



When Building Codes Aren't Followed...

Crane Engineering | Building Science

 CRANE ENGINEERING subsidiary

Presented by: Andy Thielen, PE

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying 1.5 hours of credit toward Building Officials and Residential Contractors continuing education requirements."

For additional continuing education approvals, please see your credit tracking card.

Warning!

- The following is a montage of various incidents that relate directly back to the building code being ignored or not followed. **Any resemblance to a project that you have been involved in is unfortunate and you have our condolences.**

What are Building Codes?

- A **building code**, or **building control**, is a set of rules that specify the minimum acceptable level of safety for constructed objects such as buildings and other structures. The main purpose of building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures. The building code becomes law of a particular jurisdiction when formally adopted by the appropriate governmental or private authority.

What are Building Codes?

- Building codes are generally intended to be applied by architects, engineers, contractors and building officials.
- Building codes are also used for various purposes by environmental scientists, real estate developers, subcontractors, manufacturers of building products and materials, insurance companies, facility managers, tenants, and others.
- Codes in developed western nations can be quite complex and exhaustive.
- Codes began in ancient times and have been developing ever since.
- There are instances when some local jurisdictions use their own building codes. In the past, all major cities in the US had their own building codes. Due to ever increasing complexity and cost of developing building regulations, all municipalities in the country have chosen to adopt nationally recognized model codes such as the International Code Council family of codes except Chicago.

What are Building Codes?

- Code of Hammurabi:
 - If a builder builds a house for someone, and does not construct it properly, and the house which he built falls in and kills its owner, then that builder shall be put to death.
 - If it kills the son of the owner, the son of that builder shall be put to death.
 - If it kills a slave of the owner, then he shall pay, slave for slave, to the owner of the house.
 - If it ruins goods, he shall make compensation for all that has been ruined, and inasmuch as he did not construct properly this house which he built and it fell, he shall re-erect the house from his own means.

What are Building Codes?

- The Book of Deuteronomy, chapter 22 verse 8:
 - When thou buildest a new house, then thou shalt make a battlement (i.e. parapet) for thy roof, that thou bring not blood upon thine house, if any man fall from thence.
- The Book of Deuteronomy, chapter 22 verse 10:
 - Thou shalt not plow with an ox and an ass together.

What are Building Codes?

- First Code in the United States:
 - Baltimore – 1859
(just in time to prevent the great Baltimore fire of 1904).
 - Minnesota first adopted a Uniform Building Code in 1971:
 - Before each municipality adopted whatever they wanted...
 - (Minneapolis modeled its codes after Chicago's Codes).

What are Minnesota's Building Codes?

- International Building Code (with Amendments)
- Elevators and Related Devices (AMSE A17.1, 17.1A, 17.2, and several others)
- Guidelines for the Rehabilitation of Existing Buildings (Chapters one to six of the 2000 Guidelines for the Rehabilitation of Existing Buildings (GREB))
- Commercial Energy Code
- Solar Energy systems
- Flood Proofing Regulations
- Minnesota Accessibility Code
- International Fuel Gas Code
- International Residential Code
- National Electric Code
- Minnesota Plumbing Code (UPC)
- Manufactured Homes
- Prefabricated Buildings
- Industrialized/Modular Buildings
- Storm Shelters
- International Fire Code
- International Mechanical Code

What is a Building?

- Modern Buildings are complex Machines!
 - Vikings Stadium:
 - $\geq 9,000$ drawings/details
 - $> 20,000$ pages of specifications
 - A Typical House:
 - 6-12 Drawings
 - No specifications
 - Has more parts than a car!
- Who Builds/Designs our Buildings?
 - Humans! (An imperfect creature)

What happens when Building Codes are ignored?

- The following are cautionary tales exposing what a lack of attention to detail can cause.
- The following are examples of what happens when Designers and/or Craftsmen are not given enough training, direction or time to do their job.

As a Contractor,

- Are you safe if you install everything in strict accordance with the Construction Documents?
 - NO!

How about this?

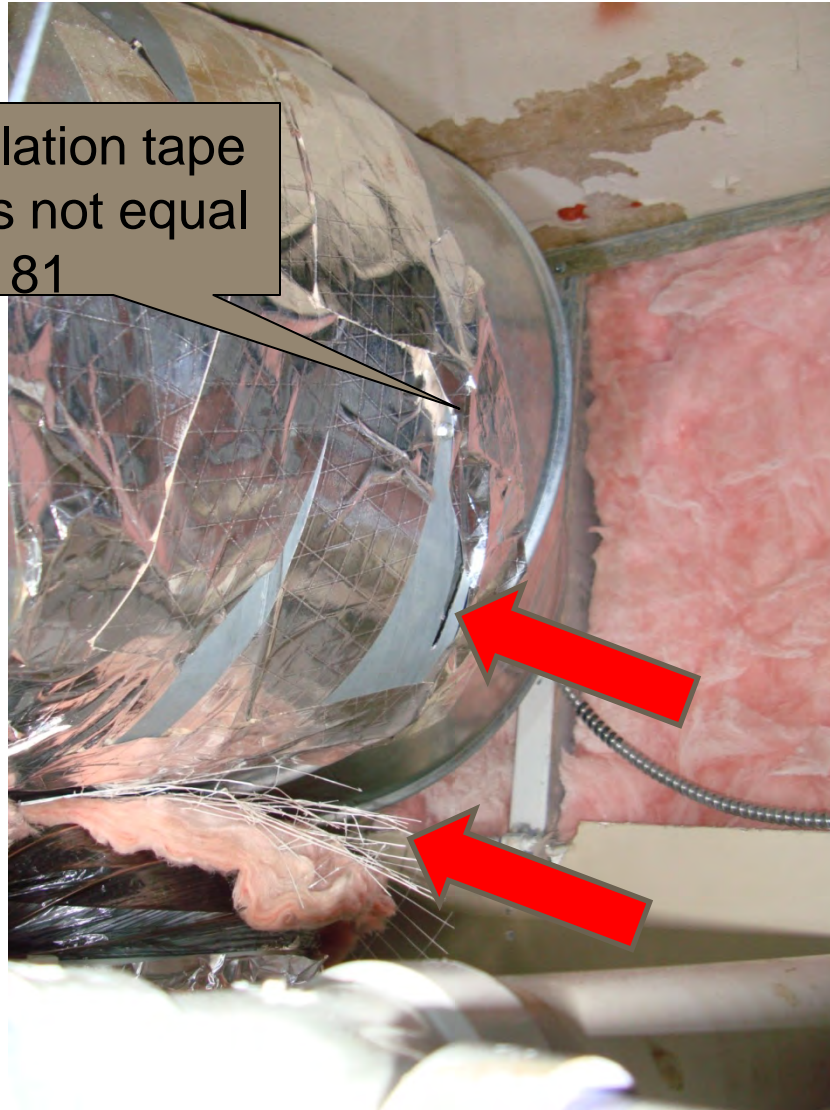




Duct Sealing

Location	Design Static Pressure	Minimum Required Sealing
All locations	Greater than 3.0 inches (750 Pa) water gauge	All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Ductwork shall be equal to or less than Leakage Class 6 as defined in Section 4 of the <i>SMACNA HVAC Duct Leakage Test Manual*</i> .
Portions of ducts not completely inside the vapor retarder/air barrier enclosing conditioned space	3.0 inches(750 Pa) water gauge and less	All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.
Portions of return air ducts in the same space as an atmospherically vented or fan-assisted appliance.	3.0 inches(750 Pa) water gauge and less	All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.
All locations	Greater than 0.50 to 3.0 inches (125 to 750 Pa) water gauge	All transverse joints and duct wall penetrations shall be sealed.
All locations	0.50 inches (125 Pa) water gauge and less	All transverse joints, longitudinal seams, and duct wall penetrations shall have no visible gaps and shall be sufficiently airtight in accordance with Section 1.7 of the <i>SMACNA HVAC Duct Construction Standards - Metal & Flexible</i> .

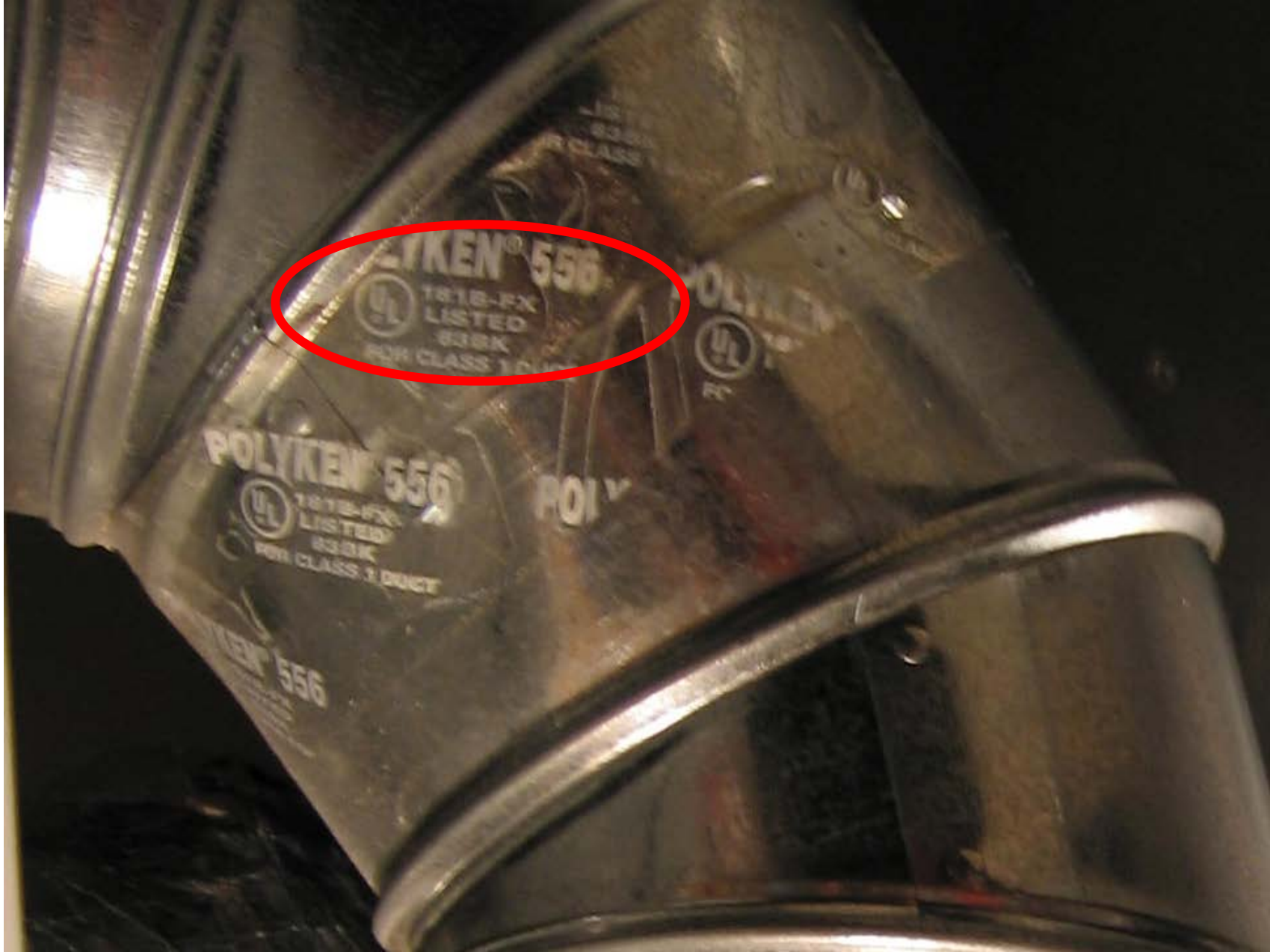
Insulation tape
does not equal
UL 181





“Duct tape” does not
equal UL 181

This
installation is 5
months old



POLYKEN® 556
UL LISTED
1818-FX
83BK
FOR CLASS 1 DUCT

POLYKEN 556
UL LISTED
1818-FX
83BK
FOR CLASS 1 DUCT

POLYKEN 556

POLYKEN
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1818-FX
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FOR CLASS 1 DUCT

POLY

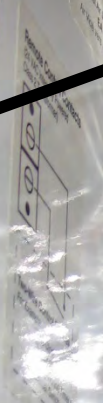
Does this meet Code?



?



WARNING
Do not touch the
inner surface of the
insulation.

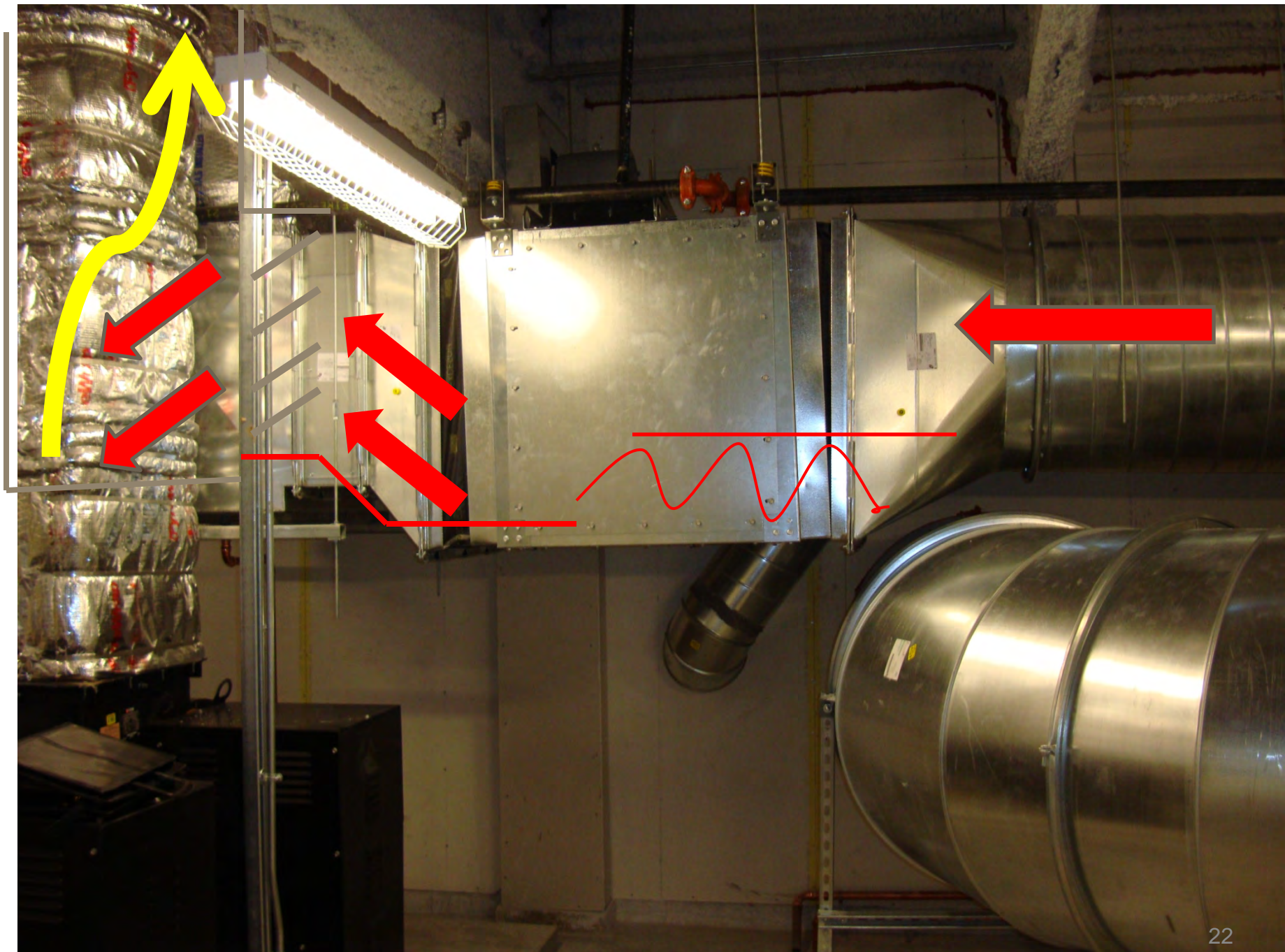


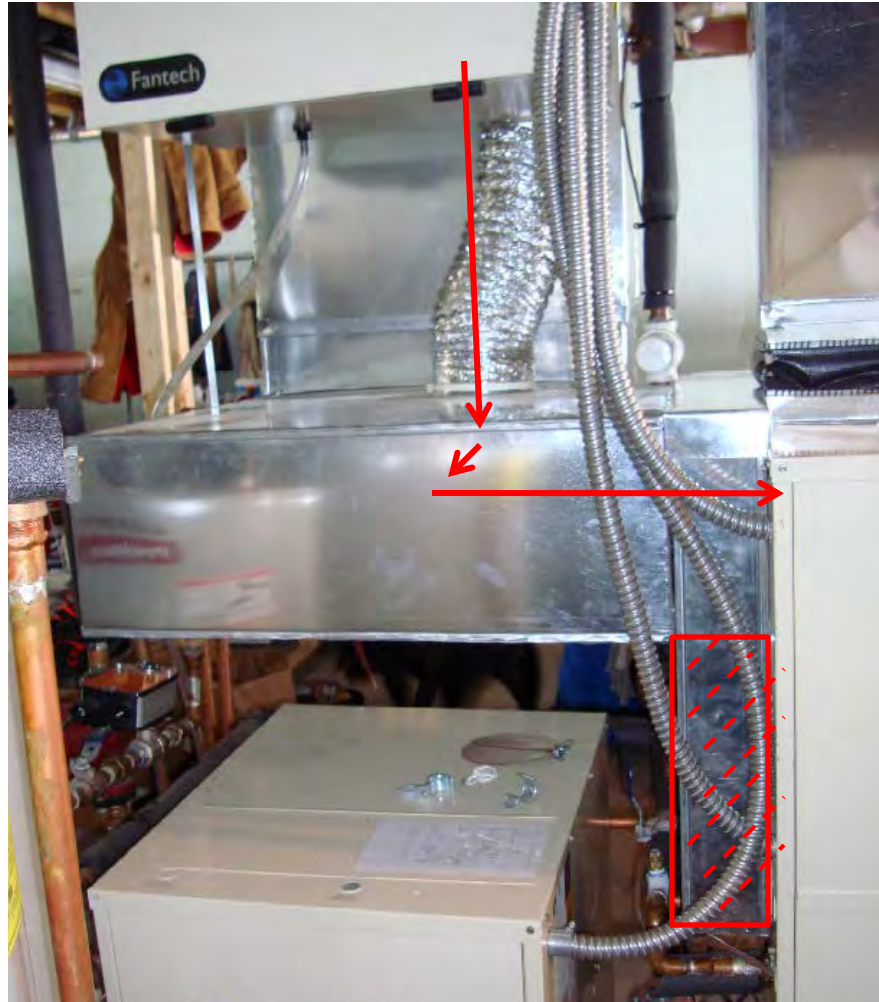
Front Air Inlet
PA
Air Pressure & Mass

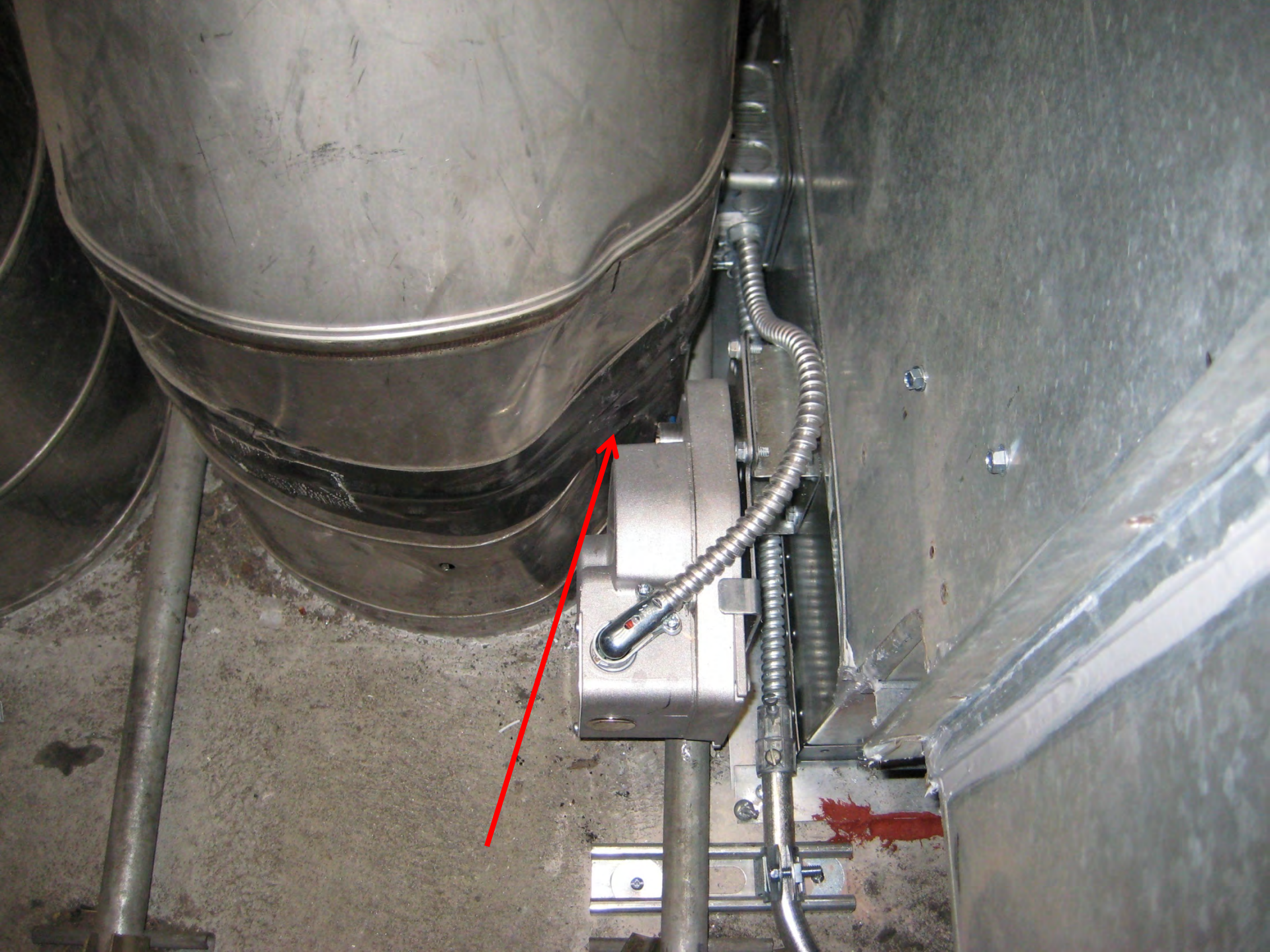
1323.6.5.3.1 Fan Power Limitation.

(prescriptive path)

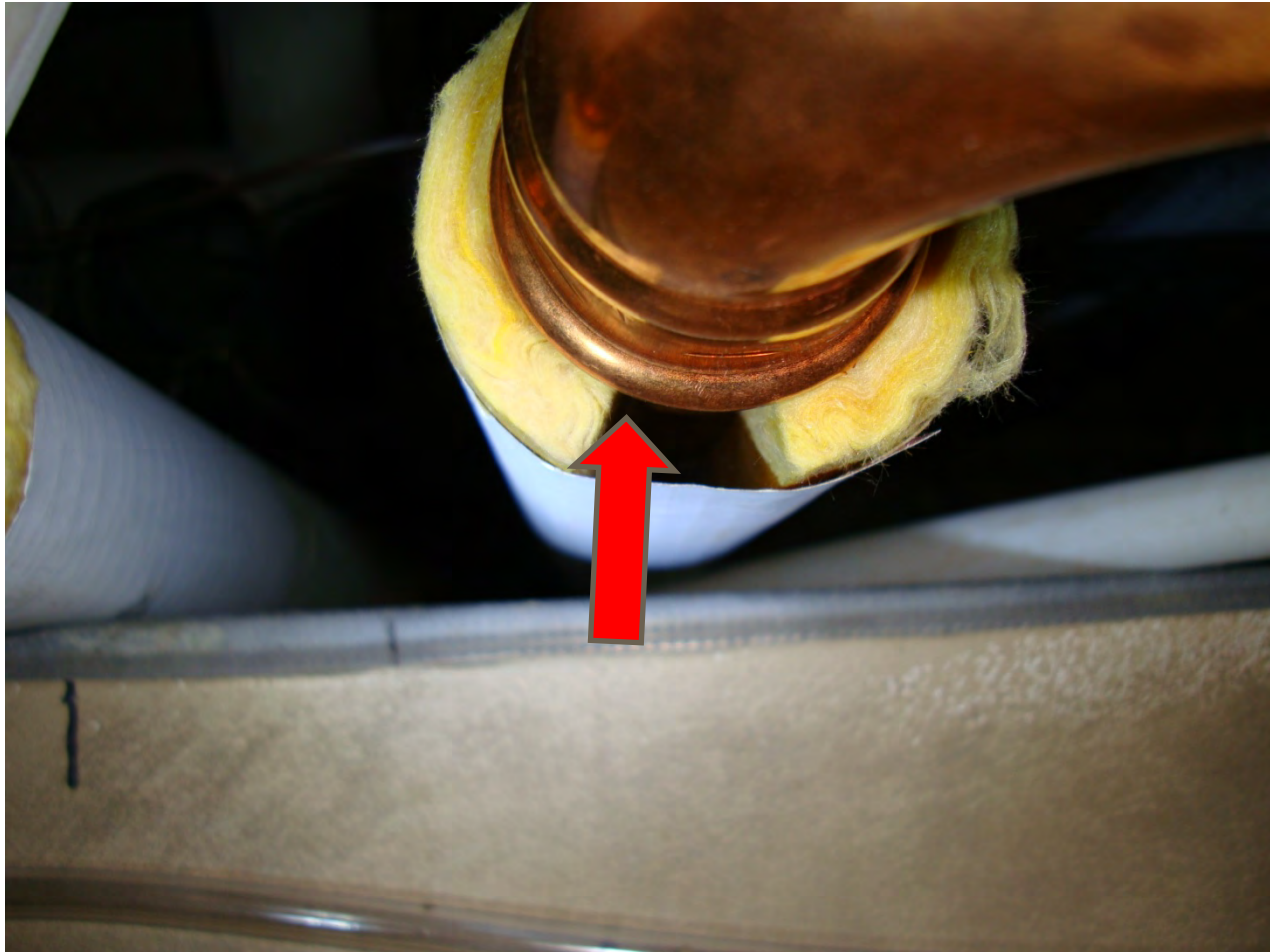
- (a) Where ...air treatment or filtering systems have pressure drops over 1 in. W.C. *when filters are clean*, or heat recovery or other devices to serve process loads in the airstream, the allowable fan system power may be adjusted using the pressure credit in the allowable fan system equation in Table 6.5.3.1.





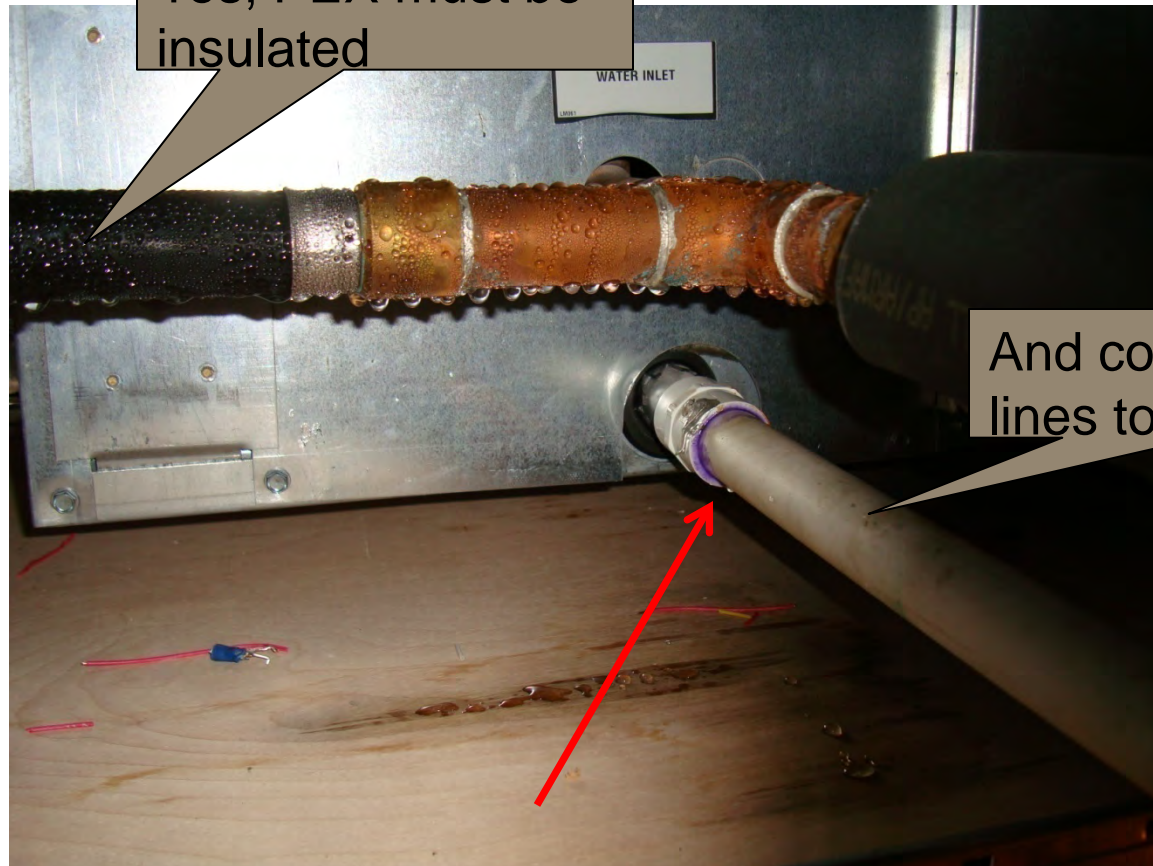


Does This Meet Code?



Piping Insulation Required?

Yes, PEX must be insulated



And condensate drain lines too

Would Acceptance Testing Catch This?





Historic Events

- Hyatt Hotel, Kansas City:
 - Walkway Collapse –114 people perish.
 - Lack of review of a changed design detail blamed.



How much solder should a solder joint contain?

- Minnesota Plumbing Code
 - ASTM B302 Standard Specification for Threadless Copper Pipe
 - ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings
 - ASTM B88 Standard Specification for Seamless Copper Water Tube
 - ASTM B828 (By reference) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings

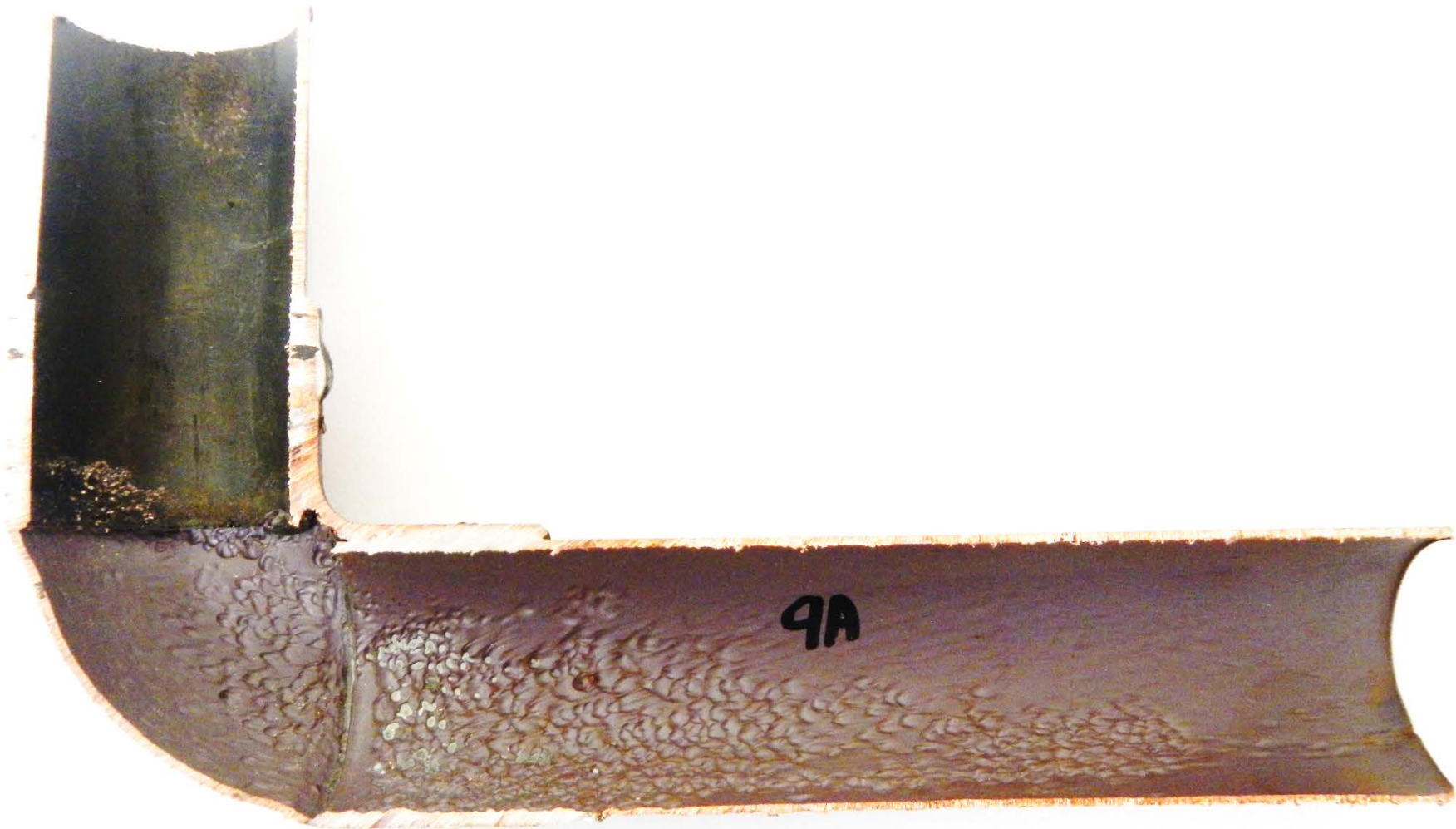


How much solder should a solder joint contain?

- **IMC 1203.3.3 Solder joints:** Joint surfaces shall be cleaned. A flux conforming to ASTM B 813 shall be applied. The joint shall be soldered with Solder conforming to ASTM B 32
 - Nothing on how much solder should be in a joint.
- **ASTM B813: Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube**
 - Nothing on how much solder should be in a joint.
- **ASTM B32: Standard Specification for Solder Metal**
 - Nothing on how much solder should be in a joint.

How much solder should a solder joint contain?

- **ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings**
 - Defines the preparation and operations to make a joint but not how much solder should be in a joint.
 - Burr removal.



9A

How much solder should a solder joint contain?

- **Copper Development Association:**
 - Table listing the weight of copper / 100 joints
 - “It is generally accepted that a minimum of 70% fill of solder material into the capillary space of the joint is required to insure acceptable strength and pressure capabilities”.
 - A total area of defects (unsoldered area, flux inclusions, or incomplete bridging of solder metal between the tube and fitting (see **Appendix A**, Bridging)) of greater than 30% of the total faying area (the front edge to the rear edge of the overlap) of any of the individual joints.
 - A sum of the lengths of the defects measured on any one line in the direction of the lap shall not exceed 30% of the length of the lap.
 - Solder voids that extend from the inside edge of the fitting to the outside edge creating a leak path through the capillary space, regardless of the area of the void.

How much solder should a solder joint contain?

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Solder Requirements for Solder Joint Pressure Fittings, length in inches*

Nominal or standard size, inches	O.D. of tube, inches	Cup depth of fitting, inches	Joint clearance, inches										Wt. in lbs. of .010 clearance per 100 joints***
			0.001	0.002	0.003	0.004	0.005**	0.006	0.007	0.008	0.009	0.010***	
1/4	.375	.310	.030	.060	.090	.119	.149	.179	.208	.238	.268	.298	.097
3/8	.500	.380	.049	.097	.146	.195	.243	.292	.341	.389	.438	.486	.159
1/2	.625	.500	.080	.160	.240	.320	.400	.480	.560	.640	.720	.800	.261
5/8	.750	.620	.119	.238	.357	.476	.595	.714	.833	.952	1.072	1.191	.389
3/4	.875	.750	.168	.336	.504	.672	.840	1.008	1.176	1.344	1.512	1.680	.548
1	1.125	.910	.262	.524	.786	1.048	1.311	1.573	1.835	2.097	2.359	2.621	.856
1-1/4	1.375	.970	.341	.683	1.024	1.366	1.707	2.049	2.390	2.732	3.073	3.415	1.115
1-1/2	1.625	1.090	.454	.907	1.361	1.814	2.268	2.721	3.175	3.628	4.082	4.535	1.480
2	2.125	1.340	.729	1.458	2.187	2.916	3.645	4.374	5.103	5.833	6.562	7.291	2.380
2-1/2	2.625	1.470	.988	1.976	2.964	3.952	4.940	5.928	6.916	7.904	8.892	9.880	3.225
3	3.125	1.600	1.328	2.656	3.985	5.313	6.641	7.969	9.297	10.626	11.954	13.282	4.335
3-1/2	3.625	1.910	1.773	3.546	5.318	7.091	8.864	10.637	12.409	14.182	15.955	17.728	5.786
4	4.125	2.100	2.281	4.563	6.844	9.125	11.407	13.688	15.969	18.250	20.532	22.813	7.446
5	5.125	2.600	3.490	6.981	10.471	13.962	17.452	20.943	24.433	27.924	31.414	34.905	11.392
6	6.125	3.000	4.848	9.692	14.538	19.383	24.229	29.075	33.921	38.767	43.613	48.459	15.815
8	8.125	3.970	8.259	16.518	24.777	33.035	41.294	49.553	57.812	66.071	74.330	82.589	26.955
10	10.125	4.000	10.370	20.739	31.109	41.479	51.848	62.218	72.587	82.957	93.326	103.696	33.845
12	12.125	4.500	13.970	27.940	41.910	55.881	69.851	83.821	97.791	111.761	125.731	139.701	45.596

NOTE: * Using 1/8 inch diameter (No. 9) wire solder (1 inch = .01227 cubic inches).

** Average Actual Consumption. Actual consumption depends on workmanship.

*** For Estimating Purposes. Includes an allowance of 100% to cover wastage and loss.

Flux requirements are usually 2 oz. per lb. of solder.

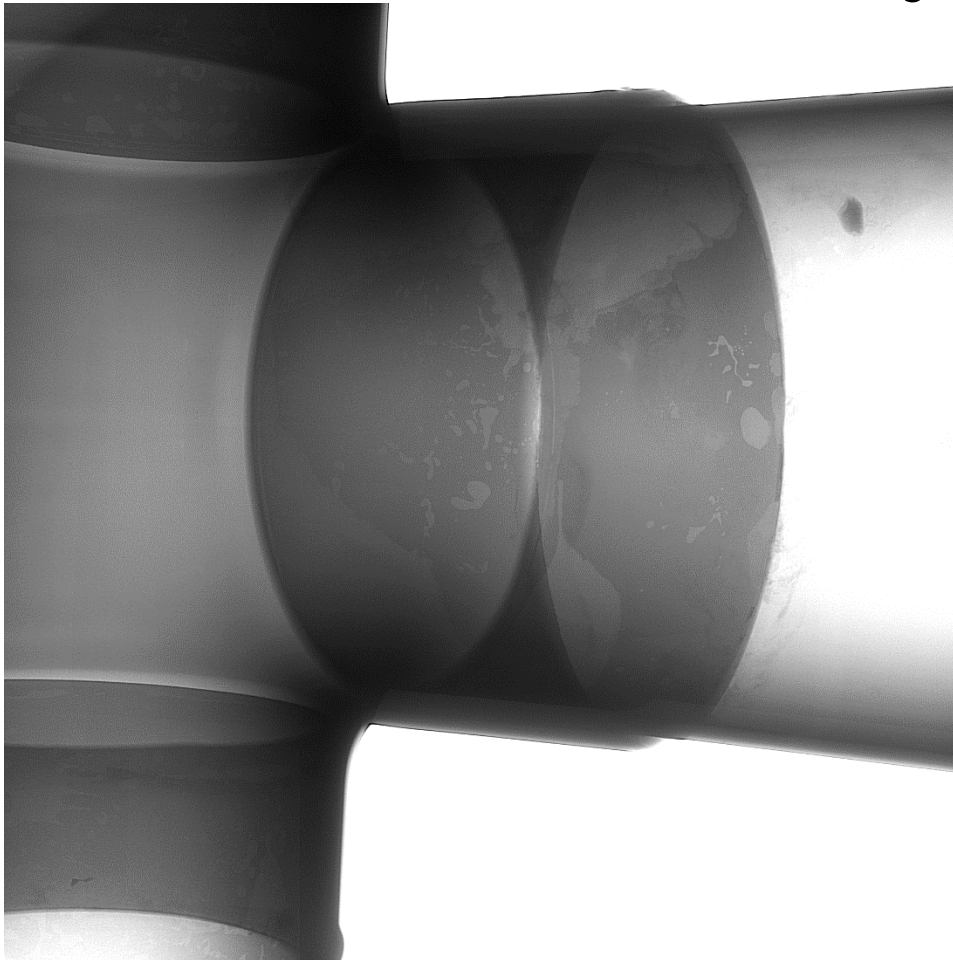
How much solder should a solder joint contain?



How much solder should a solder joint contain?



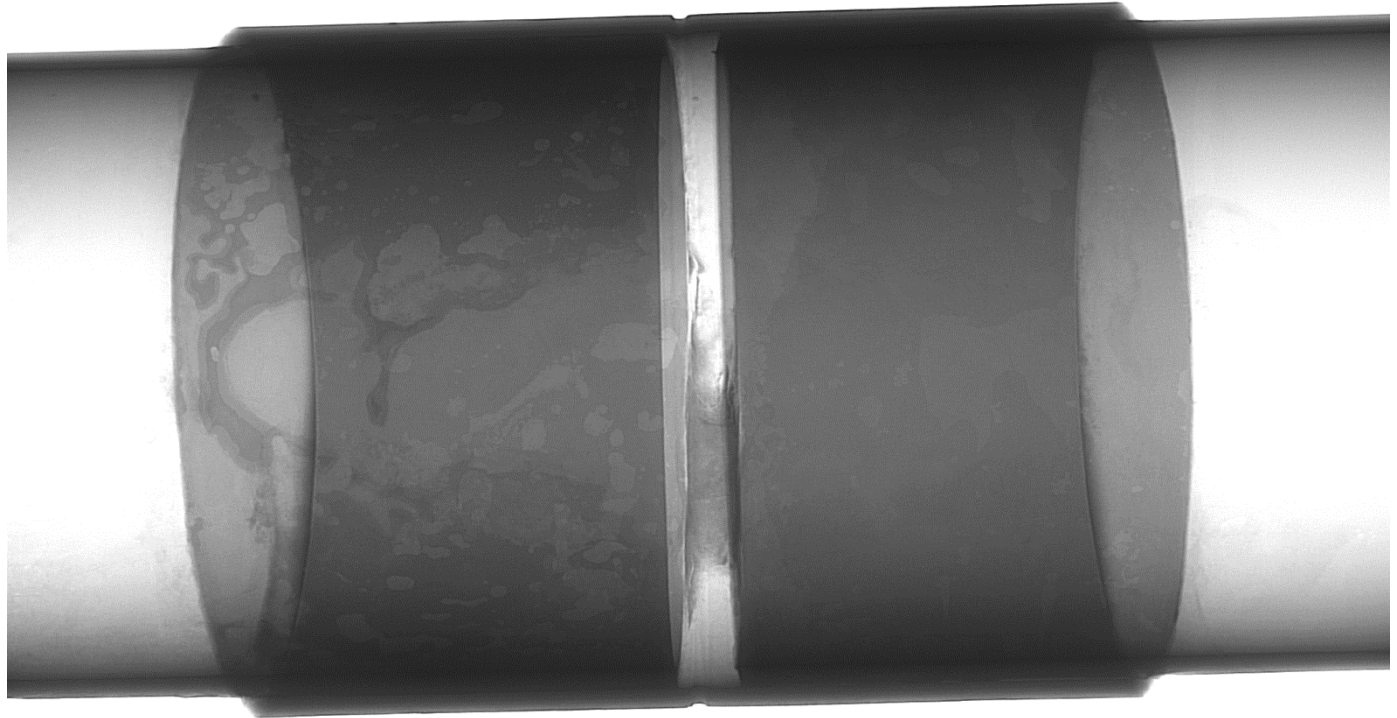
How much solder should a solder joint contain?



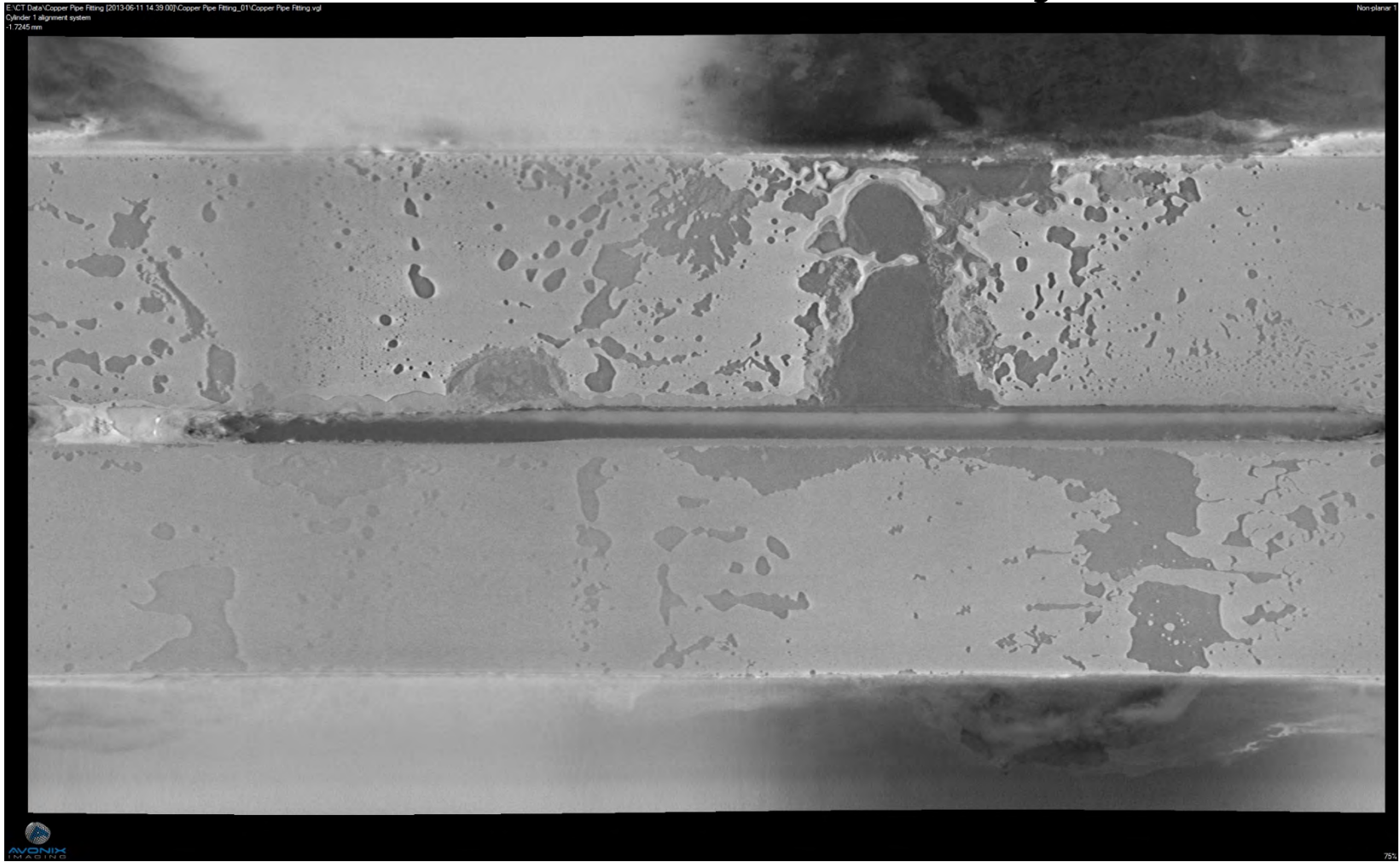
How much solder should a solder joint contain?



How much solder should a solder joint contain?



How much solder should a solder joint contain?



Domestic Water Pipe

- Minnesota Plumbing Code (4715.0420 6M & 6N)
 - Cross-linked polyethylene (PEX) tubing systems together with approved fittings must be tested at 150 psi and 210 degrees Fahrenheit for a period of not less than 30 days by a qualified independent testing laboratory acceptable to the administrative authority.
 - National Standards:
 - NSF 14 Plastics Piping System Components and Related Materials
 - NSF 61 Drinking Water System Components
- Whose fittings are tested to "*150 psi and 210 degrees Fahrenheit for a period of not less than 30 days*"?

Domestic Water Pipe



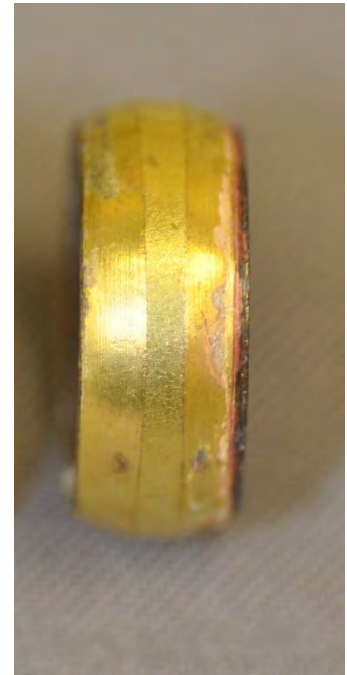
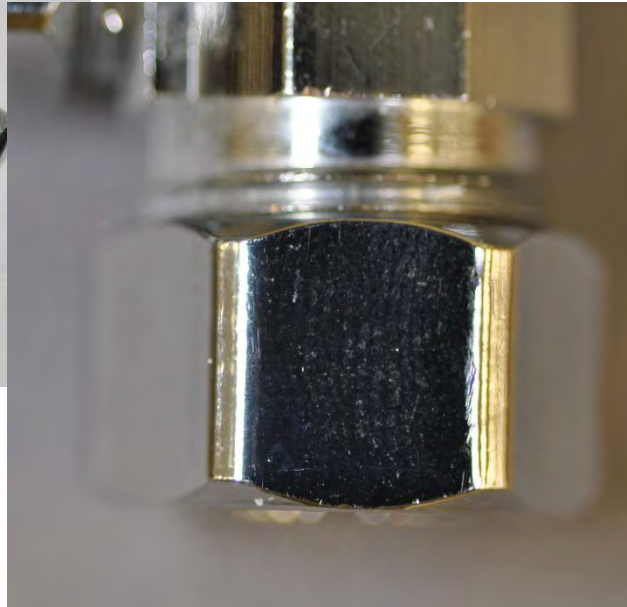
Domestic Water Pipe



Domestic Water Pipe



Domestic Water Pipe



Domestic Water Pipe



Pipe Hangers

MN Rule 4715.1430 Hangers & Supports

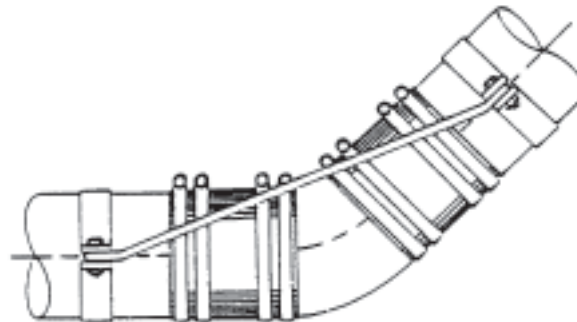
- Subpart 1: Hangers ... shall be of sufficient strength to support the pipe and its contents.
- Subpart 3
 - Horizontal PVC pipe shall be supported at 32" intervals
 - Cast Iron supported at five foot intervals except where 10' lengths are used
- Subpart 6: Base of Stack... Stacks shall be adequately supported at their bases
- UPC Table 3-2 hanger spacing:
 - Cast Iron – every other joint.
 - PVC – 4'
- IS 6 2.5.5: *"Closet bends, trap arms and similar branches shall be secured against movement in any direction."*

Pipe Hangers

- **CISPI 301 STANDARD SPECIFICATION FOR HUBLESS CAST IRON SOIL PIPE AND FITTINGS FOR SANITARY AND STORM DRAIN, WASTE, AND VENT PIPING APPLICATIONS**
- **1.1 Purpose.** The purpose of this standard is to establish standards covering material, manufacture, mechanical, physical, and chemical properties, coating, test methods, inspection, certification, markings, principal dimensions and dimensional tolerances for pipe and fittings for hubless cast iron sanitary and storm drain, sanitary waste, and vent piping applications in accordance with general needs of producers, distributors, and users. These pipe and fittings are intended for gravity flow nonpressure applications.
- **6. SUGGESTED INSTALLATION INSTRUCTIONS**
- **ABOVEGROUND INSTALLATION PROCEDURES**
 - With attention to a few basic rules the installation of cast iron soil pipe and fittings is easily accomplished.
 - (1) Cast iron soil pipe installed in the horizontal position shall be **supported at every hub** (Hub & Spigot) or coupling (Hubless). The hanger shall be placed within 18" of the hub or coupling. Joints used for connecting cast iron soil pipe possess **sufficient shear strength** to require one hanger per joint or hub. For 12" and 15" hubless pipe hangers shall be placed on both sides of the coupling when installing full 10 foot lengths.
 - (2) Installations requiring **multiple joints within a four foot developed length shall be supported at every other or alternating hubs or couplings.**

Pipe Hangers

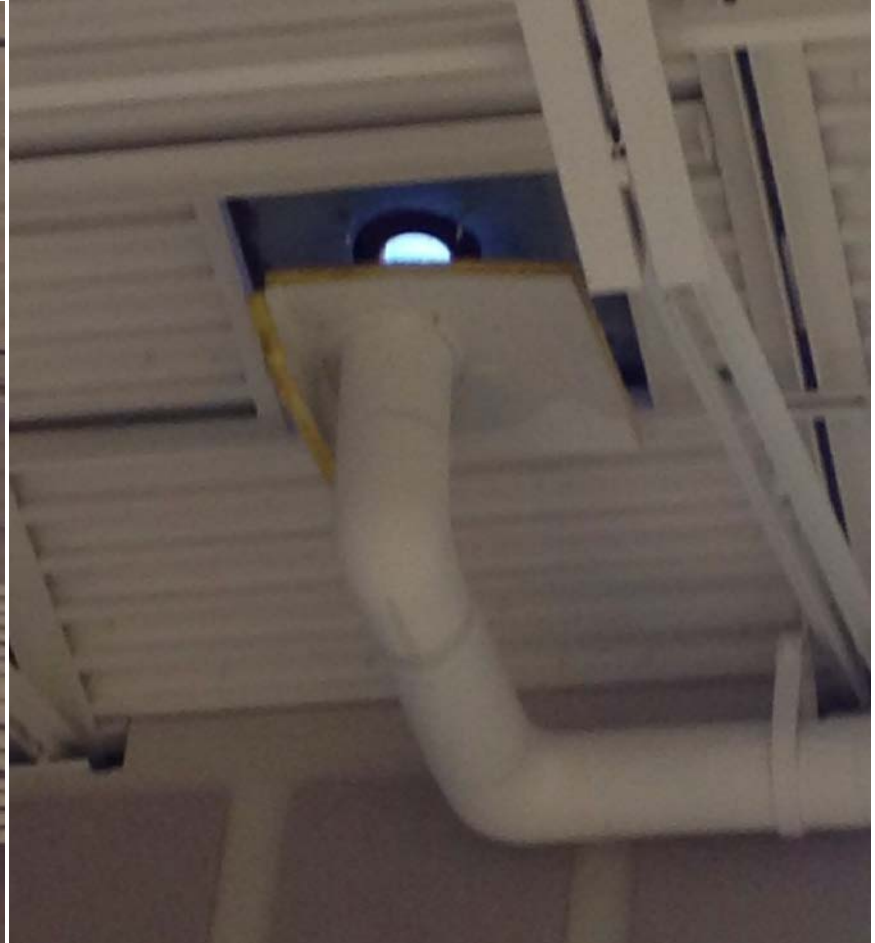
- CISPI 301 STANDARD SPECIFICATION FOR HUBLESS CAST IRON SOIL PIPE AND FITTINGS FOR SANITARY AND STORM DRAIN, WASTE, AND VENT PIPING APPLICATIONS
- ABOVEGROUND INSTALLATION PROCEDURES
 - With *Large Diameter Fittings* Horizontal pipe and fittings five (5) inches and larger shall be suitably braced to prevent horizontal movement. This shall be done at every branch opening or change of direction by the use of braces, blocks, rodding or other suitable method, to prevent movement.



Pipe Hangers

- CISPI 310 SPECIFICATION FOR COUPLING FOR USE IN CONNECTION WITH HUBLESS CAST IRON SOIL PIPE AND FITTINGS FOR
- SANITARY AND STORM DRAIN, WASTE, AND VENT PIPING APPLICATIONS.
- **1.1 Purpose.** The purpose of this specification is to establish criteria for material dimensions and dimensional tolerances for one type of **coupling used in hubless cast iron soil pipe and fittings** for sanitary and storm drain, waste and vent piping applications in accordance with general needs of producers, distributors, and users.
- **6. SUGGESTED INSTALLATION INSTRUCTIONS**
- The same requirements for CISPI 301

Pipe Hangers





Is water treatment required by Code?

International Mechanical Code:

– