EVR Series Precision Vacuum Regulator

REGULATOR USE AND STARTUP

EVR-GSD Series in Stainless Steel with standard vacuum pilot regulator

WARNING:

Make sure that you have read and understand these directions before using, installing, or maintaining the Equilibar pressure regulator. Take steps to ensure this instruction manual reaches the operator of this regulator and stays with the regulator throughout its lifetime. Use, installation, operation, and maintenance of all pressurized products including this regulator must be performed by personnel who are properly trained and qualified through experience or specific training.

Failure to properly observe the instructions contained in this document may result in, but is not limited to:

- Serious personal injury or death
- Unconstrained release of the pressurized media
- Permanent damage to the pressure regulator and/or permanent damage to connected equipment

BACKGROUND

Background: The Equilibar® Vacuum Regulator (EVR) Series is a family of precision vacuum pressure regulators that directly control vacuum pressure at the inlet "I" port. The Equilibar EVR controls this vacuum by allowing flow from the system to vent through the regulator outlet "O" port. A vacuum supply source is connected to the outlet "O" port. The flow direction is from inlet to outlet. The EVR is pilot operated so the vacuum pressure set point is determined by the pilot vacuum pressure applied to the "R" reference port. The EVR vacuum regulator will control the vacuum pressure on its inlet port in a precise 1 to 1 relationship with the vacuum pressure applied to the pilot port (also called pilot or dome). The pilot vacuum pressure may be applied with a mechanical knob adjusted vacuum regulator or with an electronic vacuum pressure regulator, see **Fig. 1**.

The Equilibar EVR uses a flexible membrane diaphragm to both sense the vacuum pressure and to provide a direct seal against the orifices in the regulator body. The pilot vacuum pressure is applied to one side of the diaphragm. The Inlet "I" port vacuum pressure is sensed on the other side of the diaphragm. When the pilot vacuum is closer to atmospheric pressure than the vacuum on the Inlet port then the diaphragm is pushed firmly against the orifices to form a seal and the regulator is effectively closed. When the inlet vacuum pressure just equals the pilot pressure, the closing forces are removed from the diaphragm and media can begin to pass from the Inlet to the Outlet port. When sufficient media has passed through the regulator, the Inlet vacuum will be reduced slightly, and the diaphragm is allowed to seal against the orifices again. In normal practice equilibrium is achieved and the diaphragm modulates into a position where just enough flow is allowed out of the regulator in order to maintain a steady controlled vacuum on the inlet port, see **Fig 2**.

Typical Circuits: Vacuum valves are used to control vacuum pressure in a vacuum distiller as various reactants are fractionally removed. The reaction process, the inward flow of the added reactants, and temperature rise in the vessel all act to increase the vessel pressure. The EVR maintains the vacuum at the desired set point by venting any media which would otherwise cause the pressure to increase. The multiple parallel orifice design of the EVR allows liquid condensates to be extracted without causing fluctuations in the controlled vacuum, see **Fig 3**.

An Equilibar EVR may be used to precisely control the vacuum pressure surrounding a plastic extrusion. Immediately after the extrusion exits the die, it remains in a soft and formable state until it cools sufficiently. During this cooling phase the pressure on the inside of the tubing must remain higher than the pressure on the outside of the tubing to prevent the extrusion from collapsing. The EVR allows the vacuum pressure to be fine-tuned so that the pressure differential is optimized to maintain the extrusion wall thickness and overall dimensions, see **Fig 4.**

EVR-BD Series in Stainless Steel with standard vacuum pilot regulator

2 SET-POINT OPTIONS

Fig. 1

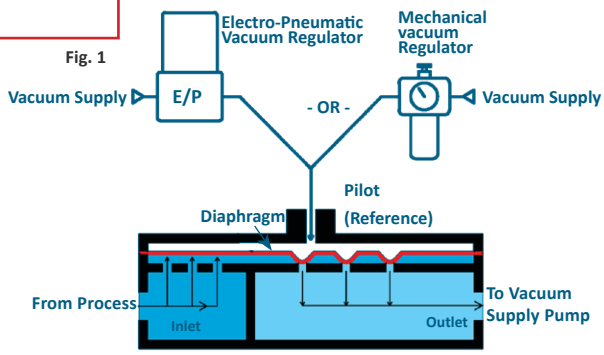


Fig. 2

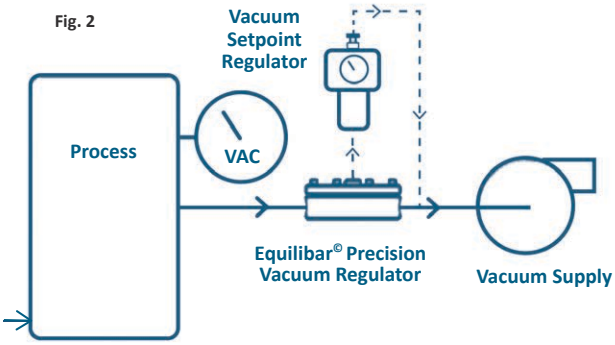


Fig. 3

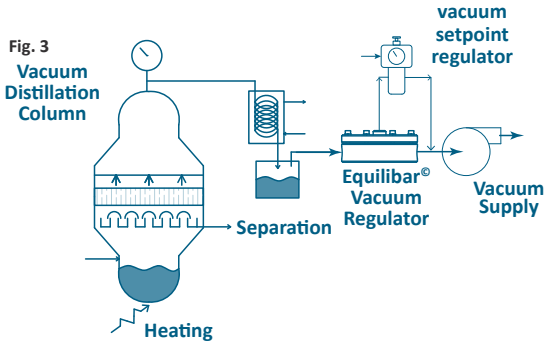
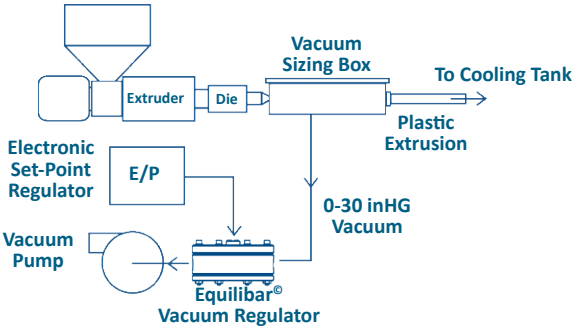


Fig. 4



EVR Series Precision Vacuum Regulator

PREPARING FOR INSTALLATION

NOTE: Equilibar has trained engineers who can work with you to suggest a vacuum regulator design, including wetted materials and pilot regulator for your specific application. These suggestions are recommendations only and are dependent on complete and accurate information from the end-user about the application.

