Product and System Troubleshooting

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WGMSC 2026

EMERSON

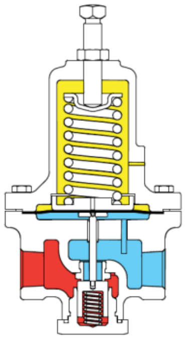
Agenda

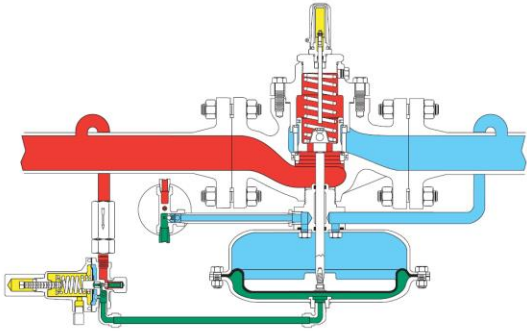
I. General Regulator Review
II. Troubleshooting Process
III. Self Op Troubleshooting
IV. Pilot Op Troubleshooting
V. Relief Valve Troubleshooting
VI. System Troubleshooting
VII. Summary

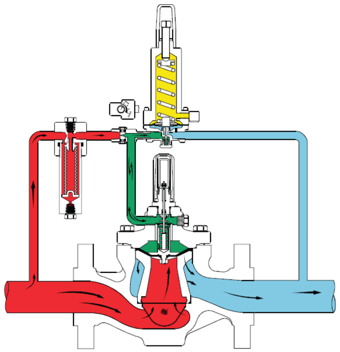
Purpose of a Pressure Regulator

Pressure Reducing

– **To match a downstream flow demand while maintaining a constant outlet (P_2) pressure**

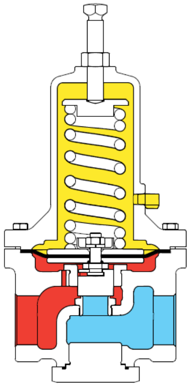


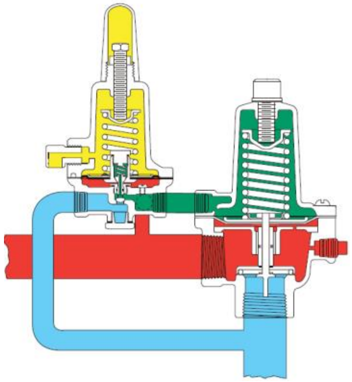


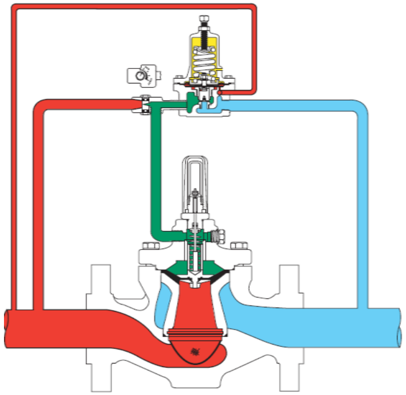


Pressure Relief/Backpressure

– **To match an upstream flow demand while maintaining a constant inlet (P_1) pressure**







Understanding the Types of Issues

Product Issue

- These type of issues **mostly** relate to damage or malfunction of the product's mechanical components
- Examples
  - High lockup/No Lockup
  - Failing Open / Closed
  - Corrosion

Application Issue

- These type of issues **mostly** relate to the system which a regulator was installed into
- Examples
  - Speed of response
  - No lockup
  - Instability

Product Issues can be caused by Application Issues and vice versa

Troubleshooting Process

1. **Define the problem**
   - What is happening / what isn't happening?
2. **Gather the information**
   - Regulator Model Number
   - Process conditions/ specs
   - Detail description of issue
   - How long have had issue
3. **What is the Application?**
   - Size and selection of regulator
   - Is the regulator installed correctly
   - Is everything else in the system installed correctly
4. **Think through the Product operation**
   - Understand the device
   - What components could be causing the problem

Take a systematic approach

Steps in System Troubleshooting

1. Define the problem.

- What is happening / what isn't happening?

Maybe the problem is obvious.

From this photo can you tell what is wrong with the regulator trim?

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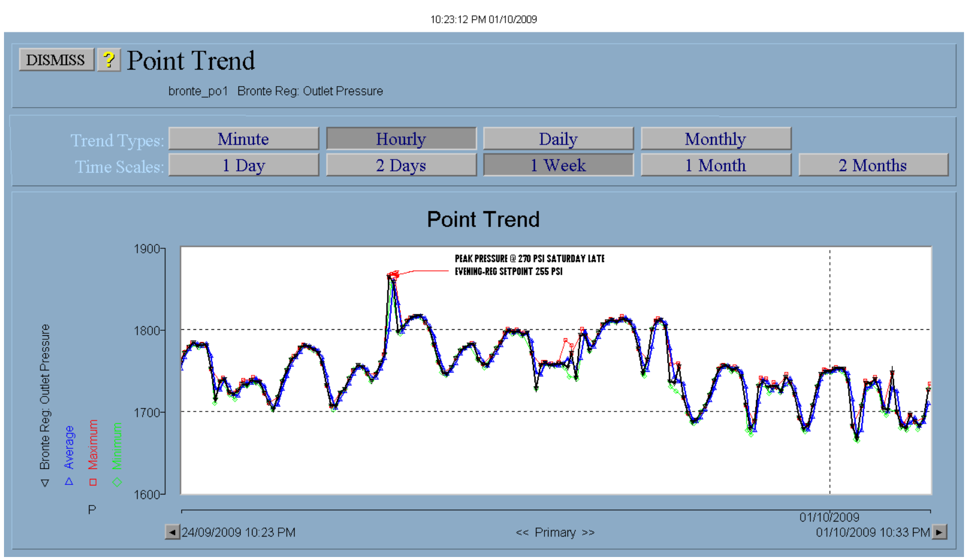
Steps in Troubleshooting

1. Define the problem

2. **Gather the information**
   - **Inlet pressures, outlet pressures, flows, temps (what was going on during the event) (video is helpful)**
   - **Serial information, location of sense lines, inlet lines (photos or video of these locations can be very beneficial)**

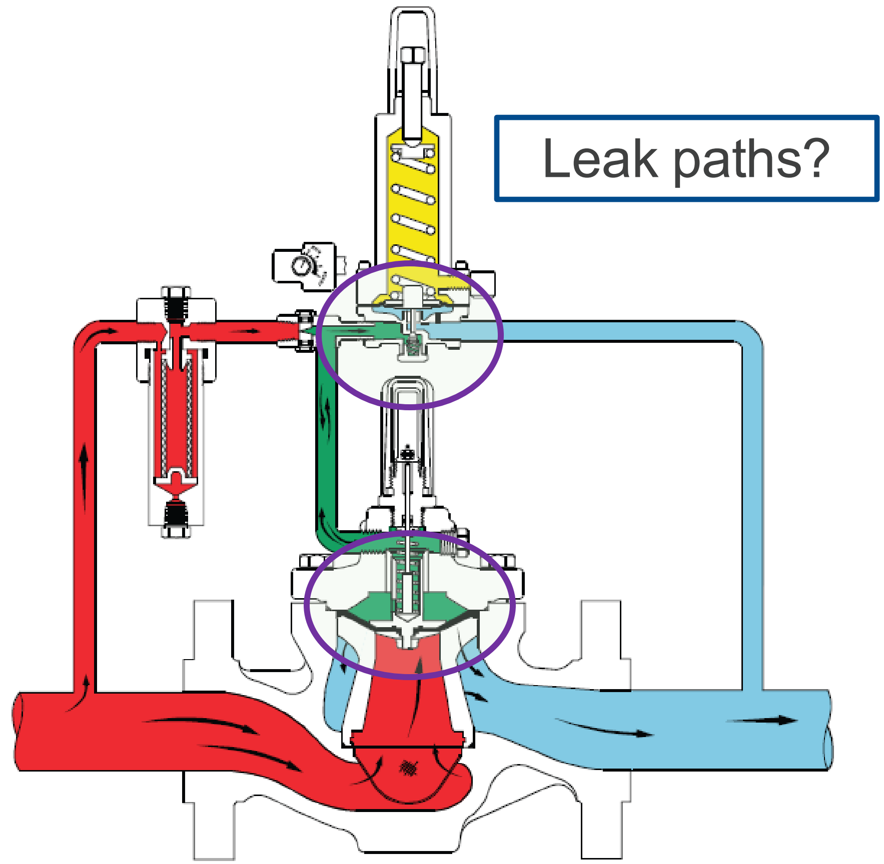


Steps in Troubleshooting

1. Define the problem
2. Gather the information
3. **What is the Application?**
   - **The wrong regulator applied can create problems which seem like a product issue, but is in fact an application issue.**

Steps in Troubleshooting

1. Define the problem.
2. Gather the information.
3. What is the application?
4. **Think through the Product operation.**
   - **Understanding how the product works will help you know where to look for potential problems.**



Troubleshooting Process

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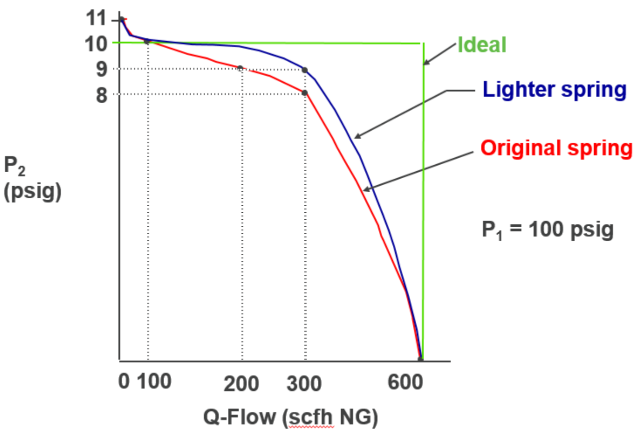
   - Size and selection of regulator
   - Is the regulator installed correctly
   - Is everything else in the system installed correctly
4. **Think through the Product operation**
   - Understand the device
   - What components could be causing the problem

By taking this approach you will best position yourself to get assistance in solving your issue in field!

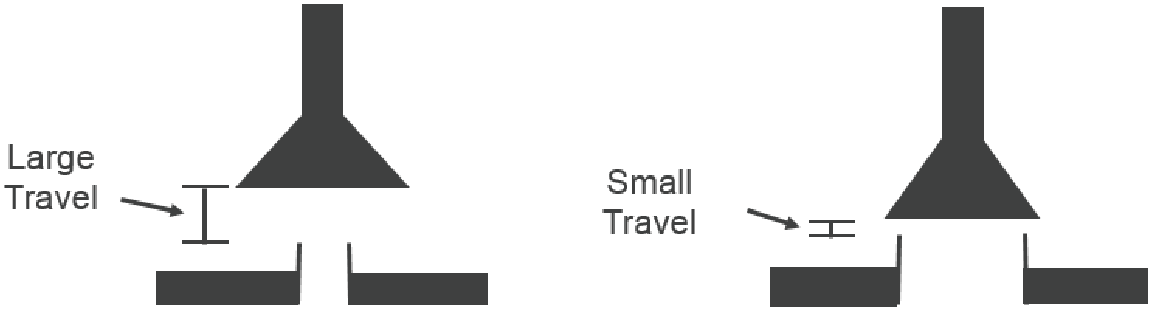
Rules of Thumb for Regulator Selection

1. **Always choose the lightest spring range for accuracy***

PILOT TYPE	OUTLET (CONTROL) PRESSURE RANGE	
	psig	bar
6351	3 to 20 5 to 35 35 to 100	0.2 to 1.4 0.3 to 2.4 2.4 to 6.9
6352	14 in. w.c. to 2 psig 2 to 10	35 mbar to 0.1 bar 0.1 to 0.7
6353	3 to 40 35 to 125	0.2 to 2.8 2.4 to 8.6
6354L(1)	85 to 200	5.9 to 13.8
6354M(2)	175 to 220	12.1 to 15.2
6354H(2)	200 to 300	13.8 to 20.7



2. **Always choose the smallest orifice to reduce inlet sensitivity and stability***



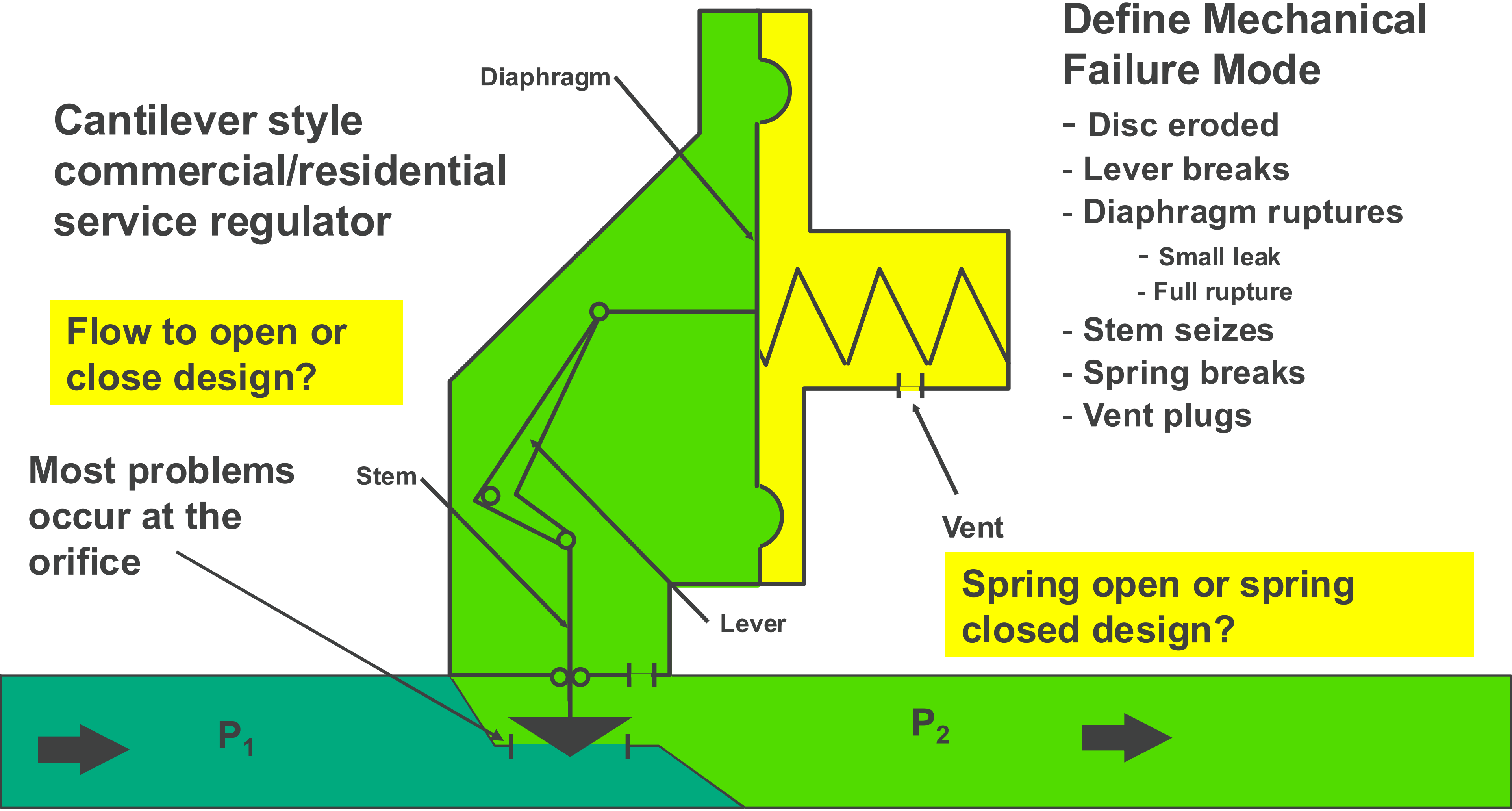
Self Operated Troubleshooting

Self-Operated Regulator Failure Modes

Cantilever style commercial/residential service regulator

Flow to open or close design?

Most problems occur at the orifice



Define Mechanical Failure Mode

- Disc eroded
- Lever breaks
- Diaphragm ruptures
  - Small leak
  - Full rupture
- Stem seizes
- Spring breaks
- Vent plugs

Spring open or spring closed design?

