

Pilot Operated Pressure Relief Valves (POPRV)

**October 2020 Chief Inspectors Meeting
Prepared by: J. F. Ball**



Objectives

- **Definition/ Manufacturers**
- **Basic Operation**
- **Flowing Pilot vs Non-Flowing Pilot**
- **Snap / Pop Action Pilot**
- **Modulating Pilot**
- **ASME Code Status**
- **Applications**
- **Features/Benefits (and Concerns)**
- **Code Updates**
- **Options**

Definition

(PTC-25)

- *pilot-operated PRV*: a pressure relief valve in which the disk is held closed by system pressure, and the holding pressure is controlled by a pilot valve actuated by system pressure.

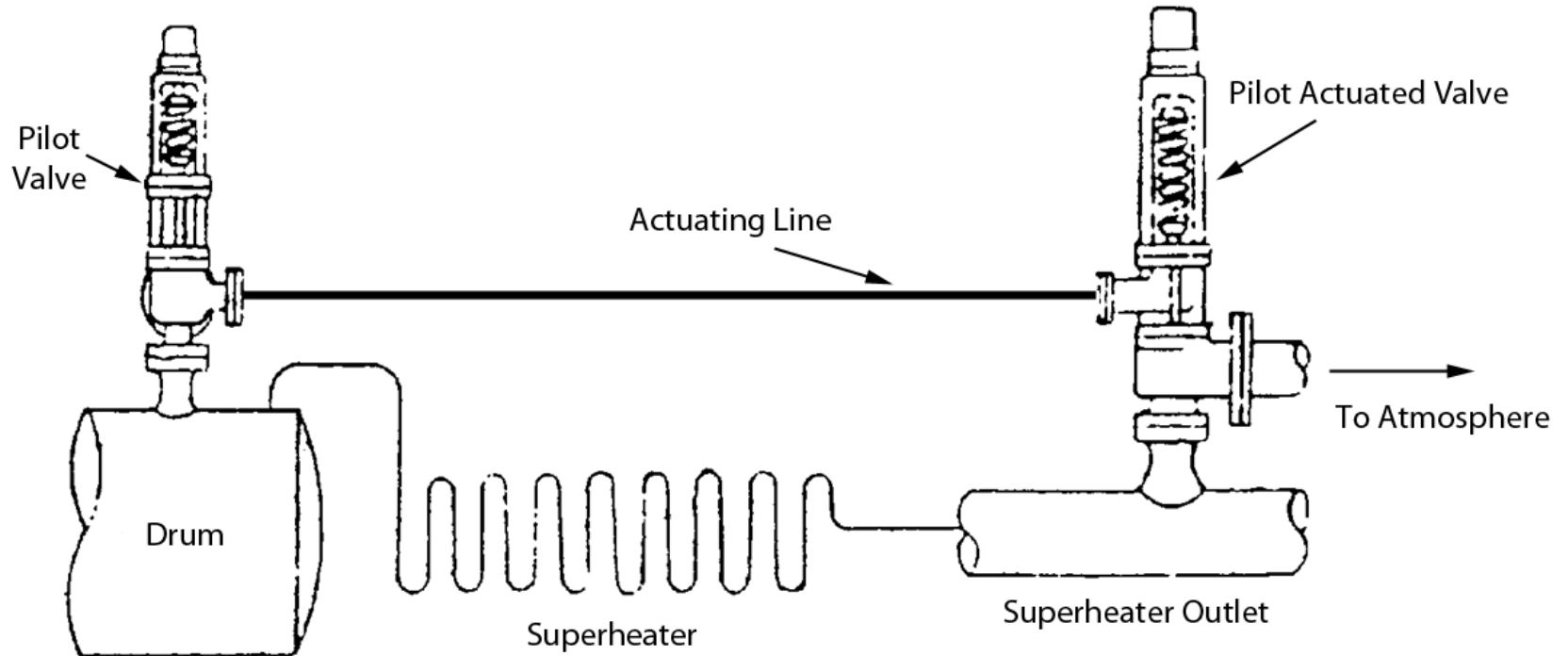


Manufacturers

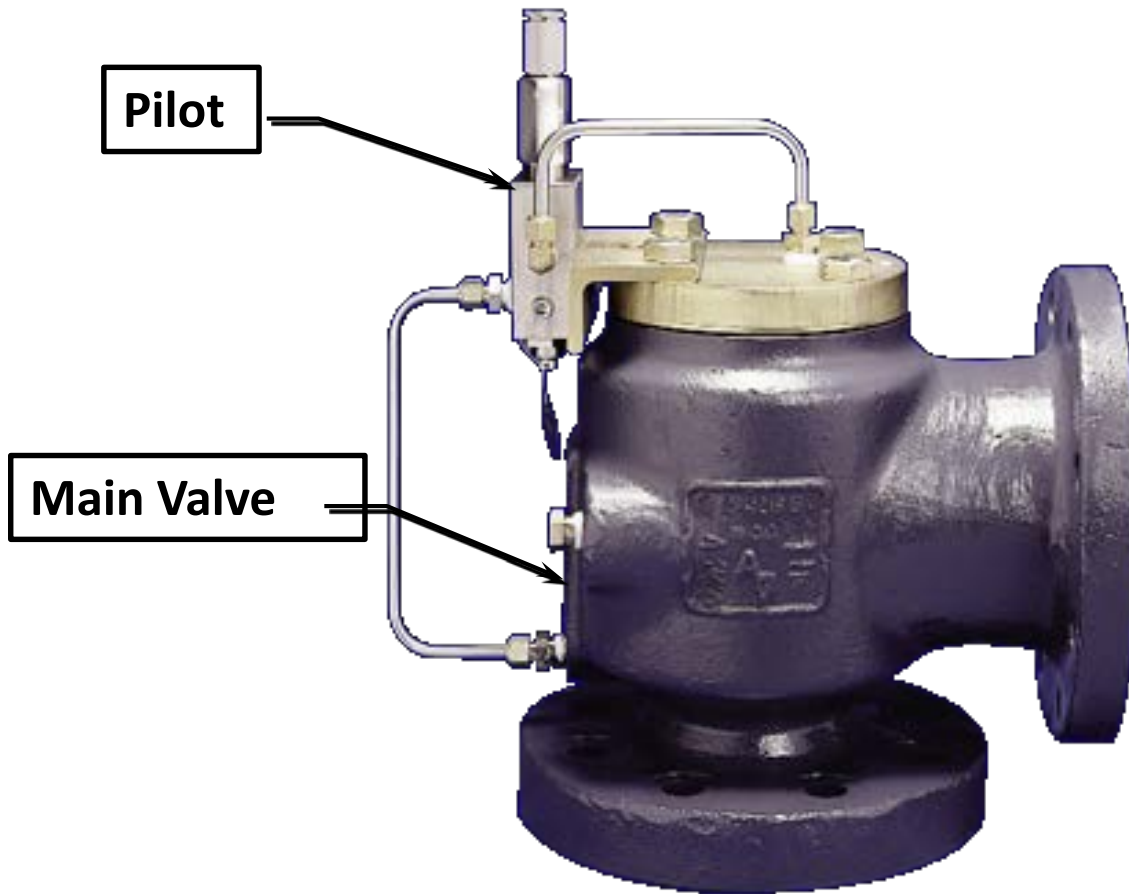


Anderson Greenwood
Dresser
Farris
Target Rock (nuclear)
Mercer
Taylor Valve
Leser
Apparecchi
Weir Power

Early Pilot Valve Usage



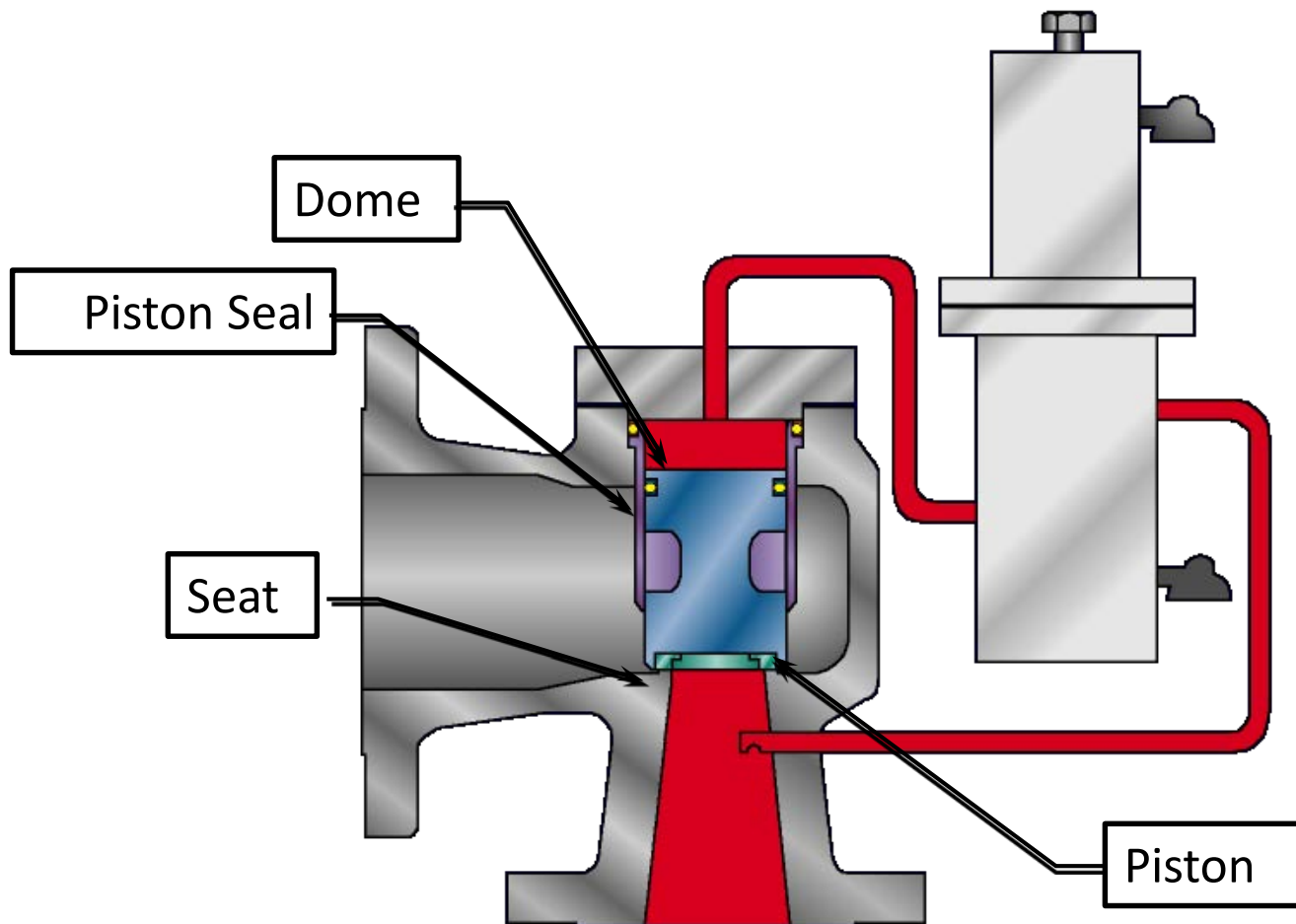
Basic Operation



The Pilot controls the Main Valve action of:

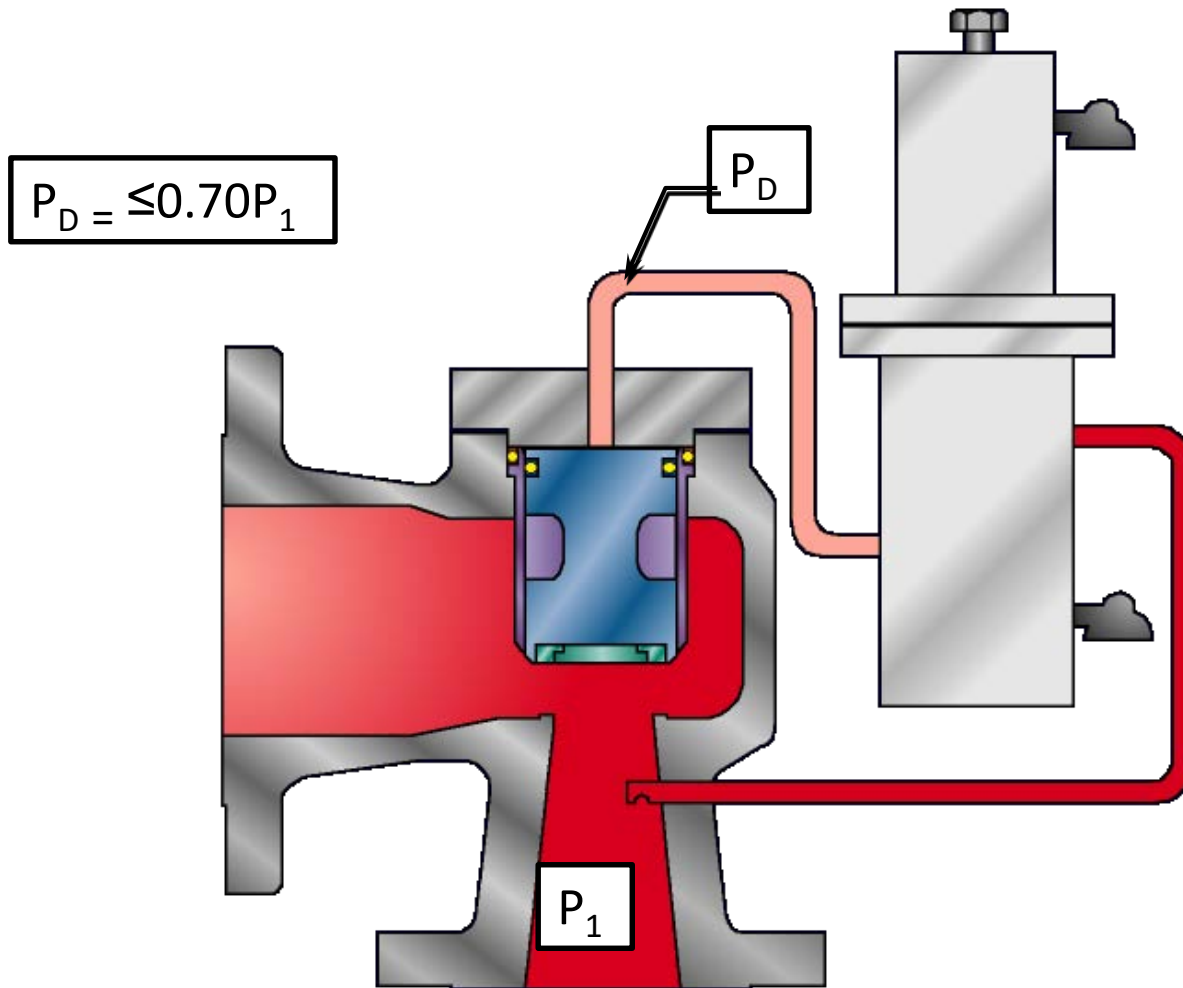
- **Opening Pressure**
- **Closing Pressure**
- **Style Of Action**

Basic Operation



Below set pressure, force imbalance due to differential area keeps main valve closed

