xylem
Let's Solve Water

The Little Red Schoolhouse

Large Chilled Water System Design Seminar

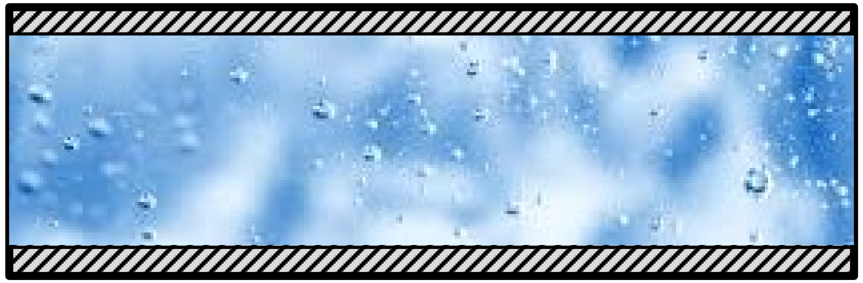
Courtesy of Oslin Nation Company

Air Management and System Pressurization

Bell & Gossett
a xylem brand

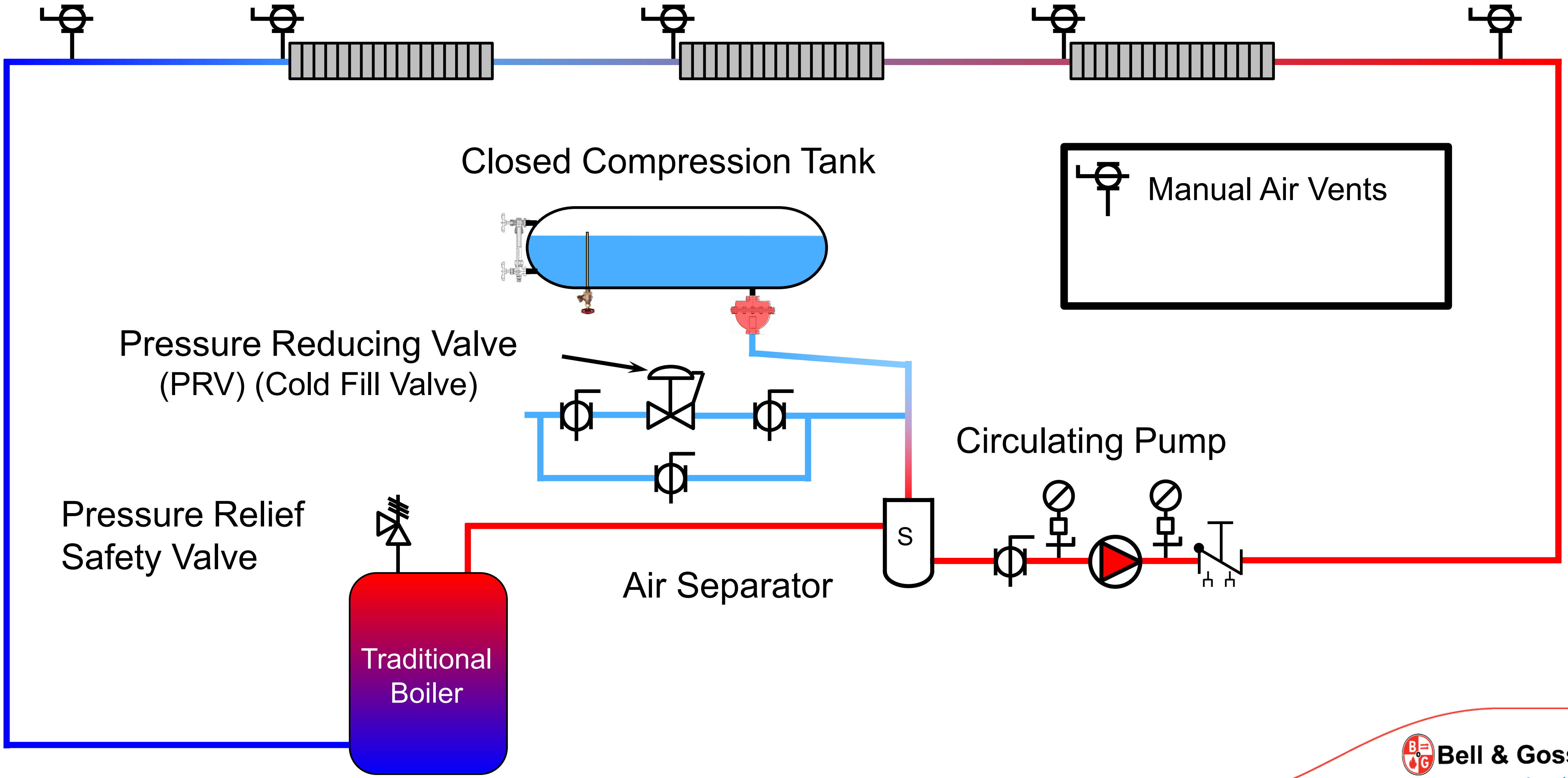
What Form of Air are we Managing?

- **Free Air:** Large visible bubbles in the water
- **Entrained Air:** Small micro-bubbles that travel at same velocity as the system water
- **Dissolved or Absorbed Air:** air gases dissolved in solution (mainly N_2 and 0_2)

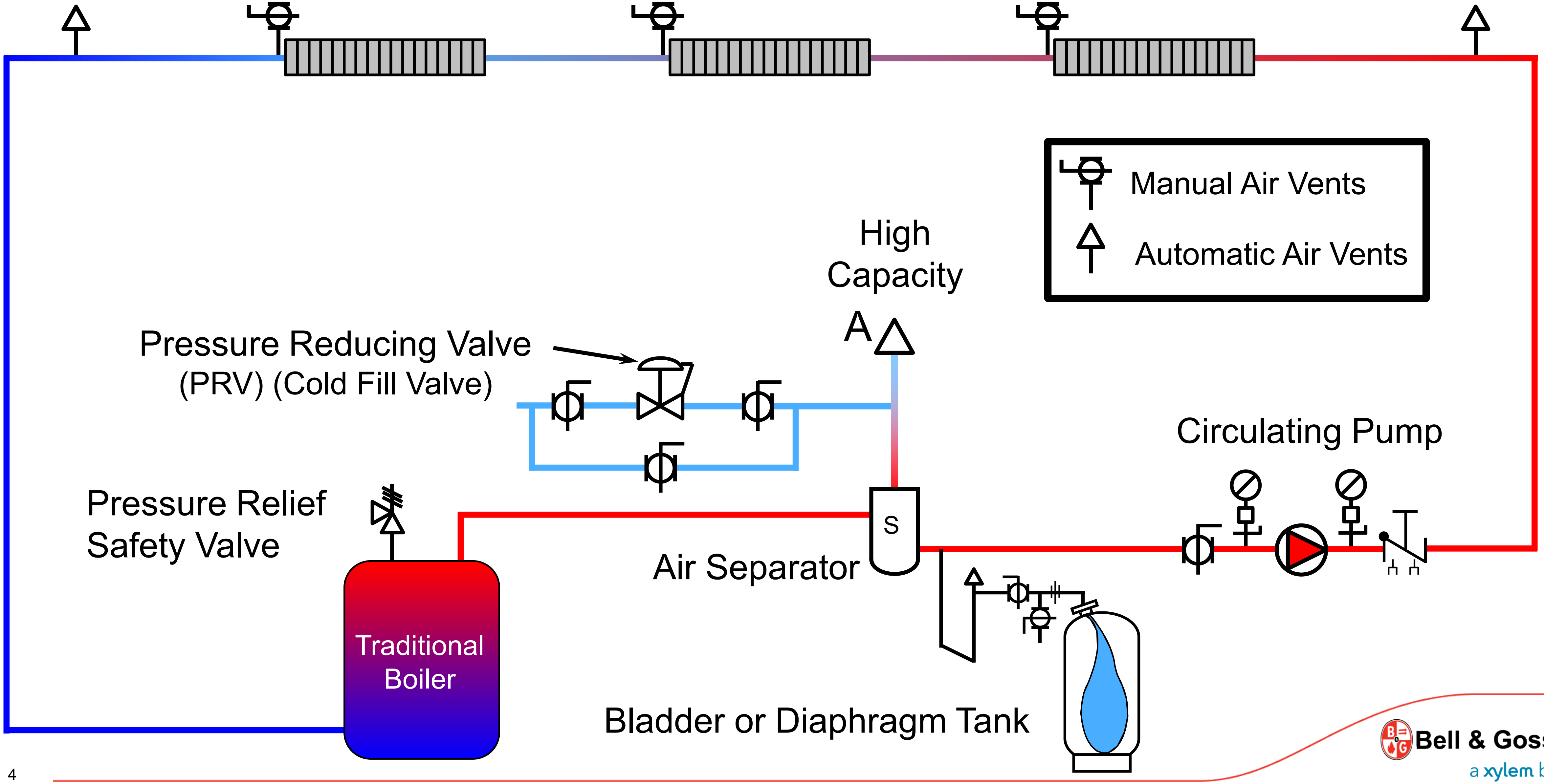


Bell & Gossett
a xylem brand

Closed Forced Circulation Hot Water System – **Air Control**

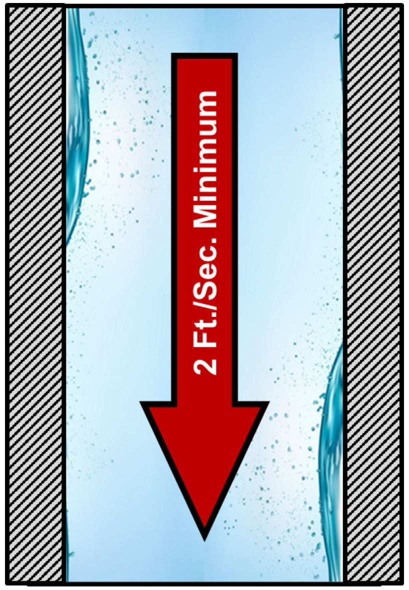


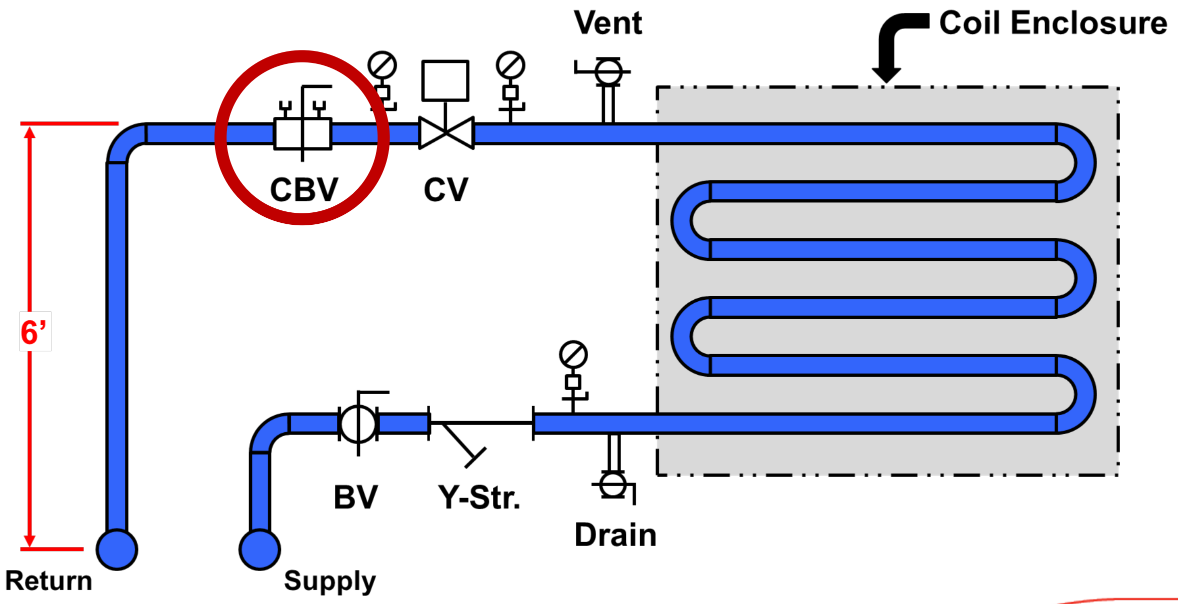
Closed Forced Circulation Hot Water System – **Air Elimination**



Good Piping Design Goals

- Avoid air traps to ensure automatic purging at full flow
- Keep fluid velocity high enough to carry air to desired point of separation
- Proportional Balance flow through each terminal unit



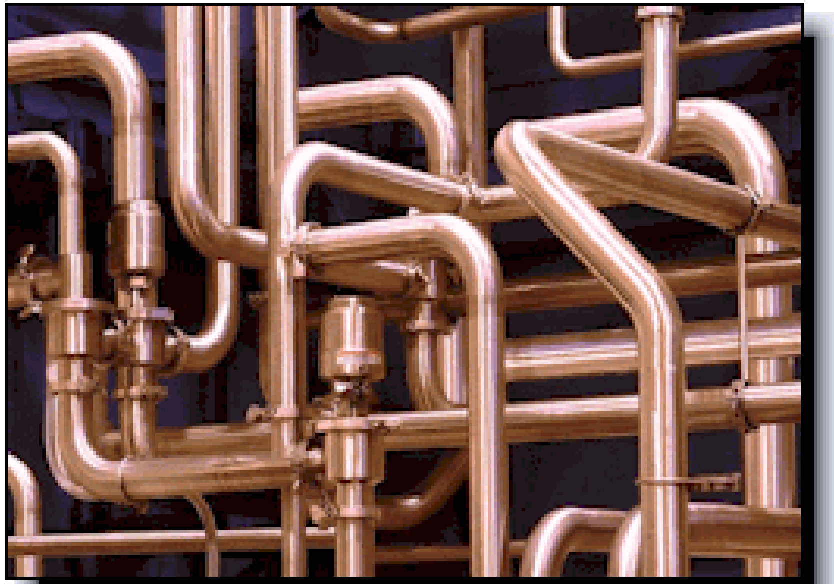


Bell & Gossett
a xylem brand

Air Management in a Closed Loop Hydronic System

- **Initial Fill,** Remove Gross Air By:
  - Venting
  - Purging

- **Operating,** Remove Entrained/Dissolved Air Using:
  - High Temperature
  - Low Pressure
  - Low Velocity
  - Centrifugal Action
  - Coalescence



xylem
Let's Solve Water

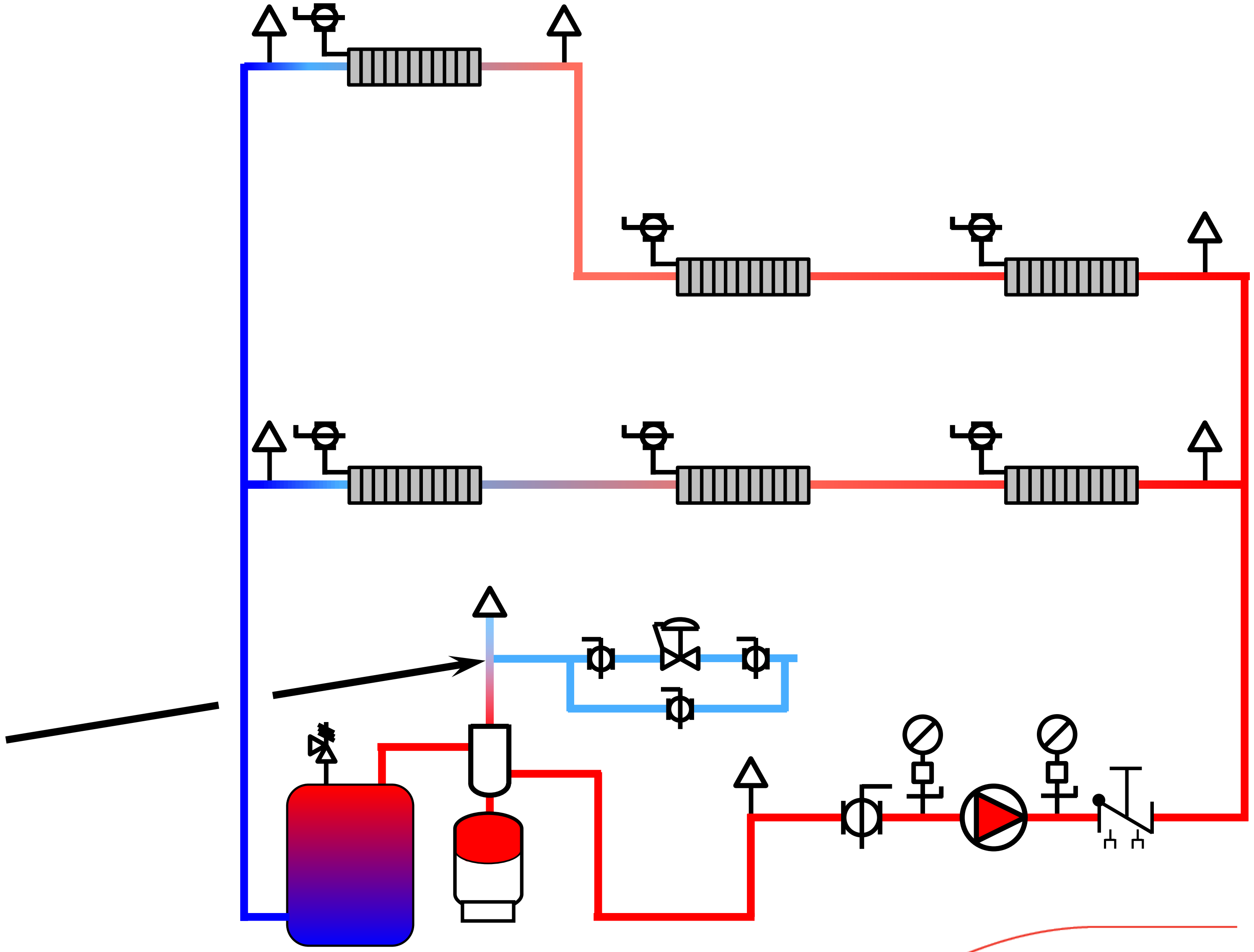
Venting and **Purging** a Closed Loop Hydronic System

Bell & Gossett
a xylem brand

System Venting - Water

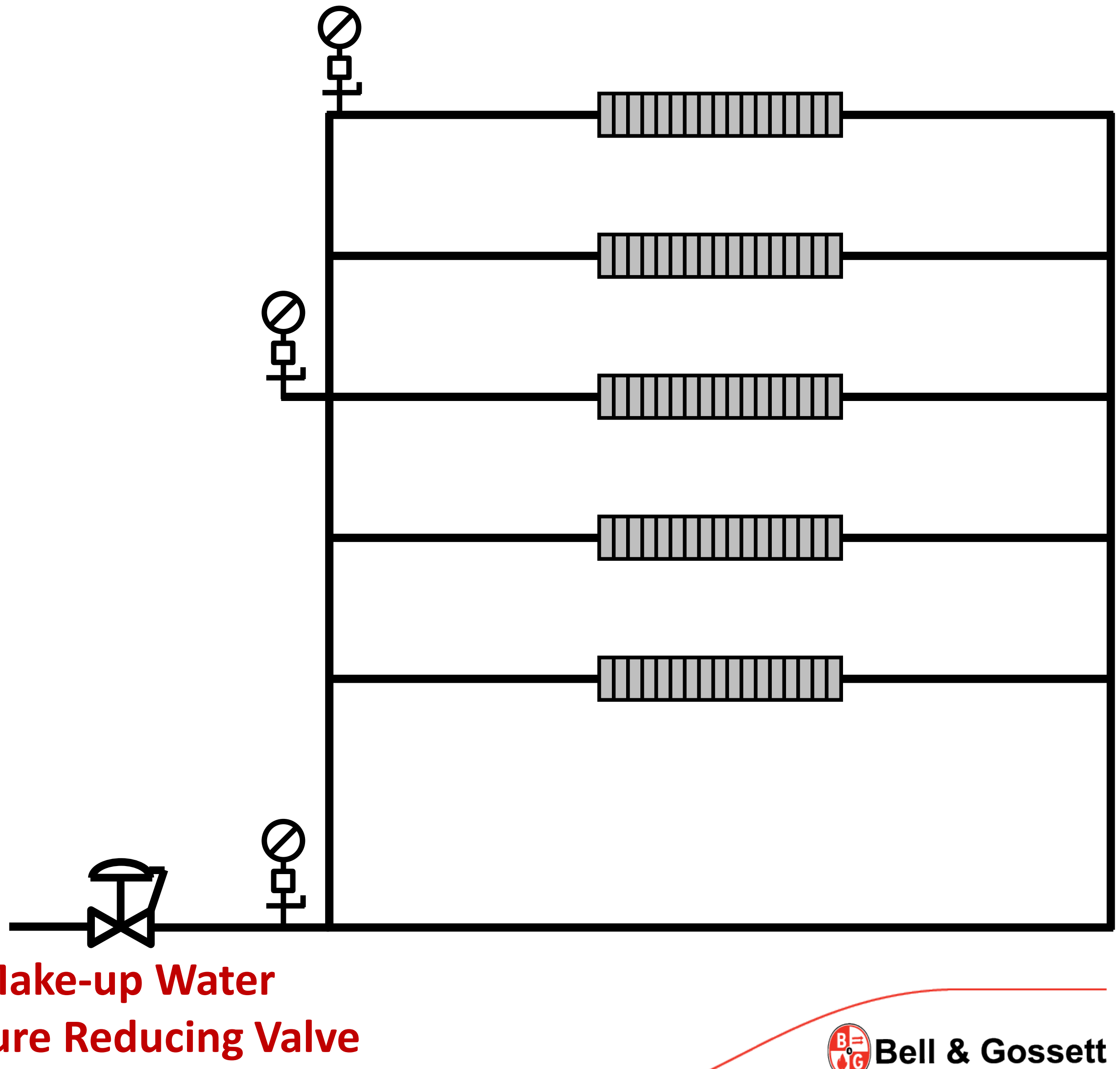
Liquid fills piping provided:

- Motive pressure is greater than air pressure in piping
- Motive pressure is greater than the static pressure of water column developed



Cold **Static** Fill Pressure: Where is the Make-up Water Valve?

- Pressure caused by weight of a column of fluid
- Influencing Factors
  - Column Height
  - Fluid Type
  - Fluid Density @ Operating Temperature



Cold **Static** Fill Pressure: Where is the Make-up Water Valve?

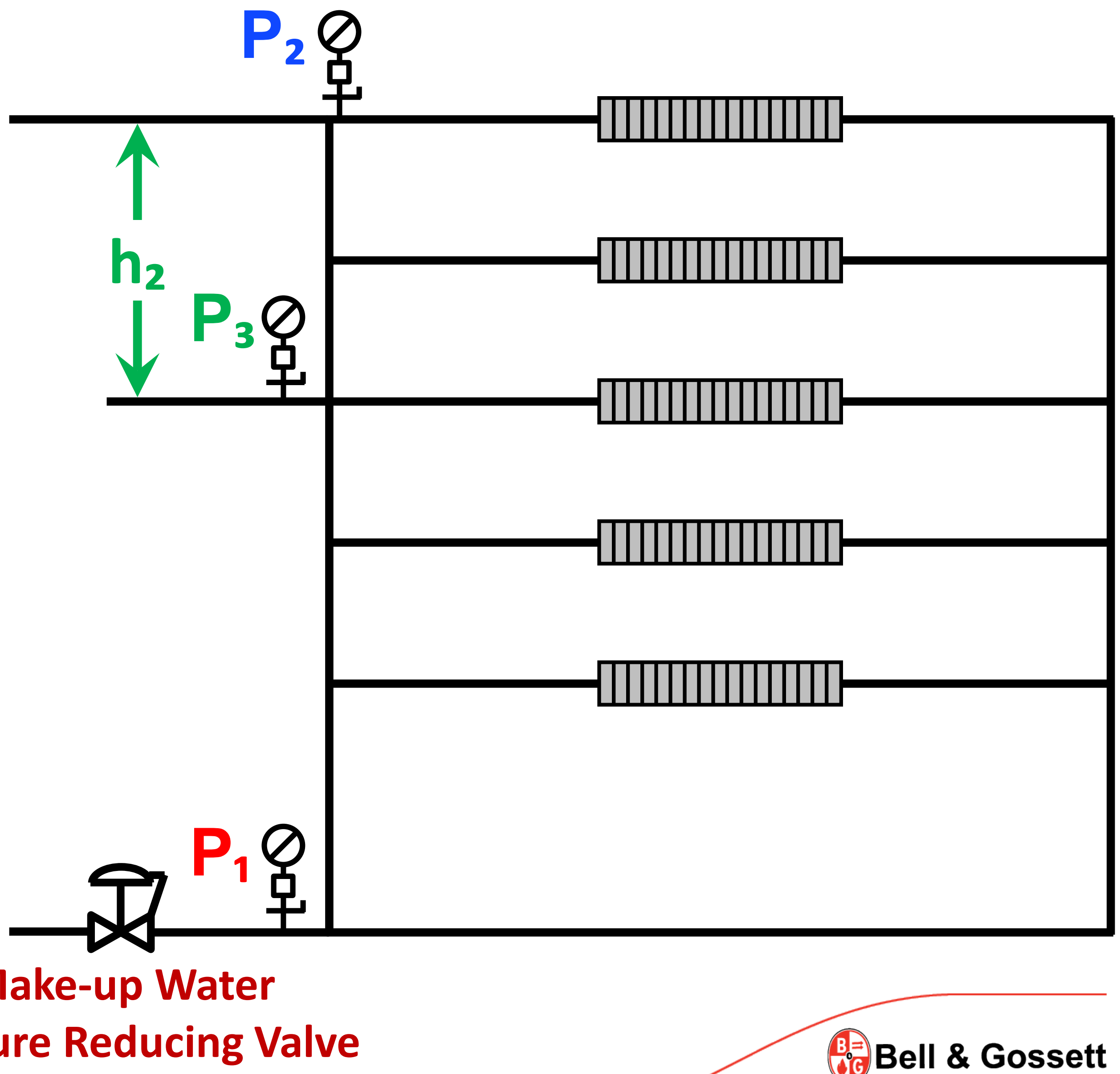
- Pressure caused by weight of a column of fluid
- Influencing Factors
  - Column Height
  - Fluid Type
  - Fluid Density @ Operating Temperature

$$P_1 = P_2 + h_1/(2.31/SG)$$

$$P_3 = P_2 + h_2/(2.31/SG)$$

NOTES:

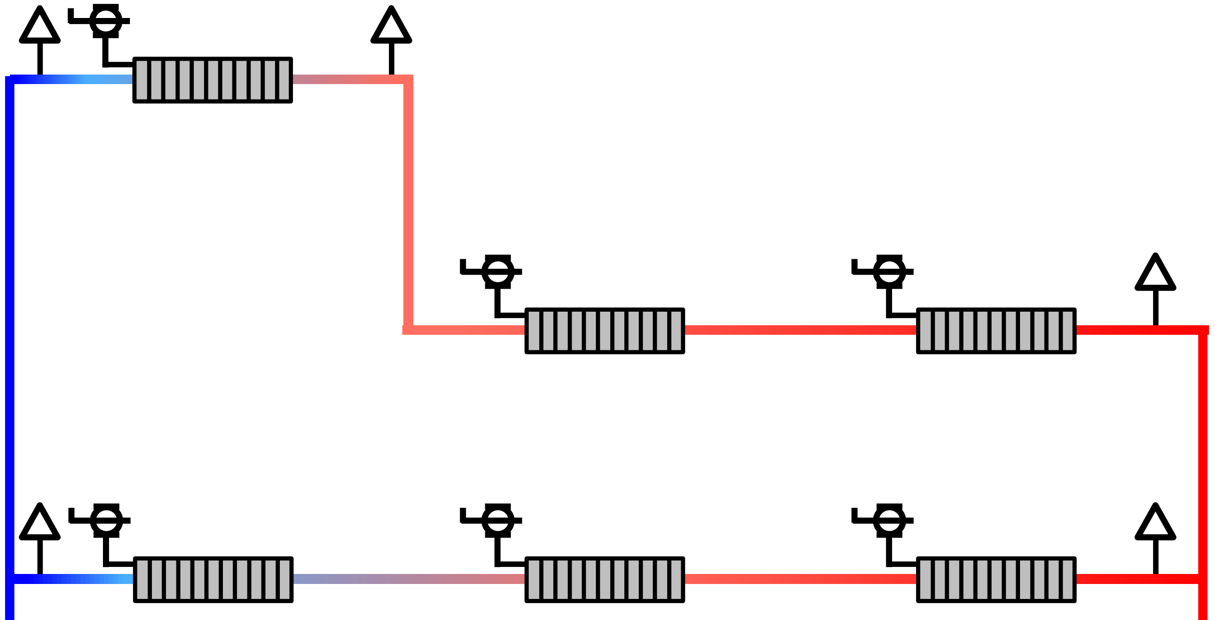
- Specific Gravity of water is **1.0**
- P_2 should be no less than **4.0 PSI**

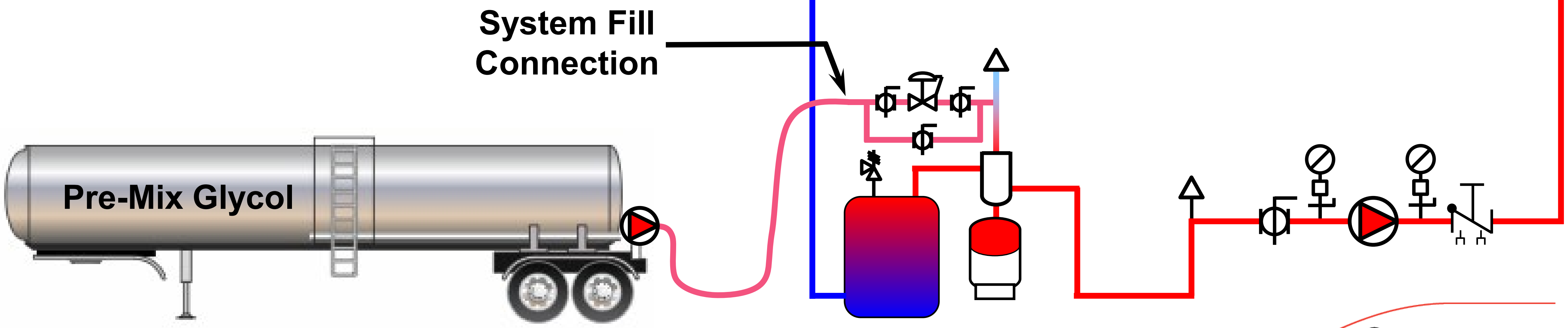


System Venting – Pre-Mix Glycol

Must calculate Cold Static Fill Pressure to properly select filling pump size

NOTE: Must consider specific gravity of glycol when converting from Feet to PSI





What's Specific Gravity got to do with it?

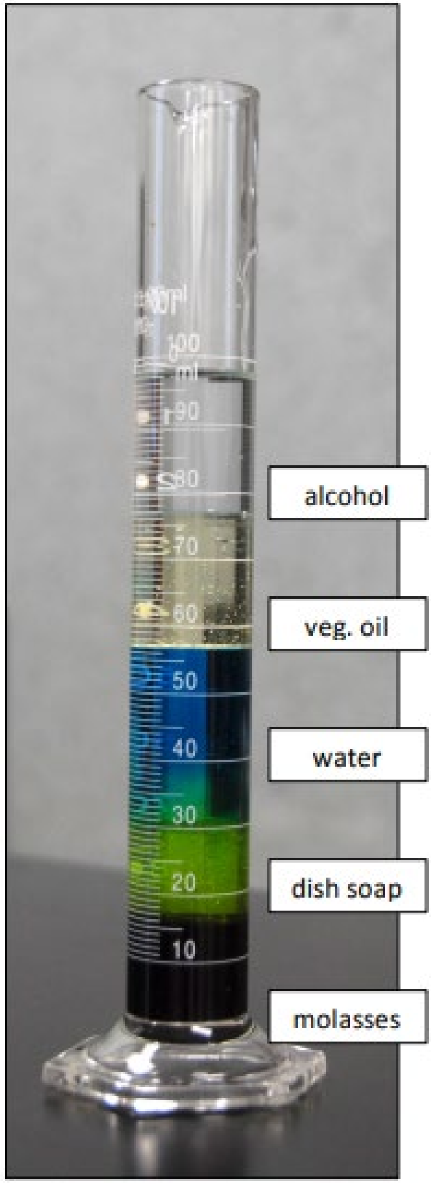
Density (ρ): How heavy a fluid is for the amount measured **(lbs./ft³)**

Specific Gravity (SG): Ratio of a fluid density compared to density of water, at a specific temperature and pressure

$$SG = \frac{\rho \text{ of Fluid}}{\rho \text{ of Water}}$$

Pump Head (ft-~~lb~~/~~lb~~)

$$\text{Pump Head (ft)} = \text{PSI} \times \frac{2.31}{SG}$$



Where does the **2.31** come from?