It is the ultimate responsibility of the end-user to determine the compatibility of the media with the materials of construction of the vacuum regulator and the pilot regulator. Equilibar vacuum pilot regulators (EVPs) and fittings are not compatible with corrosive chemicals. Wetted parts are polyethylene. If the process fluid contains corrosive gases, we recommend installing a check valve in the line from the EVP to the vacuum supply pump as described on the safety page of our website.

The diaphragm installed in the Equilibar® EVR is a careful balance between the pressure, temperature, media compatibility, and flow rate. Performance in one area may be sacrificed to obtain acceptable performance in another.

The EVR is intended for processes where at least a **very small gas flow** is present at all times. If your process is gas-tight, an Equilibar application engineer can discuss easy methods of providing a small gas bleed in the process.

- Inspect the EVR for any damage. Consult Equilibar before proceeding if you find any damage.
- Verify that the part number on the EVR product label matches what you had requested
- Verify that the rating on the EVR label for maximum allowable working pressure (MAWP) and maximum allowable working temperature (MAWT) will not be exceeded when the EVR is used.
- Verify the system process fluid will not exceed the MAWP and MAWT of the pilot regulator.
- Call, write, or e-mail Equilibar if you have any questions, concerns, or need a new copy of these instructions. Be sure to include the full part number and serial number of the EVR you are inquiring about. (Phone +1-828-650-6590 or email info@equilibar.com)
- Take precautions to prevent injury to personnel in the event of a diaphragm failure or external leak. Sensitive fluid controls can experience internal or external leaks. See standard terms and conditions for important limitations of liability notes.
- Diaphragms may fail in the open or closed position. Proper safety precautions should be taken for either failure mode.
- The EVR is not orientation sensitive and may be mounted in any plane and maintain good vacuum control. Media draining or other considerations may need to be taken in to account by your specific application requirements.
- The ports in the EVR series that are plugged with pipe plugs are for machining operations during the manufacturing process. They are common with the outlet “O” vent port. These ports may be used to conveniently connect the vacuum supply to the pilot regulator.
- Every Equilibar regulator is individually hand tested at the factory for operation and external leakage. Leak testing is performed at 1.5X the MAWP. Typically this is 1.5 X standard atmospheric pressure, or 1.5 Bar gauge pressure.
- Equilibar regulators are cleaned internally and externally at the factory using aqueous based cleaners in an ultrasonic cleaner and manual wipe down with denatured alcohol.
- A small amount of DuPont Krytox lubricant is occasionally used on the internal non-wetted O-ring.
- Inlet ports are stamped with an “I” as shown. Outlet ports are stamped with an “O”.
- Many Equilibar diaphragms are manufactured with a small tab of protruding material. This is nonfunctional and is included only to allow easy inspection of the diaphragm material and thickness without the need to disassemble the regulator.
- The inlet “I” port is connected to the point in the system where it is desirable to maintain or control the pressure. The best pressure control will be seen if the plumbing to the EVR inlet port is as short and as large as practical to minimize the amount of pressure drop in the plumbing.
- Tapered pipe thread inlet/outlet port connections will require the addition of a sealant. PTFE tape may be used if it is compatible with your process and media. Take care not to let the PTFE tape extend past the first two male threads to prevent the PTFE tape from being ingested by the regulator. Tape or other debris can prevent the EVR from closing tightly and therefore not able to maintain the vacuum pressure at low flow rates. PTFE based pipe dope or an anaerobic “Loctite” product may also be used. Confirm the thread sealant used is compatible with your process, temperature, and media. Note: Do not use anaerobic sealants on the port connections made to the black pilot regulator. Anaerobic sealants will attack and damage the plastic that the black regulator is made from.
- Install a strainer or filter upstream of the EVR where necessary to prevent plugging of the orifices. Recommended 100 micron/100 mesh or better.
- System media will be vented out the EVR outlet “O” vent port, also called an exhaust port. Be sure that the media is vented to a safe environment, away from employees, and in accordance with applicable laws in your jurisdiction.
- Even inert gasses can cause suffocation through oxygen displacement. Take care to ensure that adequate ventilation and oxygen levels will be maintained.
- Provide adequate exhaust line capacity. Short or oversized exhaust lines are recommended.
- The Equilibar EVR is not a “Safety Accessory” as defined by the Pressure Equipment Directive 2014/68/EU. Be sure to install appropriate over and/or under pressure protection devices such as safety relief valves, vacuum relief valves, or rupture discs to protect the system and the EVR from exceeding the maximum allowable working pressures and to protect the system from excessive vacuum that could collapse tanks, vessels, or plumbing. These safety devices must meet applicable law, codes, regulations, and standards for your jurisdiction. All EVR regulators are rated to withstand full vacuum without damage.
- Any bolt, screw, or connector that is threaded into a stainless steel body should have some small amount of lubricant to prevent thread galling. Threads galling together is usually permanent and causes the regulator to be scrapped. The Equilibar factory applies engineering-approved lubricant to all bolt and screw thread connections that are not wetted by the process fluid.
- The flow through the Equilibar vacuum pilot regulator (EVP) is from atmosphere to the vacuum pump, so no process gases are entering the EVP in normal operation. (There is always a slight bleed through the EVP). If the process fluid contains corrosive gases, we recommend installing a check valve in the line from the EVP to the vacuum supply pump to prevent corrosion in the pilot. Note, the check valve will limit the control range of the EVR due to the dP across it to open. Selecting a check valve with minimal opening dP will minimize this effect. For more information, visit https://www.equilibar.com/equilibar-safety-information/
- Exercise caution when adjusting the pilot pressure. The EVR will attempt to adjust the inlet vacuum pressure at the same rate that the pilot vacuum pressure is being adjusted. This can result in extremely rapid release of media through the outlet (O) port of the regulator. Adjust the pilot pressure as slowly as practical.
- The EVR is designed to have maximum pilot pressure applied even when there is no pressurized media at the inlet (I) port. No damage will result.
- The EVR is designed, manufactured, and tested in accordance with sound engineering practices and the European Community Pressure Equipment Directive 2014/68/EU (the PED). Because the EVR series is used only at pressures less than 0.5 Bar gauge (above atmosphere) the PED does not apply and no specific PED Declaration of Conformity is issued for the EVR Series.