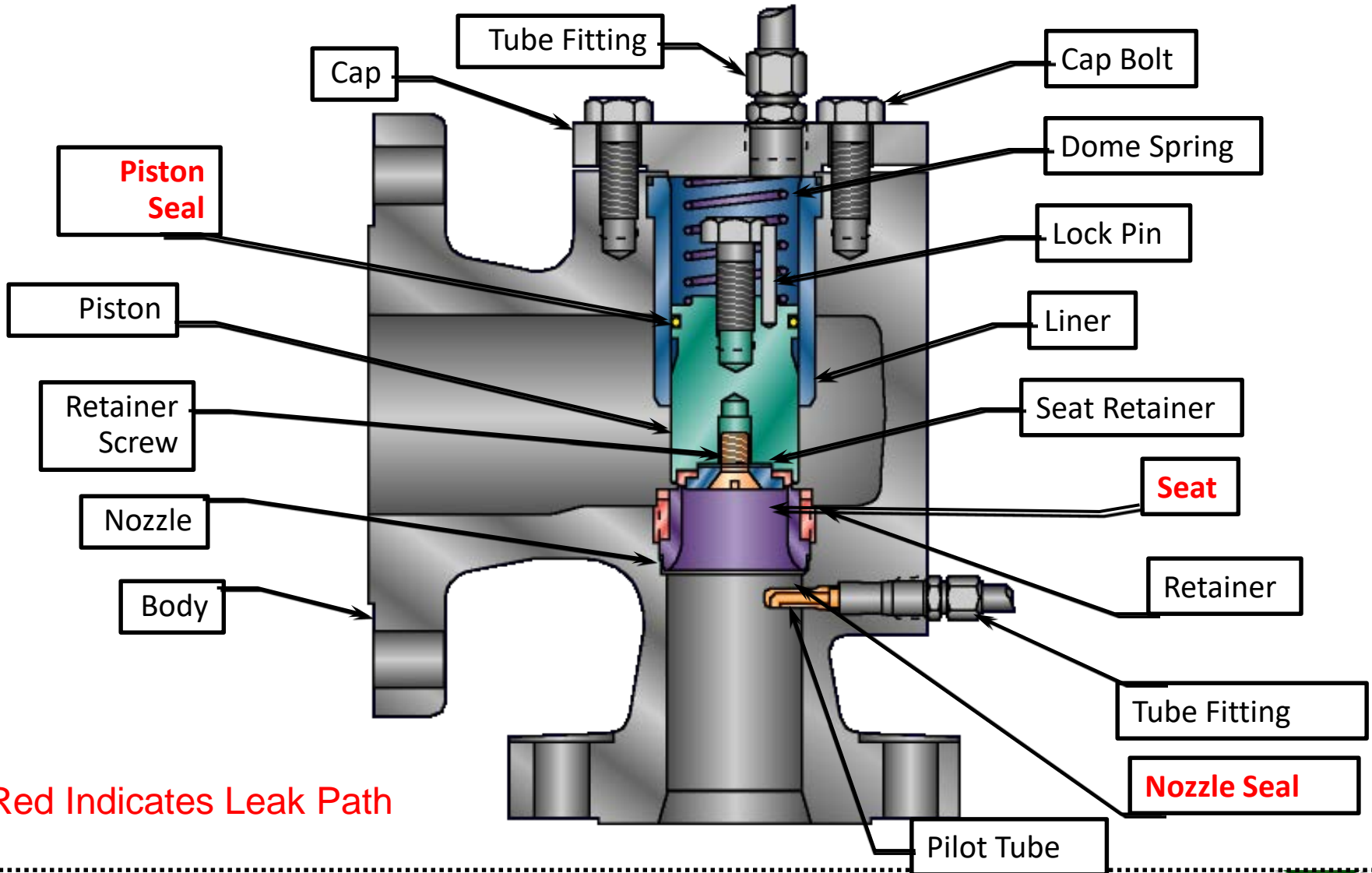
Basic Operation



Above set pressure with Main Valve open

Standard Main Valve

(AG Valve Series 200, 400, 500 and 800)



Flowing vs. Non-Flowing Pilot

Flowing Pilot –

When the main valve is open and flowing, there is system fluid flowing through the pilot.

Non-Flowing Pilot –

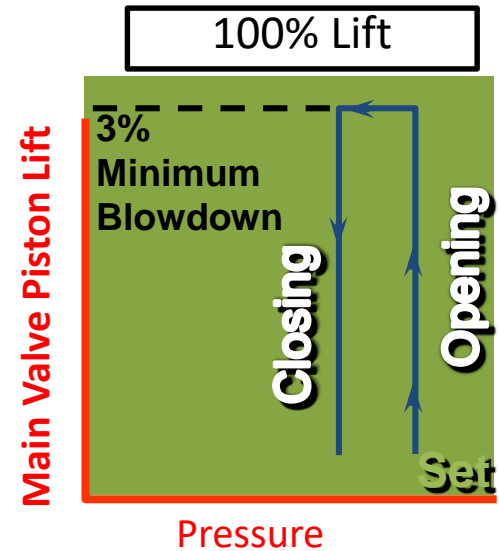
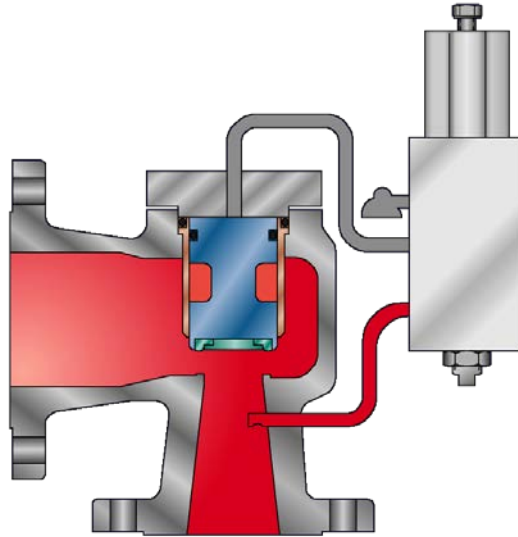
When the main valve is open, there is no system fluid flowing through the pilot.



Main Valve Action Based on Pilot Style

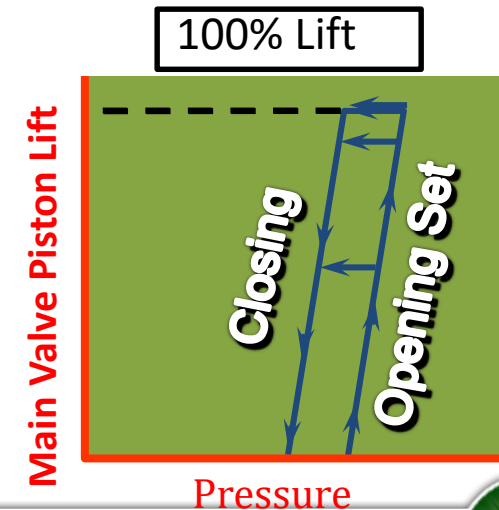
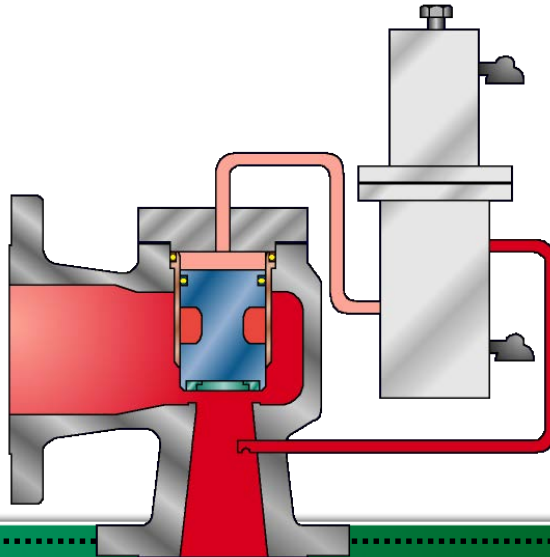
Pop

Main Valve Fully Open at Set Pressure



Modulating

Main Valve Opens According to Relief Demand



Pop Action Pilot (Series 200)

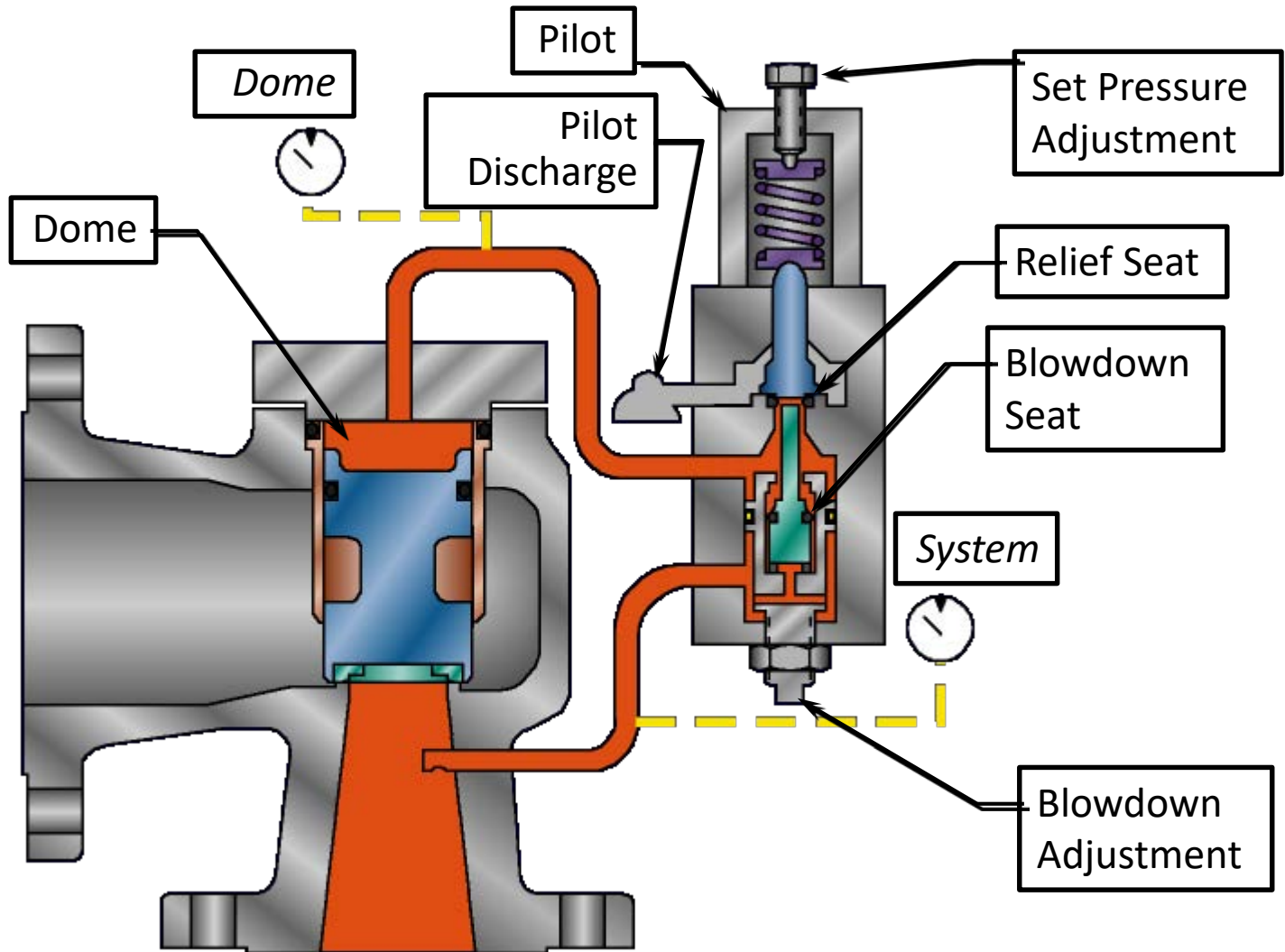
- **Pop Action Pilot (snap action)**
- **Gas or Mixed Phase Service**
- **Non flowing pilot design (no hydrates formed)**

Hydrates are solids that contain water.



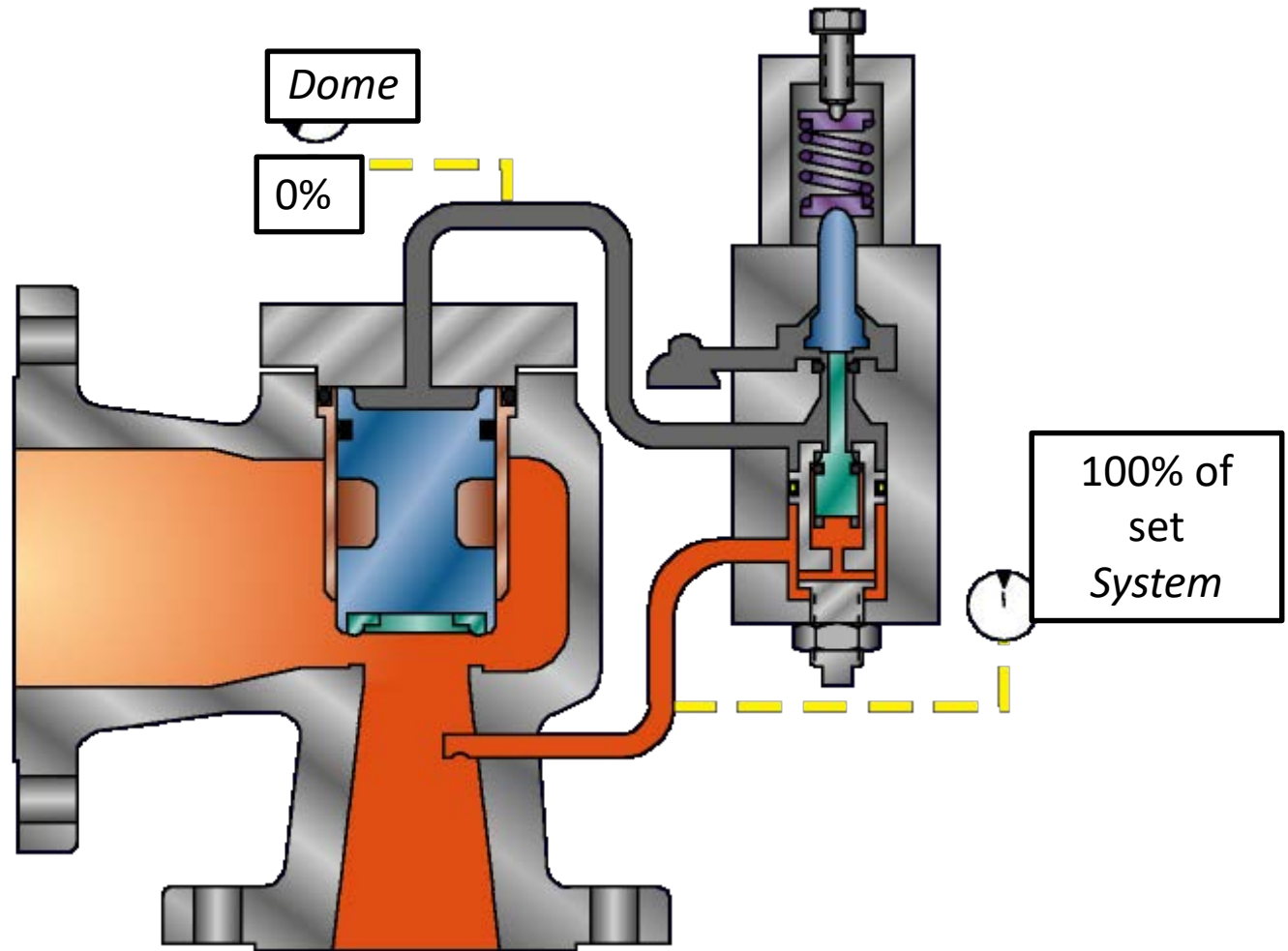
Series 200

(Normally Closed Position)