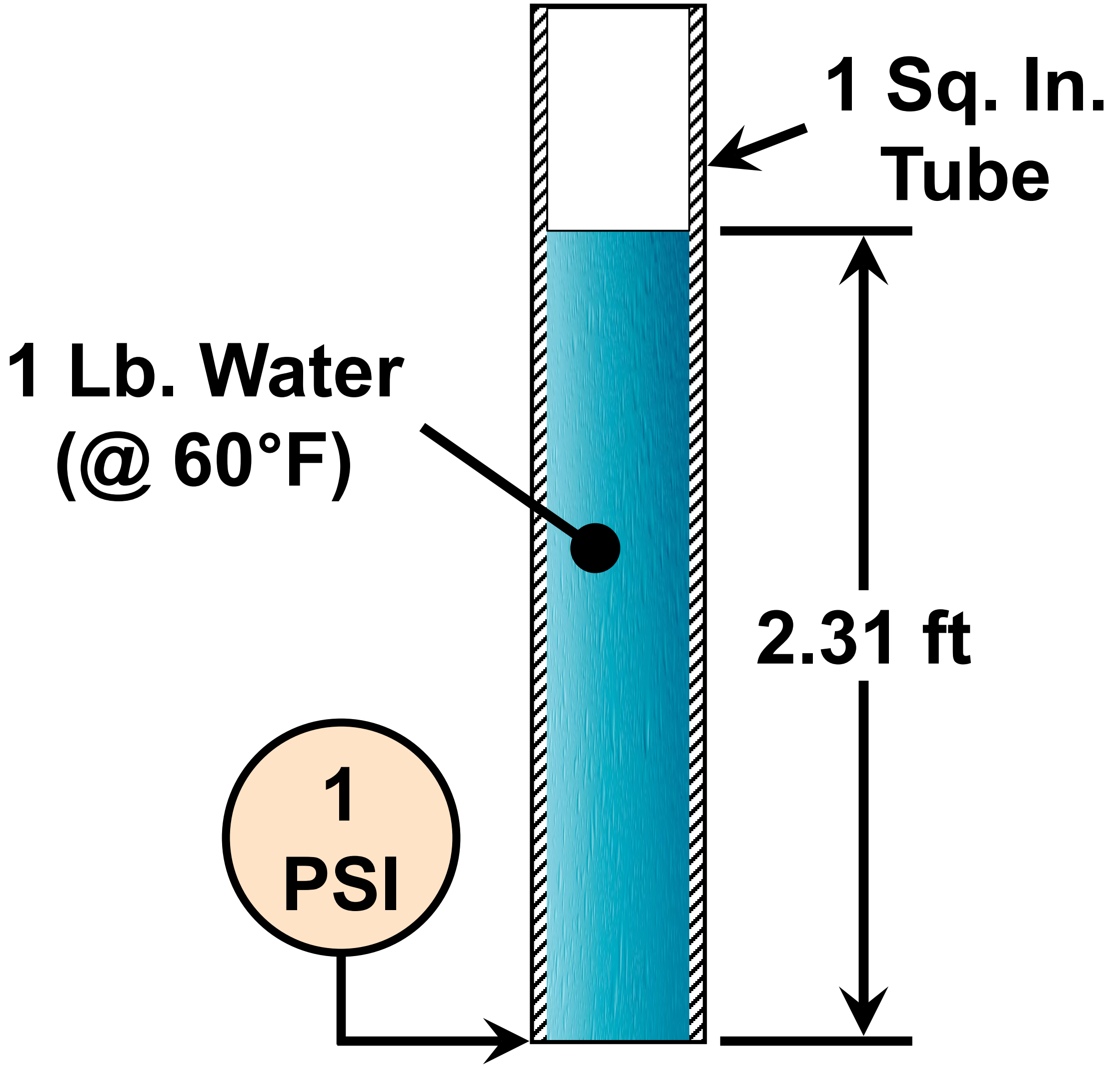
- 1 Cu. Ft. of **water** (@ 60°F) weighs 62.4 lbs
- 1 Sq. Ft. of area has 144 Sq. In.

$$\frac{144}{62.4} = 2.31 \text{ (ft/PSI)}$$

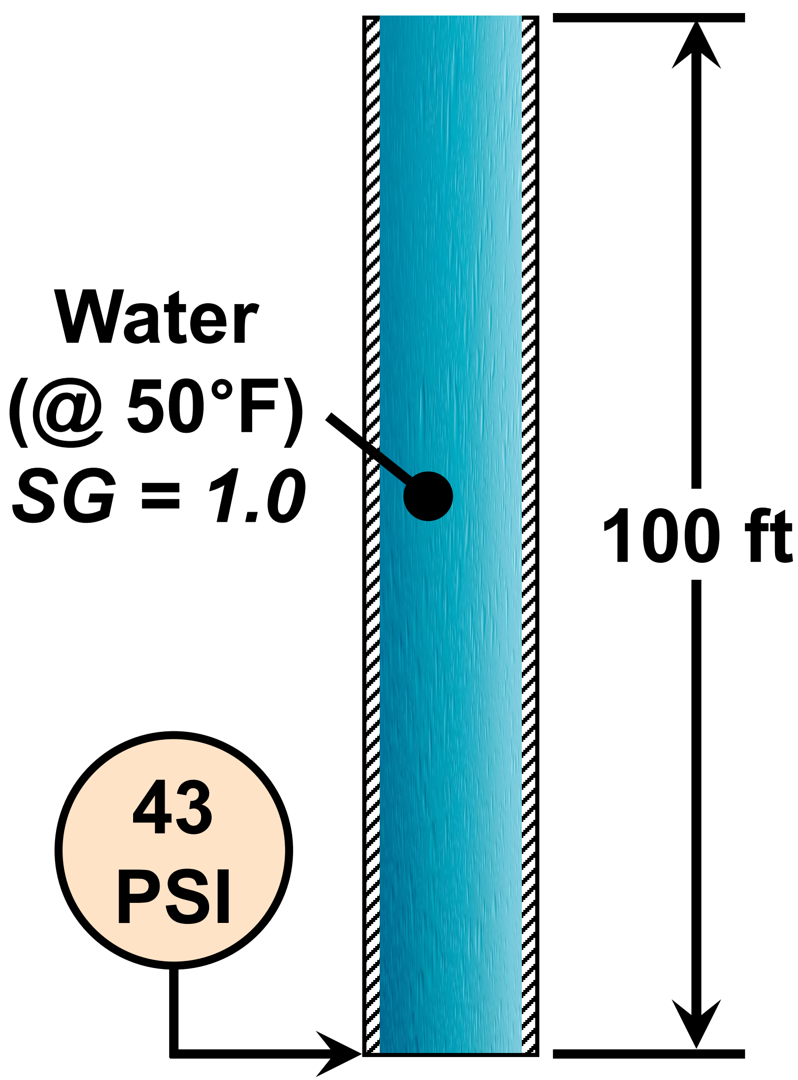
$$\frac{62.4}{144} = .433 \text{ (PSI/ft)}$$

Example:

- 1 ft water column = 0.433 PSI
- 2 ft water column = 0.866 PSI
- 3 ft water column = 1.299 PSI



Another look at Static Pressure using Specific Gravity of a Fluid

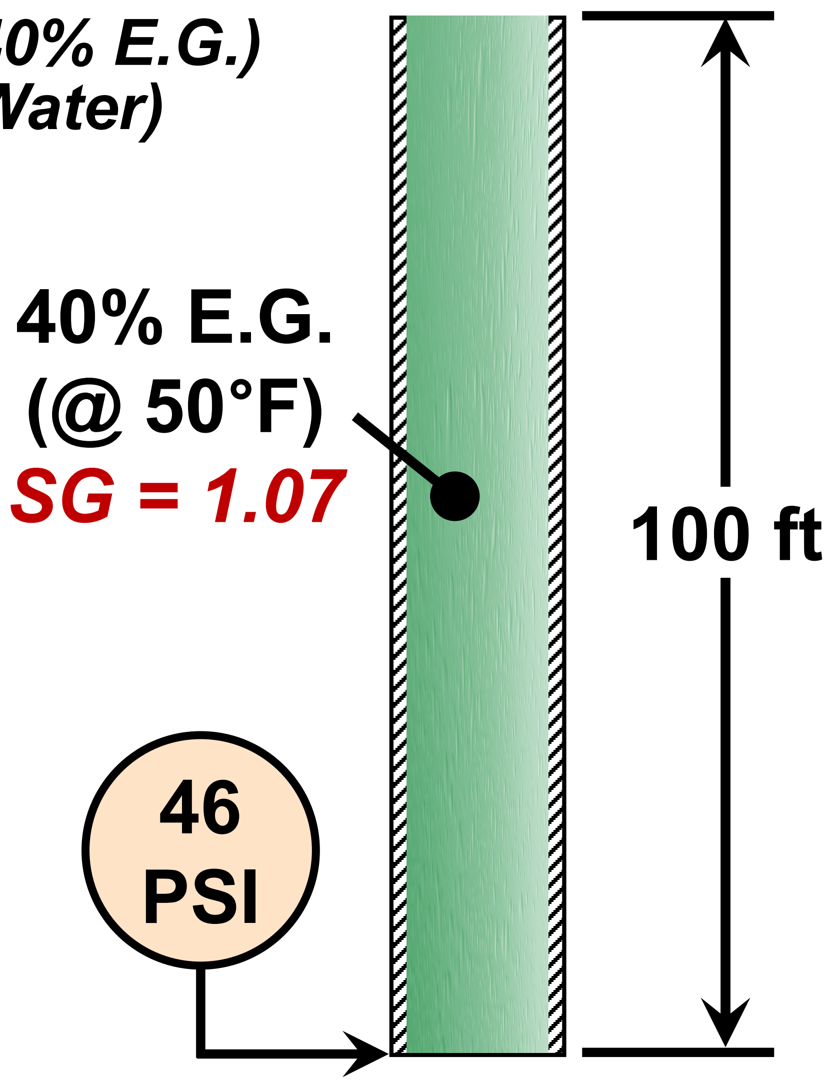


$$SG = \frac{66.47\ (\rho \text{ of } 40\%\ E.G.)}{62.41\ (\rho \text{ of Water})}$$

$$SG = 1.065 \approx 1.07$$

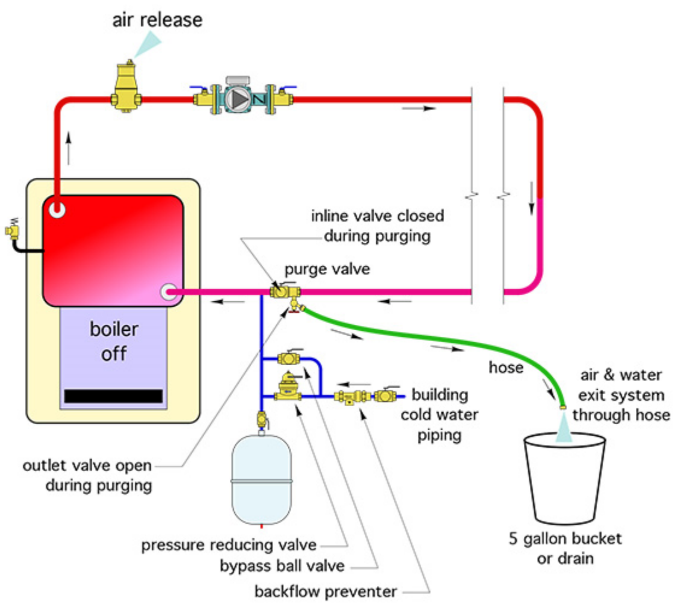
$$PSI = \frac{100\ ft}{2.31/1.07}$$

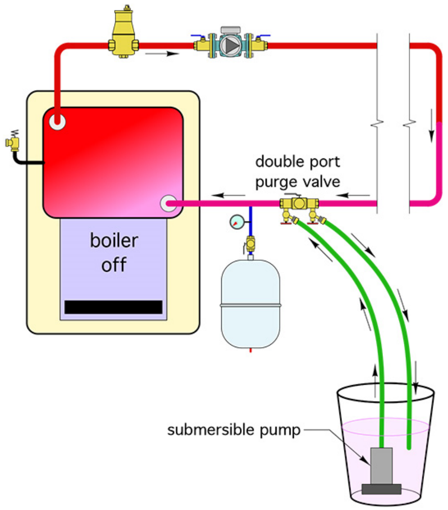
$$PSI = 46.1 \approx 46$$



System Purging: High Velocity Circulation

Municipal Pressure





Pump Pressure

From "Cloudy"

To "Clear"

Air Separation Equipment

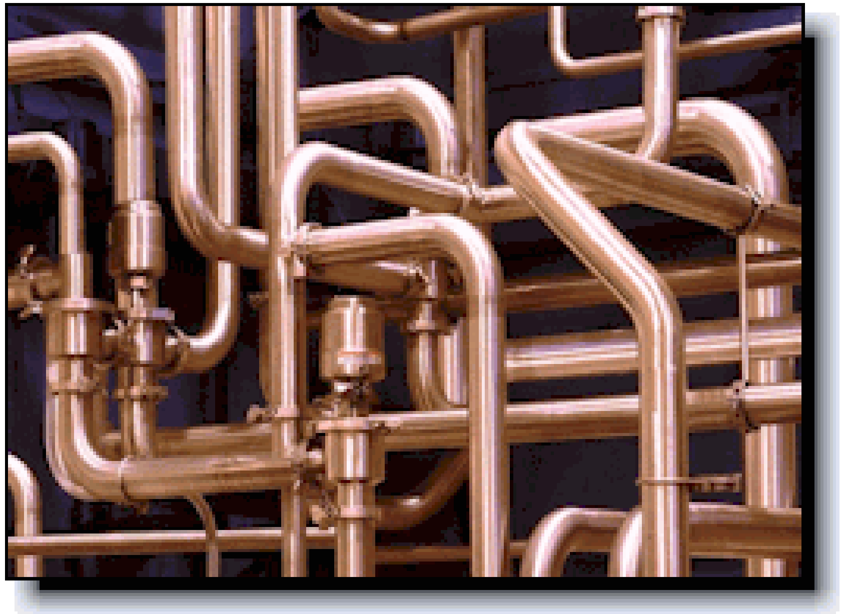
Capturing the Entrained and Dissolved Air

xylem
Let's Solve Water

Bell & Gossett
a xylem brand

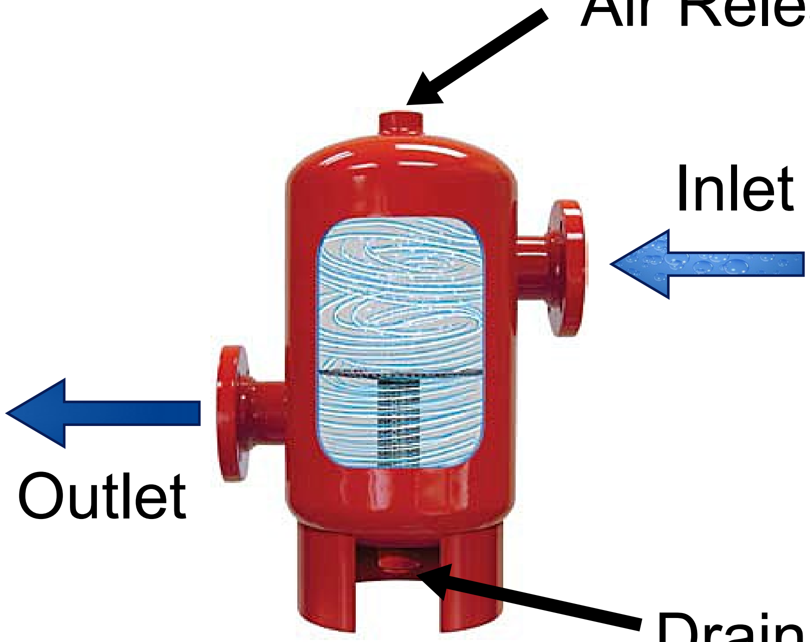
Air Management in a Closed Loop Hydronic System

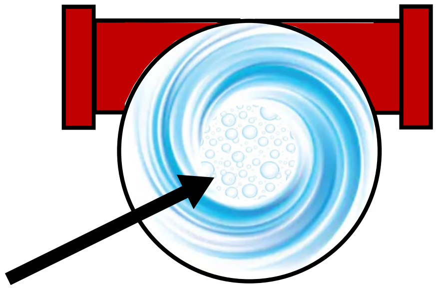
- **Initial Fill,** Remove Gross Air By:
  - Venting
  - Purging



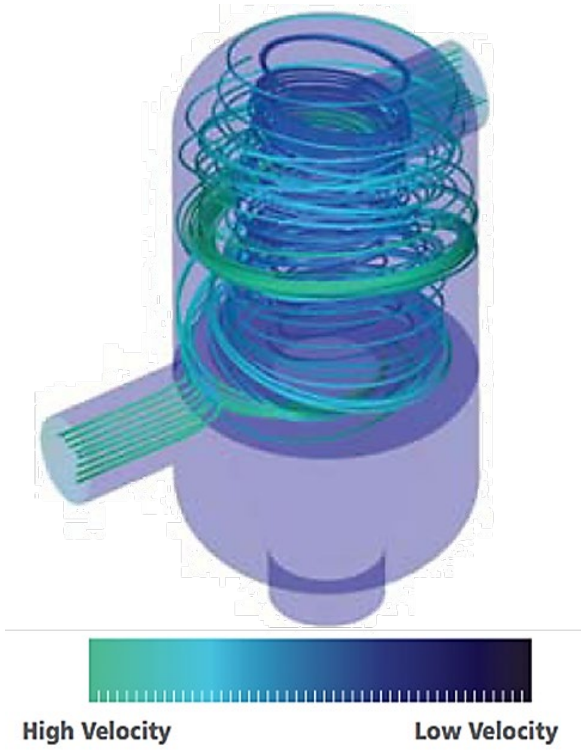
- **Operating,** Remove Entrained/Dissolved Air Using:
  - High Temperature
  - Low Pressure
  - Low Velocity
  - Centrifugal Action
  - Coalescence

Tangential Air Separator – Centrifugal Action





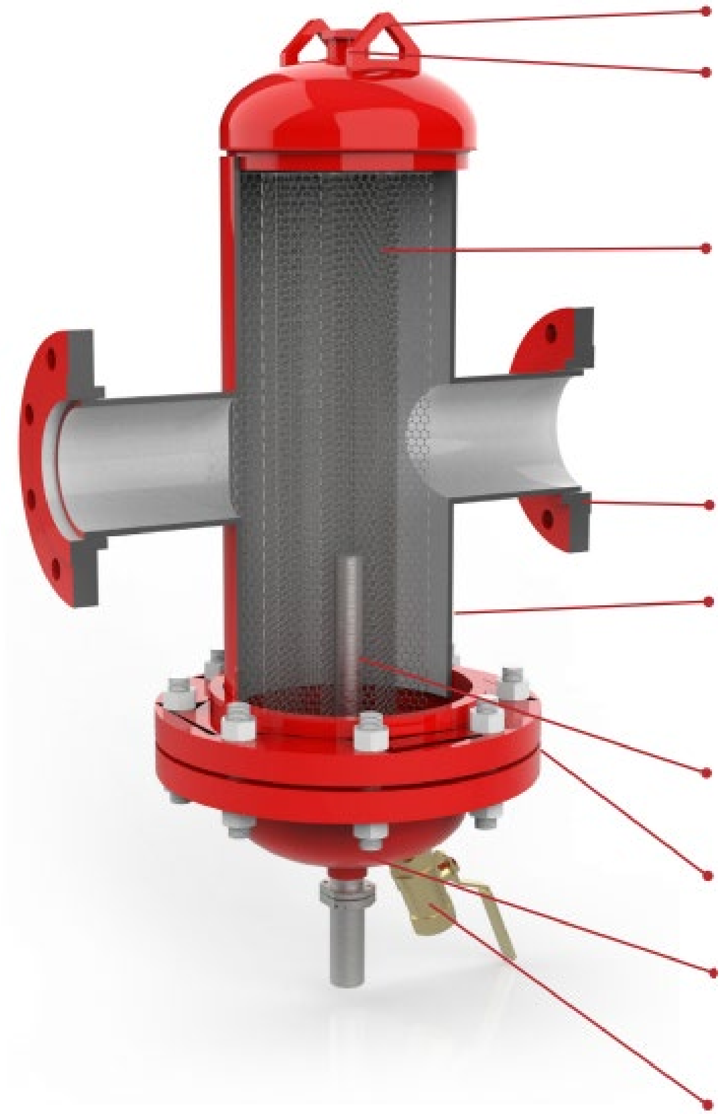
Plan View



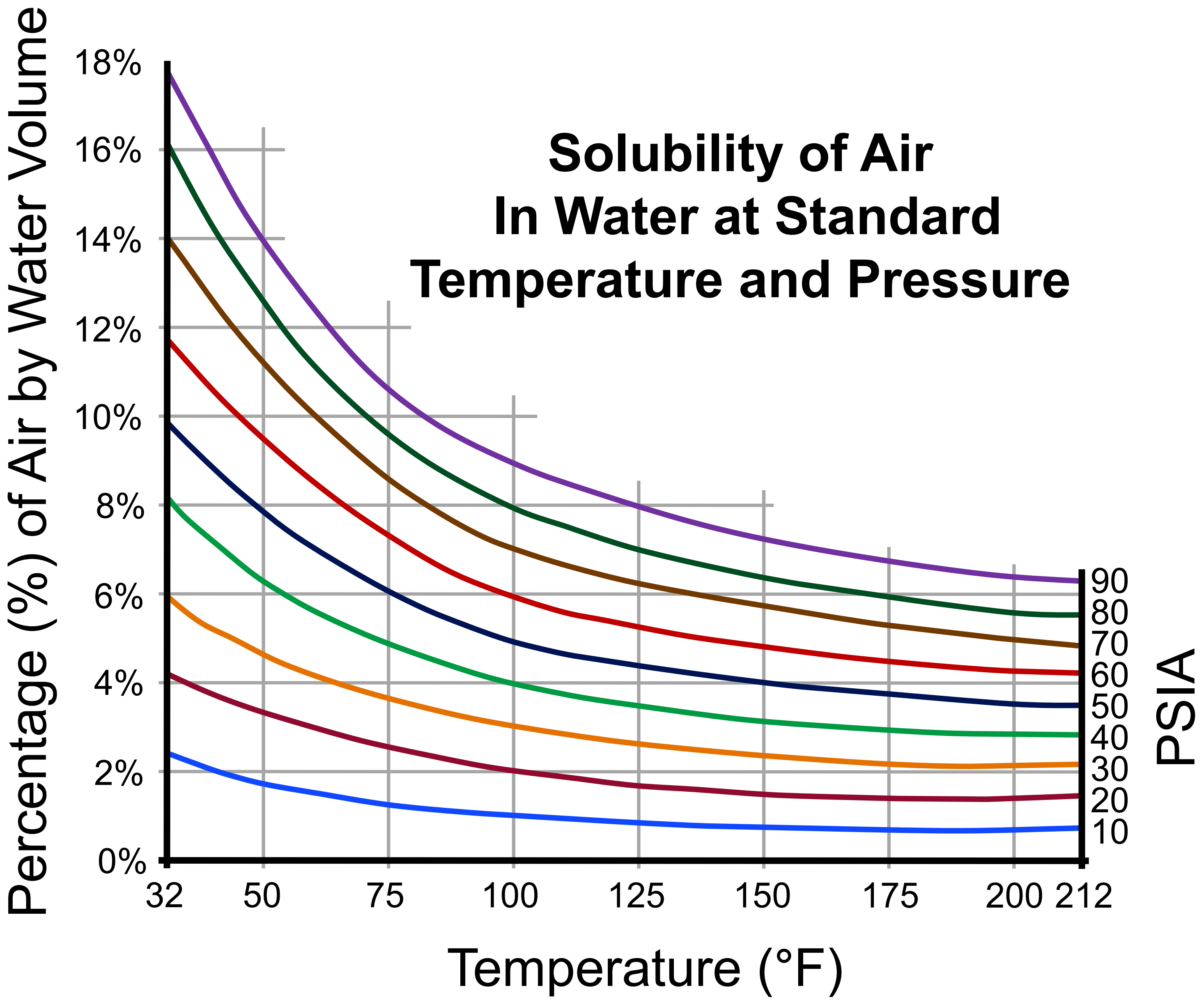
Designed, built, inspected and stamped per Section VIII, Div. 1 of ASME Code

Bell & Gossett
a xylem brand

Coalescing Style Air & Sediment Removal Separator

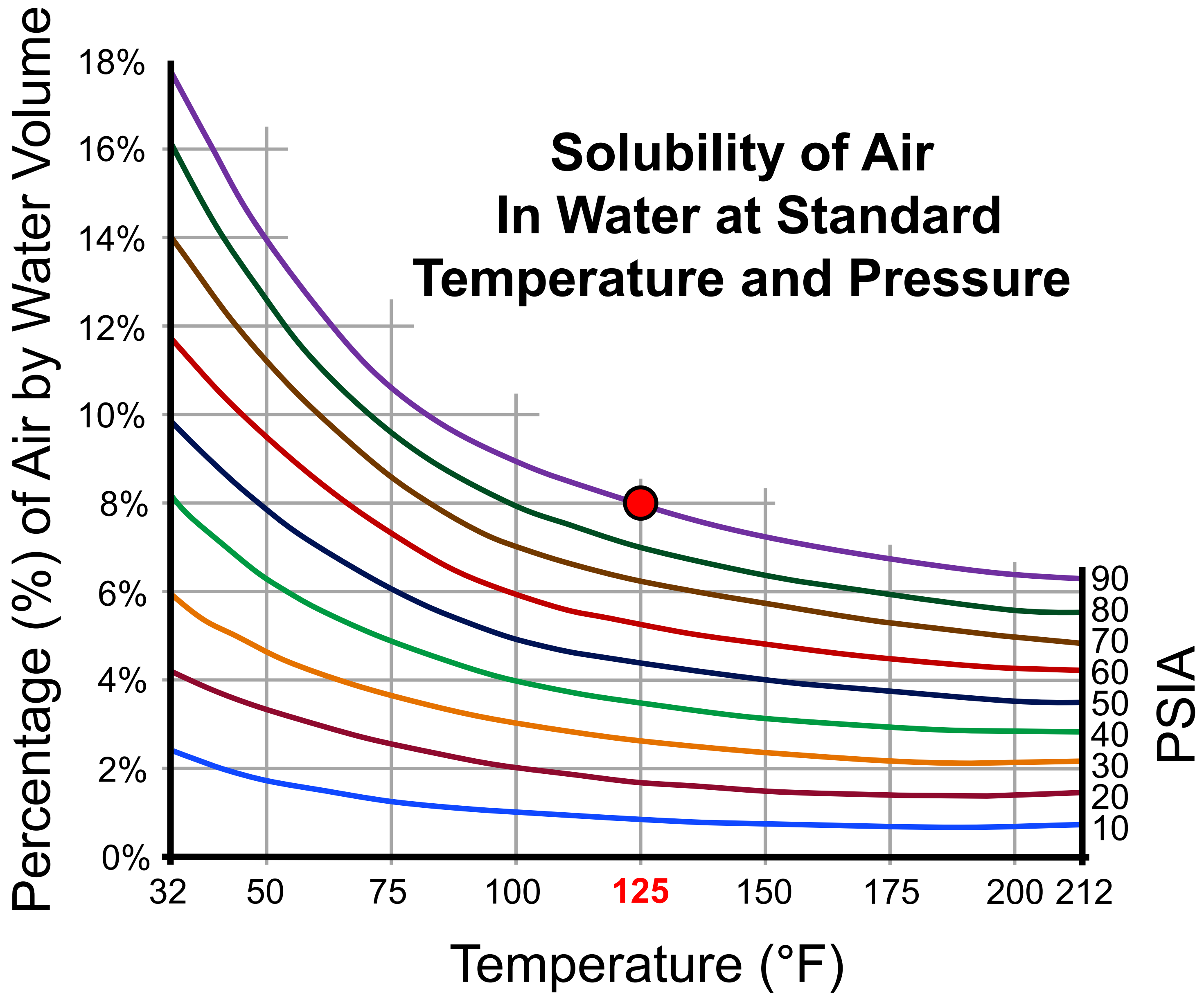


Dissolved Air: The influence of Temperature and Pressure



Bell & Gossett
a xylem brand

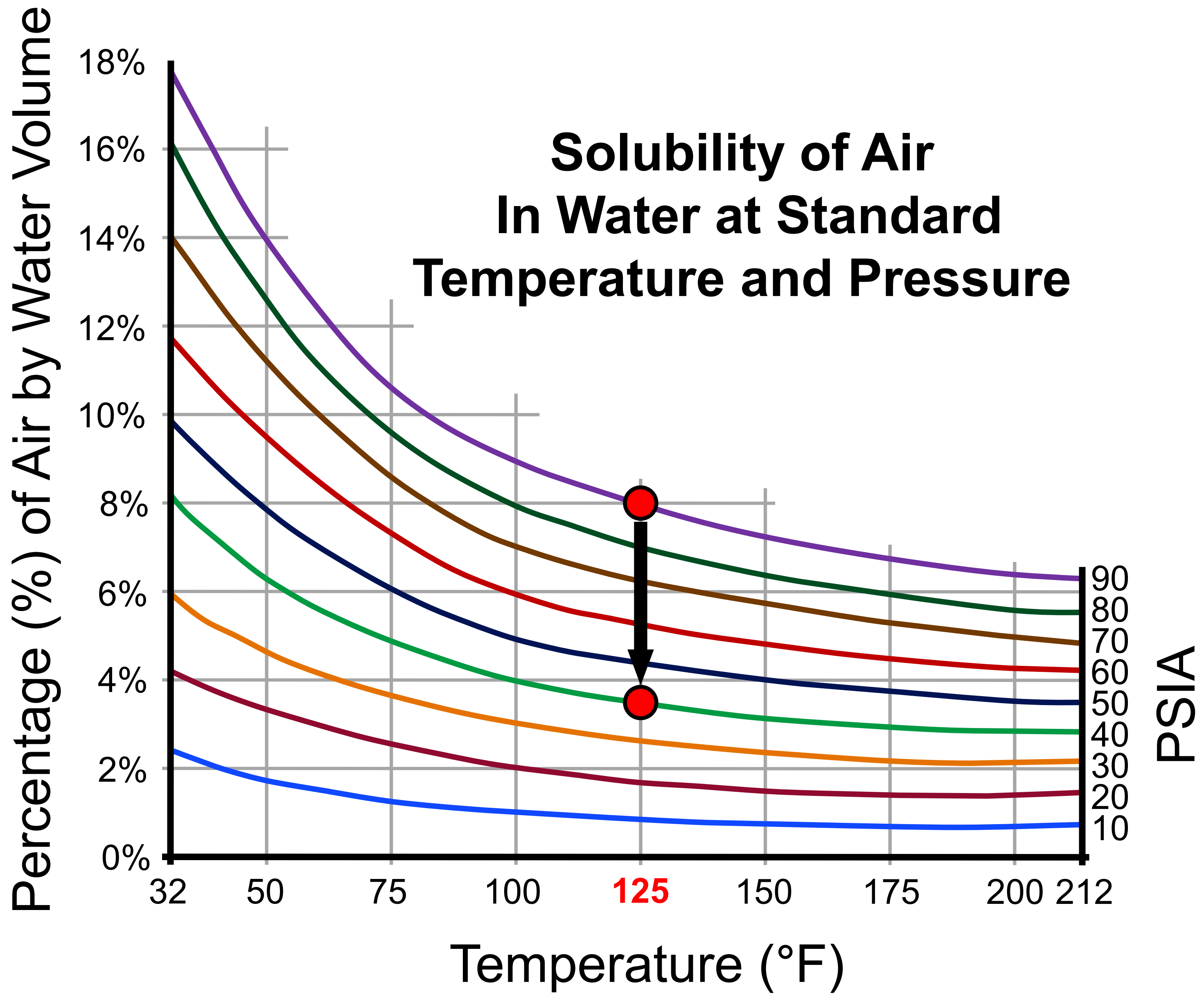
Dissolved Air: The influence of Temperature and Pressure



"Hold" Temperature, Lower Pressure

- 125°F water @ 90 PSIA has 8.0% Air

Dissolved Air: The influence of Temperature and Pressure

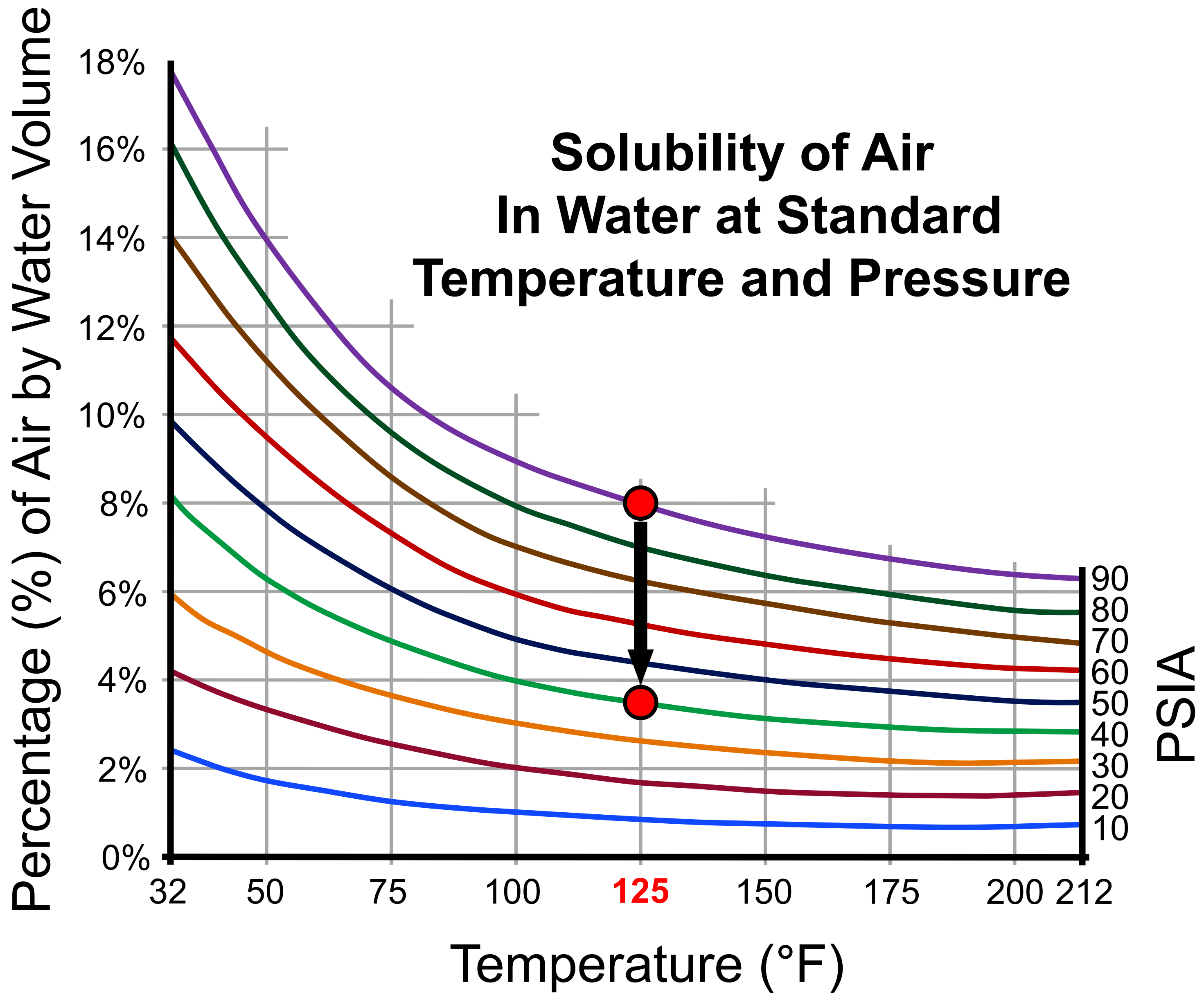


<u>**"Hold" Temperature, Lower Pressure**</u>

- 125°F water @ 90 PSIA has 8.0% Air
- 125°F water @ 40 PSIA has 3.5% Air

Bell & Gossett
a xylem brand

Dissolved Air: The influence of Temperature and Pressure

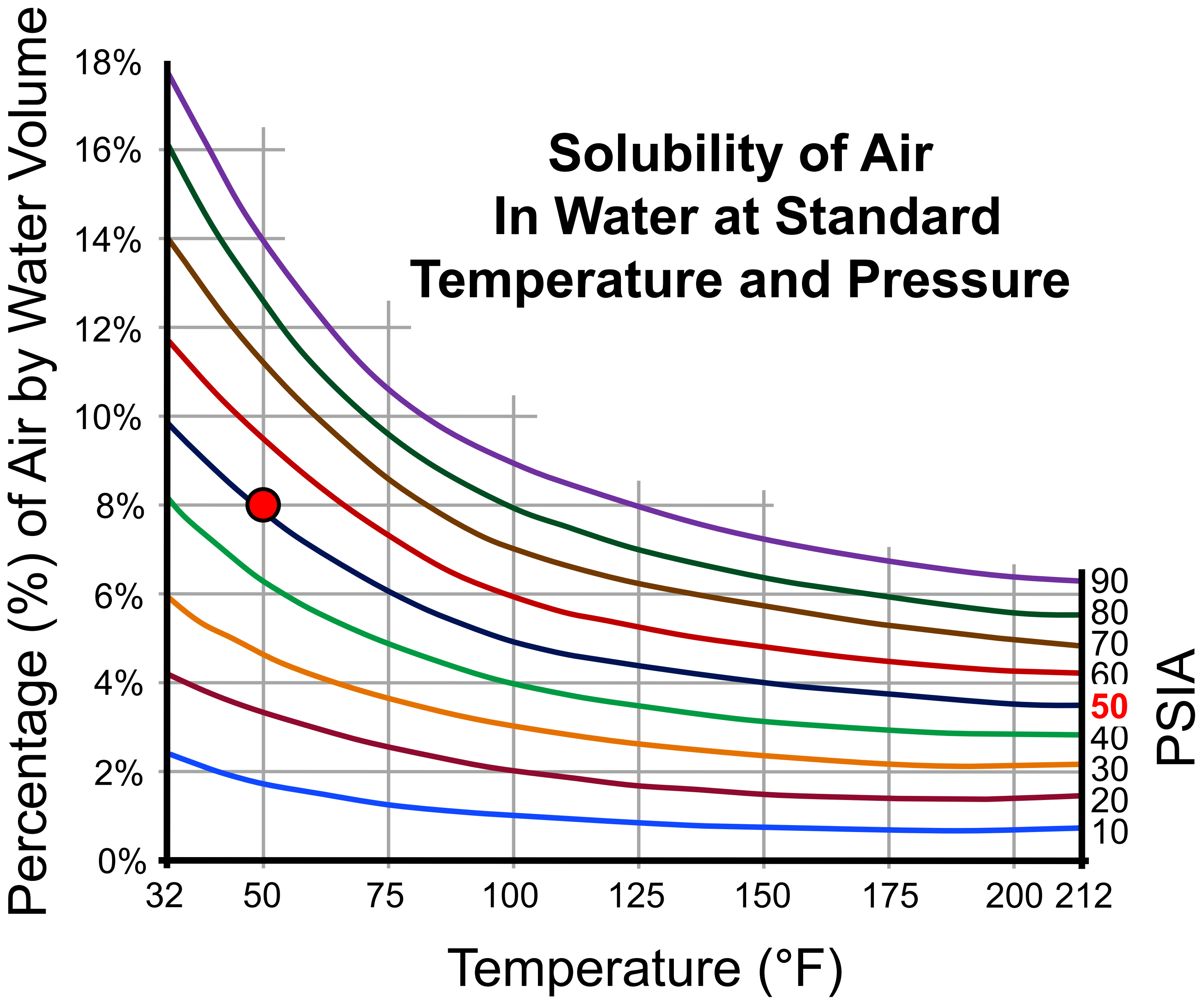


<u>"Hold" Temperature, Lower Pressure</u>

- 125°F water @ 90 PSIA has 8.0% Air
- 125°F water @ 40 PSIA has 3.5% Air
- **Example:** 1,000 Gallons @ 125°F

