3	—	—	261	113	364	215	415	267	466	318	569	420	671	523	
	4	—	—	—	—	314	117	366	168	417	219	519	321	622	424	
	5	—	—	—	—	—	—	—	—	367	120	470	223	572	325	
	6	—	—	—	—	—	—	—	—	—	—	420	124	523	226	
	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
11001	2	459	241	684	468	909	692	1022	805	1135	917	1360	1143	1586	1368	
	3	—	—	575	248	800	474	913	587	1026	699	1251	925	1477	1150	
	4	—	—	—	—	691	258	804	369	917	482	1142	707	1368	933	
	5	—	—	—	—	—	—	—	—	808	264	1034	490	1259	715	
	6	—	—	—	—	—	—	—	—	—	—	—	—	1150	497	
	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

All Published Torques are Guaranteed Minimum Values.

Performance Data — Imperial and Metric

Double-Acting Actuators

RPC-Series – Imperial

Model	Volume (cu in) Δ	Volume (cu in) Δ	Maximum Operating Pressure (PSIG)	Approximate Weight (lbs)
RPC 250	8.5	10.4	120	3.7
RPC 450	15.4	19.8	120	4.9
RPC 1000	30.2	43.2	120	9.1
RPC 2250	71.0	96.0	120	16.9
RPC 3650	147.4	163.1	120	33.0
RPC 5000	174.7	184.2	120	43.5
RPC 11000	341.2	389.4	120	87.5

Spring-Return Actuators

RPC-Series – Imperial

Model	Volume (cu in) (60-167)	Maximum Operating Pressure (PSIG)	Approximate Weight (lbs)
RPC 250-SR	10.4	120	4.4
RPC 450-SR	19.8	120	6.6
RPC 1000-SR	43.2	120	12.2
RPC 2250-SR	96.0	120	23.1
RPC 3650-SR	163.1	120	46.0
RPC 5000-SR	184.2	120	65.1
RPC 11000-SR	389.4	120	125.2

Double-Acting Actuators

RPC-Series – Metric

Model	Volume (cm ³) Δ	Volume (cm ³) Δ	Maximum Operating Pressure (PSIG)	Approximate Weight (kg)
RPC 251	139	170	8.5	1.7
RPC 451	252	324	8.5	2.2
RPC 1001	495	708	8.5	4.1
RPC 2251	1163	1573	8.5	7.7
RPC 3651	2415	2673	8.5	15.0
RPC 5001	2863	3018	8.5	19.7
RPC 11001	5591	6381	8.5	39.7

Spring-Return Actuators

RPC-Series – Metric

Model	Volume (cm ³) Δ	Maximum Operating Pressure (PSIG)	Approximate Weight (kg)
RPC 251-SR	170	8.5	2.0
RPC 451-SR	324	8.5	3.0
RPC 1001-SR	708	8.5	5.5
RPC 2251-SR	1573	8.5	10.5
RPC 3651-SR	2673	8.5	20.9
RPC 5001-SR	3018	8.5	29.5
RPC 11001-SR	6381	8.5	56.8

Notes:

Operating Temperature:

Standard: -40°F to +180°F [-40°C to +82°C]

High Temperature: 0°F to +350°F [-18°C to +177°C]

Operating Pressure Range: 40 to 120 PSIG [3 to 8 BAR]

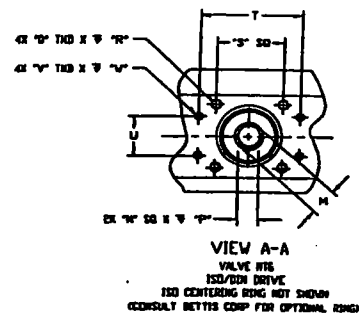
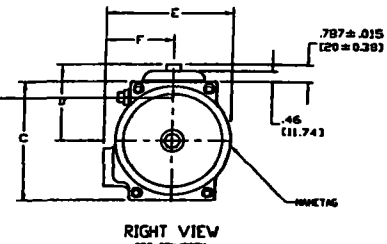
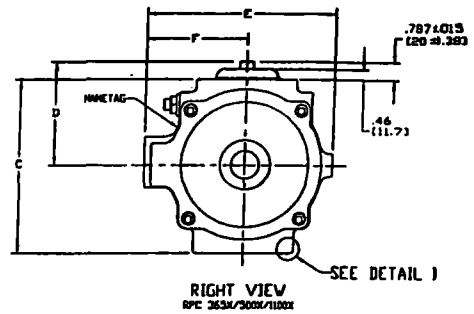
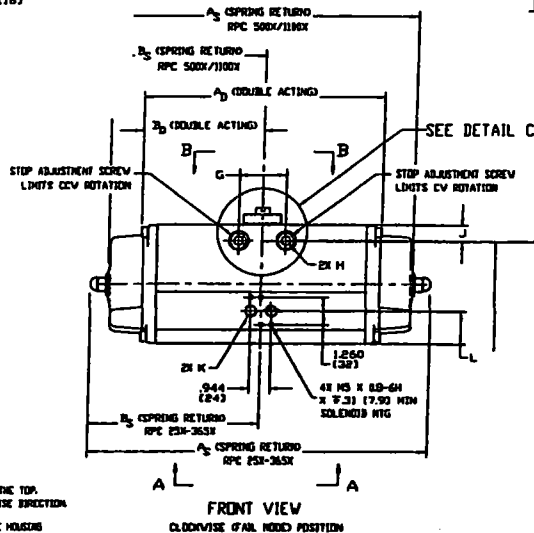
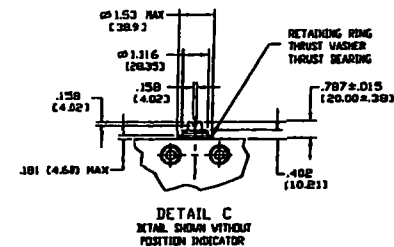
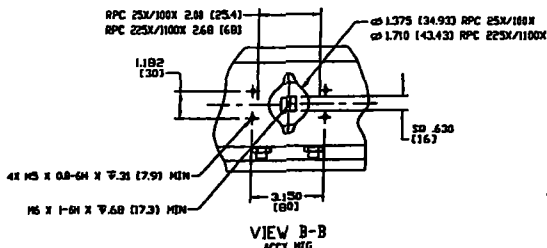
Operating Media: Dry non-corrosive gas.

▲ Maximum volume including cavity required for calculating consumption per stroke.

• Maximum Operating Pressure (MOP) is the pressure required to produce the maximum rated torque of the actuator.
RPC Maximum Operating Pressure is 120 PSIG [8 BAR].

If a relief valve is required, the relief valve set pressure shall be equal to the supply pressure plus 15% or regulator setting plus 15%, whichever is less, however, in no instance shall this setting exceed 140 PSIG (9.3 BAR).

Dimensions — Imperial and Metric



1. ACTUATOR IS SHOWN IN THE CLOCKWISE POSITION AS VIEWED FROM THE TOP.
A 2" (50.8MM) IS AVAILABLE IN CLOCKWISE AND COUNTERCLOCKWISE DIRECTION.
2. BOTTOM FACE OF TORQUE SHAFT IS RECESSED FROM THE BASE OF THE HOUSING
A TOLERANCE OF 0.005 IN (0.127 MM) IS ALLOWED.

General Dimensions — Imperial

TABLE 1												
Model	A	B	C	D	E	F	G	H	I	J	K	L
250	in.	6.33	8.15	3.165	4.075	3.03	2.30	3.19	1.87	1.280	M5 x 0.8-6H	.516
450	in.	6.33	8.54	3.165	4.270	3.78	2.68	3.80	2.12	1.280	M6 x 1-6H	.516
1000	in.	7.59	10.85	3.795	5.425	4.72	3.15	4.80	2.69	1.820	M8 x 1.25-6H	.654
2250	in.	10.63	14.55	5.315	7.275	5.51	3.54	5.51	3.0	2.124	M10 x 1.5-6H	.747
3650	in.	11.91	18.94	5.95	9.47	6.89	4.25	7.33	4.14	3.27	M12 x 1.75-6H	1.02
5000	in.	14.20	19.12	7.10	9.58	7.72	4.58	8.20	4.39	3.124	M12 x 1.75-6H	1.122
11000	in.	19.11	25.30	9.56	12.65	9.81	5.47	9.50	5.06	3.750	M16 x 2-6H	1.419

Mounting Dimensions — Imperial

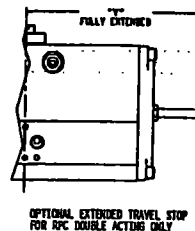
Model	Unit	Thread	Length	Weight	Volume	Pressure	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate	Flow Rate
250	in.	1/4 NPT	1.05	.562	.433	1.08	.250-20 UNC	.31	1.392	3.250	1.172	.250-20UNC	.31	.155	4.38											
450	in.	1/4 NPT	1.08	.721	.551	1.08	.250-20 UNC	.31	1.392	3.250	1.172	.250-20UNC	.31	.152	4.33											
1000	in.	1/4 NPT	1.26	1.014	.748	1.09	.312-18 UNC	.47	1.950	4.312	1.750	.312-18 UNC	.39	.145	5.42											
2250	in.	1/4 NPT	1.51	1.156	.866	1.69	.375-18 UNC	.59	2.840	4.312	1.750	.312-18 UNC	.39	.153	7.95											
3650	in.	1/4 NPT	3.75	1.318	1.063	1.38	.500-13 UNC	.75	2.84	3.48	3.48	.375-18 UNC	.59	.222	8.31											
5000	in.	1/4 NPT	4.18	1.318	1.063	1.38	.500-13 UNC	.75	3.480	10.00	3.480	.500-13 UNC	.75	.172	9.67											
11000	in.	1/4 NPT	5.22	1.788	1.418	1.77	.625-11 UNC	.94	3.896	10.00	3.896	.625-11 UNC	.94	.272	12.77											

General Dimensions — Metric

		E				F				G				H													
Model	Unit	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
251	mm	160.8	207.0	80.4	103.5	77.0	58.5	81.1	47.5	32.51	M5 x 0.8-6H	13.11															
451	mm	160.8	216.9	80.4	108.5	96.0	68.1	96.9	53.9	32.51	M6 x 1-6H	13.11															
1001	mm	192.8	275.8	96.4	137.8	120.0	80.1	121.8	68.3	46.23	M8 x 1.25-6H	16.61															
2251	mm	270.0	369.6	135.0	184.8	140.0	89.9	140.0	76.2	53.95	M10 x 1.5-6H	18.97															
3651	mm	303.0	481.0	151.0	241.0	175.0	108.0	188.0	105.0	83.00	M12 x 1.75-6H	26.00															
5001	mm	360.7	485.6	180.4	242.8	196.0	118.4	208.3	111.5	79.36	M12 x 1.75-6H	28.49															
11001	mm	485.4	642.6	242.8	321.3	244.0	139.0	242.0	128.52	95.26	M16 x 2-6H	36.05															

Mounting Dimensions — Metric

Model	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
251	mm	1/4 BSPP	26.7	14.27	11	27.4	M6 x 1-6H	7.9	35.36	82.55	29.77	M6 x 1-6H	7.9	3.94	111.3											
451	mm	1/4 BSPP	27.4	18.31	14	27.4	M6 x 1-6H	7.9	35.36	82.55	29.77	M6 x 1-6H	7.9	3.86	110.1											
1001	mm	1/4 BSPP	32.1	25.76	19	27.8	M8 X 1.25-6H	11.9	49.53	109.52	44.45	M8 X 1.25-6H	10	3.68	137.7											
2251	mm	1/4 BSPP	38.4	29.36	22	43.0	M10 X 1.5-6H	15	72.14	109.52	44.45	M8 X 1.25-6H	10	3.87	201.9											
3651	mm	1/4 BSPP	95.25	33.48	27	35.05	M12 X 1.75-6H	19.05	72.14	88.39	88.39	M10 X 1.5-6H	15	5.64	211.1											
5001	mm	1/4 BSPP	106.2	33.48	27	35.05	M12 X 1.75-6H	19.05	88.39	254.00	88.39	M12 X 1.75-6H	19.05	4.37	245.6											
11001	mm	1/4 BSPP	132.6	45.42	36	44.96	M16 X 2-6H	23.88	98.96	254.00	98.96	M16 X 2-6H	23.88	6.91	324.4											



RPC Solenoid

RPC Solenoids are custom designed for use with the RPC-Series pneumatic actuator product line. They are standard as NAMUR, the direct mount feature which eliminates interconnecting tubing and fittings.