Installing EVR Series Vacuum Regulator

INSTALLATION OF EVR WITH MANUAL PILOT SETPOINT REGULATOR*

1. Attach the inlet "I" of the Equilibar® Vacuum Regulator (EVR) to the point in the system where the vacuum needs to be regulated.
2. Attach the outlet "O" of the EVR to your vacuum supply.
3. Attach the manual pilot regulator to the reference (pilot) port on the top of the EVR.
4. If your manual pilot regulator is BLACK: connect the side labelled OUTPUT to the reference port of the EVR such that the arrow on the unit is pointing away from the reference port. The port labelled IN will be connected to your vacuum supply. Note: Do not use anaerobic sealants on the port connections made to the black pilot regulator. Anaerobic sealants will attack and damage the plastic that the black regulator is made from.
   - If your manual pilot regulator is WHITE: connect the side labelled SET to the reference port of the EVR. The port labelled VAC will be connected to your vacuum supply.
5. Attach the manual pilot regulator to the EVR vacuum supply port:
   - On EVRs which have PIPE ELBOWS, the vacuum supply port is a 1/8" NPT port located on the bottom of the unit between the elbows.
   - On EVRs which DO NOT have pipe elbows, the vacuum supply ports are located between the ports labelled INLET and OUTLET. These supply ports are the same size as the inlet and outlet ports and are NPT threads.
6. Adjust the vacuum pressure on the manual setpoint regulator to set the desired vacuum setpoint of the EVR.

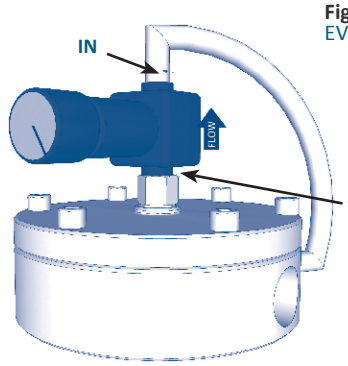


Fig. 5
EVR-GSD with black Manual pilot Regulator*

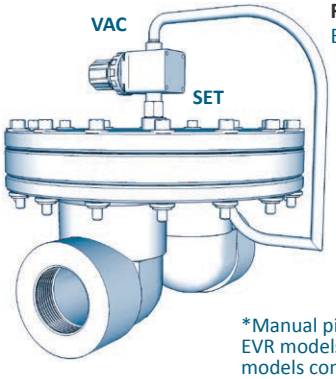


Fig. 6
EVR-BD with white Manual pilot Regulator*

*Manual pilot regulator is standard with order. Smaller EVR models come with black pilot regulators. Large EVR models come with white pilot regulators.

INSTALLATION OF EVR WITH AN ELECTRONIC PILOT SETPOINT REGULATOR

The EVR comes standard with a manual vacuum pilot regulator. If you wish to automate the process, an electronic vacuum pilot regulator can be ordered separately. The manual pilot can be used for initial setup and troubleshooting of your vacuum process, then the electronic pilot regulator can be installed knowing that the system is working properly. Contact Equilibar with questions or to discuss options. The following instructions apply to installation of an Equilibar EPC or QPV electronic vacuum regulator.

you may refer to our youtube video for instructions

1. Attach the Inlet "I" of the EVR to the point in the system where the vacuum needs to be regulated.
2. Attach the Outlet "O" of the EVR to your vacuum supply.
3. Attach a line from the port labelled OUT on the Equilibar QPV or EPC Electronic Regulator to the reference pilot port on the top of the EVR.
4. Attach a line from the "E" exhaust port of the EPC or QPV to the vacuum supply port on the EVR.
   - On EVRs which have PIPE ELBOWS, the vacuum supply port is a 1/8" NPT port located on the bottom of the unit between the elbows.
   - On EVRs which DO NOT have pipe elbows, the vacuum supply ports are located between the ports labelled INLET and OUTLET. These supply ports are the same size as the inlet and outlet ports and are NPT threads.
5. Leave the port labelled IN on the EPC or QPV open to atmosphere. A screen or filter is recommended.
6. Connect the leads from the power cord to the correct terminals in your PLC per the instructions with the electronic pilot regulator.
7. Connect the power cord to the electronic pressure regulator.
8. Adjust the pressure on the electronic pilot regulator using a 0-10V or 4-20 mA signal (depending on your unit) to set desired vacuum setpoint for the EVR.

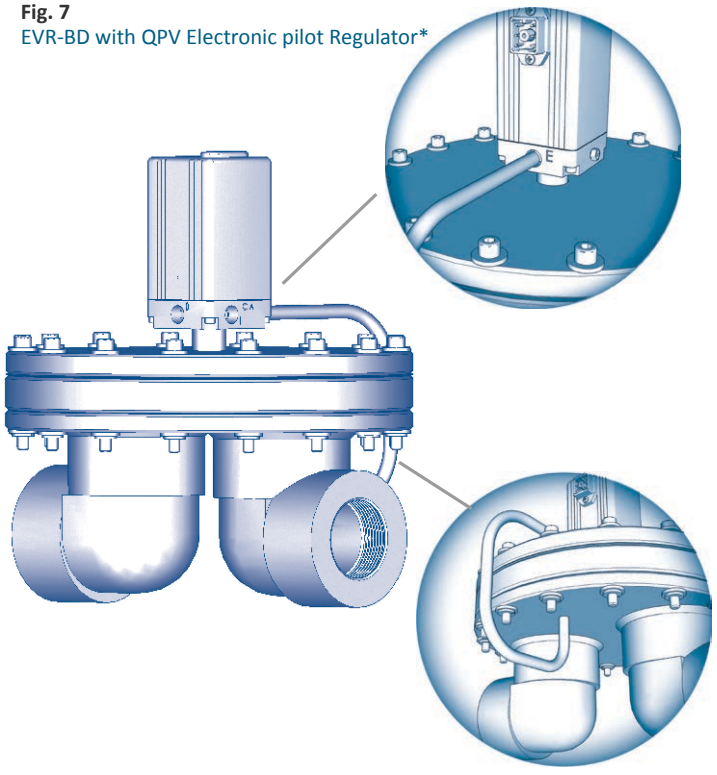


Fig. 7
EVR-BD with QPV Electronic pilot Regulator*

INSTALLATION OF EVR WITH RSV REMOTE SENSE VACUUM PILOT

The EVR comes standard with a manual vacuum pilot regulator. If you wish to run the process in remote sense mode, we recommend using at Equilibar Remote Sense Vacuum (RSV) pilot regulator which is ordered separately. If you ordered the RSV pilot with your EVR, you will receive the standard manual vacuum pilot (SVP) in addition to the RSV. The SVP is a simple robust installation and is included to help with startup or later troubleshooting. An Equilibar SVP can be used to test whether the design concept will work, that adequate vacuum supply is available, that line sizes are sufficiently large, etc. If an EVR works properly with the SVP, then the RSV can be installed knowing the vacuum system works. Any issues occurring after the installation of an RSV are then isolated to the RSV. Please contact Equilibar with any questions.

The RSV is a highly sensitive mechanical vacuum pilot regulator that provides closed-loop control of the Equilibar Vacuum Regulator (EVR).

Both regulators work together to control the vacuum at the location sensed by the remote sense port on the RSV.

The schematic in Fig. 8 shows how the RSV works together with the EVR.

- The control vacuum is shown in blue.
- The vacuum supply is shown in red
- The pilot pressure supplied to control the EVR is shown in purple.

1. Connect the Vacuum Supply (**VS**) Port of the RSV to the strongest vacuum in the system. Most EVRs have a small fitting on the bottom (BD Series) or side (GS Series) that can be conveniently used to connect the vacuum supply for the pilot regulator (shown in Fig. 5 & 6 on page 3). Or VS can be connected to any strong vacuum source that you have available.
2. Connect the Pilot Port (**P**) of the RSV to the reference or top port of the EVR. **Note:** For optimal performance, use a length of tubing to provide 16.5 cu in (170cc) of volume between the RSV "**P**" port and the EVR reference port.
3. Connect the Remote Sense Port (**RS**) to the portion of your process that you would like to be controlled. This can be right at the EVR inlet or closer to the process. Equilibar vacuum regulator assemblies may come with a "Tee" or other fitting for easy assembly with the RSV. See sample schematics in Fig. 10, 11, 12 and 13.

   Note: The RSV is shown mounted directly to the EVR reference port in the schematic, but for optimal performance, use a length of tubing to provide 16.5 cu in (170cc) of volume between the RSV pilot "**P**" port and the EVR reference port.
4. There is a "bleed" port (**B**) that senses the atmospheric pressure and where a small amount of air is ingested (goes to vacuum supply). This port has a preinstalled filter. It is labeled "atmospheric bleed" in Fig. 9. Nothing else needs to be done to this port.

Other notes:

- Other than the tubing between the RSV and the EVR reference port, keep all tubing lengths to a minimum practical length and use tubing with an outer diameter of at least 3/8" or 10mm.
- The RSV is shown to sense directly at the inlet of the port in Fig. 10 and Fig. 12. Users can install the sensing line closer to the point of control for higher precision.

Fig. 8
RSV operating schematic

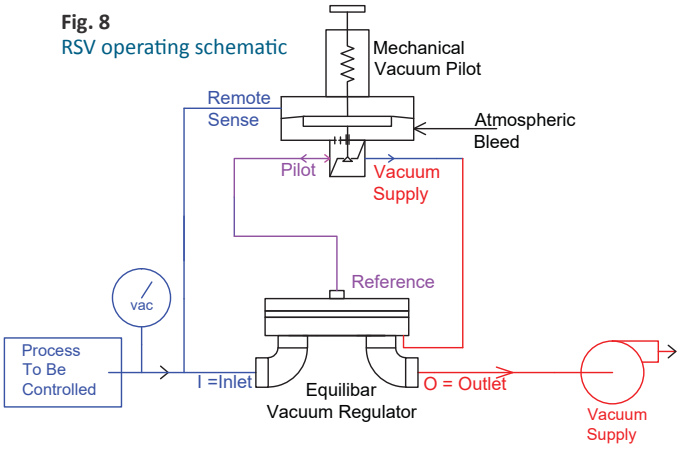


Fig. 9
RSV port configuration

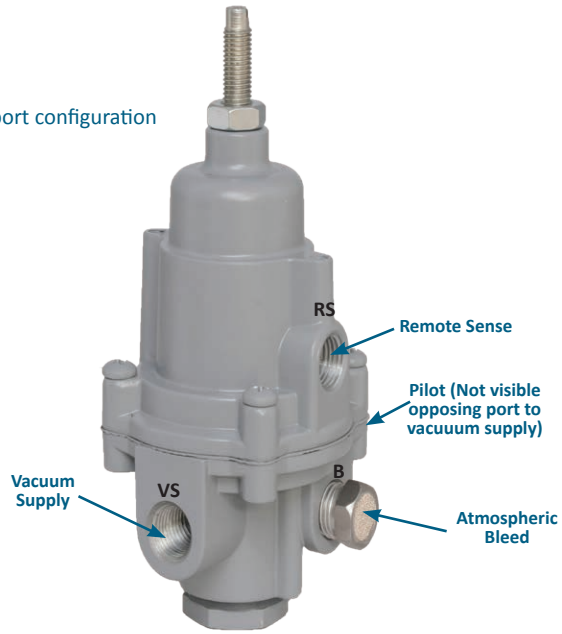


Fig. 10
EVR-GSD assembly with RSV pilot

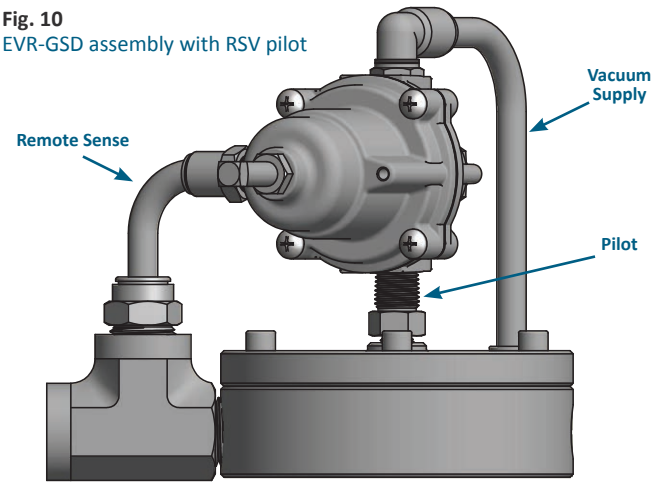


Fig. 11
Exploded View EVR-GSD assembly
with RSV pilot

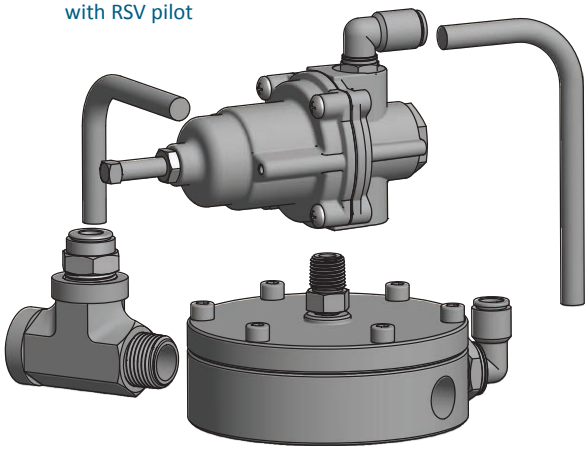


Fig. 12
EVR-BD assembly with RSV pilot

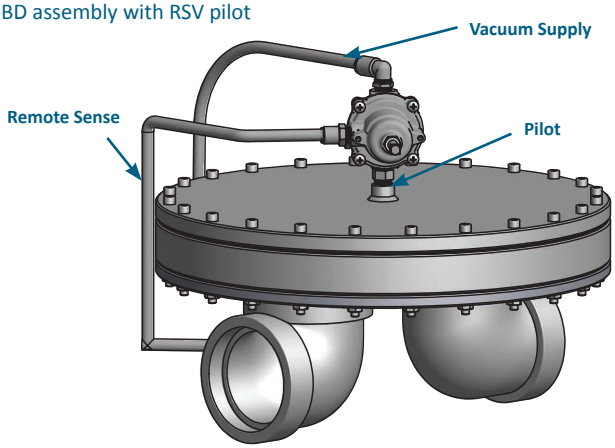
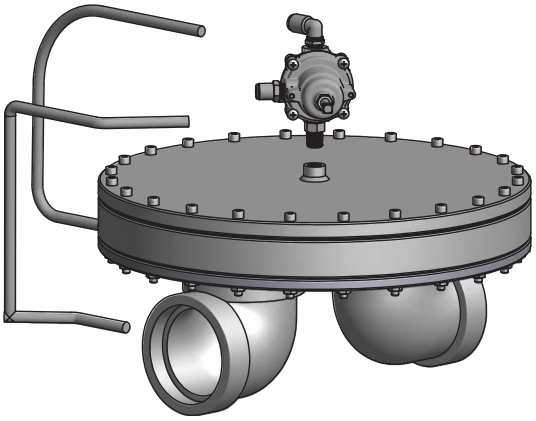


Fig. 13
Exploded View EVR-GSD assembly with RSV pilot



HOW TO ADJUST THE RSV PILOT

Once installed per the instructions below, the RSV Pilot can be adjusted by simply turning the adjusting screw on the top of the unit. Turning clockwise will increase the vacuum set-point (lower the pressure). Turning counter-clockwise will lower the vacuum set-point (increase the pressure).

DISASSEMBLY / CLEANING

To maintain or clean the RSV regulator,

1. Remove each of the 4 main screws
2. Remove the top cap and diaphragm assembly
3. Remove the hex nut on the bottom of the regulator
4. Clean out any dust or debris
5. Note that there is a small precision bleed orifice under the diaphragm. Check to make sure that it is not blocked.

RE-ASSEMBLY

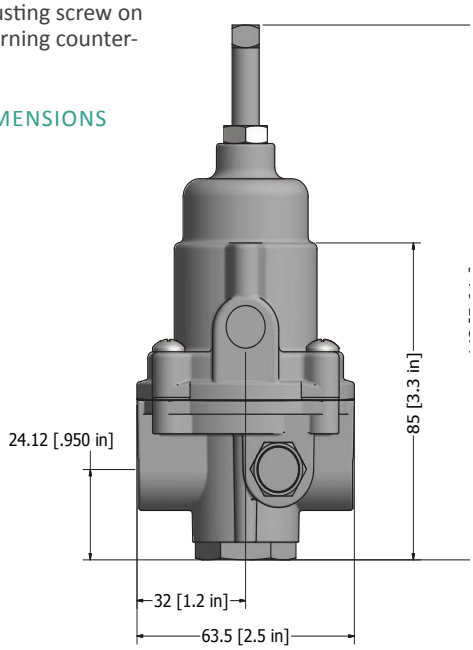
To maintain or clean the RSV regulator,

1. Remove each of the 4 main screws
2. Remove the top cap and diaphragm assembly
3. Remove the hex nut on the bottom of the regulator
4. Clean out any dust or debris
5. Note that there is a small precision bleed orifice under the diaphragm. Check to make sure that it is not blocked.

TROUBLESHOOTING RSV

If the unit fails to perform, contact factory engineers to review system installation.

RSV PILOT DIMENSIONS



EVR-GSD4 with remote sense vacuum pilot regulator and adjustment knob cap.

EVR Series Precision Vacuum Regulator Maintenance

ADDITIONAL INSTALLATION NOTES

TIPS WHEN USING PVC EVR MODELS

Equilibar recommends using a suitable thread sealant on pipe threads of gray plastic PVC models and that users take caution not to over torque fittings into PVC EVR bodies. Excess torque can result in damage or cracking of the plastic EVR. Industry standard recommendation is about 1/4 turn past hand tight.

RATED PRESSURE NOTE

Equilibar regulator bodies have a Shell pressure rating based on the body and bolt strength using principles of the ASME B31.3 and confirmed using hydrostatic testing. These Shell pressure ratings are the maximum rating for each design as listed in the technical brochures. For example, BD16 in SS316L (BD16S) is listed with a maximum pressure rating of 70 psig.

Equilibar configures individual regulators to the specific customer application which may involve fitting the valve with a thinner diaphragm to meet precision or low-flow requirements. The diaphragm selection, operating temperature, chemical composition or other factors cause pressure derating. Therefore, the MAWP printed on an Equilibar BPR label reflects that of the selected diaphragm and application conditions but will not exceed the Shell pressure rating of the body design. For EVR models, the MAWP is expressed in vacuum units.

The maximum pressure rating for the shell is always based on the body and bolt strength and is not printed on the product label. Customers may contact Equilibar engineers if they desire to increase unit MAWP by upgrading diaphragm thickness.