  1,000 x (.08 - .035) = 45 Gal. **Released Air**

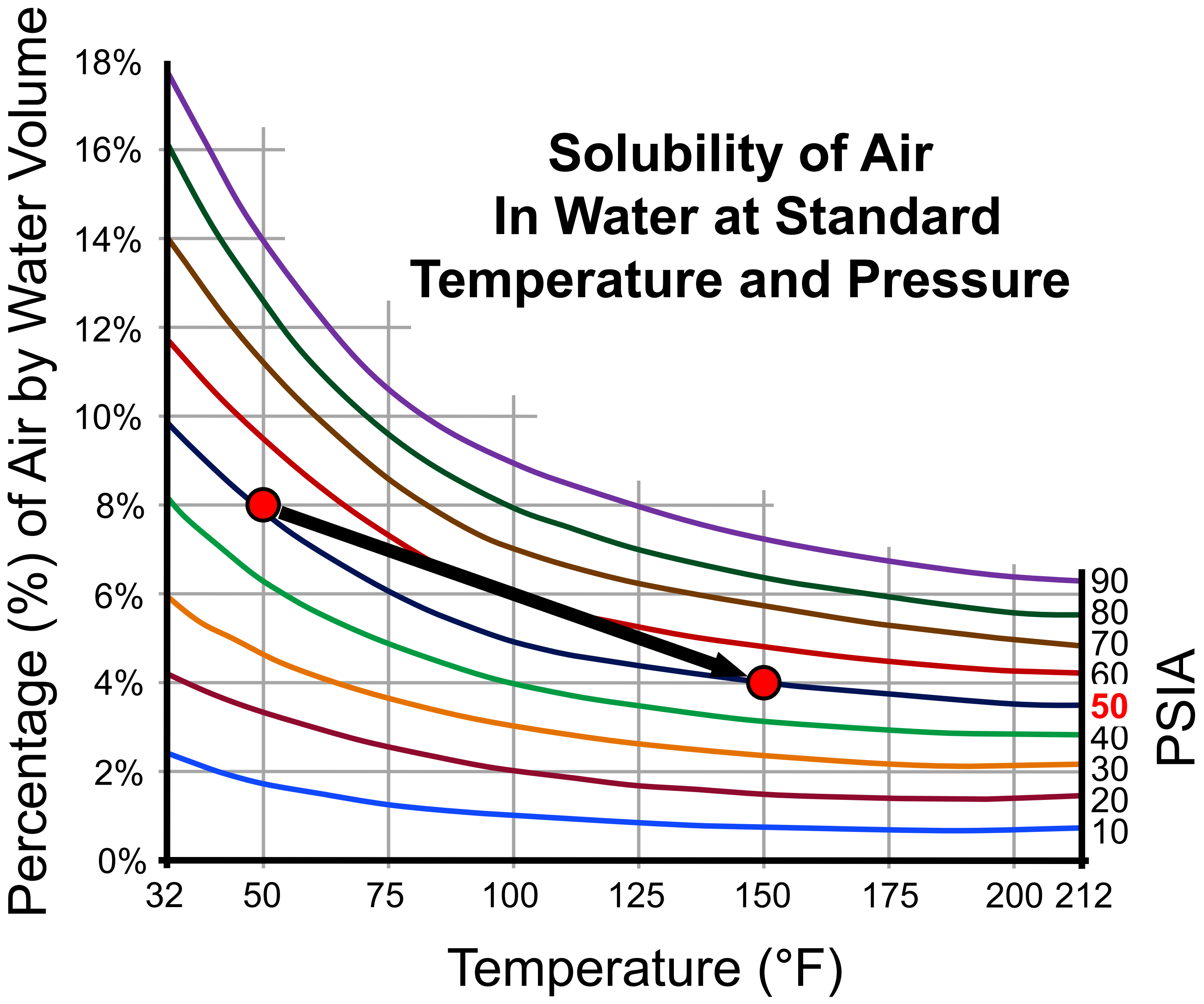
Dissolved Air: The influence of Temperature and Pressure



<u>"Hold" Pressure, Raise Temperature</u>

- 50°F water @ 50 PSIA has 8.0% Air

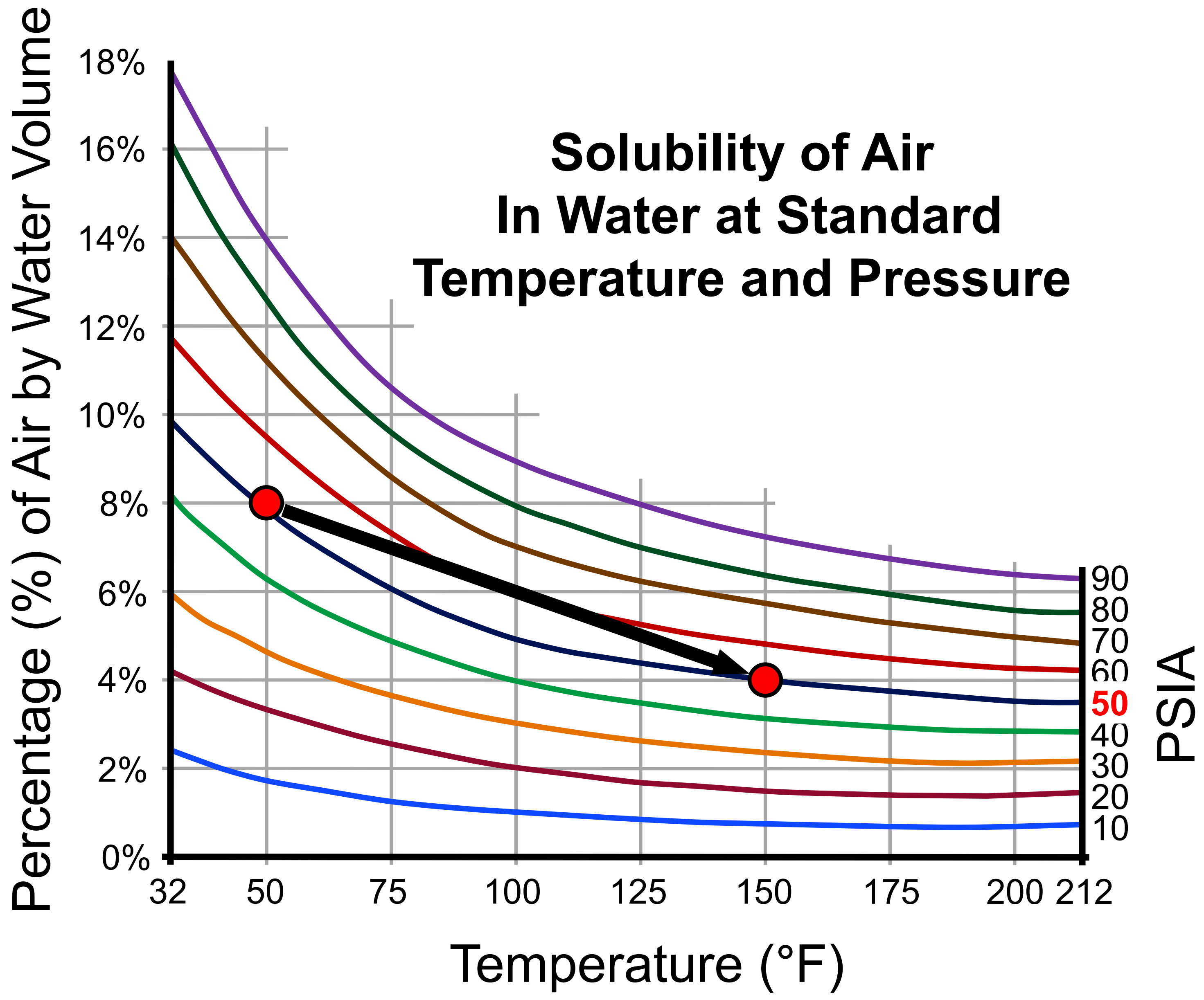
Dissolved Air: The influence of Temperature and Pressure



<u>"Hold" Pressure, Raise Temperature</u>

- 50°F water @ 50 PSIA has 8.0% Air
- 150°F water @ 50 PSIA has 4.0% Air

Dissolved Air: The influence of Temperature and Pressure



<u>"Hold" Pressure, Raise Temperature</u>

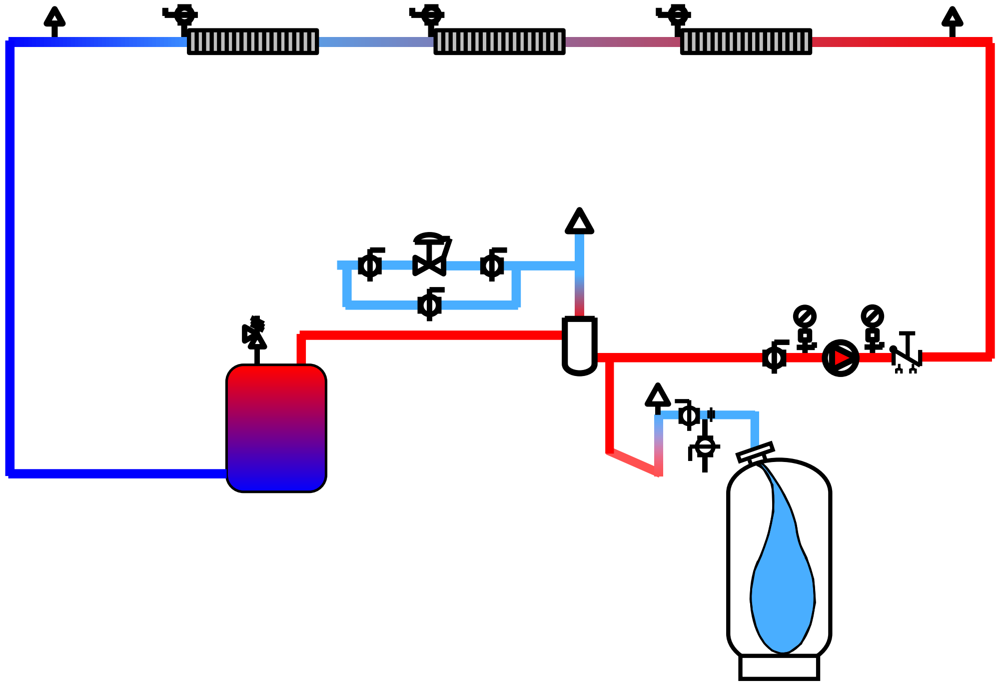
- 50°F water @ 50 PSIA has 8.0% Air
- 150°F water @ 50 PSIA has 4.0% Air
- **Example:** 1,000 Gallons from 50°F to 150°F

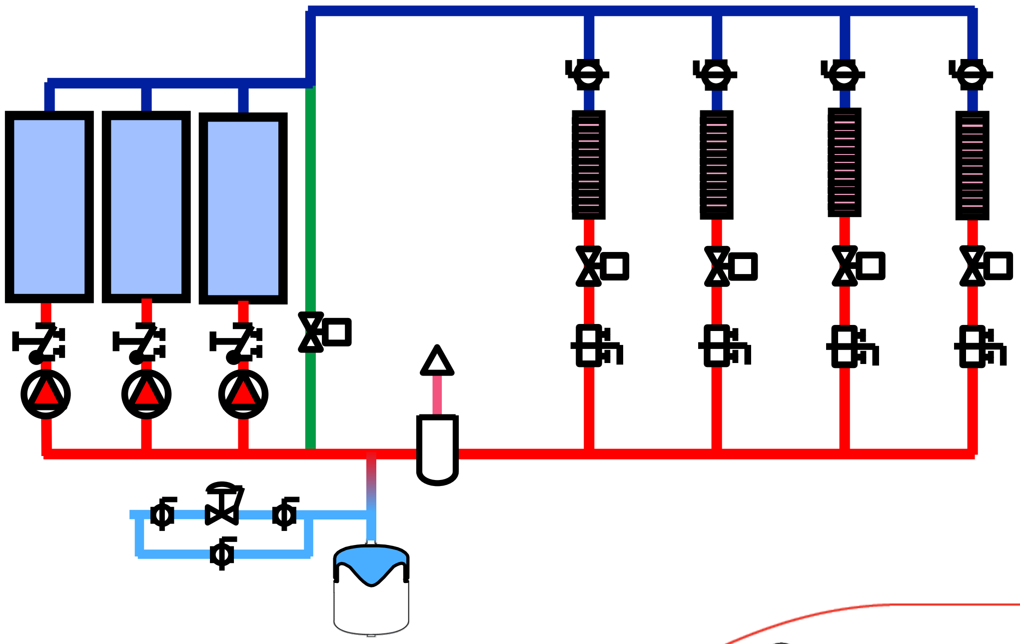
1,000 x (.08 - .04) = 40 Gal. **Released Air**

Bell & Gossett
a xylem brand

Air Separation Equipment: Location for Optimal Performance

- Recommended Location
  - Where system fluid is warmest
  - Where system pressure is lowest





Bell & Gossett
a xylem brand

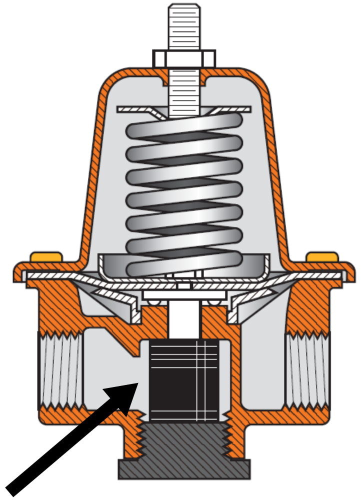
xylem
Let's Solve Water

Pressurization Equipment

Bell & Gossett
a xylem brand

Pressure Limit Components – Make-up Fluid

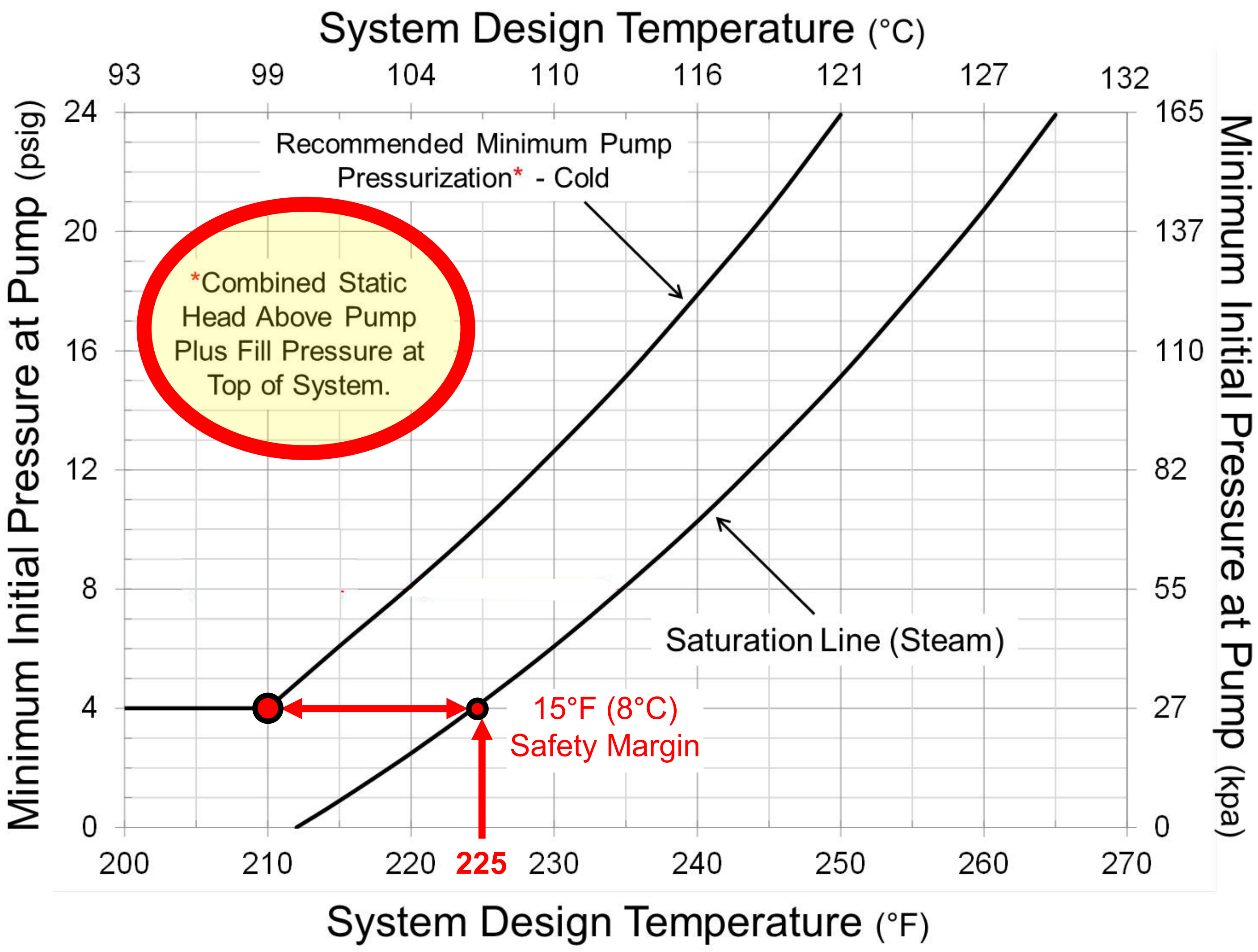
Water Systems



Glycol Systems

Bell & Gossett
a xylem brand

Minimum Cold Pressurization at the Pump. **Pump Location??**



Small/Medium Wet Rotor

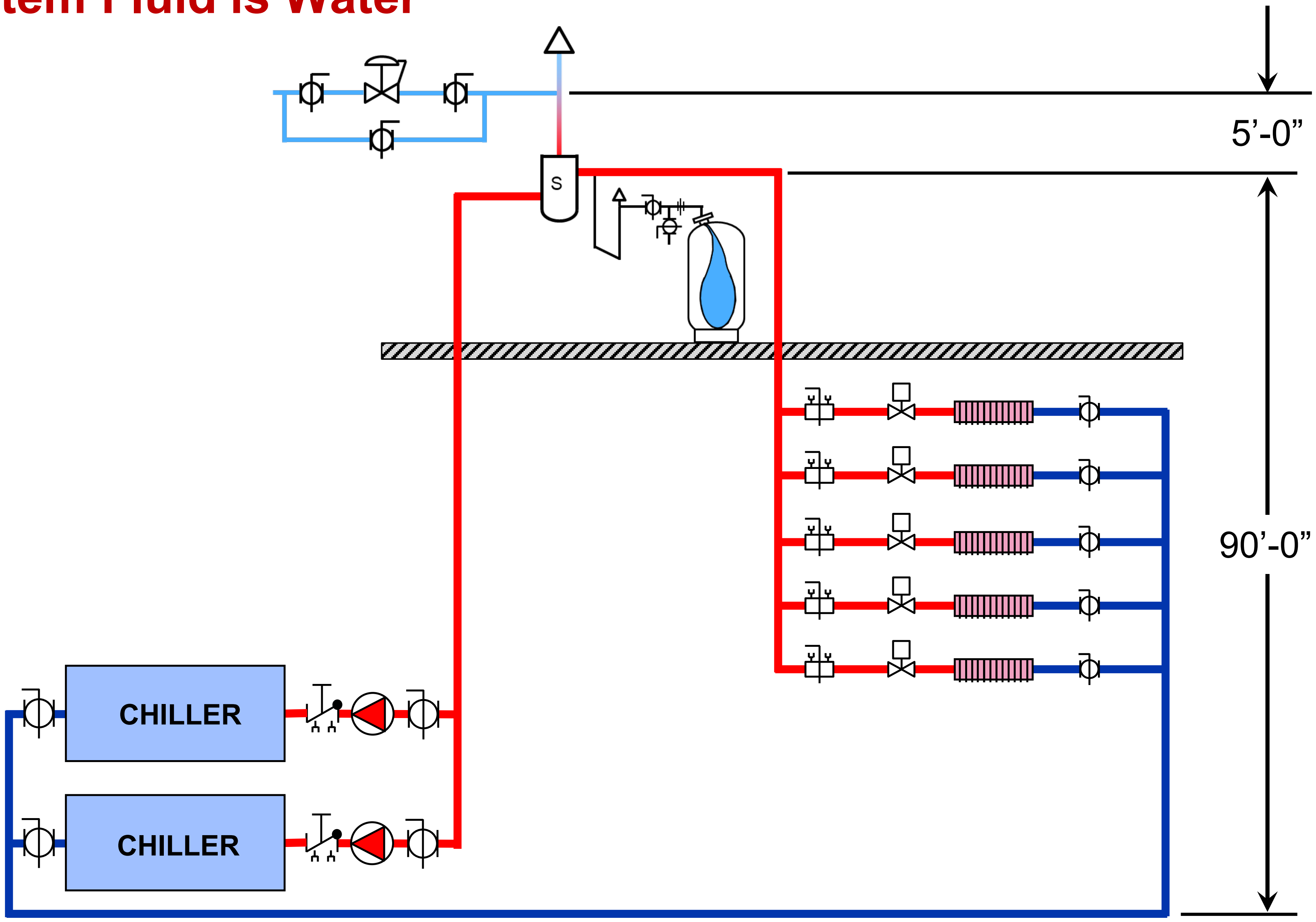
Oil Lubricated

Grease Lubricated

**** Check Pump's Net Positive Suction Head Requirement (NPSHR)***

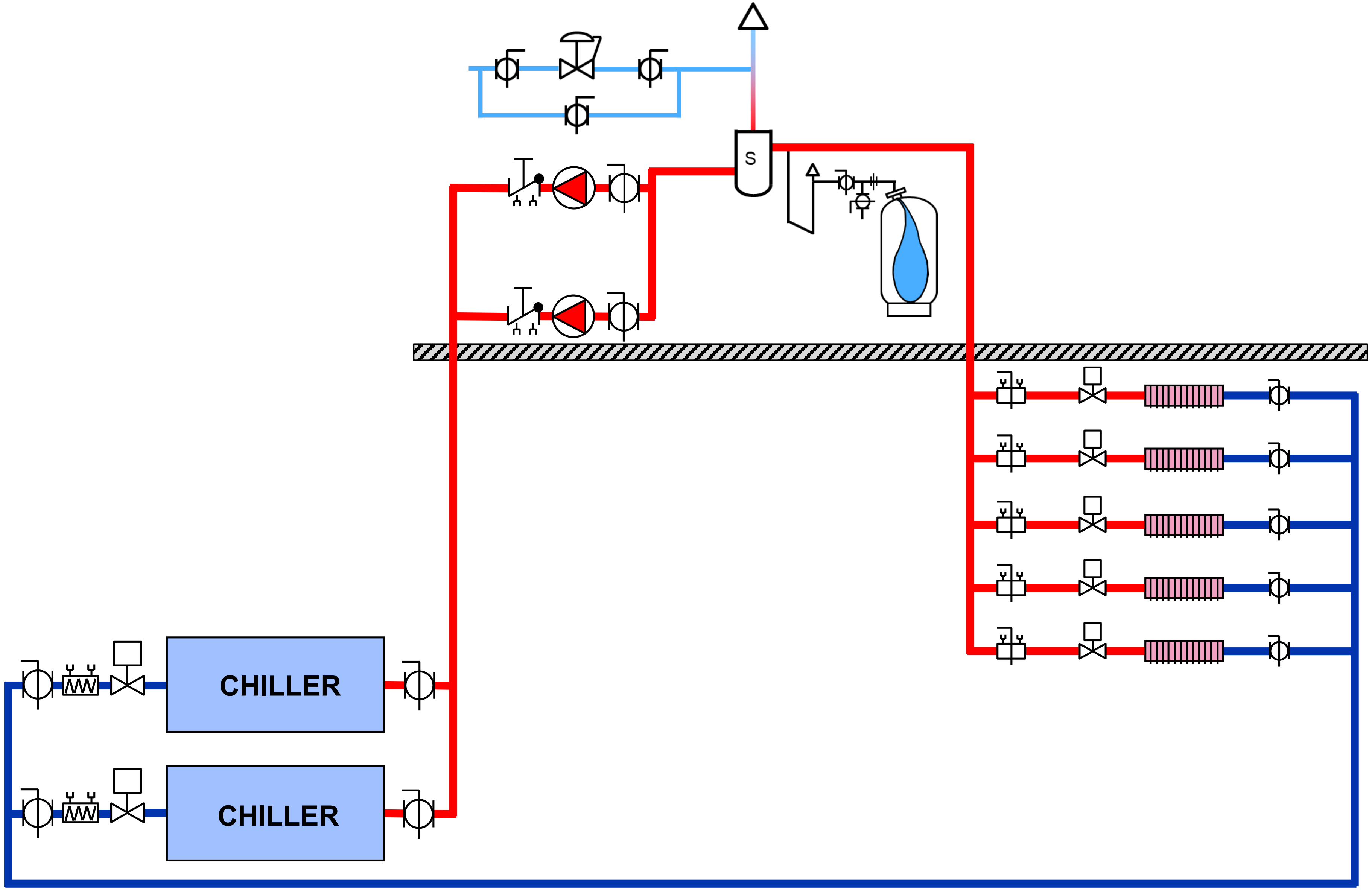
What's the Cold Static Fill Pressure PRV Setpoint?

* System Fluid is Water



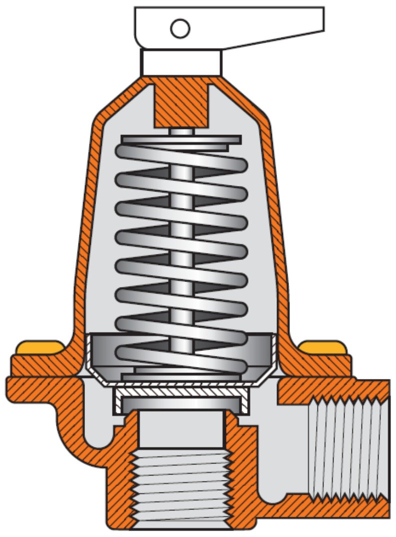
What's the Cold Static Fill Pressure PRV Setpoint?

* What's the required pump NPSH?



Bell & Gossett
a xylem brand

Pressure Limit Components: ASME Safety Relief Valve



#790 & 1170

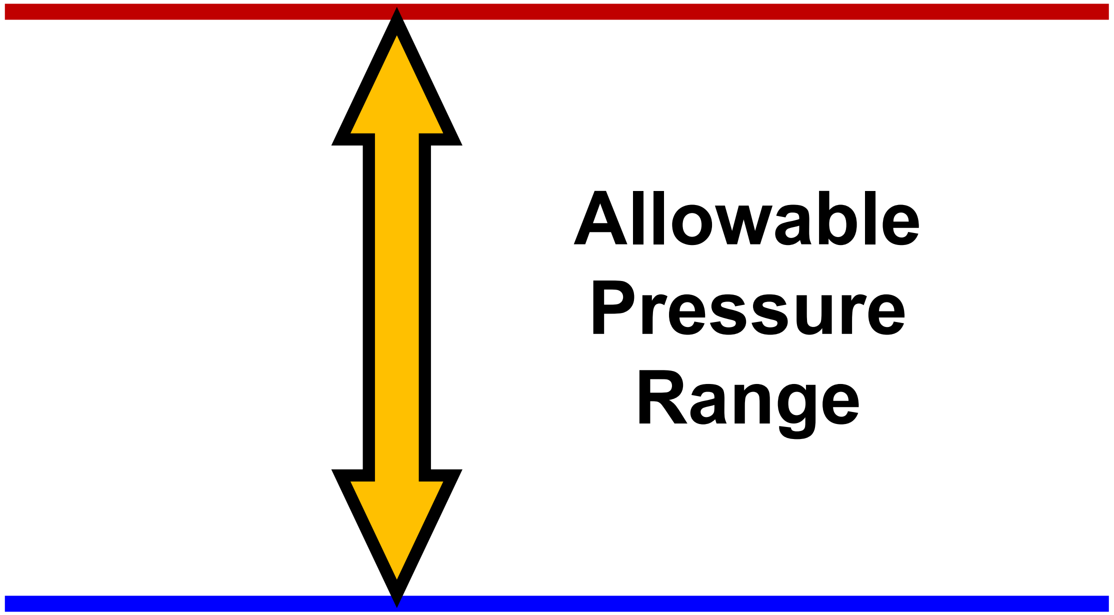
#3301 & 4100

Size, Capacity & Relief Setting for B&G ASME Safety Relief Valves[1]

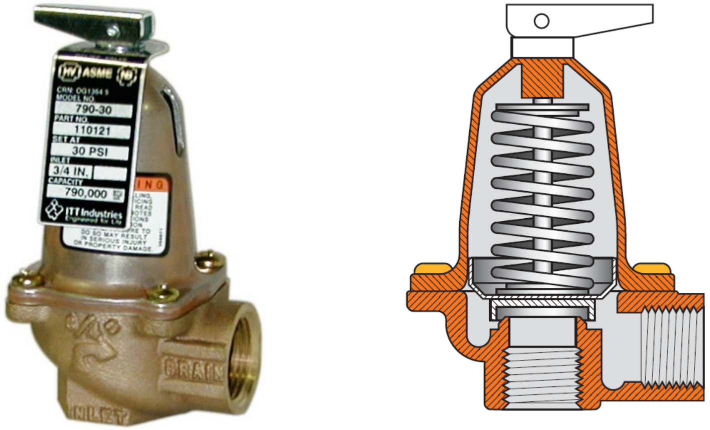
Relief Setting PSIG	Model Number Capacity in BTU Per Hour			
	Iron Body		Bronze Body	
30	3301-30 3,300,000	4100-30 4,100,000	790-30 790,000	1170-30 1,170,000
36	3301-36 3,800,000	4100-36 4,600,000	790-36 900,000	1170-36 1,330,000
45	3301-45 4,500,000	4100-45 5,515,000	790-45 1,065,000	1170-45 1,575,000
50	3301-50 4,900,000	4100-50 5,990,000	790-50 1,160,000	1170-50 1,710,000
75	NOT AVAILABLE		790-75 1,615,000	1170-75 2,385,000
100			790-100 2,075,000	1170-100 3,060,000
125			790-125 2,535,000	1170-125 3,735,000

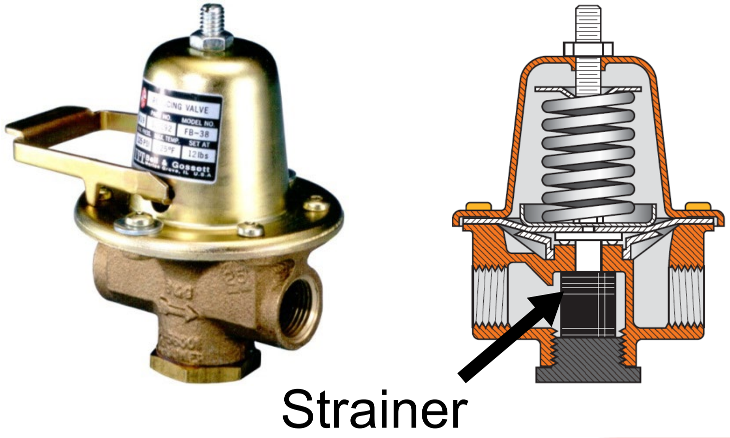
Pressure Limit Components - The "**Allowable Pressure Range**"