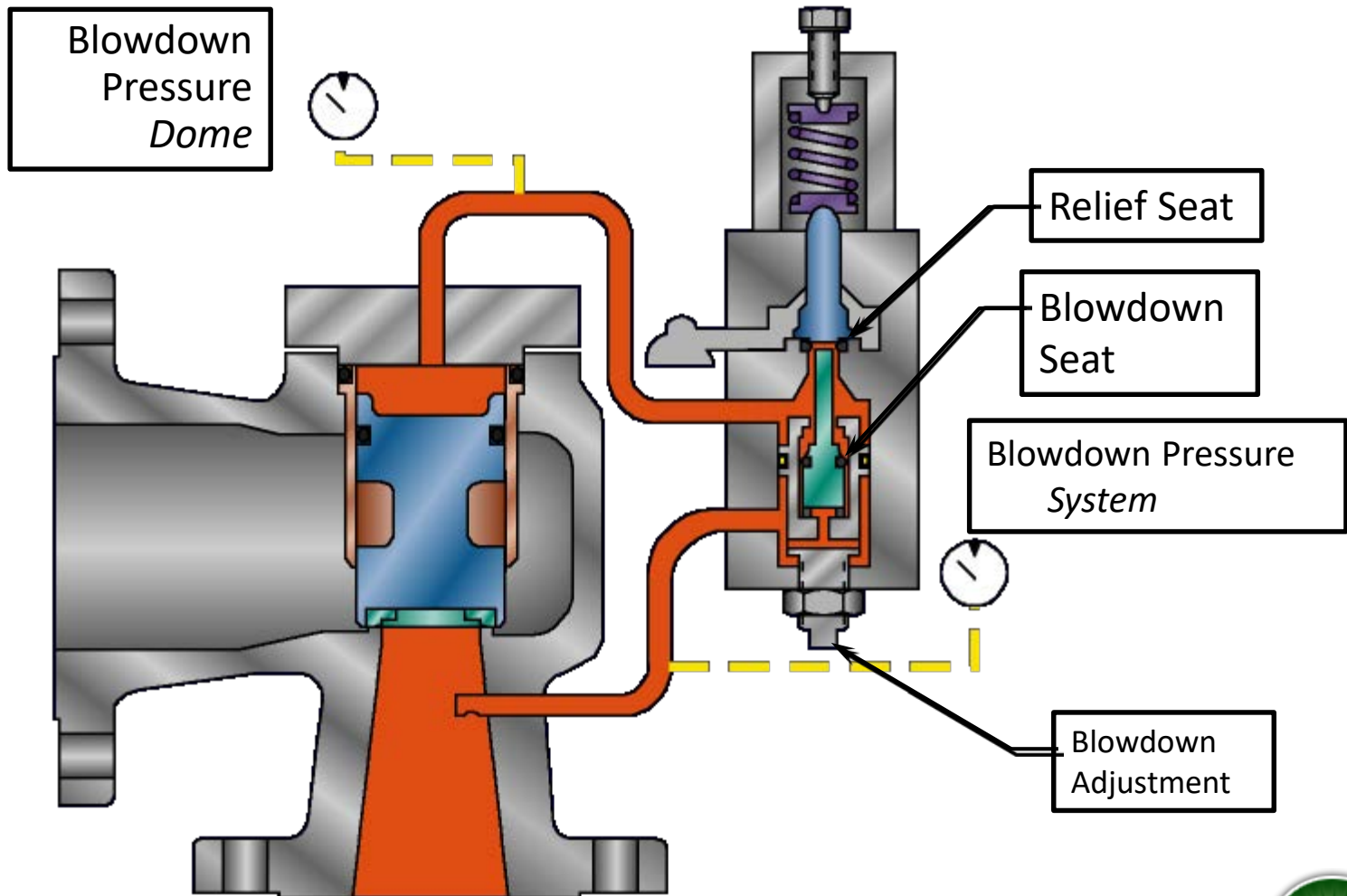
Series 200

(Relieving Position)



Series 200

(Re-Closed Position)



Series 200 POPRV (Pop Pilot)

**Main Valve Dome
Volume Discharged
Through Vent**

Examples: **1F2, 0.0005 ft³**
2J3, 0.0019 ft³
4P6, 0.0145 ft³
6R8, 0.0543 ft³
8T10, 0.0973 ft³

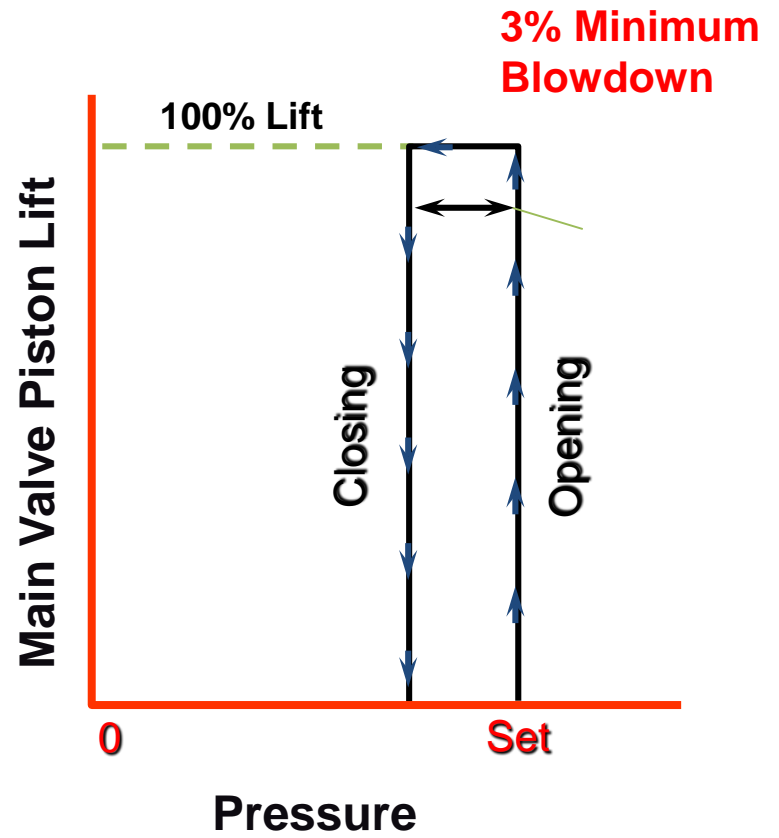
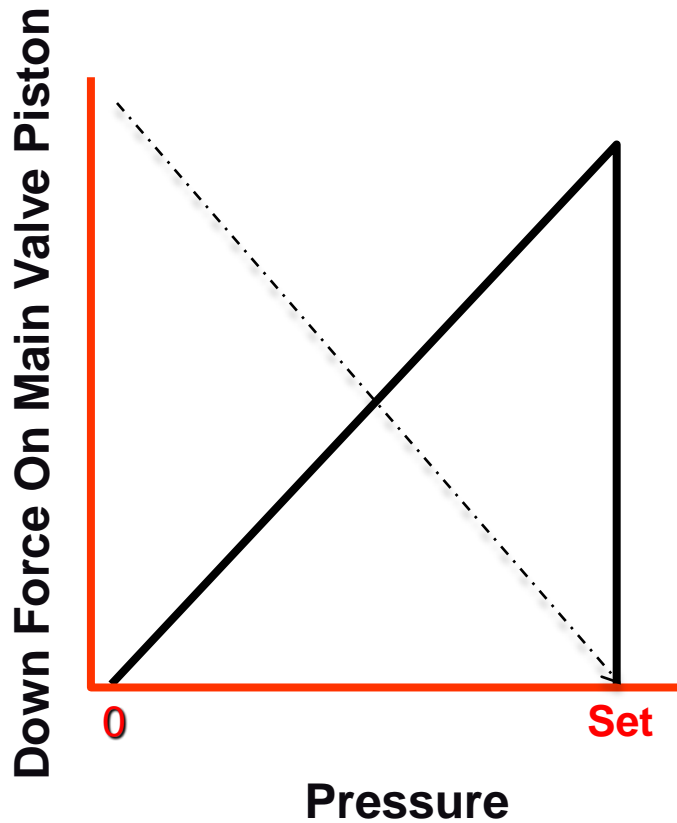
**Approximate
Operating Time to
Full Lift for Gas**

Examples: 1F2, 0.14 second
2J3, 0.19 second
4P6, 0.47 second
6R8, 0.77 second
8T10, 1.13 second

Less than 1/2 a shot



Series 200 POPRV



Series 200 POPRV

- Pop Action with Full Lift at Set Pressure
- For Gas and Mixed Phase Services
(Up to $\frac{1}{3}$ Liquid by Volume)
- Set Pressures 25 to 10,000 psig [1.72 To 690 barg]
- Temperatures -423 to 550°F [-252 to 287°C]
- Main Valve Tight to Set Pressure
- Minimum Pilot Cracking Pressure:
100 psig [6.90 barg] and Above: 95% Of Set
Below 100 psig [6.90 barg]: 90% Of Set
- Range of Blowdown Adjustment: 3 To 15% Of Set Pressure
(Below 5% Only with Remote Sensing)
- Pilot Must Vent to Atmospheric Pressure
(Bug Screen or Tube to a Sump)

Series 200 POPRV Benefits

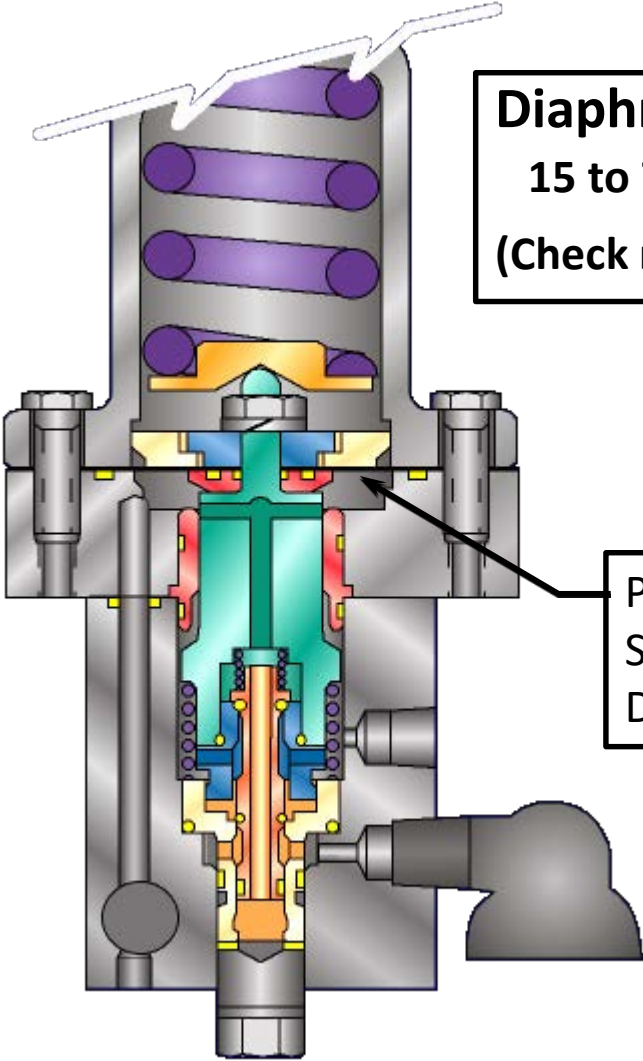
- Allows Higher System Operating Pressure for Maximized Process Output
- Non-Flowing Pilot Design Minimizes Flow Through the Pilot and Ingress of Particulates
- Minimum Pilot Venting — Only the Main Valve Dome Volume
Example: 2J3 = 0.0019 ft³ [0.00005 m³]
- No Emissions While Valve Closed
- Safe, Externally Adjustable Blowdown
- Set Pressure and Lift Unaffected by Back Pressure
- Protection Against Resonant Chatter

Modulating Pilot (Series 400)

- Modulating Action
- Gas, Liquid, or Mixed Phase
- Non flowing pilot design



Series 400 Pilots



Diaphragm Style

15 to 740 psig [1.03 To 51.03 barg]

(Check mfg. specifications)

Pressure
Sense
Diaphragm

Pressure
Sense
Piston

Piston Style

100 to 1480 psig

[6.90 to 102 barg]



Series 400 Pilots Advantages

Diaphragm Style

Best Sensitivity

Best Repeatability

Piston Style

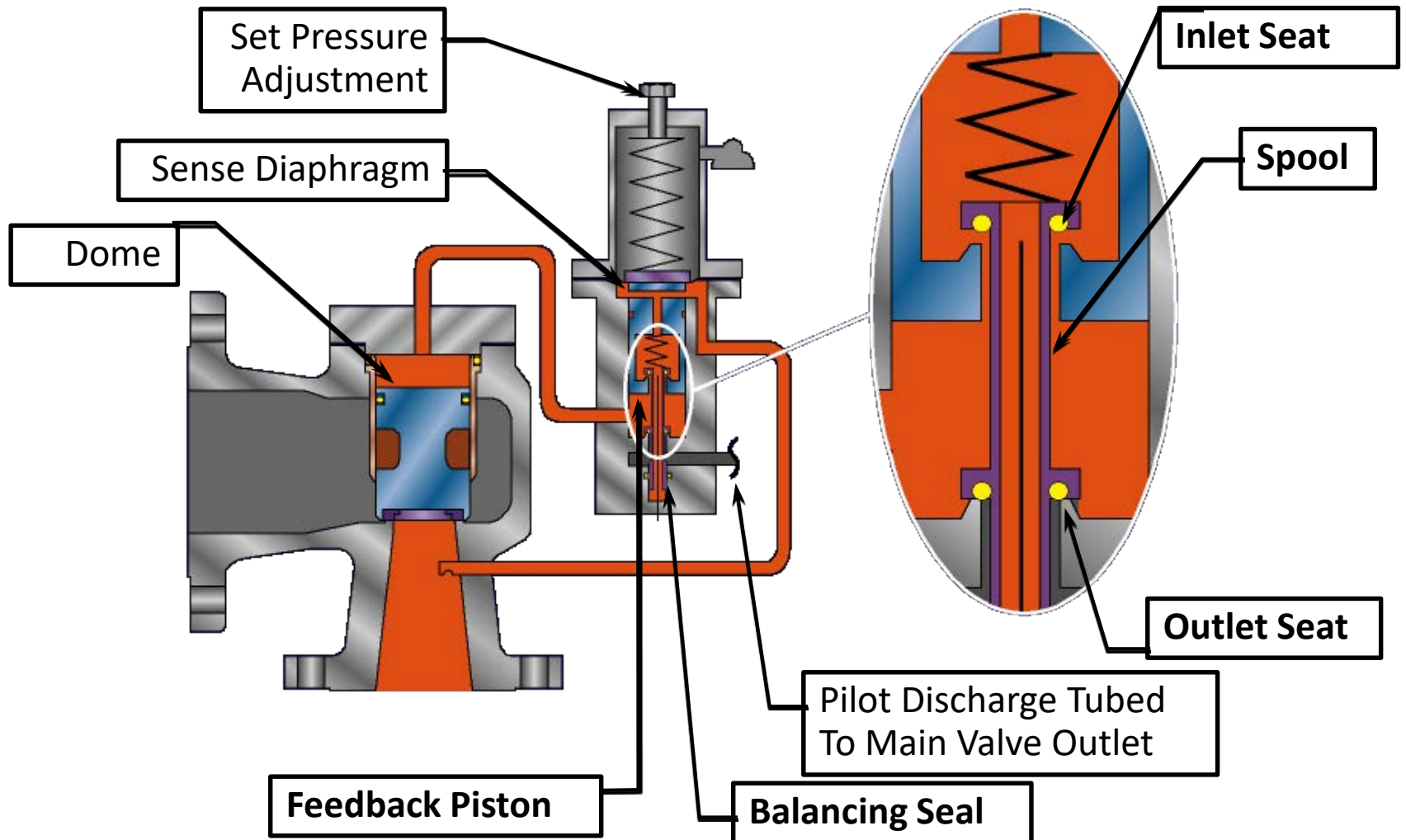
More Rugged

Better Able to
Tolerate Pressure
Pulsations and
Higher Pressures

Wider Selection
of Soft Goods

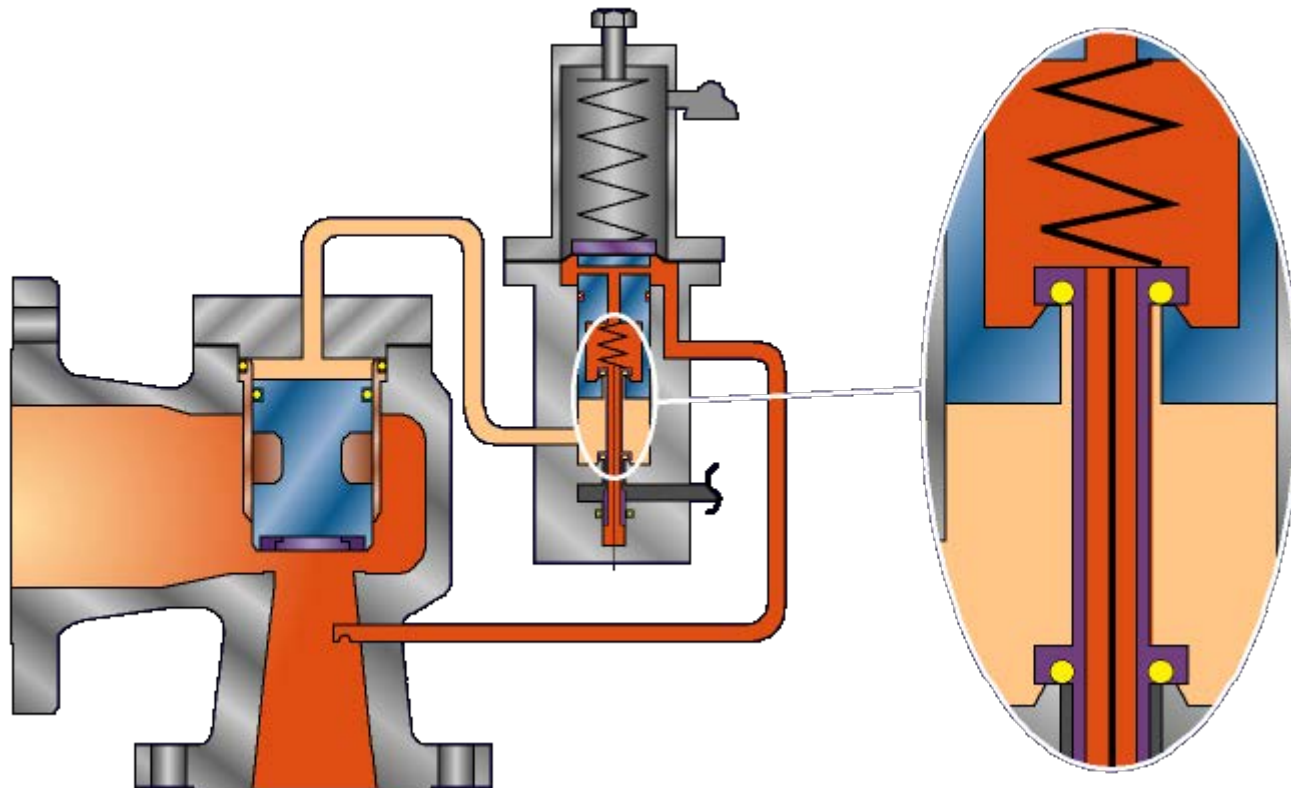
Series 400 POSRV

(Normally Closed Position)