INITIAL DIAPHRAGM SETTING

Equilibar recommends an initial setting of polymer and rubber diaphragms up to 1.5X of application operating pressure. This is achieved by applying pressure to the reference port of the Equilibar. This setting of the diaphragm can help the diaphragm preform at lower flow rates. For metal diaphragms Equilibar does not recommend applying a set pressure higher than 1X of operating pressure for best performance. The unit is designed to withstand full differential pressure of rated pressure from reference/pilot to process pressure.

REFERENCE PRESSURE AND PRESSURE TESTING

Equilibar recommends that reference pressure always be applied when pressurizing the process (inlet and outlet) ports of the Equilibar, such as in the case of pressure testing a system that has an Equilibar BPR installed. This helps prevent the diaphragm from lifting and deforming into the cap which can have a negative impact on performance of the diaphragm.

TROUBLESHOOTING

PROBLEM	POSSIBLE SOLUTIONS
Maximum flow is reduced	**The internal orifices may be blocked with debris. Inspect and remove as required. Maintain an upstream filter.**
Excessive vacuum is on the controlled port	**Many EVR diaphragm types cannot seal tightly and require a constant flow rate.** • Add a small bleed of suitable gas and continuously add gas to the EVR inlet port. • Ask an Equilibar engineer if a different diaphragm might be more suitable **Debris may be preventing the diaphragm from making an effective seal.** • Make sure all the outlet orifices under the diaphragm are clear and in good repair **The vacuum on the pilot port may be different than expected** • Install a vacuum pressure gauge in the line feeding the EVR pilot reference port. Make sure the pilot pressure regulator is functioning correctly.
Too little vacuum is on the controlled port	**Inadequate supply vacuum** • Install a vacuum pressure gauge in the vacuum supply line as near to the EVR as possible. The supply line for the pilot regulator is a good spot. • Verify that the supply vacuum is greater than the desired vacuum control pressure **EVR may be undersized** • Compare the pilot vacuum pressure (using a vacuum gauge) to the controlled vacuum pressure as near the EVR inlet port as possible • A large difference indicates an undersized EVR regulator • Confirm this by reducing the amount of system flow to the EVR. The EVR should resume normal operation with reduced flows.
No control over vacuum level	• Diaphragm may have ruptured; check and replace if necessary. This can be done by applying a small amount of positive pressure to the pilot port (less than 1 Bar/15 psig), trapping it, and observing any leak down rate. • Pilot regulator inlet and outlet might be reversed. Verify using the pilot connection procedure in this manual • Using a vacuum gauge as near the EVR outlet port as possible, verify that adequate supply vacuum is present • Using a vacuum pressure gauge, verify that the pilot vacuum pressure applied to the EVR pilot port is at the correct level

PATENTS

equilibar.com/support/patents/

EVR Series Precision Vacuum Regulator Maintenance

MAINTENANCE NOTES

- Maintain strainer or filter upstream of device.
- Annual inspection of diaphragm integrity is recommended, especially for applications where there is strong or regular pulsing.
- It is expected that O-rings and diaphragms will need to be replaced on a regular basis, the timing of which is dependent on the application.
- It is recommended to order spare parts prior to performing maintenance. The following replacement part kits are available for order:
  - RBK – Rebuild Kits – replacement parts for O-rings AND diaphragms
  - DI – Diaphragm Kit – replacement parts for diaphragms only
  - OR – O-ring Kit – replacement parts for the O-rings only
- Visit our maintenance website or contact us for more information.

ASSEMBLY INSTRUCTIONS: **EVR-BD TYPE UNITS**

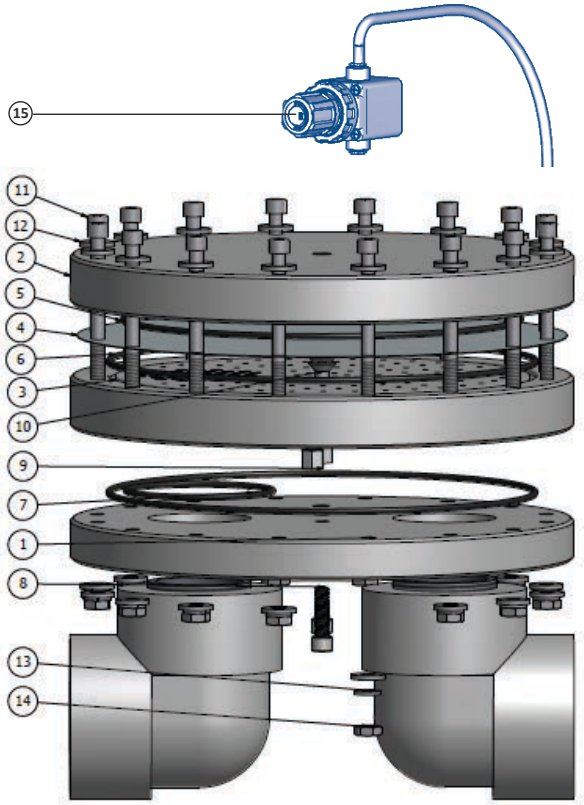
After you disassemble and complete annual cleaning and maintenance for the EVR-BD, follow these steps to reassemble.

1. [***This step is applicable to polymer units only***] Insert sealing screws (8) into the bottom plate (1) and tighten into hex couplings(9) on the opposite side of the bottom plate.
2. ***For all units:*** Insert two bolts(11) through the bolt holes in the top of the body (middle) plate(3) and invert the body such that the O-ring grooves are facing upward. Rest the body plate on the bolt heads.
3. Insert the two (one large, one small) body O-rings (7), into the body's O-ring grooves.
4. Invert the bottom plate(1) and place over the body plate(3), using the two large bolts(11) to align it. Make sure that the inlet port (marked with "I") is placed over the inner O-ring(7).
5. Firmly grip the body(3) and bottom plate(1) together and invert the unit.
6. [***This step is applicable to polymer units only***] Insert the socket hex bolts(1) into the two countersunk alignment holes in the center of the body(3) and screw into the couplings(9).
7. ***For all units:*** You can now remove the two large bolts(11) used to align the body(3) with the bottom plate(1) during steps 1-6.
8. Insert the remaining body O-ring(6) into the top of the body plate(3). *Some EVR-BD units may not include an upper body O-ring.*
9. Invert the reference cap(2) and insert four long bolts(11) and washers (12), if they are included, into the top of the reference cap.
10. Lightly lubricate the reference cap O-ring(5). This O-ring is not exposed to the process fluid and can be lubricated. Some EVR-BD units many not include a reference cap O-ring.
11. Inspect diaphragm for any damage. If damaged, do not install. Contact Equilibar. Lay the diaphragm(4) over the reference cap(2) and bolts(11), holding the O-ring(5) firmly in place.
12. Holding the reference cap(2) with a firm grip, invert it onto the body / bottom plates(3 &1), using the bolts to align.
13. Gently secure the reference cap bolts using the provided washers(12), lock washers(13) and nuts(14).
14. Add remaining bolts, washers, lock washers and nuts. Gently secure.
15. Tighten all bolts using a torque wrench, tightening in a star pattern (shown in **Fig**. 6 on p.5) to the recommended torque wrench settings.
16. If your rebuild kit contains a new label, be sure to apply it to the EVR body; The wetted materials or operating parameters may have changed.

