

Training Excellence
Knowledge Win
Advancement
Excel Learning
Partner Maximize
Success Mastery Prescience
Performance Achievement
Information
Reward
Grow

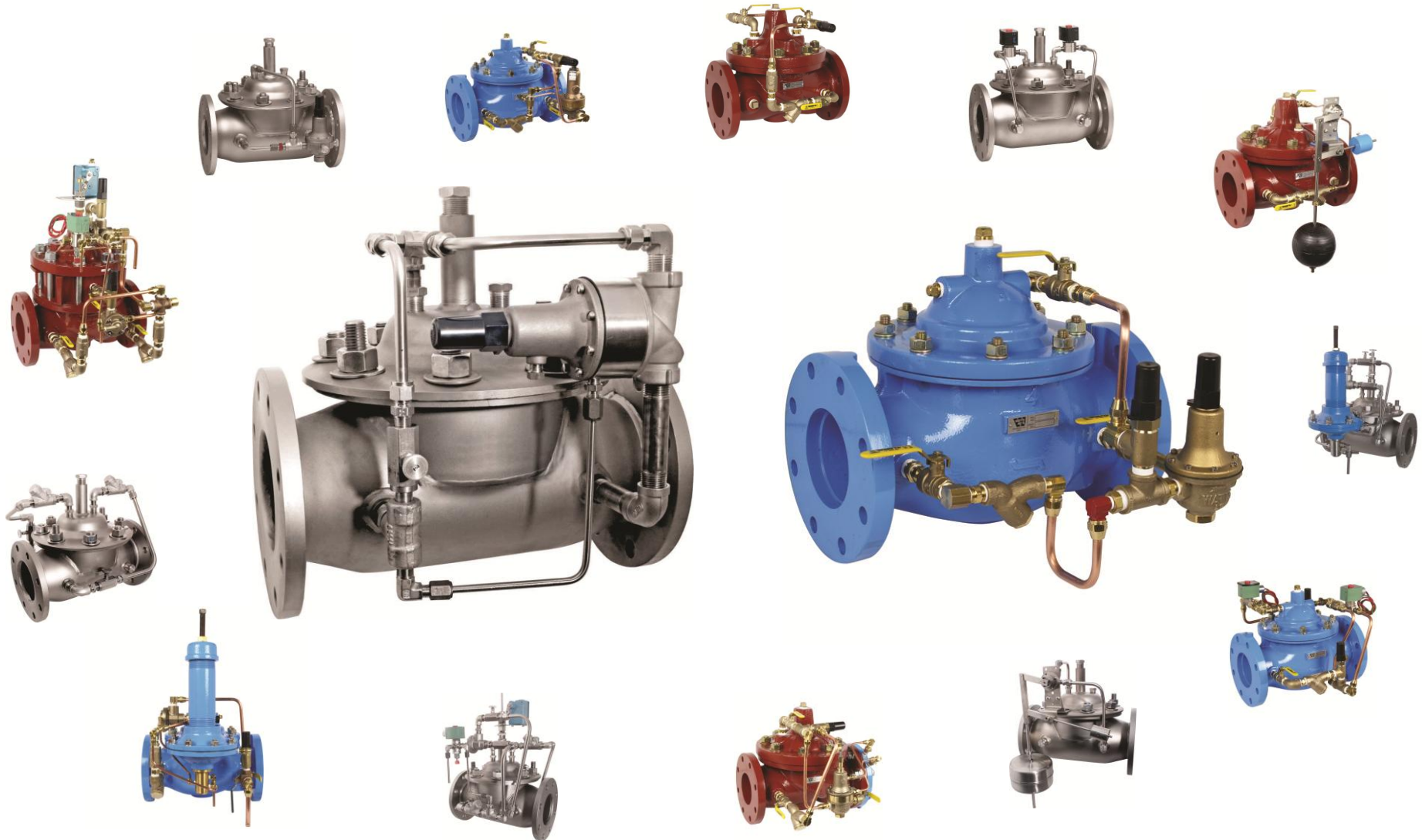
ACV 101 - PRV FUNDAMENTALS & APPLICATIONS

Jon Davis

RepMasters, Inc.



WHAT IS A PRV?



WHAT IS A PRV?

*A PRV IS SIMPLY A FUNCTION OF, OR
AN APPLICATION OF AN ACV*



WHAT IS AN ACV?

- ACV stands for *Automatic Control Valve*
 - Hydraulic Pilot Controlled
 - Diaphragm/ Piston Operated Valve
 - Actuated/Powered by Line Pressure - Differential
 - PRV
 - Cla-Val/ Singer or “Tedder Valve”
 - Pilot Operated Valve
 - Diaphragm Valve

ACV Purpose of Functions

Float Control.....	<i>Controls Level in a Tank or Reservoir, uses a float</i>
Solenoid Control.....	<i>Zone Control or Electric On-Off/Override</i>
Flow Control w/orifice plate....	<i>Maintains Constant Rate-Of-Flow</i>
Pressure Reducing Control.....	<i>Maintains Constant Downstream Pressure</i>
Pressure Sustaining/Relief.....	<i>Maintains Minimum or Maximum Upstream Pressure</i>
Non-Surge Check.....	<i>Closes on Reverse Flow (adjustable opening & closing speed)</i>
Surge Anticipation	<i>Recognizes a drop in pressure, initiating opening prior to surge</i>
Altitude Control.....	<i>Maintains Level in a Ground Level or Elevated Storage Tank or Reservoir using pressure head as control (NO FLOAT)</i>
Pump / Well Control.....	<i>Controls Pipeline Surges from Starting and Stopping of Pumps</i>
Various others Commercial.....	<i>Shutdown, excessive pressure valves, etc..</i>

ACV

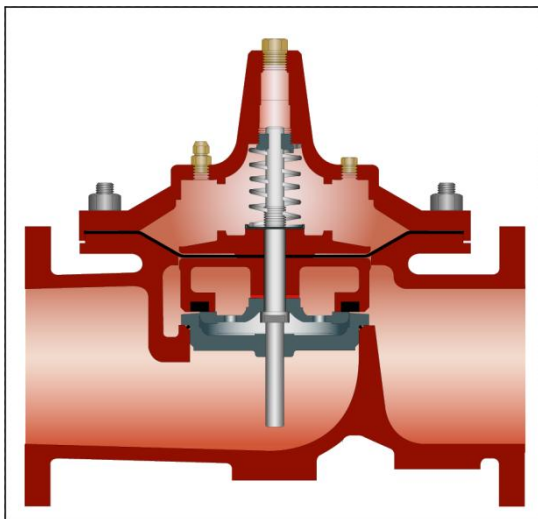
Introduction To Fundamentals

REMOVING THE VOODOO



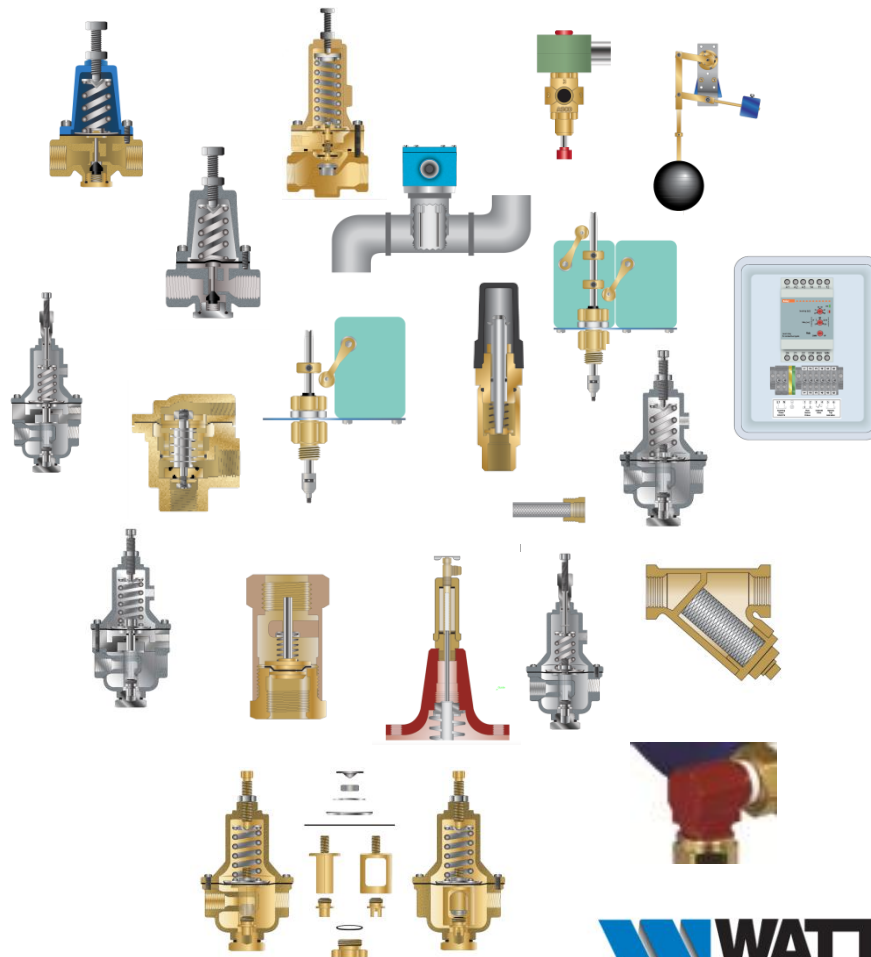
WHAT MAKES AN ACV?

Main Valve



+

Pilots and Accessories



Fundamentals



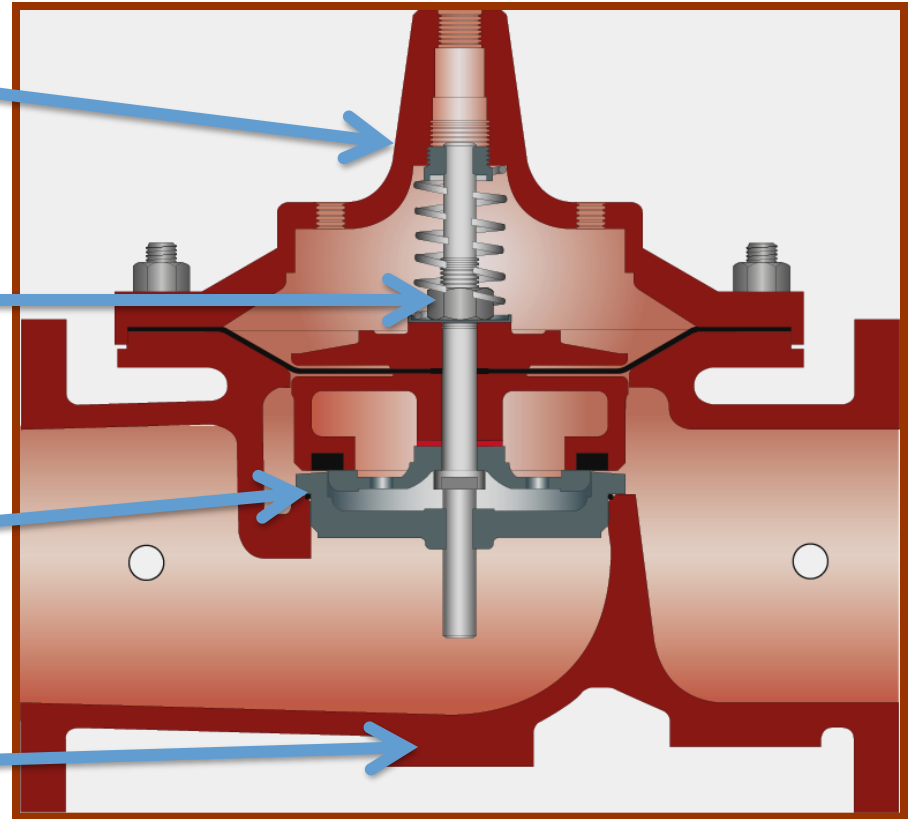
Basic Valve Construction

Valve Cover

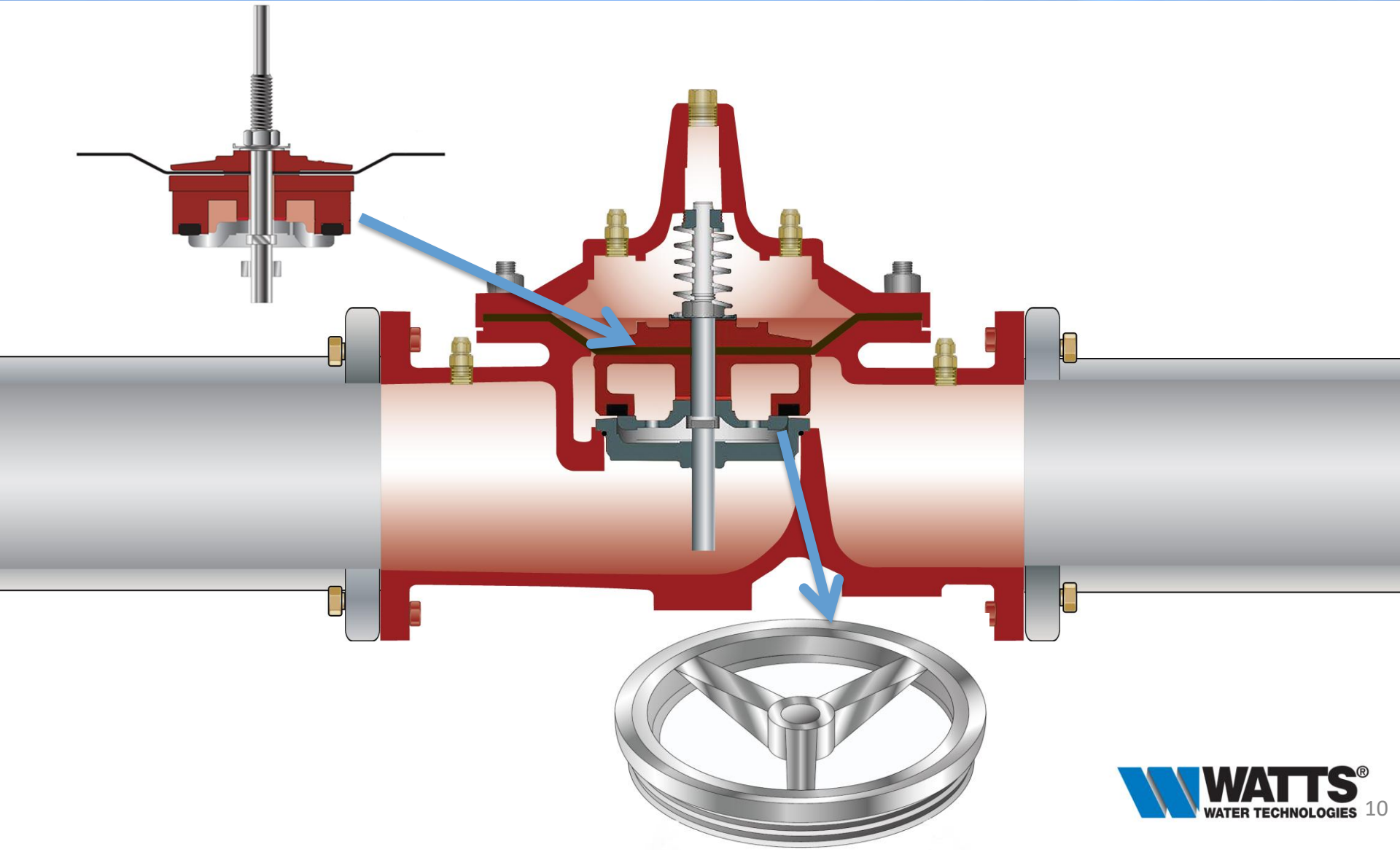
Disc & Diaphragm
Assembly

Disc Seat

Valve Body

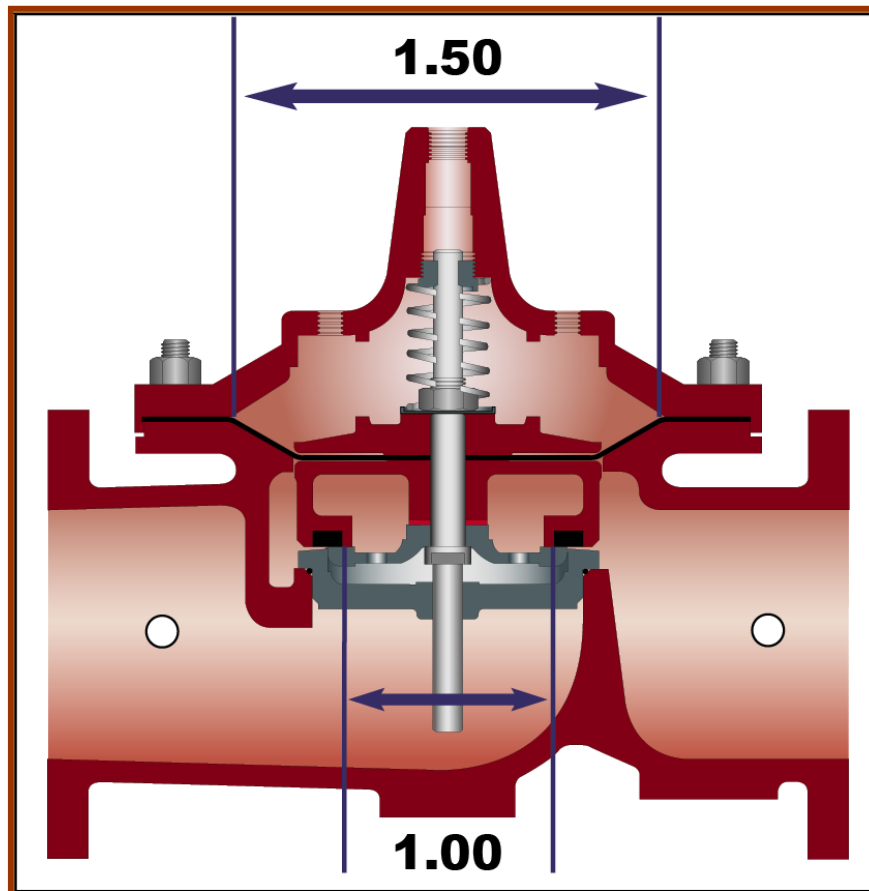


Mystery Revealed

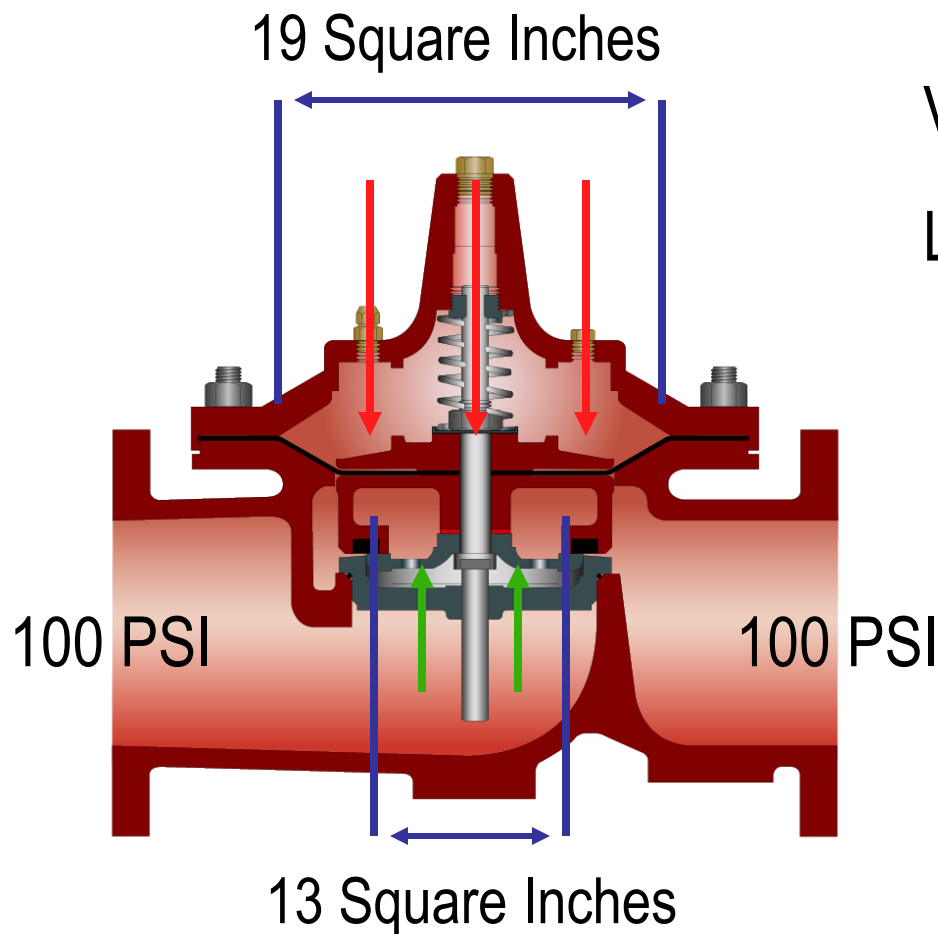


Operating Principle – How?

- Diaphragm to Seat Ratio is 1.5 : 1



Operating Principle On-Off Operation (Single Chamber)



Valve Size: 4"

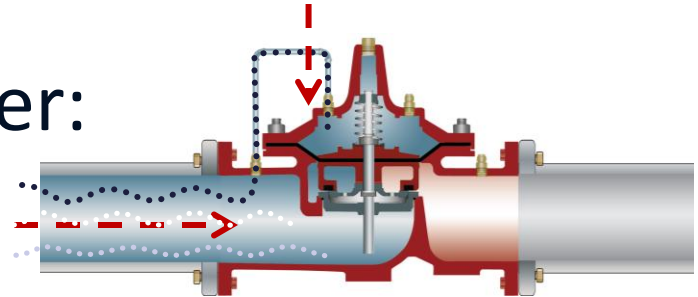
Line Pressure: 100 PSI

Downward Force: 1,900 Lbs.

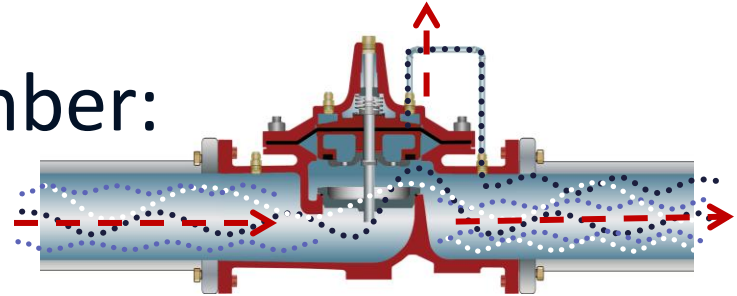
Upward Force: 1,300 Lbs.

Operating Principle

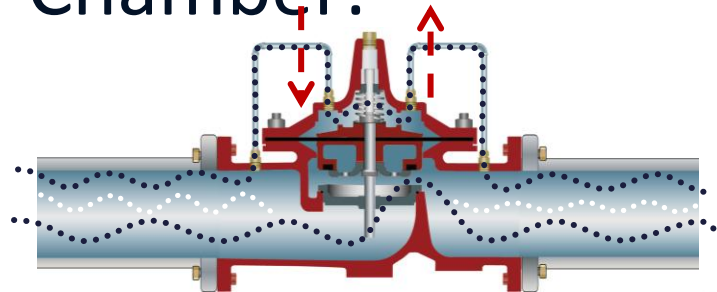
- Pressure into Cover Chamber:
 - VALVE CLOSES



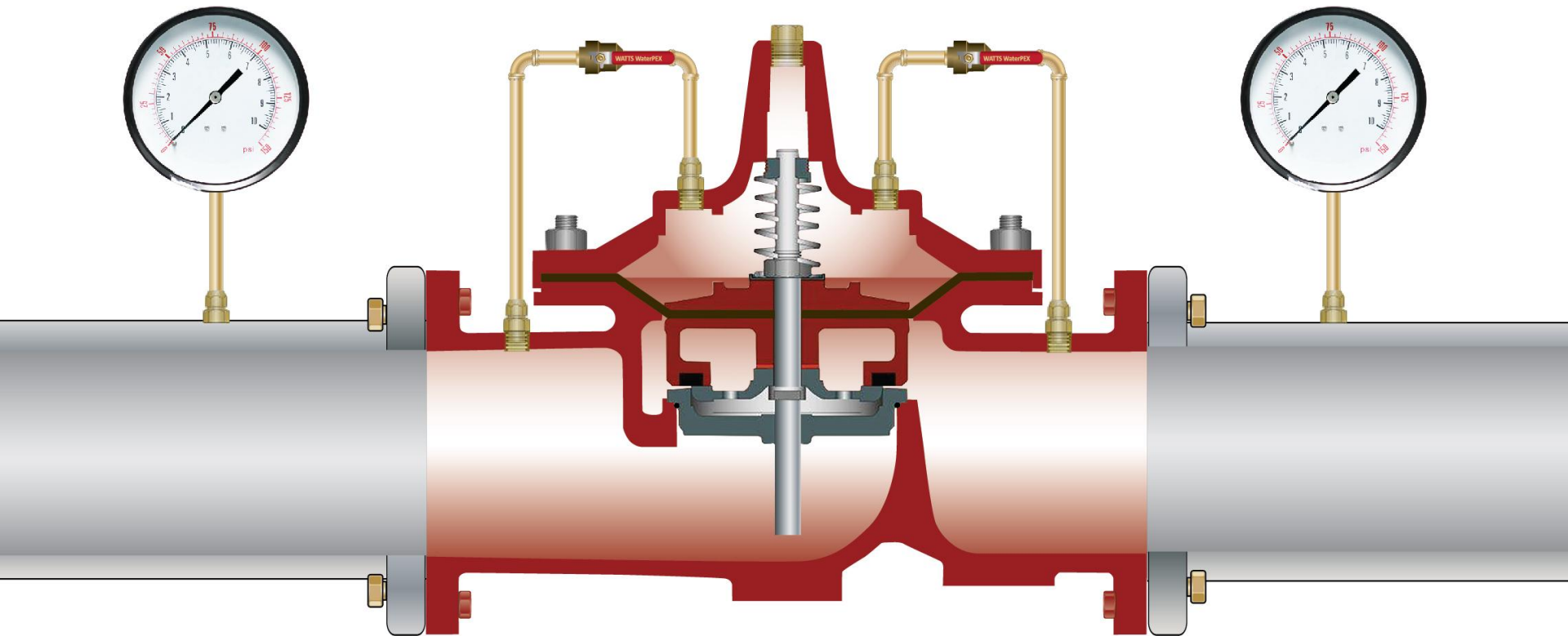
- Pressure out of Cover Chamber:
 - VALVE OPENS



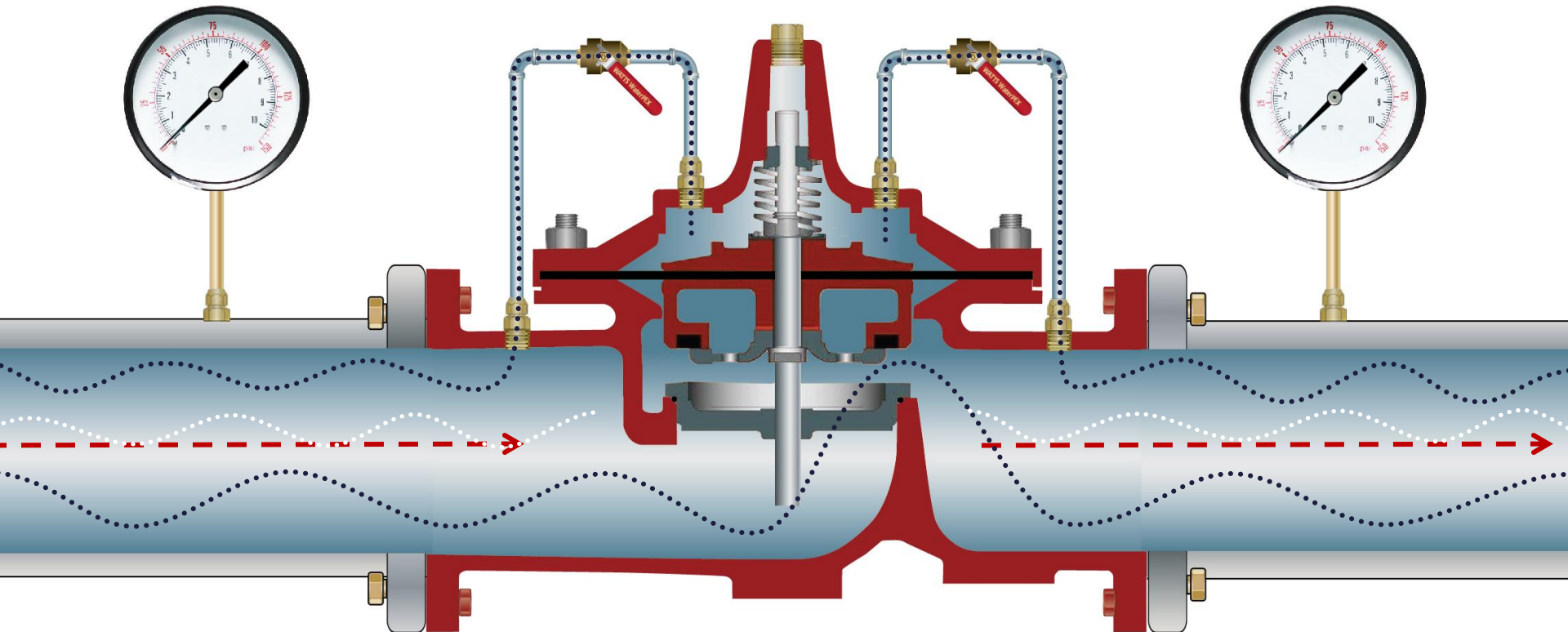
- Pressure regulated in Cover Chamber:
 - VALVE MODULATES