General Description

Balanced spool construction allows 5/2 NAMUR valve to be converted to 3/2. Bi-directional tapered T-seal of carboxylated nitrile provides up to 5 times the abrasion resistance and service life of Buna-N seals.

Operation

The normally closed solenoid valve operates when the coil is electrically energized and returns when the coil is de-energized.

Note, if your application requires reduced or slow spring stroke travel times, consult the factory.

Media

Dry or lubricated non-corrosive gas.

Pressure

Minimum operating differential: 35 psi (2 BAR).

Maximum operating differential: 150 psi (10 BAR).

Flow Factor

Cv=2

Orientation

Valve may be mounted in any attitude/position.

Coil Enclosure

NEMA 4X – Watertight, dust tight, and corrosion resistant – indoor and outdoor. Intended for use indoors or outdoors to protect against splashing water, seepage of water, falling or hose directed water and severe external condensation. All coils are UL and CSA listed.

NEMA 4X, 7, 9 – combination watertight and explosion proof – indoor and outdoor. Offers the same protection as NEMA 4X listed above plus hazardous location ratings NEMA 7, Class I, Division I & II Group C & D, NEMA 9, Class II, Division I & II Group E, F & G. UL & CSA Listed.

Coil Construction-NEMA 4X-7-9

1/2 NPT., potted, 2-18" leads.

Optional DIN connector

Temperature: -20°F to +150°F (-29°C to +66°C)

Coil Rating

NEMA 4X-7-9: Continuous duty molded Class H insulation.

Coil Voltage

- DC-12, 24, 48, 120
- AC-24/60, 110/50-120/60, 220/50-240/60
- ±10% of Nominal

Power Consumption

Standard construction NEMA 7	6 Watts
Standard construction NEMA 4	4.8 Watts
Intrinsically safe construction	2.1 Watts
Low Power NEMA 7	1.8 Watts

Materials

Valve Body – Aluminum Anodized.

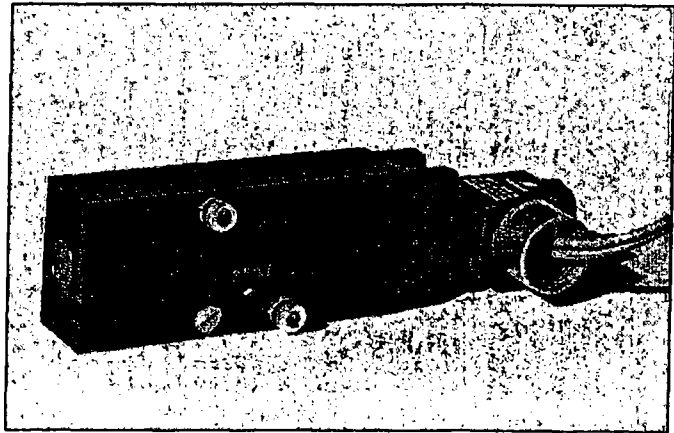
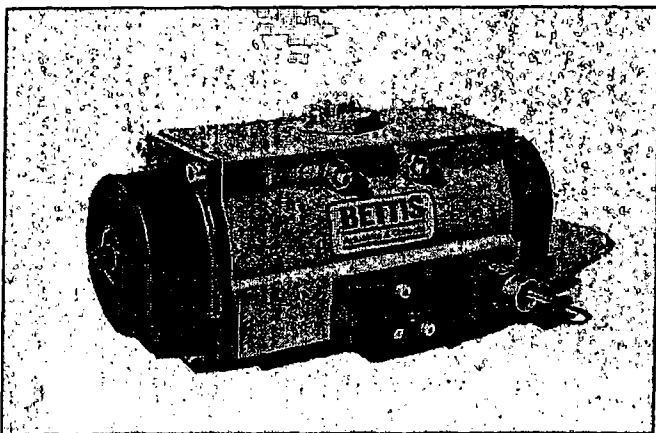
Seals/O-rings – Carboxylated Nitrile.

Fasteners – Stainless Steel.

Optional Features

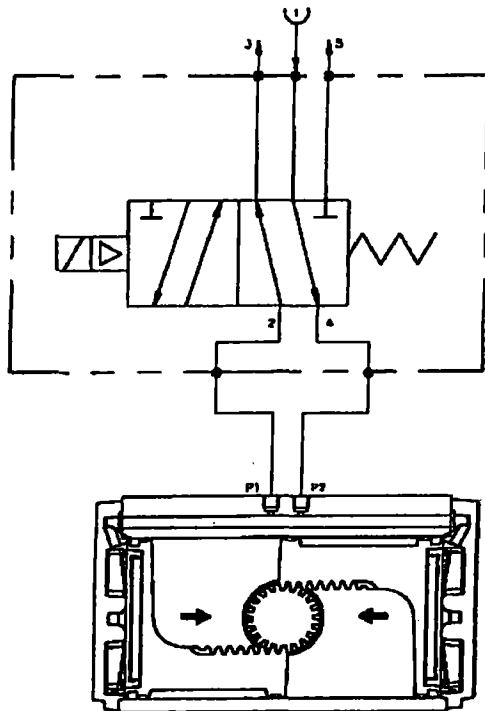
Dual coil – 2 position.

Close-loop spool.

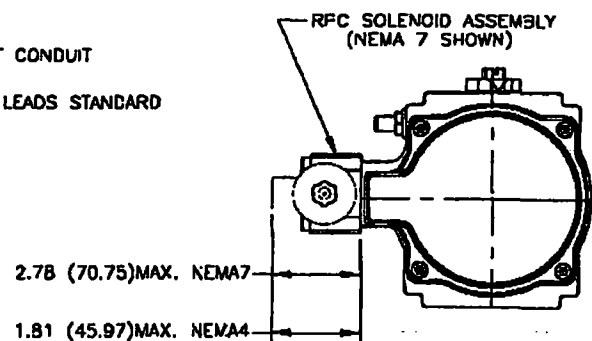
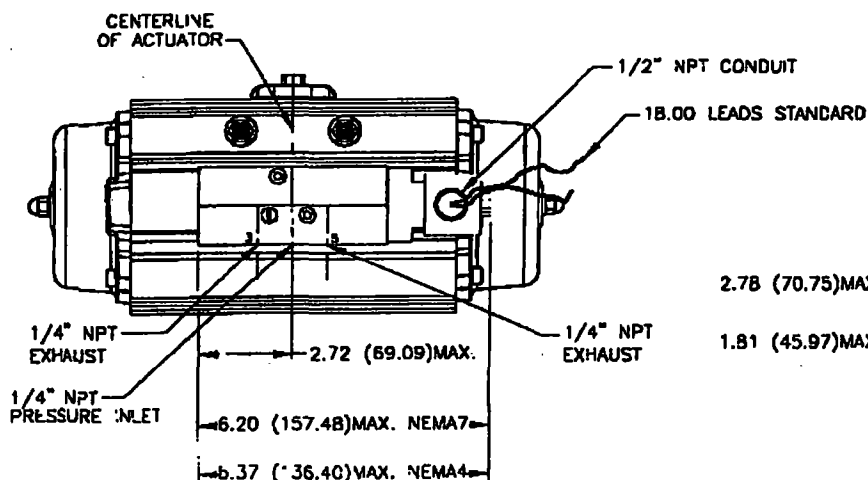
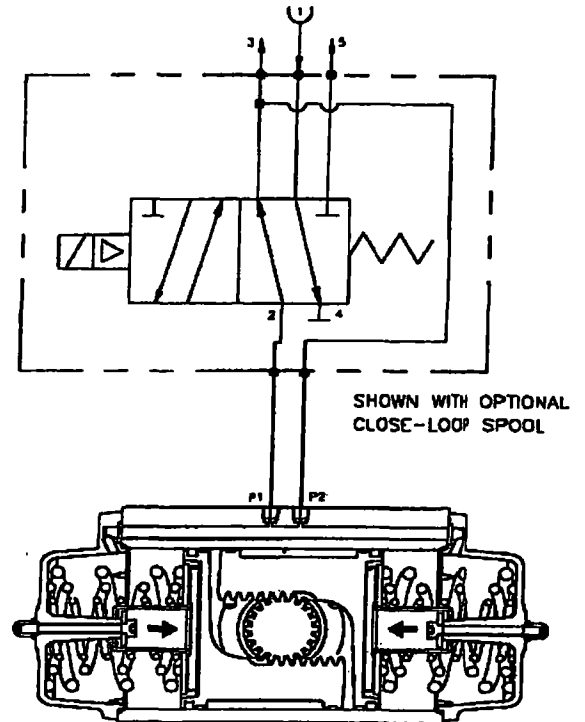


Solenoid Dimensions

5/2 (4-way)



3/2 (3-way)



Solenoid valve dimensions are applicable to double-acting and spring-return models.

BETTIS

Actuators & Controls

A Daniel Industries Company

Accessories/Options

Gear Operators

Gear Operators are offered for all models in declutchable (double-acting) or non-declutchable (spring-return) configurations. RPC gear overrides come with all components necessary for new or retrofit installation.

Partial Test Stroke Devices (PTSD)

Partial Test Stroke Devices (PTSD) allow for a simple, mechanical means of testing for the proper operation of your automation system without upsetting flow processes. Bettis has PTSD for testing in either clockwise or counter-clockwise direction with variable degrees of rotation.

End of Stroke Locking Devices

End of Stroke Locking Devices provide positive locking of both actuator and valve, helping to ensure system and downstream safety.

BettiSwitch

Bettis offers the BettiSwitch for dependable position indication and other system uses.

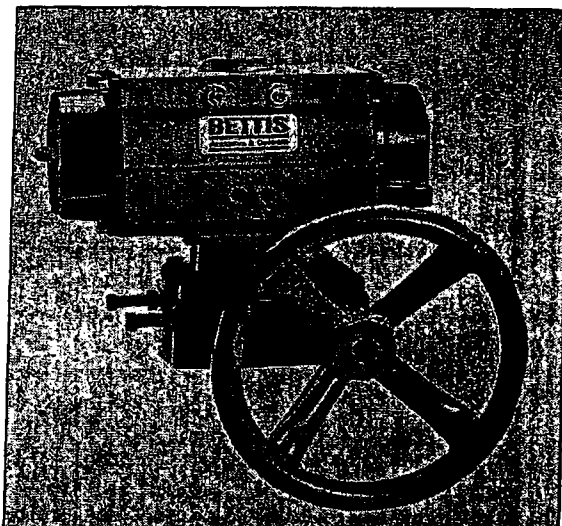
Limitswitches, Positioners and Accessories

Bettis can meet your requirements for practically any accessory, control device or control system you may need (ie., air fail systems, positioners, switches, and potentiometers).

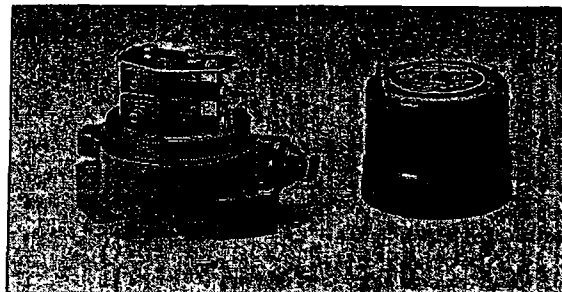
Quality Assurance

Bettis Actuators are designed and built to meet or exceed the highest international quality standards and procedures. Lloyd's Register Quality Assurance, ISO 9001 and many other international, corporate, and Bettis' own internal quality standards assure you of receiving what you paid for - confidence in quality.