- **Upper pressure limit, P_2**
- ***Safety Relief Valve*** **setting**



- **Lower pressure limit, P_1**
- ***Pressure Reducing Valve*** **setting**





The “Pressure Range” influence on Air Management Tank sizing

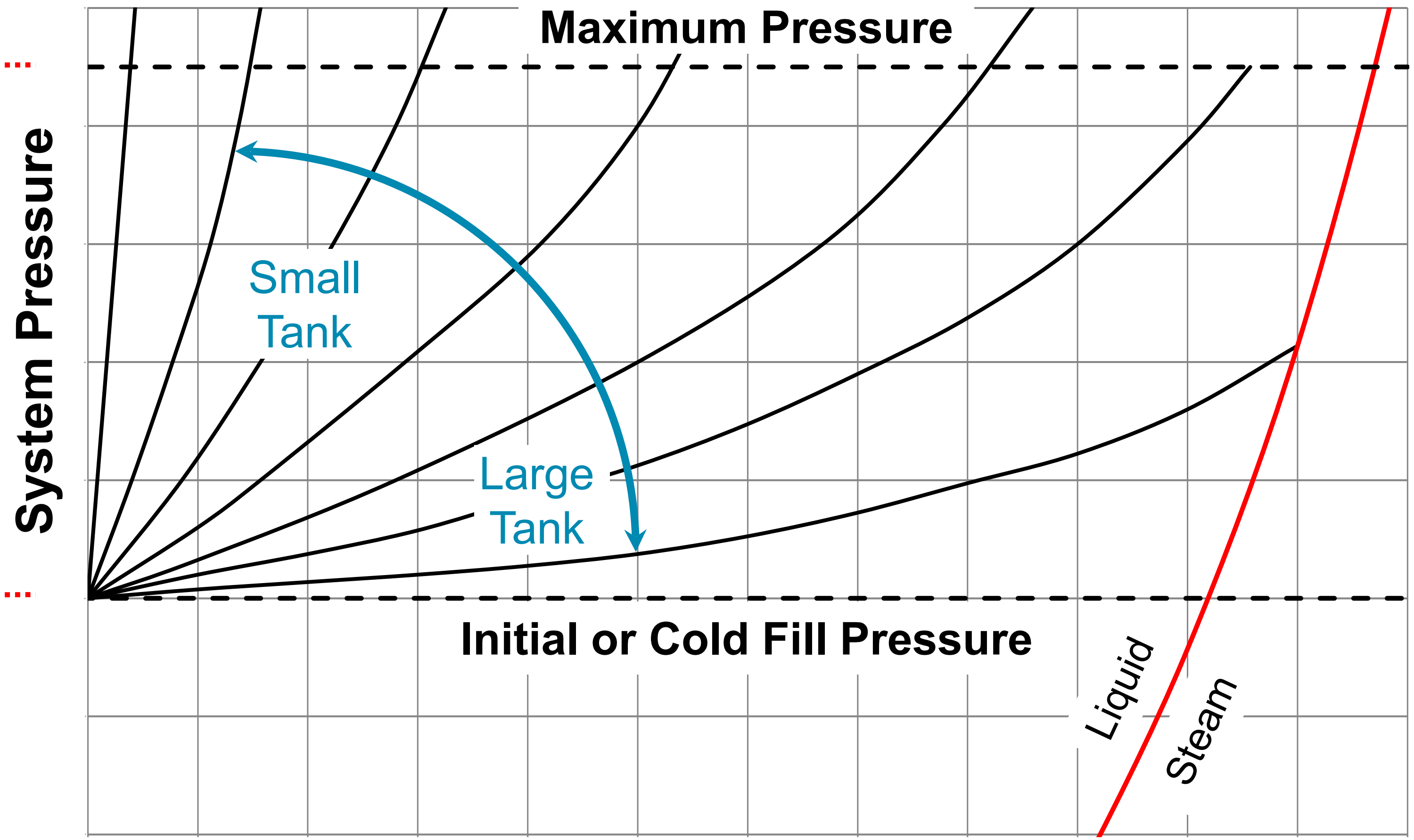
Upper Pressure Limit

ASME Relief

Valve Rating

Lower Pressure Limit

PRV Setting



Average System Temperature

Allowable

Pressure

Range

The “Pressure Range” influence on Air Management Tank sizing

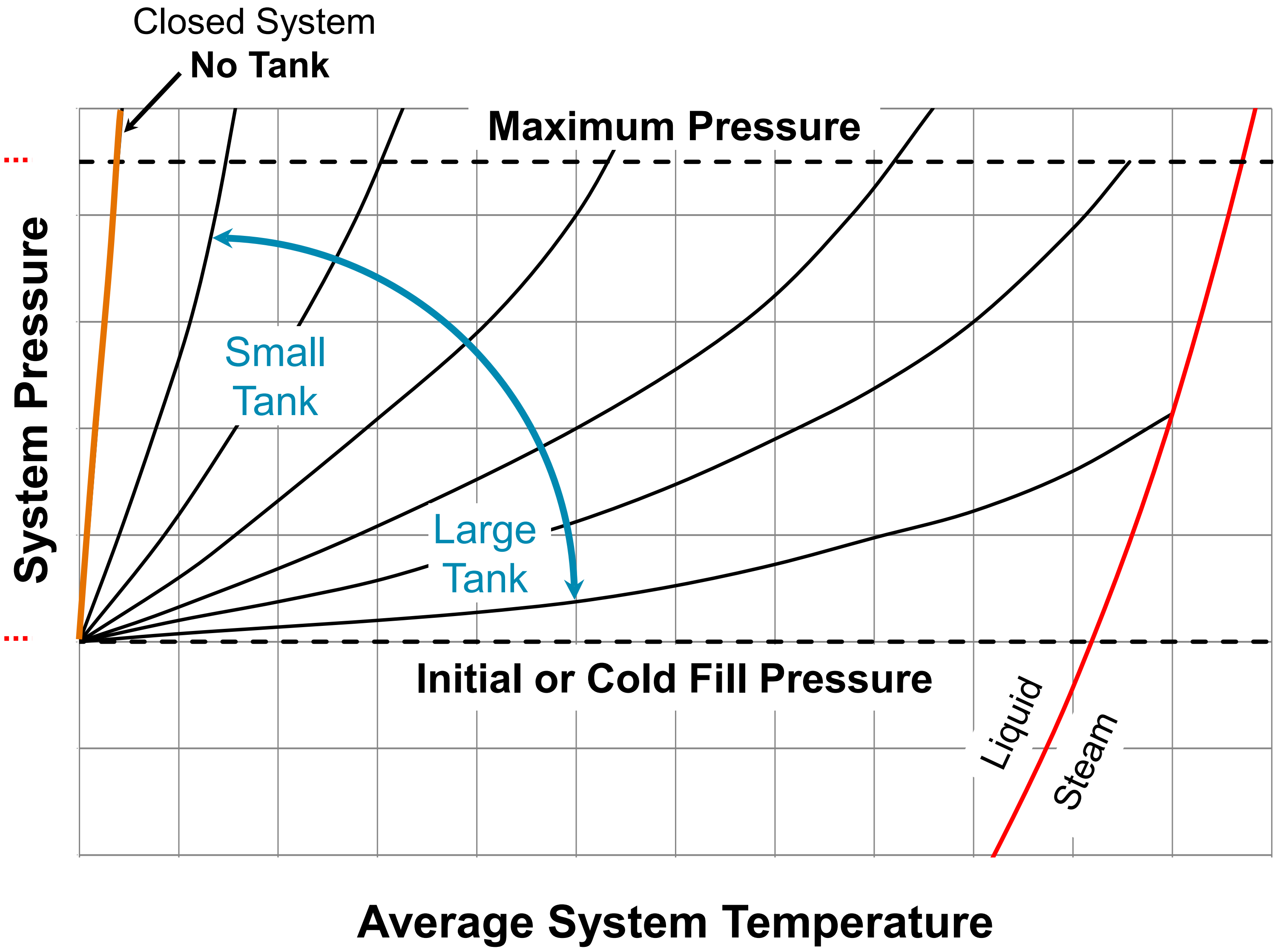
Upper Pressure Limit

ASME Relief

Valve Rating

Lower Pressure Limit

PRV Setting

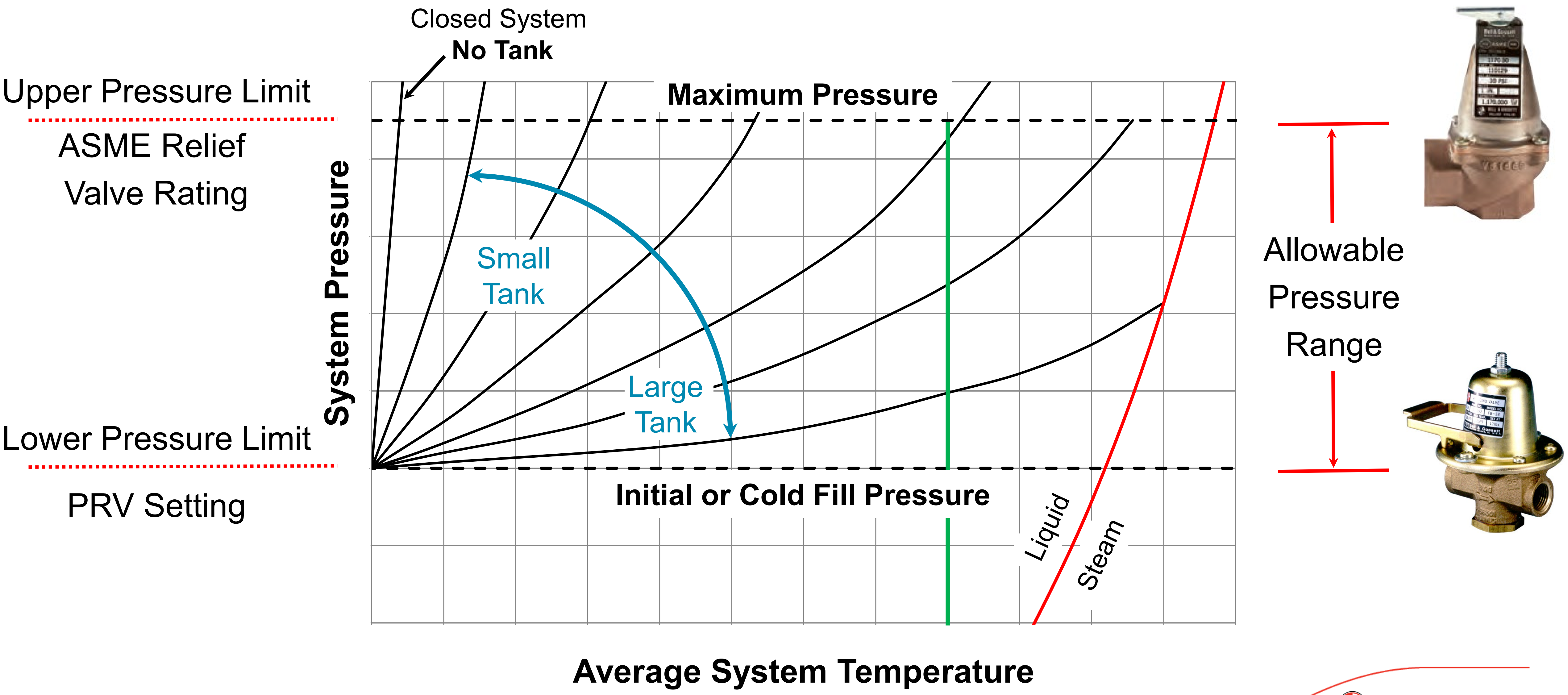


Allowable

Pressure

Range

The “Pressure Range” influence on Air Management Tank sizing



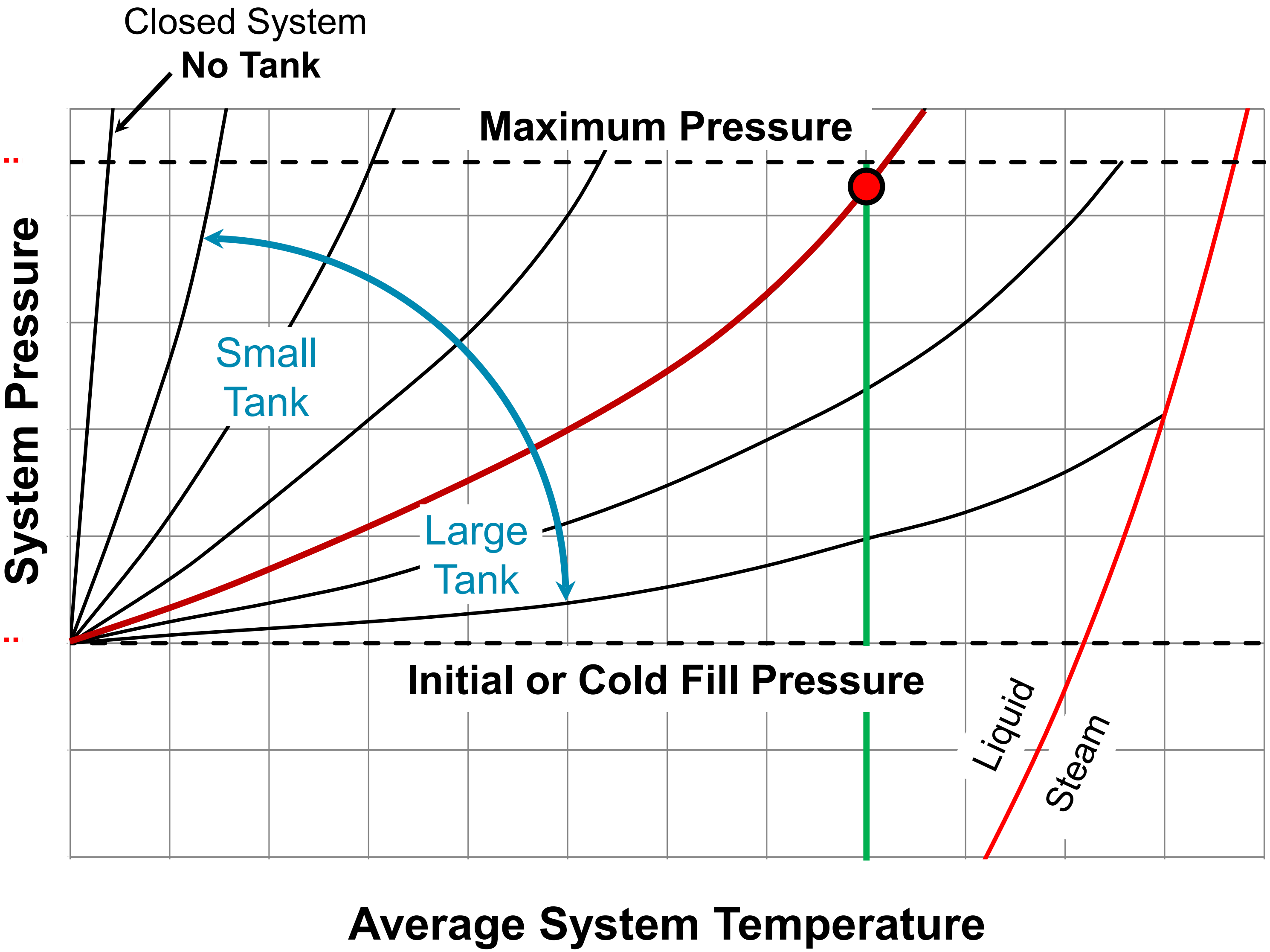
The “Pressure Range” influence on Air Management Tank sizing

Upper Pressure Limit

ASME Relief Valve Rating

Lower Pressure Limit

PRV Setting



Allowable Pressure Range

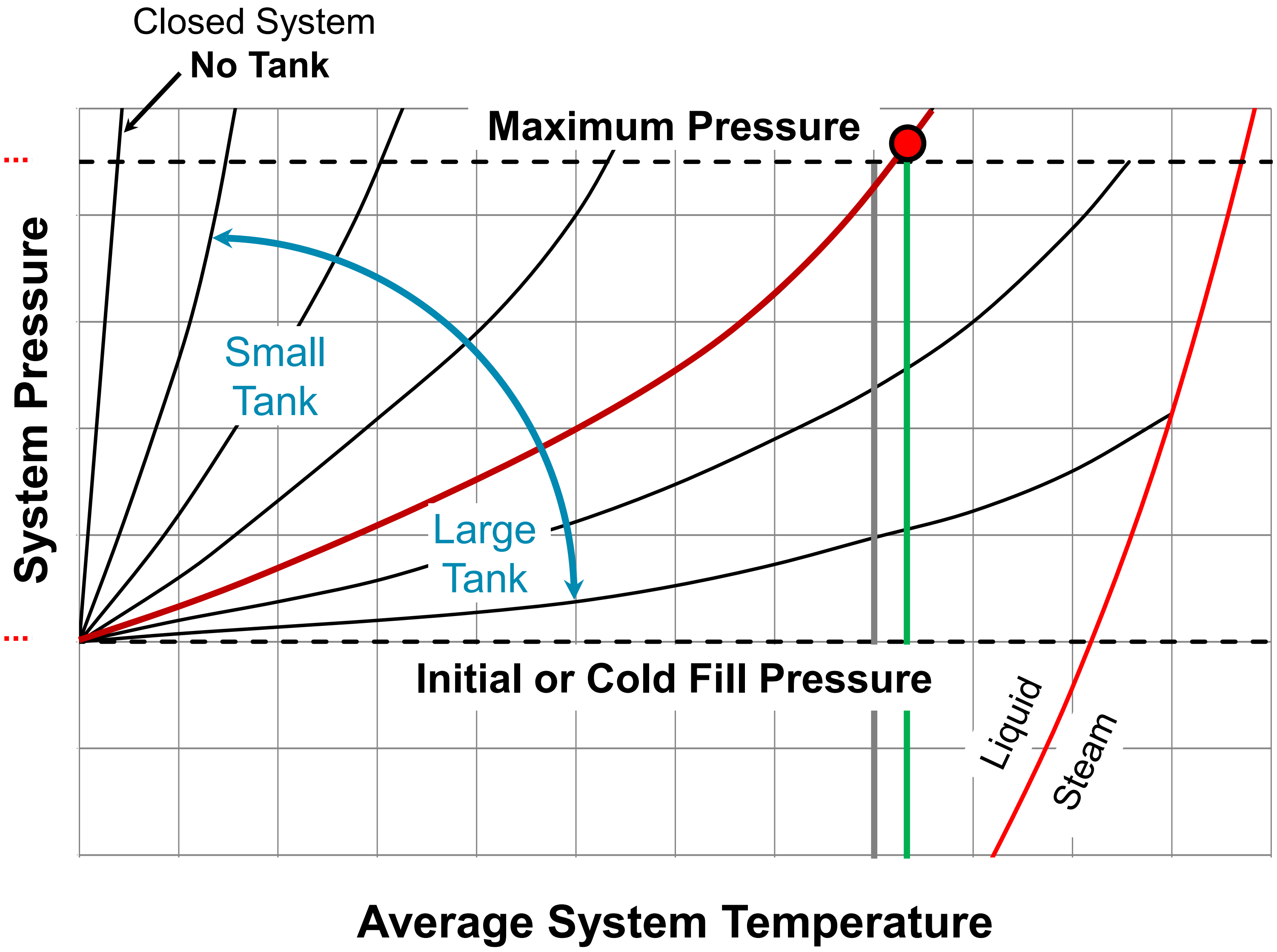
The “Pressure Range” influence on Air Management Tank sizing

Upper Pressure Limit

ASME Relief Valve Rating

Lower Pressure Limit

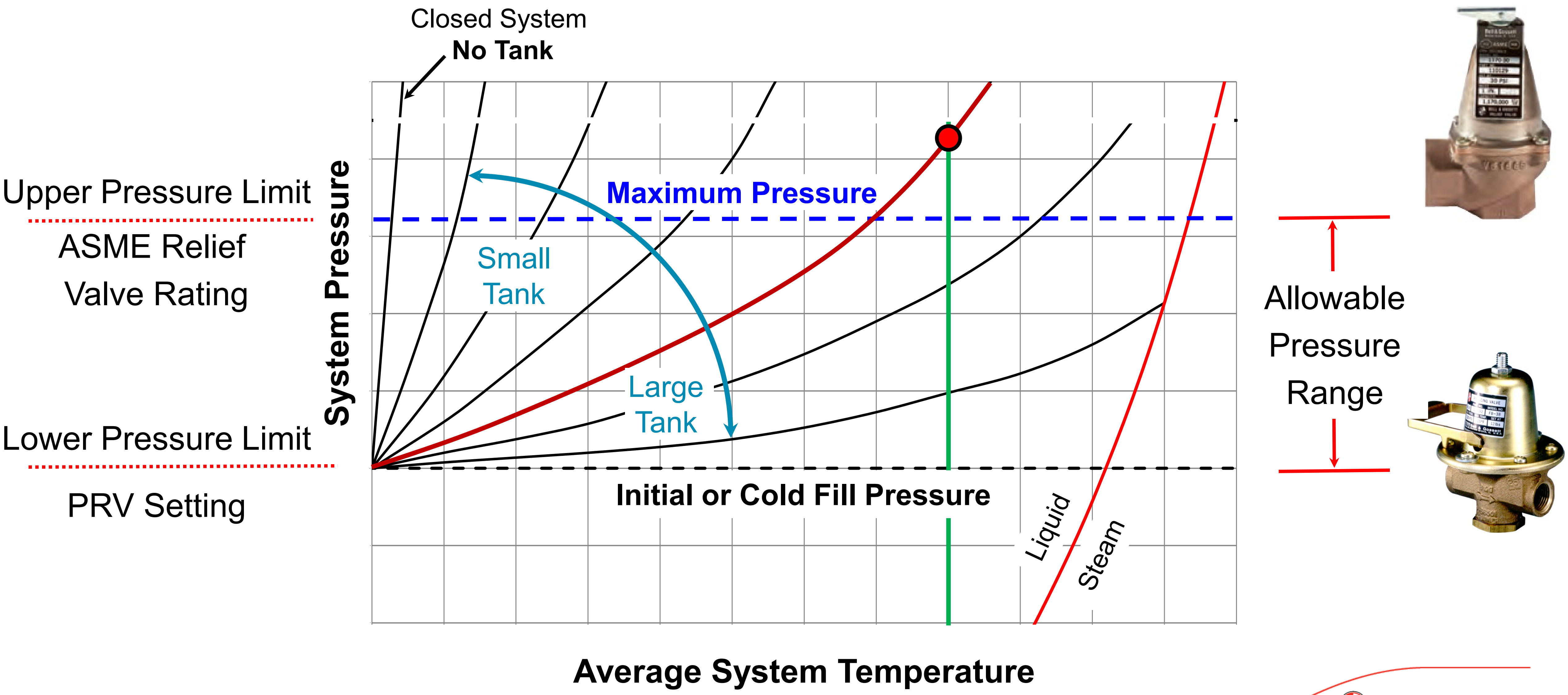
PRV Setting



Allowable Pressure Range

Bell & Gossett
a xylem brand

The “Pressure Range” influence on Air Management Tank sizing



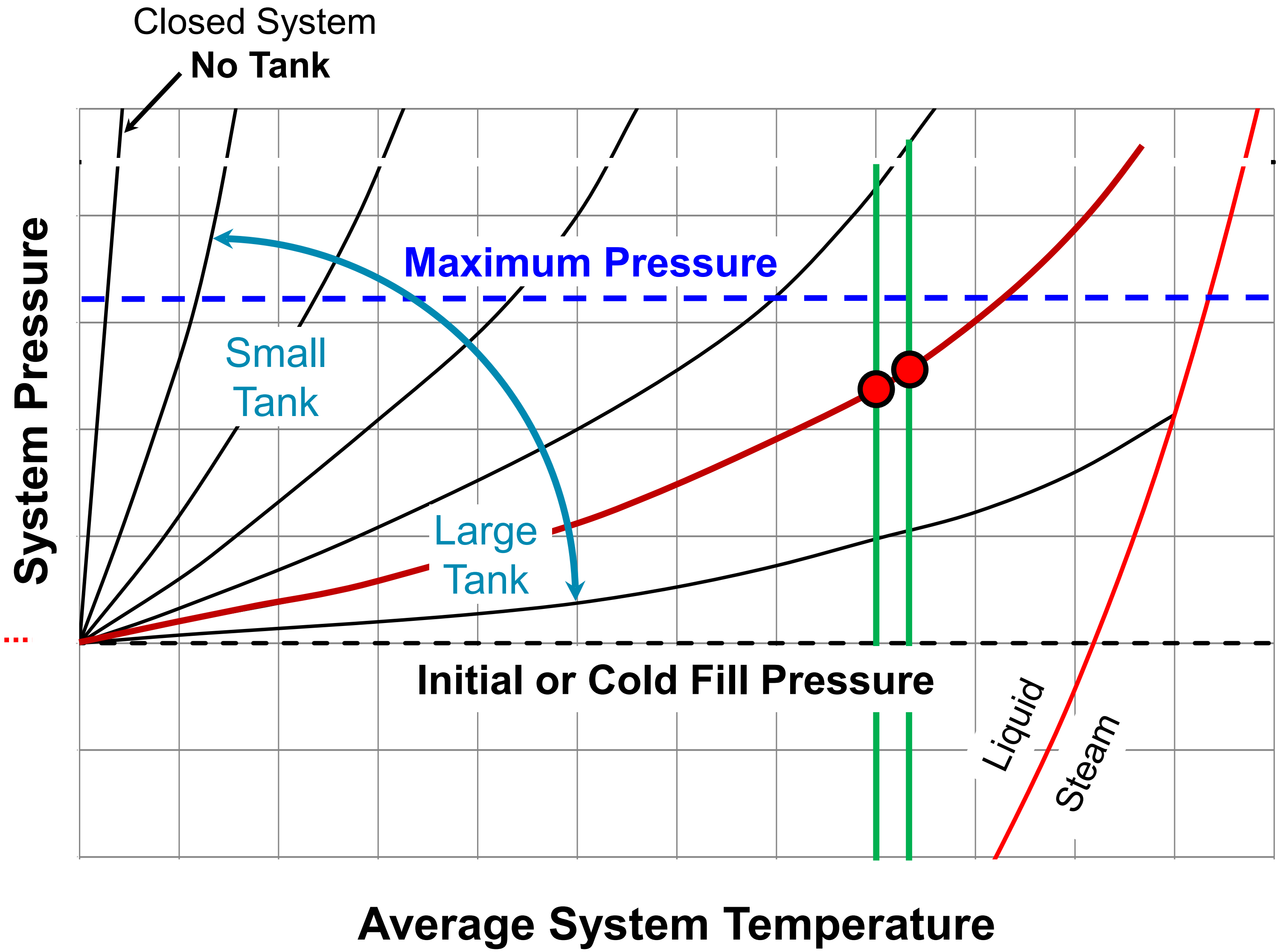
The "Pressure Range" influence on Air Management Tank sizing