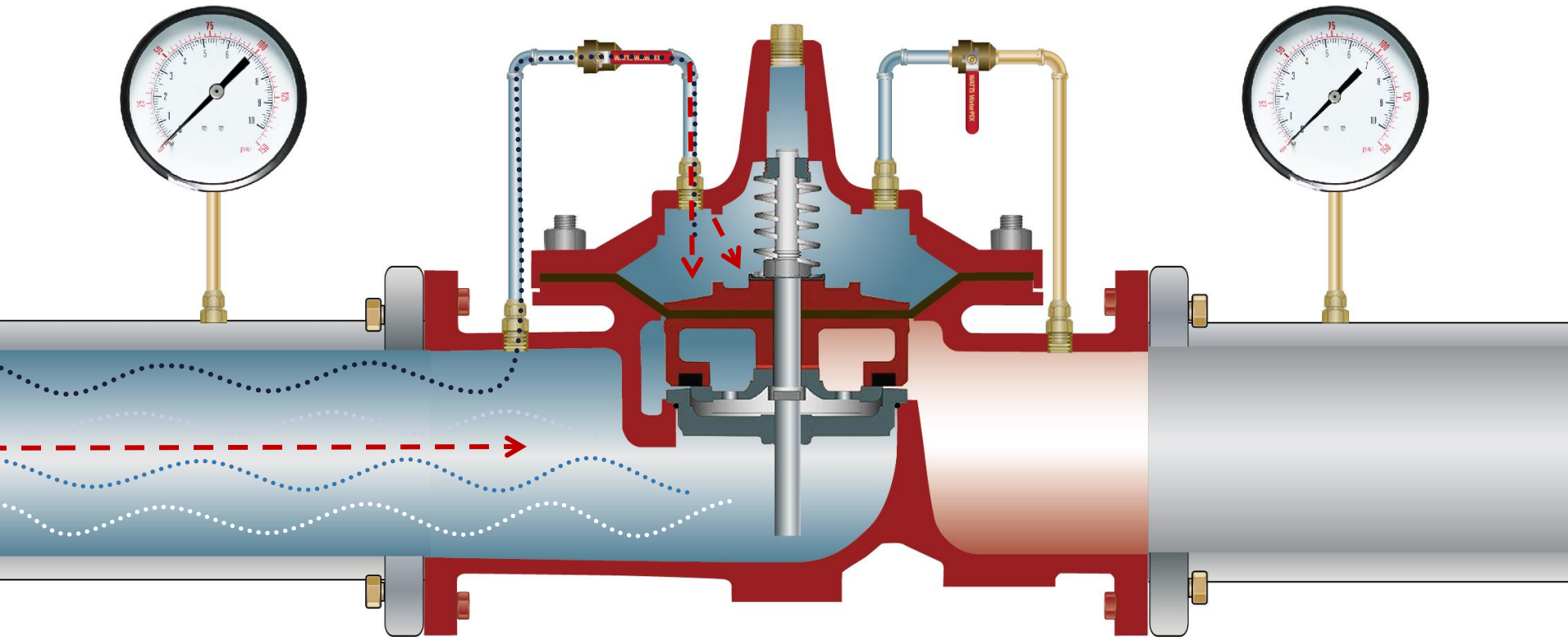
Operation Explained



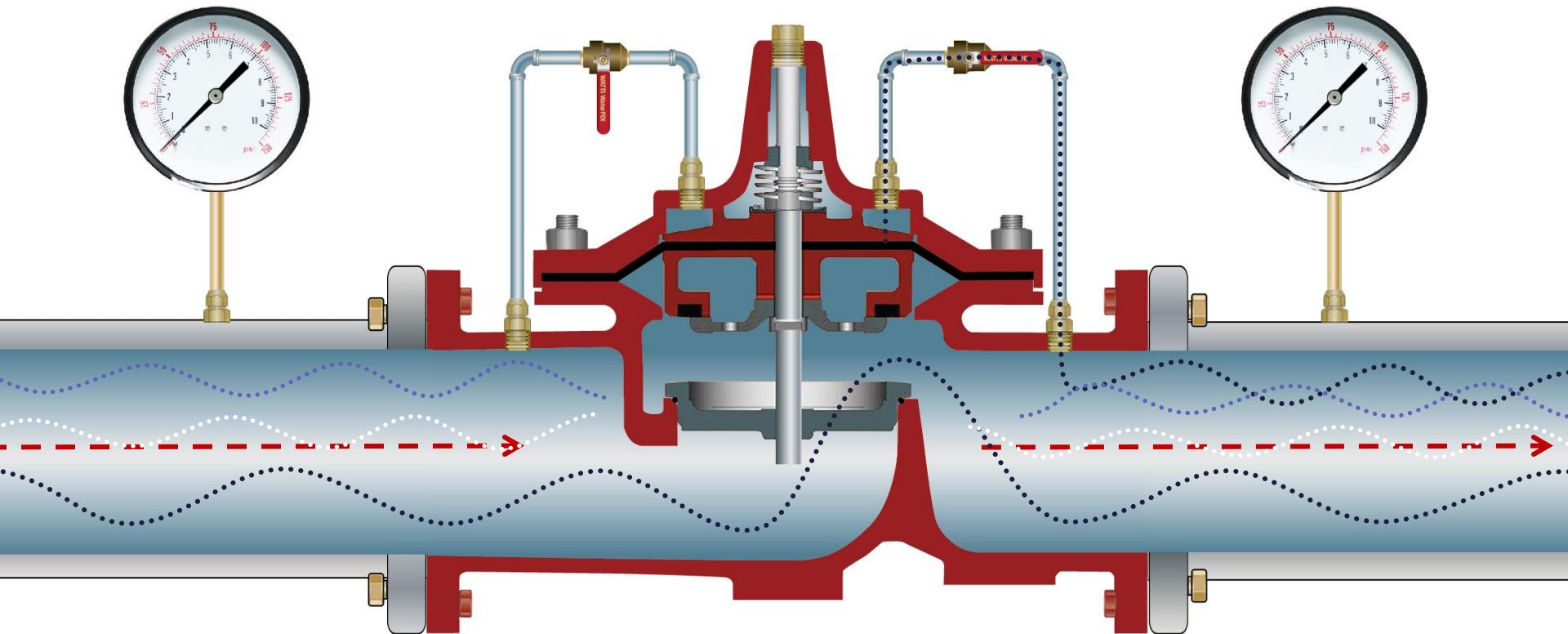
Operation Explained



Operation Explained



Operation Explained

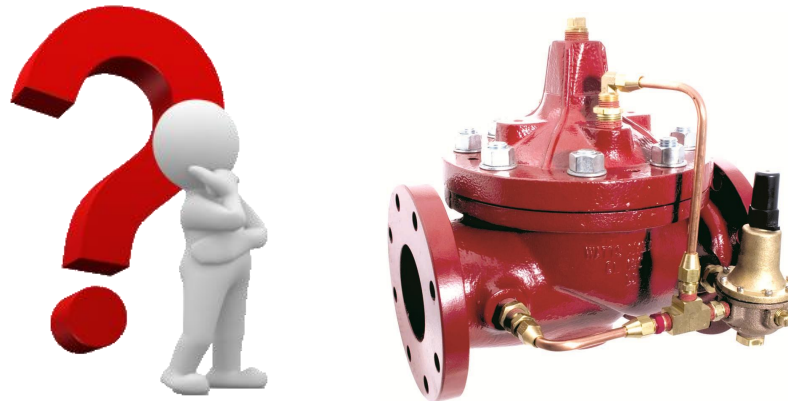


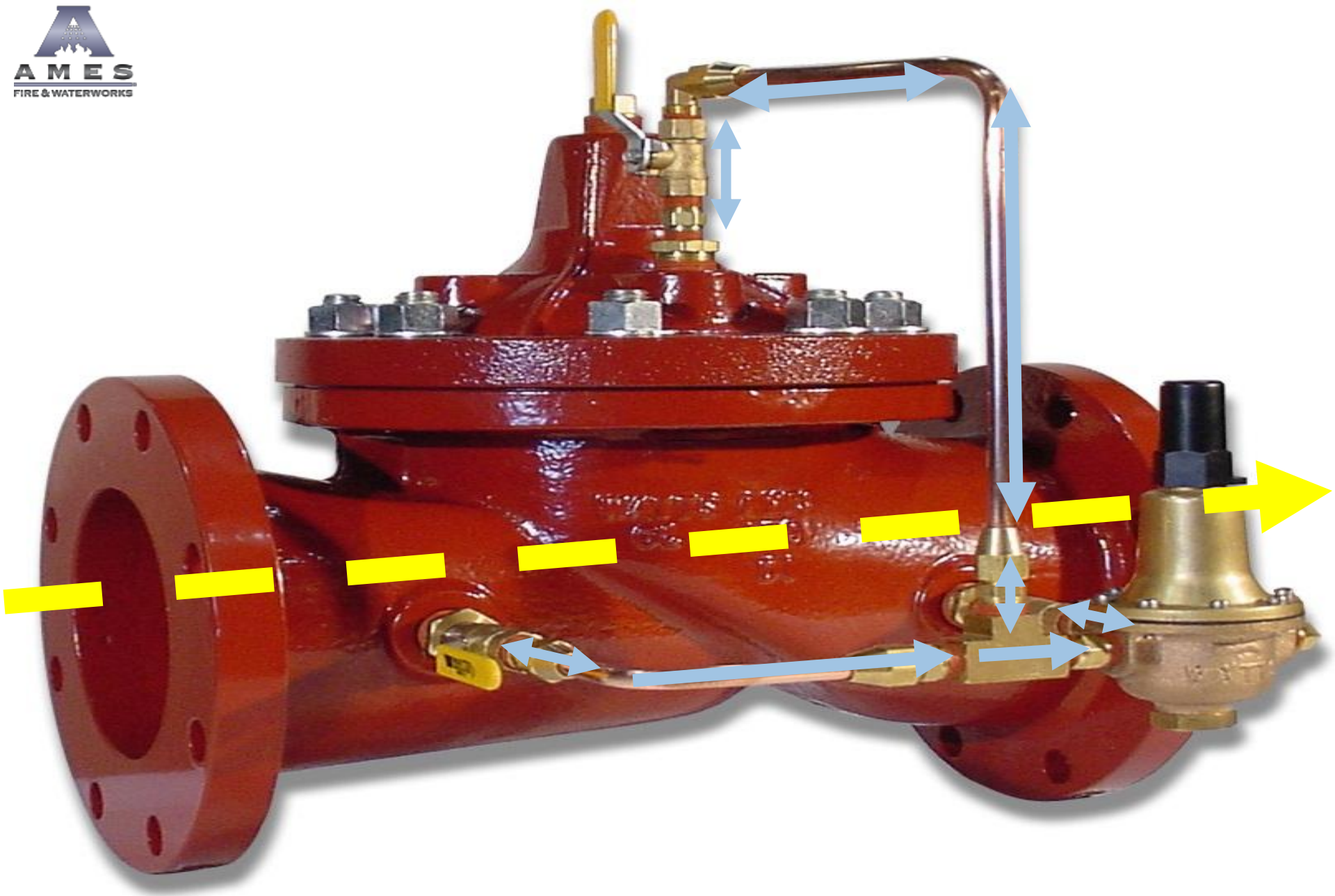
Watts ACV

Automatic Control Valve 101

Introduction Module 2

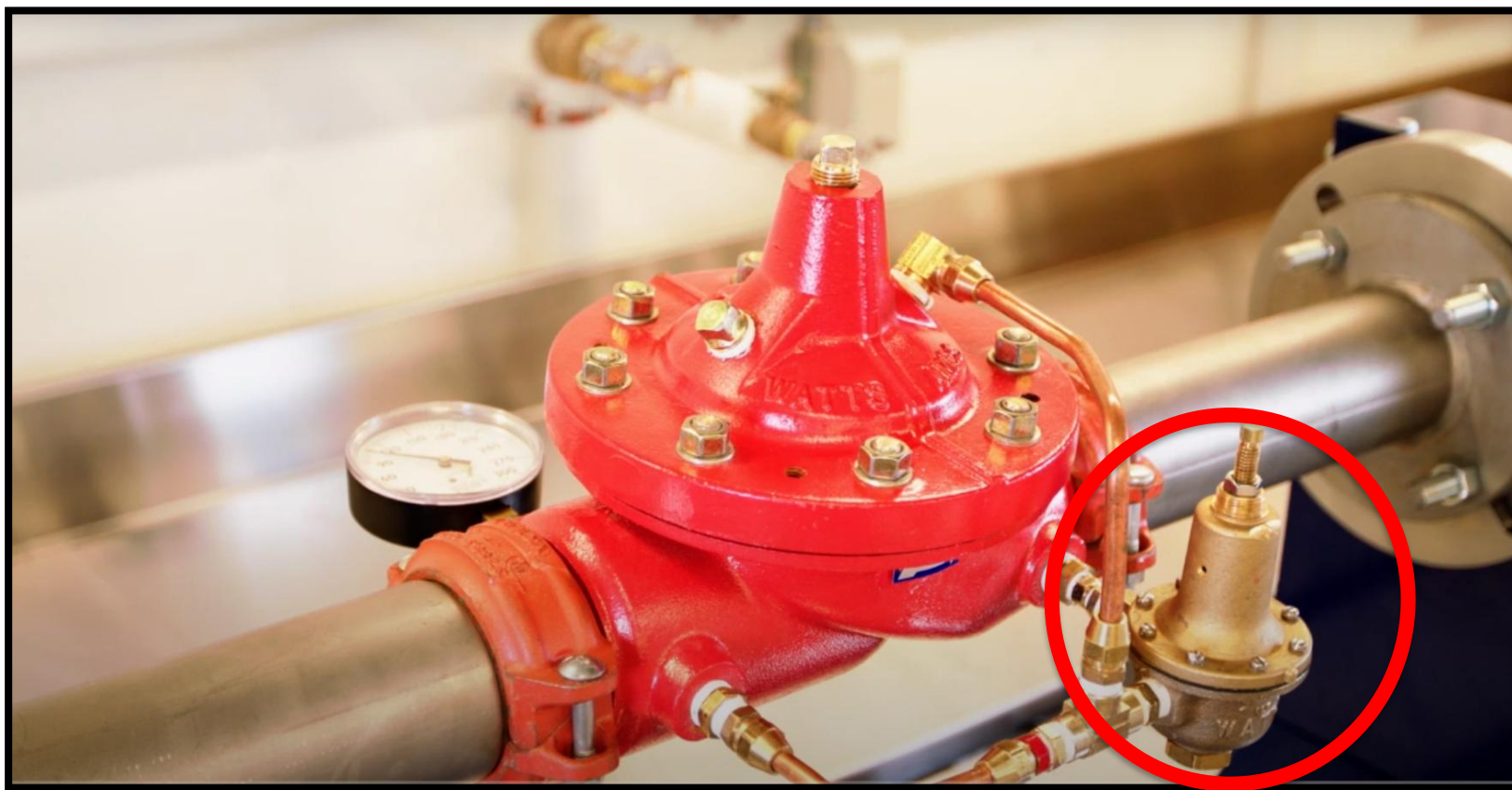
Theory of Operation





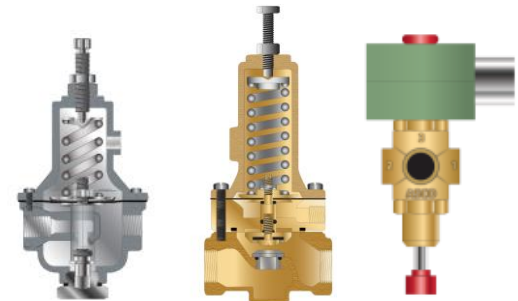
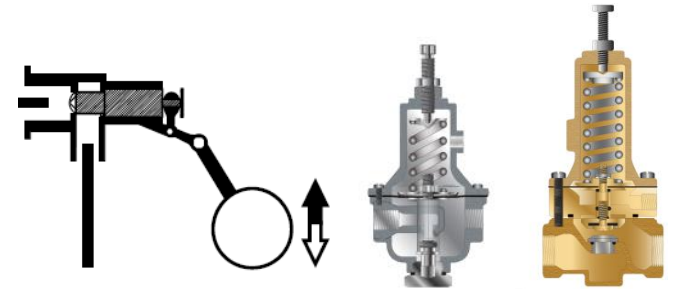
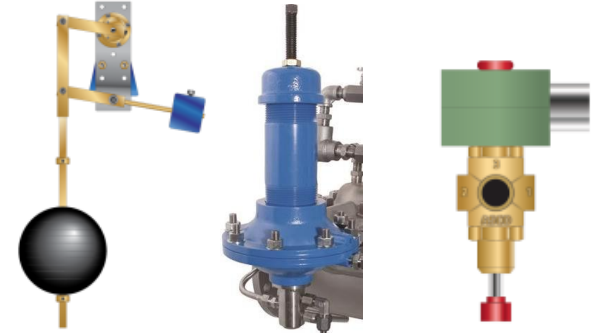
HOW DOES AN ACV WORK?

The Pilot tells the Main Valve what to do



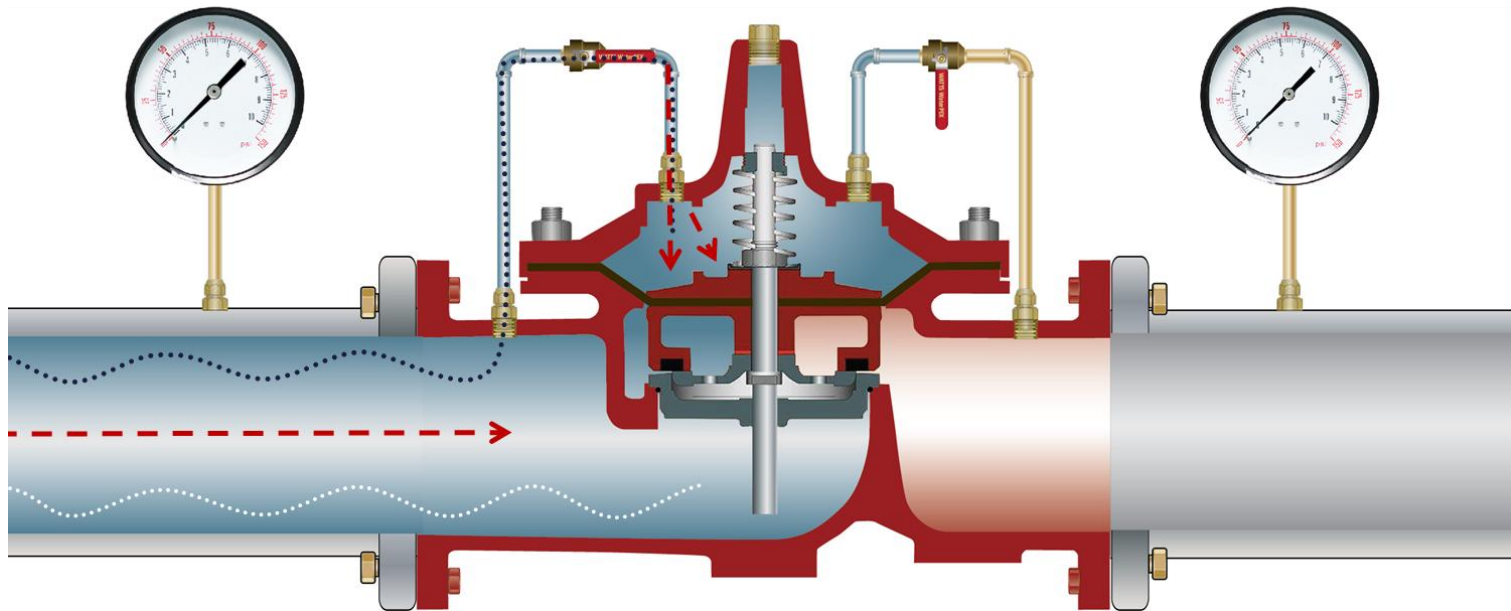
Types of Operation

- On/Off
 - Valve is open or closed drip tight
- Modulating - Regulating
 - Valve is in a throttling position
- Combination
 - Regulating control with solenoid override
 - Two regulating controls in series



Types of Operation – Non-Modulating Service

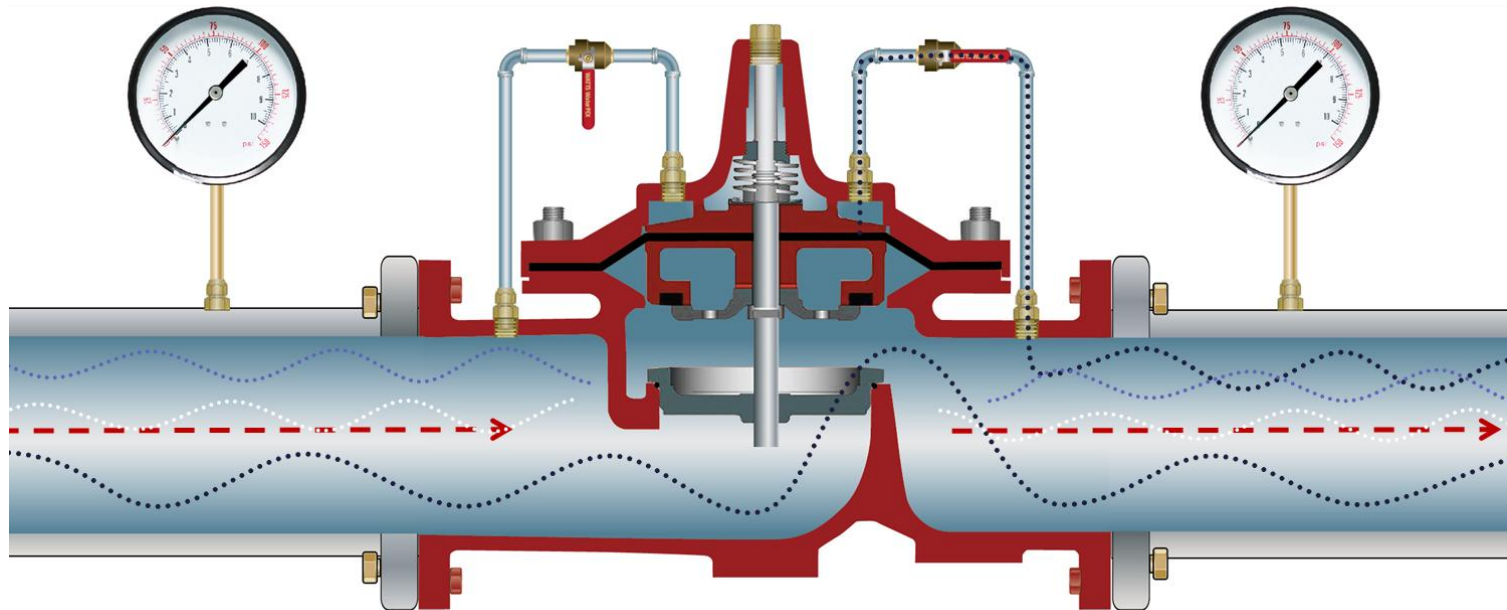
Almost all Non-Modulating Valves use some sort of 3-Way Control Pilot – These Pilots all have three ports and three connections. A Supply Port, a Cover Port and a Drain Port. These Pilots either block the Drain Port or the Supply Port while interconnecting the Cover Port with the unblocked Port – In this case the Supply is Connected to the Cover or Common Port while blocking the Drain and the Valve is Closed – ALL 3 – WAY PILOTS WORK LIKE THIS!!



Types of Operation – Non-Modulating Service

So, the Valve comes open when the 3-Way Control Pilot Shifts Positions and blocks the Supply Port while interconnecting the Common or Cover Port with the Drain Port and the Valve comes Open

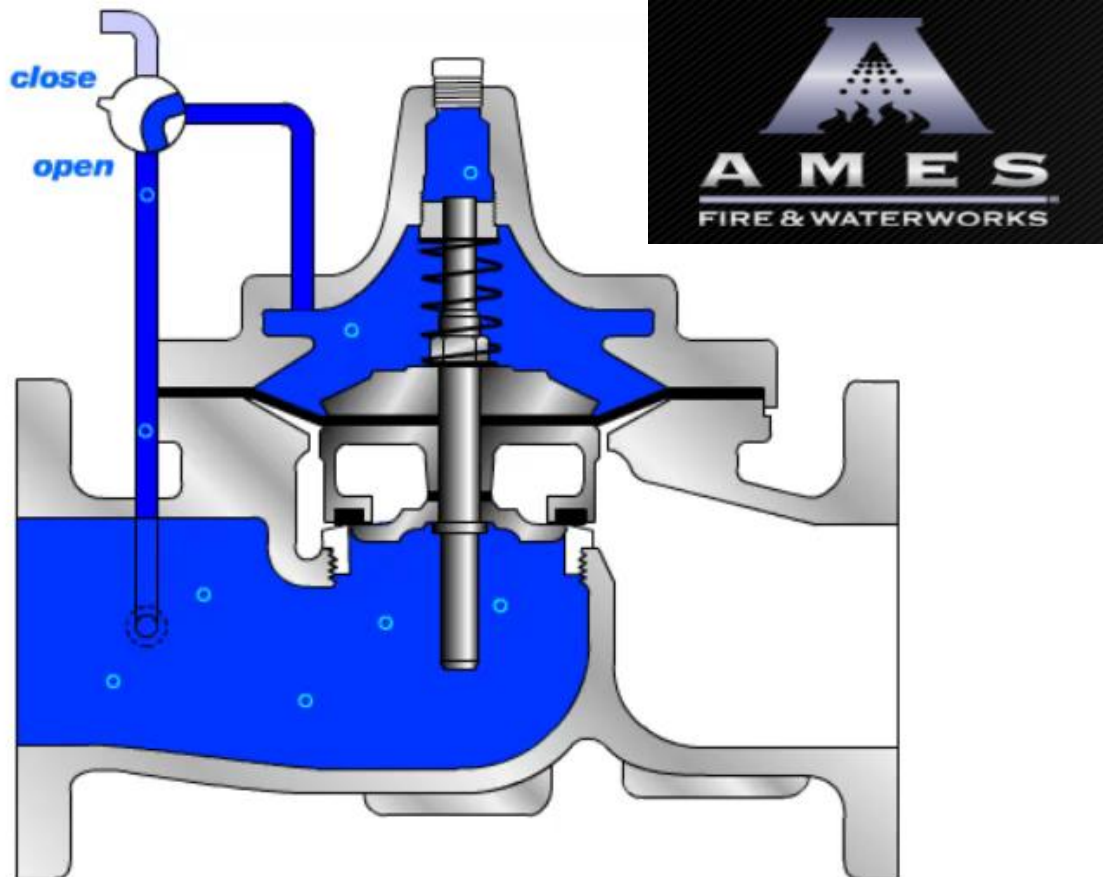
ALL THREE-WAY PILOTS WORK LIKE THIS!!



Types of Operation – On/ Off Valve

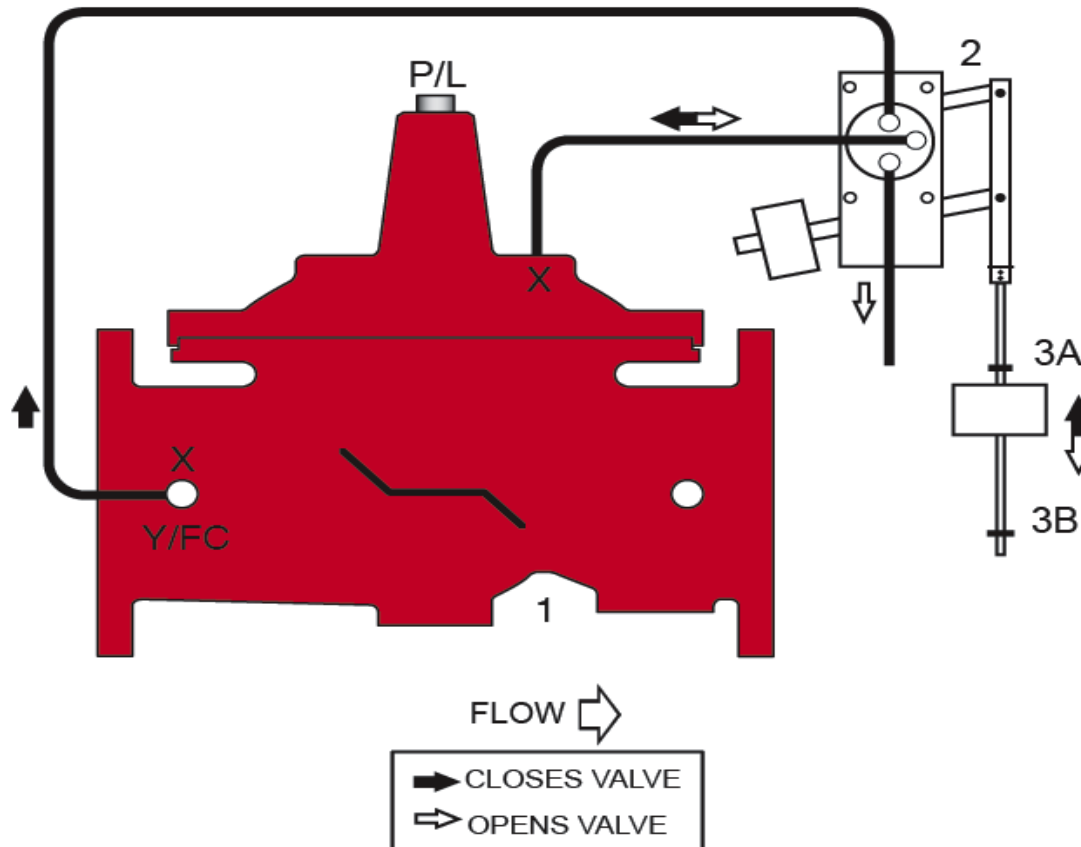
Non-Modulating Valves Need 3 Connections

- 1) Supply Port/ Connection, 2) Cover Port/ Connection, 3) Drain Port/ Connection

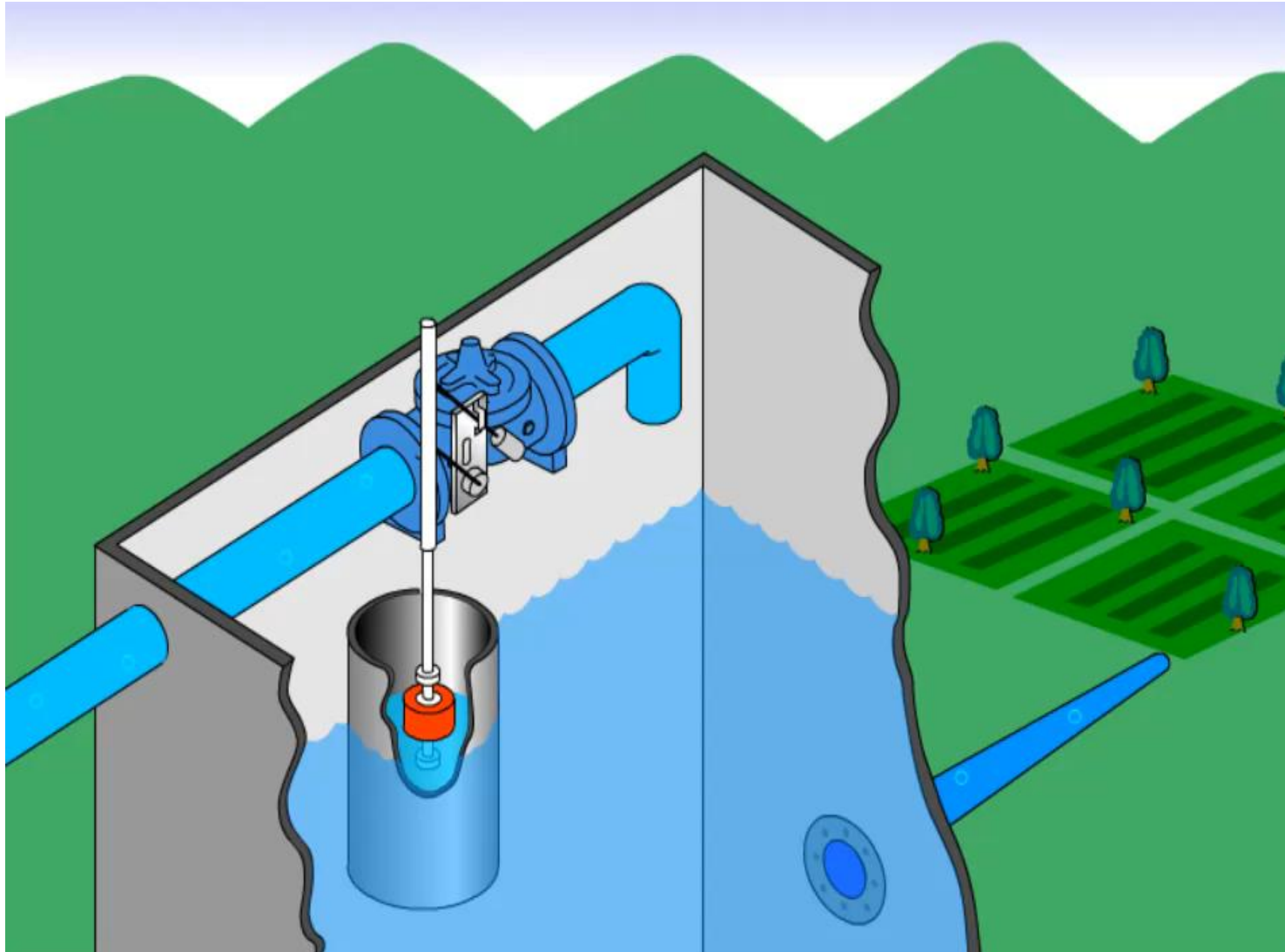


Types of Operation – On/ Off Valve

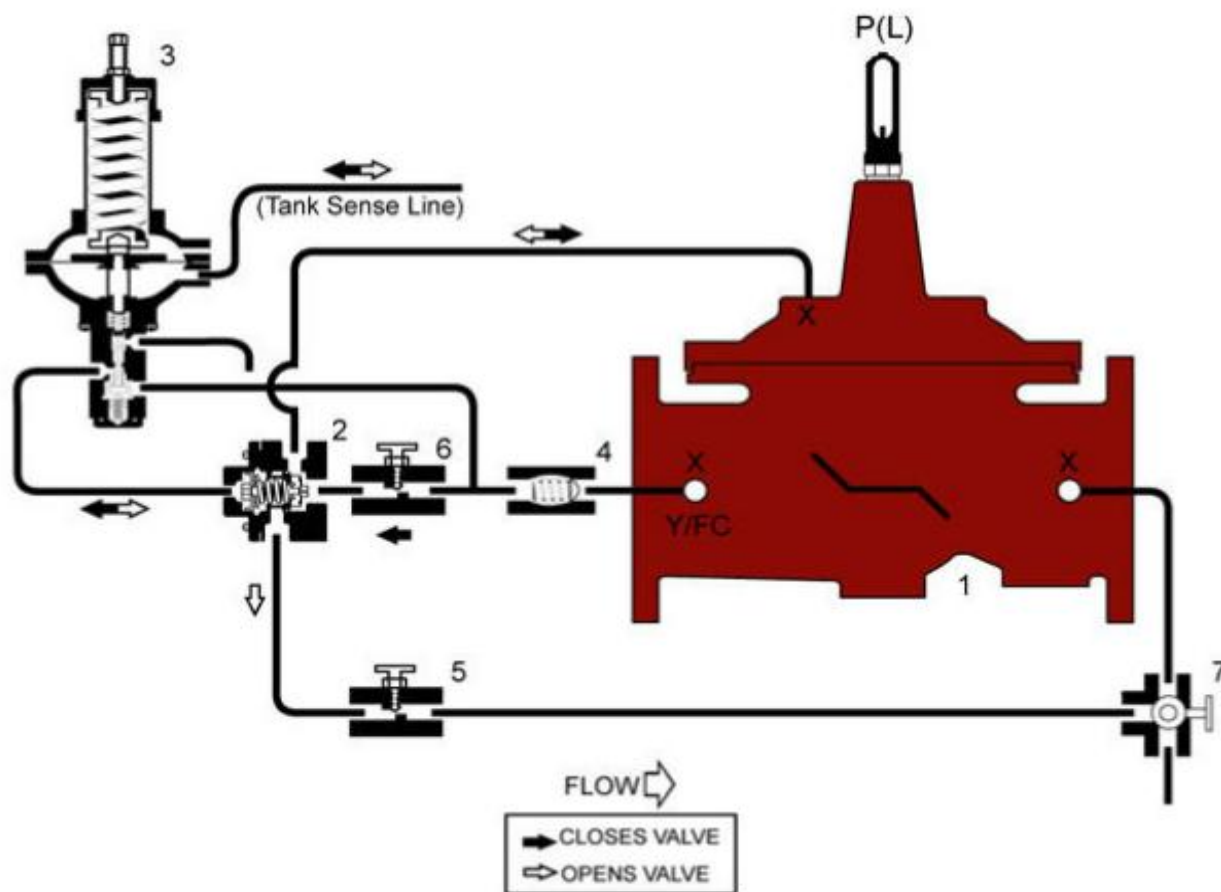
Watts/ Ames 970 Series Float Valve



Types of Operation – On/ Off Valve



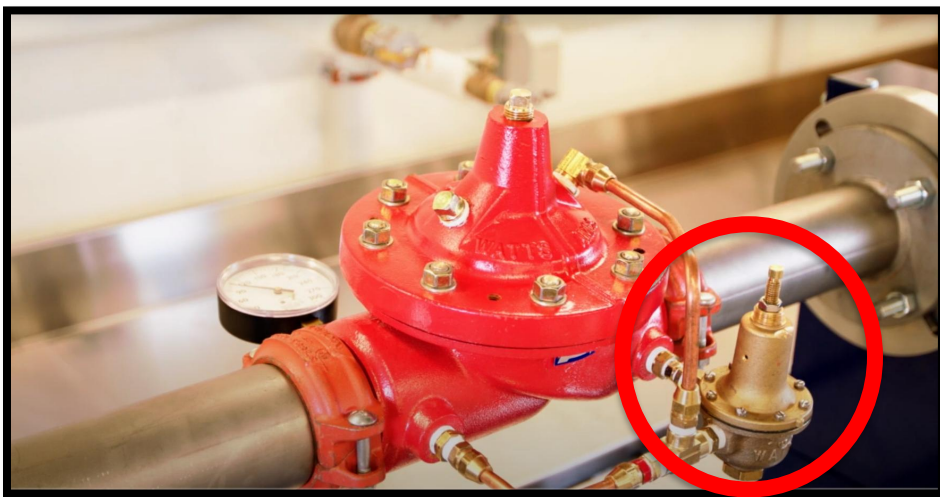
Types of Operation – On/ Off Valve



THE AMES SERIES 960GD ALTITUDE VALVE FOR ONE-WAY FLOW IS DESIGNED TO KEEP WATER STORAGE TANKS FULL VIA THE SINGLE POINT AMES MODEL 27 ALTITUDE CONTROL PILOT.

HOW DOES AN ACV WORK?

The Pilot tells the Main Valve what to do



Pressure Reducing ACV Pilot

DIRECT ACTING vs ACV (Piloted)



Water Pressure Reducing Valves



End Connections

To facilitate installation and servicing of a WPRV, Watts offers a variety of end fitting configurations, including union fittings (female threaded, solder, CPVC, PEX, Quick-Connect, and press end connections), flanged valves, water meter threads and special lay lengths for water meter installations. Please refer to valve models for specific availability of end connection options.



Solder



Threaded



CPVC



PEX



Quick-Connect



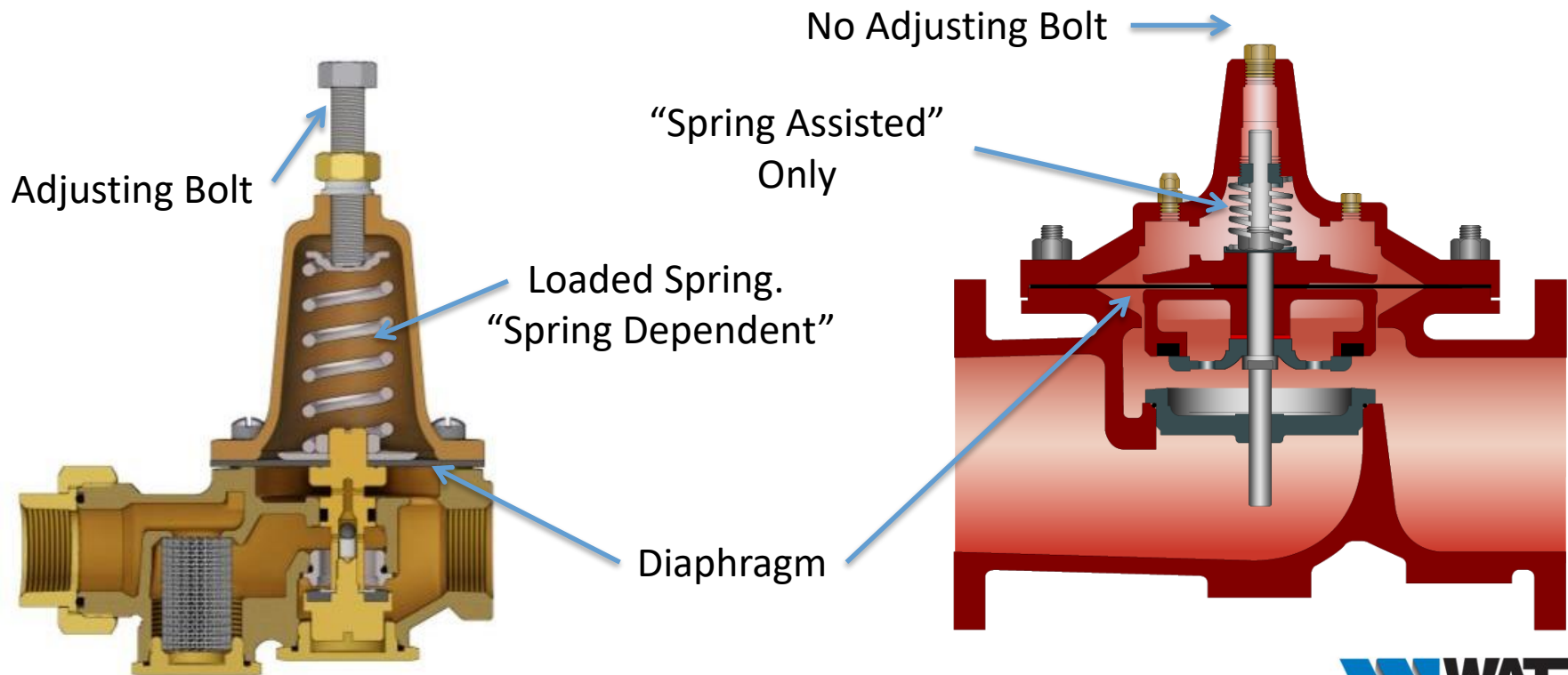
Press

PRV Pressure Reducing Valve Watts LF25AUB-Z3

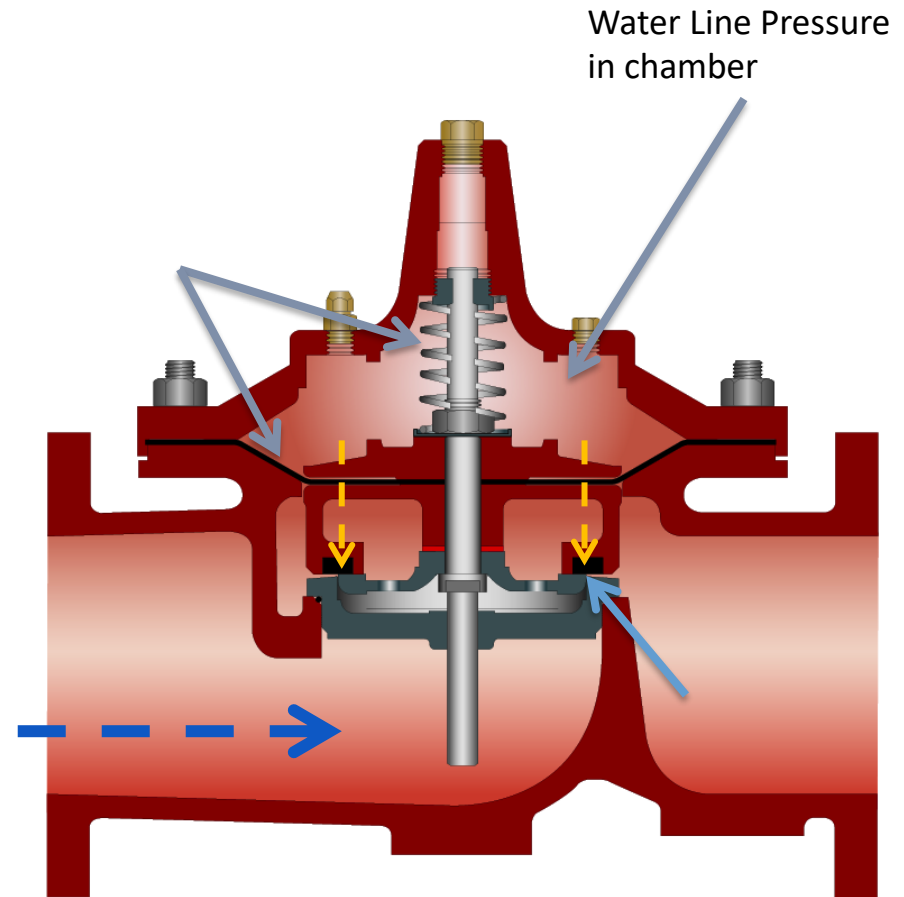
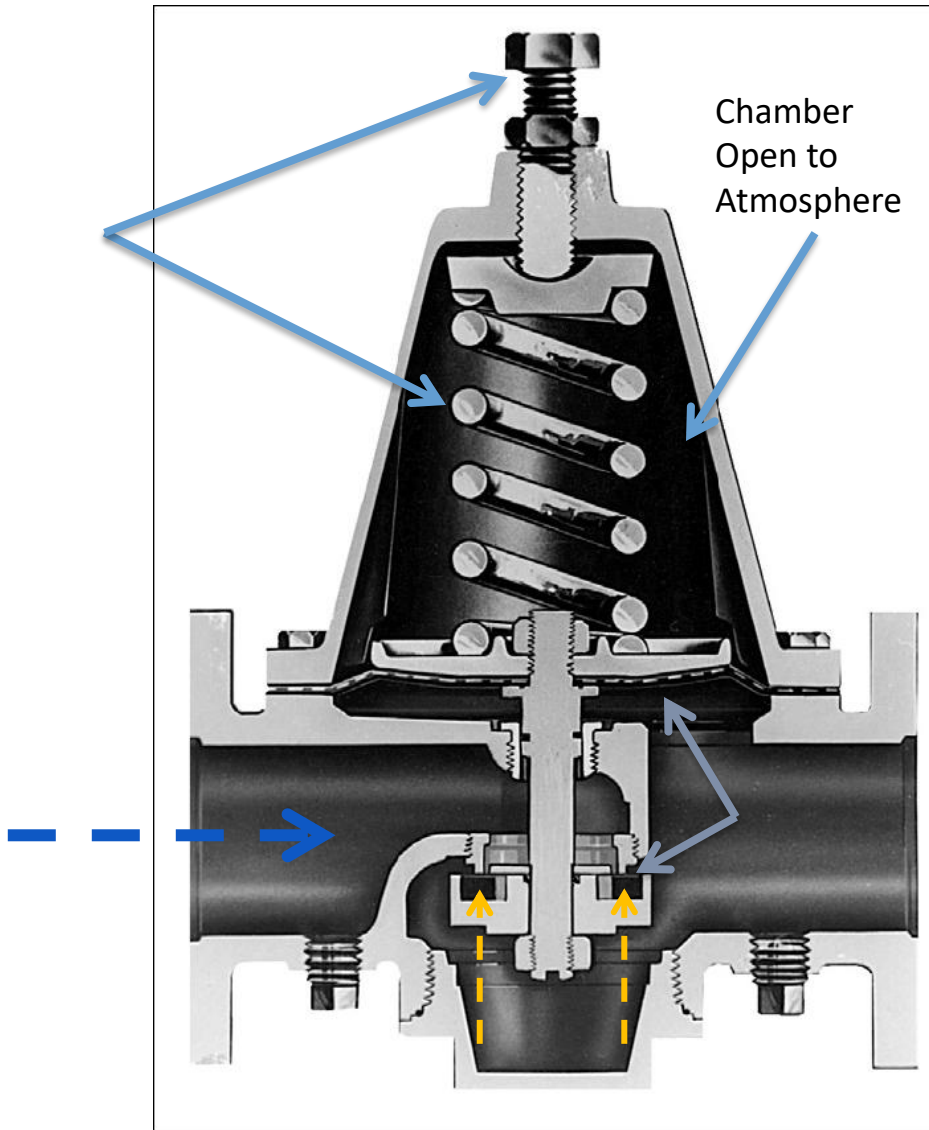


DIRECT ACTING vs ACV (Piloted)

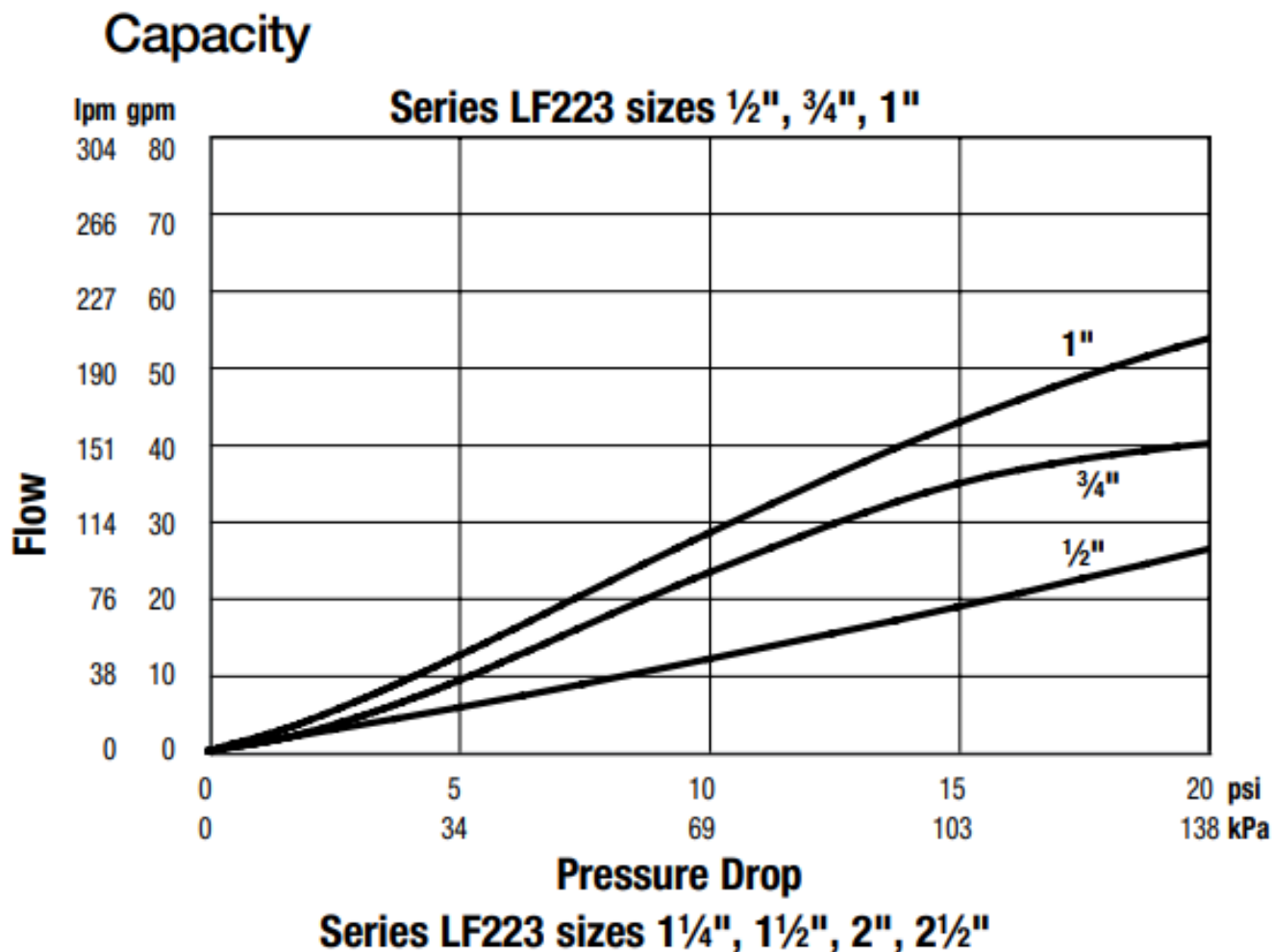
- Operating Principle
 - Compare Direct Acting vs ACV Main Valve:



DIRECT ACTING vs ACV (Piloted)