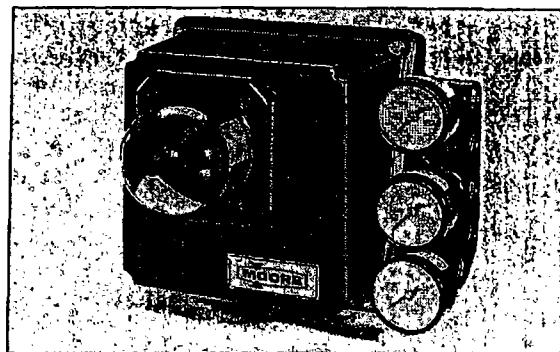
Gear Operator



BettiSwitch



Positioners



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Fax: 403/450-1400

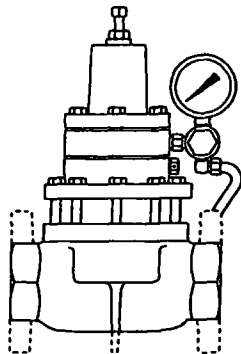
Bettis France

30/36 Allee du Plateau
93250 Villemomble
France
Tel: 48 12 26 10
Fax: 48 12 26 19

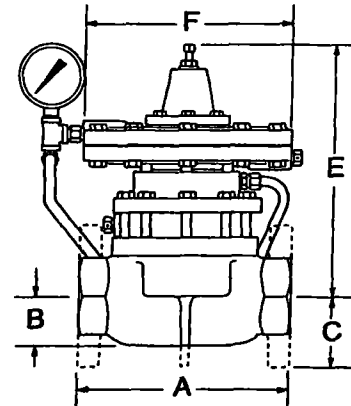
BACK PRESSURE
PRESSURE REDUCING
PRESSURE REDUCING-BALANCED
LIQUID BACK PRESSURE
PRESSURE DIFFERENTIAL
UPSTREAM DIFFERENTIAL PRESSURE
BACK PRESSURE VACUUM
PRESSURE REDUCING VACUUM

LOW PRESSURE BACK PRESSURE
OUNCES BACK PRESSURE TO VACUUM
OUNCES PRESSURE REDUCING
OUNCES PRESSURE REDUCING VACUUM
VACUUM BACK PRESSURE TO VACUUM

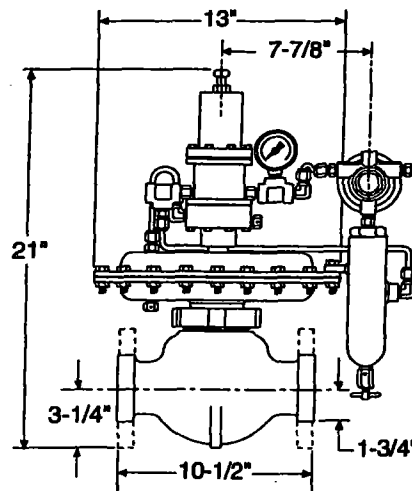
CAST IRON OR DUCTILE



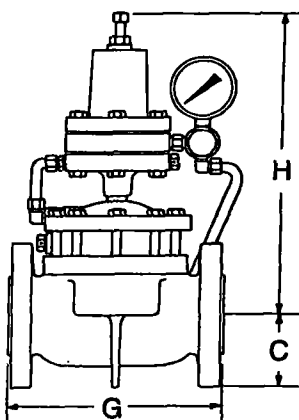
CAST IRON OR DUCTILE BODY



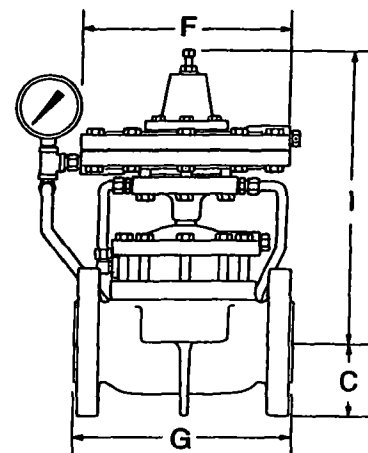
250 S/FGT-BP-S



STEEL



STEEL BODY



LINE SIZE	BODY STYLE	A	B	C	D*	E	F	G	H*	I
1"	SCRD	4 ³ / ₈	1 ¹ / ₈		7 ¹ / ₂	11 ⁵ / ₈	8 ³ / ₈			
2"	SCRD	8 ¹ / ₂	2 ¹ / ₈		11 ¹ / ₂	10 ¹ / ₂	8 ³ / ₈			
	FLGD	9		3	11 ¹ / ₂	10 ¹ / ₂	8 ³ / ₈	9 ¹ / ₈	14 ¹ / ₂	14
	GRVD	8 ³ / ₄	2 ¹ / ₈		11 ¹ / ₂	10 ¹ / ₂	8 ³ / ₈			
3"	SCRD	12	3 ¹ / ₁₆		13	12	8 ³ / ₈			
	FLGD	12 ³ / ₁₆		3 ³ / ₄	13	12	8 ³ / ₈	12 ⁵ / ₁₆	16 ¹ / ₂	15 ¹ / ₂
4"	SCRD	15	4		14 ¹ / ₂	13 ³ / ₁₆	8 ³ / ₈			
	FLGD	15 ¹ / ₈		4 ¹ / ₂	14 ¹ / ₂	13 ³ / ₁₆	8 ³ / ₈	15	18 ¹ / ₂	16 ¹¹ / ₁₆
6"	FLGD	22 ¹ / ₈		5 ¹ / ₂	17	14 ⁷ / ₈	8 ³ / ₈	22	20 ¹ / ₂	18 ³ / ₈

FLANGE DIMENSIONS ARE ASA 150 LB. STANDARD. *Add 7/8" to PRB and USDP Regulators for this dimension.

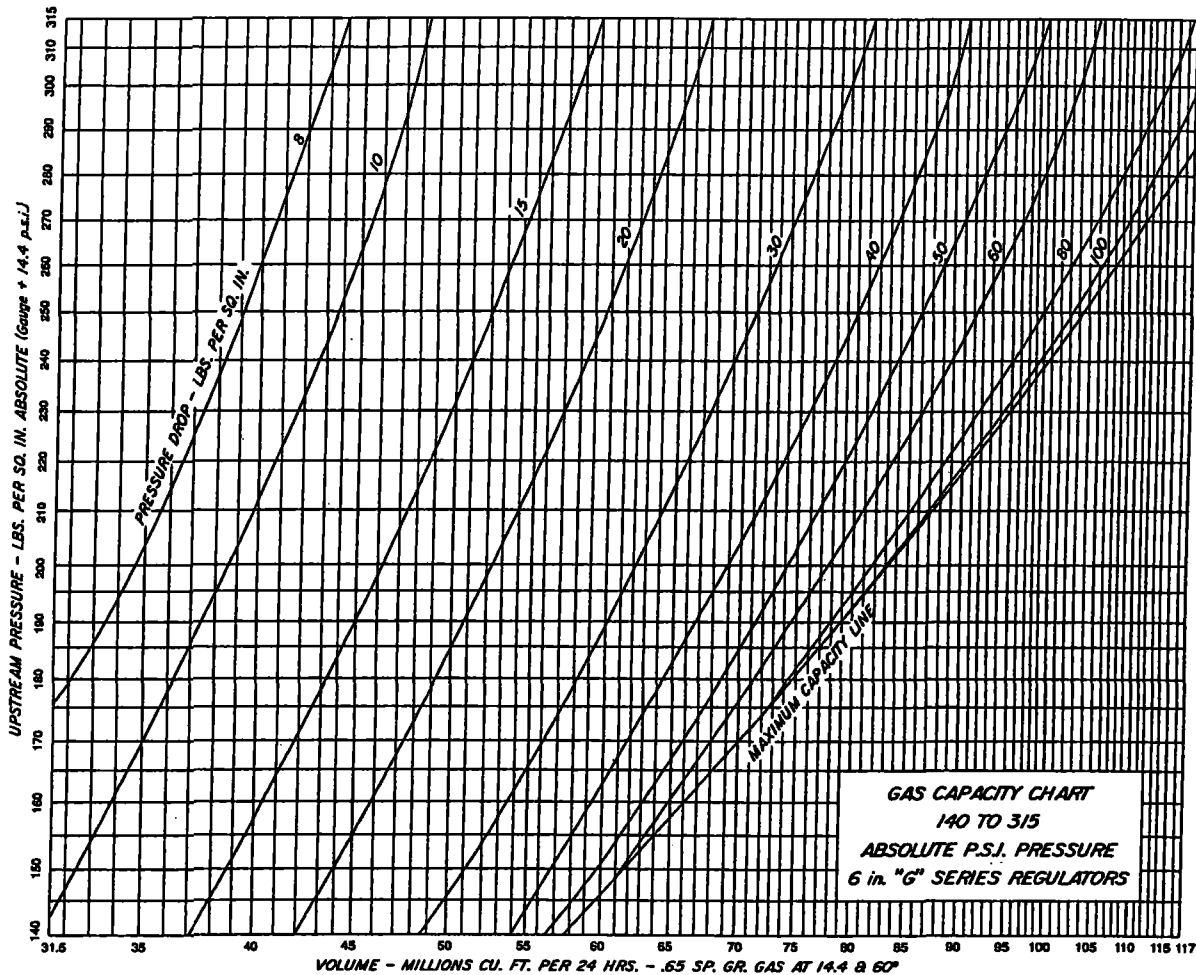
300 lbs. Maximum W.P. Valves

CAPACITY-Bbls. Water/Day, Steady Flow

PRESSURE DROP ACROSS VALVE PSIG	VALVE SIZE - INCHES			
	1	2	3	4
1	745	1,760	3,350	7,800
2	1,060	2,500	4,900	11,000
3	1,300	3,050	6,100	13,500
4	1,500	3,500	7,000	15,600
5	1,700	3,900	7,800	17,500
10	2,300	5,600	11,000	24,700
15	2,900	6,800	13,500	30,200
20	3,300	7,900	15,600	34,900
30	4,100	9,600	19,200	42,700
40	4,700	11,100	22,100	49,300
50	5,300	12,400	24,800	55,200
60	5,800	13,600	27,100	60,500
70	6,200	14,700	29,300	65,400
80	6,700	15,700	31,300	69,800
100	7,500	17,600	33,500	78,200
125	8,400	19,700	39,200	87,500
150	9,300	21,500	40,750	93,000
200	10,750	25,000	47,000	108,000
250	12,100	28,000	52,000	120,000
300	13,300	30,900	57,250	130,000

For gravity correction, multiply the above figures by \sqrt{G}
 Where "G" is the specific gravity of the flowing liquid.