Self-Operated Product Issues

Failure Type	Regulator Symptom	Common
Disc Eroded	High/No Lockup	Yes
Orifice Damaged	High/No Lockup	Yes
Vent Plugged	Sluggish Response/No Response to demand change	No
Lever Breaks	Depending on flow to open or flow to close design (Fail wide open / Fail closed)	No
Diaphragm Leaks	Small leak out the spring case vent and performance impacted	No
Diaphragm Ruptures	P1=P2; Fail wide open	Yes for metal diaphragms
Spring Breaks	Fail Closed or decreased setpoint	No
Stem Seizes	Various issues	No

Self-Operated Application Issues

Issue	Common Causes
High Lockup / No Lockup	Class IV seal or hard elastomer used
Instability	Oversized / Control line placement / Operating outside manufacturers' specification
Outlet pressure shifts w/ inlet pressure	Inlet sensitivity
Not enough capacity	Undersized for the application
Not enough capacity	Wrong configuration used
Speed of response	Control line placement or control line configuration

Solving your Instability Problems: Self-Operated

- Go up one spring range
  - Heavy spring desensitizes the regulator
  - Impacts accuracy

- Change to a smaller orifice size
  - 2nd rule of thumb!

- Change models
  - Sometimes a model change will eliminate problem

- Control line placement
  - Non turbulent location

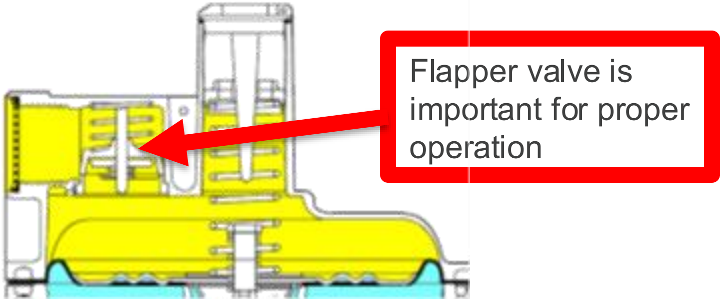
Self-Operated: System Stability / Noise Issues

Can you define the noise heard?

Buzz	Pants	Hammer	Chugs
Surges	Vibrates	Hunts	Honks

<u>Noise is common when:</u>

- Cap removed
- Flapper valve broken
- High P_1 with orifice too large for inlet
- Improper vent piping

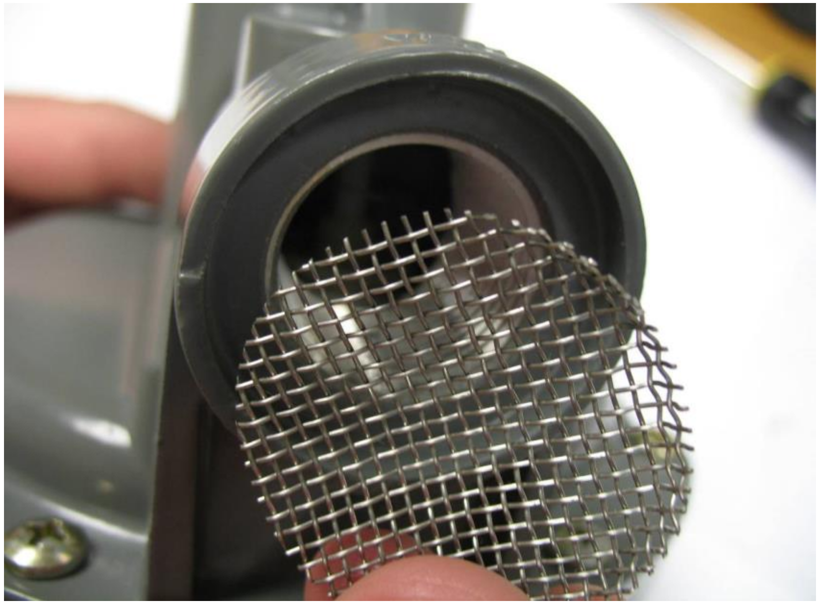


Spring Case Assembly Design

Internal SST flapper valve spring

<u>Spring Case Vent Assy</u>
- **Slight restriction in spring case outbreathing/inbreathing**
- **Flapper valve design**
- **Creates stability**

Screen Vent Installation

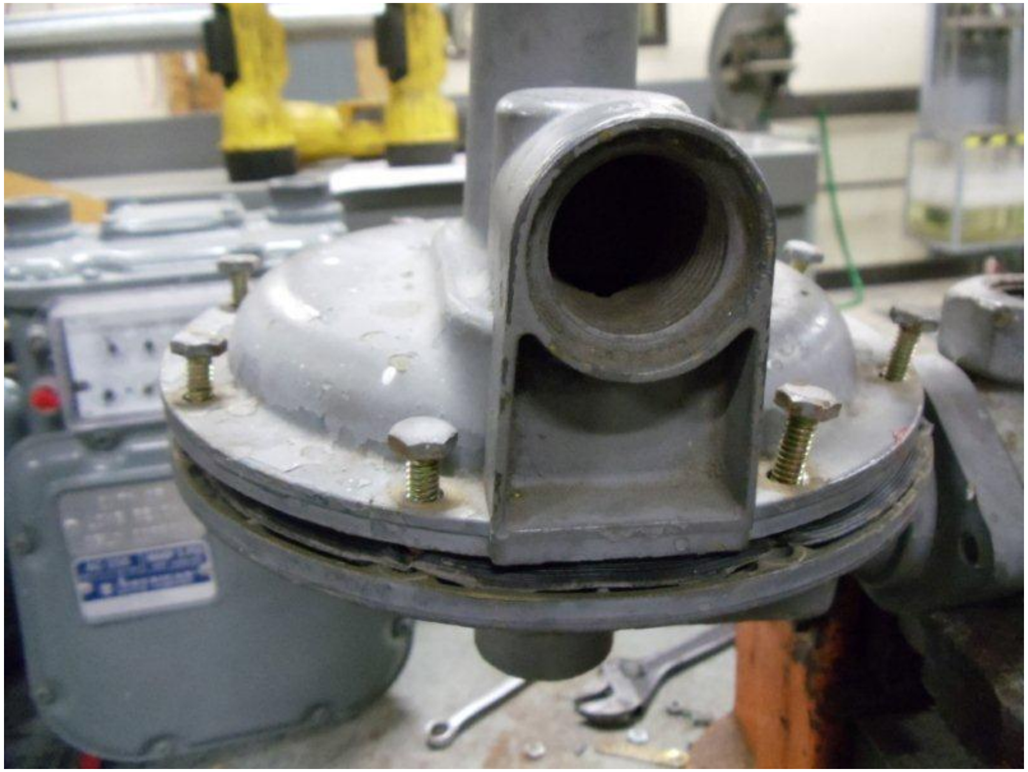


Screen Design
• Meets ANSI B109.4 and CSA 6.18

Assembly Steps
- Install screen into vent hole with curved side in

The vent opening shall be designed to resist blockage by ice, sleet, snow and insects, and be resistant to the formation of corrosion residue on the surfaces of screen ports.
ANSI B109.4 – 4.8.2

Damaged Flapper Assembly and Missing Screen

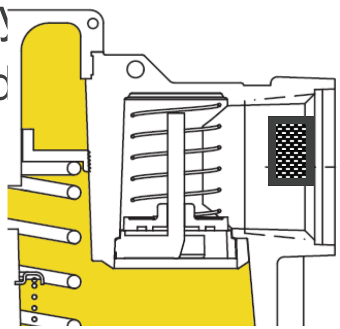


Inside the Damaged Regulator

As found by a utility worker…

Vent Piping Best Practice

- **Restricted vent piping can cause the following:**
  - Slow speed of response
  - Instability
  - Reduced



1 inch pipe

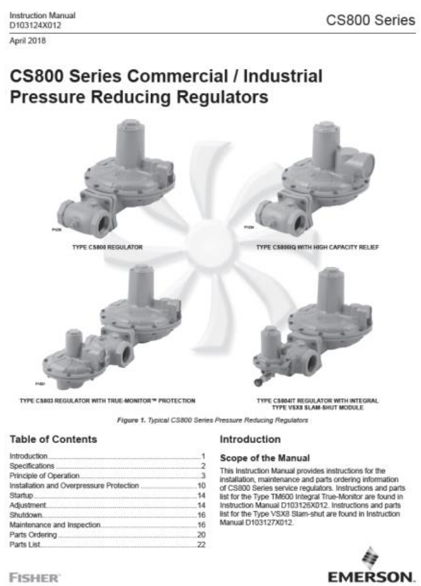
<u>Vent Pipe Guidelines – w/o IRV</u>

- **Use same diameter pipe as vent**
- **Increase 1 pipe size for every 50’**
- **1 pipe elbow equals 3’ of straight pipe**

<u>Vent Pipe Guidelines – w/IRV</u>

- **Use same diameter pipe as vent**
- **Increase 1 pipe size for every 10’**
- **1 pipe elbow equals 3’ of straight pipe**

They Walk Among Us….


Instruction Manual
D103124X012
CS800 Series
April 2018

CS800 Series Commercial / Industrial Pressure Reducing Regulators

TYPE CS800 REGULATOR
TYPE CS800IQ WITH HIGH CAPACITY RELIEF
TYPE CS803 REGULATOR WITH TRUE-MONITOR™ PROTECTION
TYPE CS804IT REGULATOR WITH INTEGRAL TYPE VSX8 SLAM-SHUT MODULE

Figure 1. Typical CS800 Series Pressure Reducing Regulators

Table of Contents

Introduction

Scope of the Manual

This Instruction Manual provides instructions for the installation, maintenance and parts ordering information of CS800 Series service regulators. Instructions and parts list for the Type TM600 Integral True-Monitor are found in Instruction Manual D103126X012. Instructions and parts list for the Type VSX8 Slam-shut are found in Instruction Manual D103127X012.

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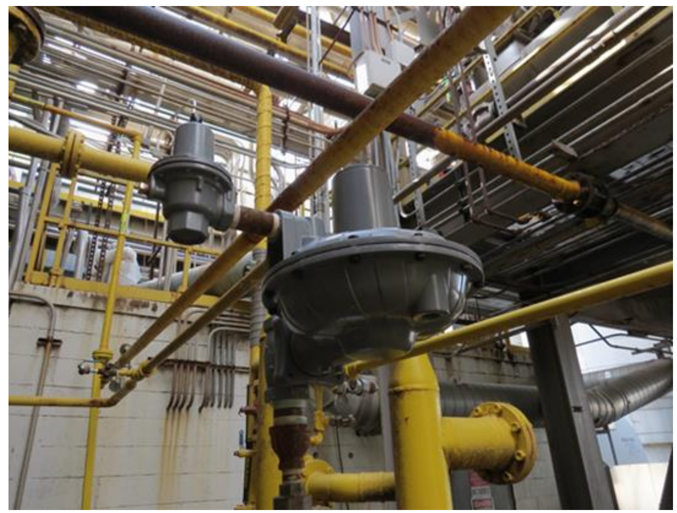


What is wrong with this installation?

<u>Be careful not to put restrictions in the vent of the regulator</u>

Proper Regulator Installations?

Solving Your Instability Problems: Self-Operated

- Go up one spring range
  - Heavy spring desensitizes the regulator
  - Impacts accuracy

- Change to a smaller orifice size – **Best Practice**

- Check vent piping

- Control line placement
  - Non turbulent location

- Add a dampener or a full-bore needle valve on the control line to dampen the pressure signal getting to your diaphragm

- Change models
  - Sometimes a model change will eliminate problem

Troubleshooting Question

Question:

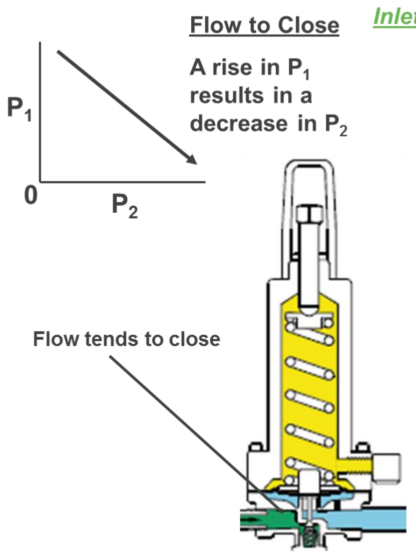
My regulator's setpoint varies widely during operation. My inlet fluctuates from 100 psig to 350 psig, and I see a shift in downstream pressure of +/- 5 psig. What's happening?

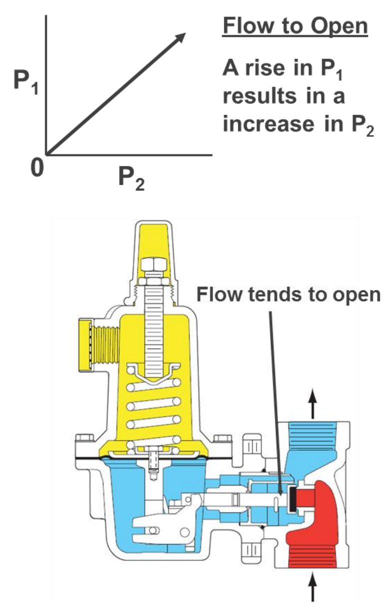
Troubleshooting Question

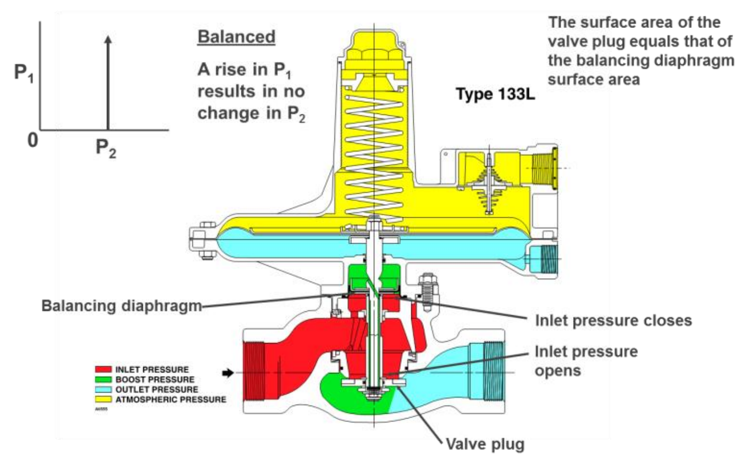
Answer:

This might have something to do with how the regulator is operating. P2 set point can be influenced based upon the flow-action and the orifice area. You could look into balanced option or reduce the orifice area if possible.

Inlet Sensitivity



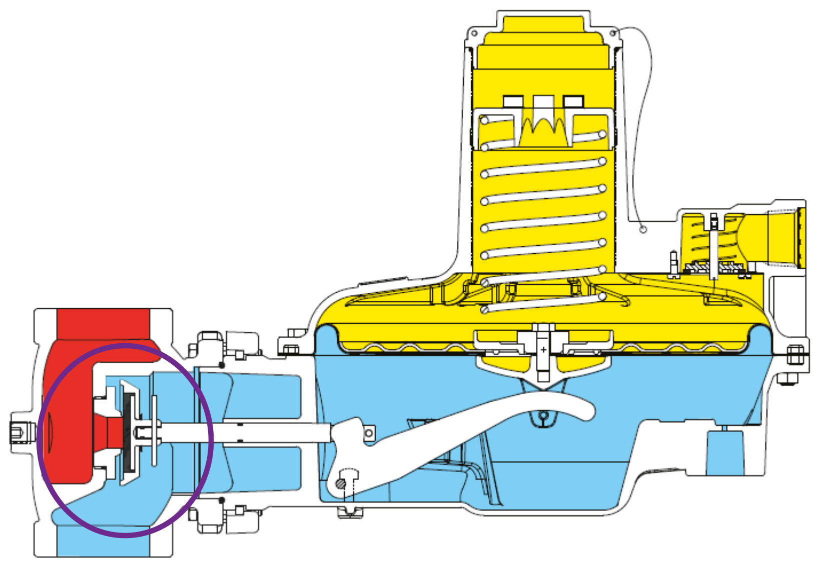




Troubleshooting Question

Question:

Hey AE team, I have a customer that accidently over-pressured the outlet of a CS800IN during lockup test at the installation. Now it isn't locking up, what do you think happened?



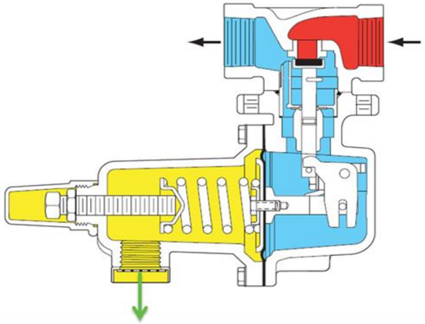
Troubleshooting Question

Answer:

Check the disc for damage. When you over-pressure self operated regulators, you can potentially cause damage to the disk/orifice.