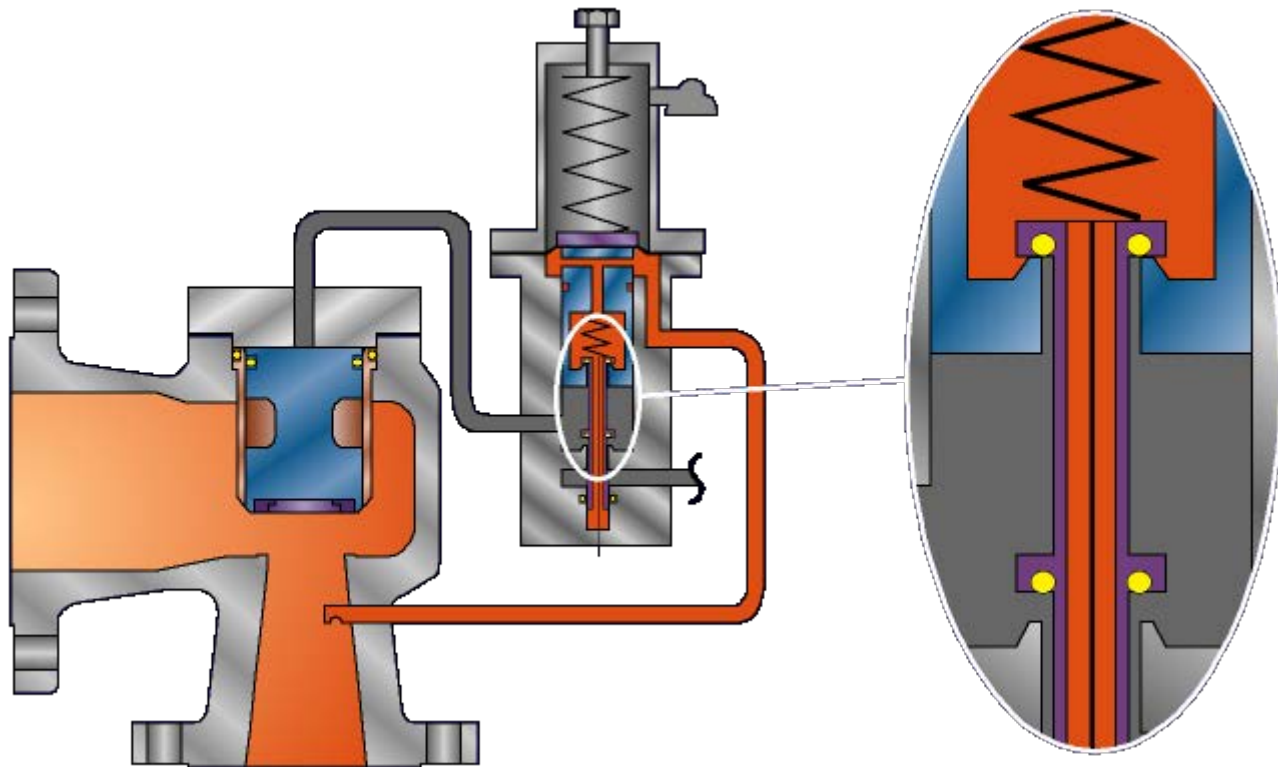
Series 400 POSRV

(At or Slightly Above Set Pressure, Main Valve Modulating)



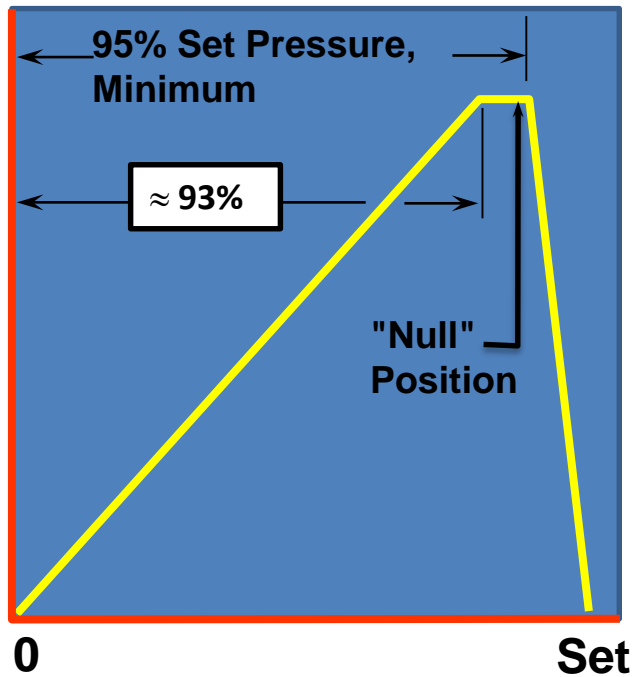
Series 400 POPRV

(Above Set Pressure and at Full Lift)



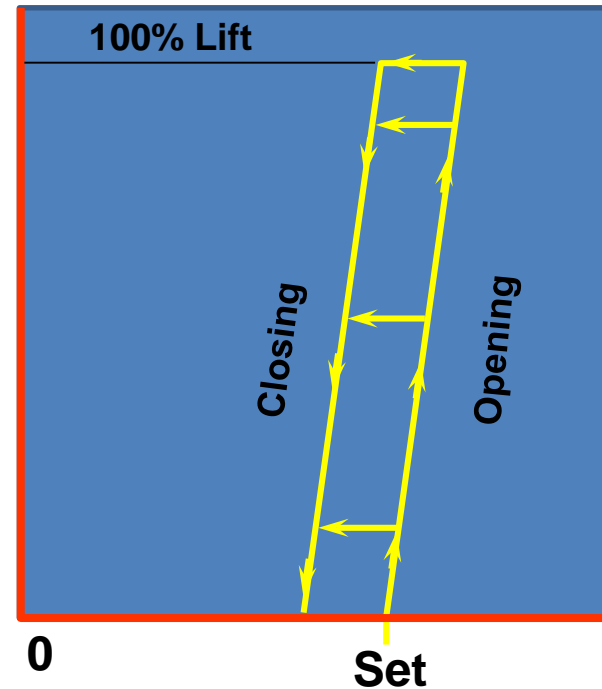
Series 400 POPRV

Down Force On Main Valve Piston



Pressure

Main Valve Piston Lift



Pressure

Series 400 POPRV

- Modulating Action, with the *Main Valve Opening according to the Relief Demand*. Opens Only Enough to Keep the System at Set Pressure - - - Similar to Back Pressure Regulator
- Consistent Operation Regardless of Process Phase State
- Set Pressures 15 to 1480 psig [1.03 To 102.1 barg]
- Temperatures -65 to 550°F [-54 To 286°C]
- Main Valve Tight to Set Pressure
- Minimum Pilot Cracking Pressure: 95% of Set
- Pilot Is Balanced Against Back Pressure. The Discharge Is Connected to Main Valve Outlet as Standard
- Set Pressure and Lift Unaffected by Back Pressure

Series 400 POPRV Benefits

- Less Wasted/Lost Product (+ \$)
- No Emissions
- Minimized Releases and Pollution
- Less Noise
- Greater System Output by Being Able to Operate Nearer to Set Pressure
- Set Pressure and Lift Unaffected by Back Pressure
- No PRV Chatter Due to Poor Inlet Piping
(Caution: Check valve capacity using flowing pressure)

Code Status

- Capacity certified and available with ASME Code Designator for Sections I, III, and VIII.
- Certified fluids include steam, air/gas and liquid.



Code Status

- Two nameplates required – one on pilot and one on main valve with ASME symbol
- Dual fluid certification available for Section I economizers using Code Case 2446 (steam and water)
- Pilot sensing line to be protected from freezing (PG-73.2.12)

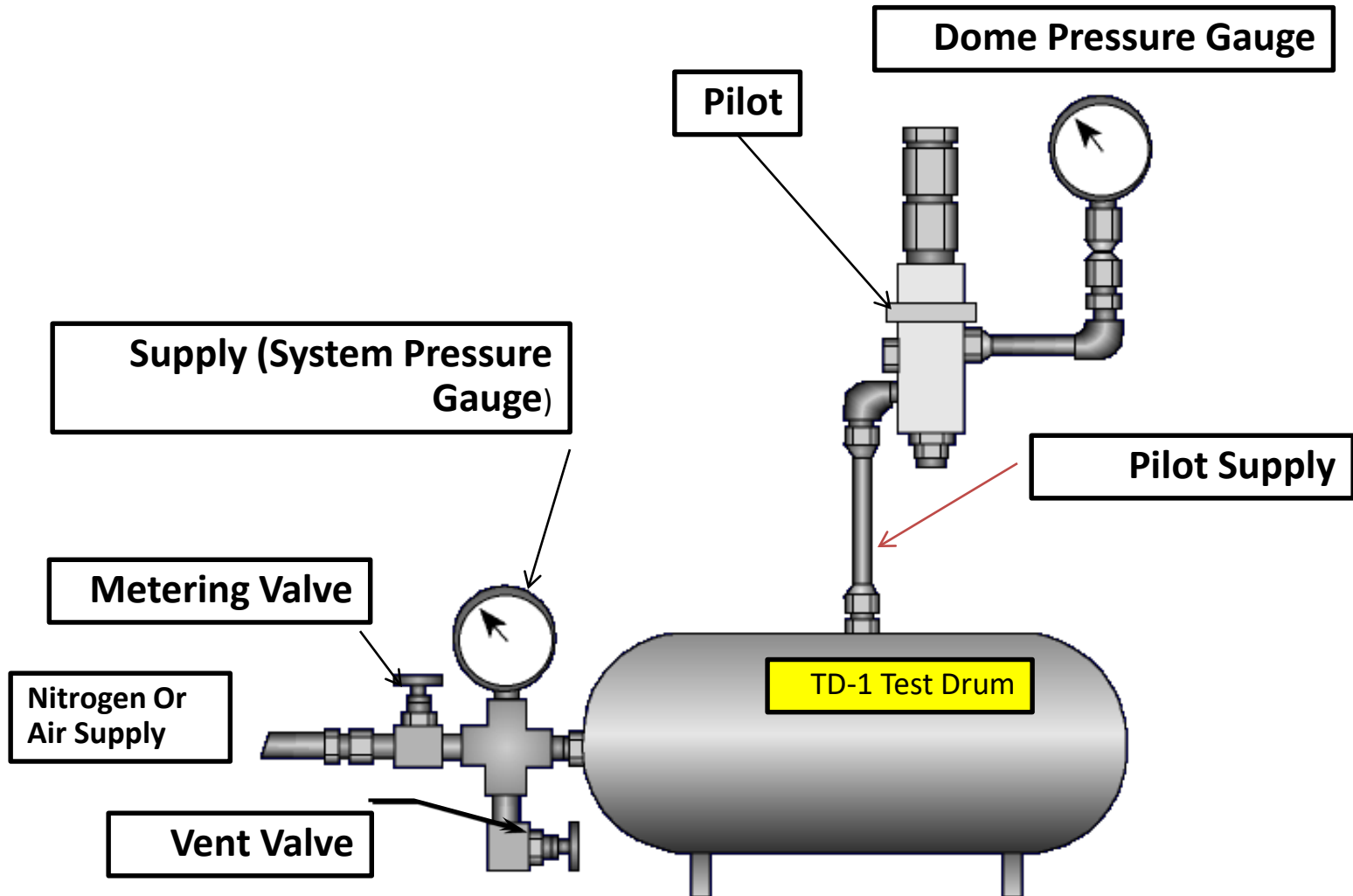


Code Status

- Initial capacity tests may be done using the main valve only, along with operational tests to prove function and lift



Testing of Pilots



Applications Considerations

There are several things you have to consider when selecting a pilot operated relief valve:

Type of service:

Air, gas, vapor, liquid, steam, etc.

Temperature:

-420°F to 500°F (depending on type of pilot).

Set Pressure:

Low Pressure: inches of water to 50 psig,
diaphragm type main valve.

High Pressure: 20 psig to 6000 psig,
piston type main valve.

Compatibility

Elastomers, plastic seat, seals.



Available for NACE service

Features/Benefits

1. **Price: less expensive in larger valves**
2. **Size: 8" x 10" POPRV 32" to 36" tall
Spring Loaded PRV is 60" tall**
3. **Can be used dirty or wet service**
4. **Balanced for back pressure**
5. **Bubble tight up to 95% of set pressure**



Features/Benefits

6. **Easy adjustment of set pressure and blowdown (reset) adjustment**
7. **Reduced maintenance costs, no lapping or machining of parts (pilot can be replaced as a part)**
8. **Remote pressure pickup**
9. **Manual or remote blowdown**
10. **Field test connection**
11. **Pilot lift lever available**





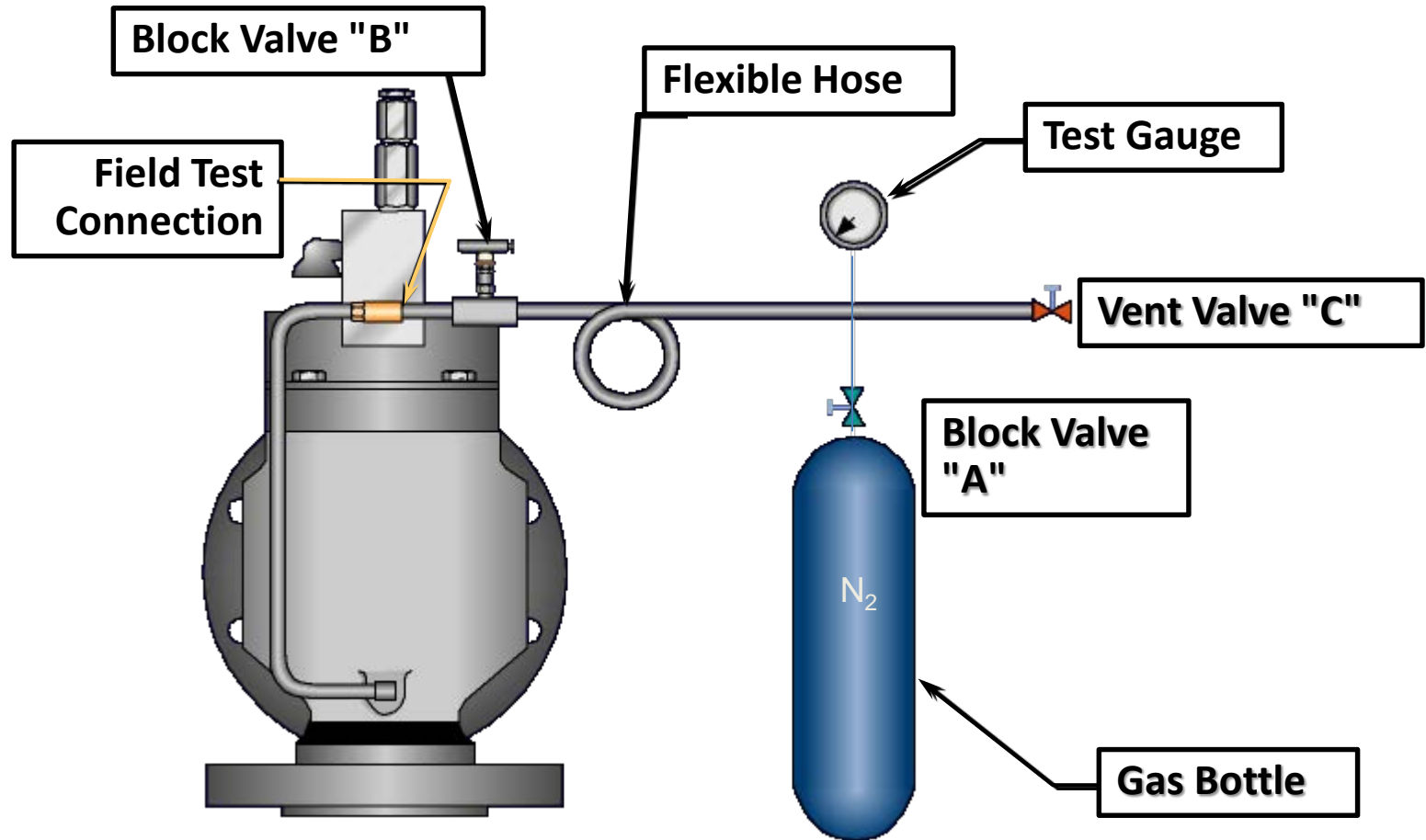
POPRV Options

Field Test Connection (Series 200 POSV)



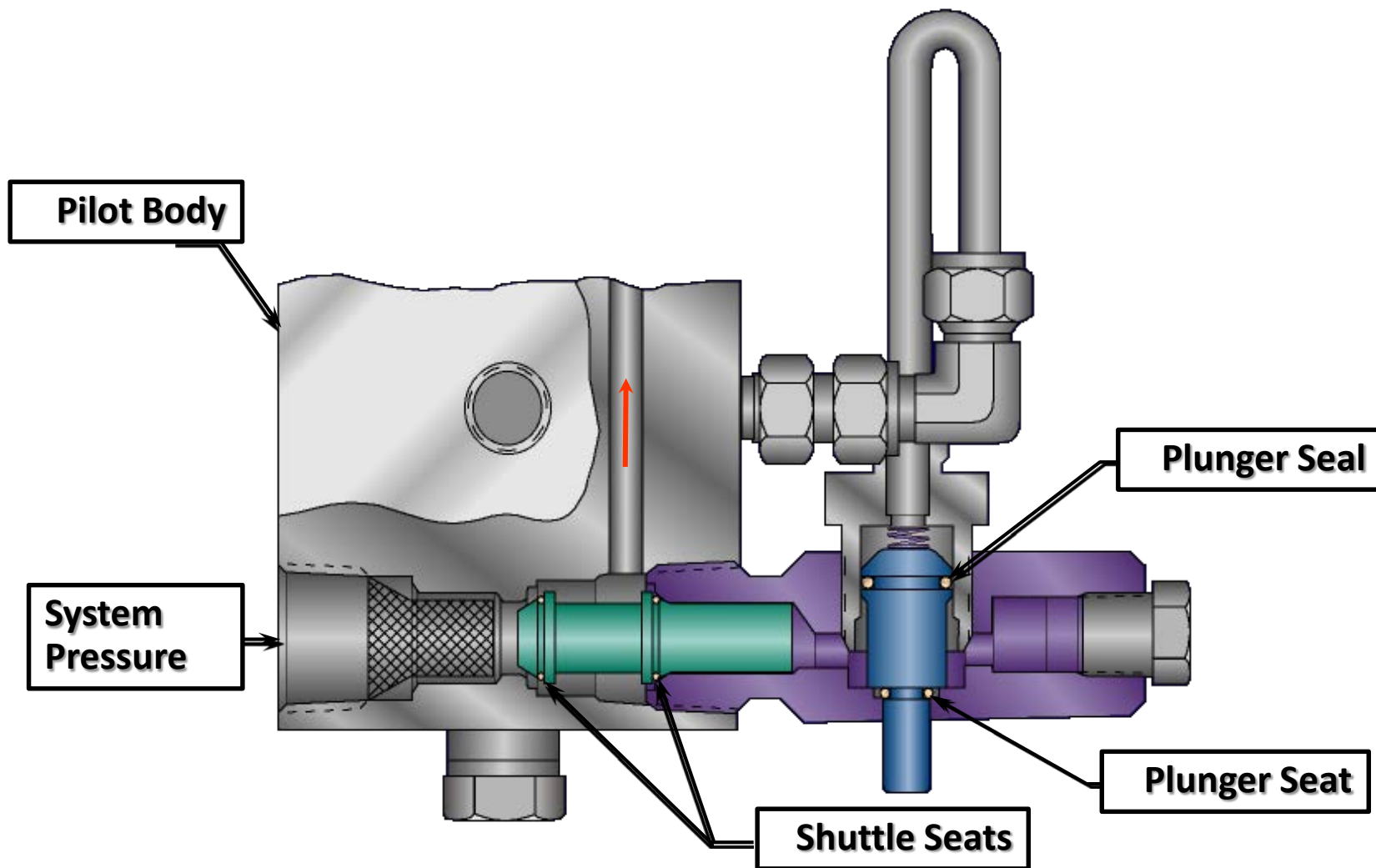
Field Test Procedure

(Series 200)



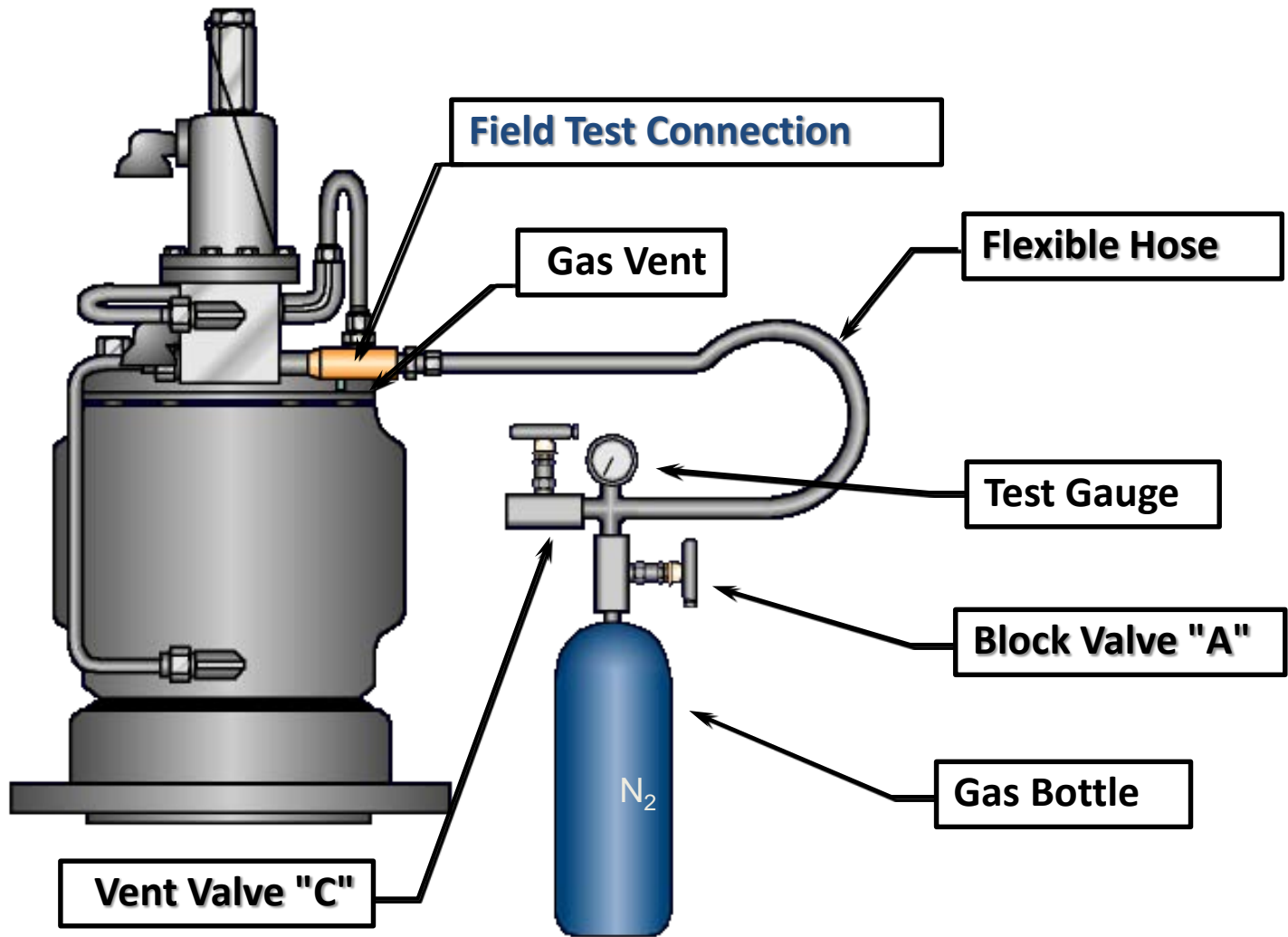
Field Test Connection and Indicator

(Series 400 POSV)

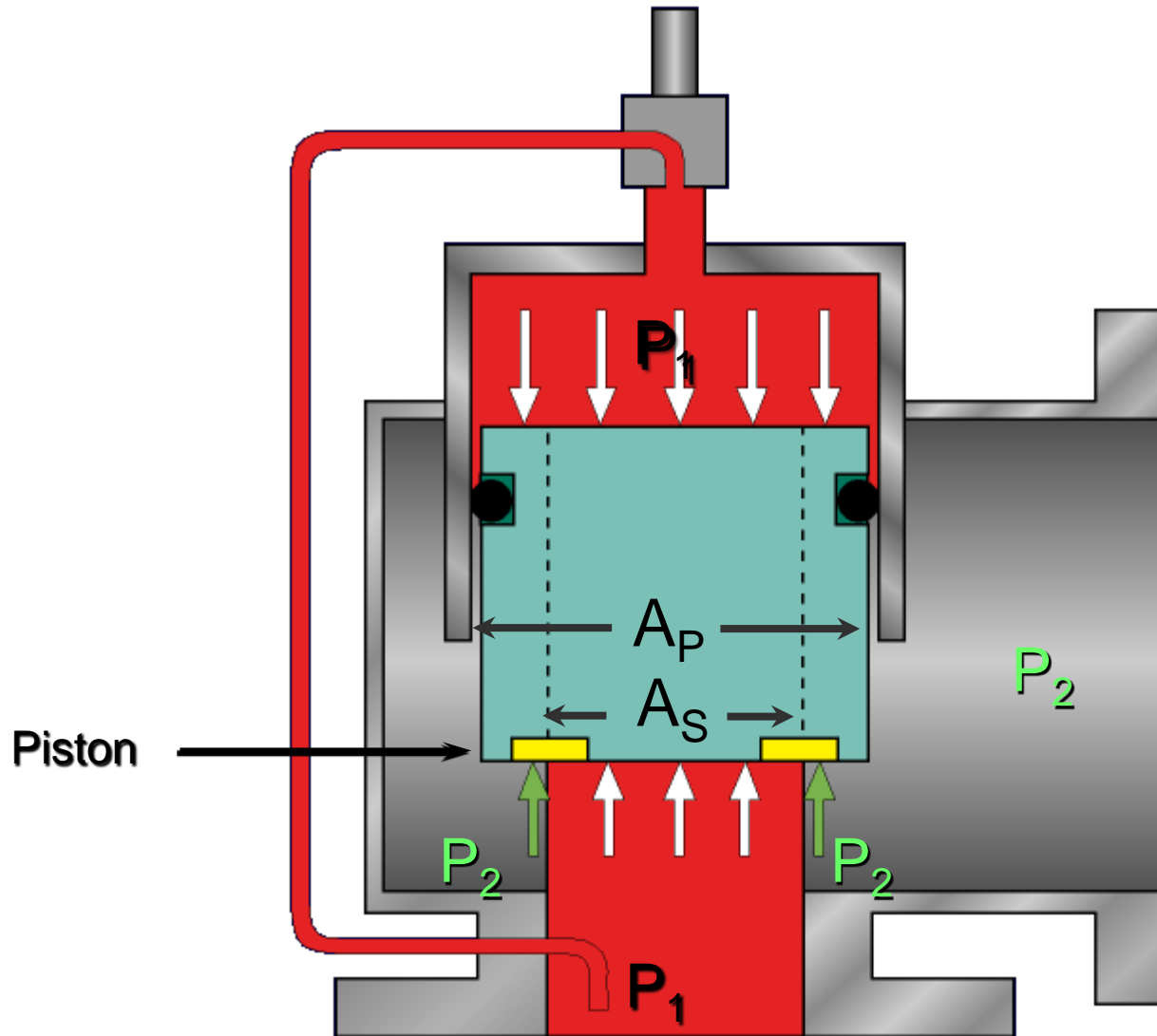


Field Test Procedure

(Series 400 POSRV)