220, 275 and 300 lbs. Maximum W.P. Valves



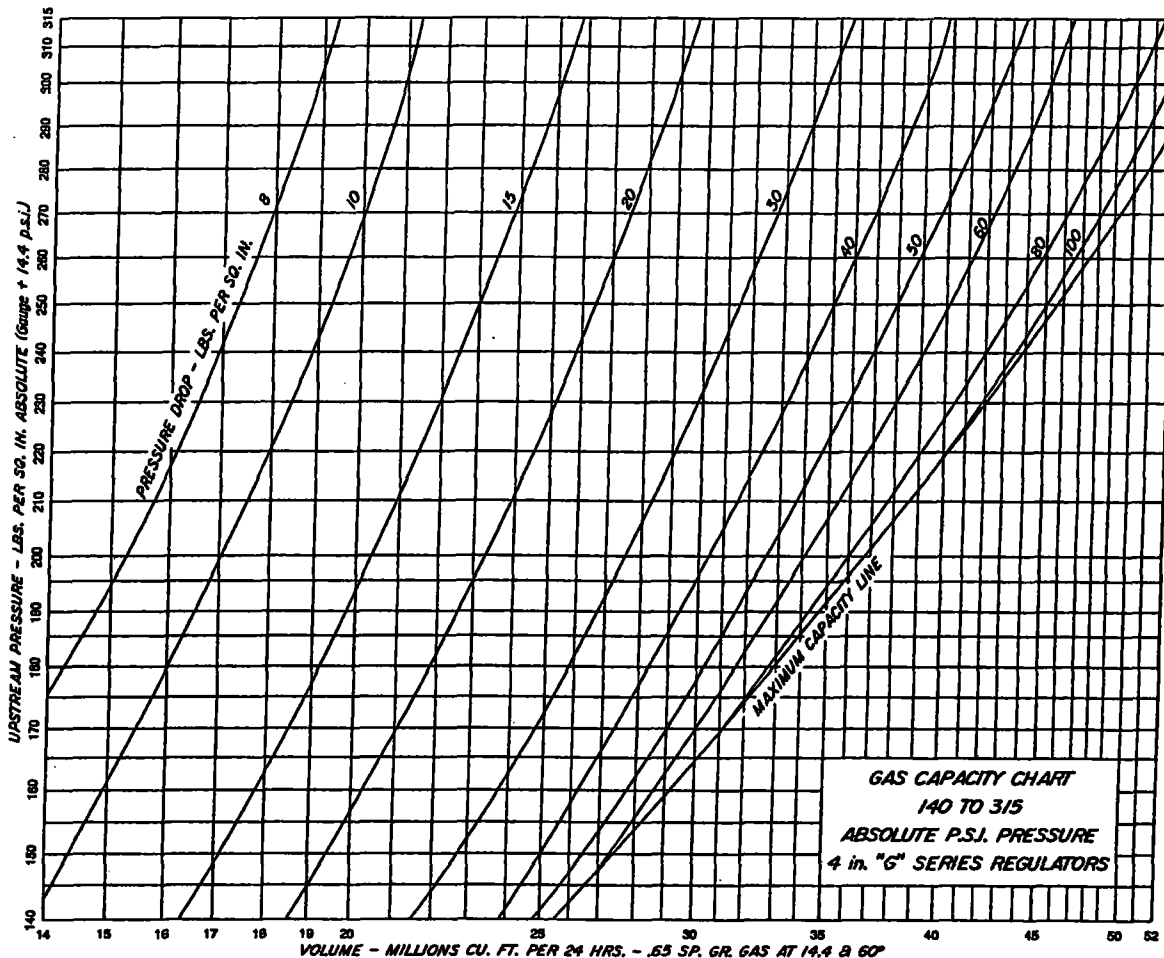
Gas capacities are based on pressure taken immediately upstream and downstream from the regulator in a wide open position.

Critical flow exists across a valve or orifice when the downstream absolute pressure is approximately half of the upstream absolute pressure. Any decrease in downstream pressure will not increase the flow through the valve. Critical flow conditions on the charts are represented by the MAXIMUM CAPACITY LINE.

HOW TO USE CHARTS: Locate UPSTREAM PRESSURE at left of chart. Follow horizontally across to PRESSURE DROP (upstream minus downstream pressure). Read VOLUME directly below. If the horizontal projection of the upstream pressure does not intersect the given pressure drop, flow is critical. In this case project UPSTREAM PRESSURE horizontally to the MAXIMUM CAPACITY LINE and read VOLUME directly below.

*For gravity correction multiply above capacities by $\sqrt{\frac{.65}{G}}$ where G equals specific gravity of gas.

220, 275 and 300 lbs. Maximum W.P. Valves



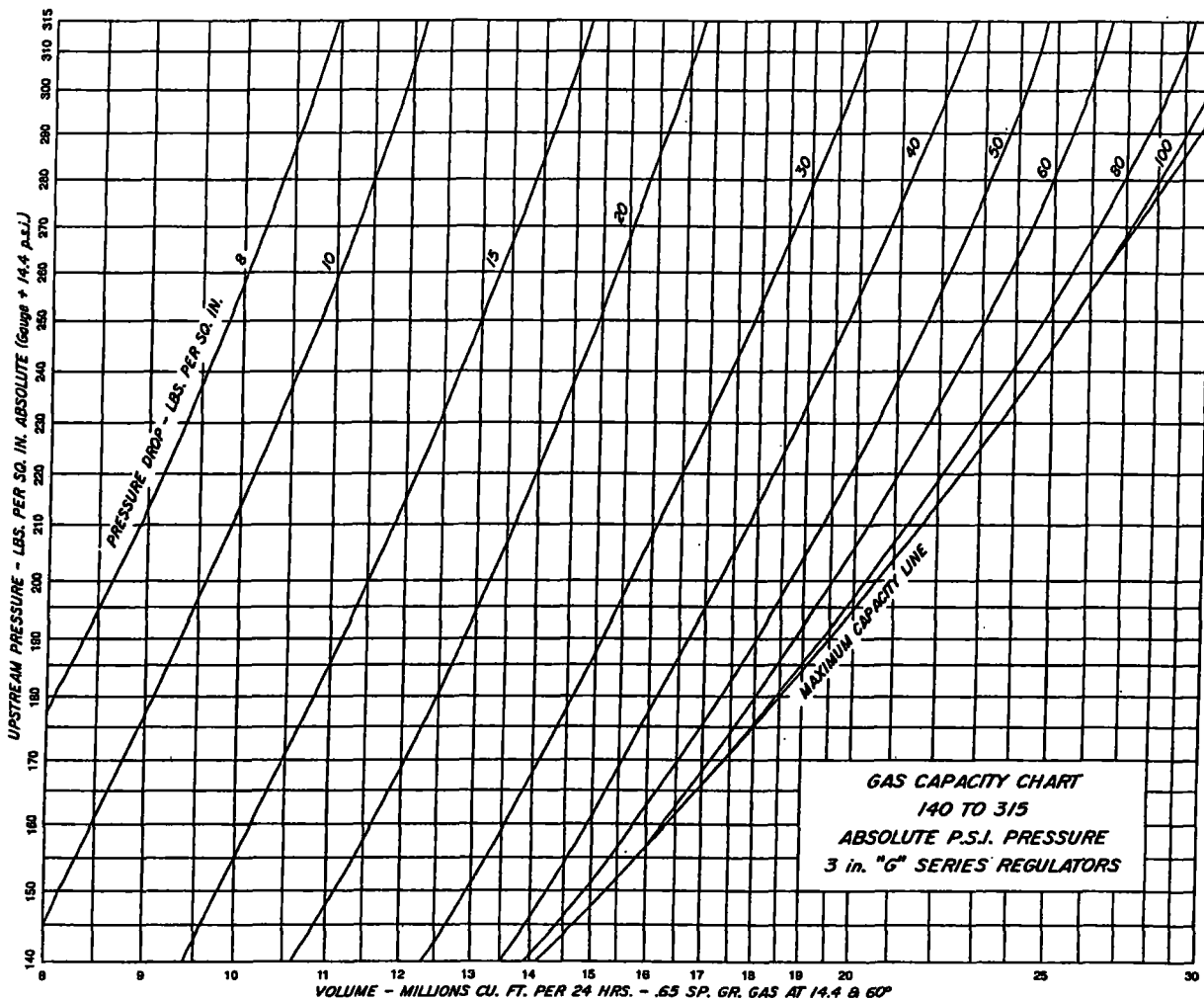
Gas capacities are based on pressure taken immediately upstream and downstream from the regulator in a wide open position.

Critical flow exists across a valve or orifice when the downstream absolute pressure is approximately half of the upstream absolute pressure. Any decrease in downstream pressure will not increase the flow through the valve. Critical flow conditions on the charts are represented by the MAXIMUM CAPACITY LINE.

HOW TO USE CHARTS: Locate UPSTREAM PRESSURE as left of chart. Follow horizontally across to PRESSURE DROP (upstream minus downstream pressure). Read VOLUME directly below. If the horizontal projection of the upstream pressure does not intersect the given pressure drop, flow is critical. In this case project UPSTREAM PRESSURE horizontally to the MAXIMUM CAPACITY LINE and read VOLUME directly below.

*For gravity correction multiply above capacities by $\sqrt{\frac{.65}{G}}$ where G equals specific gravity of gas.

220, 275 and 300 lbs. Maximum W.P. Valves



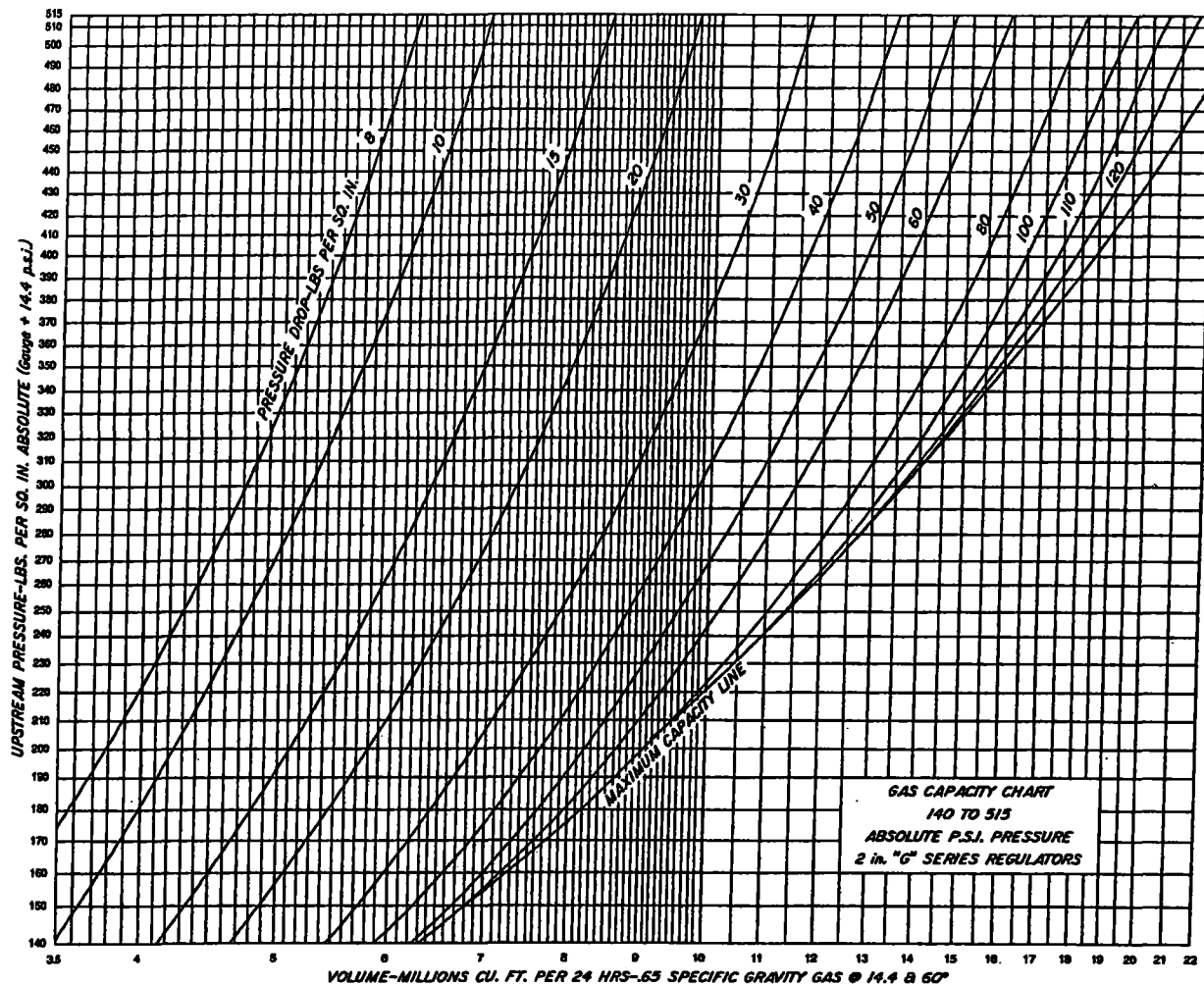
Gas capacities are based on pressure taken immediately upstream and downstream from the regulator in a wide open position.

Critical flow exists across a valve or orifice when the downstream absolute pressure is approximately half of the upstream absolute pressure. Any decrease in downstream pressure will not increase the flow through the valve. Critical flow conditions on the charts are represented by the MAXIMUM CAPACITY LINE.

HOW TO USE CHARTS: Locate UPSTREAM PRESSURE at left of chart. Follow horizontally across to PRESSURE DROP (upstream minus downstream pressure). Read VOLUME directly below. If the horizontal projection of the upstream pressure does not intersect the given pressure drop, flow is critical. In this case project UPSTREAM PRESSURE horizontally to the MAXIMUM CAPACITY LINE and read VOLUME directly below.