Upper Pressure Limit

ASME Relief Valve Rating

Lower Pressure Limit

PRV Setting



Allowable Pressure Range

Bell & Gossett
a xylem brand

The “Pressure Range” influence on Air Management Tank sizing

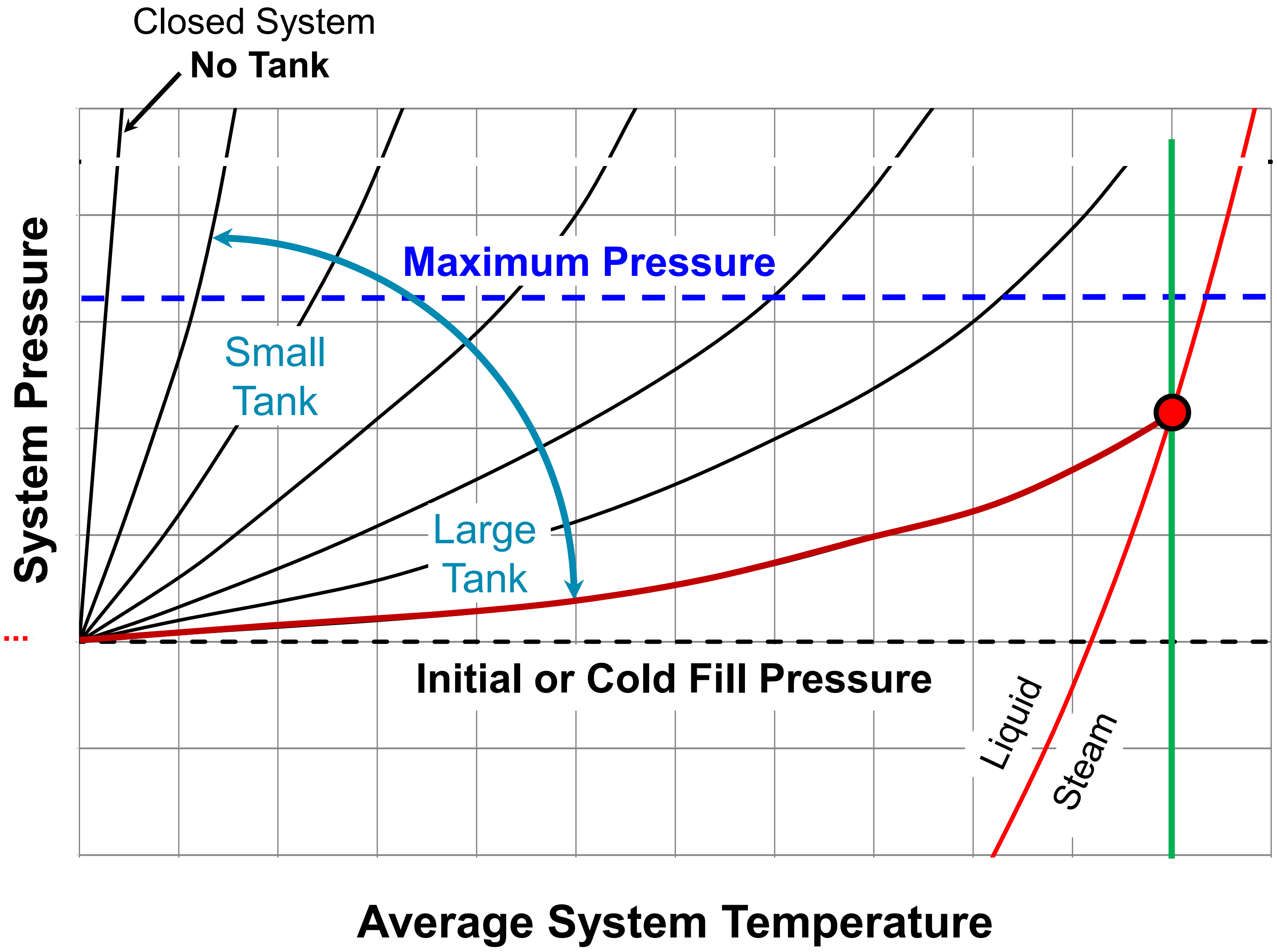
Upper Pressure Limit

ASME Relief

Valve Rating

Lower Pressure Limit

PRV Setting

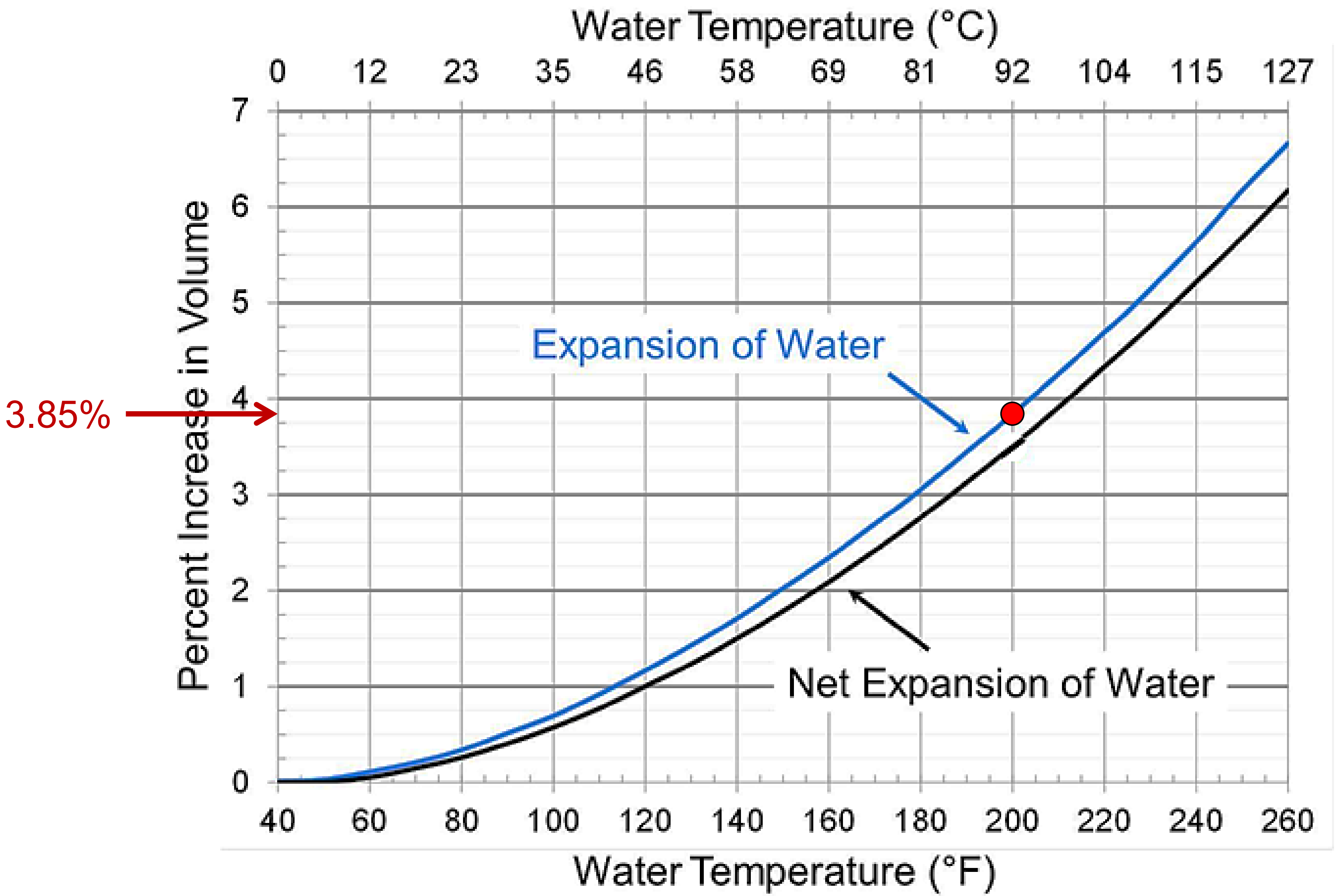


Allowable

Pressure

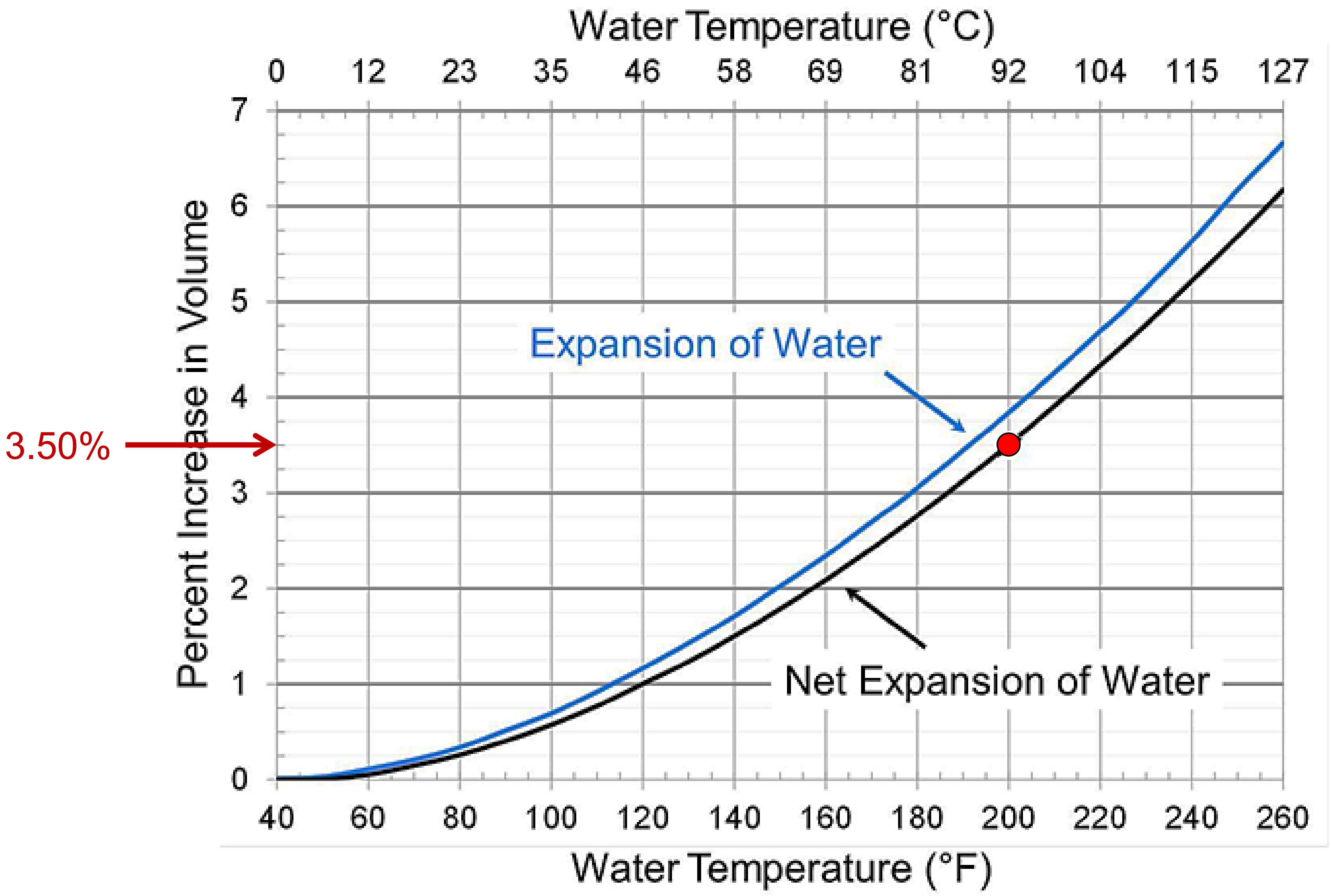
Range

Water Expansion vs. Temperature



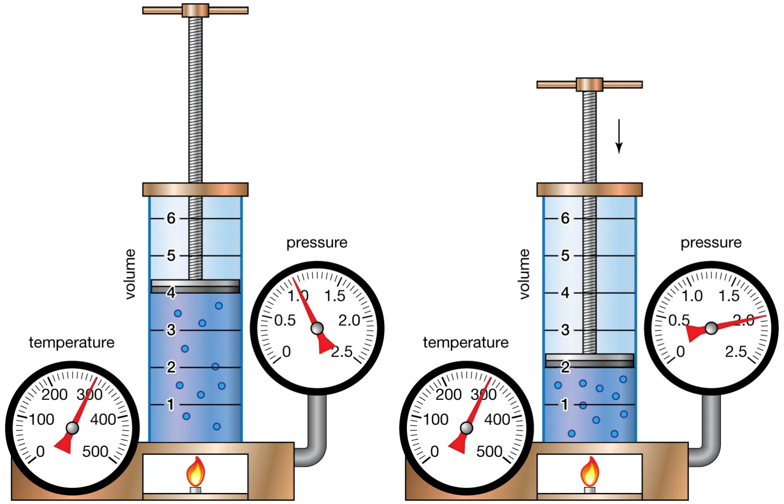
Bell & Gossett
a xylem brand

Water Expansion vs. Temperature

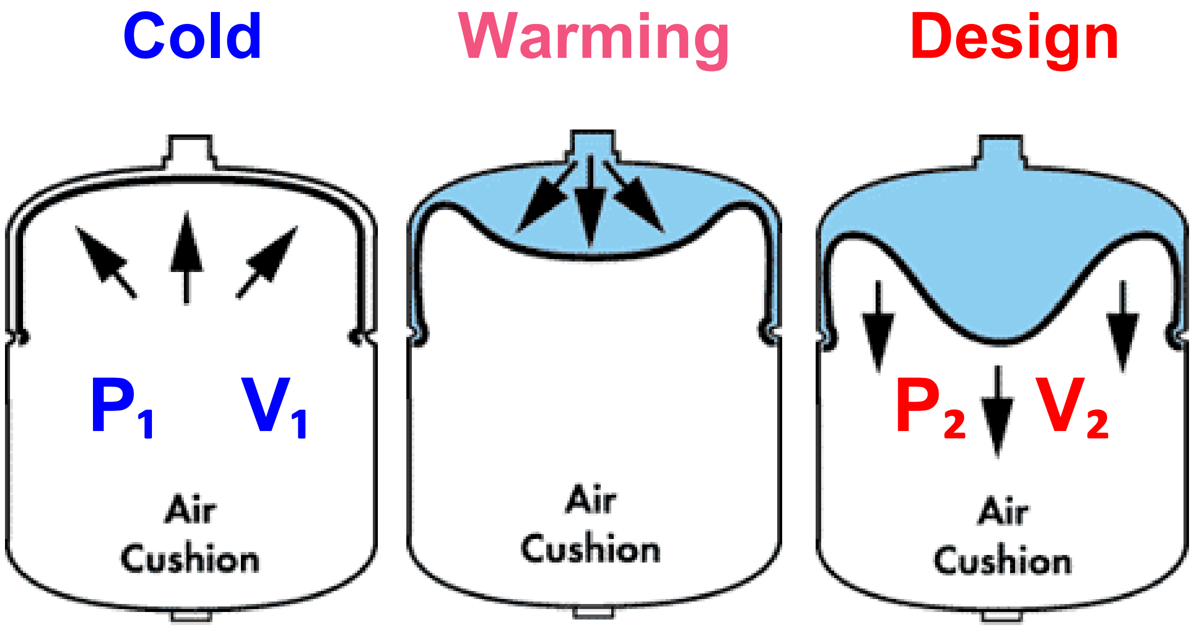


Boyle's Law – The Behavior of a Gas

At **Constant Temperature,** the **Volume** of gas is inversely proportional to the **Pressure** exerted by the gas.

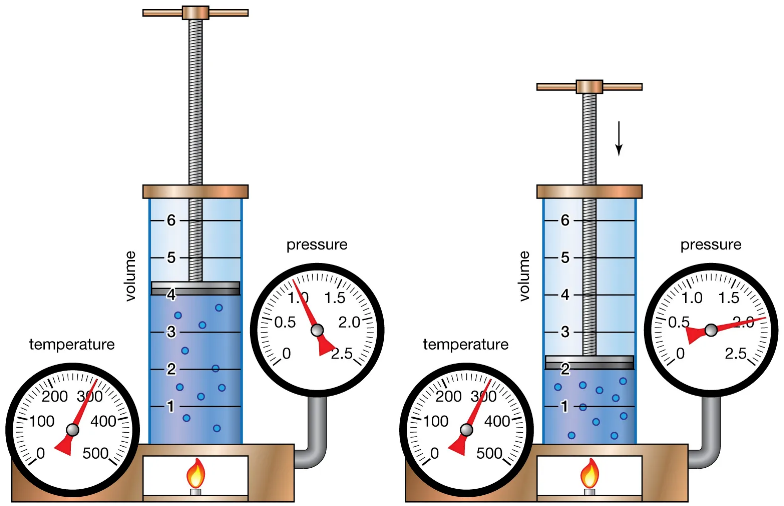


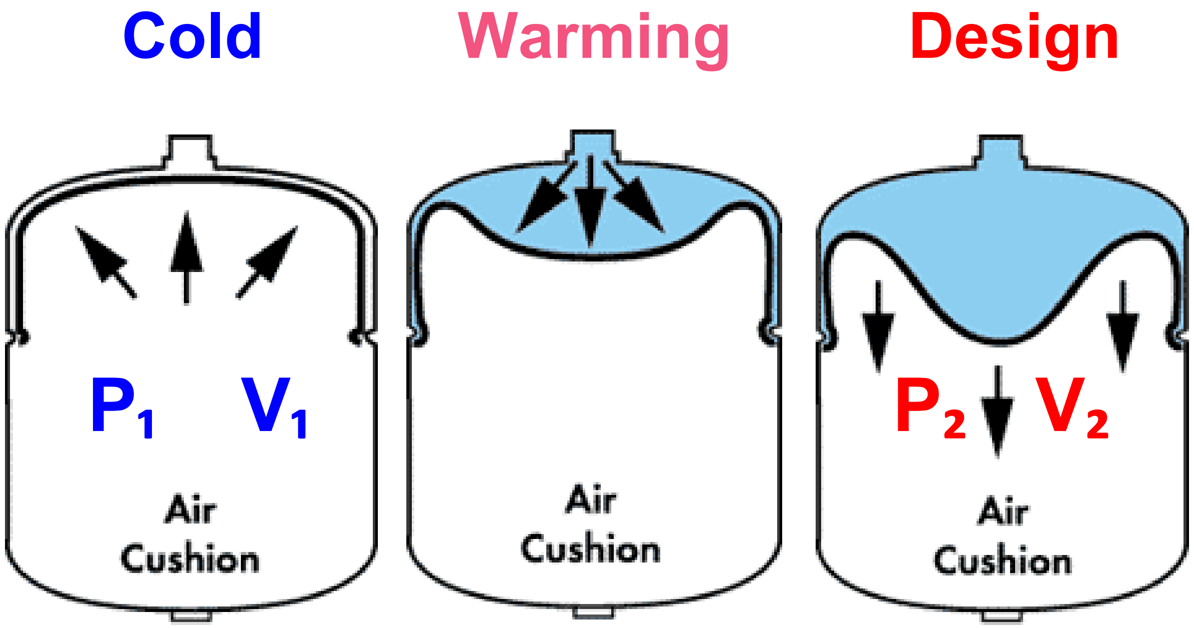
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$



Boyle's Law – The Behavior of a Gas

At **Constant Temperature,** the **Volume** of gas is inversely proportional to the **Pressure** exerted by the gas.



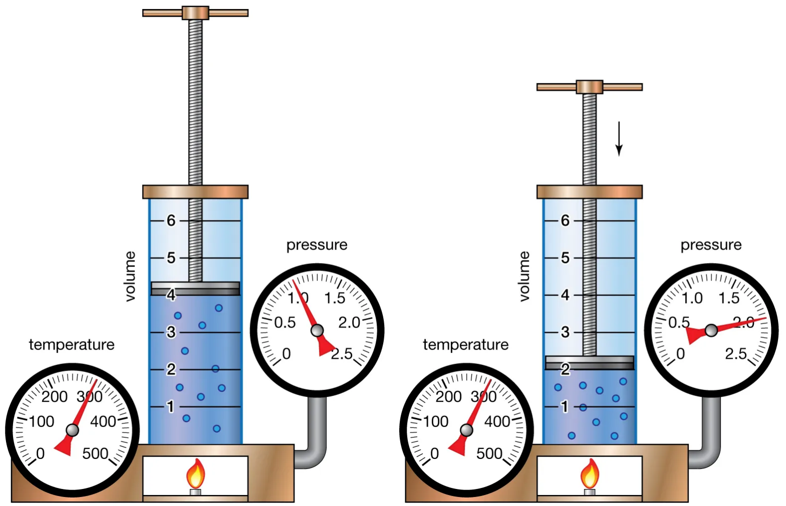


$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P_1V_1 = P_2V_2$$

Boyle's Law – The Behavior of a Gas

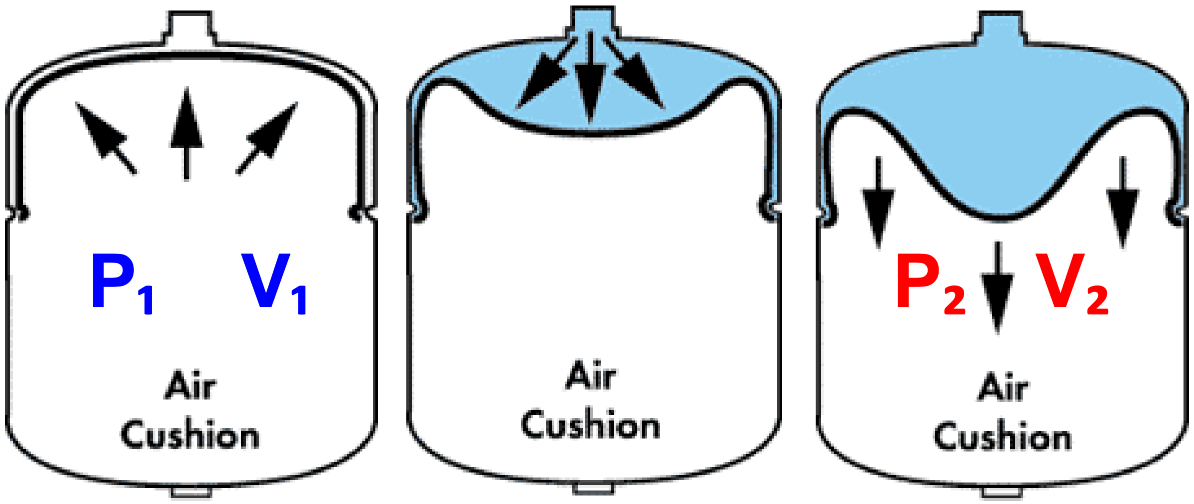
At **Constant Temperature,** the **Volume** of gas is inversely proportional to the **Pressure** exerted by the gas.



$$\frac{P_1V_1}{\cancel{T_1}} = \frac{P_2V_2}{\cancel{T_2}}$$

$$P_1V_1 = P_2V_2$$

Cold **Warming** **Design**



V_2 ↓ P_2 ↑

Bell & Gossett
a xylem brand

Diaphragm or Bladder Pre-Charged Tank Types (Air Elimination)

Limited Acceptance
Diaphragm

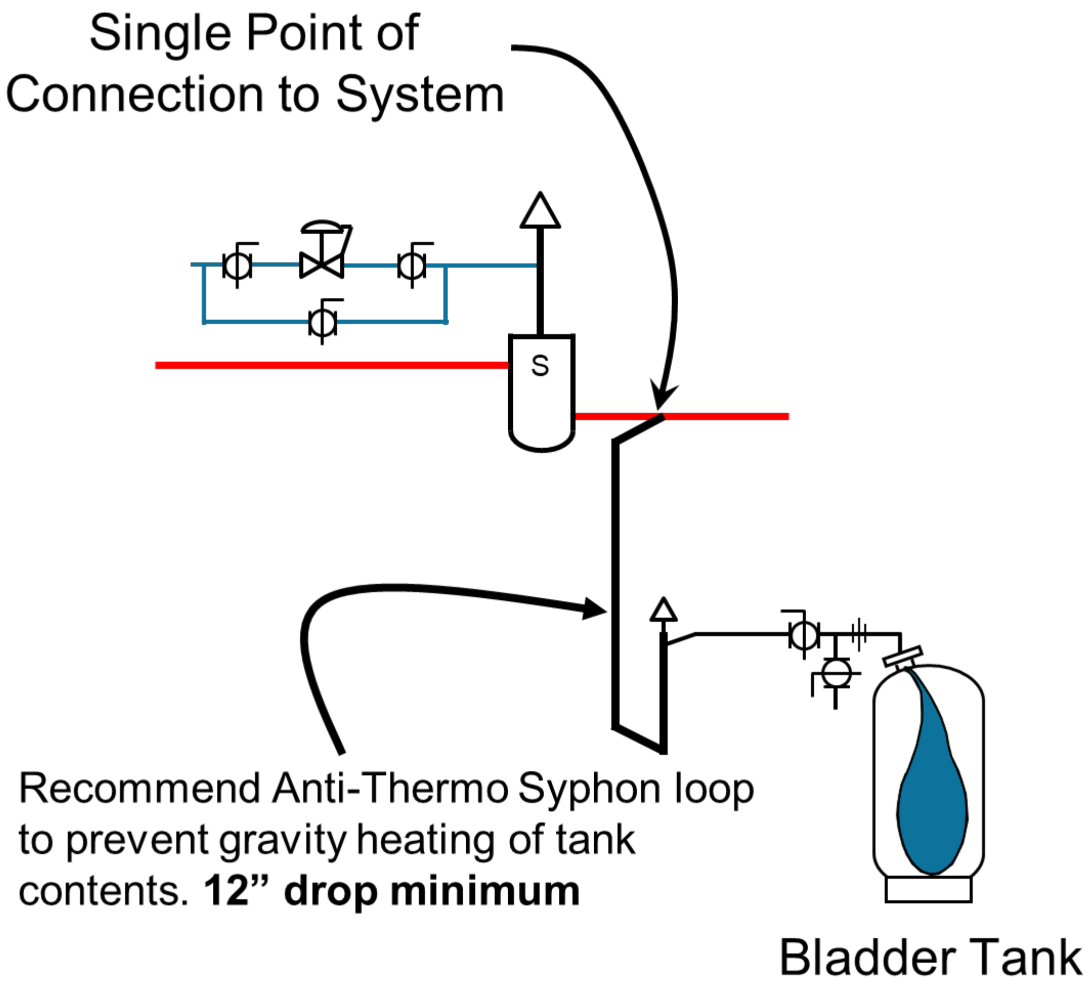
Limited Acceptance
Bladder

Full Acceptance
Bladder

***NOTE: B&G** Tanks for **HVAC** applications factory "Pre-Charge" is **40 PSI**

- Field adjust, **with tank empty**, to job specific Cold Static Fill Pressure, prior to introduction to system.

Pre-Charged Tanks (Air Elimination) - Piping

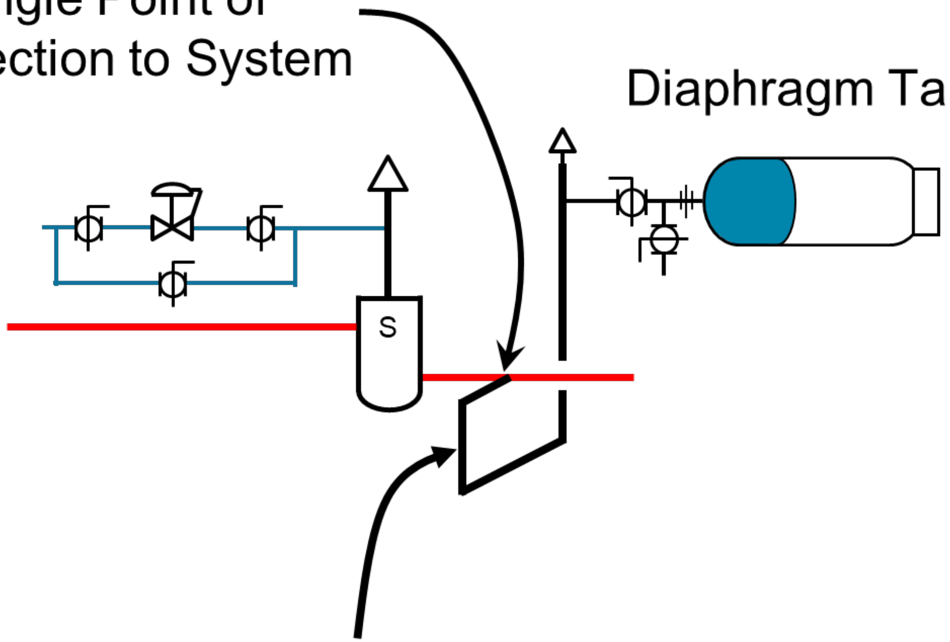


Bell & Gossett
a xylem brand

Pre-Charged Tanks (Air Elimination) - Piping

Single Point of Connection to System

Diaphragm Tank

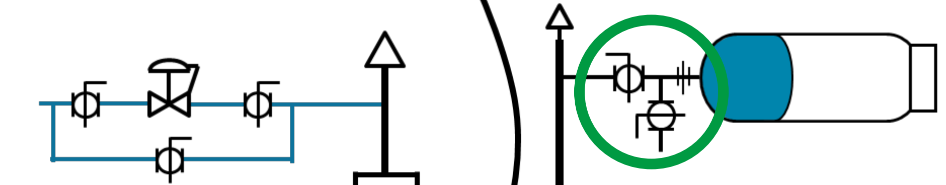


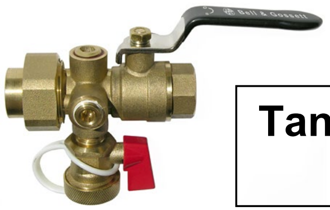
Recommend Anti-Thermo Syphon loop to prevent gravity heating of tank contents. **12" drop minimum**

Pre-Charged Tanks (Air Elimination) - Piping

Single Point of Connection to System

Diaphragm Tank



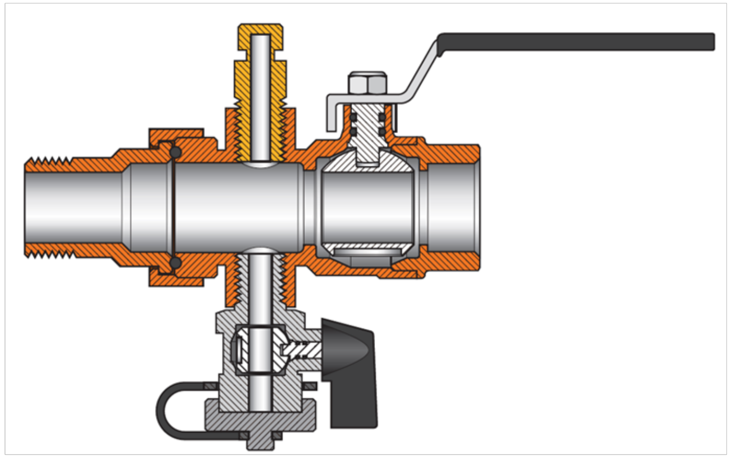


Tank Purge Valve (TPV)

Recommend Anti-Thermo Syphon loop to prevent gravity heating of tank contents. **12" drop minimum**

*** Check State and Local Codes**

Tank



*** Not to be used in Potable Water Systems**

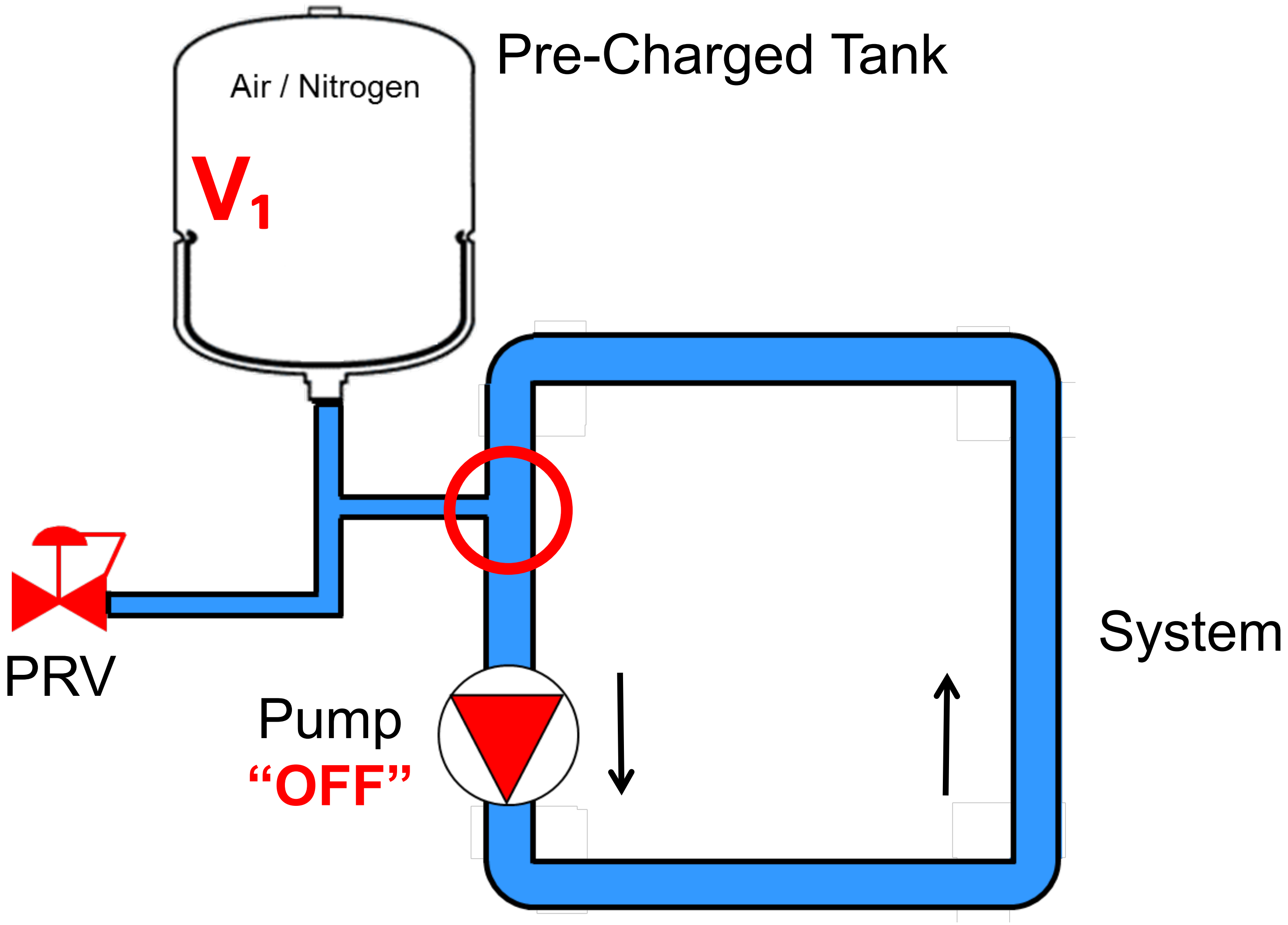
The “Point of No Pressure Change”

Tank Location – System Pressure Reference

AIR CHARGE

Pump
"OFF"

$$\frac{P_1 V_1}{T_1}$$



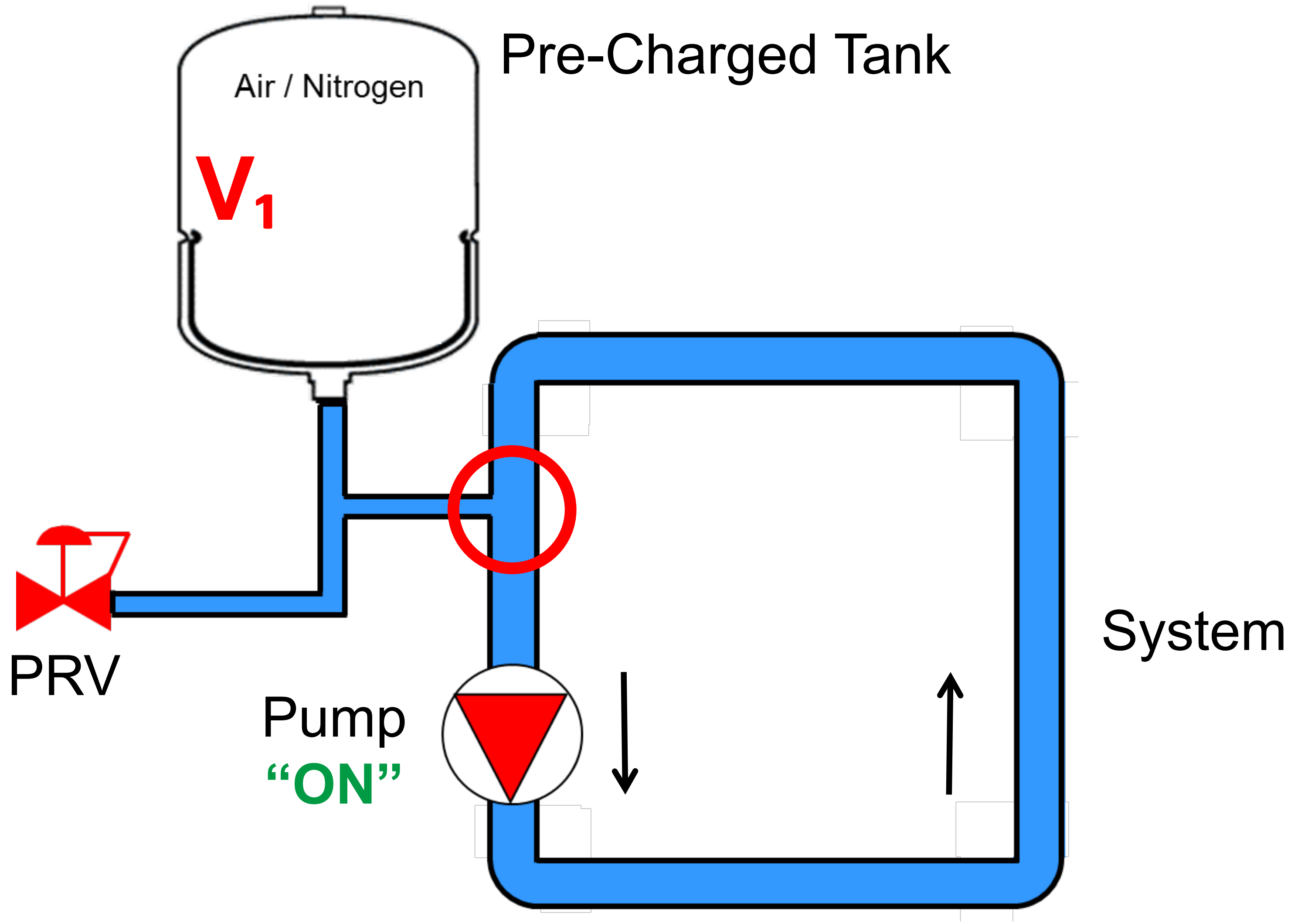
System at Cold Fill Temperature

Tank Location – System Pressure Reference

AIR CHARGE

Pump	Pump
"OFF"	**"ON"**

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$



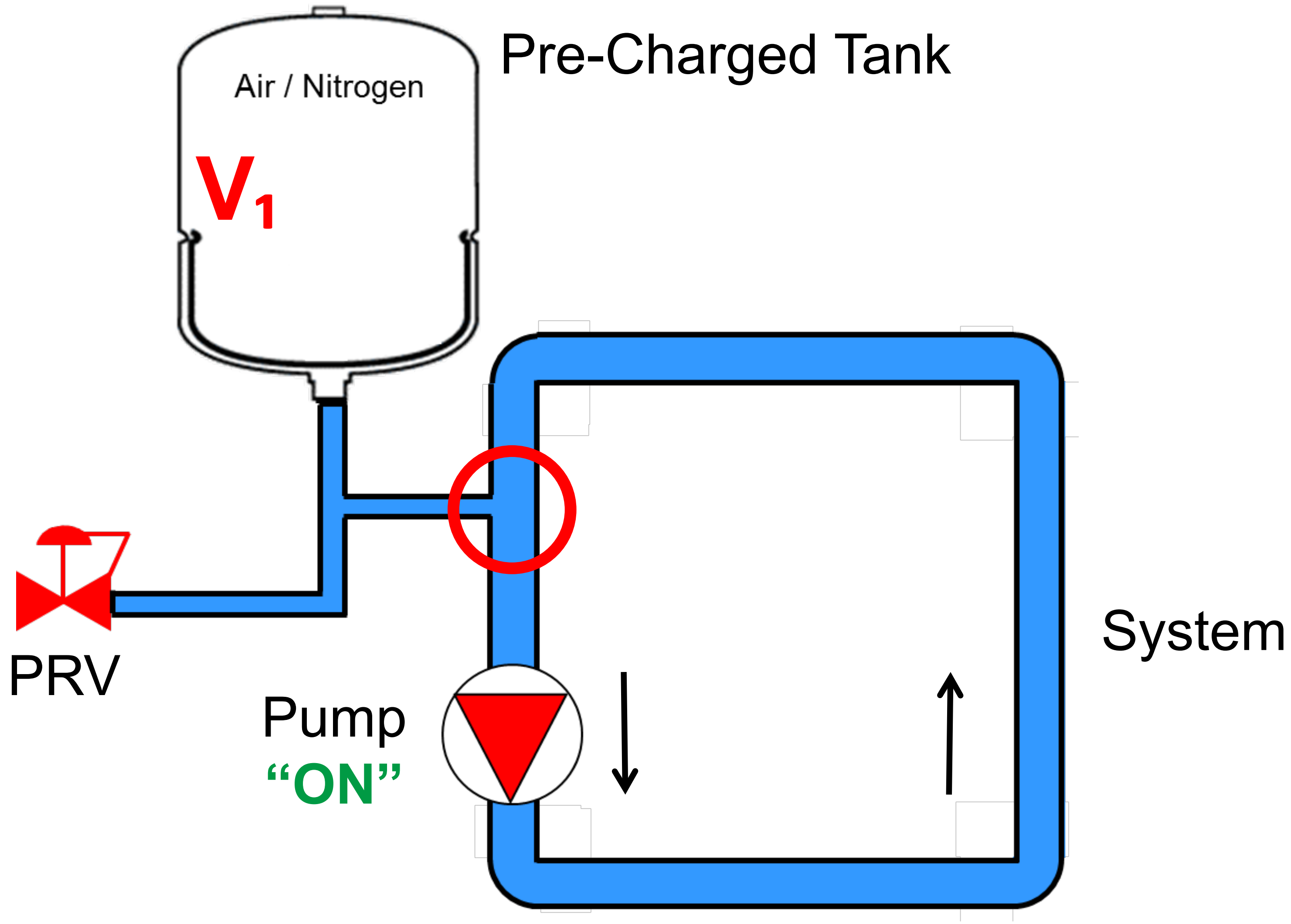
System at Cold Fill Temperature

Tank Location – System Pressure Reference

AIR CHARGE

Pump **"OFF"**   Pump **"ON"**

$$\frac{P_1V_1}{\cancel{T_1}} = \frac{P_2V_2}{\cancel{T_2}}$$



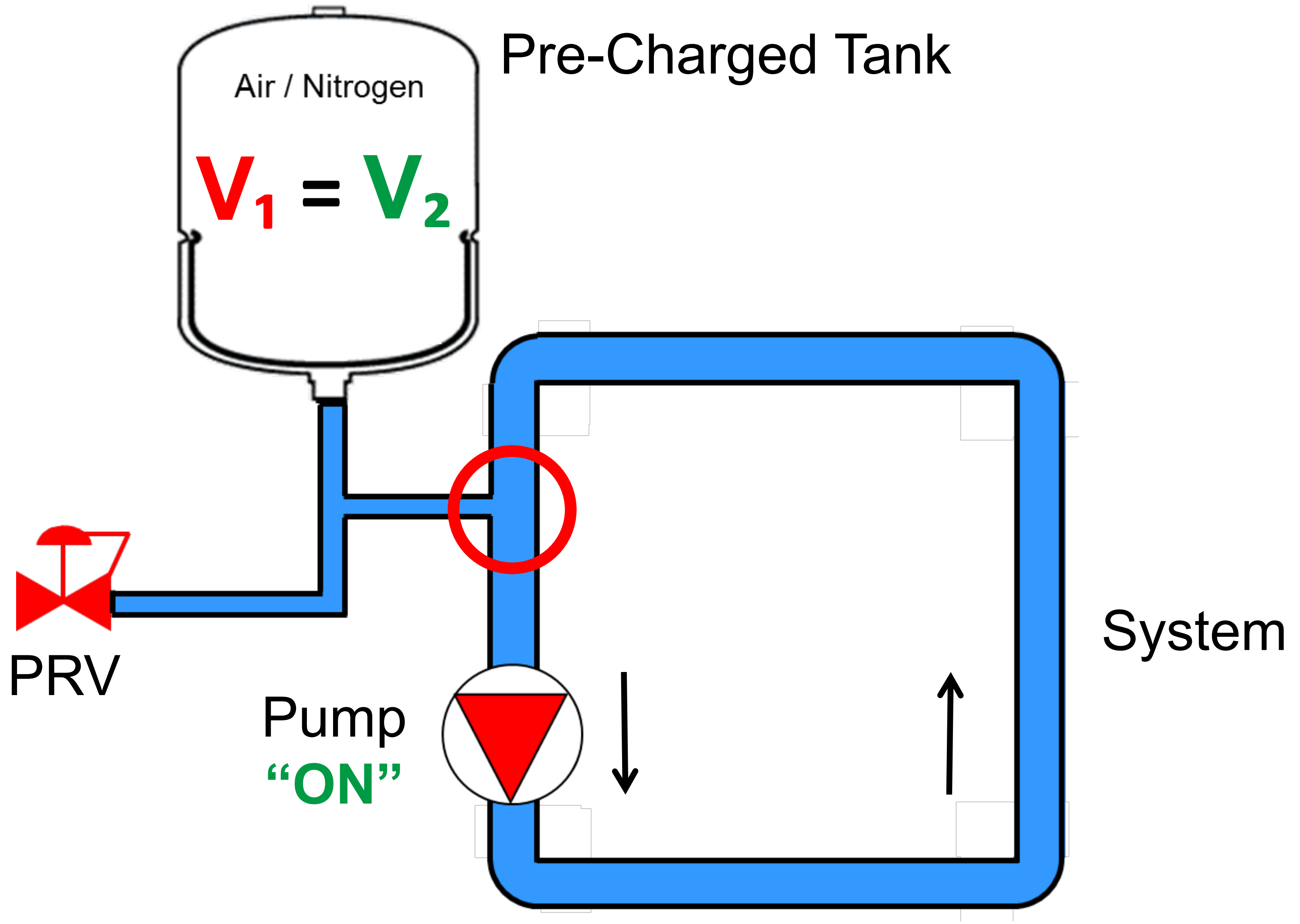
System at Cold Fill Temperature

Tank Location – System Pressure Reference

AIR CHARGE

Pump "OFF" | Pump "ON"

$$\frac{P_1 \cancel{V_1}}{\cancel{T_1}} = \frac{P_2 \cancel{V_2}}{\cancel{T_2}}$$