Note: Gap between sections should be even, but will not disappear

17. Follow steps on p. 3 to attach the pilot regulator(15) to the EVR cap.

Fig. 14 Exploded view of EVR-BD in PVC



Recommended Torque Wrench Settings[1]

#10 or M5 bolts	45-55 in-lbf torque (6.2-7.3 N-m)
¼" or M6 bolts	65-77 in-lbf torque (7.3-8.7 N-m)
5/16" bolts	142-156 in-lbf torque (16-17.6 N-m)
Polymer Units	40-45 in-lbf torque (4.5-6.2 N-m)

*Consult factory for any models or bolts not listed here

[1]Recommended Torques for Lubricated screws

EVR Series Precision Vacuum Regulator Maintenance

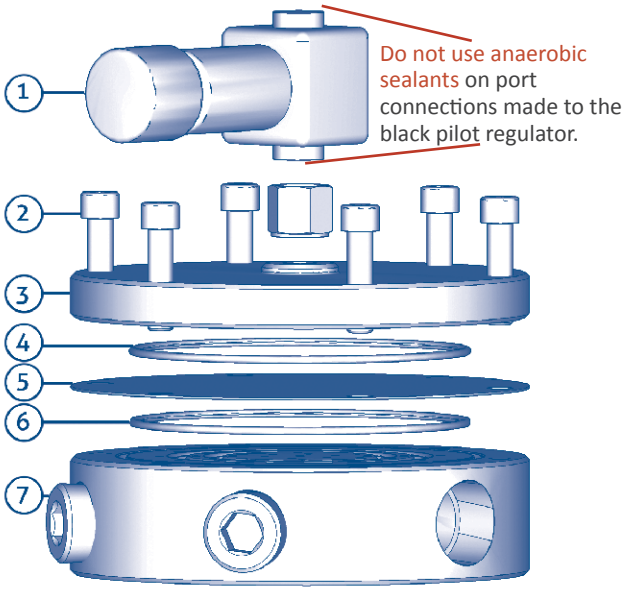
ASSEMBLY INSTRUCTIONS: **EVR-GSD TYPE UNITS**

After you disassemble and clean your EVR, follow these steps to reassemble. Refer to our rebuild youtube videos for more information.

1. Lay Reference Cap (3) upside down with every other cap screw (2) inserted
2. Carefully place O-ring (4) inside groove of Reference Cap*.
   *Some units may not have a Reference Cap O-Ring, in which case disregard.
3. Inspect diaphragm (5) for any damage. Replace if any question about condition.
4. Lay diaphragm (5) onto Reference Cap and center.
5. *Where Applicable, insert O-ring (6) into groove on body (7). If O-ring rests on inner groove wall, slight stretching of O-ring to rest on the outer wall is recommended. This is not required for crush seal designs.
6. Invert Body (7) onto diaphragm, aligning cap screws.
7. Lift up reference cap to meet body and hold assembly together while inverting to upright position. Take care not to let any O-rings to pop out of their groove.
8. Finger tighten all cap screws
9. Add remaining cap screws and finger tighten.
   Note: On metal units, cap screws will typically thread into the body(7). On Polymer units, cap screws will typically use a nut to secure in place.
10. Tighten all cap screws using a torque wrench at the recommended setting and tightening in a star pattern as shown in Fig. 16 below.
11. If your rebuild kit contains a new label, be sure to apply it to the EVR as the wetted materials or operating parameters may have changed.
12. Follow steps starting on p. 3 to attach the pilot regulator(1) to the EVR cap. Note: Do not use anaerobic sealants on the port connections made to the black pilot regulator. Anaerobic sealants will attack and damage the plastic that the black regulator is made from.

Note:
Gap between sections should be even, but will not disappear.

Fig. 15 Exploded view of EVR-GSD



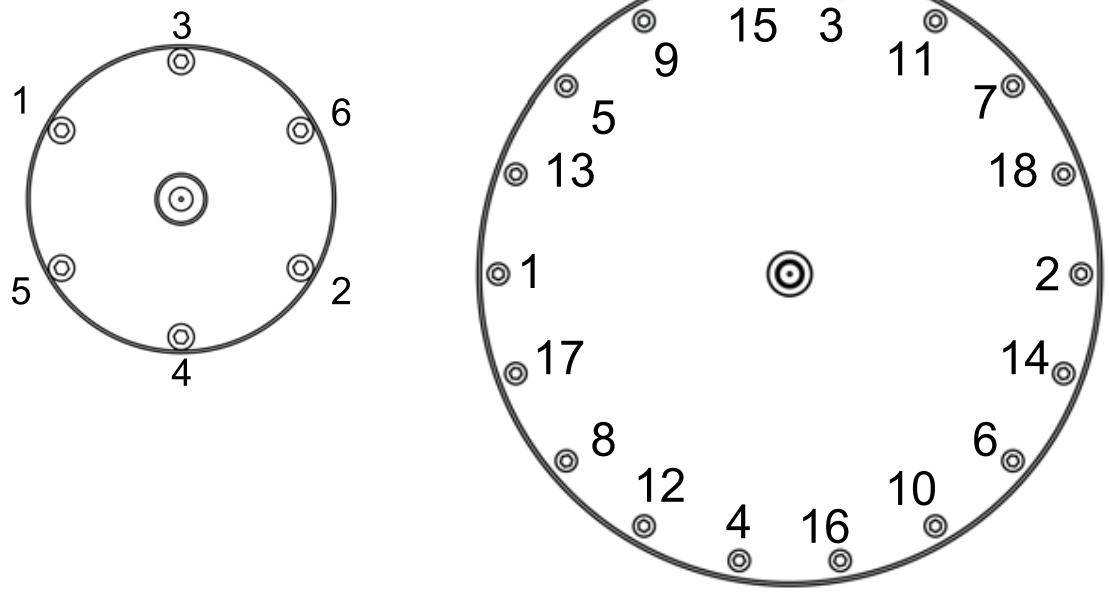
Recommended Torque Wrench Settings[1]

#10 or M5 cap screws	45-55 in-lbf torque (6.2-7.3 N-m)
¼" or M6 cap screws	65-77 in-lbf torque (7.3-8.7 N-m)
5/16" cap screws	142-156 in-lbf torque (16-17.6 N-m)
Polymer Units	40-45 in-lbf torque (4.5-6.2 N-m)

*Consult factory for any models or cap screws not listed here

[1]Recommended Torques for Lubricated screws
*See Rebuilding an Equilibar Back Pressure Regulator videos:
www.equilibar.com/support/maintenance-spare-parts-rebuild-instructions/

Fig. 16 Sample Torque Patterns



Equilibar's quality system is **ISO 9001:2015** certified.