*For gravity correction multiply above capacities by $\sqrt{\frac{.65}{G}}$ where G equals specific gravity of gas.

220, 275, 300 and 500 lbs. Maximum W.P. Valves



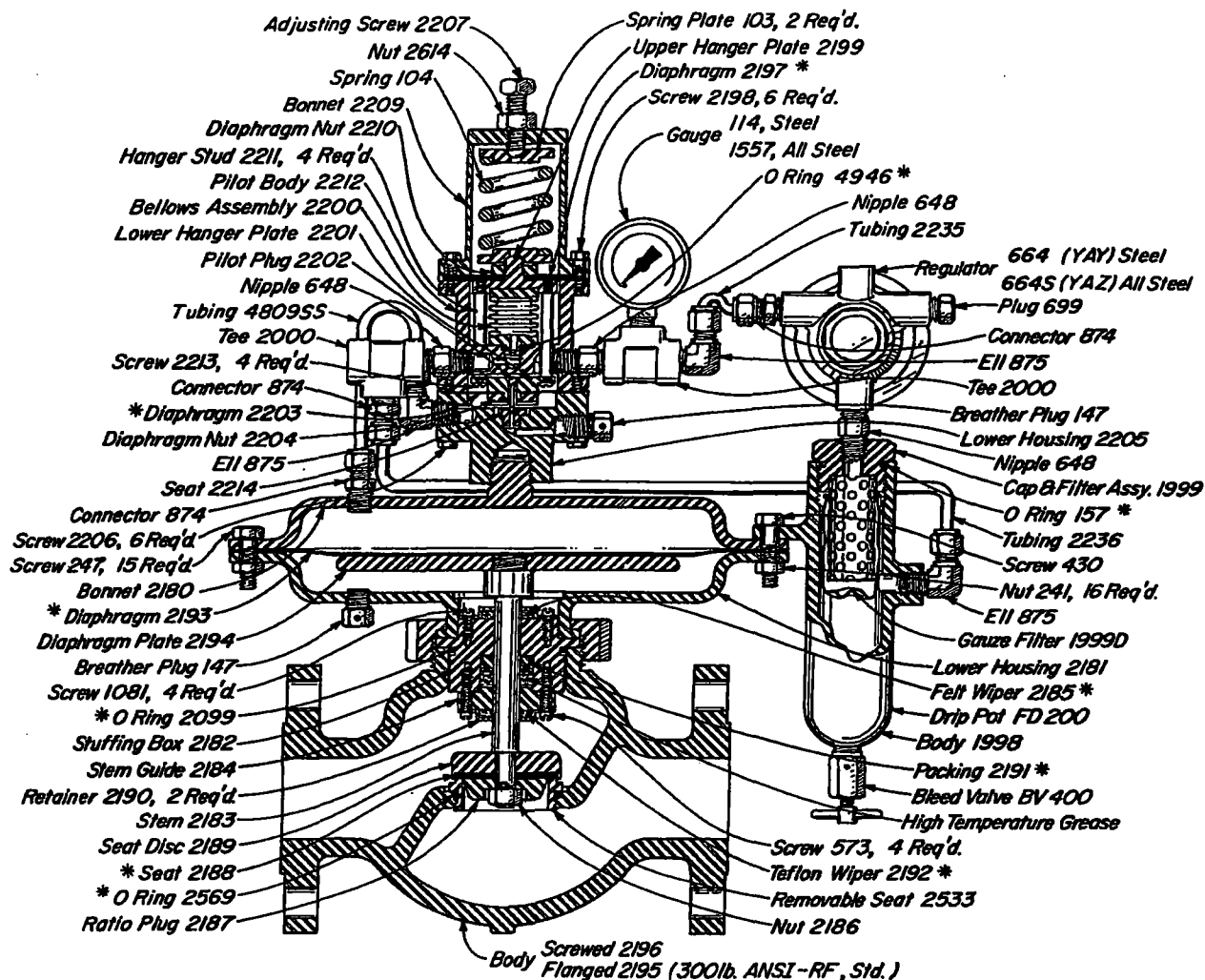
Gas capacities are based on pressure taken immediately upstream and downstream from the regulator in a wide open position.

Critical flow exists across a valve or orifice when the downstream absolute pressure is approximately half of the upstream absolute pressure. Any decrease in downstream pressure will not increase the flow through the valve. Critical flow conditions on the charts are represented by the MAXIMUM CAPACITY LINE.

HOW TO USE CHARTS: Locate UPSTREAM PRESSURE at left of chart. Follow horizontally across to PRESSURE DROP (upstream minus downstream pressure). Read VOLUME directly below. If the horizontal projection of the upstream pressure does not intersect the given pressure drop, flow is critical. In this case project UPSTREAM PRESSURE horizontally to the MAXIMUM CAPACITY LINE and read VOLUME directly below.

*For gravity correction multiply above capacities by $\sqrt{\frac{.65}{G}}$ where G equals specific gravity of gas.

250 S/FGT BP-S/STL
STEEL/ALL STEEL
500 lbs. W.P.



VALVES AVAILABLE: STEEL & ALL STEEL

CAT. NO.	SIZE	TYPE	REG. NO	DES. PRESS.	OPER. PRESS.
ABB	2"	SCRD.	250 SGT BP-S	500	500
ABA	2"	FLGD.	250 FGT BP-S	500	500
ABB1	2"	SCRD.	250 SGT BP-STL	500	500
ABA1	2"	FLGD.	250 FGT BP-STL	500	500

Dimensions, refer to Table of Contents.

*These parts are recommended spare parts and are stocked as repair kits. To order repair kit, specify size of regulator. Example: "2" 250G Repair Kit."

APPLICATION:






Vent lines on oil and gas separators, flow treaters, compressor stations, gas gathering systems.

PRESSURE RANGE:

50 psig to 500 psig

CAPACITY:

Refer to Table of Contents.

-  Pilot Bellows Assembly
-  Motor Valve Stem Assembly
-  Upstream Pressure
-  Pilot Supply Pressure
-  Motor Valve Diaphragm Pressure

OPERATION:

The Pilot Assembly and Motor Valve Stem Assembly (Crosshatched) are the only moving units in the regulator. The PILOT PLUG consists of two stainless balls rigidly connected together. The upper seat for the PILOT PLUG is the Motor Valve Diaphragm Pressure inlet (Violet to Yellow). The lower seat for the PILOT PLUG is the pressure vent (Yellow to Atmosphere).

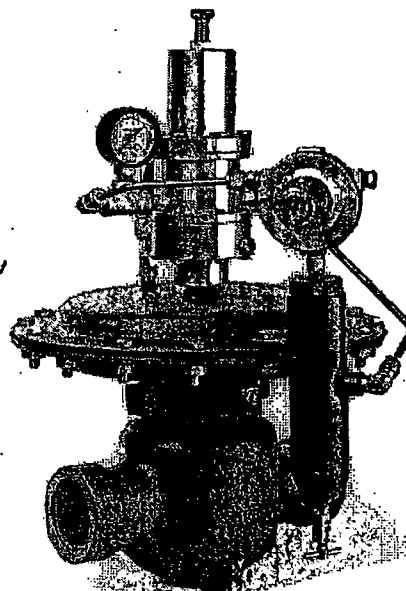
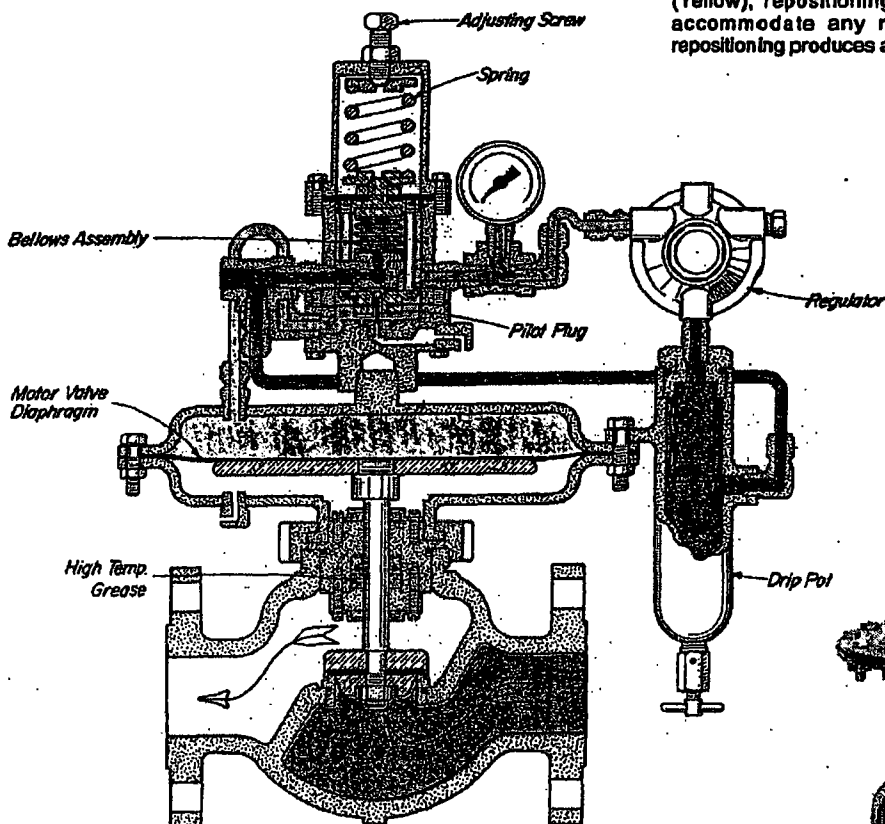
The PILOT SPRING in the bonnet loads the upper side of the Pilot Assembly and is opposed on the underside by Upstream Pressure (Red) in the BELLOWS ASSEMBLY.

Assume the PILOT SPRING is compressed with the ADJUSTING SCREW for a set pressure greater than the Upstream Pressure (Red) in the BELLOWS ASSEMBLY. The Pilot Assembly is forced downward by the PILOT SPRING. The lower seat for the PILOT PLUG (Yellow to Atmosphere) is closed and the upper seat for the PILOT PLUG (Violet to Yellow) is open. This allows Pilot Supply Pressure (Violet) to load the MOTOR VALVE DIAPHRAGM to close the motor valve. The area of the MOTOR VALVE DIAPHRAGM is sixteen times the area of the motor valve seat, assuring a positive shut-off.

As the Upstream Pressure (Red) increases to the set pressure, the BELLOWS ASSEMBLY expands upward against the Pilot Assembly, moving the PILOT SPRING to first close the upper seat (Violet to Yellow) and then open the pressure vent (Yellow to Atmosphere). As the Motor Valve Diaphragm Pressure (Yellow) is decreased, the Upstream Pressure (Red) acting under the motor valve seat, opens the valve.

With relief of Upstream Pressure (Red) through the motor valve, the Pilot Assembly assumes a position in which both seats of the PILOT PLUG are closed.

The non-bleed, three-way valve action of the PILOT PLUG against its seat adjusts the Motor Valve Diaphragm Pressure (Yellow), repositioning the Motor Valve Stem Assembly to accommodate any rate of flow. The rapid but stable repositioning produces a true throttling action.