System at Cold Fill Temperature

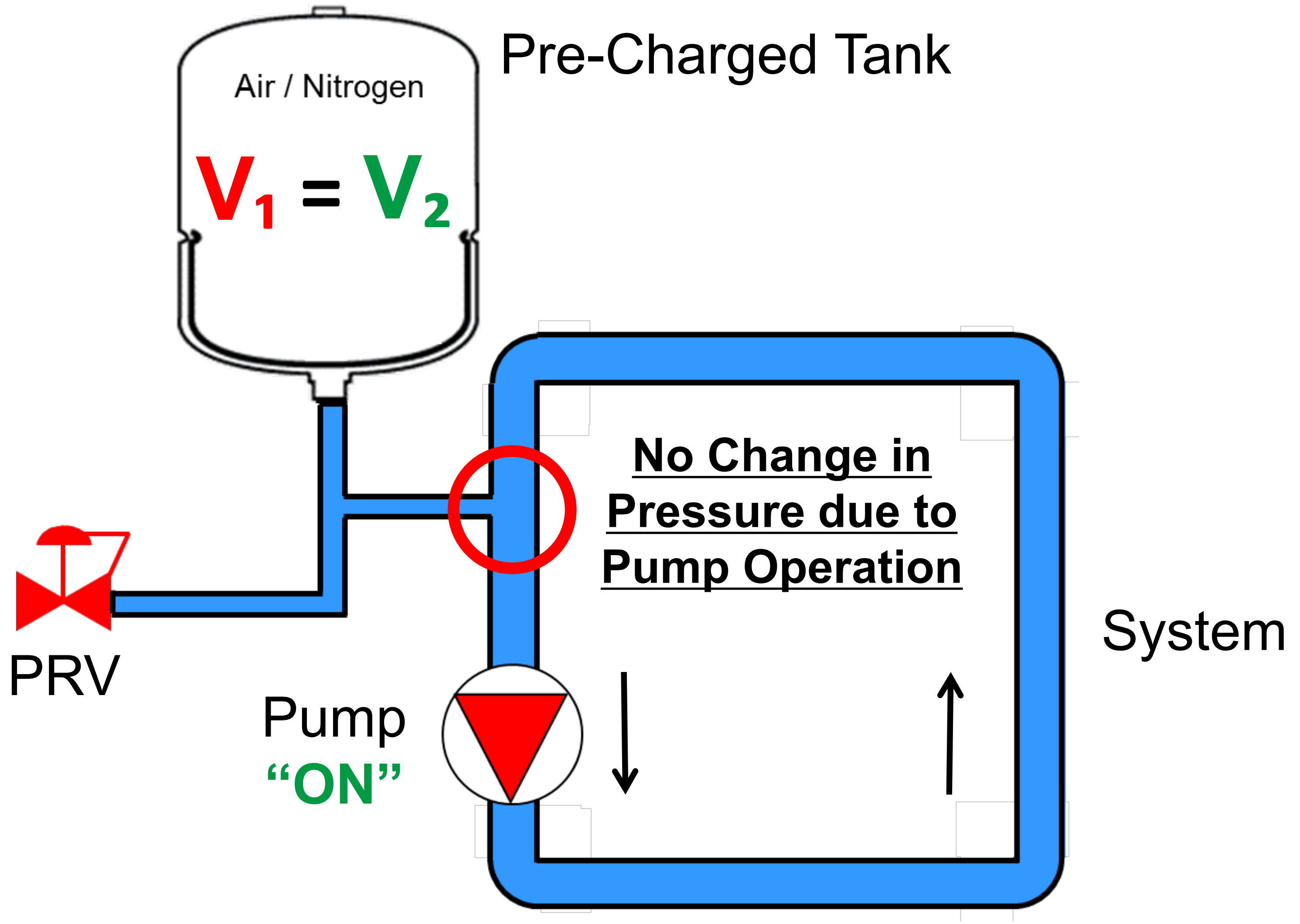
Tank Location – System Pressure Reference

AIR CHARGE

Pump "OFF"	Pump "ON"

$$\frac{P_1 \not{V_1}}{\not{T_1}} = \frac{P_2 \not{V_2}}{\not{T_2}}$$

$$P_1 = P_2$$



System at Cold Fill Temperature

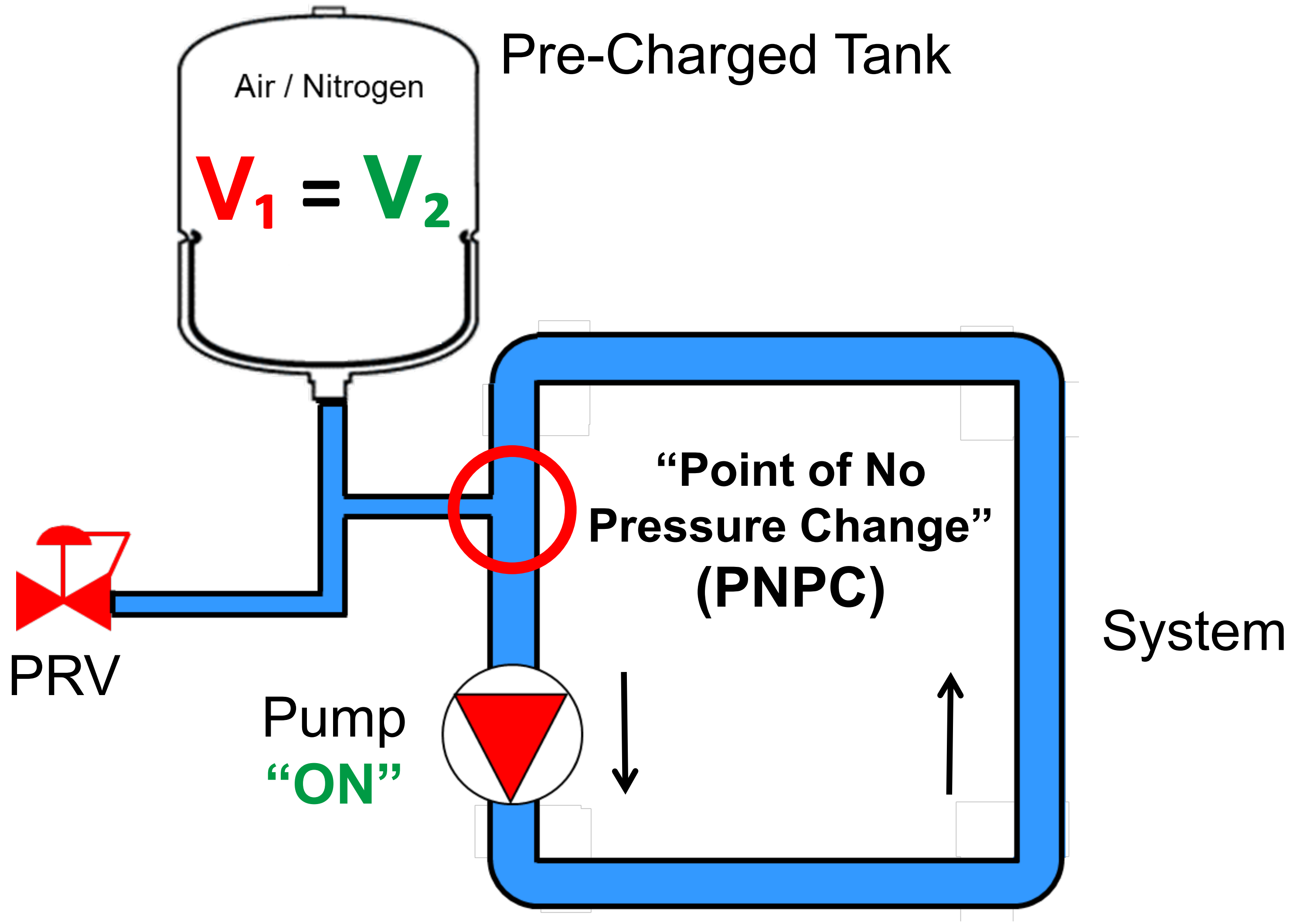
Tank Location – System Pressure Reference

AIR CHARGE

Pump "OFF"	Pump "ON"

$$\frac{P_1 \cancel{V_1}}{\cancel{T_1}} = \frac{P_2 \cancel{V_2}}{\cancel{T_2}}$$

$$P_1 = P_2$$



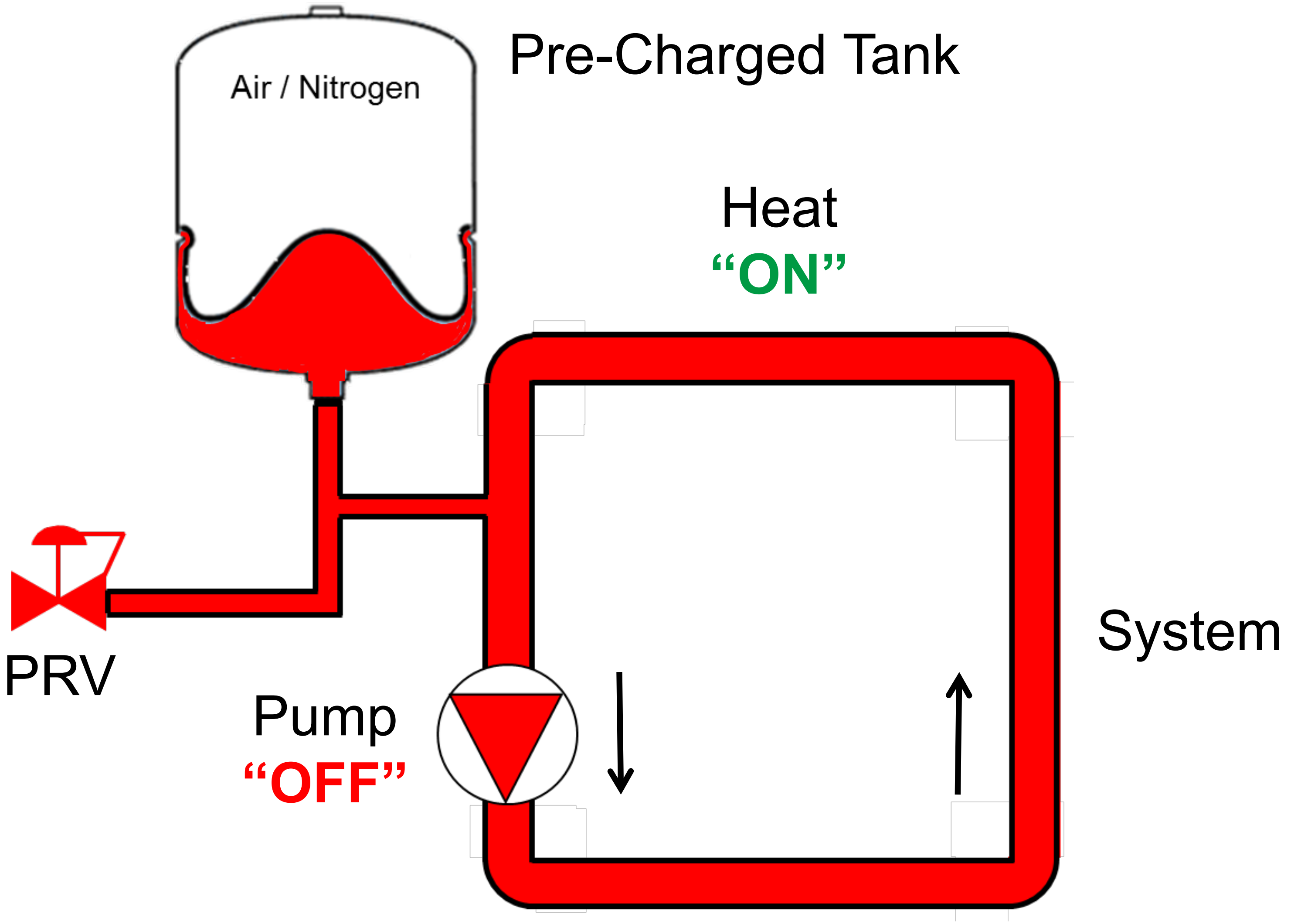
System at Cold Fill Temperature

Tank Location - Point of No Pressure Change (PNPC)

AIR CHARGE

Heat "OFF" — Heat "ON"

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$



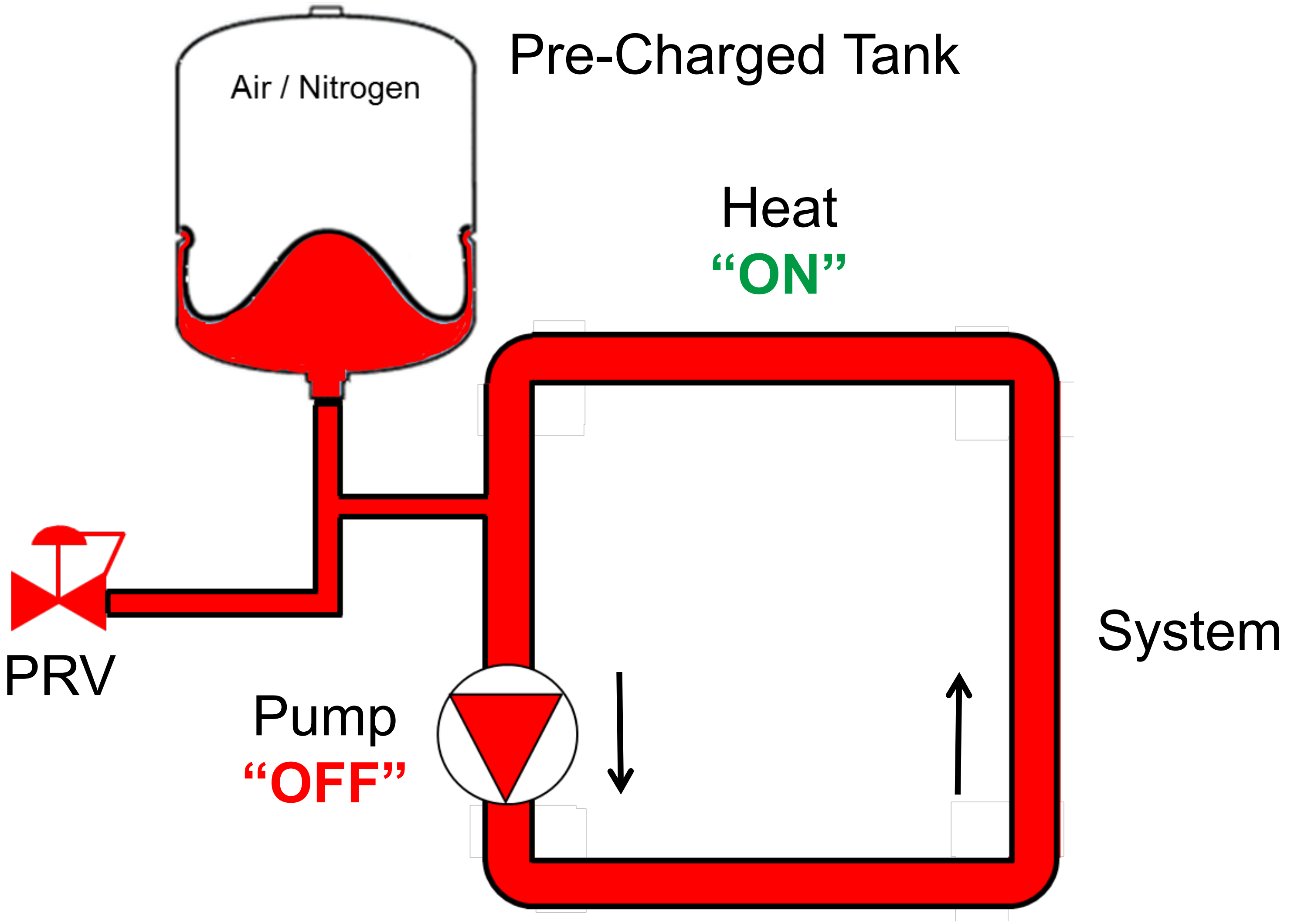
System at Average Design Temperature

Tank Location - Point of No Pressure Change (PNPC)

AIR CHARGE

Heat **"OFF"** Heat **"ON"**

$$\frac{P_1V_1}{\cancel{T_1}} = \frac{P_2V_2}{\cancel{T_2}}$$



System at Average Design Temperature

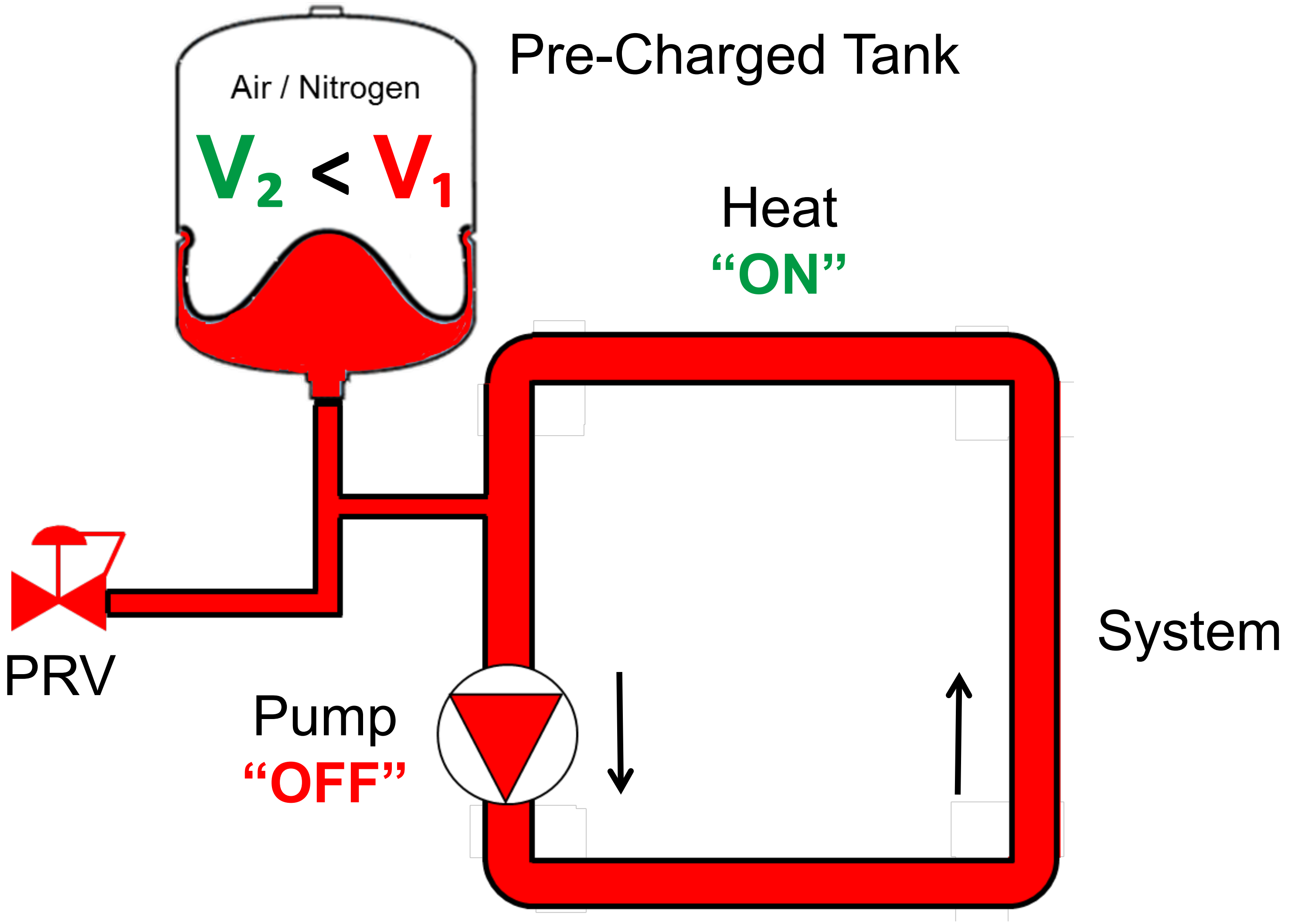
Tank Location - Point of No Pressure Change (PNPC)

AIR CHARGE

Heat	Heat
"OFF"	"ON"

$$\frac{P_1 V_1}{\cancel{T_1}} = \frac{P_2 V_2}{\cancel{T_2}}$$

$$V_2 < V_1$$



System at Average Design Temperature

Tank Location - Point of No Pressure Change (PNPC)

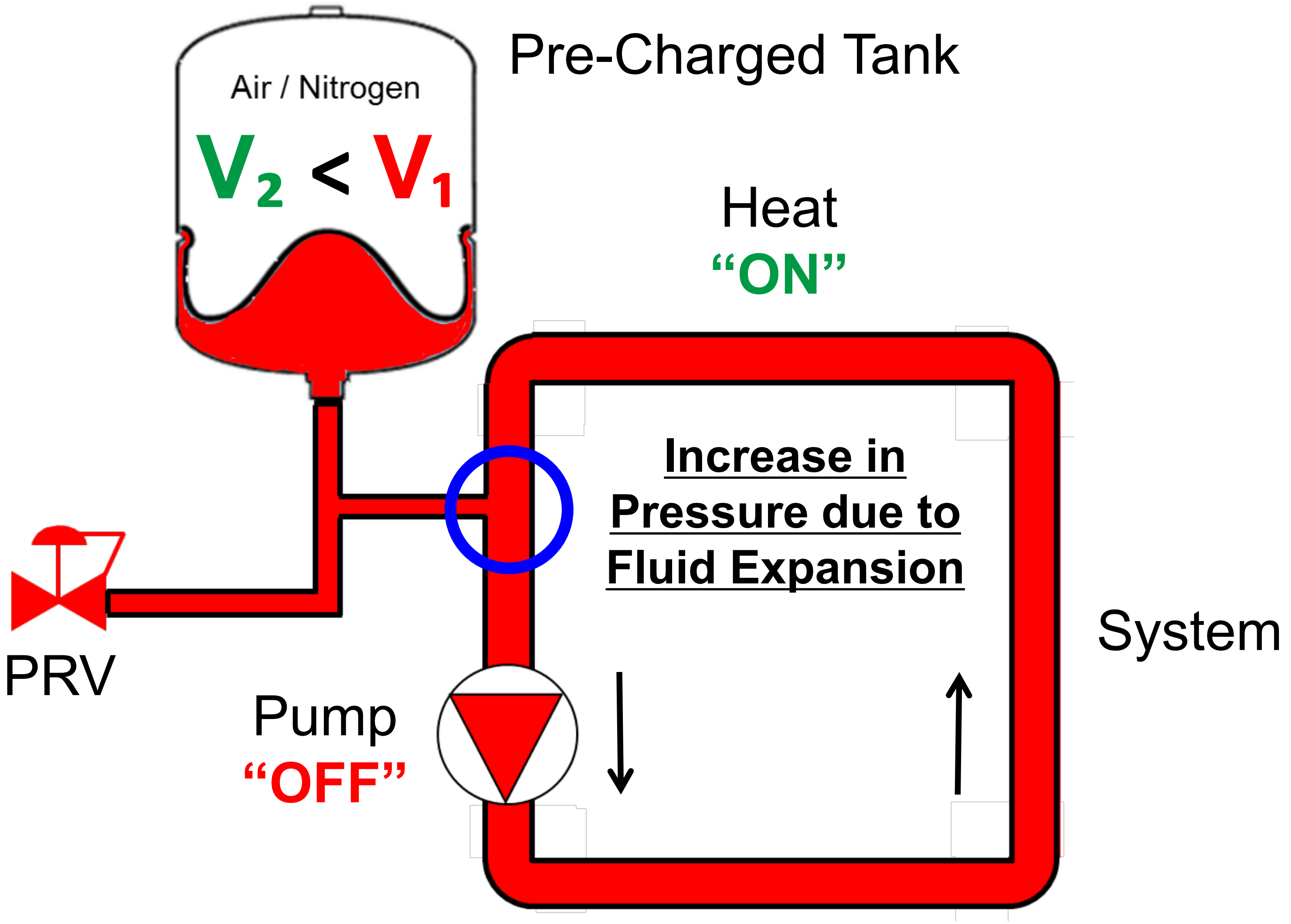
AIR CHARGE

Heat "OFF" | Heat "ON"

$$\frac{P_1V_1}{\not{T_1}} = \frac{P_2V_2}{\not{T_2}}$$

$$V_2 < V_1$$

$$P_2 > P_1$$



System at Average Design Temperature

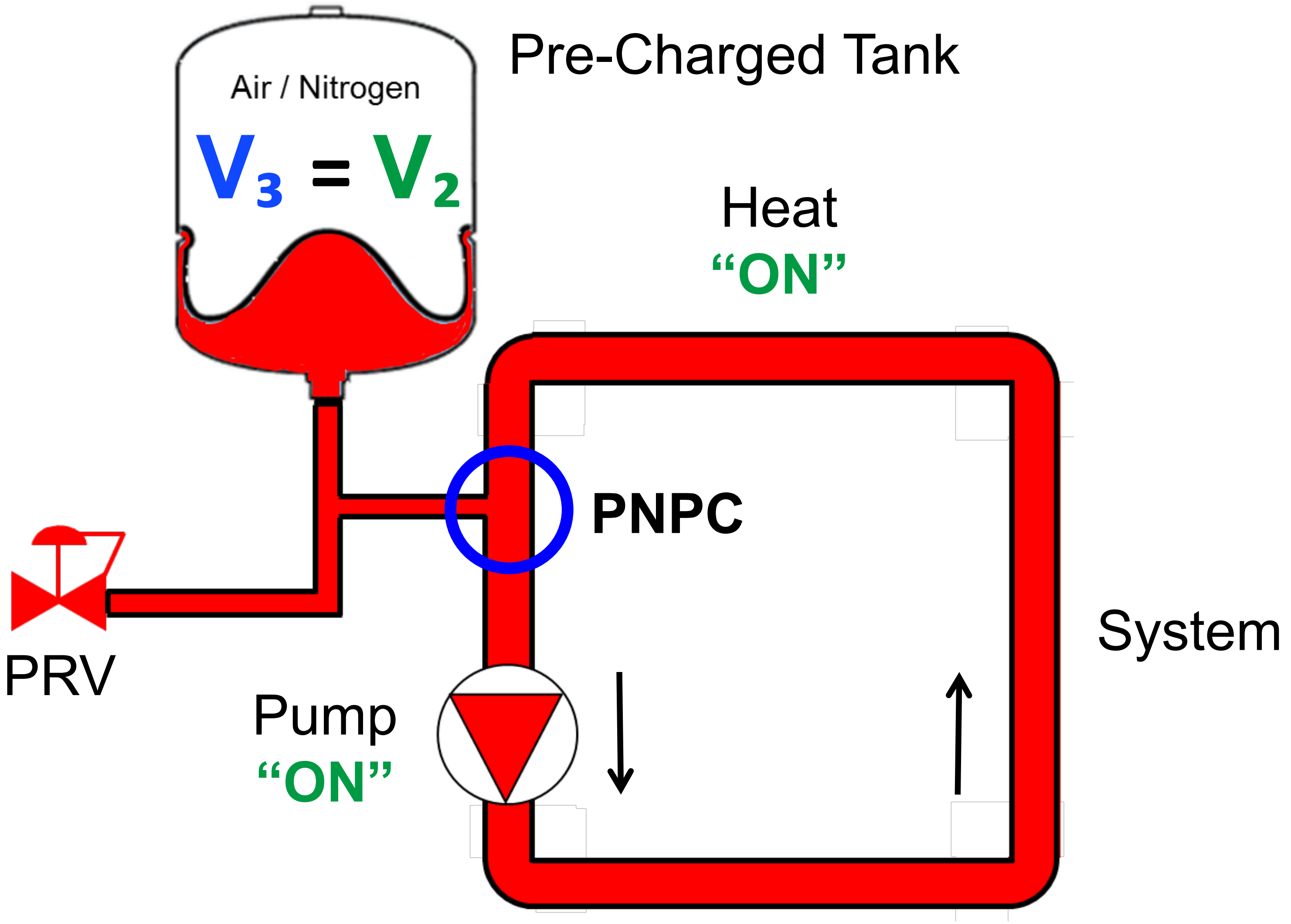
Tank Location - Point of No Pressure Change (PNPC)

AIR CHARGE

Heat "ON" | Pump "ON"