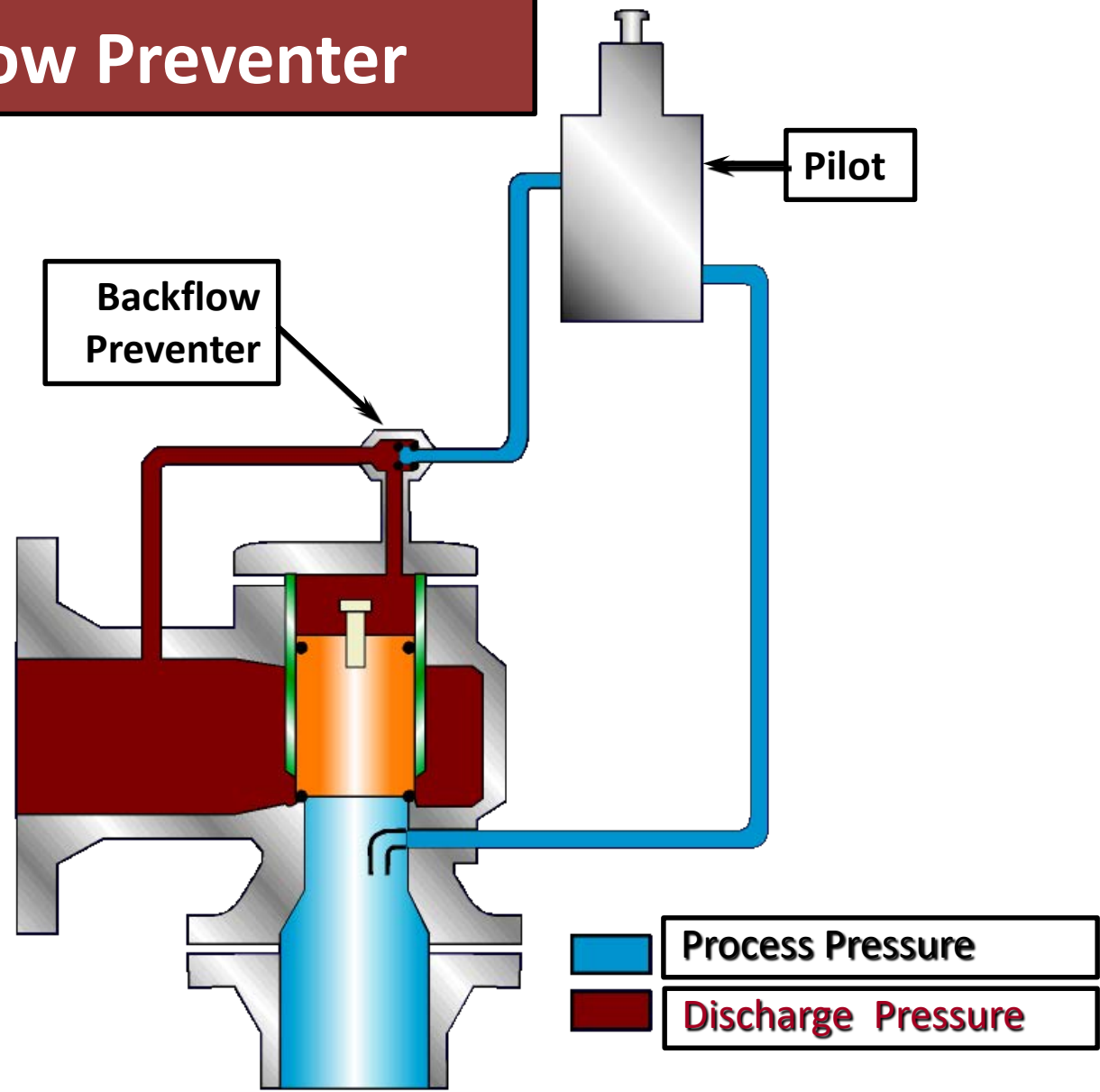


Back Pressure on POPRV



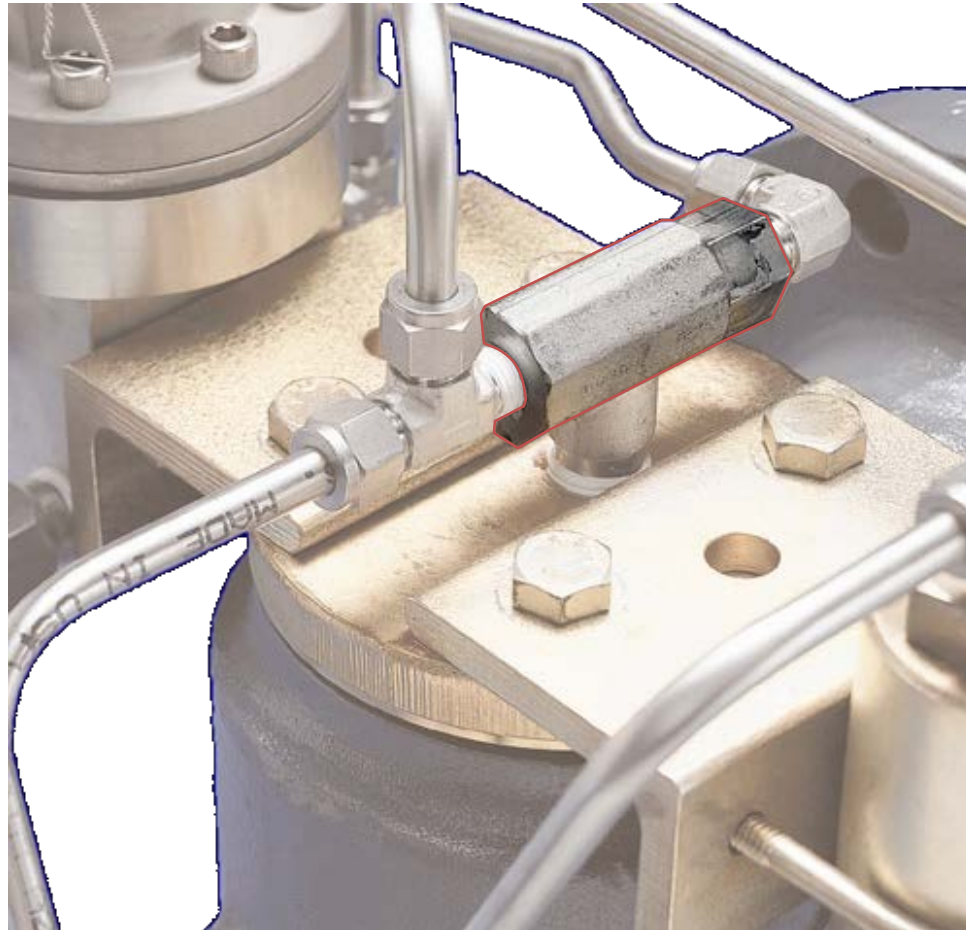
Series 200 POPRV with Backflow Preventer

$$P_2 > P_1$$



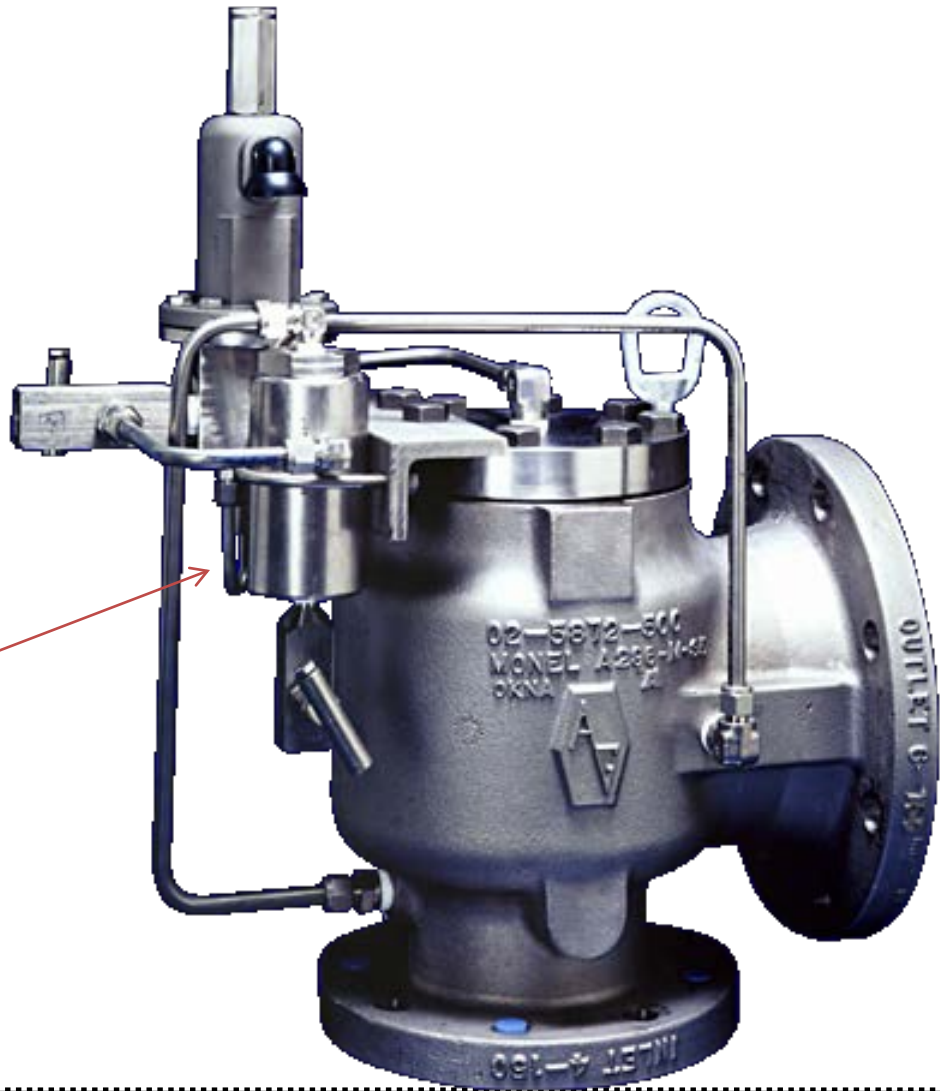
Backflow Preventer

(Can Be Field Retrofitted)