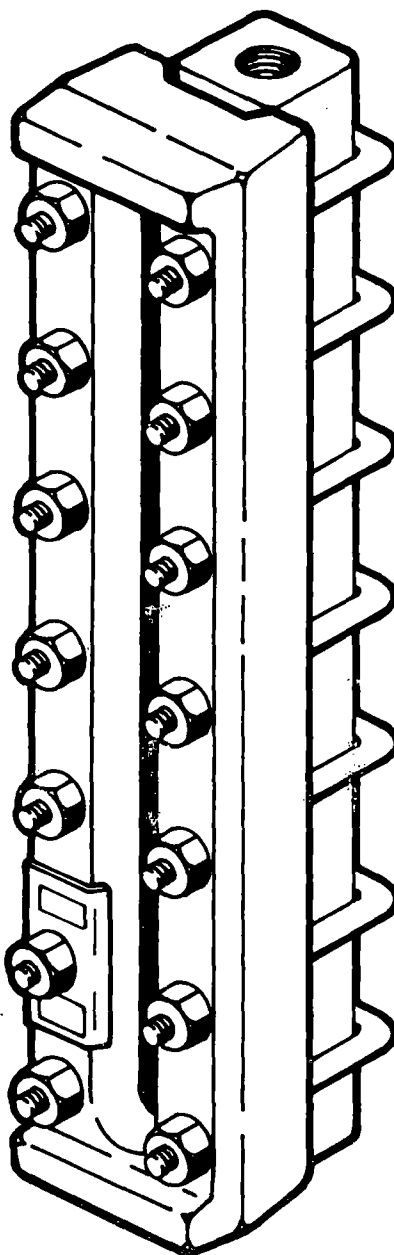
250 SGT BP-S

PENBERTHY®

Section	2000
Instal. Instr.	2950M
Issued	9/96
Replaces	6/95

Flat Glass Gages

Series M



Installation/Operation/Maintenance Instructions

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PRODUCT WARRANTY

Penberthy Inc., warrants its products as designed and manufactured by Penberthy to be free of defects in material and workmanship for a period of one year after the date of installation or eighteen months after the date of manufacture, whichever is earliest. Penberthy will, at its option, replace or repair any products which fail during the warranty period due to defective material or workmanship.

Prior to submitting any claim for warranty service, the owner must submit proof of purchase to Penberthy and obtain written authorization to return the product. Thereafter, the product shall be returned to Penberthy in Prophetstown, Illinois, with freight prepaid.

This warranty shall not apply if the product has been disassembled, tampered with, repaired or altered outside of the Penberthy factory, or if it has been subjected to misuse, neglect or accident.

Penberthy's responsibility hereunder is limited to repairing or replacing the product at its expense. Penberthy shall not be liable for loss, damage, or expenses directly or indirectly related to the installation or use of its products, or from any other cause or for consequential damages. It is expressly understood that Penberthy is not responsible for damage or injury caused to other products, building, property or persons, by reason of the installation or use of its products.

THIS IS PENBERTHY'S SOLE WARRANTY AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED WHICH ARE HEREBY EXCLUDED, INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This document and the warranty contained herein may not be modified and no other warranty, expressed or implied, shall be made by or on behalf of Penberthy unless modified or made in writing and signed by the President or a Vice President of Penberthy.

1.0 About the Manual

This manual has been prepared as an aid and guide for personnel involved in installation or maintenance. All instructions must be read and understood thoroughly before attempting any installation, operation, or maintenance. Failure to follow *any* instruction could possibly result in a malfunction of the gage or glass breakage with resulting sudden release of pressure, property damage or physical injury to personnel.

SAFETY INSTRUCTIONS

Penberthy does not have any control over the manner in which its liquid level gage is handled, installed or used. Penberthy cannot and will not guarantee that a liquid level gage is suitable or compatible for the user's specific application.



WARNING



Contained fluids may be pressurized and can unexpectedly exit vessel connections due to apparatus or material failure. Safety glasses should be worn when installing a liquid level gage. Failure to do so could result in serious physical injury to personnel.

2.0 Introduction

Penberthy liquid level gages are used to allow direct visualization of liquid level in vessels. By peering through the glass, it is possible to monitor color, clarity, and level of a gas/liquid interface. Gages are available in varying lengths and configurations (end connect, side connect, multiple sections, NPT or flange connections, etc.). Visual indication can be enhanced by using reflex glass or illuminators (accessory).

2.1 System Description

Penberthy gages are comprised of six basic components. Each component may vary slightly, depending on the desired physical and mechanical properties for the gage. Use the exploded parts view in Section 11 as additional reference material.

Chamber - provides a pressure retaining metallic channel for the liquid to enter and be viewed. Slot(s) are machined into the chamber to provide direct visualization of the process fluid.

Gaskets - seal the gap and prevent leakage between the chamber and the glass. Gaskets are available in a variety of materials for compatibility with the media in the gage.

Glass - glass allows for visual observation of the process fluid in the chamber

Cushion - acts as a protective buffer between the glass and the cover. For proper sealing cushions must be as hard as or harder than the gasket material.

Cover - protects the glass assembly from external hits and provides a flat, rigid surface that is used to evenly compress the gage assembly.

Bolting - compresses the components between the covers (transparent gages) or cover and chamber (reflex gages).

Shield (optional) - used to prevent the process media from contacting the glass.

3.0 Available Models

Penberthy medium (Series M) pressure liquid level gage are designed for applications other than steam/water: 1) requiring pressure ratings lower than that of Penberthy Series H liquid level gages, 2) where pressure ratings are greater than those possible using low pressure (Series L) liquid level gages, or 3) for Series L pressure ranges where iron covers are not allowed.

3.1 Design Ratings at Maximum and Minimum Operating Temperatures

Gasket Material	Glass Size	Model RM Reflex	
		Wetted Parts Material Steel or Stainless Steel w/B7 Bolting	
Grafoil® (standard) or Non-Asbestos		-20°F (-29°C) to 100°F (37°C)	600°F (315°C)
	1	3000 PSIG (20685 KPa)	2220 PSIG (15305 KPa)
	2	2910 PSIG (20065 KPa)	2150 PSIG (14825 KPa)
	3	2820 PSIG (19445 KPa)	2080 PSIG (14340 KPa)
	4	2725 PSIG (18790 KPa)	2040 PSIG (14065 KPa)
	5	2630 PSIG (18135 KPa)	1950 PSIG (13445 KPa)
	6	2535 PSIG (17480 KPa)	1875 PSIG (12930 KPa)
	7	2440 PSIG (16825 KPa)	1805 PSIG (12445 KPa)
	8	2345 PSIG (16170 KPa)	1740 PSIG (12000 KPa)
	9	2250 PSIG (15515 KPa)	1660 PSIG (11445 KPa)
PTFE/ Top-Chem 2000®	1 - 9	3000 PSIG (6205 KPa) at -20°F (-29°C) to 500°F (260°C) reference Application Report for gage pressure limitation at specific temperatures	
25% glass filled PTFE	1 - 9	900 PSIG (6205 KPa) at -20°F (-29°C) to 100°F (37°C) 450 PSIG (3105 KPa) at 500°F (260°C)	
NBR/Buna N®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 225 PSIG (1550 KPa) at 250°F (121°C)	
FKM/Viton®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 180 PSIG (1240 KPa) at 400°F (204°C)	
PTFE/Teflon®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 150 PSIG (2275 KPa) at 500°F (260°C)	

TABLE 1

NOTE:

Lower temperatures are possible with metallic material variation. (e.g., 316 Stainless construction, Grafoil® gaskets/cushions useable to -325°F [-198°C])

Gasket Material	Glass Size	Model TM Transparent	
		Wetted Parts Material Steel or Stainless Steel w/B7 Bolting	
Grafoil® (standard) or Non-Asbestos		-20°F (-29°C) to 100°F (37°C)	600°F (315°C)
	1	2500 PSIG (17235 KPa)	1850 PSIG (12755 KPa)
	2	2315 PSIG (15960 KPa)	1720 PSIG (11860 KPa)
	3	2130 PSIG (14685 KPa)	1575 PSIG (10860 KPa)
	4	1940 PSIG (13375 KPa)	1435 PSIG (9895 KPa)
	5	1750 PSIG (12065 KPa)	1295 PSIG (8930 KPa)
	6	1565 PSIG (10790 KPa)	1160 PSIG (8000 KPa)
	7	1375 PSIG (9480 KPa)	1015 PSIG (7000 KPa)
	8	1190 PSIG (8205 KPa)	880 PSIG (6070 KPa)
	9	1000 PSIG (6895 KPa)	740 PSIG (5100 KPa)
PTFE/ Top-Chem 2000®	1 - 9	2500 PSIG (6205 KPa) at -20°F (-29°C) to 500°F (260°C) reference Application Report for gage pressure limitation at specific temperatures	
25% glass filled PTFE	1 - 9	900 PSIG (6205 KPa) at -20°F (-29°C) to 100°F (37°C) 450 PSIG (3105 KPa) at 500°F (260°C)	
NBR/Buna N®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 225 PSIG (1550 KPa) at 250°F (121°C)	
FKM/Viton®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 180 PSIG (1240 KPa) at 400°F (204°C)	
PTFE/Teflon®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 150 PSIG (2275 KPa) at 500°F (260°C)	
PCTFE/(Kel-F®) Shields 0.063" (1.6 mm) thick	1 - 9	300 PSIG (2067 KPa) at -20°F (-29°C) to 100°F (37°C) 180 PSIG (1240 KPa) at 400°F (148°C)	

TABLE 2

NOTE:

Lower temperatures are possible with metallic material variation. (e.g., 316 Stainless construction, Grafoil® gaskets/cushions useable to -325°F [198°C])

The pressure and temperature ratings may deviate from the above tables if the gasketing materials of construction and/or bolting are other than those specified. Higher and/or lower temperature ratings are available with different materials of construction.

To determine the maximum allowable working pressure for a specific temperature within the design limits stated in the tables, the user should refer to Penberthy dimension sheets, or when provided, the specifically stated design limits on a Penberthy product proposal.

NOTE: under no circumstances should shields be used in reflex style gages. Installation of shields in reflex style gages will keep the liquid from coming in contact with the refractive prisms, thereby prohibiting visualization of the liquid level in the gage.



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NEVER exceed these design ratings or application data. Exceeding design ratings or application data may result in mechanical failure of gage components resulting in death, serious personal injury and property damage.

4.0 Inspection

Upon receipt of a liquid level gage, check all components carefully for damage incurred in shipping. If damage is evident or suspected, do not attempt installation. Notify carrier immediately and request damage inspection.

Penberthy's standard 1 section TM gage consists of: (1) chamber, (2) gaskets, (2) borosilicate flat glass, (2) rubber bands, (2) cushions, (2) covers, (1) washer, (1) nameplate, and (6 - 14) bolting sets, depending on the size.

4.1 Glass Inspection

The self stick caution tape was applied at the factory to protect the glass during shipping, handling, and installation. Do not remove the tape from the glass until all installation procedures have been completed, except during receiving inspection to momentarily inspect glass for shipping damage. Glass that is not protected will be vulnerable to dust, grit, tools and any other objects which may scratch, chip, or break the glass.



WARNING



DO NOT use glass that is chipped or even slightly scratched. Glass surface defects weaken the glass which may result in glass breakage and fluid loss under pressure resulting in serious personal and property damage.

4.2 User Rating Inspection

The user should confirm that:

- 1) the Series M liquid level gage model and assembly number stamped on the nameplate conforms to the description on the user's purchase order,
- 2) the operating conditions described in the purchase order agree with the actual operating conditions at the installation site,
- 3) the actual operating conditions at the installation site are within the application data shown on the Penberthy Technical Data Bulletin or product proposal referred to above, and
- 4) the materials of construction of the liquid level gage are compatible with both the contained media and surrounding atmosphere in the specific application.

SAFETY INSTRUCTIONS

If the size, model, or performance data of the liquid level gage as received does not conform with any of the criteria above, do not proceed with installation. Contact an authorized Penberthy distributor for assistance. The incorrect gage can result in unacceptable performance and potential damage to the gage.

5.0 Installation

Installation should only be undertaken by qualified personnel who are familiar with equipment of this type. They should have read and understood all of the instructions in this manual. The user should refer to Penberthy dimension sheets or Penberthy product proposal to obtain dimensional information for the specific size and model liquid level gage.

Penberthy recommends that all liquid level gage installations be provided with gage valve sets equipped with ball check shut-off. Gage valve sets are designed to isolate the gages from the pressure vessel when it becomes necessary to drain or service the gages. The ball check shut-off is designed to retard leakage of the contained fluid in the event of gage glass breakage. Ball checks are available for both positive and negative vessel pressures.

The number of different types of gage and valve installations is too great to adequately detail in an installation manual. It is, therefore, the user's responsibility to assure that the knowledgeable installation personnel plan and carry out the installation in a safe manner. The following procedures are some of the installation guidelines that should be employed.