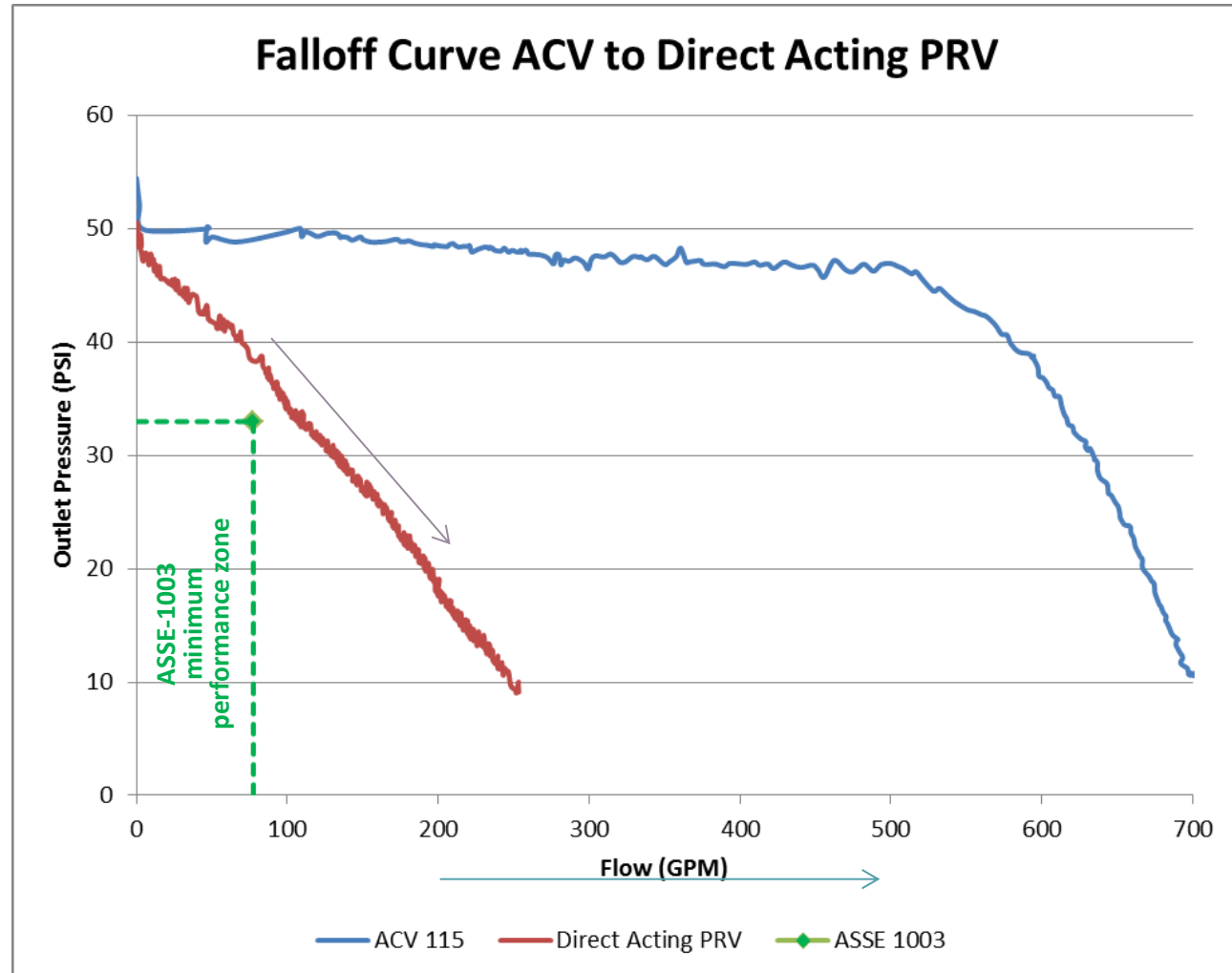


DIRECT ACTING vs ACV (Piloted)



DIRECT ACTING vs ACV (Piloted)

- Functions
- Sizes 1-1/4" to 36"+
- End Connections
- Control Options
- Performance
- Volumetric Capacity
- Pressure (line and set)
- Longevity
- Adaptability after installation
- Ownership Cost



DIRECT



VS



ACV

Direct Acting Pressure Reducing Valve

- For smaller commercial or domestic applications
- Mechanical force vs hydraulic force to regulate downstream demand
- Most efficient with consistent flows and demands

Pilot Operated Diaphragm Control Valve (Pressure Reducing Function) - ACV

- For commercial or municipal applications
- Dependent on a direct acting pilot to control flows off the cover
- Can handle a much wider range of flows and demands efficiently
- Less fall off (flow vs. PSI)

ACV



ATTACK OF VOOODOO

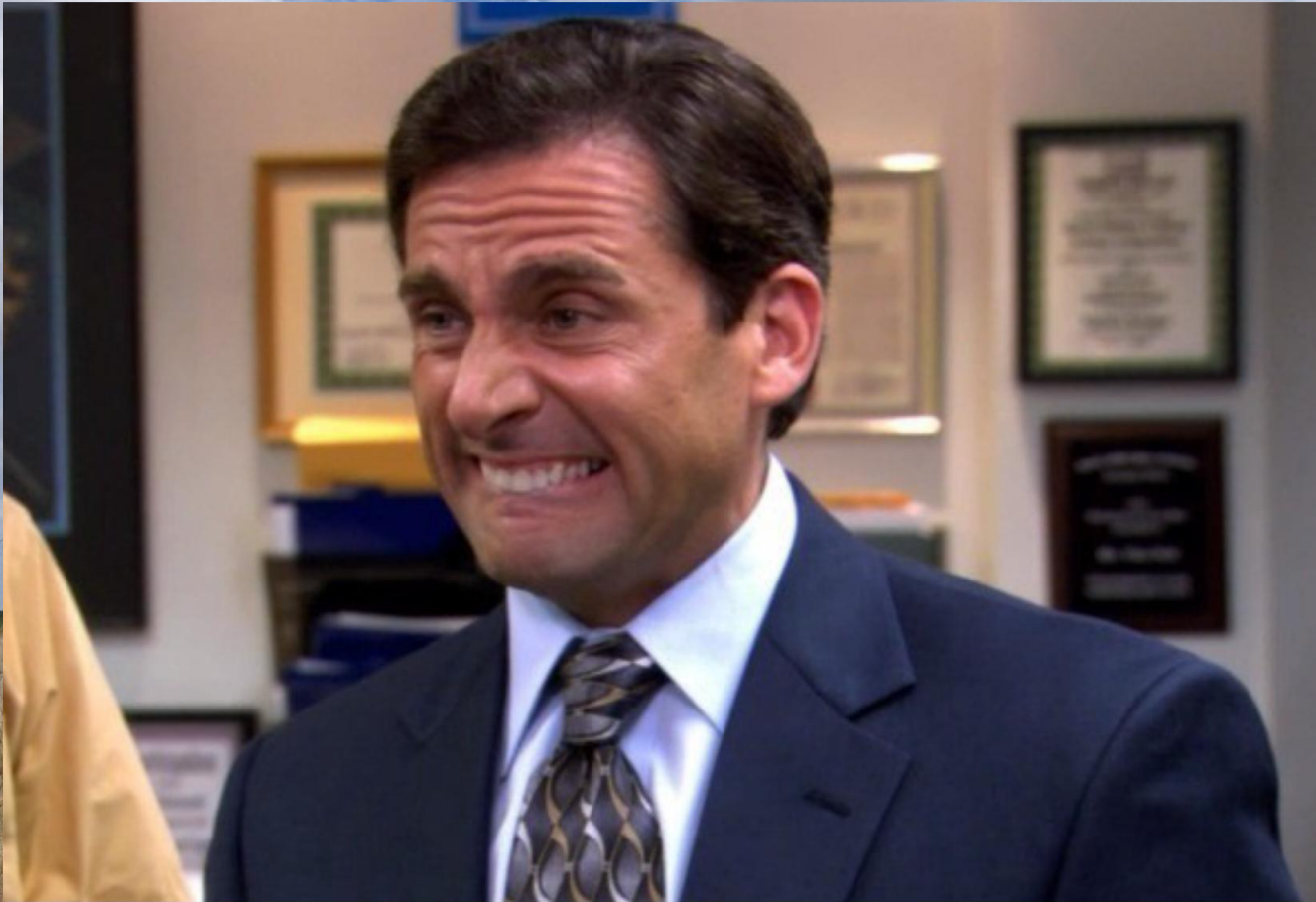


Watts ACV

Automatic Control Valves

Issues & Problems

Size Matters.....



“That’s What Said”

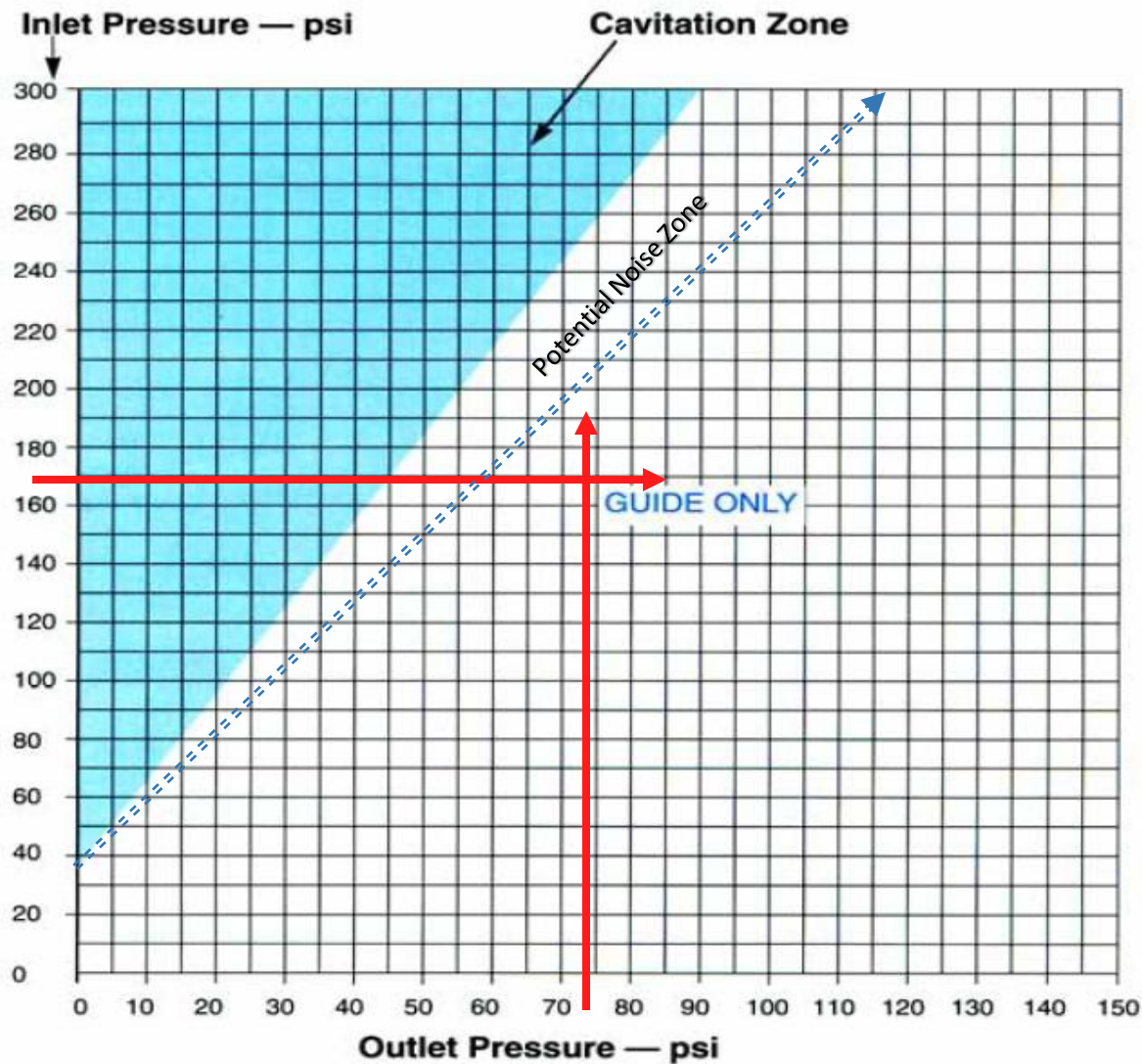
Issues with Oversizing



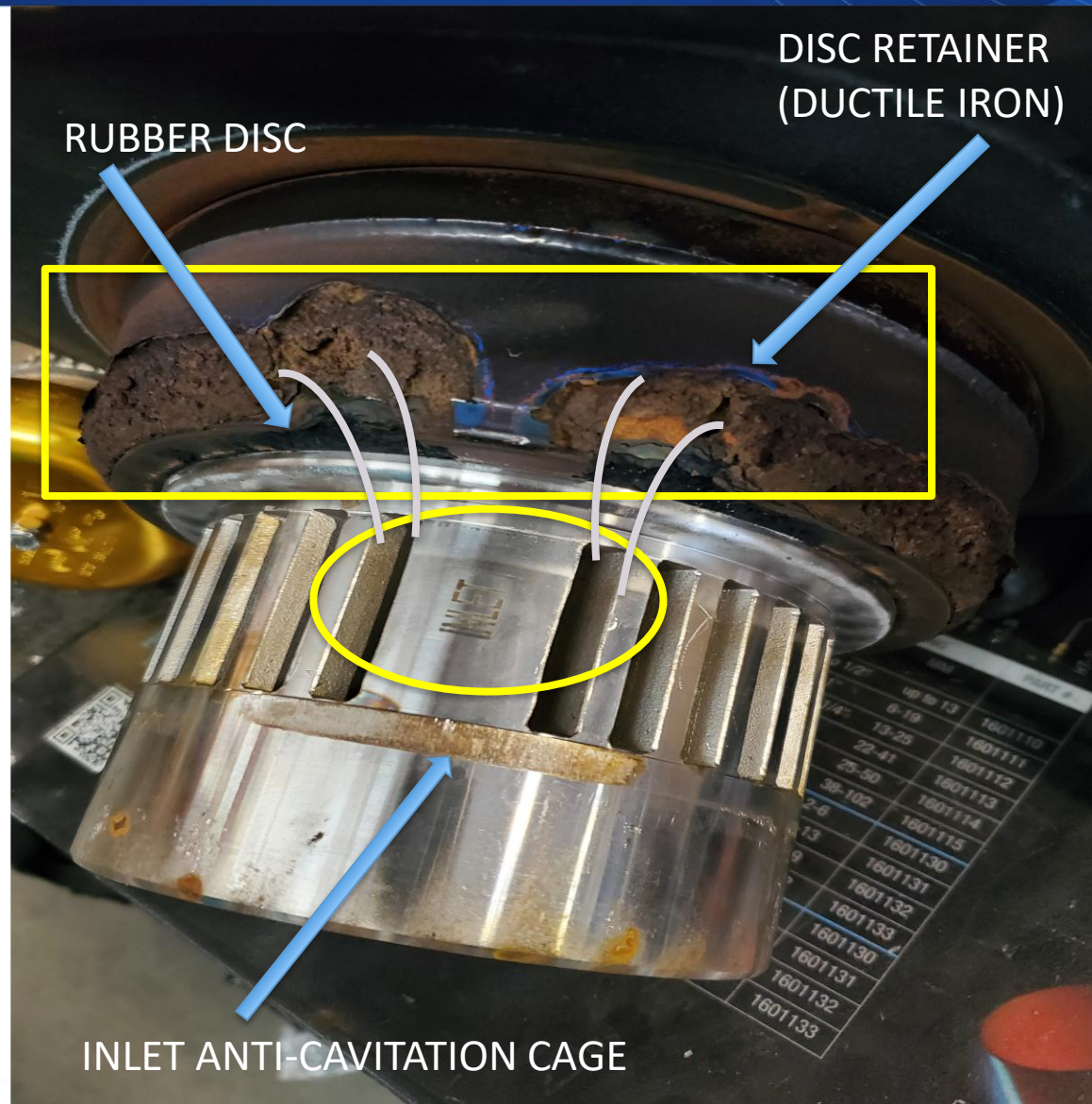
What is Cavitation?

- **Cavitation:**
 - The formation of bubbles within a liquid at low-pressure regions that occur in places where the liquid has been accelerated to high velocities
 - Creates erosion, noise and reduced efficiency because of flow distortion
- **Velocity:**
 - The speed of water (FT/S)
 - The pressure difference from a restriction causing fluid to move faster to maintain the upstream pressure (Bernoulli's Principal)

Cavitation Avoidance



Issues with Oversizing



Why are PRV's oversized?

- Meet fire flow demand
- Meet max system demands
- Minimal or normal demands are not taken into consideration
- The “just in case” dominated the typical demands

Issues with Oversizing



Meets max fire flow demands, but what about low flows?