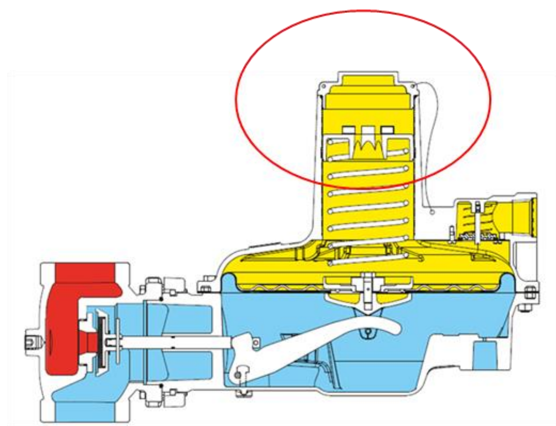
Other Common Issues

- **Vents should always be pointed down**
  - Away from the sky to prevent rainwater from filling spring case
  - Moisture will drain away
  - Avoid placement to close to the ground or meter
  - Can void warranty



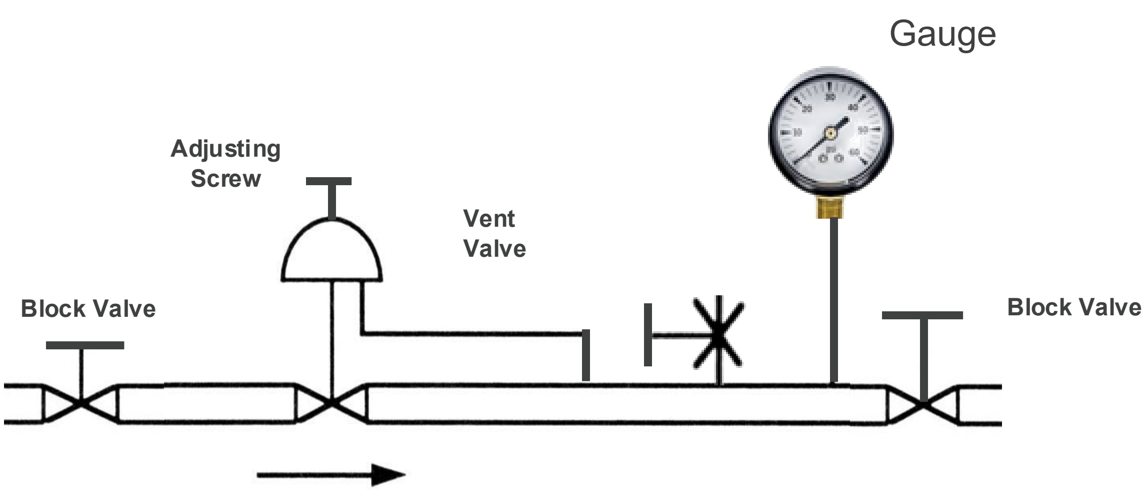
Other Common Issues

- **Adjusting Screw Caps and Vent Stabilizer**
  - Can cause instability when operating if cap is removed
    - Regulator reacts too “fast”
    - IRV non-functional in certain failure modes
  - Stabilizers help the regulator breathe
    - Blocked open/closed can cause instability



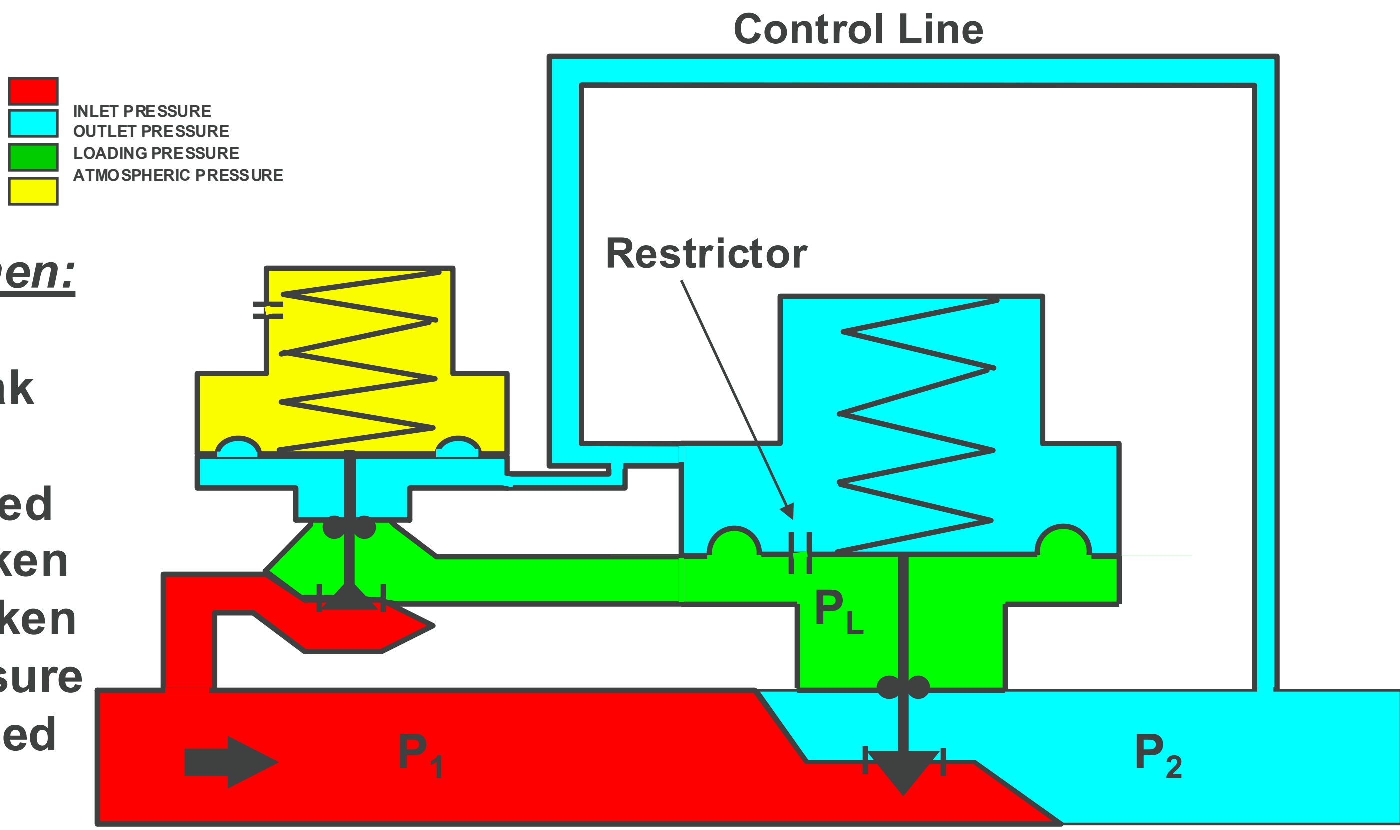
Establishing Setpoint – Best Practice

a) Close downstream block valve
b) Open vent valve to allow ~ 50 scfh of flow using spud
   a) Note: this amount will vary depending on size of orifice
c) Open upstream block valve – slowly
d) Adjust pressure using adjusting screw and gauge
   i. Clockwise to increase
   ii. Counter-clockwise to decrease
e) Once setpoint is achieved, slowly close vent valve to check for lockup
f) Repeat steps “B” and “E” to verify setpoint and lockup



Pilot Operated Troubleshooting

Loading Style Pilot-Operated Regulator Failure Modes



What happens when:

- $P_1 = P_2$
- Control line break
- Pilot failed open
- Restrictor plugged
- Main spring broken
- Diaphragms broken
- No pilot P_1 pressure
- Control line closed

Spring open or spring closed design?

Flow to open or close design?

Loading Style Product Issues

Failure Type	Regulator Symptom	Common
Control Line Break	Regulator will fail wide open	No
Control Line Closed	Regulator will not respond	No
Inlet Filter Clogged or inlet supply closed to pilot	Regulator will not open	No
Restrictor Plugged	Regulator will not close	No
Internal Ice buildup	Regulator will either fail open or closed	No
External Ice buildup over vent	Sluggish response	No
Orifice/Plug damage	Regulator will not lockup	Yes
Main diaphragm rupture	Regulator will not open	No
Pilot diaphragm rupture	Regulator will fail wide open	No

Loading Style Application Issues

Issue	Common Causes
Low Flow Instability	Oversizing / Regulator type / Control line placement
Instability	Control line / Downstream pipe volume / bleed line location
Speed of Response	Type of regulator/pilot chosen for application
Outlet pressure accuracy	Undersized, minimum differential violated, inlet sensitivity, gain
Noise	High pressure drops at high flows
Buzzing	Harmonic resonance
Freezing	Water content in my gas
Lockup	Debris/fallout

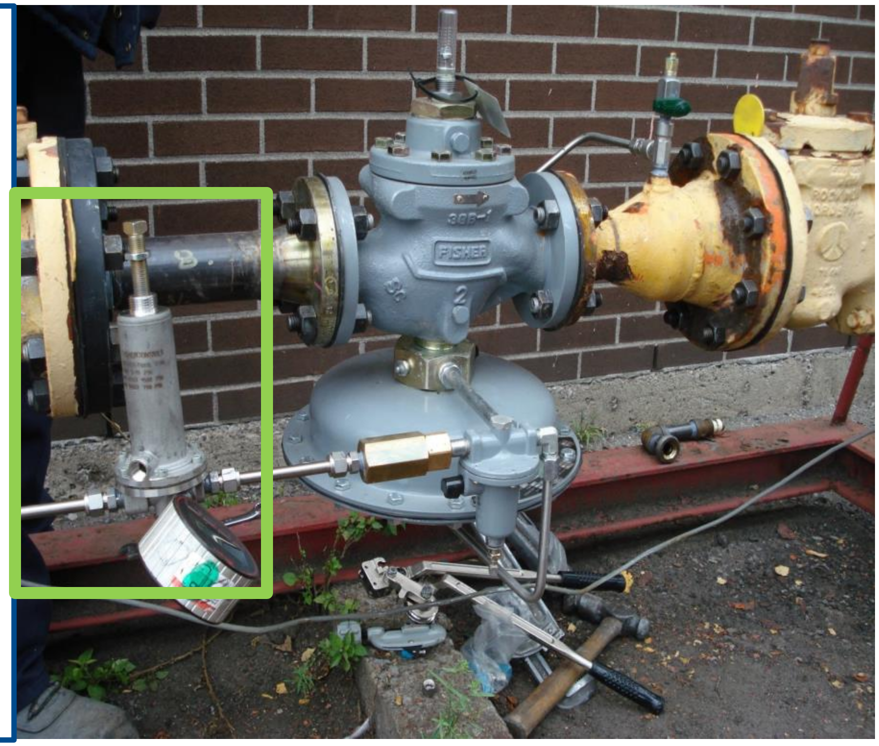
Solving your instability problem

- Install a ‘Pilot Supply’ regulator
  - Decreases gain / sensitivity
  - Lowers/eliminates inlet sensitivity
- Move to larger restrictor size
  - Decreases gain / sensitivity
- Next heavier control spring
  - Decreases gain / sensitivity
- Installing full bore needle valve on control line
  - Dampens signal going to pilot for slower response
  - Mostly used in Liquid service

Pilot Supply Regulator

Guidelines for Pilot Supply Regulators

- **Ensure adequate capacity to prevent starving the pilot and preventing max flow**
- **Match pressure ratings on inlet and outlet connections to ensure adequate safety**
- **When setting a pilot supply, ensure that there is adequate pressure to the pilot or excessive droop can be a result**
- **Call us for support**



Will not work with unloading style regulators such as an EZR

Pilot Supply Regulator to Reduce Gain

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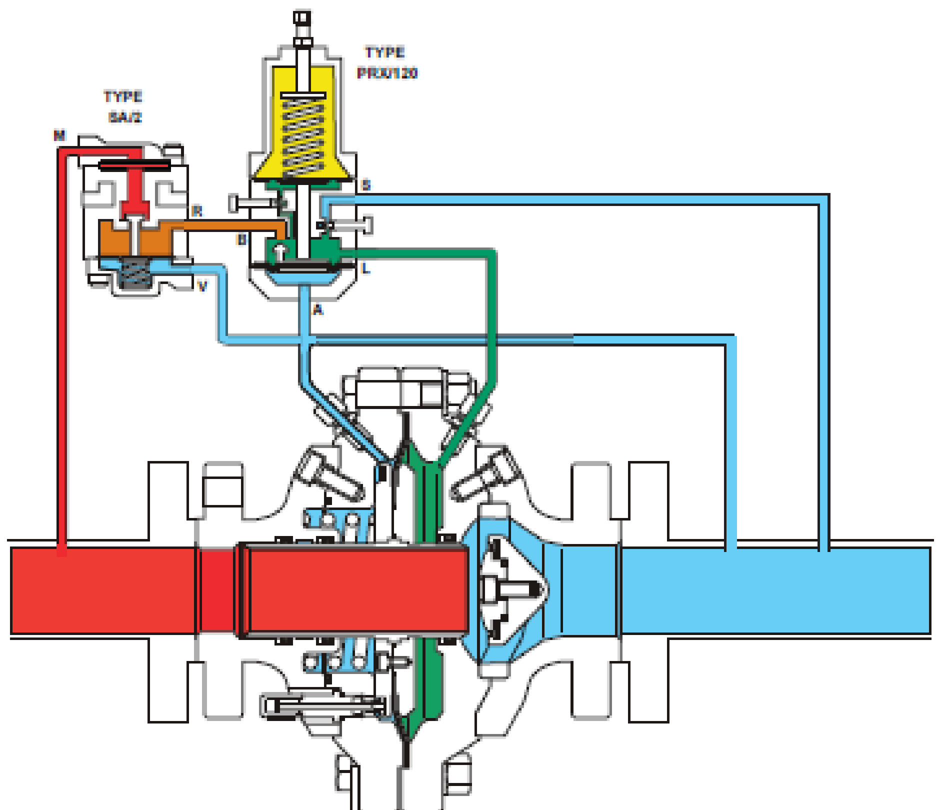
Sulfur Buildup

- Does anything stand out in the picture below?

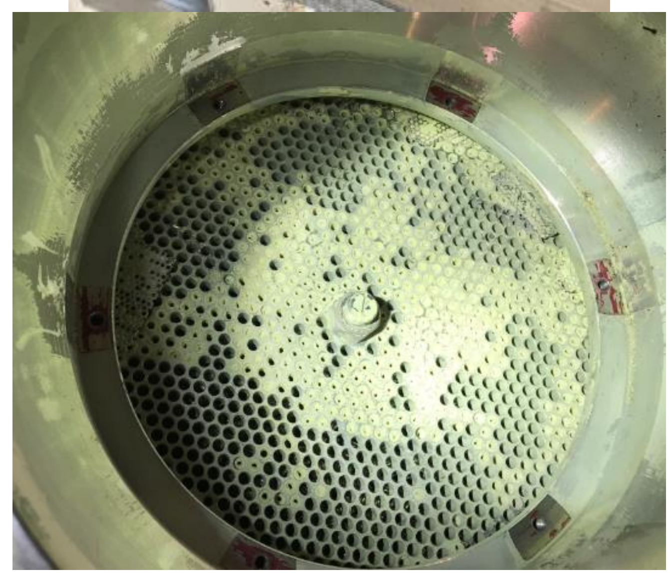
Troubleshooting Loading Style

Hello AE Team,

Can you help assist in a startup. The customer needs to rebuild a FL valve because they noticed that it would not lockup. Can you assist and be on site for the startup?