5.1 Piping Strain

The gage should be mounted and connected so that it does not support any piping weight. Piping not properly supported, independent of the gage, may subject the gage to stresses that can cause leaks or glass breakage. Support brackets are available as an accessory.

5.2 Differential Thermal Expansion

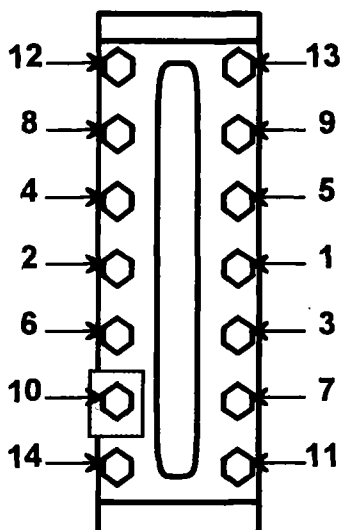
High mechanical loads may be imposed on a gage by expanding and contracting pipes due to hot or cold service. Such mechanical loads on the gage must be minimized by the use of expansion loops in the system. Failure to allow for expansion or contraction can result in leaks or glass breakage.

5.3 Mirror Viewing

For added safety, a system of indirect viewing by means of mirrors should be installed to protect personnel from the hazards of possible gage failure.

5.4 Nut Retorquing (not applicable for gages with Belleville washers) - see Section 5.5

Nut retorquing is vital to the operation of a liquid level gage because gaskets take permanent set under initial bolt loading at assembly. Tightening of nuts before installation to values specified in Table 3 is necessary to insure pressure retaining capabilities of liquid level gage to specific design ratings. The user must refer to the liquid level gage model and assembly number and to the purchase order or tag to determine materials of construction.



**Nut Tightening Sequence
Figure 1**

BOLT TORQUE VALUES

GAGE MODELS and GASKET MATERIAL	ft-lb
RM, TM w/Grafoil® (standard)	25 to 30
RM, TM w/Non-asbestos (optional)	30 to 35
Top-Chem 2000®	25 to 30
25% glass filled PTFE	20
All Models w/Teflon®, Viton® or elastomeric (optional)	10
TM with PCTFE/(Kel-F®) Shields (optional) 0.063"	10

Table 3

Using a torque wrench, tighten nuts in five ft-lb increments following the "Z" pattern sequence in Figure 1, until the torque values shown in Table 3 above for the specific liquid level gage are reached. For multiple section gages, torque the center

section(s) and progressively work toward the ends of the gage.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and retorqued if necessary.



WARNING

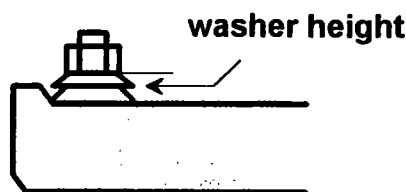


Failure to comply with the proper torquing sequence or force/height value can lead to leakage, gasket blow-out or glass breakage resulting in gage failure, serious injury and/or property damage.

NOTE: Depending on gage size there may be less bolting than shown in Figure 1. Start at the center and follow "Z" pattern outward to the limit of bolting on a specific gage.

5.5 Belleville Washers

Belleville washers are used to reduce or eliminate the need to retorque nuts. This is especially important for gages subject to pressure and/or thermal cycling and also in offshore applications where use of wrenches often cracks or chips the protective coat. The conical washers allow for material expansion and contraction while maintaining axial bolt loading and, therefore, compression on the gasket.



**Belleville Washer Height
Figure 2**

**CONICAL SPRING HEIGHT
FOR BELLEVILLE WASHERS**

GAGE MODELS	No. of Washers per nut	Spring Height (top of cover to bottom of nut) inch (mm)
RM	4	0.264 (6.7)
TM	2	0.136 (3.5)

Table 4

The effective range of a Belleville washer is measured in height (or compression distance) of the washer **NOT TORQUE**. Refer to Figure 2 and Table 4 for proper compression height. Do not tighten nuts until the washers are flat. Belleville washers cannot absorb expansion when flat.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and stack height, if necessary.

6.0 Operation

Before initializing liquid level gage operation, check that all installation procedures have been completed. Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. Check to determine that all connections are pressure tight. Assure that nuts have been retorqued to their proper values as specified in Table 5. Remove self stick caution tape from the glass and inspect to be sure that glass is clean and free of any damage such as cracks, scratches, pits, and chips.

6.1 Hydrostatic Test



DANGER



Liquid level gage installations should be brought into service slowly to avoid excessive shock or stress on the glass. Rapid pressurization or sudden changes in temperature may cause glass breakage. To avoid excessive thermal shock or mechanical stress on glass, the connecting valves should be opened slightly, and the gage temperature and pressure allowed to slowly equalize. If the valves are equipped with ball checks, the valves must be opened all the way after the pressure and temperature have equalized to permit operation of the automatic ball checks in the event of failure. Failure to follow the recommended operating procedures can result in death, severe personal injury and/or property damage.

Take all precautions necessary to handle the possibility of leakage during the test. Hydrostatically pressure test all installations to at least 100 PSIG but less than design pressure and correct any leakage before proceeding.

7.0 Maintenance



WARNING



Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. DO NOT proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

The rate at which components degrade is dependent upon a variety of conditions. Pressure, temperature and process media all influence the rate at which gage components deteriorate. Higher temperatures can accelerate the deterioration of gaskets, cushions, glass, and metals. Acids and similar chemicals can break down the integrity of almost any material. Concentration of chemicals can accelerate the corrosion rate. Penberthy cannot create a blanket maintenance schedule for every application.

The end user is the most familiar with the process media and conditions and must be responsible for creating a maintenance schedule. The user must create maintenance schedules, safety manuals, and inspection details for each liquid level gage. Realistic maintenance schedules can only be determined with full knowledge of the services and application situations involved. These will be based upon the user's own operating experience with their specific application.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and retorqued or repaired as necessary.

On all installations the following items should be regularly evaluated by the user for purposes of maintenance:

- 1) glass, for cleanliness and signs of damage or wear,
- 2) shields, if used, for signs of clouding, wear or deterioration,
- 3) gage, for signs of leakage around gaskets or at connections and
- 4) gage, for signs of internal or external corrosion.

7.1 Maintenance Procedures

GLASS should be given regular and careful attention. Keep glass clean using a commercial glass cleaner and a soft cloth. Inspect the surface of the glass for any clouding, etching or scratching or physical damage such as bruises, checks or corrosion. Glass that is damaged is weakened and may break under pressure. Shining a light at approximately a 45° angle will aid in detecting some of these conditions. Typical damaged areas will glisten more brightly than the surrounding glass because the light is reflected.

Detection of any damage, problem areas or surface wear is sufficient evidence to take the liquid level gage out of service. DO NOT proceed with operation of the liquid level gage until the glass has been replaced with a glass replacement kit following the assembly instructions in Section 8.

SHIELDS showing any signs of clouding, wear, or deterioration are an indication that the gage glass has been exposed, or could soon be exposed to the contained fluid. Immediately take liquid level gage out of service. **DO NOT** proceed with operation of the liquid level gage until shields and glass have been replaced by following the disassembly-reassembly instructions in Section 8.

GASKET LEAKS must be repaired immediately. **DO NOT** proceed with operation of a liquid level gage until gaskets have been replaced by following Section 8 assembly instructions.

CONNECTION LEAKS at a flanged or threaded connection should be corrected by tightening the bolting at the connection or by taking the liquid level gage out of service and wrapping the connection threads with Teflon® tape on all male pipe threads.

CORROSION may occur if the user has selected an improper material for the liquid level gage application. It is the responsibility of the user to choose a material of construction compatible with both the contained fluid and the surrounding environment. If internal or external corrosion is present, an investigation must immediately be performed by the user. It may be necessary to contact an authorized Penberthy distributor to better determine the origin of the corrosion.

7.2 Troubleshooting

Problem:	glass becomes prematurely etched or clouded in service
Cause:	fluid being handled is not compatible with the glass or shields
Solution:	replace the glass and install shields which will not be affected by contained fluid
Problem:	glass continually breaks in service despite careful attention to maintenance procedures
Cause:	thermal shock, hydraulic shock, mechanical loads, exceeding design ratings or a combination of these
Solution:	check entire system to determine possible sources of loads. Check application to determine actual operating conditions and contact an authorized Penberthy distributor on how to proceed.

8.0 Removal - Disassembly - Reassembly



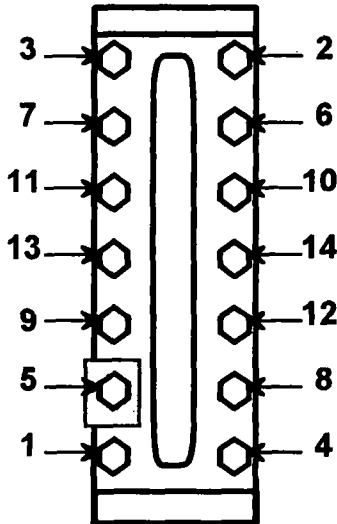
WARNING



Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. **DO NOT** proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature, and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

8.1 Disassembly

Secure workbench longer than the liquid level gage, and sufficiently wide to lay out parts as they are removed.



Nut Loosening Sequence
Figure 3

- 1) Lay gage on bench so nut side of fastener is up.
- 2) Hold gage firmly, and loosen nuts starting at both ends of each section and then proceeding from both ends to the center of each section as shown in Figure 3.
- 3) Nut Loosening Sequence
 - remove nuts, washer, and nameplate
 - tap covers with rubber hammer as needed to loosen and remove
 - for belleville washer assemblies: to remove covers, studs may need to be removed by laying the assembly on its side and knocking the studs/U-bolts through the cover with a hammer and punch
 - remove cushions, glass, shields (if any), and gaskets
 - tap liquid chamber or remaining covers as necessary with rubber hammer to break loose, and remove remaining components
 - remove, destroy, and dispose of all glass, cushions, gaskets, and shields. Under no circumstances should these components be re-used or installed on a gage

NOTE: If size of gage is smaller than shown, follow spiraling sequence from the ends until all bolting is loosened.



WARNING



Once used cushions, gaskets, and shields are permanently deformed by compression and if re-used, may cause leaks and high stress points resulting in glass breakage. Glass may contain hidden damage and internal stresses caused by previous usage. If re-used, the glass may break under pressure causing personal and property damage.

8.2 Inspection of Glass Seating Surfaces

Clean the glass seating surfaces on the liquid chamber and cover with a soft metal scraper (preferably brass) to remove all burrs, rust, and remnants of the previous gaskets and cushions. Exercise extreme care to avoid gouging or scarring gasket and cushion seating surfaces.

Use a known flat piece of metal the same approximate length as the glass or a new piece of glass and a thickness gage to check flatness of each glass seating surface on liquid chamber and under cover. Surface must be flat within 0.002 inch. If any one surface is found to be beyond a tolerance of 0.002 inch, the entire gage must be disposed of and replaced. Gasket seating surface must have a final surface finish of 450 to 500 AARH.



WARNING



Flatness of glass seating surfaces outside 0.002 inch tolerance specified is an indication of the gage having been overstressed through repeated exposure to mechanical, thermal, or hydraulic shock during its previous service. Operation of a liquid level gage which has been overstressed will result in abnormal stresses on the glass which may cause glass to break. If surface finish is not in the 450 - 500 AARH range, gasket may extrude under pressure with resulting sudden release of pressure, leakage of contained fluid, serious personal injury, or property damage.

Glass seating surfaces should NOT be machined to achieve seating tolerance. The chamber and cover are designed for a critical thickness to achieve the pressure/temperature ratings. Machining glass seating surfaces may result in non-compliance to the necessary critical thickness due to material removal.