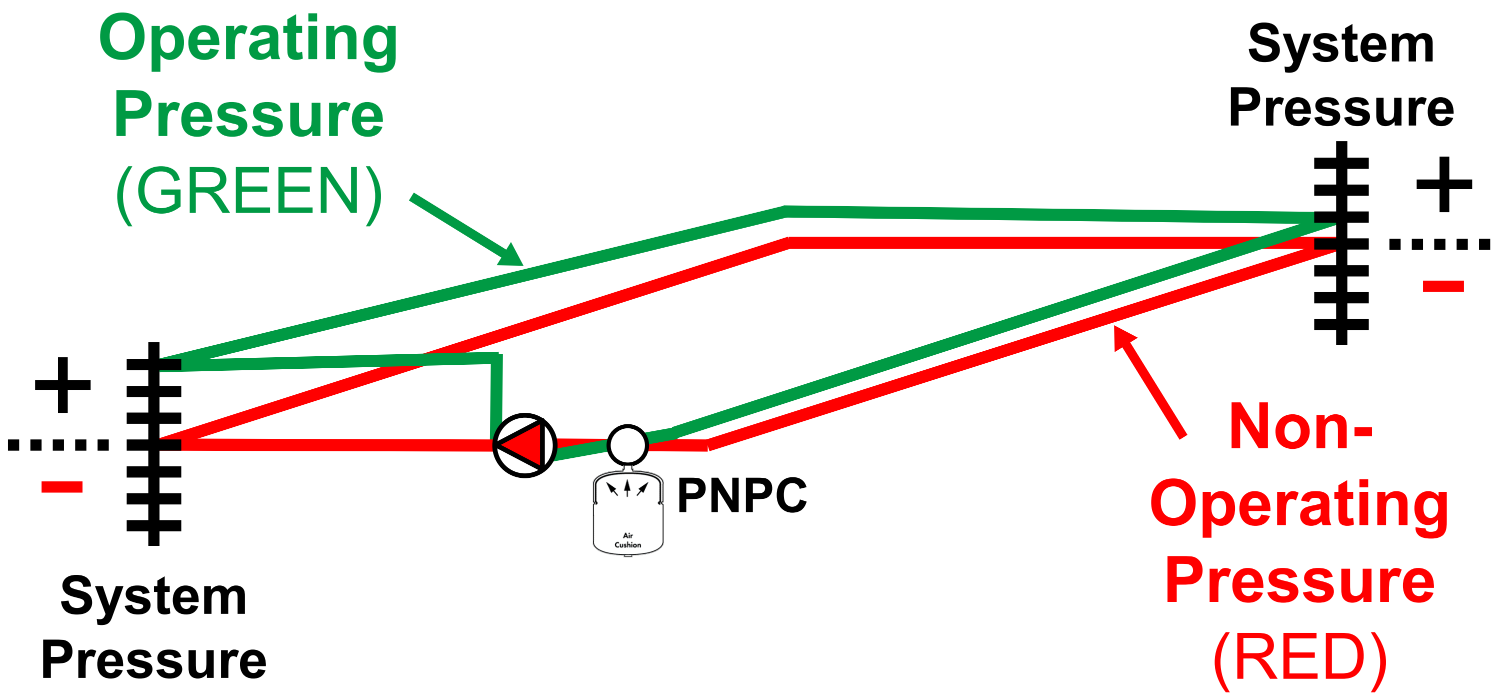
$$\frac{P_2\cancel{V_2}}{\cancel{\;\;}} = \frac{P_3\cancel{V_3}}{\cancel{T_3}}$$

$$P_2 = P_3$$



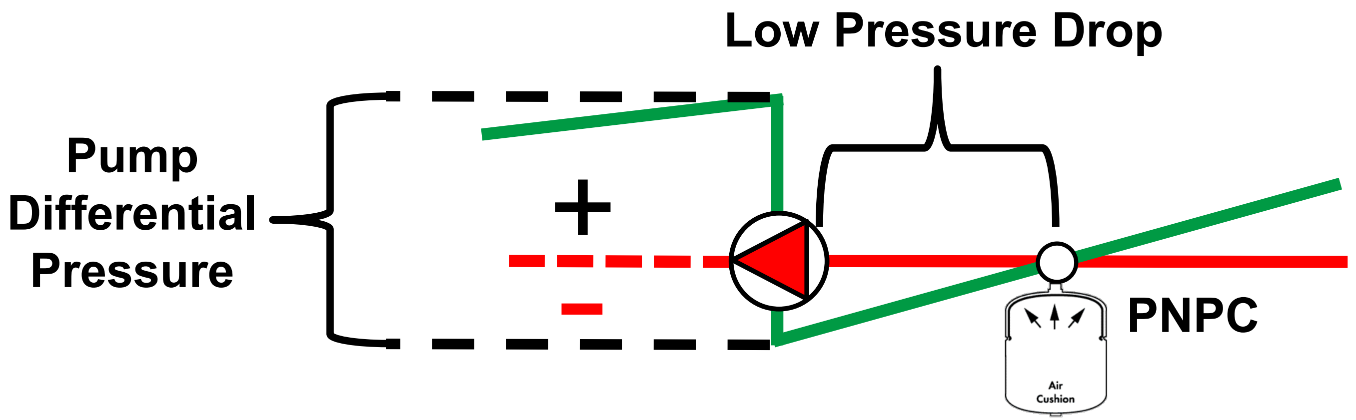
System at Average Design Temperature

Pumping Away from the Point of No Pressure Change

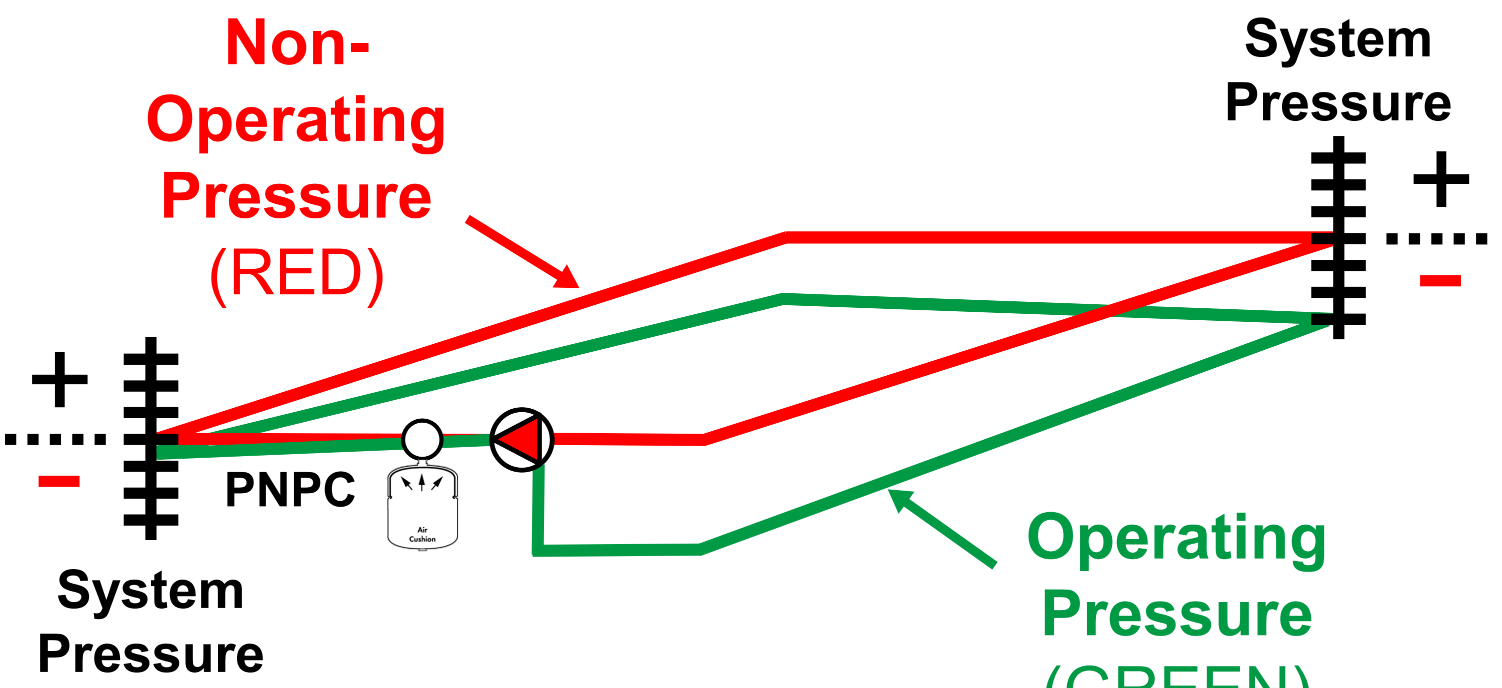


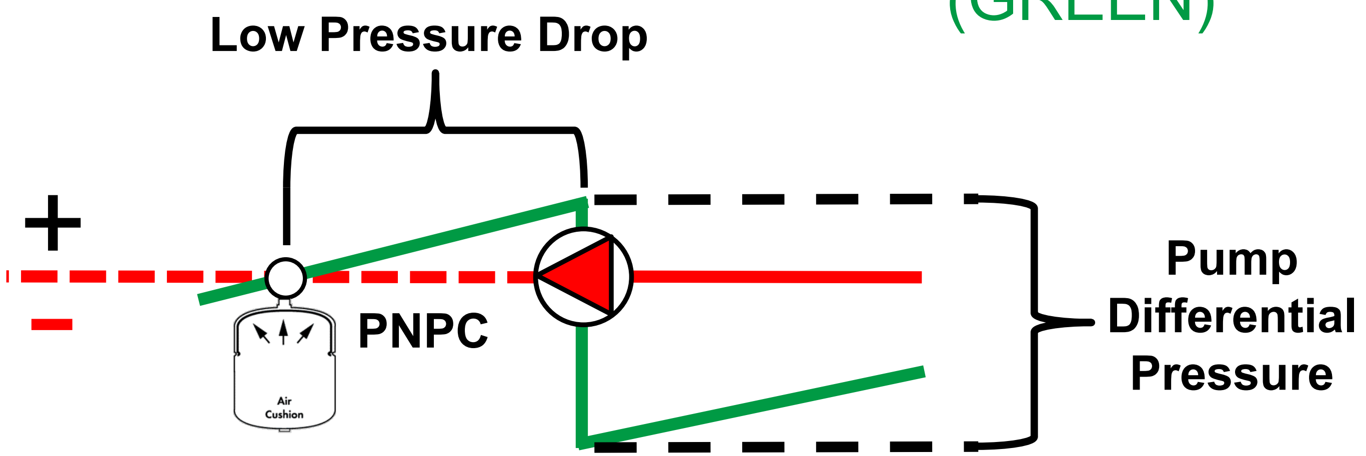
Benefits

- Proper Venting Pressure
- Prevents Air Release/Boiling
- Stable Pump Suction Pressure



Pumping **Towards** the Point of No Pressure Change





Potential Problems

- Vacuum, Vents draw air in
- Air Release/ Possible Boiling
- Addition of Make-up Water?

Sizing the Expansion Tank

What information do you need?

- What is the fluid? *(or it's Thermal Properties)*
- How much fluid will the system hold? *(The System Volume)*
- Fluid temperature at time of fill
- Fluid temperature at operating conditions
- Cold static fill pressure *(PRV connection to highest point, plus safety factor)*
- Safety Relief Valve Setting

Pre-Charged Tank Sizing Equation – Considerations for Simplification

- Isothermal *(Constant Temperature)* conditions in the tank.
- Expansion of the tank and its water can be ignored.
- Air cannot escape from the tank.
- System fills slowly.
- Ignore volume of air liberated during heating.

Pre-Charged Tank Sizing Equation

$$V_t = \frac{(E_w - E_p)}{1 - \frac{P_f}{P_o}} V_s$$

V_t = Tank Volume (gallons)

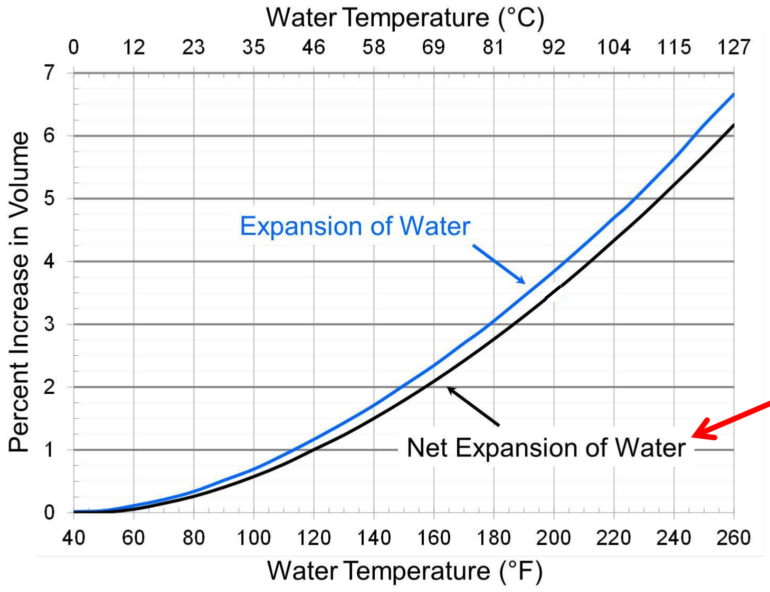
V_s = Volume of System (gallons)

$(E_w - E_P)$ = Net Water Expansion Factor

P_f = Design Tank Fill Pressure (psia)*

P_o = Final Tank Operating Pressure (psia)*

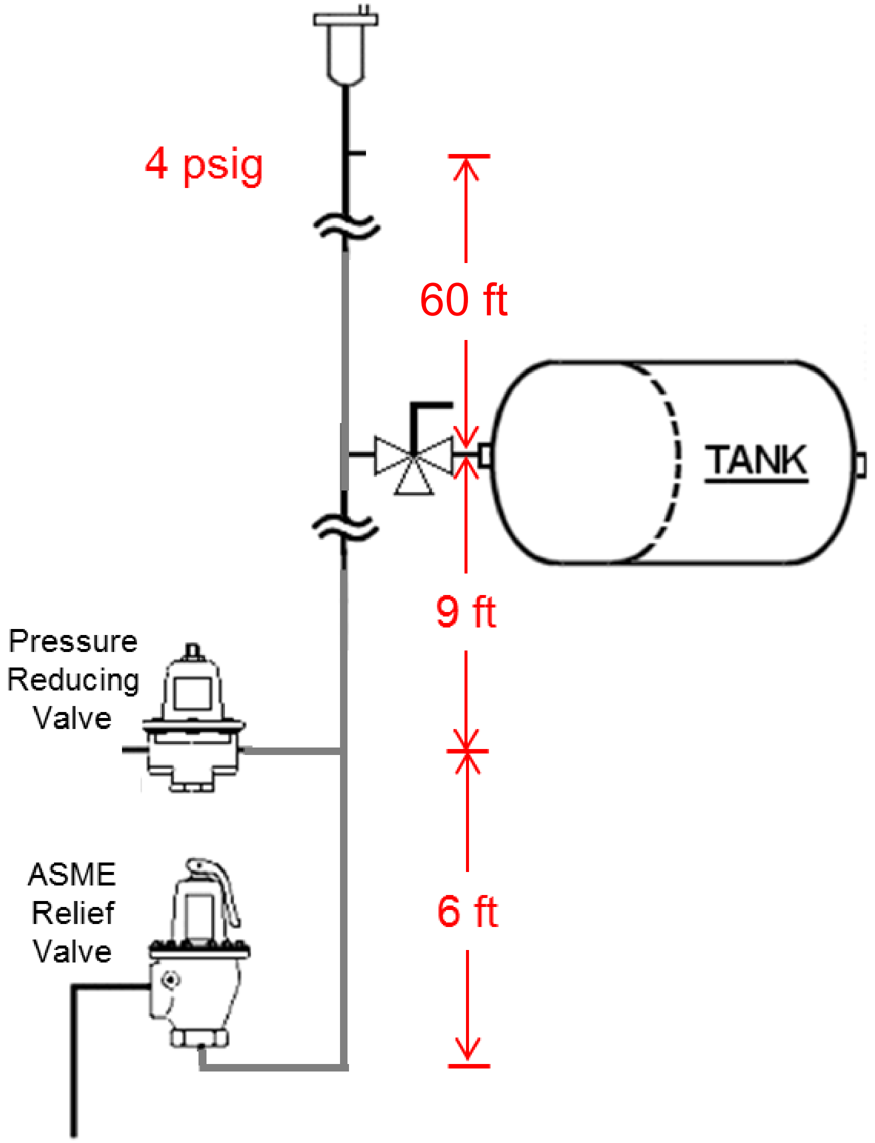
* Absolute pressure



$(E_w - E_p)$

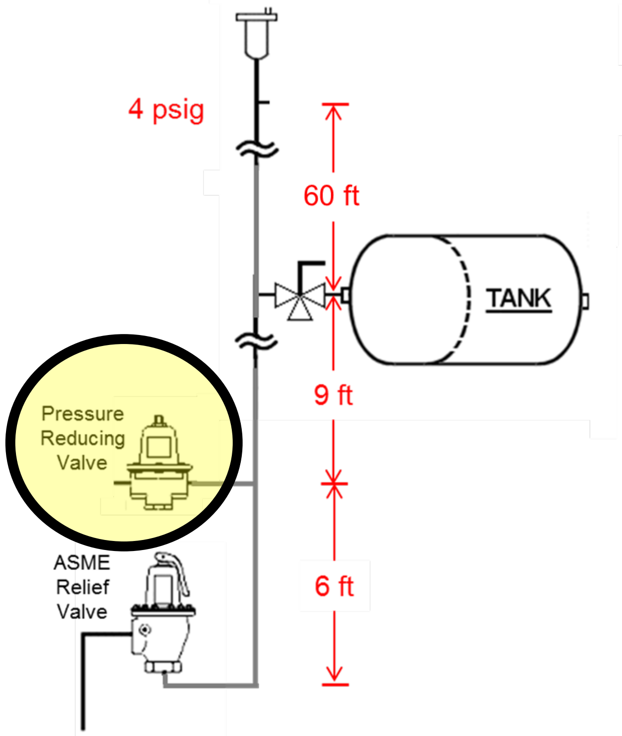
Bell & Gossett
a xylem brand

Example Problem



Water Only System (40°F)
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

Step 1: Required PRV Setting



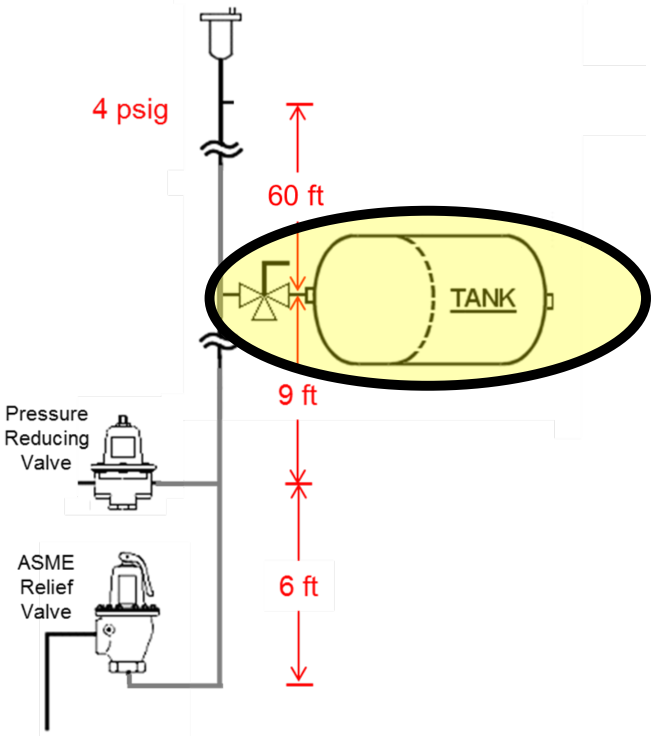
Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

Static Head at PRV: 69 ft ÷ 2.31 ft/psi = 30.0 psi

Pressurization at Top of System: 4.0 psi

Pressure Reducing Valve Setting: 34.0 psi

Step 2: Required Design Tank Fill Pressure: *The "Pre-Charge"*



Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

Static Head at Tank: 60 ft ÷ 2.31 ft/psi = 26.0 psi

Pressurization at Top of System: 4.0 psi

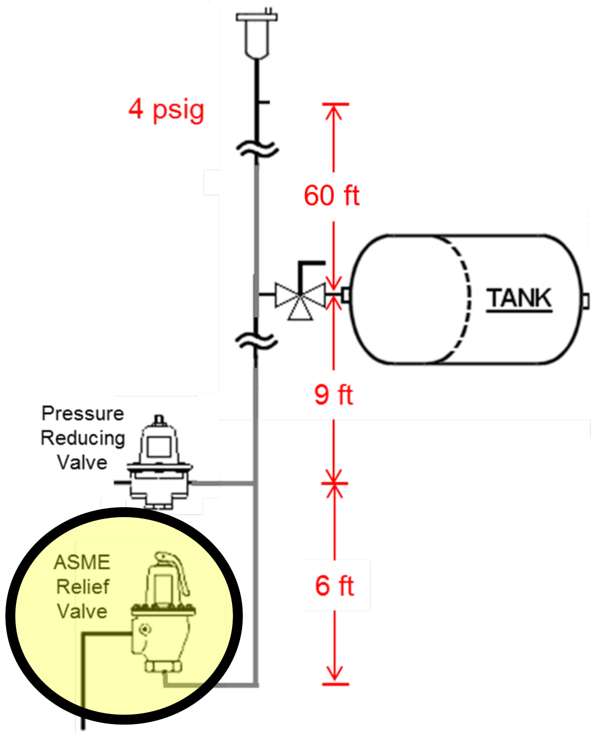
Design Tank Fill Pressure: 30.0 psi

Pre-charge Tank to 30.0 PSI

Prior to Installation

No Liquid in the Tank

Step 3: Final Tank Operating Pressure



Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

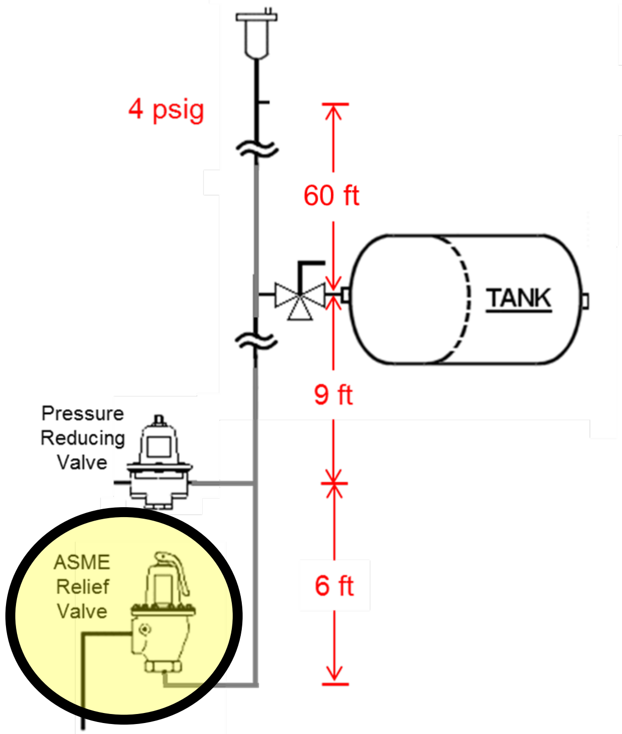
Static Head above ASME Relief Valve: 75 ft ÷ 2.31 ft/psi = 32.5 psi

System Top Pressurization: 4.0 psi

Initial Total Back-Pressure at ASME Relief Valve: 36.5 psi

Bell & Gossett a xylem brand

Step 3: Final Tank Operating Pressure



Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

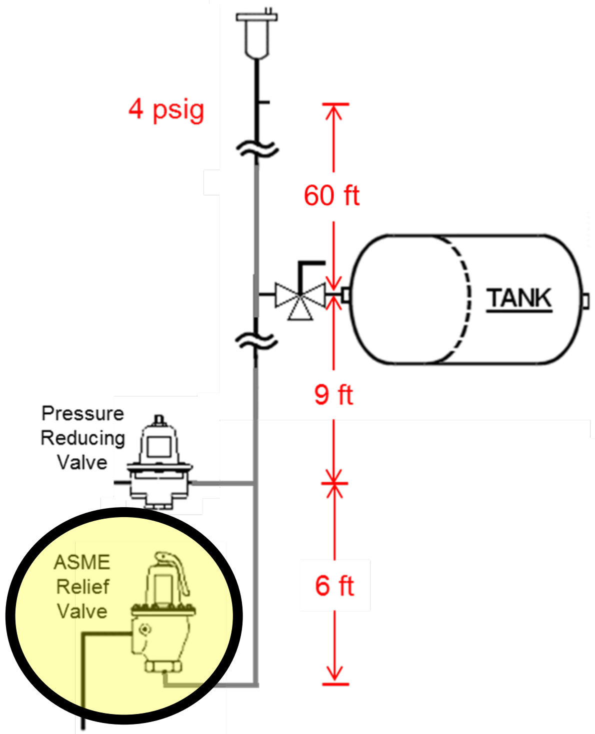
Static Head above ASME Relief Valve: 75 ft ÷ 2.31 ft/psi = 32.5 psi

System Top Pressurization: 4.0 psi

Initial Total Back-Pressure at ASME Relief Valve: 36.5 psi

Derate ASME Relief Valve Rating **(10% or 5 psig minimum):** 45.0 psi

Step 3: Final Tank Operating Pressure



Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

Static Head above ASME Relief Valve: 75 ft ÷ 2.31 ft/psi = 32.5 psi

System Top Pressurization: 4.0 psi

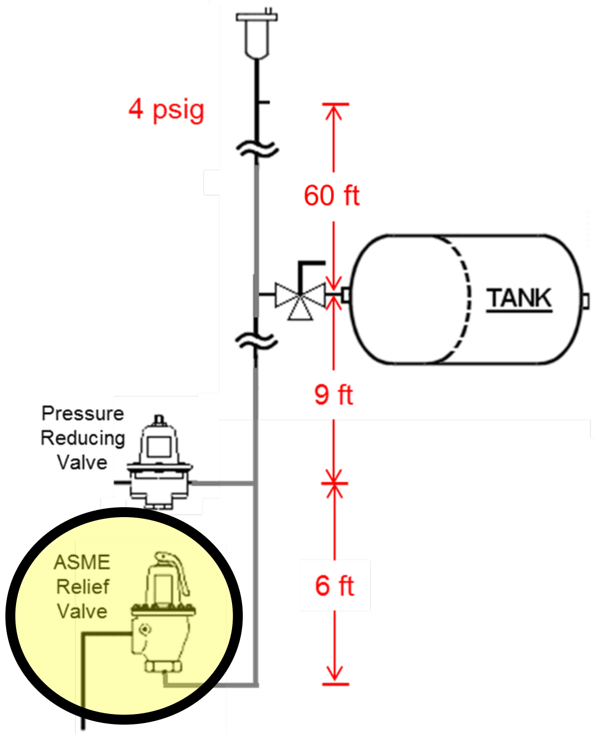
Initial Total Back-Pressure at ASME Relief Valve: 36.5 psi

Derate ASME Relief Valve Rating **(10% or 5 psig minimum):** 45.0 psi

Maximum Pressure Increase at ASME Relief Valve:

45.0 psi – 36.5 psi = 8.5 psi

Step 3: Final Tank Operating Pressure



Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

Static Head above ASME Relief Valve: 75 ft ÷ 2.31 ft/psi = 32.5 psi

System Top Pressurization: 4.0 psi

Initial Total Back-Pressure at ASME Relief Valve: 36.5 psi

Derate ASME Relief Valve Rating **(10% or 5 psig minimum):** 45.0 psi

Maximum Pressure Increase at ASME Relief Valve:

45.0 psi – 36.5 psi = 8.5 psi

Final Tank Operating Pressure *(@ System Design Temperature):*

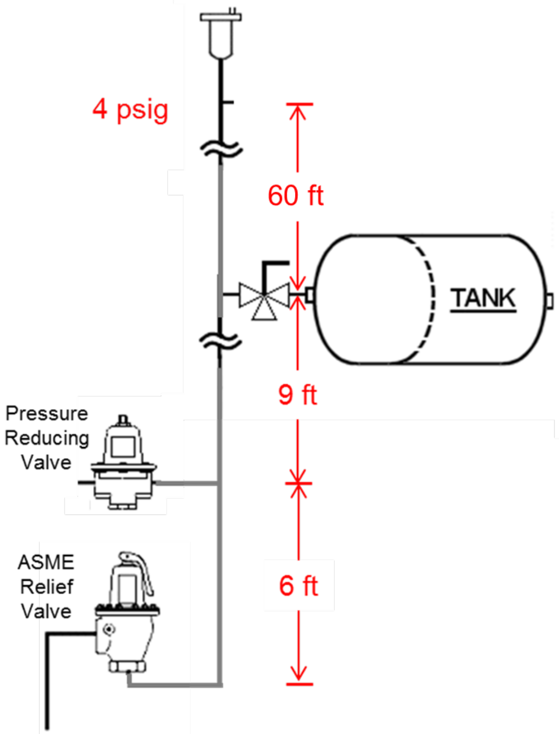
Design Tank Fill Pressure + Maximum Pressure Increase

30.0 psi + 8.5 psi = **38.5 psi**

Bell & Gossett
a xylem brand

Step 4: Acceptance Factor

$$V_t = \frac{(E_w - E_p)}{1 - \frac{P_f}{P_o}} V_s$$



Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

Pf = Design Tank Fill Pressure = 14.7 + (4 + 26.0) = 44.7 psia

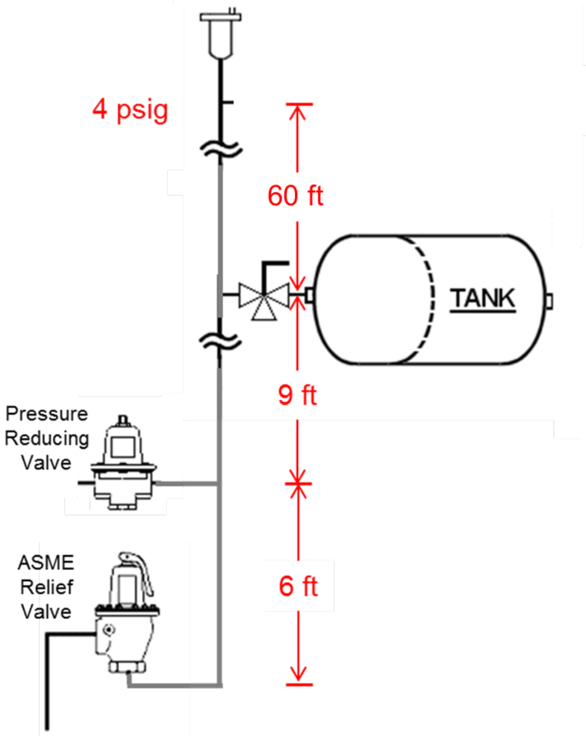
Po = Final Tank Operating Pressure = 14.7 + (4 + 26.0 + 8.5) = 53.2 psia

(At System Operating Temperature)

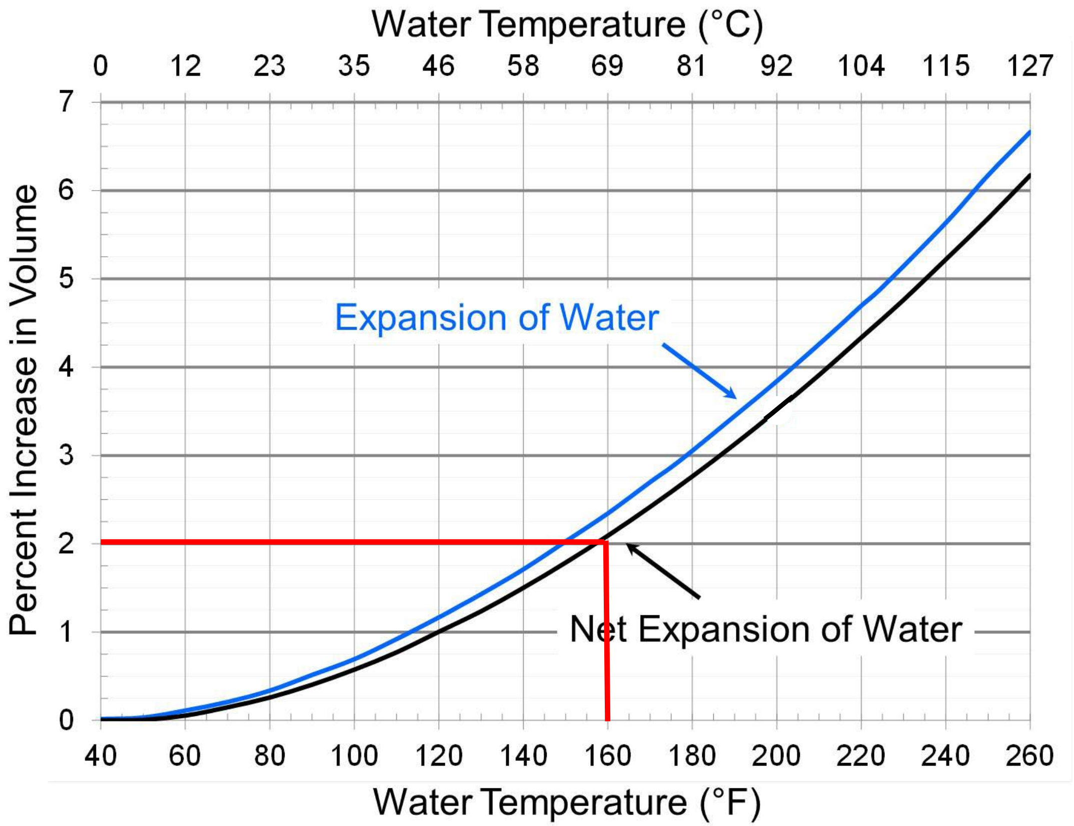
Acceptance Factor = 1 – (Pf ÷ Po)

Acceptance Factor = 1 – (44.7 ÷ 53.2) = **0.160**

Step 5: Net Water Expansion Volume (Acceptance Volume)



Water Only System (40°F)
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler



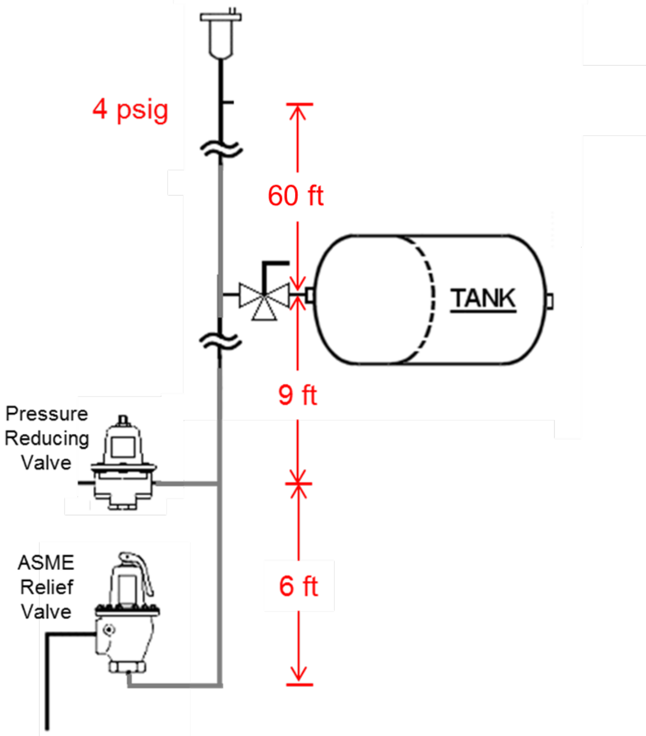
Net Water Expansion Factor: $(E_w - E_p)$ is 0.020

Net Water Expansion Volume $(E_w - E_p)$ Vs:

= (0.020)*(2,600 gal) = **52.0 Gallons**

Bell & Gossett
a xylem brand

Step 6: Required Tank Volume Size



Water Only System
2,600 Gallons System Volume
160°F Design Operating Temperature
30°F ΔT across the Boiler *(System)*
4 psig Pressurization at Top of System
50 psig ASME Safety Relief Valve on Boiler

$$V_t = \frac{(E_w - E_p)}{1 - \frac{P_f}{P_o}} V_s$$

Vt = (Net Water Expansion Volume) ÷ (Acceptance Factor)

Vt = 52.0 gal ÷ 0.160 = **325.0 gallons**

Step 7a: Select Tank: “B” Series Full Acceptance Bladder

Minimum Tank Acceptance Volume ≥ 52.0 gallons

Minimum Tank Volume ≥ 325.0 gallons

CONSTRUCTION

System Connection: Forged Steel

Shell: Carbon Steel

Bladder: Heavy Duty Butyl Rubber

Designed and Constructed per ASME Section VIII, Division 1

MAXIMUM OPERATING LIMITS

Maximum Design Pressure: 125 PSI (862 kPa)

Design Temperature: 240°F (115°C)

MODEL NUMBER	PART NUMBER				TANK AND ACCEPTANCE VOLUME GAL (L)	TAGGING INFORMATION	QUANTITY
	PRESSURIZED EXPANSION TANKS	WITH SIGHT GLASS	WITH SEISMIC RESTRAINTS	WITH SIGHT GLASS & SEISMIC RESTRAINTS			
B200	116051	116070	116089	116108	53 (200)		
B300	116052	116071	116090	116109	80 (300)		
B400	116053	116072	116091	116110	106 (400)		
B500	116054	116073	116092	116111	132 (500)		
B600	116055	116074	116093	116112	158 (600)		
B800	116056	116075	116094	116113	211 (800)		
B1000	116057	116076	116095	116114	264 (1,000)		
B1200	116058	116077	116096	116115	317 (1,200)		
B1400	116059	116078	116097	116116	370 (1,400)		1

Step 7b: Select Tank: “D” Series Limited Acceptance Diaphragm

Minimum Tank Acceptance Volume ≥ 52.0 gallons

Minimum Tank Volume ≥ 325.0 gallons

CONSTRUCTION

System Connection: Forged Steel
Shell: Carbon Steel
Diaphragm: Heavy Duty Butyl Rubber
Designed and Constructed per ASME Section VIII, Division 1

MAXIMUM OPERATING LIMITS

Maximum Design Pressure: 125 PSI (862 kPa)
Design Temperature: 240°F (115°C)

Model No.	Part Numbers				Volume gal (L)		Tagging Information	Quantity
	PRESSURIZED EXPANSION TANKS	WITH SIGHT GLASS	WITH SEISMIC RESTRAINTS	WITH SIGHT GLASS & SEISMIC RESTRAINTS	Tank	Acceptance		
D-15	116298	116311	116324	116337	7.8 (30)	6.3 (24)		
D-20	116299	116312	116325	116338	11 (42)	8.8 (33)		
D-40	116300	116313	116326	116339	25 (95)	20.2 (76)		
D-60	116301	116314	116327	116340	35 (132)	28 (106)		
D-80	116302	116315	116328	116341	45 (170)	36 (136)		
D-100	116303	116316	116329	116342	60 (227)	48.5 (184)		
D-120	116304	116317	116330	116343	70 (265)	56.5 (214)		
D-144	116305	116318	116331	116344	80 (303)	65 (246)		
D-180	116306	116319	116332	116345	90 (341)	73 (276)		
D-200	116307	116320	116333	116346	115 (435)	93 (352)		
D-240	116308	116321	116334	116347	140 (530)	113.5 (430)		
D-260	116309	116322	116335	116348	158 (598)	128 (485)		
D-280	116310	116323	116336	116349	211 (799)	171 (647)		2

Step 7b: Select Tank: “D” Series Limited Acceptance Diaphragm

Minimum Tank Acceptance Volume ≥ 52.0 gallons

Minimum Tank Volume ≥ 325.0 gallons

CONSTRUCTION
System Connection: Forged Steel
Shell: Carbon Steel
Diaphragm: Heavy Duty Butyl Rubber
Designed and Constructed per ASME Section VIII, Division 1

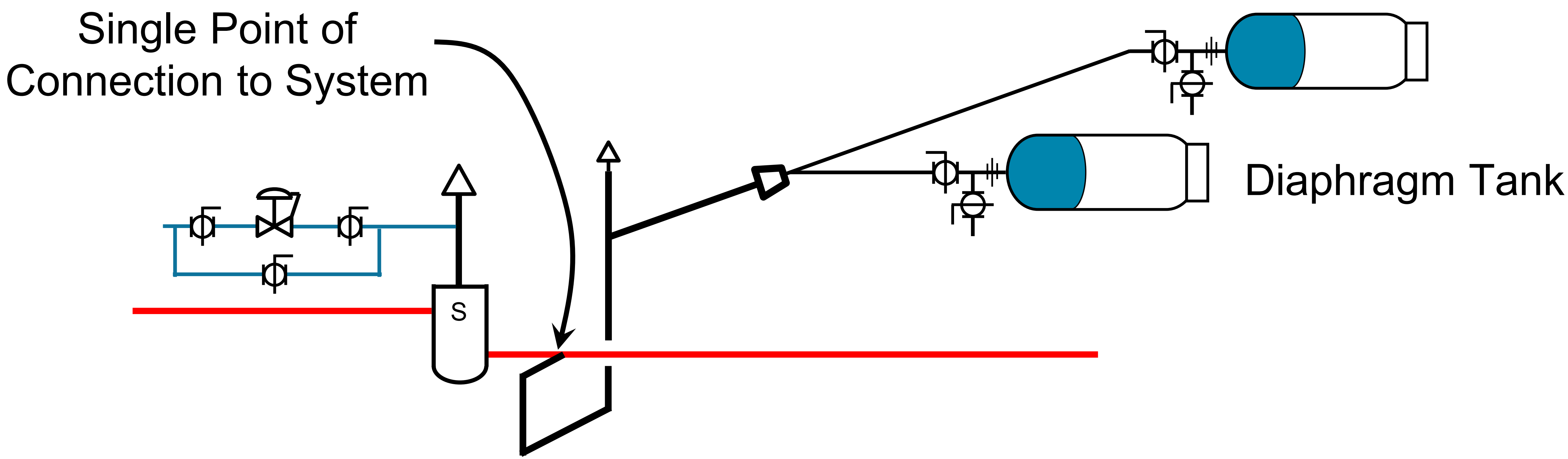
MAXIMUM OPERATING LIMITS
Maximum Design Pressure: 125 PSI (862 kPa)
Design Temperature: 240°F (115°C)

Model No.	Part Numbers				Volume gal (L)		Tagging Information	Quantity
	PRESSURIZED EXPANSION TANKS	WITH SIGHT GLASS	WITH SEISMIC RESTRAINTS	WITH SIGHT GLASS & SEISMIC RESTRAINTS	Tank	Acceptance		
D-15	116298	116311	116324	116337	7.8 (30)	6.3 (24)		
D-20	116299	116312	116325	116338	11 (42)	8.8 (33)		
D-40	116300	116313	116326	116339	25 (95)	20.2 (76)		
D-60	116301	116314	116327	116340	35 (132)	28 (106)		
D-80	116302	116315	116328	116341	45 (170)	36 (136)		
D-100	116303	116316	116329	116342	60 (227)	48.5 (184)		
D-120	116304	116317	116330	116343	70 (265)	56.5 (214)		
D-144	116305	116318	116331	116344	80 (303)	65 (246)		
D-180	116306	116319	116332	116345	90 (341)	73 (276)		
D-200	116307	116320	116333	116346	115 (435)	93 (352)		1
D-240	116308	116321	116334	116347	140 (530)	113.5 (430)		
D-260	116309	116322	116335	116348	158 (598)	128 (485)		
D-280	116310	116323	116336	116349	211 (799)	171 (647)		1

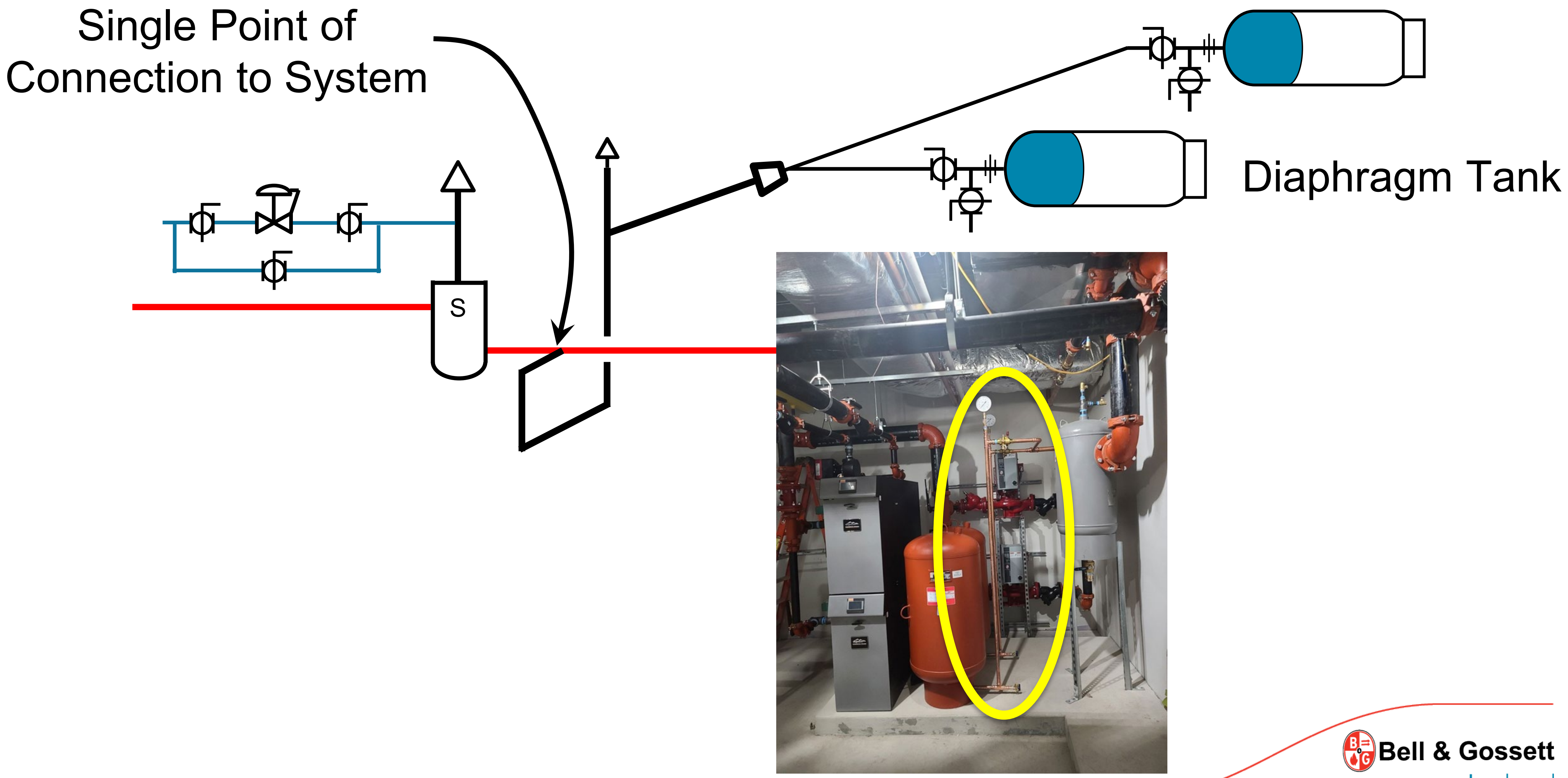
Different Size Tanks?

115 + 211 = 326 gal

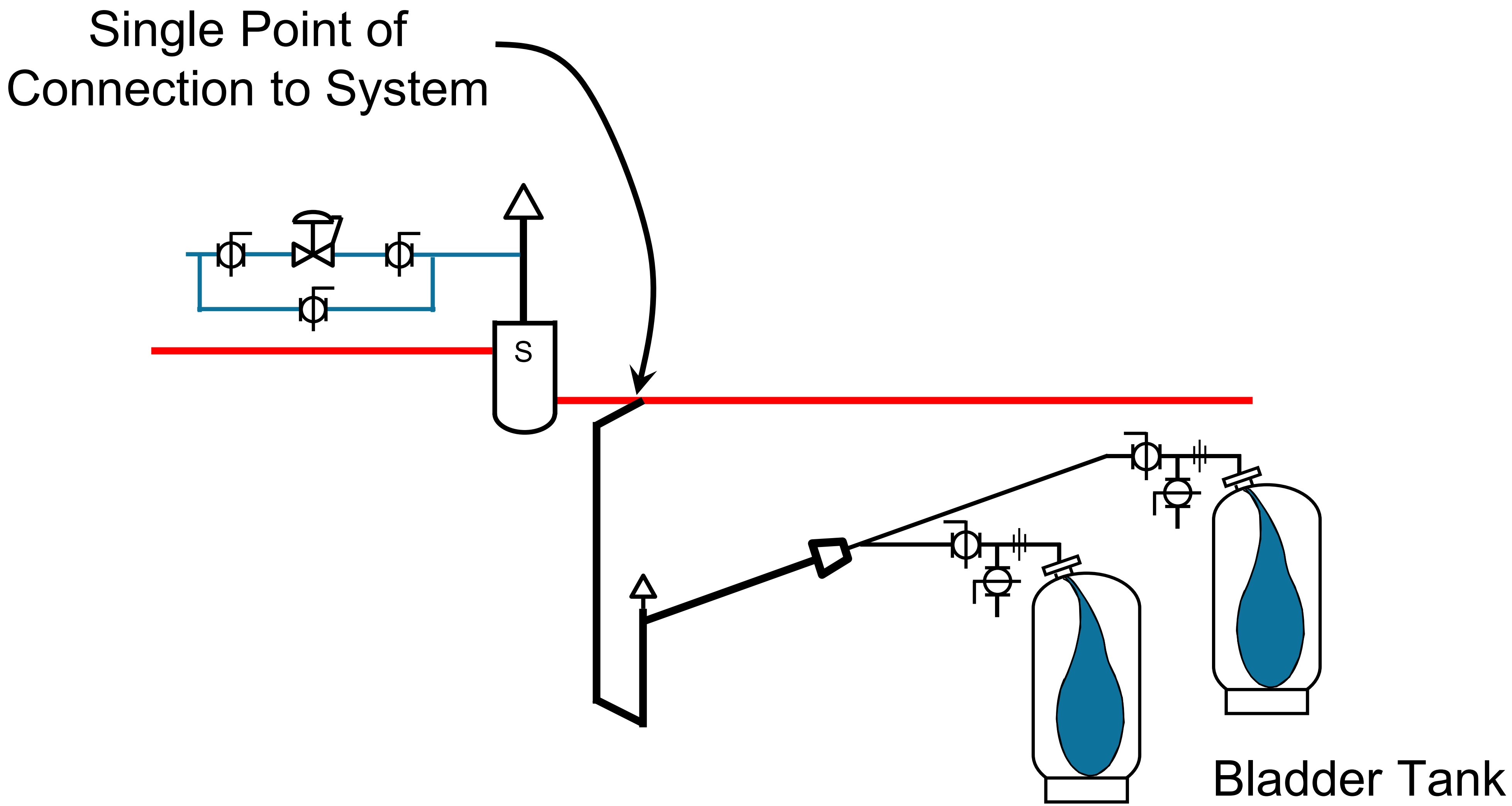
Multiple Diaphragm or Bladder Pre-Charged Tanks - Piping



Multiple Diaphragm or Bladder Pre-Charged Tanks - Piping

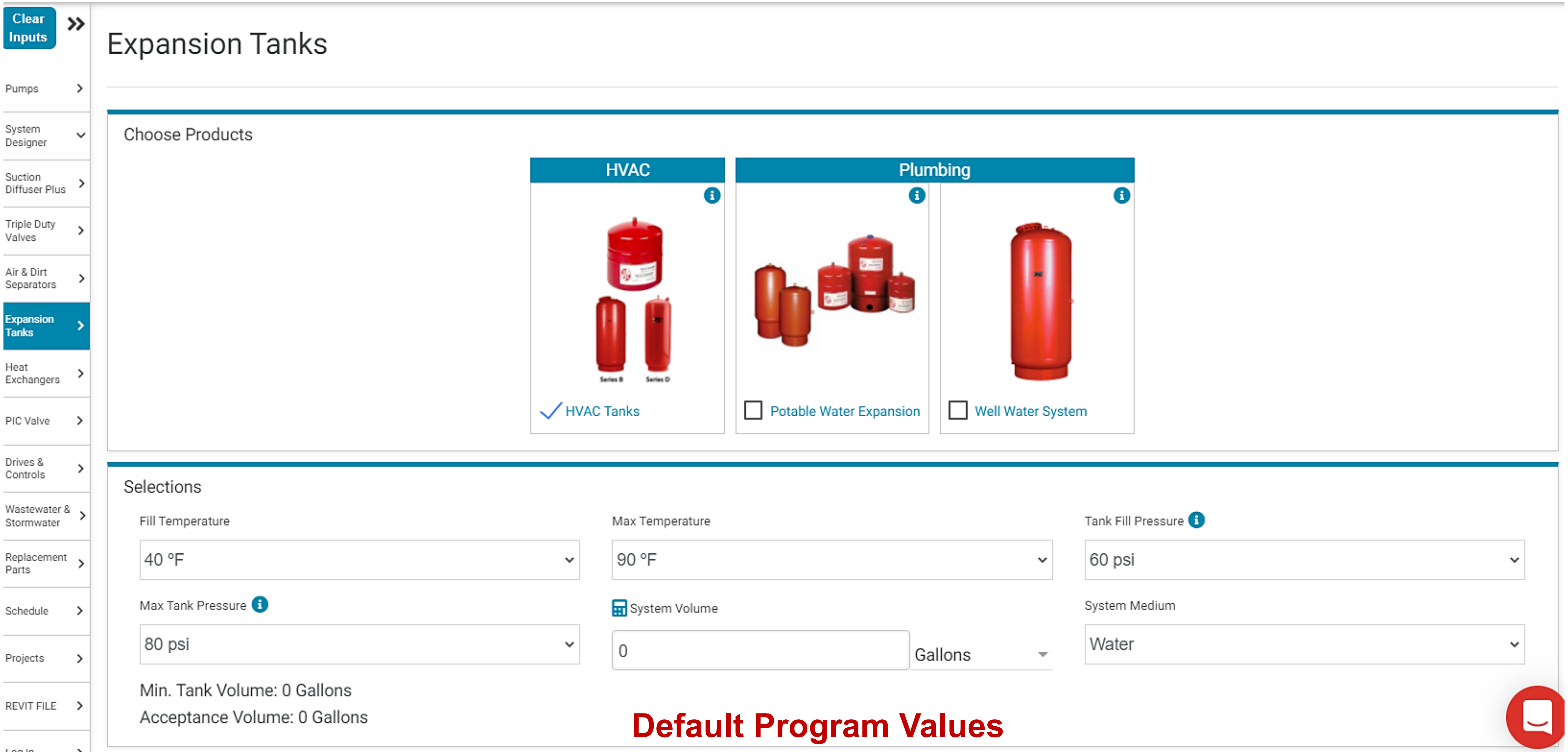


Multiple Diaphragm or Bladder Pre-Charged Tanks - Piping



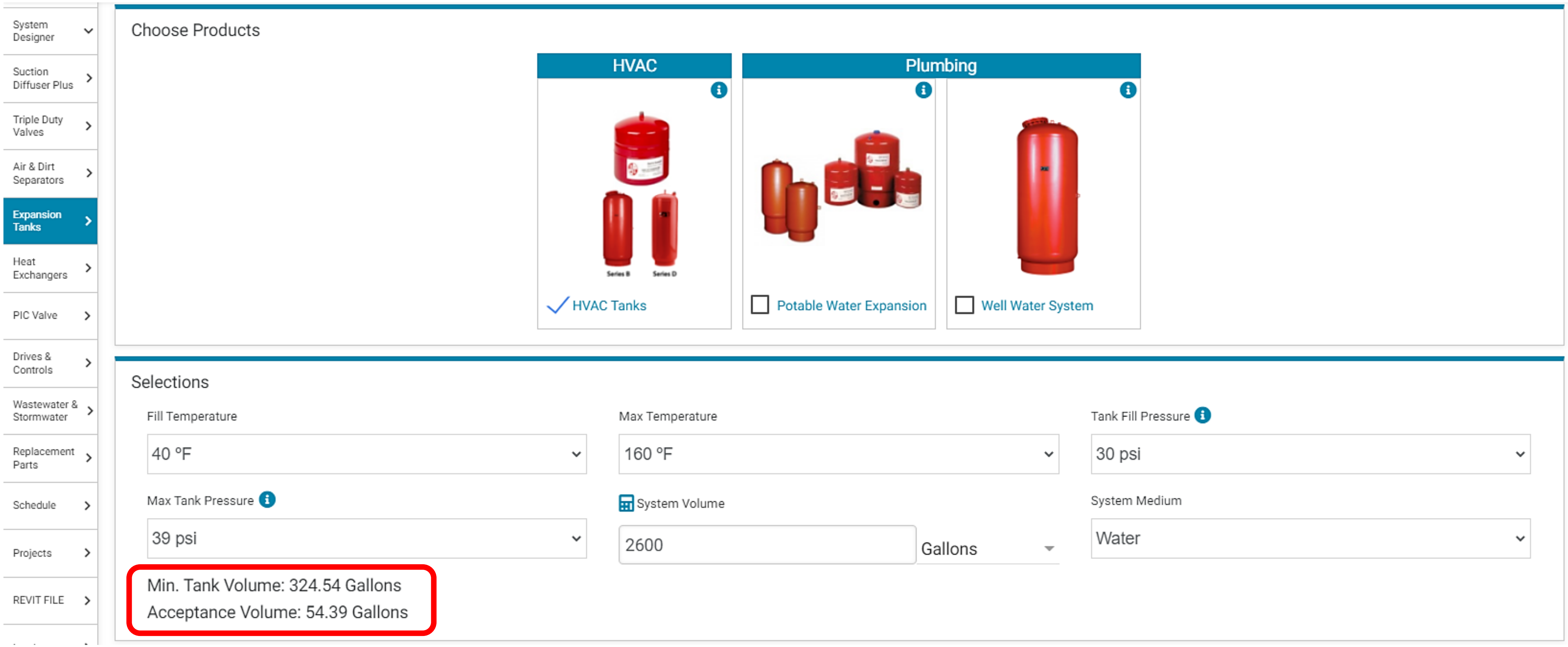
Bell & Gossett
a xylem brand

The “Easy Way” – ESP Systemwize



Bell & Gossett
a xylem brand

The “Easy Way” – ESP Systemwize

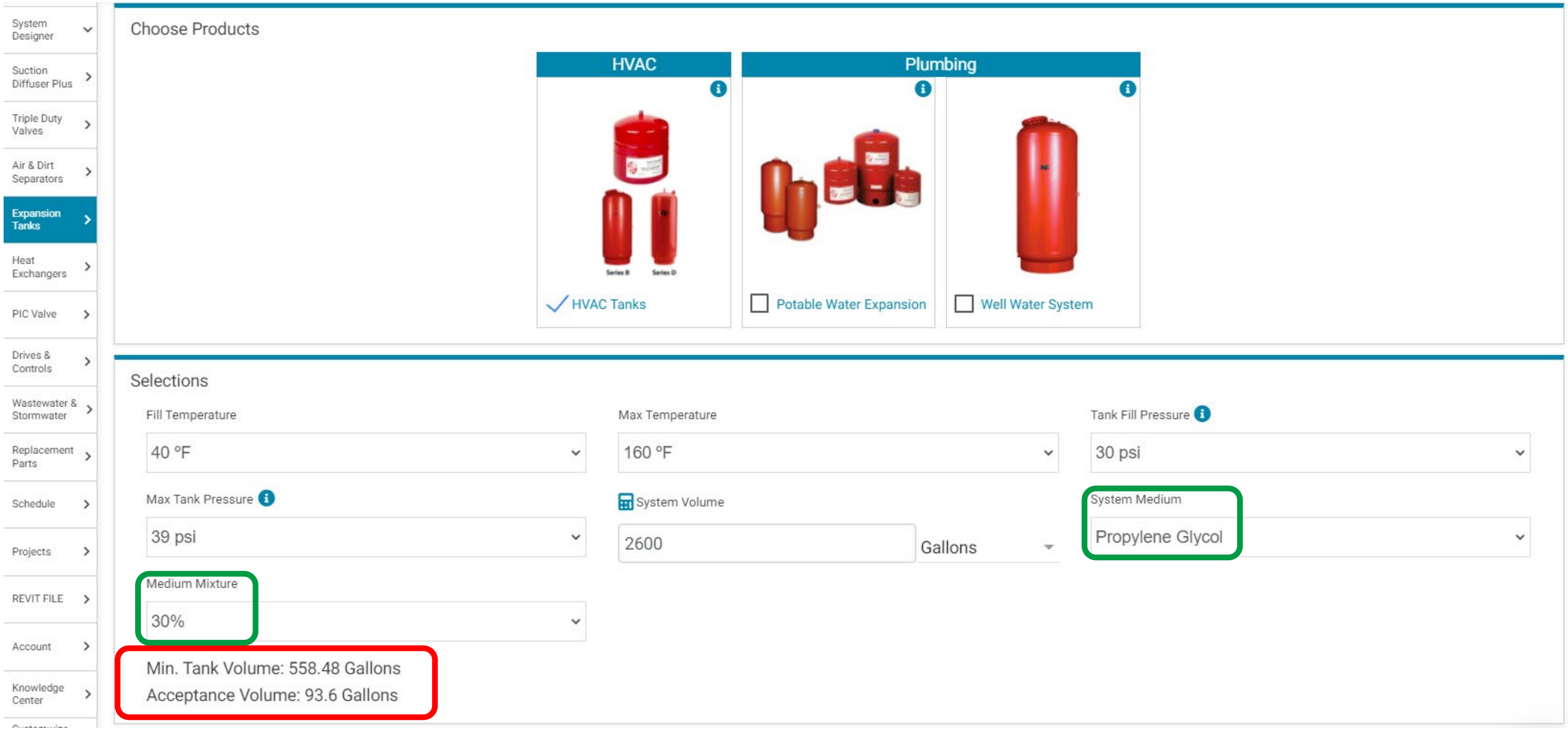


Bell & Gossett
a xylem brand

The "Easy Way" – ESP Systemwize

Required Tank Volume (gal)	Required Acceptance Volume (gal)	Recommended Models	Qty	Actual Tank Volume (gal)	Actual Acceptance Volume (gal)	Price Index	Orientation	Type	ASME Rated	Max Design Temperature F (C)	Max Working Pressure PSIG (kPa)	Shipping Weight (lbs)	Actions
324.54	54.39	B1400	1	370.0	370.0	---	Horizontal/Vertical	Bladder	Yes	240.0 (116)	125.0 (862)	950.0	Select Documents Note
324.54	54.39	D280	2	211.0	84.0	---	Horizontal/Vertical	Diaphragm	Yes	240.0 (116)	125.0 (862)	827.0	Select Documents Note
324.54	54.39	B800	2	211.0	211.0	---	Horizontal/Vertical	Bladder	Yes	240.0 (116)	125.0 (862)	475.0	Select Documents Note
324.54	54.39	D200	3	110.0	34.0	---	Horizontal/Vertical	Diaphragm	Yes	240.0 (116)	125.0 (862)	400.0	Select Documents Note
324.54	54.39	B500	3	132.0	132.0	---	Horizontal/Vertical	Bladder	Yes	240.0 (116)	125.0 (862)	410.0	Select Documents Note

What if System Fluid is changed to 30% Propylene Glycol?

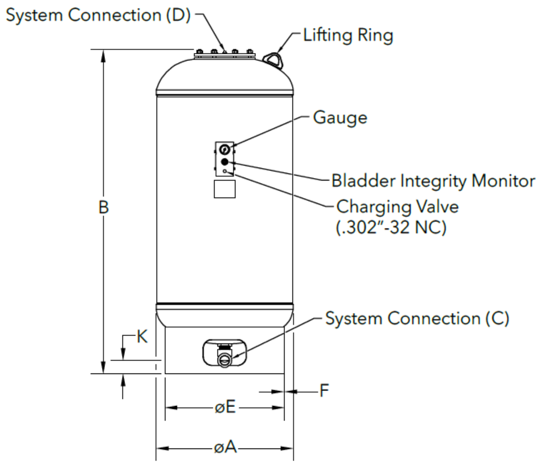


Bell & Gossett
a xylem brand

What if System Fluid is changed to 30% Propylene Glycol?

Required Tank Volume (gal)	Required Acceptance Volume (gal)	Recommended Models	Qty	Actual Tank Volume (gal)	Actual Acceptance Volume (gal)	Price Index	Orientation	Type	ASME Rated	Max Design Temperature F (C)	Max Working Pressure PSIG (kPa)	Shipping Weight (lbs)	Actions
558.48	93.6	B2500	1	660.0	660.0	---	Horizontal/Vertical	Bladder	Yes	240.0 (116)	125.0 (862)	1510.0	Select Documents Note
558.48	93.6	B1200	2	317.0	317.0	---	Horizontal/Vertical	Bladder	Yes	240.0 (116)	125.0 (862)	795.0	Select Documents Note
558.48	93.6	D280	3	211.0	84.0	---	Horizontal/Vertical	Diaphragm	Yes	240.0 (116)	125.0 (862)	827.0	Select Documents Note
558.48	93.6	B800	3	211.0	211.0	---	Horizontal/Vertical	Bladder	Yes	240.0 (116)	125.0 (862)	475.0	Select Documents Note

SERIES "B" (ASME) PRESSURIZED EXPANSION TANKS



Will the single tank fit through the doorway??

How much heavier is it??

Bell & Gossett
a xylem brand

Is a Single Tank still an option?

DIMENSIONS AND WEIGHTS

Model	A in (mm)	B in (mm)	C FNPT (in)	D (in)	E in (mm)	F in (mm)	G in (mm)	H in (mm)	I in (mm)	J in (mm)	K in (mm)	Shipping Wt. lbs (kg)	Flooded Wt.* lbs (kg)
B-200	24 (610)	43 (1,092)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	210 (95)	651 (295)
B-300	24 (610)	55 (1,397)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	225 (102)	891 (404)
B-400	30 (762)	49 (1,245)	1-1/2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	300 (136)	1,183 (537)
B-500	30 (762)	57 (1,448)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	335 (152)	1,435 (651)
B-600	30 (762)	65 (1,651)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	360 (163)	1,676 (760)
B-800	32 (813)	76 (1,930)	2	3/4	28 (711)	0.14 (4)	9/16 (14)	31 (787)	3 (76)	3 (76)	5.25 (133)	475 (215)	2,233 (1,013)
B-1000	36 (914)	76 (1,930)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	552 (250)	2,751 (1,248)
B-1200	36 (914)	88 (2,235)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	679 (308)	3,320 (1,506)
B-1400	36 (914)	100 (2,540)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	688 (312)	3,770 (1,710)
B-1600	48 (1,219)	74 (1,880)	1-1/2	3/4	42 (1,067)	0.14 (4)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,046 (474)	4,561 (2,068)
B-2000	48 (1,219)	86 (2,184)	1-1/2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,150 (522)	5,548 (2,516)
B-2500	48 (1,219)	104 (2,642)	2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	46 (1,168)	4 (102)	4 (102)	N/A	1,444 (655)	6,942 (3,148)

Is a Single Tank still an option?

DIMENSIONS AND WEIGHTS

Model	A in (mm)	B in (mm)	C FNPT (in)	D (in)	E in (mm)	F in (mm)	G in (mm)	H in (mm)	I in (mm)	J in (mm)	K in (mm)	Shipping Wt. lbs (kg)	Flooded Wt.* lbs (kg)
B-200	24 (610)	43 (1,092)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	210 (95)	651 (295)
B-300	24 (610)	55 (1,397)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	225 (102)	891 (404)
B-400	30 (762)	49 (1,245)	1-1/2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	300 (136)	1,183 (537)
B-500	30 (762)	57 (1,448)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	335 (152)	1,435 (651)
B-600	30 (762)	65 (1,651)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	360 (163)	1,676 (760)
B-800	32 (813)	76 (1,930)	2	3/4	28 (711)	0.14 (4)	9/16 (14)	31 (787)	3 (76)	3 (76)	5.25 (133)	475 (215)	2,233 (1,013)
B-1000	36 (914)	76 (1,930)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	552 (250)	2,751 (1,248)
B-1200	36 (914)	88 (2,235)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	679 (308)	3,320 (1,506)
B-1400	36 (914)	100 (2,540)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	688 (312)	3,770 (1,710)
B-1600	48 (1,219)	74 (1,880)	1-1/2	3/4	42 (1,067)	0.14 (4)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,046 (474)	4,561 (2,068)
B-2000	48 (1,219)	86 (2,184)	1-1/2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,150 (522)	5,548 (2,516)
B-2500	48 (1,219)	104 (2,642)	2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	46 (1,168)	4 (102)	4 (102)	N/A	1,444 (655)	6,942 (3,148)

Bell & Gossett
a xylem brand

Is a Single Tank still an option?

DIMENSIONS AND WEIGHTS

Model	A in (mm)	B in (mm)	C FNPT (in)	D (in)	E in (mm)	F in (mm)	G in (mm)	H in (mm)	I in (mm)	J in (mm)	K in (mm)	Shipping Wt. lbs (kg)	Flooded Wt.* lbs (kg)
B-200	24 (610)	43 (1,092)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	210 (95)	651 (295)
B-300	24 (610)	55 (1,397)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	225 (102)	891 (404)
B-400	30 (762)	49 (1,245)	1-1/2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	300 (136)	1,183 (537)
B-500	30 (762)	57 (1,448)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	335 (152)	1,435 (651)
B-600	30 (762)	65 (1,651)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	360 (163)	1,676 (760)
B-800	32 (813)	76 (1,930)	2	3/4	28 (711)	0.14 (4)	9/16 (14)	31 (787)	3 (76)	3 (76)	5.25 (133)	475 (215)	2,233 (1,013)
B-1000	36 (914)	76 (1,930)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	552 (250)	2,751 (1,248)
B-1200	36 (914)	88 (2,235)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	679 (308)	3,320 (1,506)
B-1400	36 (914)	100 (2,540)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	688 (312)	3,770 (1,710)
B-1600	48 (1,219)	74 (1,880)	1-1/2	3/4	42 (1,067)	0.14 (4)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,046 (474)	4,561 (2,068)
B-2000	48 (1,219)	86 (2,184)	1-1/2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,150 (522)	5,548 (2,516)
B-2500	48 (1,219)	104 (2,642)	2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	46 (1,168)	4 (102)	4 (102)	N/A	1,444 (655)	6,942 (3,148)

Is a Single Tank still an option?

DIMENSIONS AND WEIGHTS

Model	A in (mm)	B in (mm)	C FNPT (in)	D (in)	E in (mm)	F in (mm)	G in (mm)	H in (mm)	I in (mm)	J in (mm)	K in (mm)	Shipping Wt. lbs (kg)	Flooded Wt.* lbs (kg)
B-200	24 (610)	43 (1,092)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	210 (95)	651 (295)
B-300	24 (610)	55 (1,397)	1-1/2	3/4	20 (508)	0.14 (4)	9/16 (14)	22 (559)	2 (51)	2 (51)	5.25 (133)	225 (102)	891 (404)
B-400	30 (762)	49 (1,245)	1-1/2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	300 (136)	1,183 (537)
B-500	30 (762)	57 (1,448)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	335 (152)	1,435 (651)
B-600	30 (762)	65 (1,651)	2	3/4	24 (610)	0.14 (4)	9/16 (14)	27 (686)	3 (76)	3 (76)	5.25 (133)	360 (163)	1,676 (760)
B-800	32 (813)	76 (1,930)	2	3/4	28 (711)	0.14 (4)	9/16 (14)	31 (787)	3 (76)	3 (76)	5.25 (133)	475 (215)	2,233 (1,013)
B-1000	36 (914)	76 (1,930)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	552 (250)	2,751 (1,248)
B-1200	36 (914)	88 (2,235)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	679 (308)	3,320 (1,506)
B-1400	36 (914)	100 (2,540)	1-1/2	3/4	30 (762)	0.14 (4)	9/16 (14)	33 (838)	3 (76)	3 (76)	N/A	688 (312)	3,770 (1,710)
B-1600	48 (1,219)	74 (1,880)	1-1/2	3/4	42 (1,067)	0.14 (4)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,046 (474)	4,561 (2,068)
B-2000	48 (1,219)	86 (2,184)	1-1/2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	45 (1,143)	3 (76)	3 (76)	N/A	1,150 (522)	5,548 (2,516)
B-2500	48 (1,219)	104 (2,642)	2	3/4	42 (1,067)	0.20 (5)	9/16 (14)	46 (1,168)	4 (102)	4 (102)	N/A	1,444 (655)	6,942 (3,148)

What Have We Learned?

- Good piping practice enhances Air Management efficiency
- Cold Static Fill Pressure: From the **PRV location** to highest point
- Locate the Air Separator in warmest water with lowest pressure
- The Point of No Pressure Change: *Always Pump Away!!*
- Tank Pre-Charge pressure not always equal to Cold Static Fill Pressure
- Glycol Solutions will expand more than water
- Multiple tanks can be used and should be piped in parallel

Questions?

Comments?

Observations?