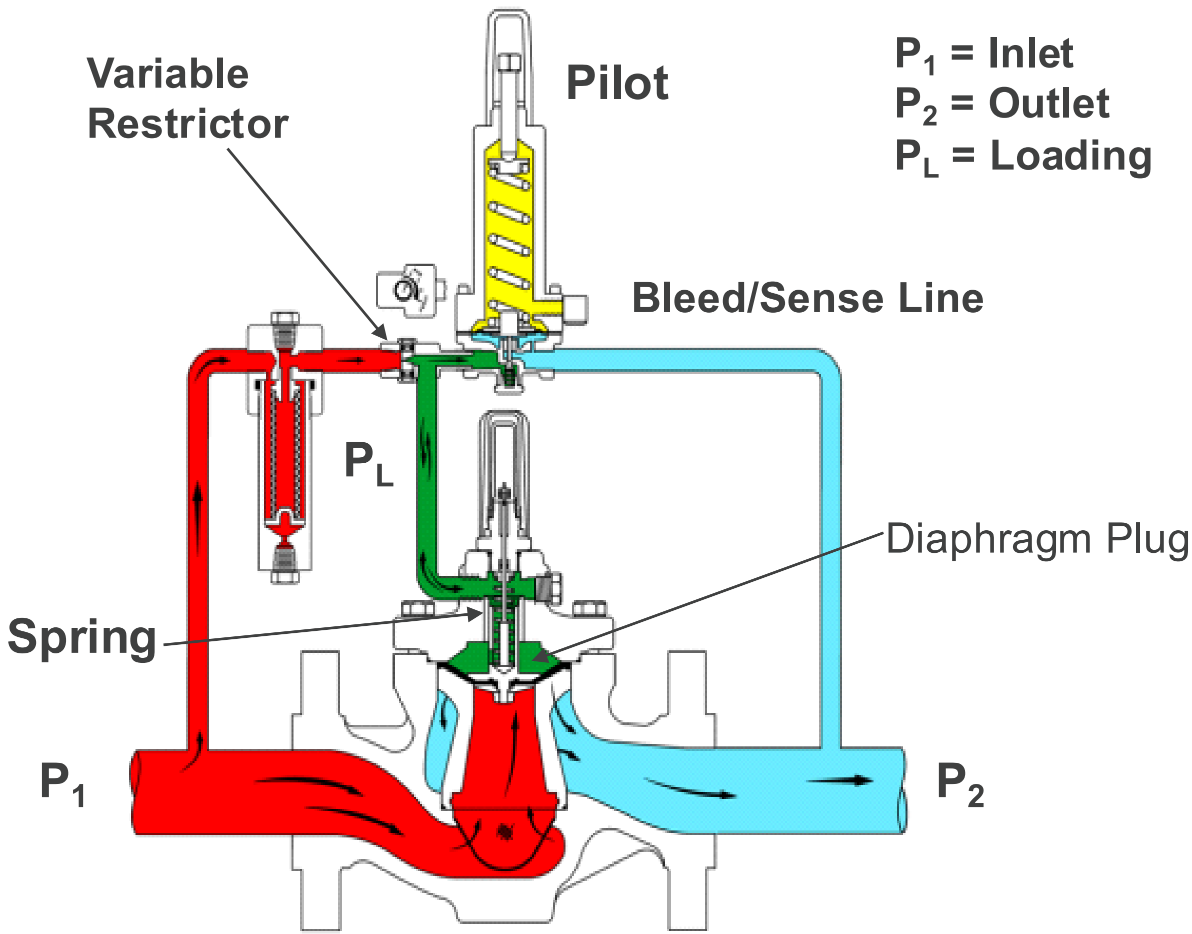
Troubleshooting Loading Style



Flexible Element Pilot-Operated Regulator Failure Modes

What happens when:

- $P_1 = P_2$
- Control line break
- Pilot failed open
- Restrictor Plugged
- Main spring broken
- Diaphragms broken
- No pilot P_1 pressure
- Control line closed



Spring open or spring closed design?

Unloading Style Product Issues

Failure Type	Regulator Symptom	Common
Control Line Break	Regulator will fail wide open	No
Control Line Closed	Regulator will fail closed	No
Inlet Filter Clogged or inlet supply closed to pilot	Regulator will fail open	No
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Internal Ice buildup	Regulator will either fail open or closed	No
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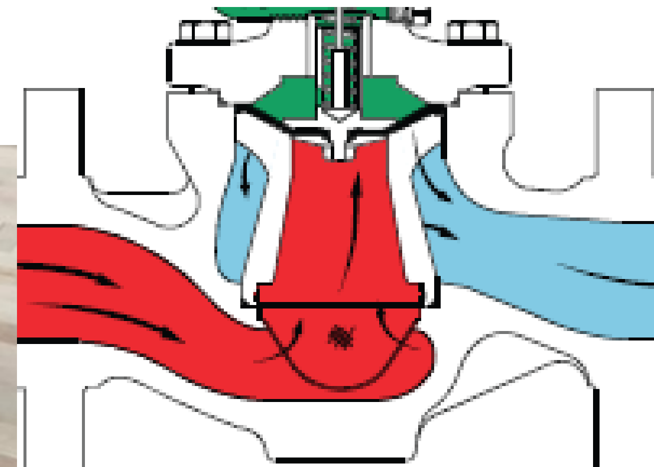
Outlet pressure accuracy	Undersized, minimum differential violated, inlet sensitivity, gain
Buzzing	Harmonic resonance
Freezing	Water content in my gas
Lockup	Debris/fallout

Unloading style / Boot Style Regulator Failures

- Damaged Boots
  - Debris
  - High pressure drops
- Constant flow rate and boot takes a “set”
  - Wide-open flow condition
- Gas entrainment into the rubber
  - Causes ballooning
- Bubba uses too much grease in upstream plug valve (dirt collector)
- Hydrates and Oils
  - Cause weakening/swelling of elastomers
- Incorrect Assembly

Dirt/Poor Filtration

Dirty gas blew the inlet filter and destroys diaphragm and plugs cage

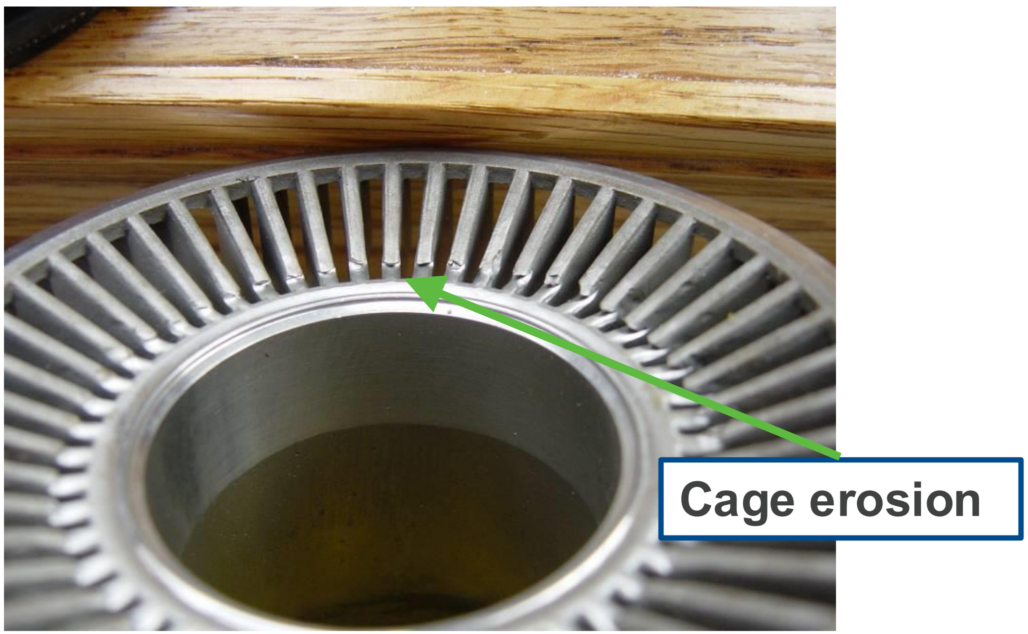


Debris-Damaged Diaphragm from Boot Style Regulator

- Debris in pipeline
- Fabric failure

Elastomer and Cage Erosion

- **Large particles in the gas stream destroy the rubber diaphragm and cage**
- **High pressure drops can cause prematurely wear diaphragm**



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Boot Style Failure

- Gas entrainment
  - Ballooning/bubbles occur when station is depressurized and gas is trying to escape

- Boot took "set"
  - Long periods of the boot in wide open position creates a situation where the boot will not be able to control
  - Not applicable for the EZR

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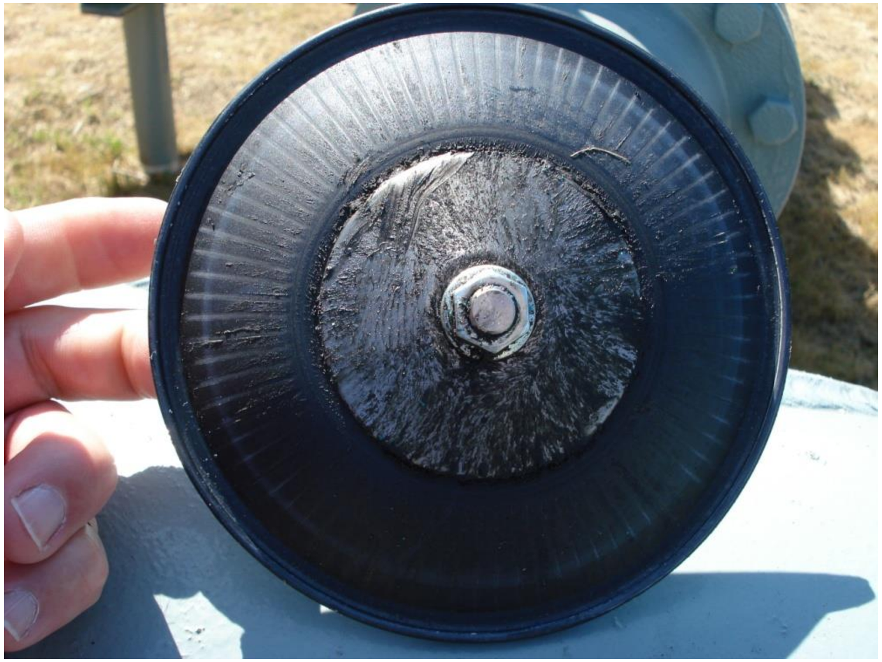
Overzealous Grease

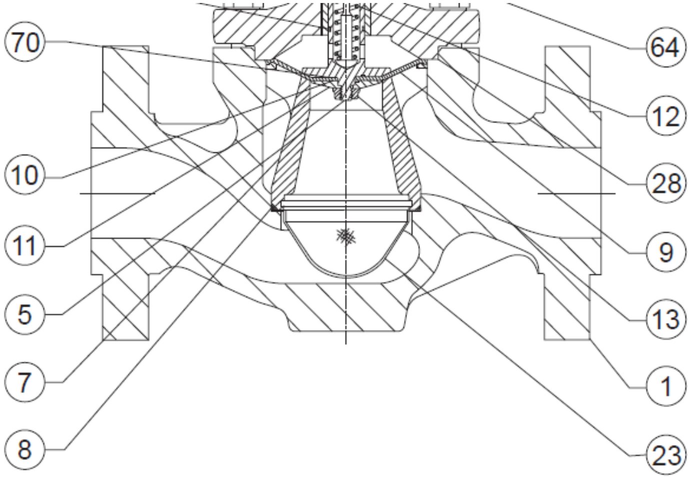


Too much grease in the upstream plug valve ends up in the regulator. Different installations.

Hydrates and Oils

Oils and other liquids can swell the diaphragm and o-rings.

Assembly Incorrect – 2 Different LDCs



Boiler Loads

Hello AE team,

I have an EZR in a boiler application. When the boiler kicks on, the pressure drops quickly and trips the solenoids on the boiler. What is the issue? It is sized correctly, so I don't know what is happening.

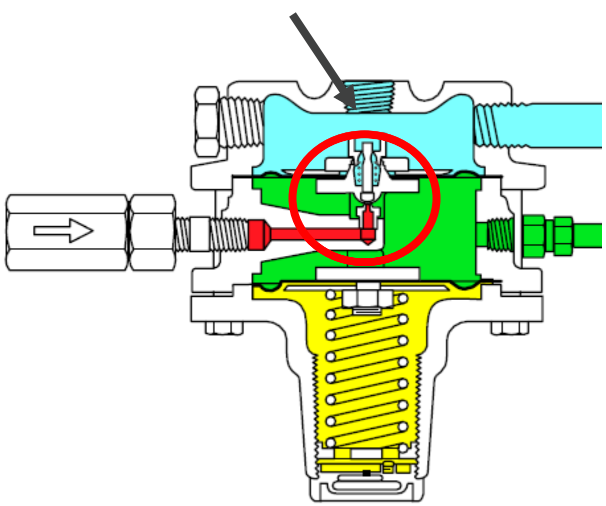
Boiler Loads

Answer:

The sudden pressure drop in the system is due to a speed of response issue. The EZR is an unloading style regulator, and the slowest regulator we produce. It is good for more constant demand applications such as a district station.

I would suggest a loading style pilot op regulator (if a self op won't work) with the 61L pilot. It provides a much faster speed of response.

Quick dump bleed



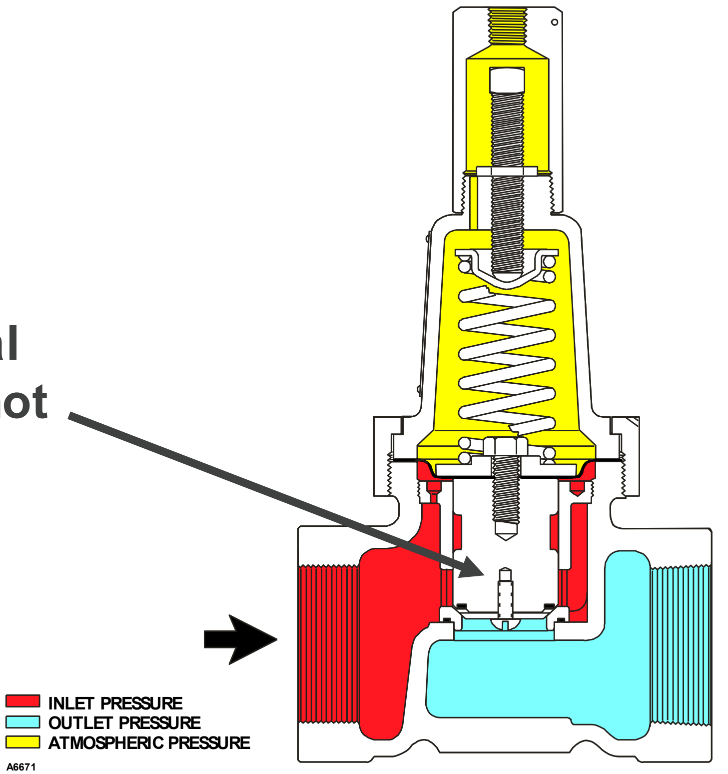
Relief Valves

Relief Valve Failure Modes

- Spring to close
- Valve plug sticking
- High buildup

Always use OEM original replacement parts and not replicators

TYPE 1805



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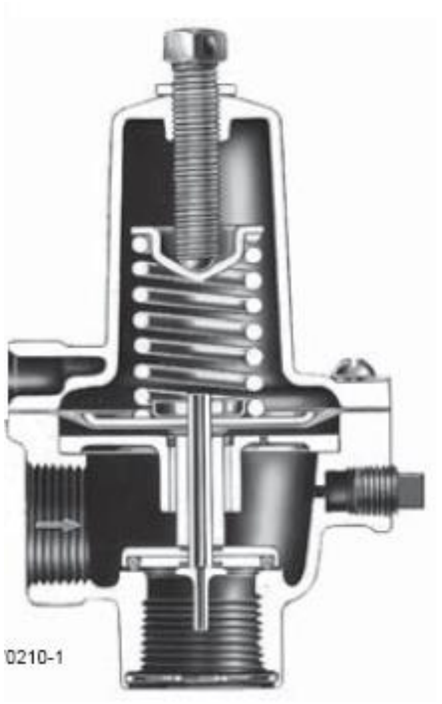
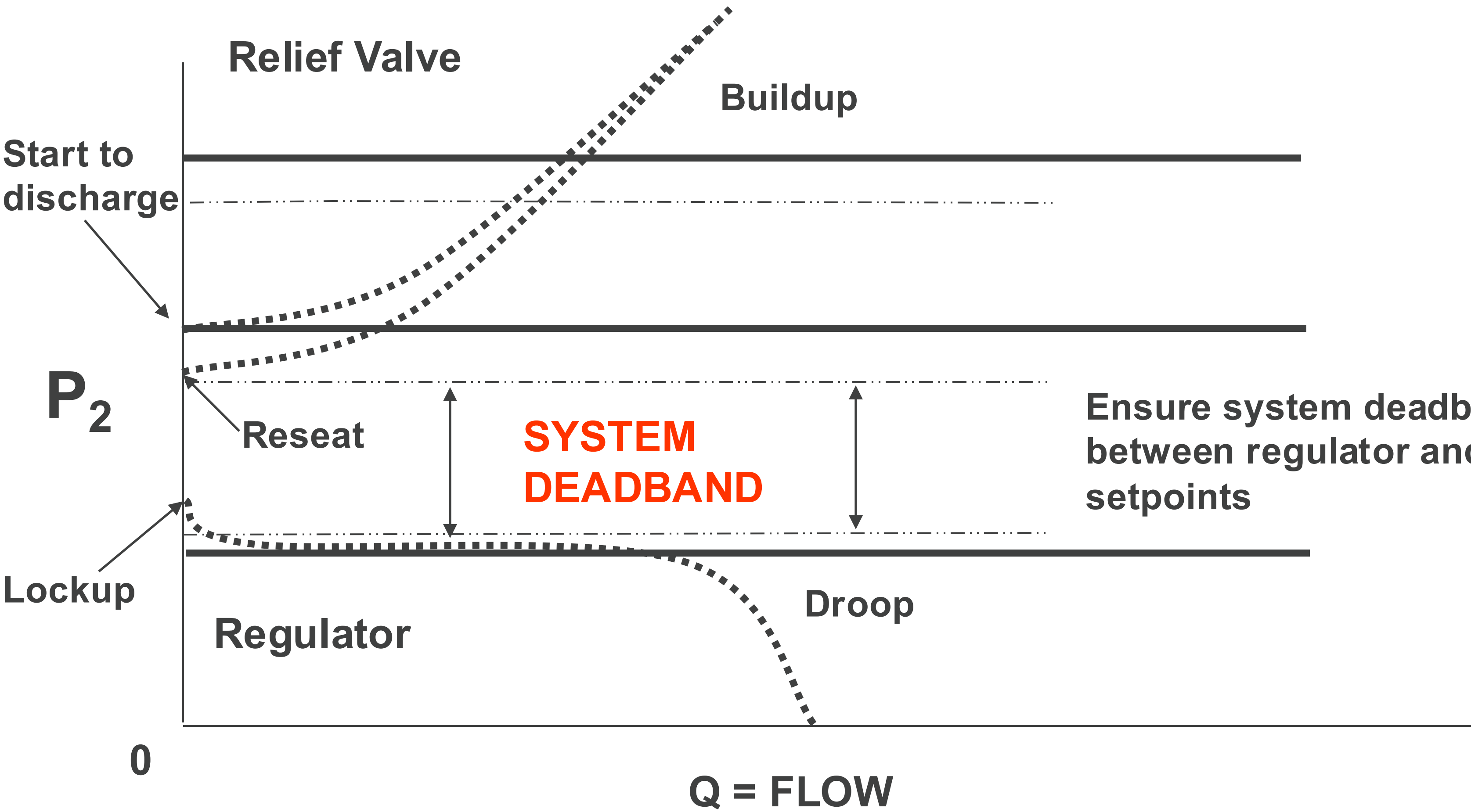
Application Problems With Relief Valves