8.3 Reassembly

If all glass seating surfaces are found to be within the 0.002 inch (0.051mm) tolerance described in the previous section, proceed to obtain new glass, gaskets, cushions and shields (if used) and proceed to reassemble as follows (refer to exploded parts view in Section 11 if needed):

- 1) clean threads on bolt and nuts to remove all paint, rust, and scale. Apply a light coat of oil to the threads.
- 2) for transparent gages, insert bolts through half the cover and lay out covers along bench, side by side, with the liquid chambers. Use chambers to space covers and line them up with vision slots.
- 3) for reflex style and belleville reflex style gages, lay out covers along bench, side by side, with liquid chambers. Use chambers to space covers and line them up with vision slots.
- 4) for transparent belleville style gages, thread nuts on stud, place two belleville washers under nut with pointed end toward the nut (see Figure 2), insert stud through each cover and lay out covers along bench, side by side, with liquid chambers. Use chambers to space covers and line them up with vision slots.
- 5) install one cushion inside each cover.



WARNING



Separate installation instructions are supplied with replacement glass. All instructions supplied with the glass must be followed as there are precautions to be taken when handling gage glass. Among the precautions is avoidance of bumping or sliding glass against any surface and inspection of individual pieces. Failure to follow any of the replacement gage glass installation instructions could result in glass breakage with resulting sudden release of pressure, personal or property damage.

- 6) install rubber band around each piece of glass, then place glass centered inside each cover.

- 7) install shields, if used, and gasket on glass being careful to keep components centered.
- 8) place liquid chamber on the gaskets (shields - if used) making sure all components are aligned with vision slot.
- 9) for reflex gage, install U-bolts in place by tapping as needed with rubber hammer, being careful not to lose alignment with vision slot.
- 10) for reflex gage, quickly turn over assembly onto back side of U-bolts. Assemble nameplate, washer, and nuts to U-bolts. Tighten nuts with fingers. Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1 until the torque values shown in Table 3 are reached.

NOTE: Depending on gage size there may be less bolting than shown in Figure 1. Start at the center and follow "Z" pattern outward to the limit of bolting on a specific gage.

- 11) for transparent gage, install gaskets in place, and shields if used.
- 12) install one cushion on each piece of glass
- 13) install rubber band around each piece of glass, then place glass centered inside each cover
- 14) install covers in place being careful to maintain components alignment inside.
- 15) install nameplate, washer, and nuts to studs. Tighten nuts with fingers. Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1 until the torque values shown in Table 3 are reached.
- 15A) for transparent belleville style gages: install nameplate and two belleville washers under each nut with pointed end toward the nut (see Figure 2). Finger tighten nuts.

NOTE: the following procedure is to be done on only one side of the gage.

- 15B) for reflex belleville style gages: install nameplate and four belleville washers under each nut with pointed end toward the nut (see Figure 2). Finger tighten nuts.
- 16A) Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1. Once 20 ft-lb is reached, begin measuring stack height. Tighten nuts in five ft-lb increments until stack spring height is within 0.008" (0.2 mm) of proper height. Individually tighten each nut until stack height is achieved. (see Table 5) To estimate washer height, add the thickness of the nut to the compressed height requirement and use this value to compare to the measurement from the top of the nut to the face of the cover.

Refer to Section 5 for installation and Section 6 for operation of liquid level gage when returning to service.

9.0 Disposal at End of Useful Life

Penberthy gages are used in a variety of fluid applications. By following the appropriate governmental and industry regulations, the user must determine the extent of preparation and treatment the gage must incur before its disposal. A Material Safety Data Sheet (MSDS) may be required before disposal services accept certain components.

Metals, glass, and polymers should be recycled whenever possible. Refer to order and Penberthy's Material Specification sheets for materials of construction.

10.0 Telephone Assistance

If you are having difficulty with your liquid level gage, notify your local Penberthy distributor. You may also contact the factory direct at (815) 537-2311 and ask for an applications engineer. So that

we may assist you more effectively, please have as much of the following information as possible when you call:

- Model #
- Name of the company from whom you purchased your liquid level gage
- Invoice # and date
- Process fluid
- Operating pressures
- Operating temperatures
- A brief description of the problem
- Troubleshooting procedures that failed

If attempts to solve your problem fail, you may be requested to return your liquid level gage to the factory for intensive testing. You must obtain a Return Authorization (R.A.) number from Penberthy prior to returning anything. Failure to do so will result in the unit being returned to you, without being tested, freight collect. To obtain a R.A. number, the following information (in addition to that above) is needed:

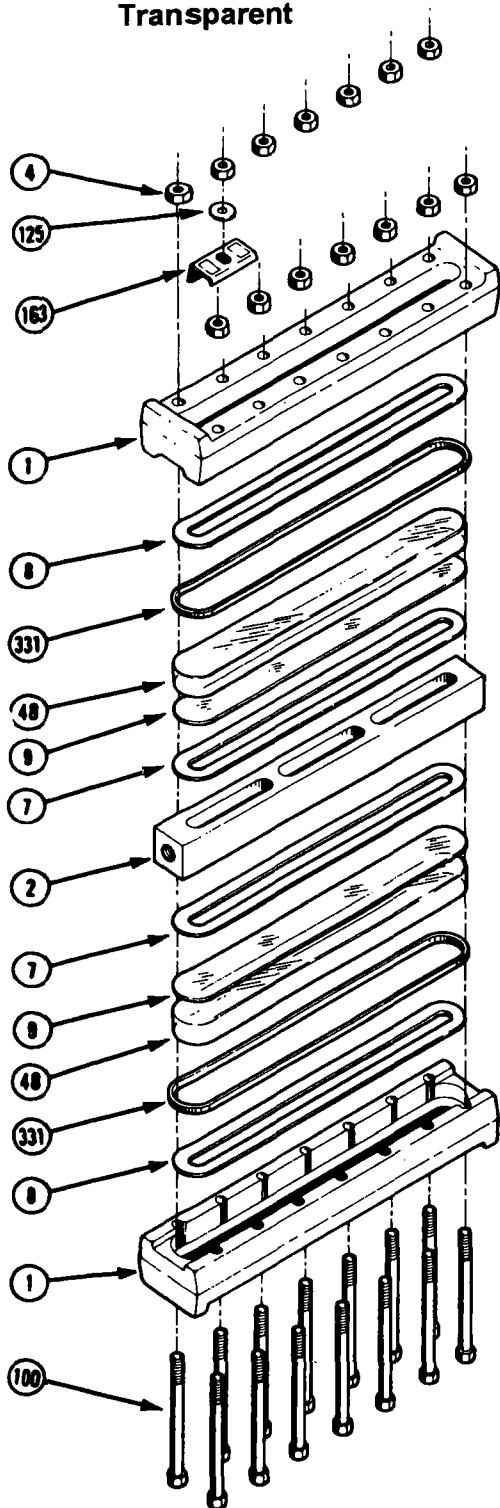
- Reason for return
- Person to contact at your company
- "Ship To" address

We recommend that you return the entire unit for testing. There is a minimum charge of \$75.00 for evaluation of non-warranty units. You will be contacted before any repairs are initiated should the cost exceed the minimum charge. If you return a unit that is covered by the warranty, but is not defective, the minimum charge will apply.

Grafoil® is a registered trademark of Union Carbide Corporation
Neoprene®, Viton®, and Teflon® are registered trademarks of E. I. du Pont de Nemours and Company
Top Chem 2000® is a registered trademark of Klinger
Kel-F® is a registered trademark of 3M

11.0 Exploded Parts Drawing

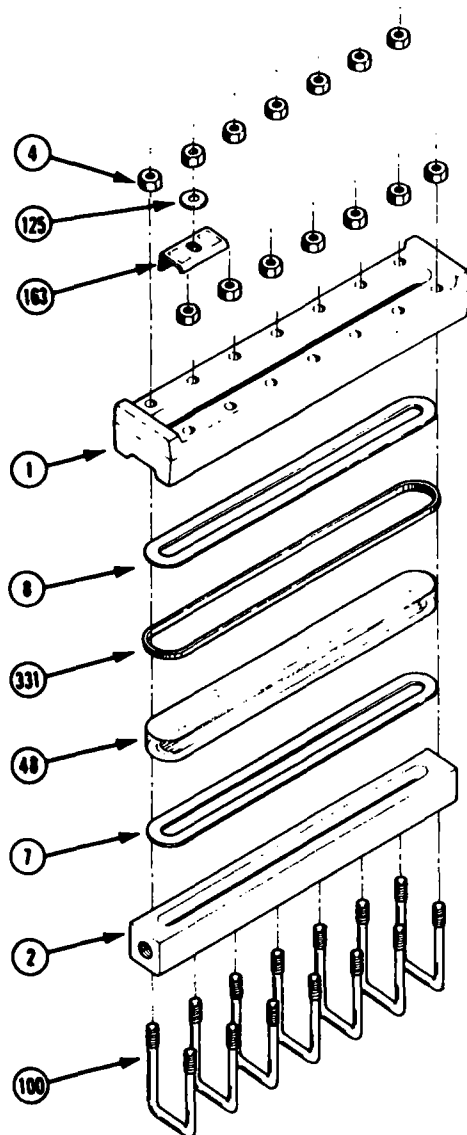
Transparent



- 1 - Cover
- 2 - Chamber
- 4 - Nut
- 48 - Glass
- 7 - Gasket
- 8 - Cushion
- 9 - Shield
- 100 - Bolt/U-bolt
- 125 - Washer
- 163 - Nameplate
- 331 - Band

Recommended Spare Parts		
REF #	ITEM	QTY
100	Bolt/U-bolt	2/1 per sect.
4	Nut	2 per sect.
48	Glass	1
7	Gasket	2
8	Cushion	2
9	Shield (if used)	2

Reflex



NOTE: size 9 shown - actual gage may be shorter and require fewer bolting components

≈ DECLARATION of CONFORMITY ≈

In conformance with ISO/IEC Guide 22 - 96
LLG.DC r C

Manufacturer's Name: Penberthy, Incorporated
Manufacturer's Address: 320 Locust Street
Prophetstown, IL 61277-1147 U.S.A.
Product:
Type of Equipment: Pressure Vessel - Liquid Level Gauge Glass
Equipment Class: Industrial Instrumentation - Hazardous Area
Model Designations: RL, TL, RM, TM, RH, TH, RMW, TMW, RLC, TLC

The product described above is in conformity with:

92/59/EEC	General product safety	1992
87/404/EEC	Simple pressure vessel	1987
89/392/EEC	Machinery	1989
EN 10213-1:4	Technical delivery conditions for steel castings	1996
ISO 7-1	Pipe threads where pressure-tight joints are made	1996
BS 10	Flanges and bolting for pipes, valves and fittings	1962
BS 21	Pipe threads for tubes and fittings where pressure-tight	1985
BS 759	Valves, gauges and other safety fittings for application	1984
BS 970 Part 1	Wrought steels for mechanical and allied engineering	1996
BS 970 Part 3	Wrought steel for mechanical and allied engineering	1991
BS 1501 Part 3	Steels for pressure purposes	1990
BS 1502	Steels for fired and unfired pressure vessels	1982
BS 1506	Carbon, low alloy and stainless steel bars and billets	1990
BS 1560	Circular flanges for pipes, valves and fittings	1989
BS 1640 Part 1	Steel butt-welding pipe fittings	1962
BS 1640 Part 2	Steel butt-welding pipe fittings	1962
BS 1965	Butt-welding pipe fittings	1963
BS 3076	Nickel and nickel alloys: bar	1989
BS 3463	Observation and gauge glasses for pressure vessels	1975
BS 3602 Part 1	Steel pipes and tubes for pressure purposes	1987
BS 3605	Austenitic stainless steel pipes and tubes	1991
BS 3643	ISO metric screw threads	1981
BS 3799	Steel pipe fittings, screwed and socket-welding	1974
BS 4504	Circular flanges for pipes, valves and fittings	1989
ASME B&PV Code, Section VIII	Rules for construction of pressure vessels	1995
ANSI/ASME B1.1	Unified screw inch threads and UNR thread form	1982
ANSI/ASME B1.20.1	Pipe threads, general purpose (inch)	1983
ANSI/ASME B16.5	Pipe flanges and flanged fittings	1988
ANSI/ASME B18.2.1	Square and hex nuts and screw inch series	1981
ANSI/ASME B18.2.2	Square and hex nuts	1972
ANSI/ASME B31.3	Process piping	1996

Date: 30 December 1996
Prophetstown, IL U.S.A.

Signature:



Name:

David J. Williams, C.Q.E.

Position:

Quality Assurance Manager