Made in the USA

EVR Series Precision Vacuum Regulator

SYSTEM HAZARD ANALYSIS

Both normal operation as well as possible failure modes and foreseeable misuse must be accounted for in the design of the system which interacts with and connects to the Equilibar back pressure regulator (BPR). It is the responsibility of the end user to account for these hazards. **Please read all of the following safety and hazard precautions before installing or operating any equipment.**

A. The EVR is not certified as or marketed as a pressure vessel safety relief valve. The EVR is a precision control valve. Guarding against overpressure or underpressure must be achieved with devices designed and marketed as such.

B. Sensitive diaphragms and external seals can leak. It is the responsibility of the end user to use this product in a way that prevents injury to personnel should leakage occur. See Standard Terms and Conditions for important Limitation of Liability notes.

C. If the internal diaphragm ruptures or leaks, the gas or fluid on the pilot port can be introduced into the process fluid. Make sure that the fluids are compatible and not hazardous when mixed.

D. If the internal diaphragm ruptures or leaks, process fluid can enter the pilot port plumbing.

i. Make sure that the process fluids and the pilot are compatible and not hazardous when mixed. Most auxiliary pressure regulators used to provide pilot pressure to the EVR are of the self-relieving design. Guard against the process fluid relieving out the vacuum pilot regulator if the EVR diaphragm fails. One method to accomplish this is to set the pilot pressure into a static volume chamber that is sealed with an ON/OFF valve after the vacuum pressure is set to the desired value. In order that the pilot pressure to the EVR can be reduced, most pilot regulators incorporate an internal bleed to atmosphere. This bleed port does introduce atmospheric air into the output "O" port and the vacuum supply line. If atmospheric air cannot be tolerated in the vacuum supply line please contact Equilibar® for alternate methods.

ii. If an electronic pressure regulator is used then special consideration must be made. In addition to reviewing the prospect of having the process media coming in contact with and venting out of the electronic vacuum pilot regulator, the possibility of ignition of the media by the electronic pressure regulator must be examined. It is the user's responsibility to determine if a hazardous area classification exists and to make sure that the electronic vacuum pilot regulator employed meets or exceeds the requirements of intrinsic safety for that area.

E. If the internal diaphragm ruptures or leaks the result is often that the EVR will fail into a closed position. This results in a blocked pipe with no path for the fluid to escape through the EVR. Over pressurization of the upstream can occur. Steps must be taken to ensure that the upstream piping is made sufficiently strong to withstand this or is guarded by an overpressure
relief device.

F. Make sure the process vacuum pressure to be controlled is connected to the EVR "I" Inlet port. Process fluid flow is from "I" Inlet to the "O" Outlet. If the EVR is connected in reverse it may still operate but it will give poor control and can result in excess pressures.

G. Observe the maximum temperature and pressure ratings on the EVR label. Take steps to ensure these values cannot be exceeded. Where necessary to protect equipment, a suitable type of safety overpressure and/or vacuum relief valve must be connected in parallel to the EVR. The overpressure relief valve must be rated to prevent the pressure or temperature from exceeding the EVR maximums as listed on the EVR label.

In some installations a rupture disc may be substituted for the safety relief valve.

H. If the discharge piping on the EVR "O" Outlet port becomes blocked, the EVR will open and fill the discharge piping to the same pressure as the maximum pressure in the system. The discharge piping must be rated to contain this pressure or have a safety relief valve to limit this pressure at or below the safe pressure of the discharge piping.

I. Do not use the EVR as a structural member. All piping and plumbing connections to the EVR should be adequately supported. The EVR series is available with a mounting bracket to facilitate the installation.

J. Enriched oxygen media (>21%) should not be used in the EVR unless Equilibar® has specifically worked with you to provide a product rated and labelled for enriched oxygen. Standard products are not oxygen cleaned. Particle impact, adiabatic compression, and diaphragm motion can all cause ignition in an enriched oxygen media. This kindling chain can cause the entire EVR to oxidize extremely rapidly resulting in high temperatures, discharge of flames and molten metal, and unrestrained escape of process fluid.

K. The metal cap and body of the EVR are excellent conductors of heat.

i. Assume the external temperature of the EVR will rise or fall to match the temperature of the process media flowing through it. In addition to thermal hazards posed to humans by directly touching the EVR exterior, it is the duty of the end user to verify that the temperatures of the process media do not exceed the ignition temperatures of any combustible gases or dust (or mixture) that may be present local to the EVR.

ii. Assume the internal temperature of the EVR will rise or fall to match the temperature of the ambient environment. Ensure that the process media flowing through the EVR cannot be damaged or ignited by the maximum and minimum ambient environment temperatures. Low ambient temperatures can cause the media within the regulator to freeze. Expansion cooling in certain gasses can also cause freezing. Freezing can block the EVR and cause excess pressures to build on the "I", Inlet, port. Expansion of water due to freezing can damage the regulator. Ice formation from freezing can perforate metallic foil diaphragms.

M. The EVR has been carefully designed by skilled engineers to provide proper safety ratios and adequate pressure regulation. Do not attempt to modify the EVR in any way, including adding or enlarging orifices or ports or replacing machine screws or bolts. Only replace the internal O-rings or diaphragms with Equilibar® factory provided repair parts.

N. Never perform maintenance or inspections on a system when pressurized fluids are present. De pressurize the system before performing this work. De-pressurize inlet pressure before the reference pressure, otherwise a quick drop in reference pressure can lead to a violent exhaust of the upstream pressure through the regulator.