- Weeping relief valves
  - Thermal expansion of downstream gas
  - Relief setpoint too close to regulator setpoint
  - Failed regulator(orifice, disk)



Regulator and Relief Setpoint Considerations



Ensure system deadband between regulator and relief setpoints

Regulator and Relief Setpoint Considerations

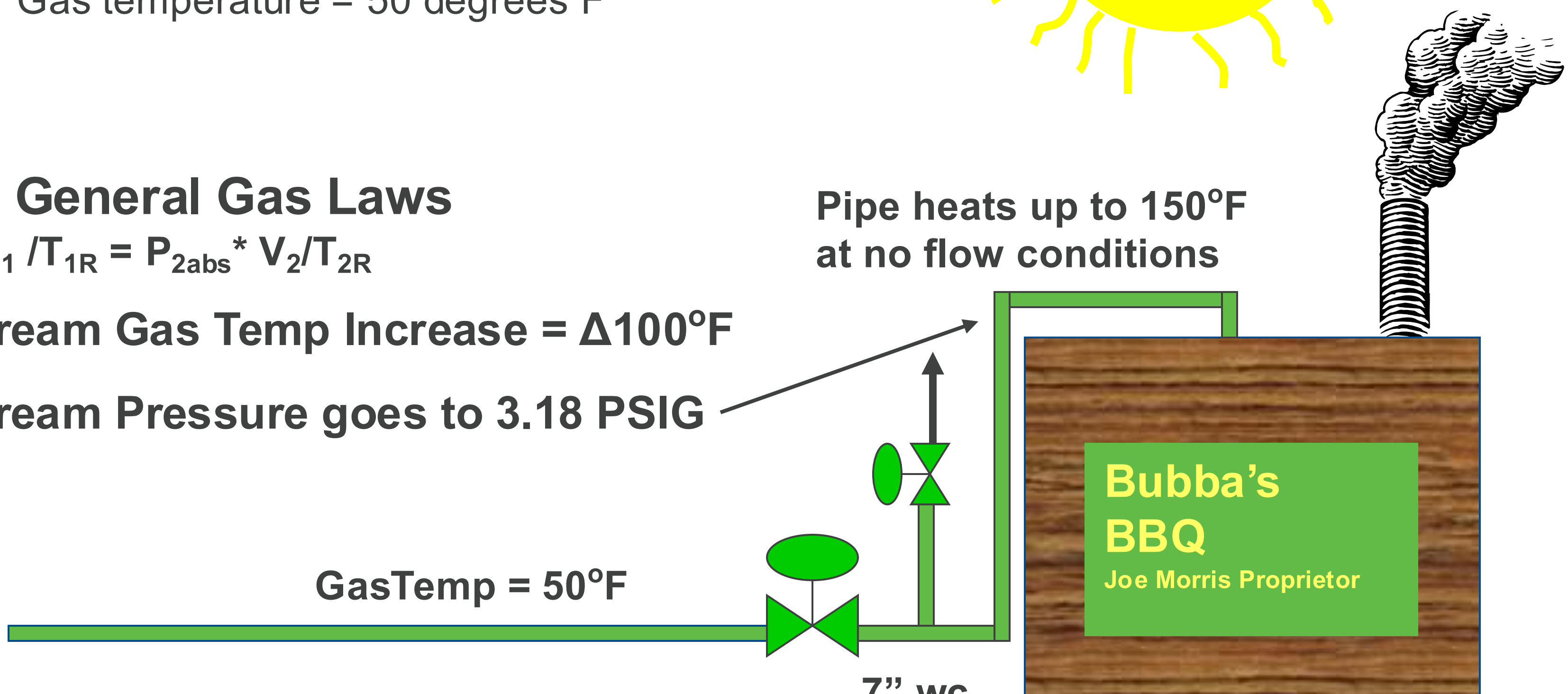
- Temperature Changes
  - Example:
    - Regulator set at 7” WC
    - Relief set at 14” WC
    - Gas temperature = 50 degrees F

Apply General Gas Laws

$P_{1abs} * V_1 / T_{1R} = P_{2abs} * V_2 / T_{2R}$

Downstream Gas Temp Increase = Δ100°F

Downstream Pressure goes to 3.18 PSIG

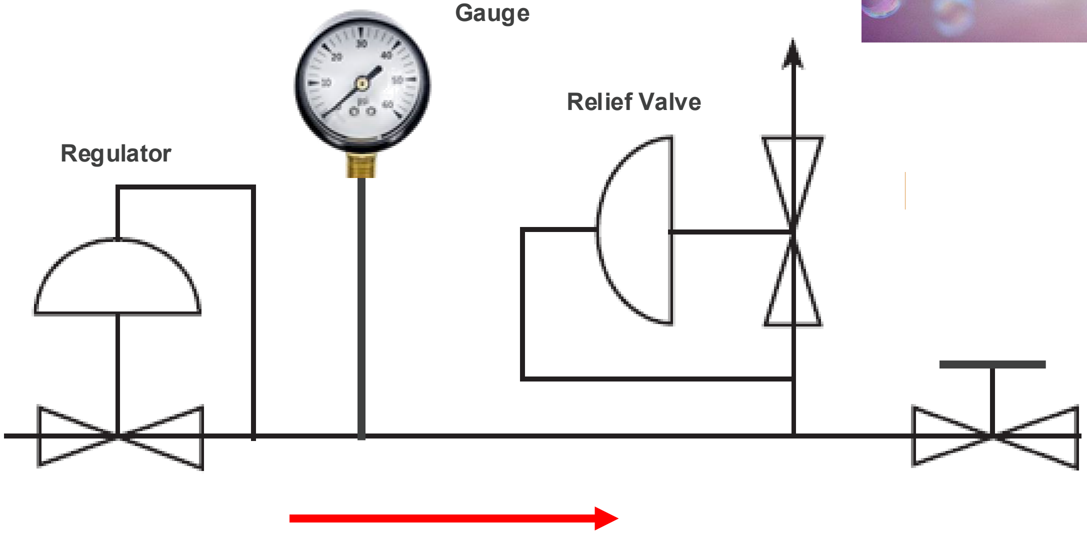


Establishing Setpoint – Best Practice

a) Close downstream block valve if relief is inside of the station

b) Increase inlet pressure until a steady stream of repeatable bubbles appears – this is setpoint

c) You can open farther to open the relief valve or reduce inlet pressure to reseat the relief valve; the relief valve will reseat at bubble tight below the original setpoint



System Troubleshooting

Regulator System Troubleshooting

- Installation Problems and Best Practice
  - Control Line
  - Vent piping
- Freezing
  - Internal
  - External
- Freeze Prevention Methods

Control Line Installation

Improper control installation can cause a regulator to cycle control the wrong pressure or respond slowly. Control lines are also called sense lines and static lines.

Plan the installation ahead of time using these guidelines:

- Make the control line as short and straight as practical
- Connect the control line 6 to 10 pipe diameters downstream of a turbulence generator (valve, tee, elbow, swage)
- Connect the control line to the point where the pressure is to be controlled

Control Line Tips

- **Control Line Diameter**

  The control line diameter should be selected to match the connection provided on the regulator. If the control line is long (over 10 feet), the size should be increased.

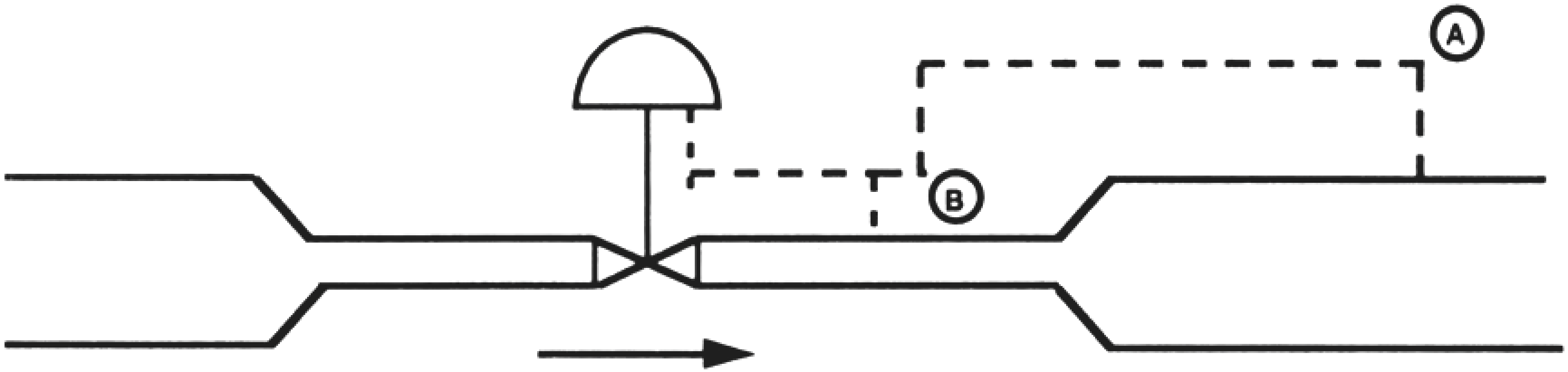
- **Control Line Length**
  - Direct-Operated Regulators

    The control line can be any length. If the system is subject to quick load changes, friction in a long control line may delay the pressure wave and slow the regulator response time.

  - Pilot-Operated Regulators

    The control line can be any length. If the control line is over 10 feet long, the diameter may be increased. A long, small diameter control line can restrict pilot bleed gas flow.

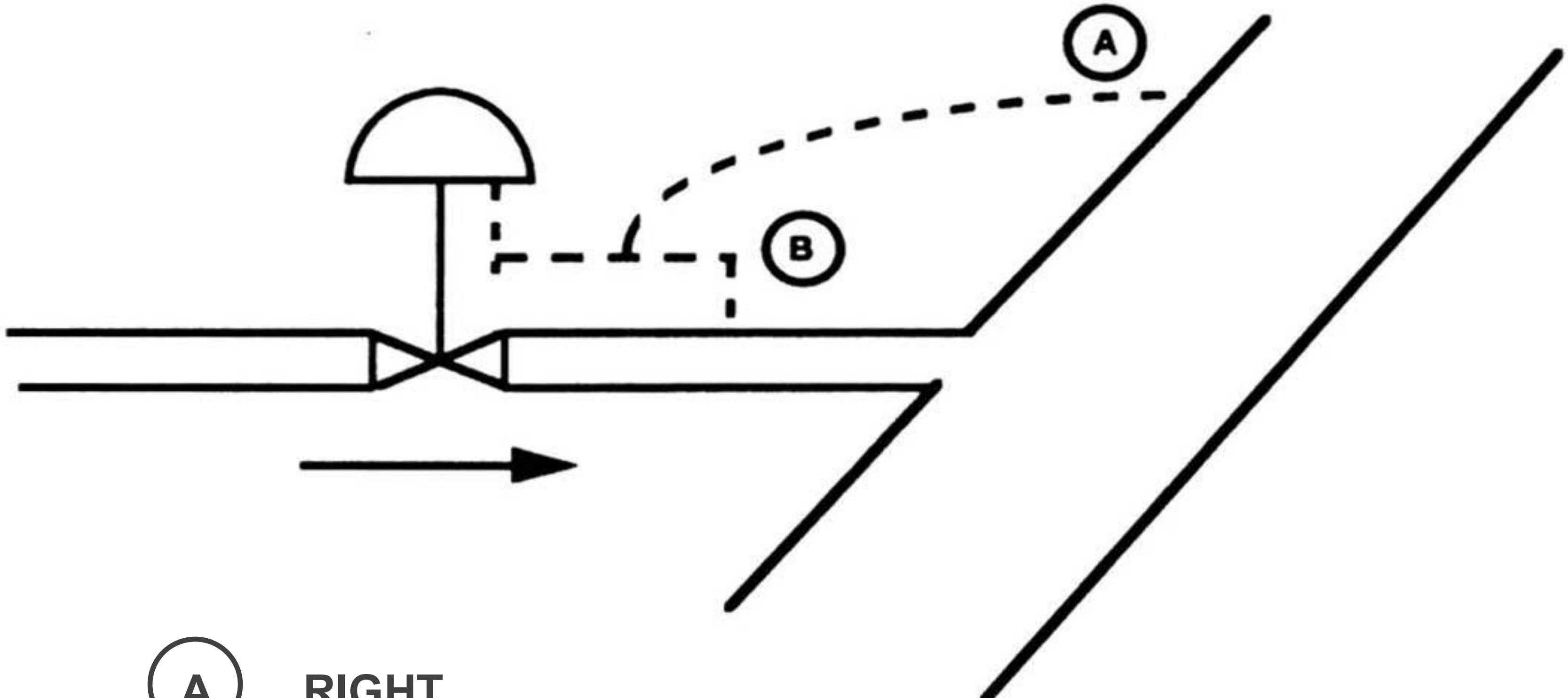
Regulator In Swages



A RIGHT

B WRONG – PRESSURE MAY BE LOWER IN THE SMALLER PIPING DUE TO HIGHER VELOCITY

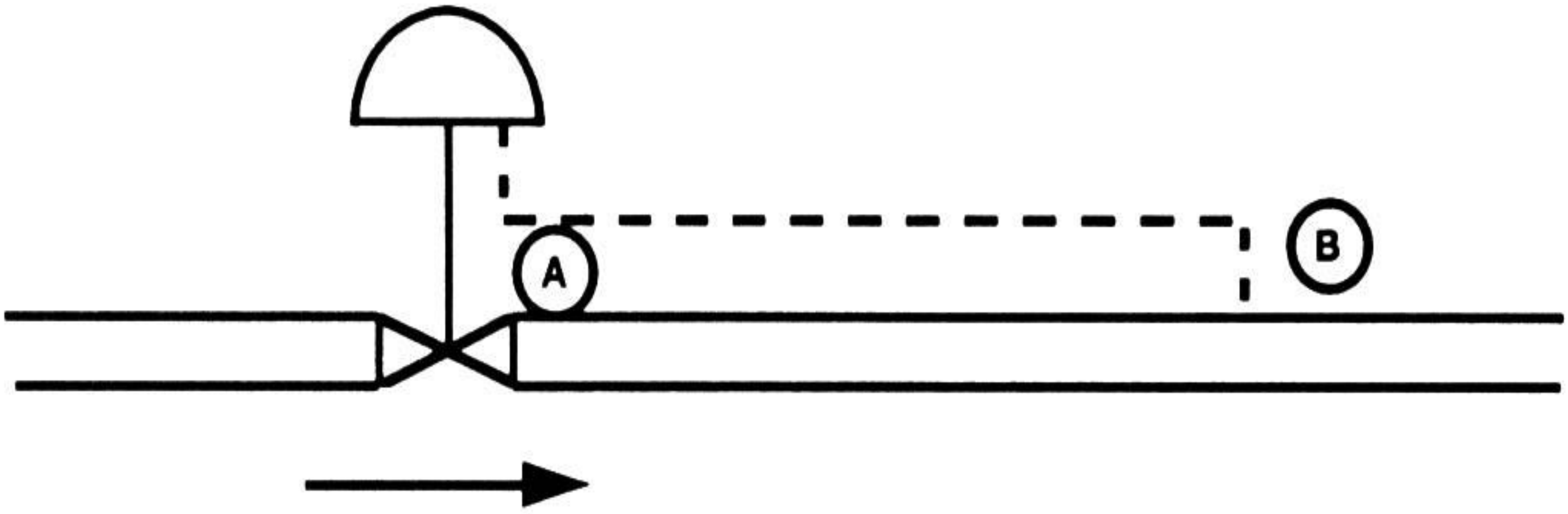
Regulator Supplying to Large Header



A RIGHT

B WRONG – PRESSURE MAY BE LOWER IN THE CONNECTING PIPING DUE TO HIGHER VELOCITY

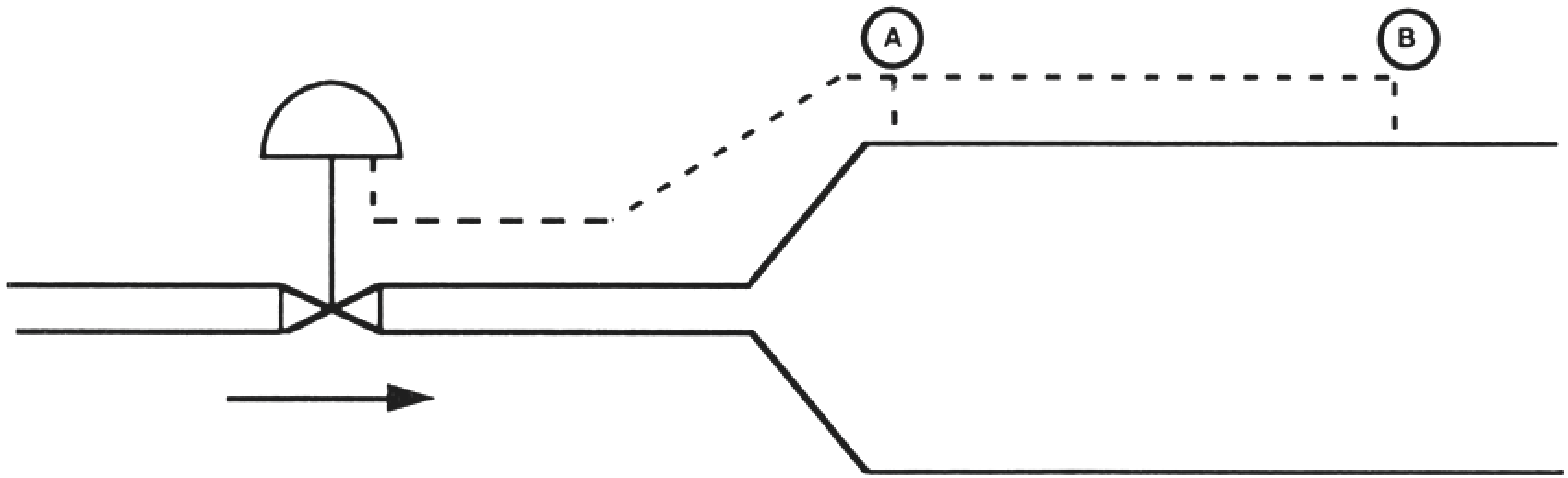
Connect the Control Line at a Location Relatively Free of Turbulence



A WRONG – TOO CLOSE TO REGULATOR OUTLET

B CORRECT – CONNECTION IS 6 TO 10 PIPE DIAMETERS DOWNSTREAM OF THE REGULATOR

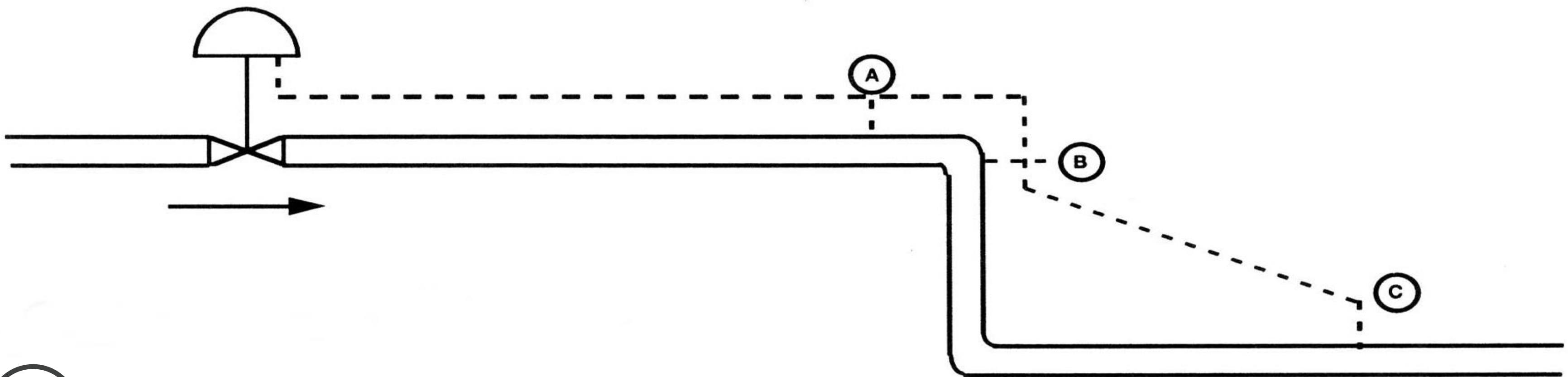
Connect the Control Line at a Location Relatively Free of Turbulence



A WRONG – PIPE SIZE CHANGE (SWAGE) CAUSES TURBULENCE

B CORRECT – CONNECTION IS 6 TO 10 PIPE DIAMETERS DOWNSTREAM OF THE SWAGE

Connect the Control Line at a Location Relatively Free of Turbulence

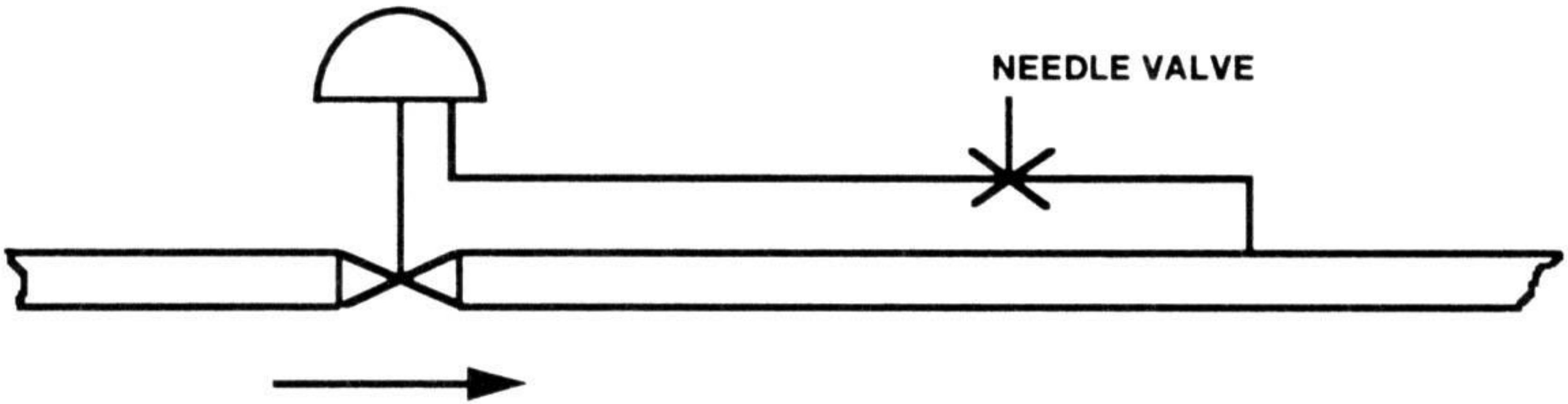


A **CORRECT** – CONNECTION IS 6 TO 10 PIPE DIAMETERS DOWNSTREAM OF THE REGULATOR

B **WRONG** – TOO MUCH TURBULENCE AT AN ELBOW

C **CORRECT** – CONNECTION IS 6 TO 10 PIPE DIAMETERS DOWNSTREAM OF THE SECOND ELBOW. WITH THE CONNECTION AT THIS POINT, THE REGULATOR WILL COMPENSATE FOR PRESSURE LOSS THROUGH THE TWO ELBOWS.

Dampen Turbulence on Direct-Operated Regulators



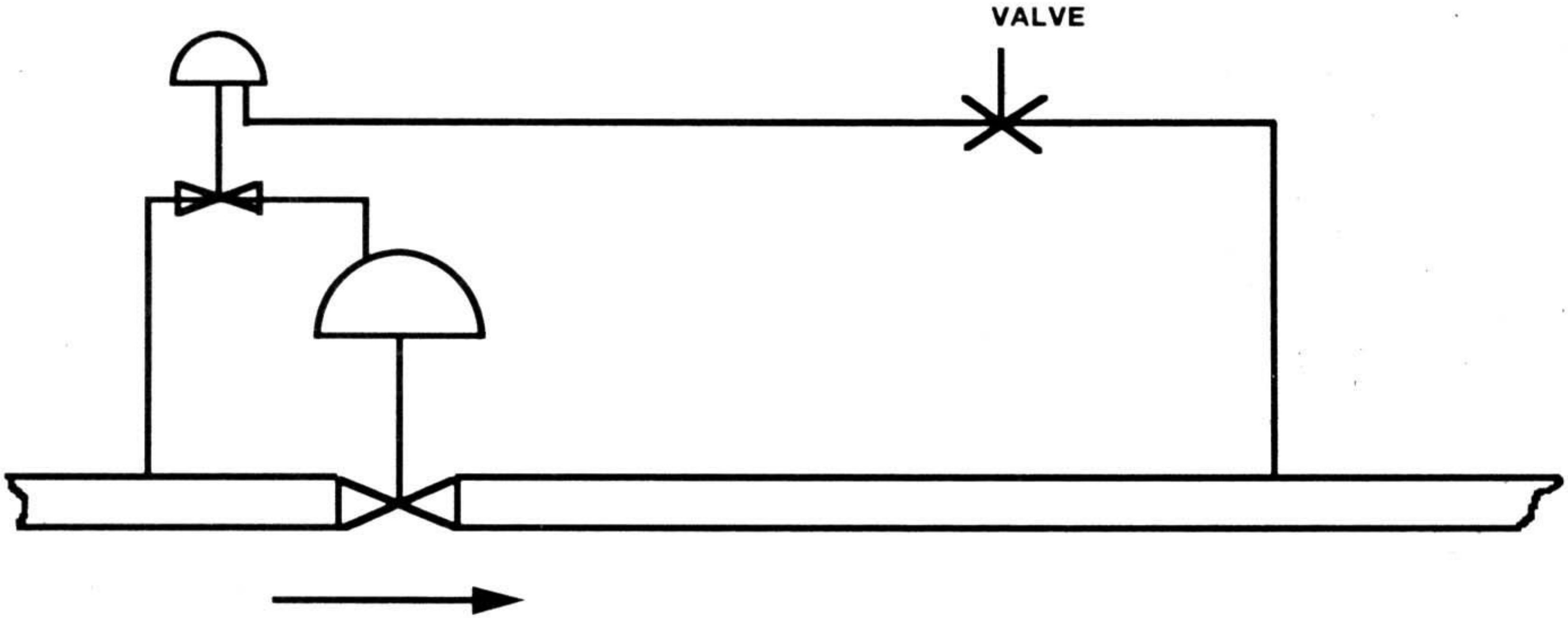
PROBLEM:

CONTROL LINE LOCATION APPEARS TO BE GOOD BUT REGULATOR CHATTERS

SOLUTION:

THROTTLE THE NEEDLE VALVE SO THE REGULATOR IS NOT SUBJECTED TO TRANSIENT PRESSURE SPIKES (DO NOT CLOSE THE VALVE)

Control Line Valve on Pilot-Operated Regulators



•THE FIRST CHOICE IS NOT TO INSTALL A VALVE IN THE CONTROL LINE

•THERE IS A SMALL FLOW (PILOT BLEED) DOWN THE CONTROL LINE. A RESTRICTION IN THE CONTROL LINE RESULTS IN A PRESSURE BUILD UP UPSTREAM OF THE RESTRICTION.

•THIS RESULTS IN A FALSE PRESSURE SIGNAL TO THE PILOT AND ALSO CAN CAUSE CYCLING

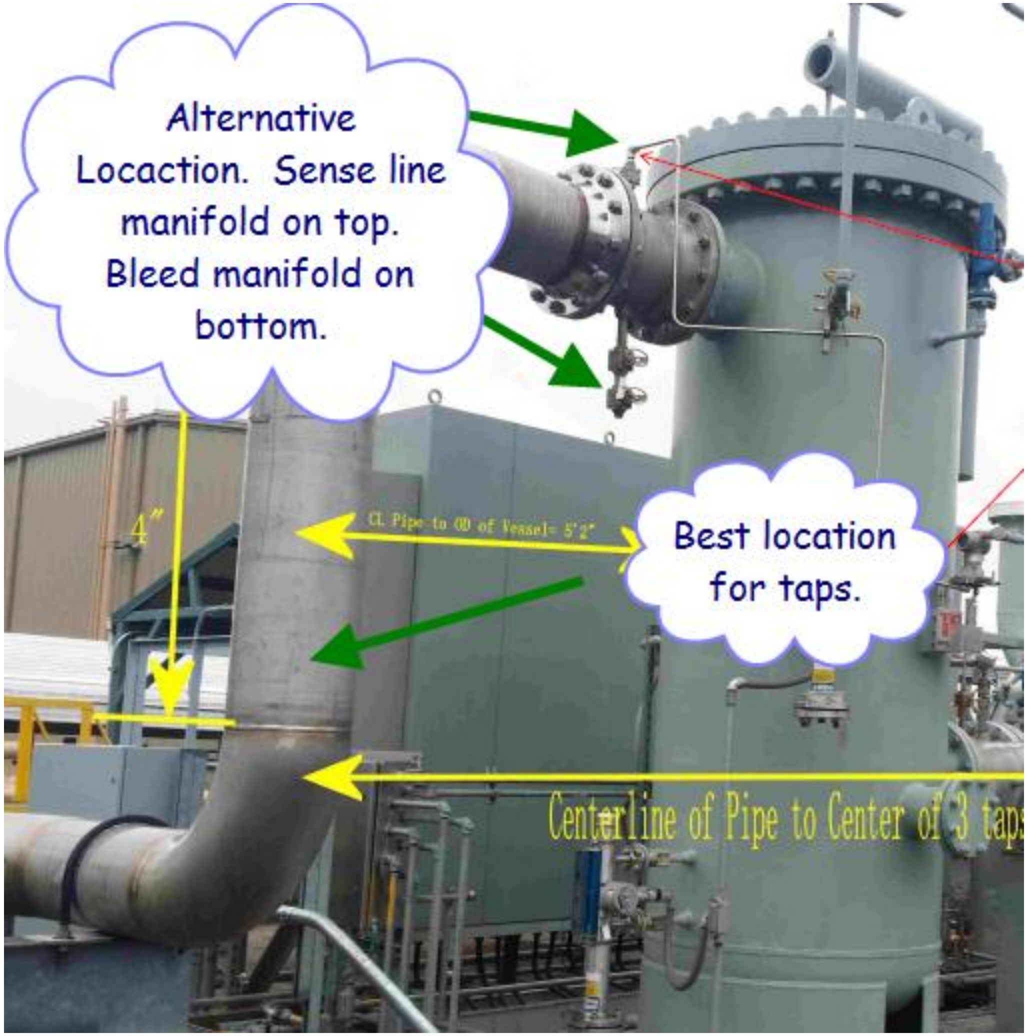
•IF A VALVE MUST BE INSTALLED, IT SHOULD HAVE A LARGE PORT AND BE IN THE FULL OPEN POSITION WHEN OPERATING

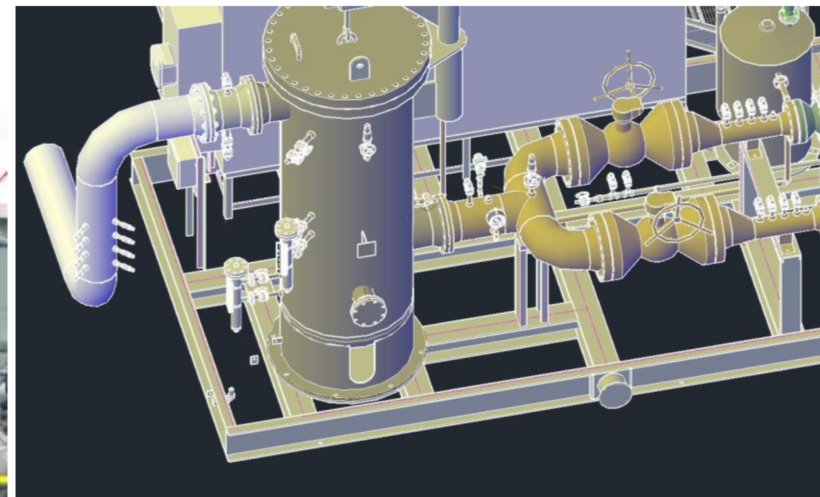
Improper Control Line Placement

Troubleshooting Example

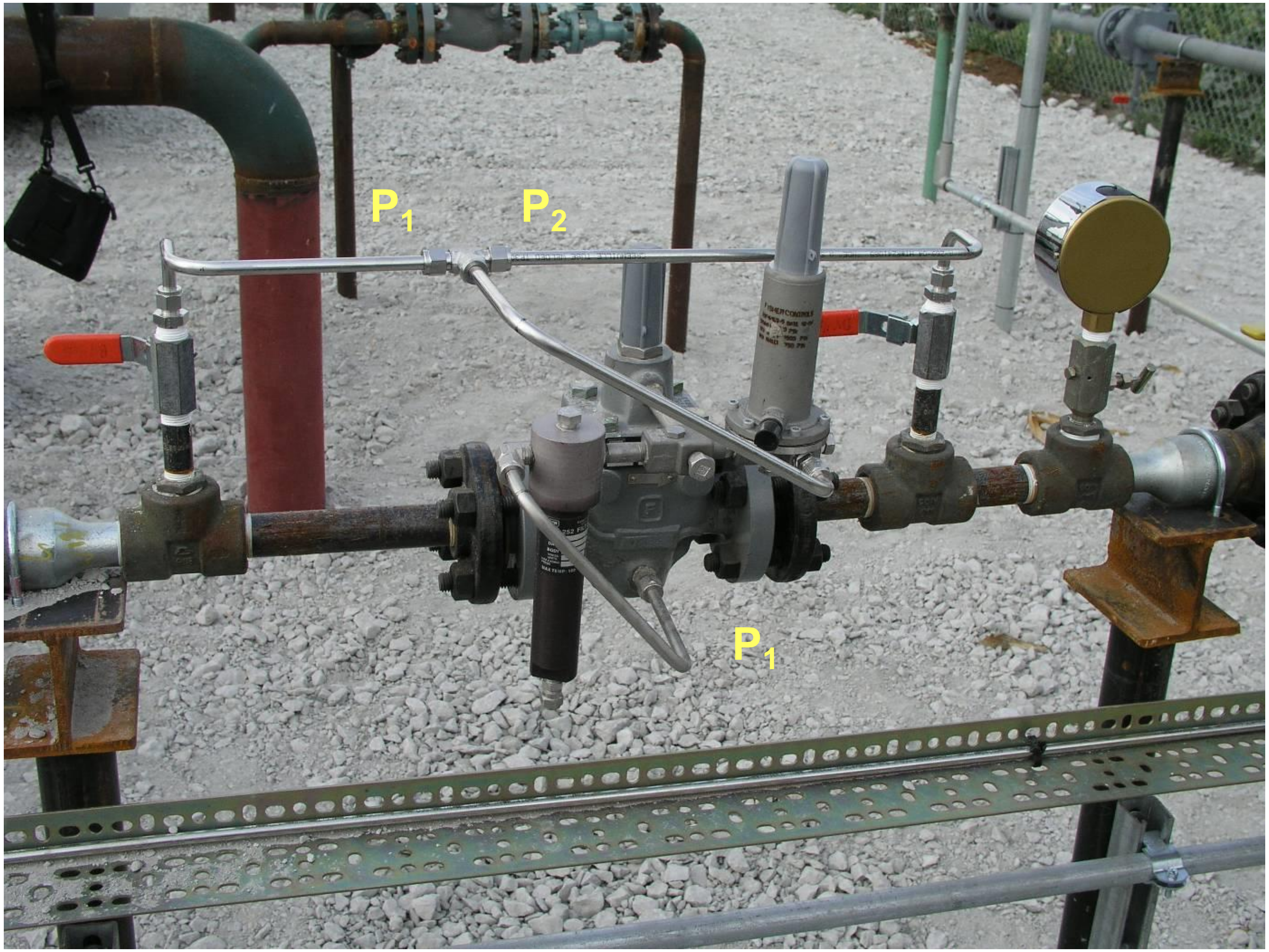
Troubleshooting Example

Troubleshooting Example: Proposed Solution





Tubing Installation Not Correct



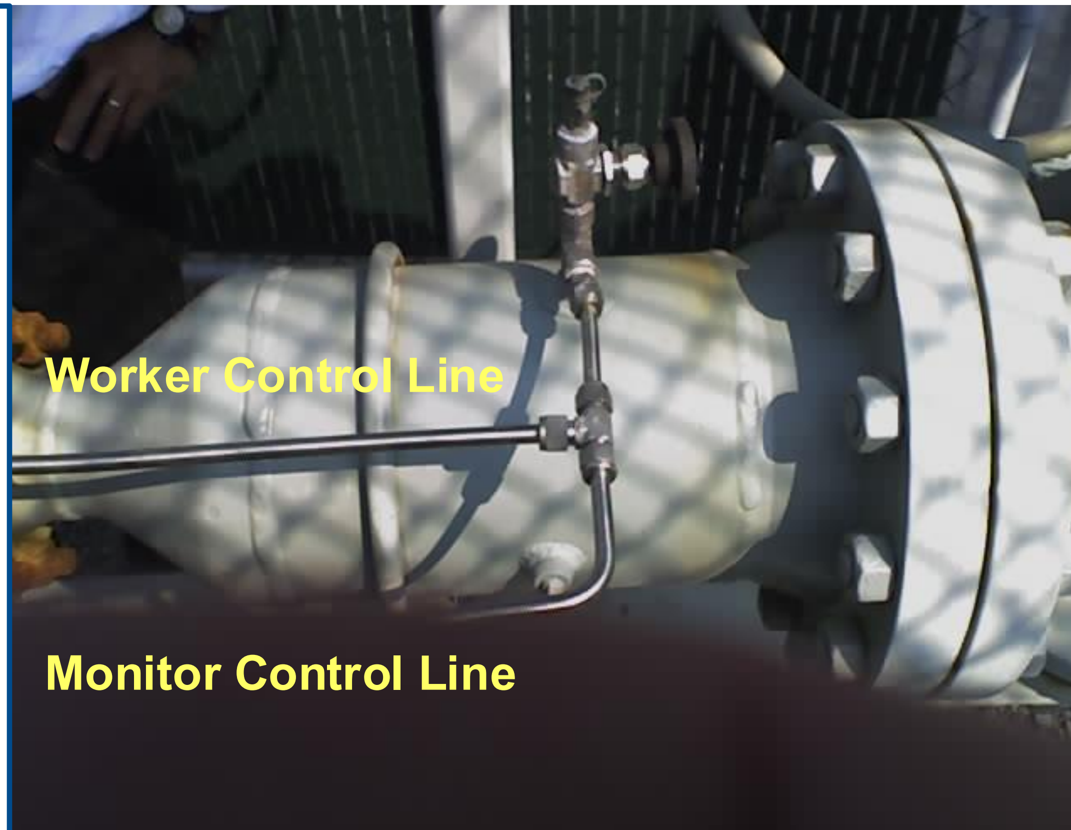
Tubing Installation Not Correct to Code

Wide Open Monitor

- Worker and monitor with same control line connection

- Will NOT meet DOT 192 or Z662 codes for single failure mode

- If upstream pilot fails open it could affect monitor/worker



Needle Valve In Control/Sense Lines

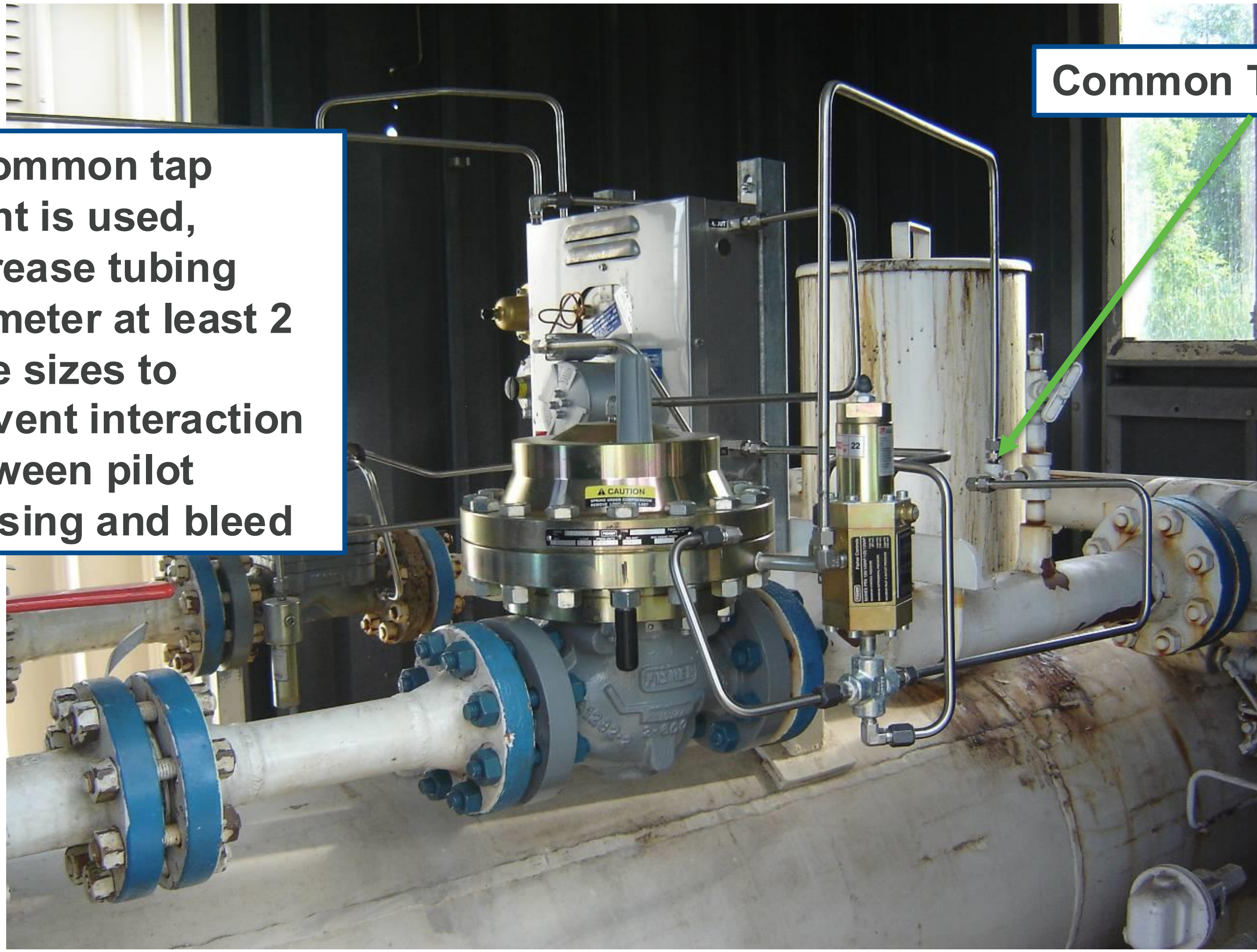
Control lines inadequate or restriction in sensing downstream pressure

Needle valve installed providing 1/8” hole in sensing

Bleed/Sense Lines Need to be Separate

Common Tap Point

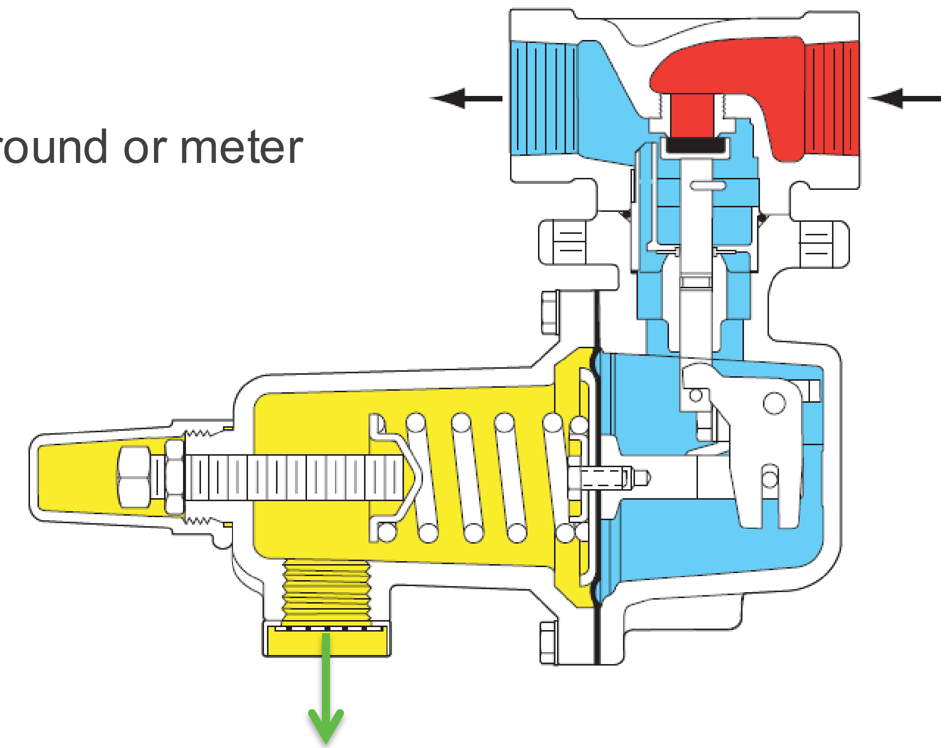
If common tap point is used, increase tubing diameter at least 2 pipe sizes to prevent interaction between pilot sensing and bleed



Freezing Due to Condensation or Vent Orientation

- **Vents should always be pointed down**
  - Away from the sky to prevent rainwater from filling spring case
  - Moisture will drain away

- **Splashback**
  - Avoid placement to close to the ground or meter



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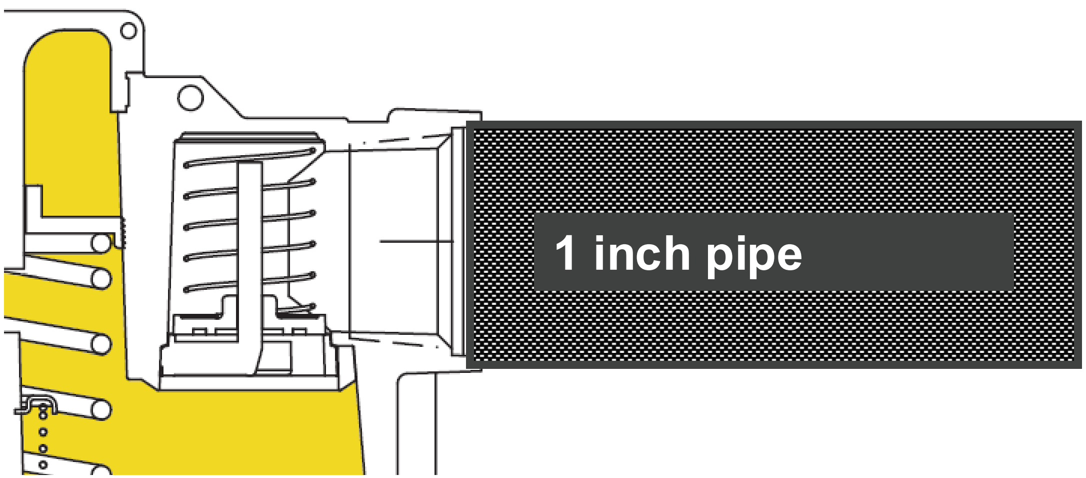
Vent Piping Best Practice

- **Restricted vent piping can cause the following:**
  - Slow speed of response
  - Instability
  - Reduced IRV capacity



Vent Pipe Guidelines – w/IRV

• Use same diameter pipe as vent
• Increase 1 pipe size for every 10’
•1 pipe elbow equals 3’ of straight pipe

Vent Pipe Guidelines – wo/IRV

• Use same diameter pipe as vent
• Increase 1 pipe size for every 50’
• 1 pipe elbow equals 3’ of straight pipe

Regulator Freezing

Joule-Thomson Effect

- **The Joule-Thomson (JT) Effect**
  - A thermodynamic process that occurs when a fluid expands from high pressure to low pressure at constant enthalpy (an isenthalpic process).
  - Such a process can be approximated in the real world by expanding a fluid from high pressure to low pressure across a valve. Under the right conditions, this can cause cooling of the fluid.

Cryogenic Society of America, Inc.

Joule-Thomson Effect with Natural Gas

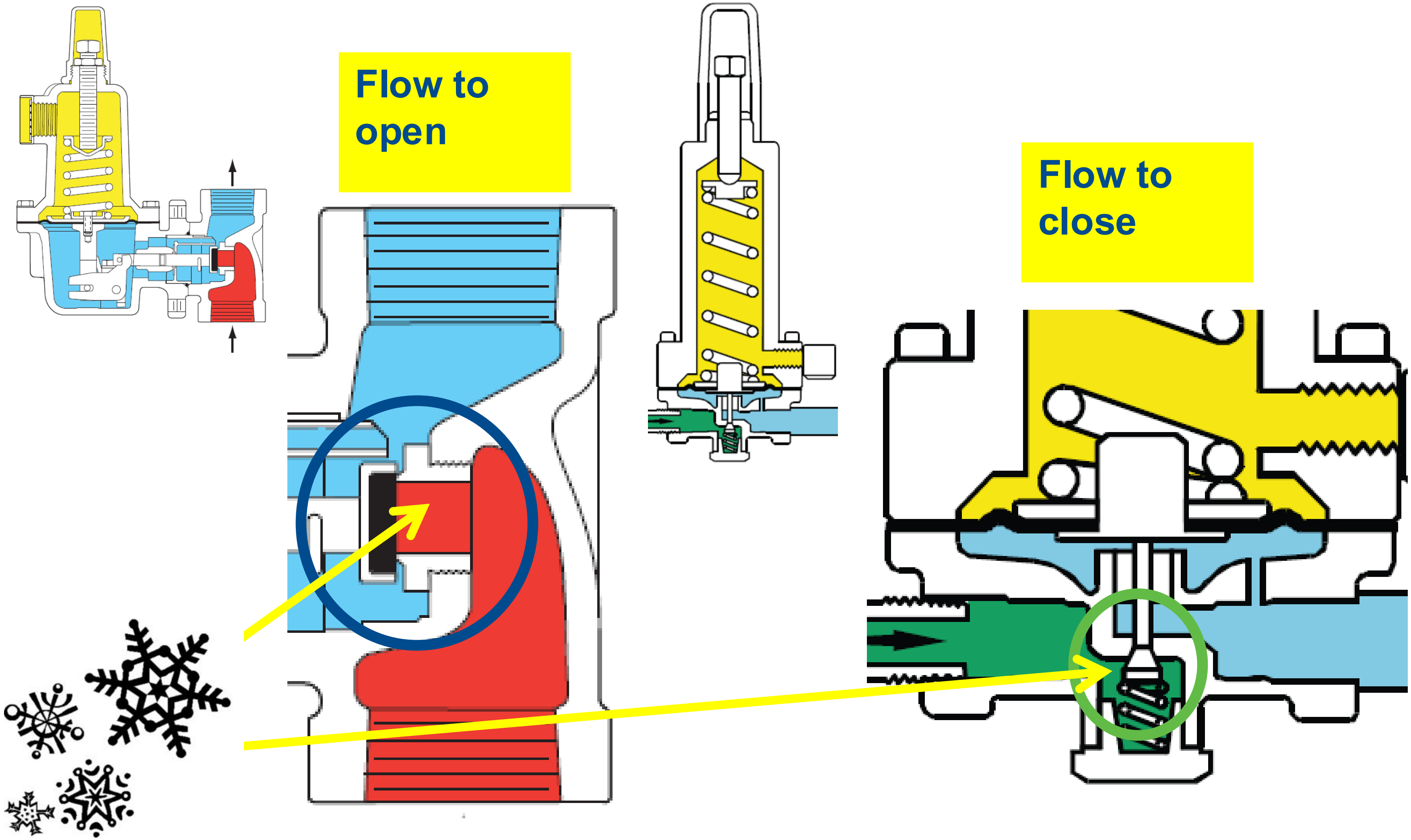
- **A common rule of thumb for Natural Gas is for every 100 psi pressure drop there will be 7 degrees F of cooling or approximately for every 15 psi of pressure drop it will experience 1 degree F of cooling.**

P1: 350 psig
P2: 50 psig

Inlet gas temp= 45F
dP= 300

What is my outlet temp?

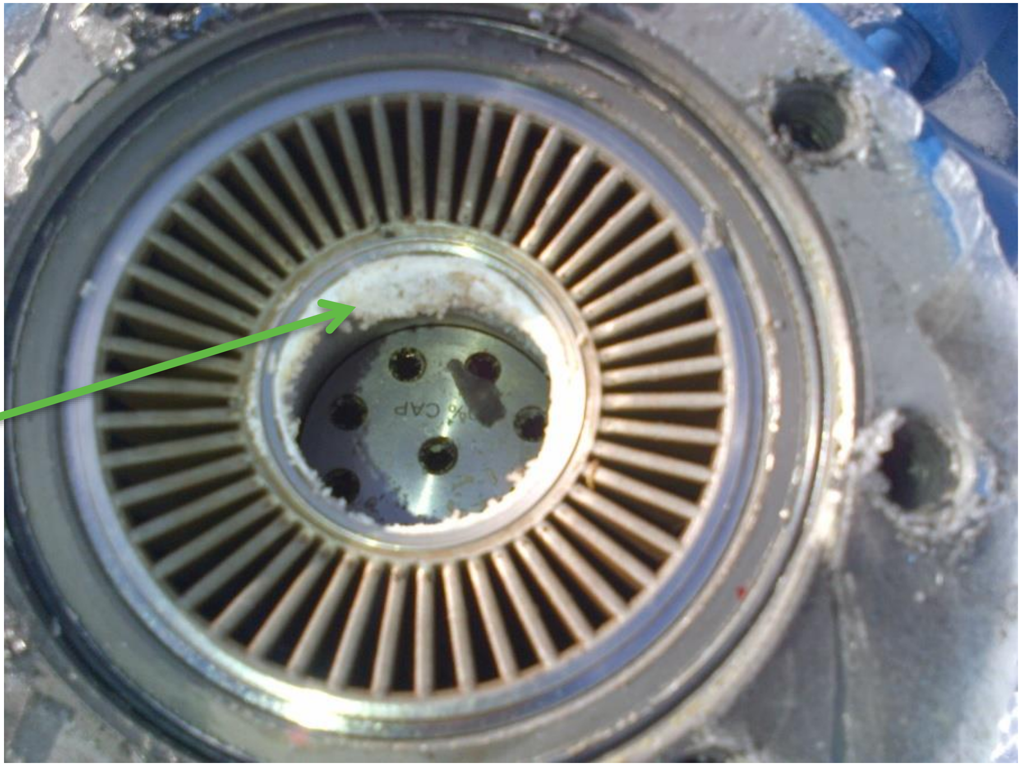
Where Do Regulators Freeze?



Hydrate Formation: Where Will it Form?

Hydrate formation is not consistent and not always predictable

Freezing occurs at the high velocity area of the pressure drop within the regulator when hydrates are present



Problems with Internal Freezing

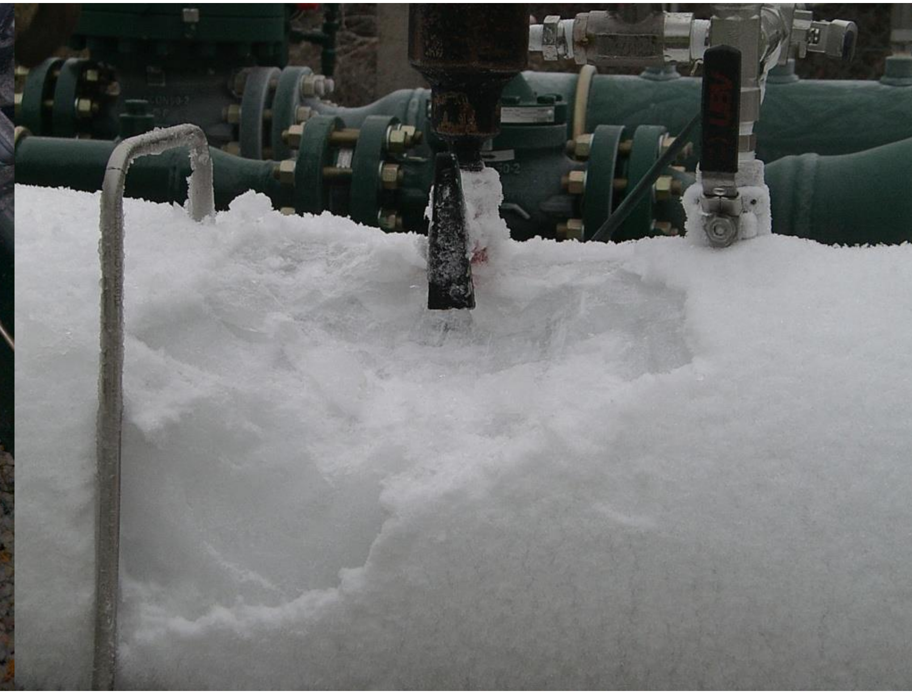
- **Regulators can fail either open or closed depending on where icing occurs losing control of the station**
  - Can damage meters, valves, and other equipment downstream if ice balls form and break loose
  - Hard to troubleshoot. When you blow the line down to investigate the ice may melt by the time you get things apart

- **Conditions that promote hydrates freezing**
  - Residual water from wells or hydrotesting
  - Low ambient temperatures
  - High pressure drops (Joule-Thomson)
  - Water vapor and hydrocarbons combine that change freezing point

Sources of the Problem

- **Hydrotesting**
  - Lack of proper pigging
- **Construction**
  - Contractor not capping pipes
  - Flooding during construction
- **Supply**
  - Moisture content at receipt points from transmission supplier
  - Wellhead gas
  - Landfill gas

Outside Freezing

What are the problems which could arise from an ice entombed regulator?

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Problems with Outside Freezing

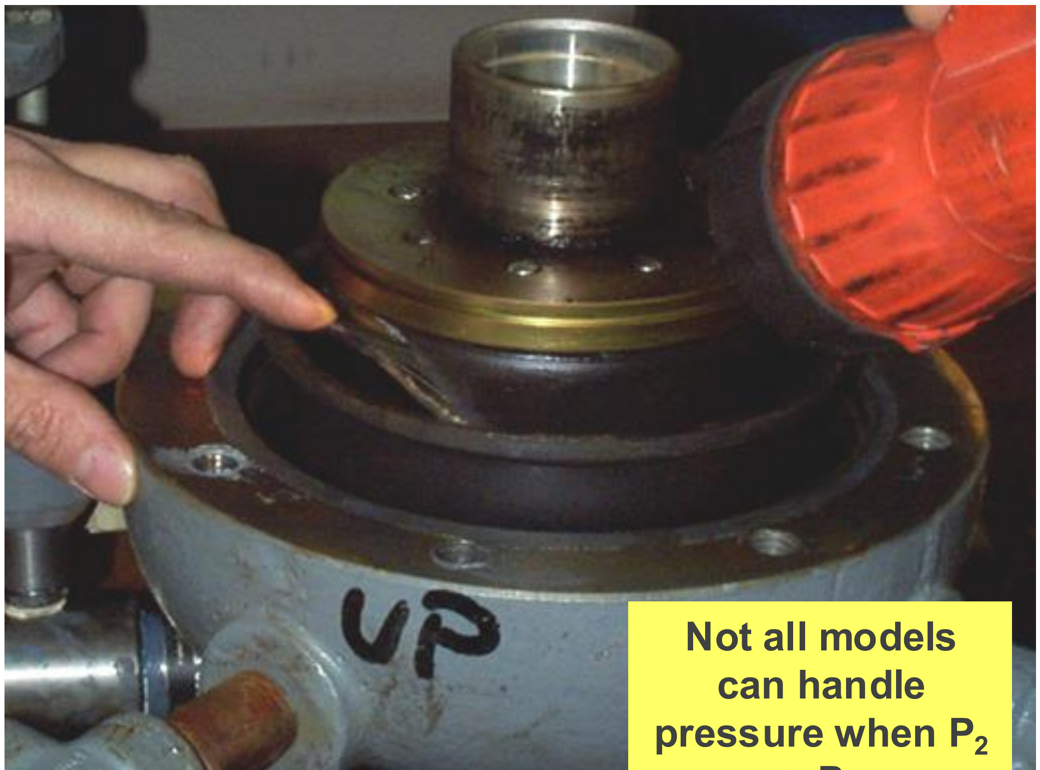
- Restricted regulator vents
- Frost heaves and damaged roads and right of ways
- Other equipment failures

Freeze Prevention Technologies

Freezing	Technology	Impacts
External	Station Line Heaters	Main Valve / Pilot
Internal	Catalytic Pilot Supply Heater	Pilot
Internal	Catalytic Enclosure	Pilot
Internal	Vortex Meter	Pilot
Internal	Alcohol Drip	Main Valve
Internal	Heat Tape	Pilot
Internal	Blankets	Main Valve / Pilot



Two-Path Pilot-Operated Regulators: Reverse Pressure



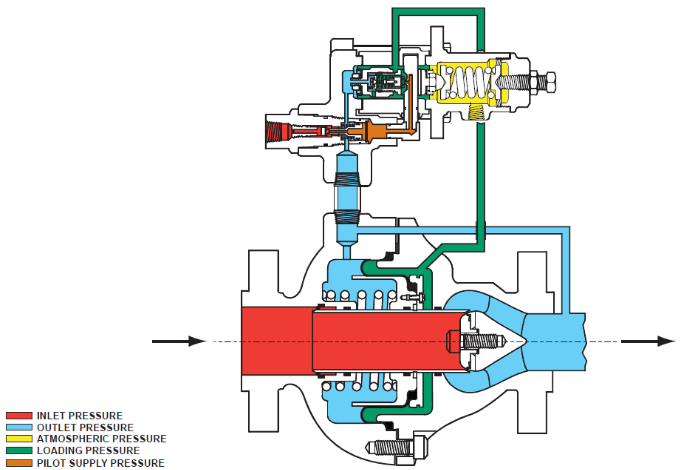
Not all models can handle pressure when $P_2 > P_1$

Two-Path Pilot-Operated Regulators: Reverse Pressure

Problem: Introducing downstream pressure prior to introducing inlet pressure to the regulator can cause the diaphragm to burst.

Solution(s):

- Open inlet valve prior to opening outlet valve
- Install a check valve between loading pressure and downstream pressure.



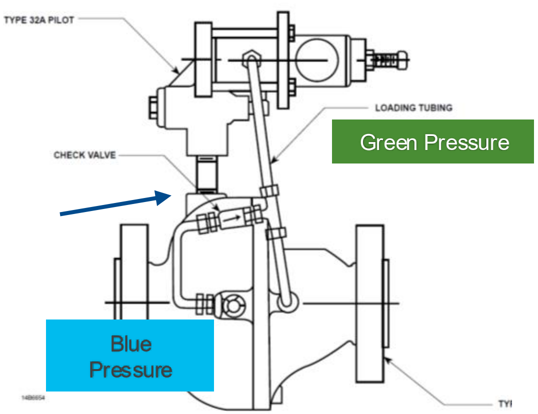


Figure 13. Backpressure Protection System Assembly

Installing Regulators Below Grade

- Installing a regulator in direct contact with ground below grade is not recommended by Emerson

  - Corrosion can make bolts fail
  - Regulator spring case can fill with water
  - Plugging spring case vent may result in elevated set points and lockup
  - Difficult to locate if there is an incident
  - Difficult to test

Corrosive Environment

Ensure compatibility of regulator materials with ambient environment

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Flange Torque Sequence

Reviewing the Troubleshooting Process

1. **Define the problem**
   - What is happening / what isn't happening?
2. **Gather the information**
   - Regulator Model Number
   - Process conditions/ specs
   - Detail description of issue
   - How long have had issue
3. **What is the Application?**
   - Size and selection of regulator
   - Is the regulator installed correctly
   - Is everything else in the system installed correctly
4. **Think through the Product operation**
   - Understand the device
   - What components could be causing the problem

By taking this approach you will best position yourself to assist in solving your customer's issue in field!

Conclusion

Basic troubleshooting of any regulator will require a working knowledge of how regulators operate and how to apply them effectively

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Troubleshooting Example

What is wrong with this example?