Ideal Operation

- Ideal PRV operation:
 - 20%-80% valve position
 - 10%-90% is not ideal, but allowable



Custom Sizing Available



WATTS ACV SIZING WORKSHEET

VERIFICATION OF PROPER SIZING

BASED OFF PERCENTAGE OF VALVE OPEN IN OPERATION

Mustang Series

Project Name/ Customer:	CU WILLIAMS VILLAGE EAST PRV			
Max. Poss. Intermittent Flow:	400	Gpm	Line Size:	6"
Maximum Continuous Flow:	280	Gpm	System Inlet Pressure:	95 psi
Normal (Est.) Operating Flow:	150	Gpm	Desired Outlet Pressure:	85 psi
Minimum Flow:	0- 55	Gpm	Pressure Differential Result:	10 psi
			Outside Cavitation Zone	Possible Cavitation

Valve Model Selected: **4" LFM115-74 PRESSURE REDUCING ACV with LOW-FLOW BY-PASS**

Valve CV Factor: **185** Gpm* Adjusted CV Factor @ 90% Open: **166.5** Gpm

Globe Body *Based off Watts Published Flow Data Charts

ΔP (Pressure Drop) $\sqrt{\Delta P}$ = **3.16** *(Based off Pressure Differential)

CV Factor at Maximum Possible Intermittent/ Peak Flow: **126.49** Gpm < **166.5** Gpm
(400 Gpm / $\sqrt{\Delta P}$ @ 3.16) **GOOD / SAFE**



PERCENTAGE OF VALVE OPEN IN OPERATION

IDEAL OPERATION IS WITHIN 20% TO 80% OPEN

10% ABOVE SEAT - 90% OPEN IS NOT IDEAL BUT ALLOWABLE



FLOW RATE (Gpm)	PERCENT OF VALVE OPEN	ADDITIONAL NOTES/ RECOMMENDATIONS
400	75.97%	
280	53.18%	REDUCE FROM 6" TO 4" FLG VALVE
150	28.49%	INTREGAL LOW-FLOW BY-PASS with 1" LFF223 (50-145)
55	10.45%	

*Percent of Valve Open Calculated as follows; (Flow Rate / $\sqrt{\Delta P}$ / Adjusted Valve CV Factor

**Calculations Assume Line Media as Potable Water at 60 Degrees Fahrenheit



AMES ACV SIZING WORKSHEET

VERIFICATION OF PROPER SIZING

BASED OFF PERCENTAGE OF VALVE OPEN IN OPERATION

Mustang Series

Project Name/ Customer:	Grand Junction Pipe & Supply - Burligame			
Max. Poss. Intermittent Flow:	90	Gpm	Line Size:	3"
Maximum Continuous Flow:	81.9	Gpm	System Inlet Pressure:	100 psi
Normal (Est.) Operating Flow:	50	Gpm	Desired Outlet Pressure:	70 psi
Minimum Flow:	7.5	Gpm	Pressure Differential Result:	30 psi
			Outside Cavitation Zone	Possible Cavitation

Valve Model Selected: **1-1/2" Ames Figure 910 Full-Port Pressure Reducing Automatic Control Valve**

Valve CV Factor: **26** Gpm* Adjusted CV Factor @ 90% Open: **23.4** Gpm

Globe Body *Based off Ames Published Flow Data Charts

ΔP (Pressure Drop) $\sqrt{\Delta P}$ = **5.48** *(Based off Pressure Differential)

CV Factor at Maximum Possible Intermittent/ Peak Flow: **16.43** Gpm < **23.4** Gpm
(90 Gpm / $\sqrt{\Delta P}$ @ 5.48) **GOOD / SAFE**



PERCENTAGE OF VALVE OPEN IN OPERATION

IDEAL OPERATION IS WITHIN 20% TO 80% OPEN

10% ABOVE SEAT - 90% OPEN IS NOT IDEAL BUT ALLOWABLE



FLOW RATE (Gpm)	PERCENT OF VALVE OPEN	ADDITIONAL NOTES/ RECOMMENDATIONS
90	70.22%	
81.9	63.90%	
50	39.01%	Will Need Reducers to 1-1/2" Valve Connection
7.5	5.85%	Valve Connection Options: *NPT (Threaded Connections) *150# Flanged Connections ** Lay Lengths Differ Between NPT & FLG Valves **

Custom Sizing Available

Selexit Configuration Number: C-26268

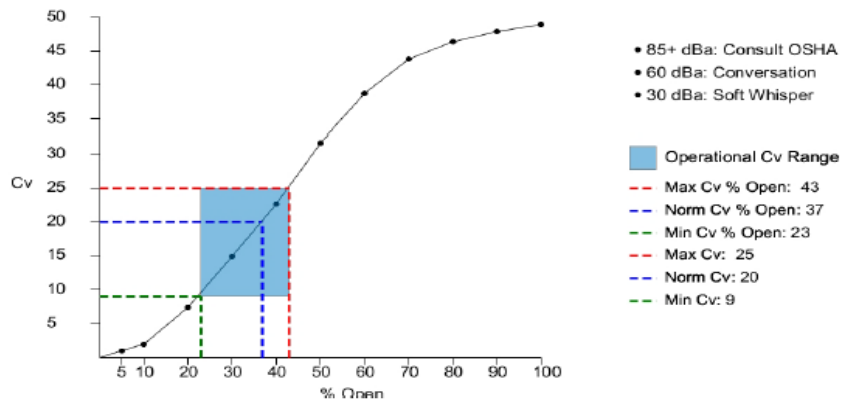
To order this valve, please visit: <https://www.watts.com/how-to-buy-sales-representative>

CMG1B - AWXX - A1C21 - J4XXX - XXXXW

Size(inches)	C	2
Body Material	M	Ductile Iron
Body Style	G	Straight
Chamber and Port	1	Single Chamber Full Port
End Connection	B	150 # Flanged
Primary Function	A	Pressure Reducing
Additional Function 1	W	Low Flow Bypass
Additional Function 2	X	None
Additional Function 3	X	None
Top Works	A	Pipe Plug
Pilot System Material	1	Lead Free Tubing, Fittings and Pilot
Pilot System Strainer	C	Wye Strainer
Speed Controls	2	Adjustable Opening Speed (AOS)
Global Elastomer Selection	1	Buna
Primary Pilot Pressure Range	J	2-30 - CP15 Pressure Reducing Internal Sensing
Secondary Pilot Pressure Range	4	50-125 - LF223 LF223 Low Flow Bypass Low Range

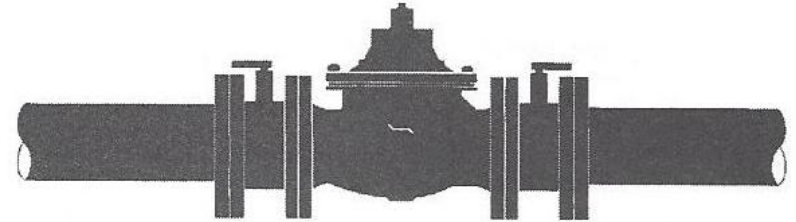
Max Valve Open:	Max Flow 160 gpm	Inlet Pressure 111 psig	Outlet Pressure 70 psig
Norm Valve Open:	Norm Flow 130 gpm	Inlet Pressure 111 psig	Outlet Pressure 70 psig
Min Valve Open:	Min Flow 60 gpm	Inlet Pressure 111 psig	Outlet Pressure 70 psig
Temperature: 60 F	Pipe Size: 2	Fluid: Water	Pipe Schedule: 40

Selected Valve	Max dBA/Cav	Norm dBA/Cav	Min dBA/Cav
Ductile Iron 2 Straight Full 150#	58 No Cavitation	55 No Cavitation	45 No Cavitation



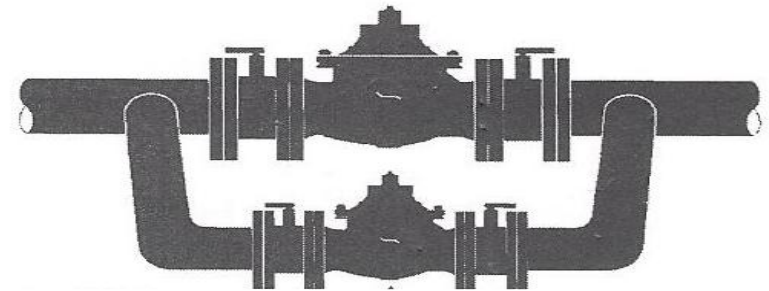
DESIGN CONSIDERATIONS EXPANDED

- SINGLE VALVE INSTALLATION



- PARALLEL VALVE INSTALLATION

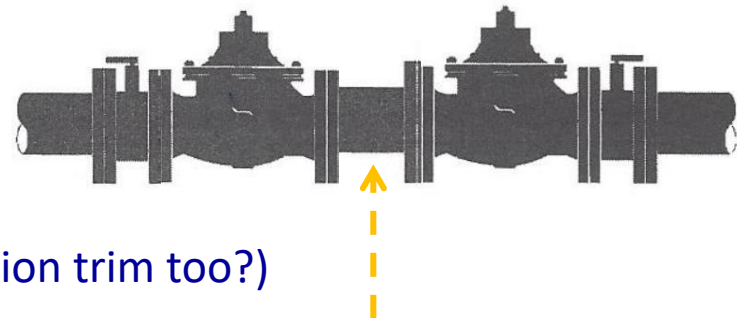
- HIGHER FLOW w/ LOW FLOW BY-PASS



- STAGED REGULATING VALVES
(In Series)

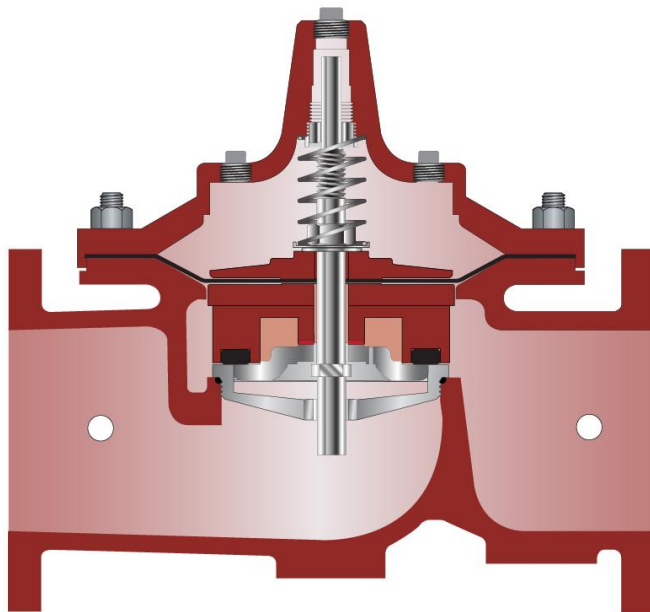
Use For Excessive Pressure Drop (anti-cavitation trim too?)

- MULTIPLE VALVES IN SUCCESSION ON SAME LINE



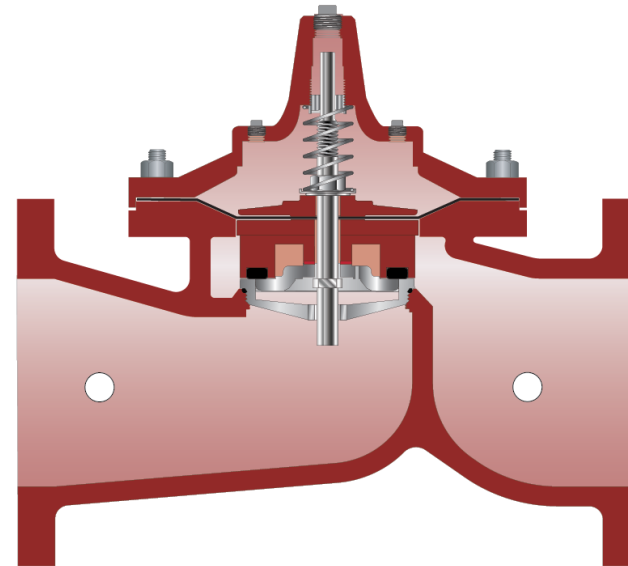
Design Considerations Expanded

6" Flanges / 6" Internals



Full Port

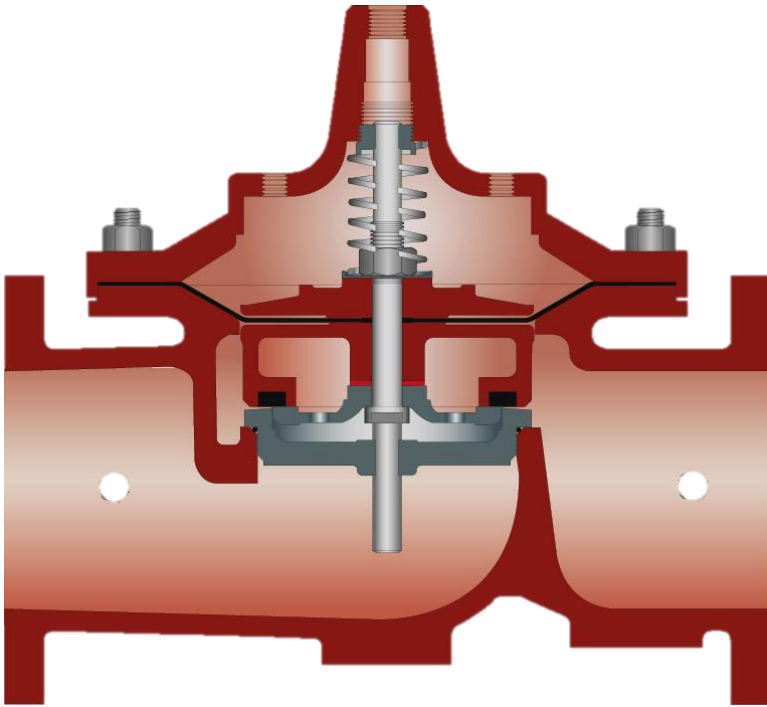
6" Flanges / **4" Internals**



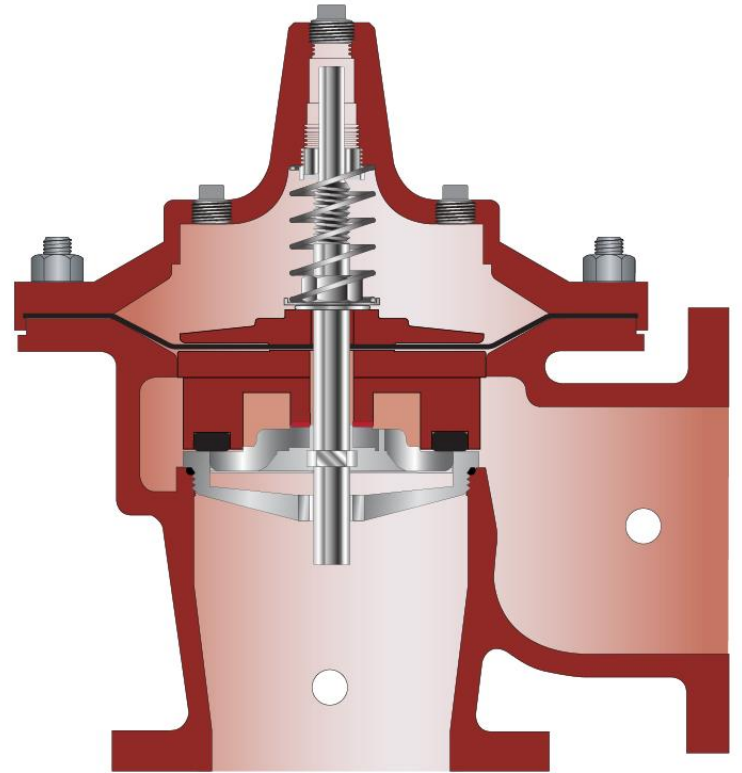
Reduced Port



Design Considerations Expanded

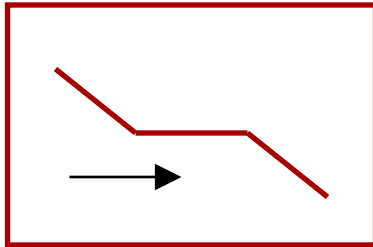
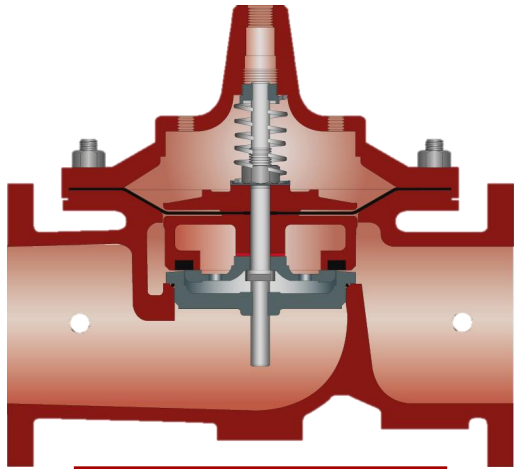


Globe Pattern



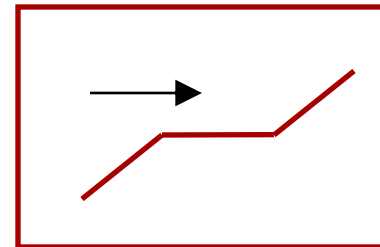
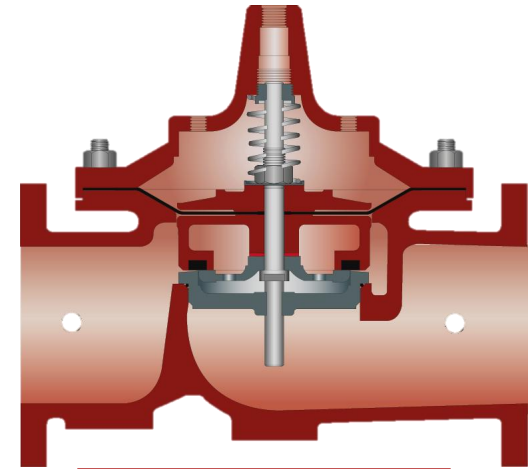
Angle Pattern

Design Considerations Expanded



Under the Seat: Valve Fails Open

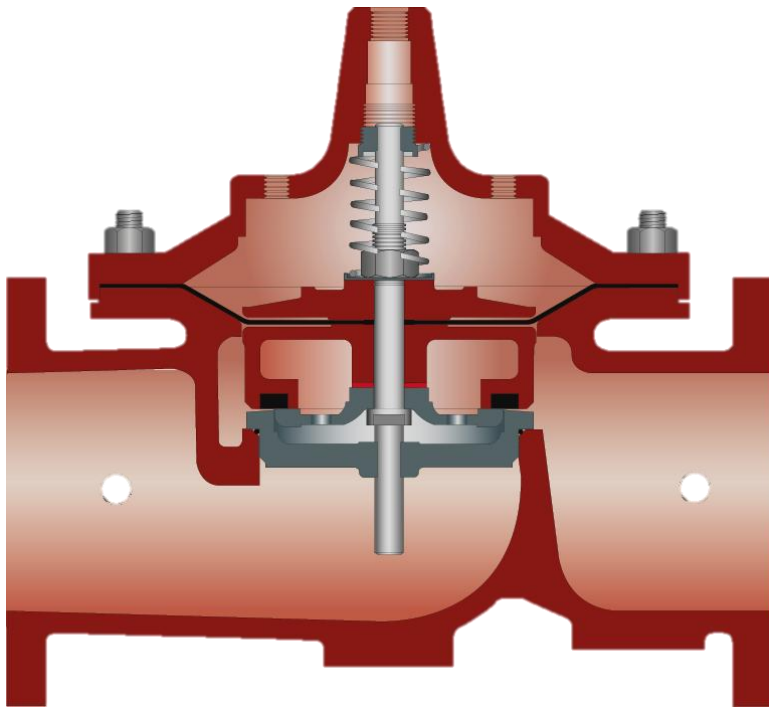
- Most Applications



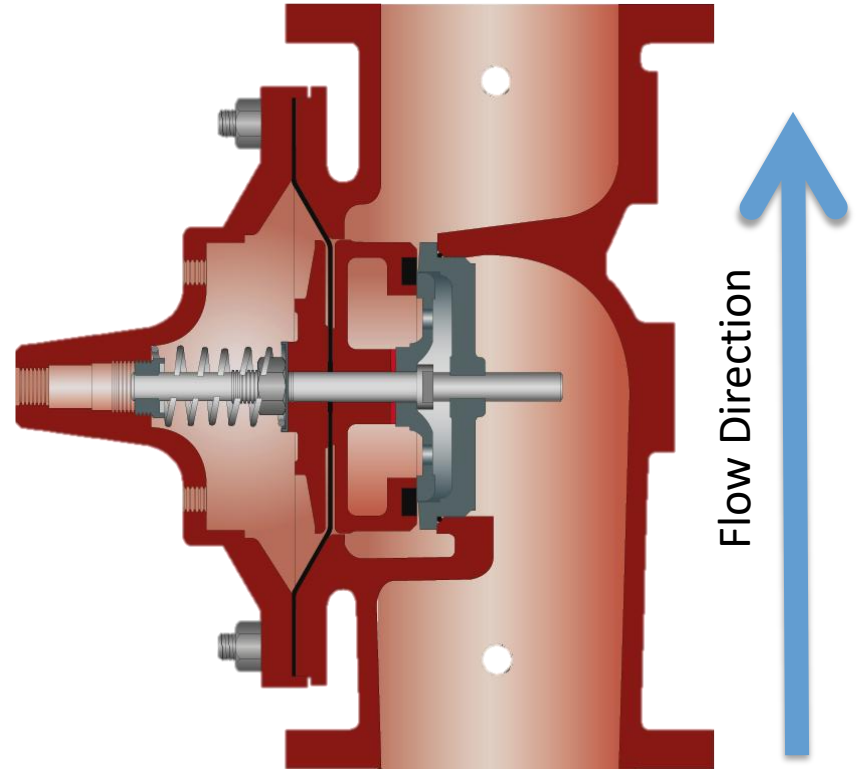
Over the Seat: Valve Fails Closed

- Specialty Applications Only
- Designated By An Identifier.
 - i.e. "R" in Model Number

Design Considerations Expanded



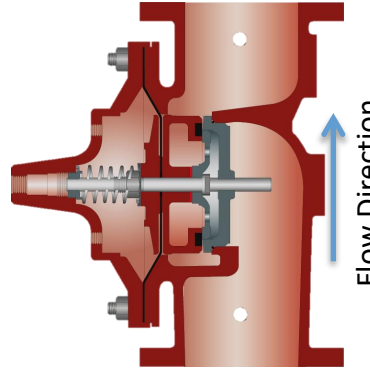
Standard Installation



6" and Smaller

Design Considerations Expanded

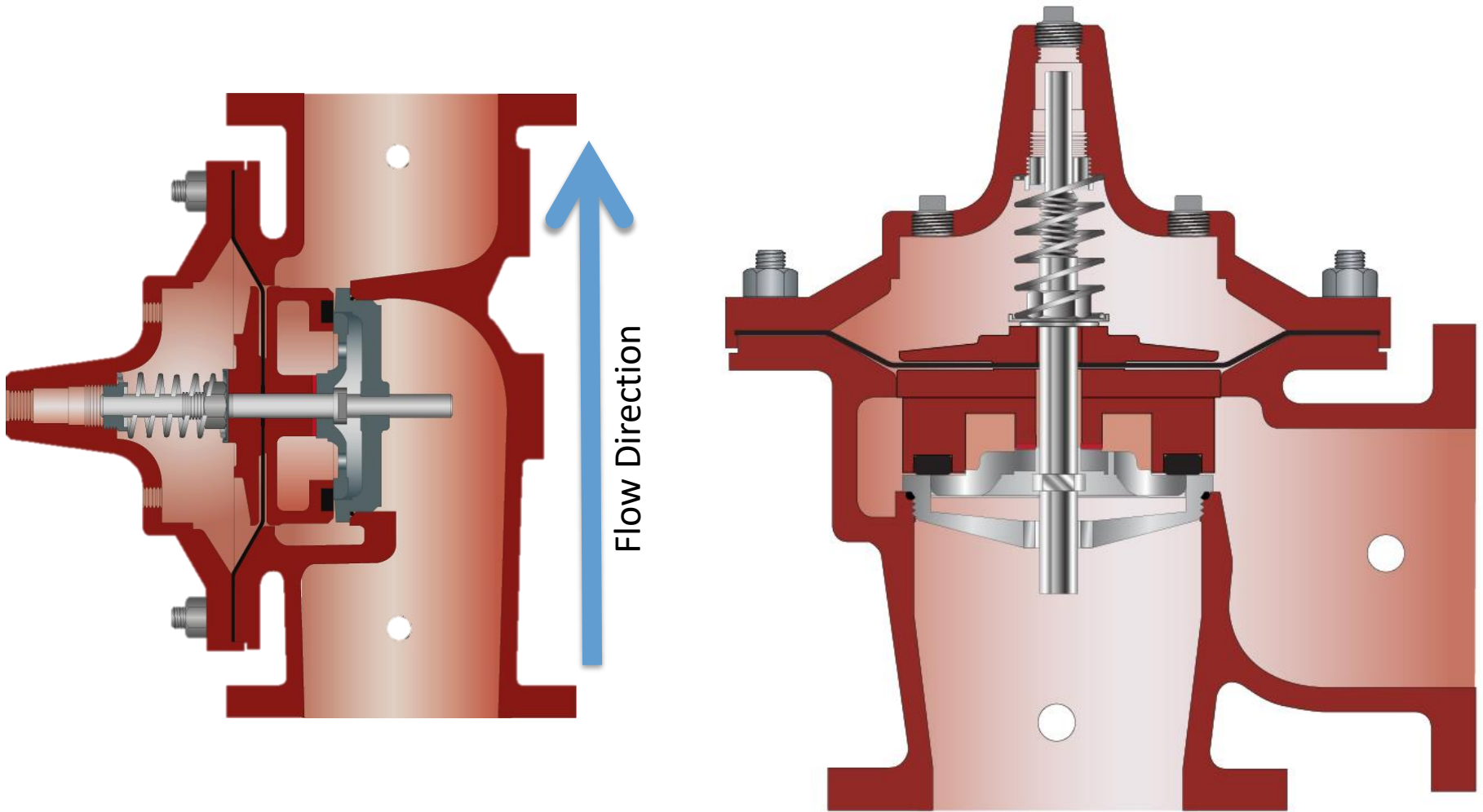
Main Valve – Vertical Installation



- Can You? Yes.
- Is It Best Practice? No.



Design Considerations Expanded



Watts on YouTube

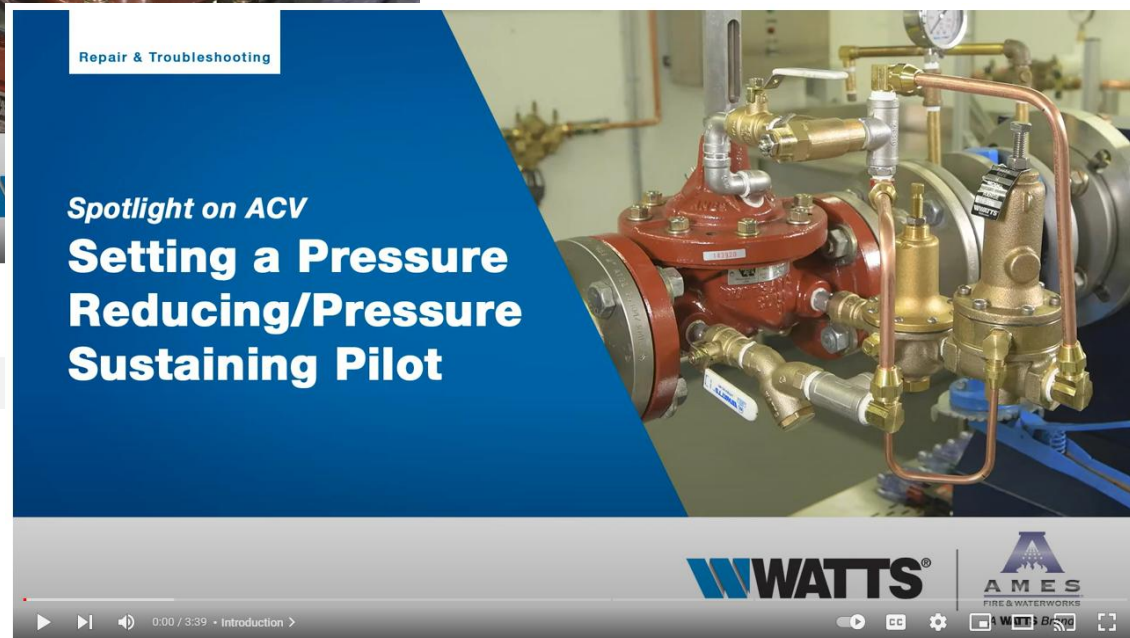


ACV Diaphragm Repair

 Watts Water
4.57K subscribers

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1.2K views 2 years ago
Take a look inside a Watts ACV and discover how to quickly and safely repair a damaged diaphragm assembly. [Show more](#)



How to set pressure reducing and sustaining for ACV

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 Like   Share  Save ...

3.5K views 2 years ago
In this video, we'll review how to set the pressure on a pressure-sustaining automatic control valve. [Show more](#)

Preventative Maintenance

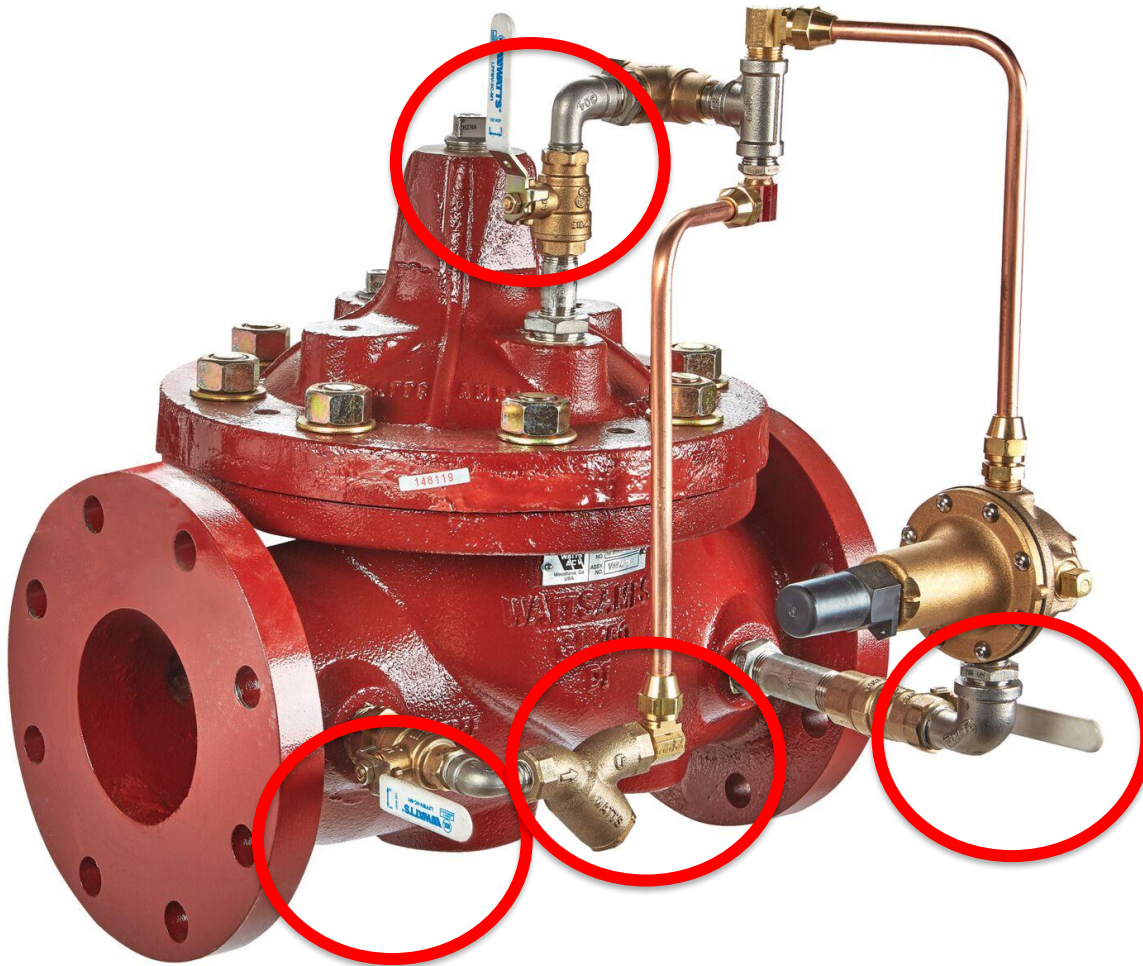
Why do we need preventative maintenance?

- PRV's are designed to fail open
- Because of the reduced flows, ports can clog up and impede the valves ability to operate
- Strainers can clog up
- Soft brass fittings can corrode causing fitting leaks
- Ensure proper operations

Common Failures



Specify Y-Strainers and Inlet/ Outlet Isolation Cocks



ACV/ PRV COMMON ISSUES & PROBLEMS

- **OVERSIZING or LINE SIZING**

- PLACES ACV OPERATION OUTSIDE OF IDEAL VALVE POSITION OF OPERATION (% OF VP)
IDEAL VALVE OPERATION IS ABOVE 20% OPEN & NOT EXCEEDING 80% OF FULLY OPEN
 - CONSTANT OPERATION OUTSIDE OF IDEAL % OF VP RESULTS IN VALVE DAMAGING CONDITIONS

- **INEFFICIENT DESIGN PRACTICES**

- DESIGNS DON'T EFFECTIVELY ADDRESS HIGH & LOW FLOWS
 - OFTEN RESULTS IN DAMAGE TO VALVES & WATER QUALITY ISSUES DUE TO STAGNATION
 - OFTEN THE SOURCE SYSTEM ISSUES (PERIODS OF LOW CONSUMPTION)

- **LACK OF PREVENTATIVE MAINTENANCE**

- OFTEN DUE TO LACK OF ACV KNOWLEDGE OR STANDARD PROCEDURES
 - VALVES FAIL OPEN DUE TO CLOGGED PORTS, STRAINERS, ETC. OR UNINSPECTED FITTINGS
 - RESULTS IN ONE IF NOT SEVERAL SYSTEM FAILURES

- **INABILITY TO CONTROL AND/ OR MONITOR**

- THE ADDITION OF VAULT TELEMETRY IS AN EXTREME EXPENSE
 - REQUIRES THE ADDTION OF SUMP, PLC, AND ELECTRICITY OFTEN EXCEEDING \$20,000
 - YOU DON'T KNOW THERE IS A PROBLEM UNTIL "THERE IS A PROBLEM"
 - LACK OF VALVE CONTROL MAKES PRV EXERCISING IMPRACTICAL (I.E. WORKING CAPITAL)



ANY QUESTIONS