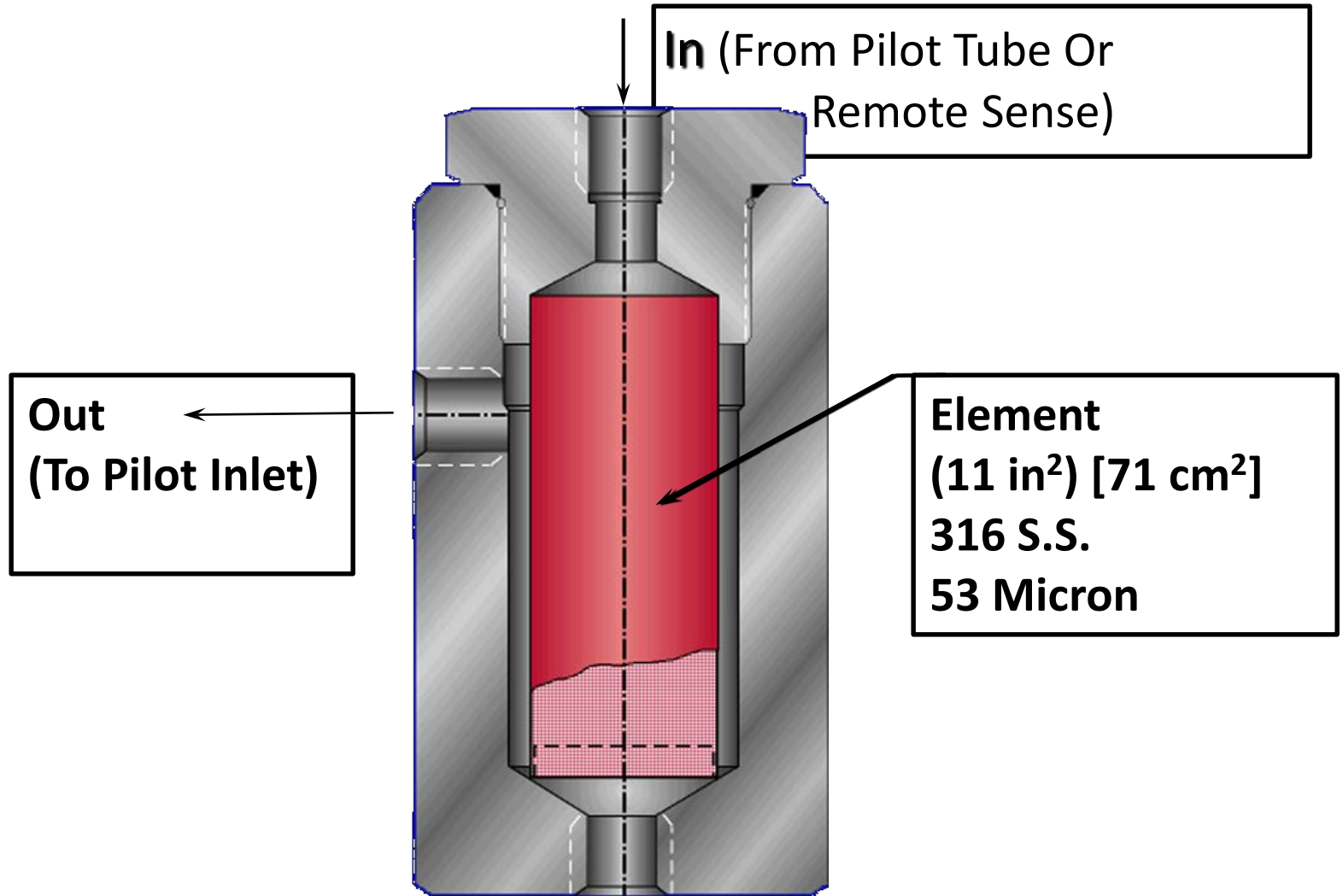


For Dirty Service

**Auxiliary Filter
In Pilot Supply**



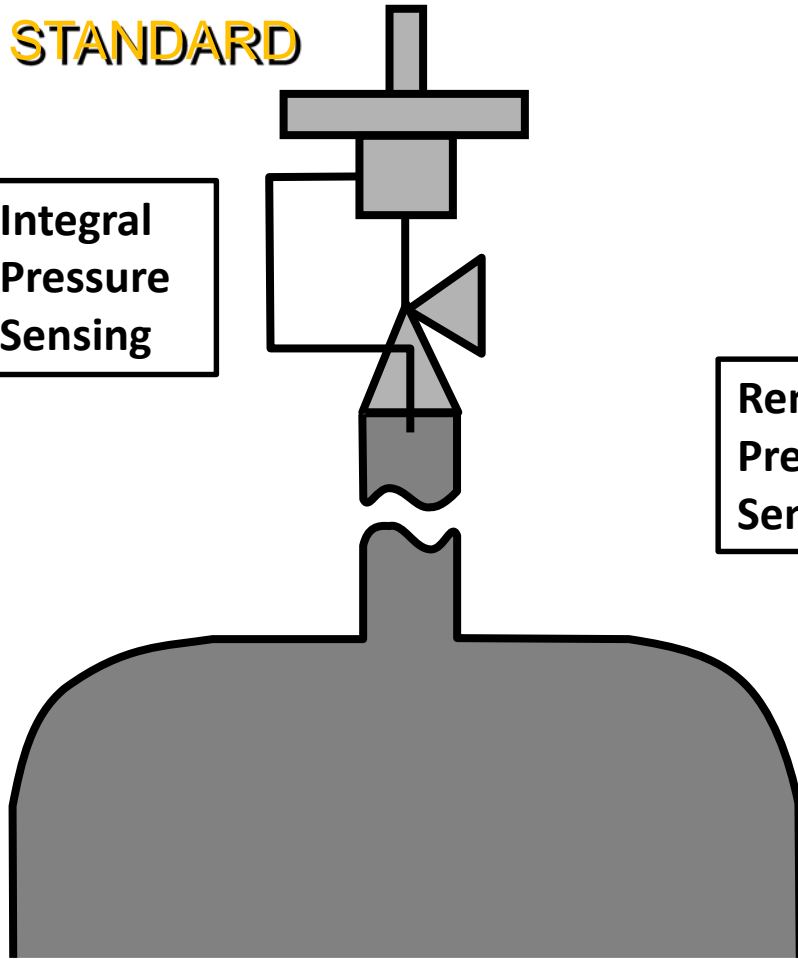
Pilot Supply Filter



Remote Pressure Sensing Option for Dirty Service and/or Excessive Inlet Losses

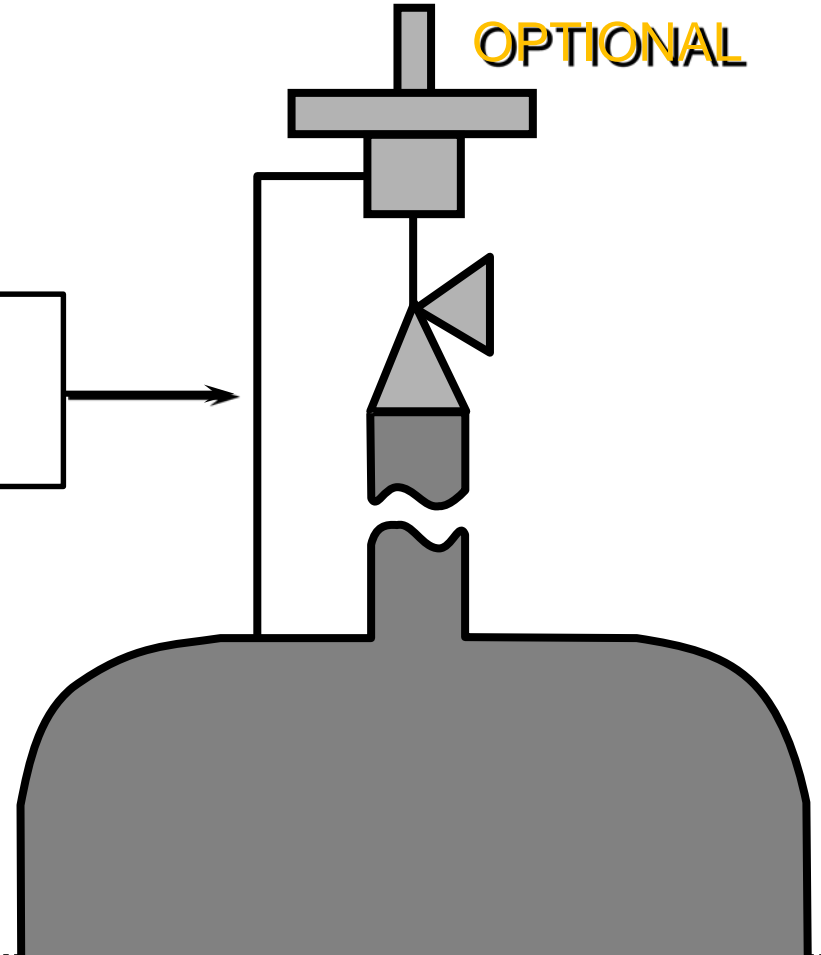
STANDARD

Integral
Pressure
Sensing

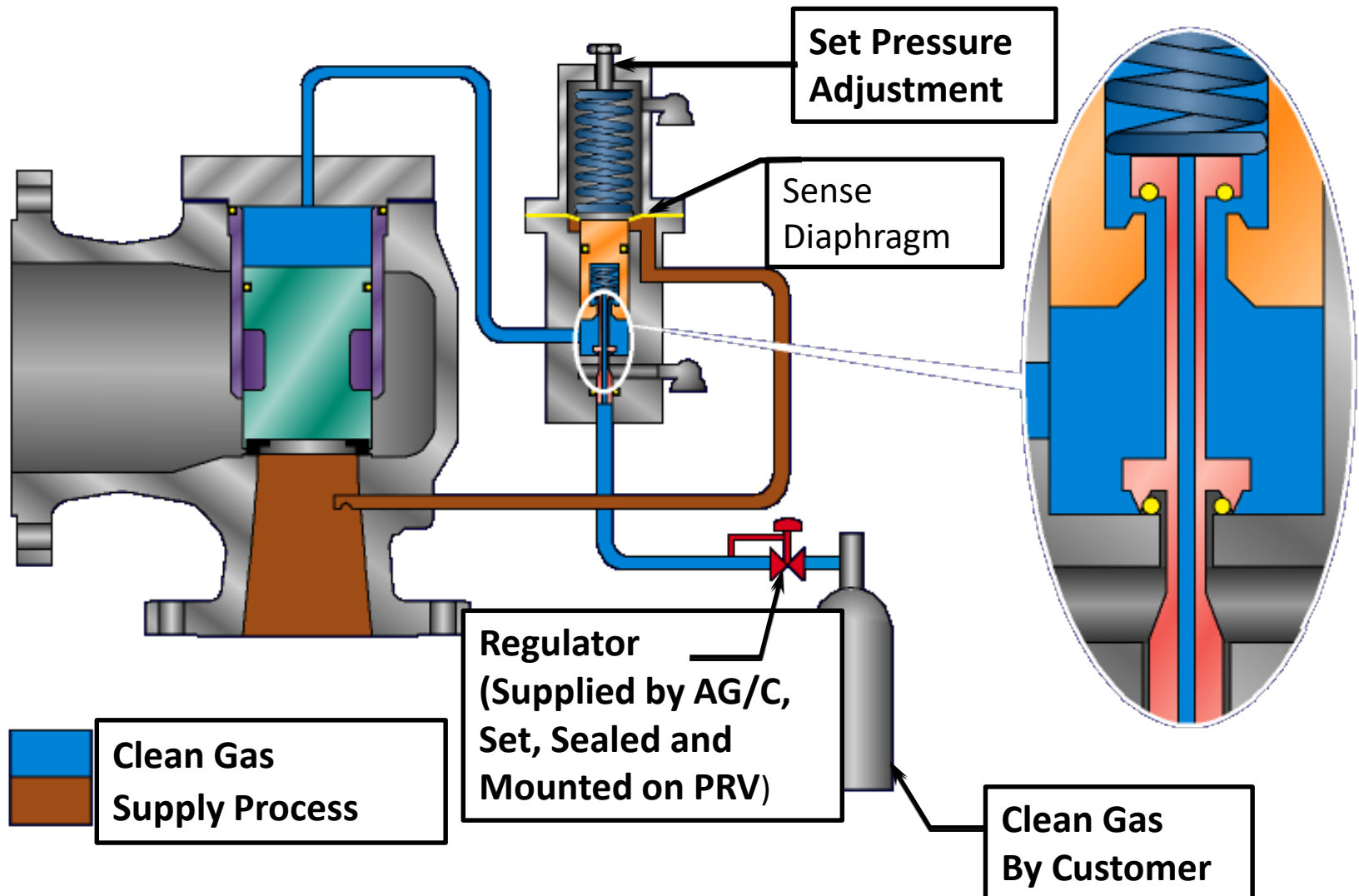


OPTIONAL

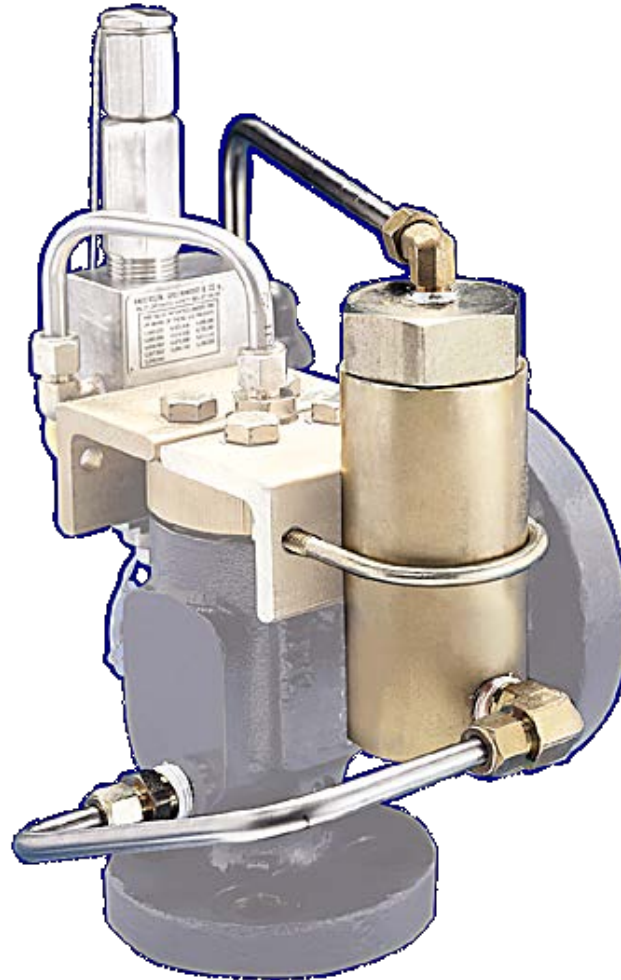
Remote
Pressure
Sensing



Iso-Dome Series 400 POSRV

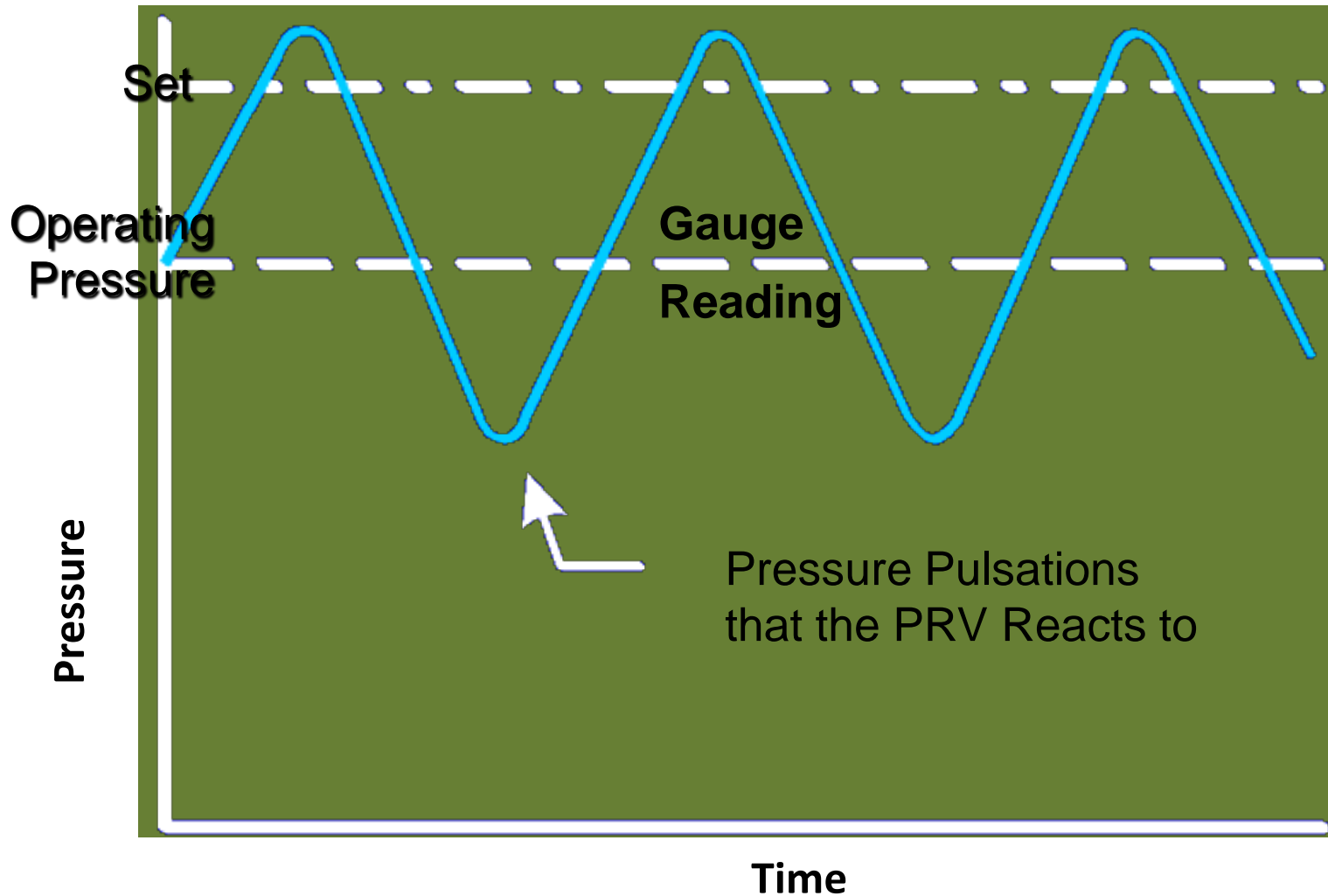


Pressure Spike Snubber for Gas Service

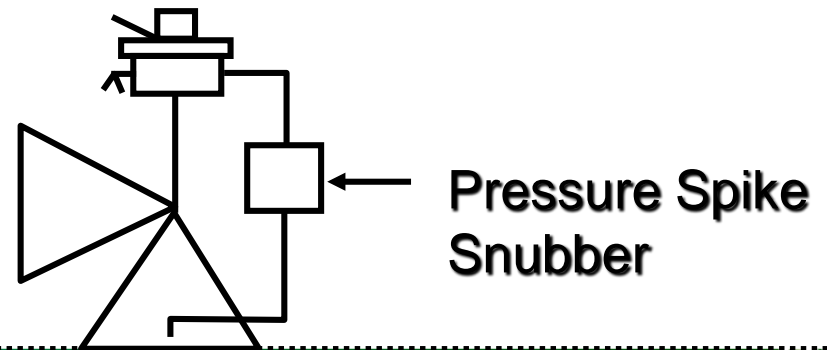
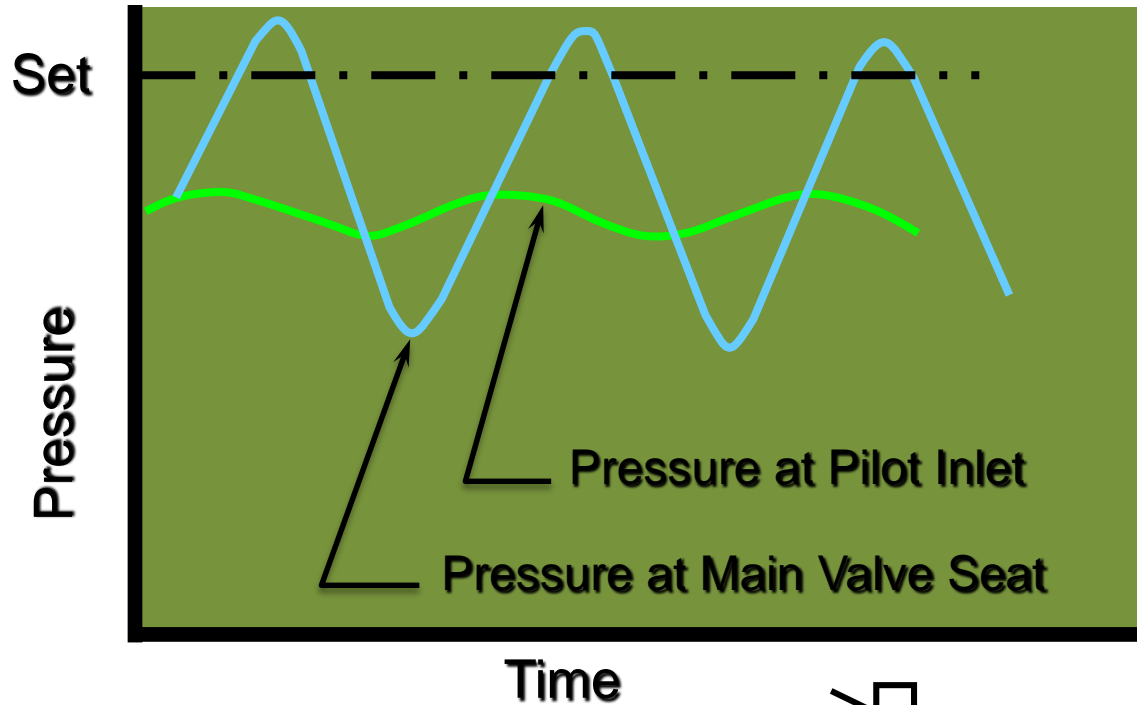


Positive Displacement Compressor

(PRV Relieves "Low")

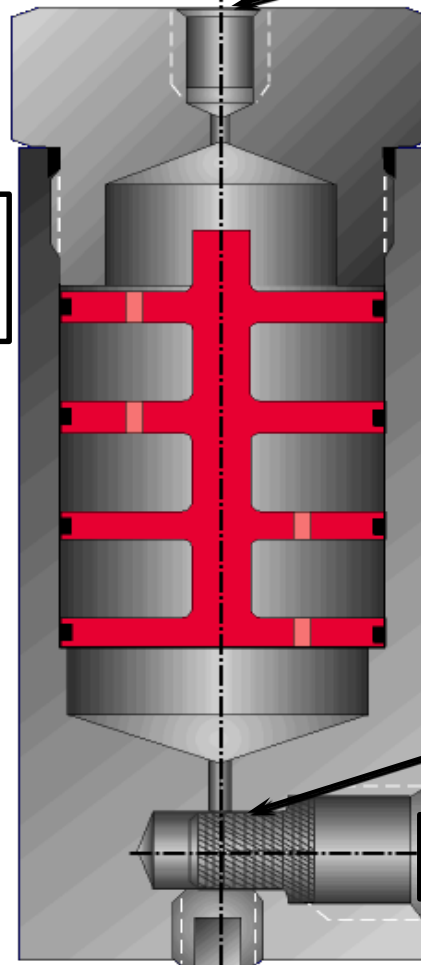


AG/C POPRV with Pressure Spike Snubber



Pressure Spike Snubber

Maximum Pressure
3705 psig [255.5 barg]



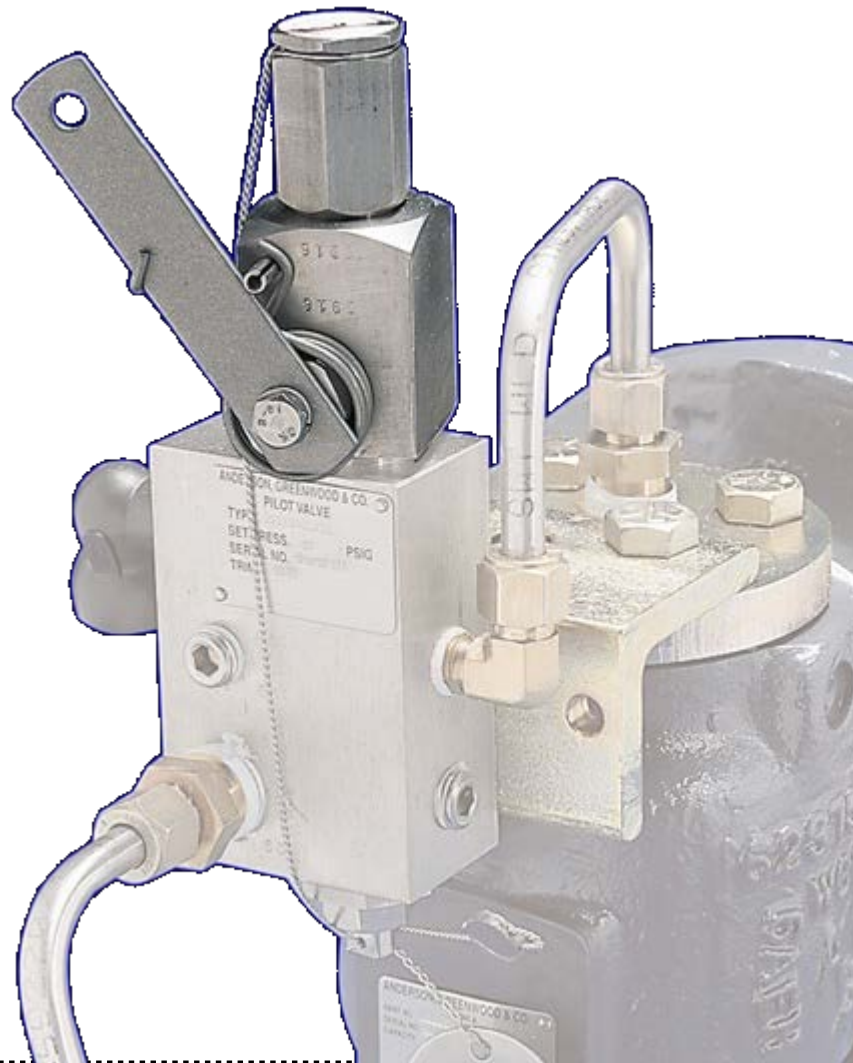
Outlet to
Series 200,
400, or 800 Pilot

143 Micron, 316 S.S.
Filter

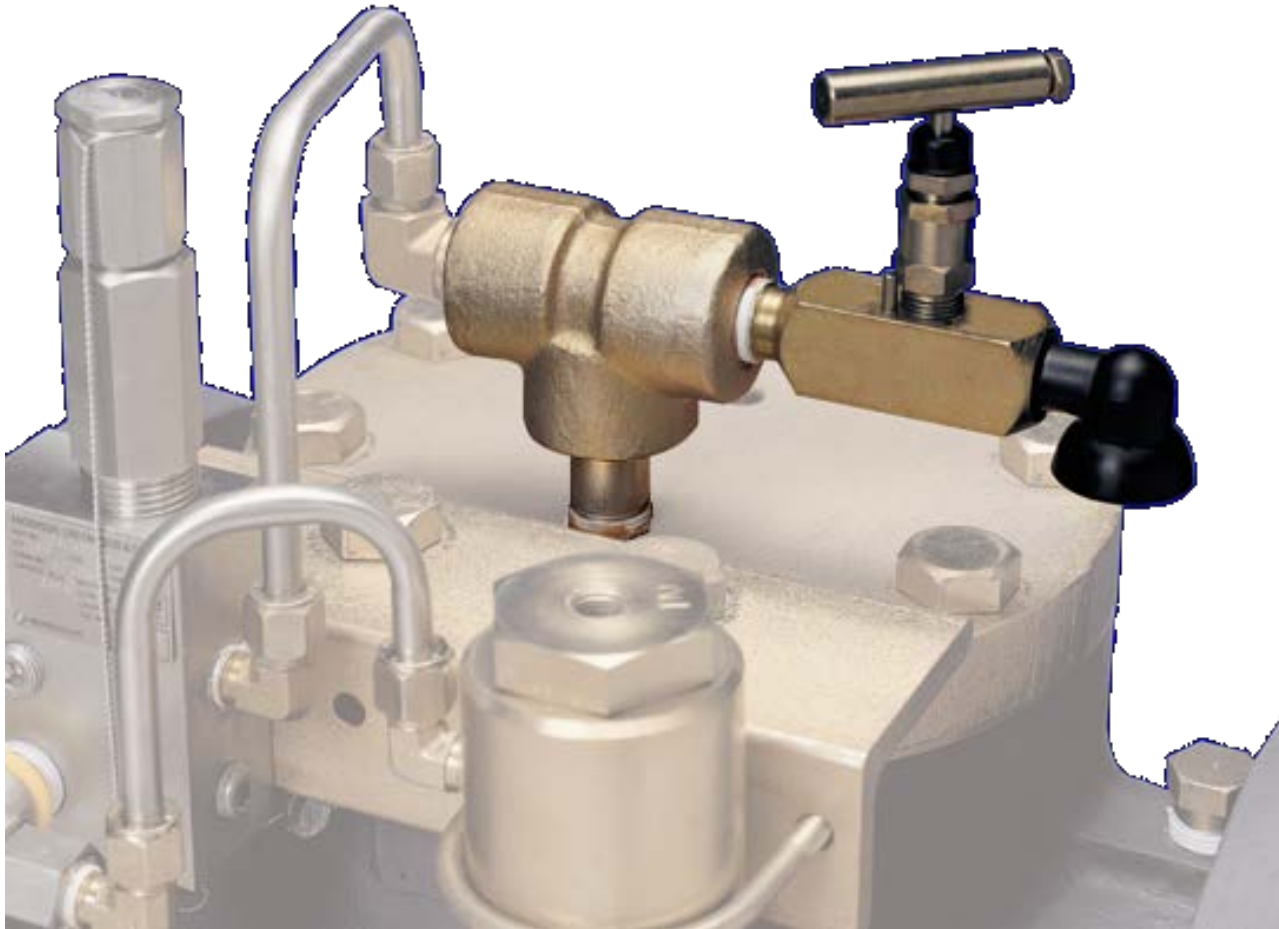
Inlet

Packed Lift Lever

**REF:
UG136 (A) (3)**

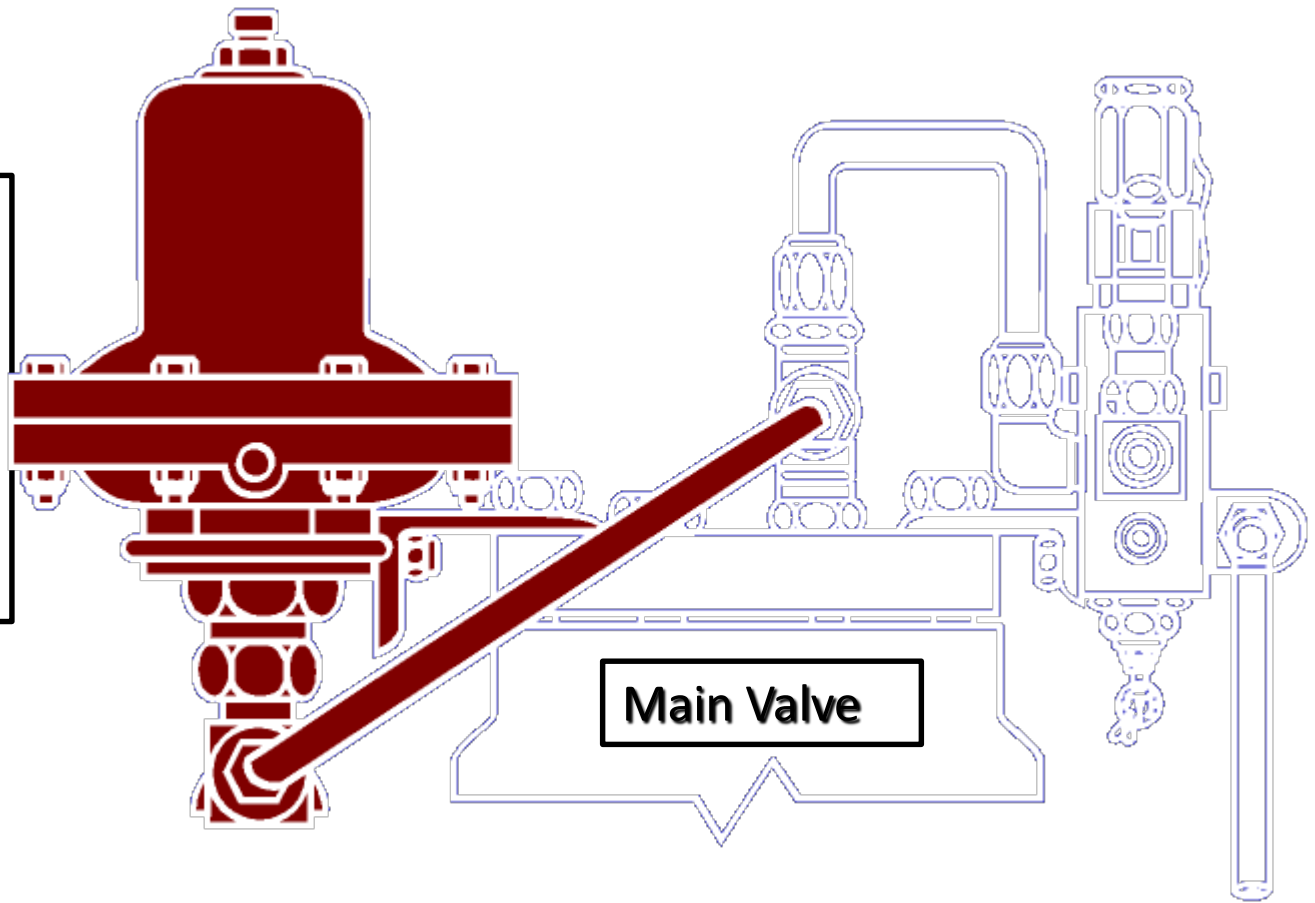


Manual Blowdown Valve

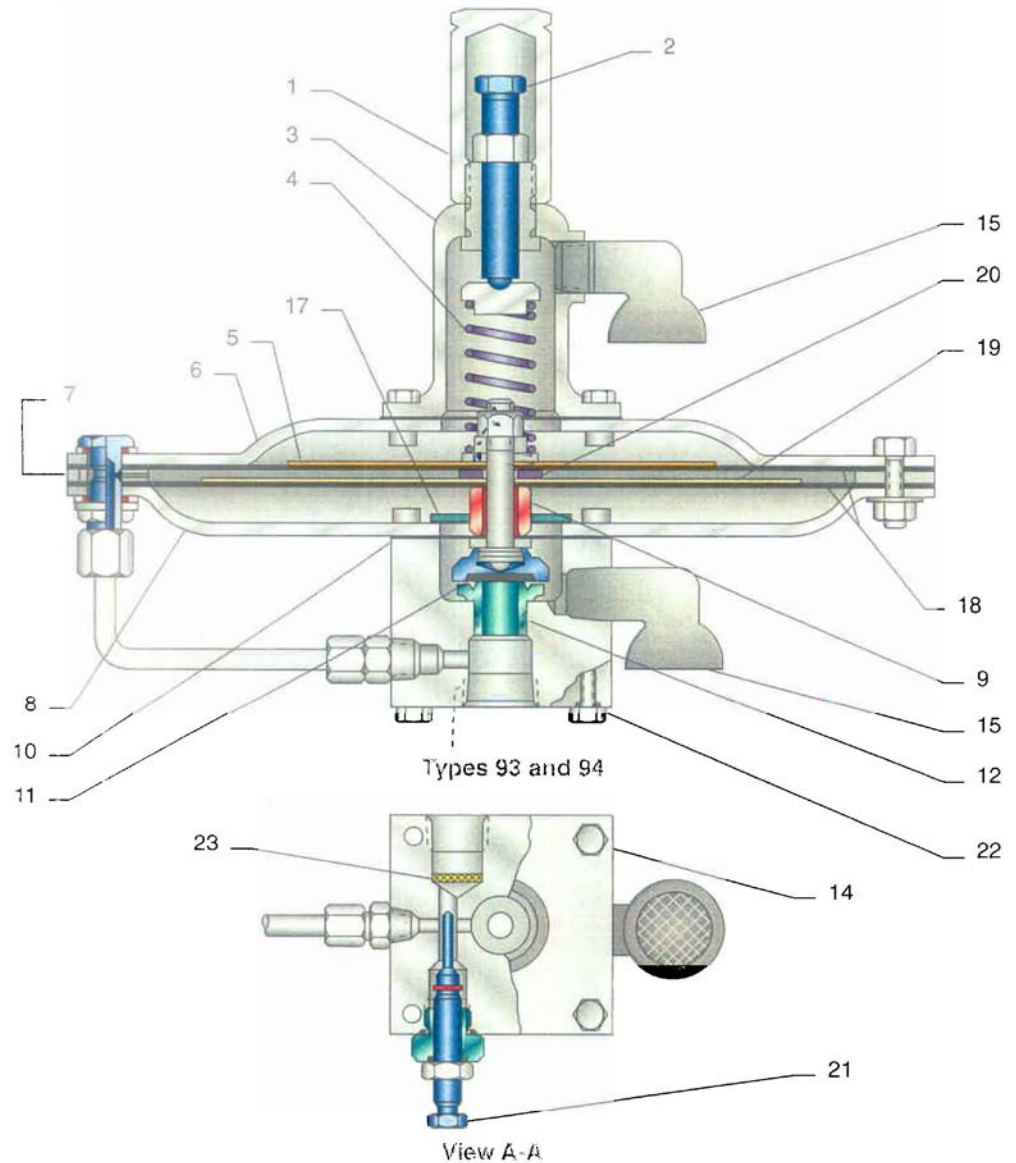


Remote Unloader

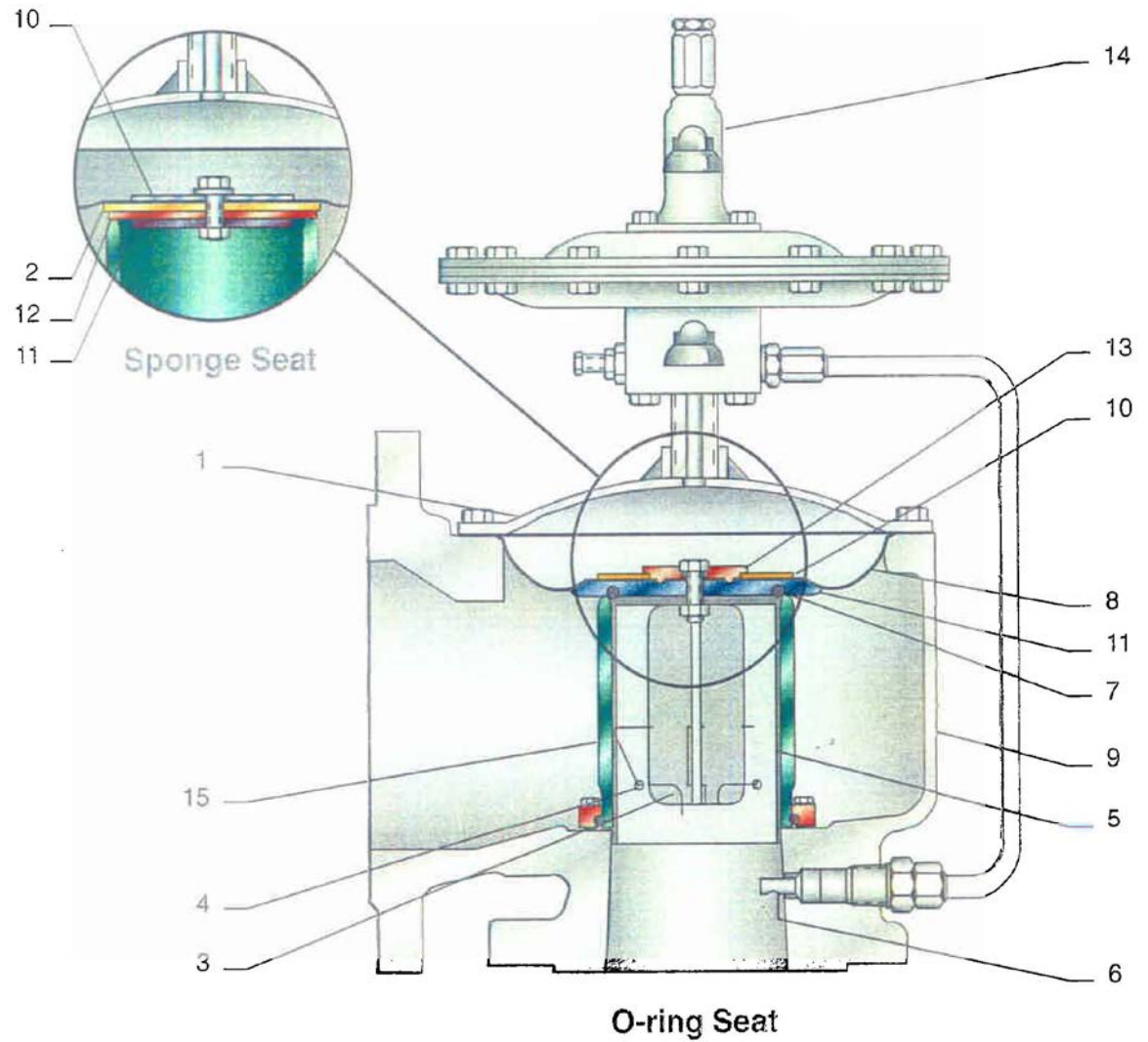
Remotely
Actuated
Pneumatic
or
Solenoid Valve
(NC or NO)



Low Pressure Variations: Series 90 Pilot



Low Pressure Variations: Series 93



Code Update for 21 addenda

- Being added - UG-129(a)(9)
The pilot and main valve of a pilot operated pressure relief valve shall each be marked with the same unique identifier to establish association of both components.
- Work on remote mounted pilots is ongoing





Thanks – questions?

Pictures courtesy of:
Anderson Greenwood
Consolidated Valve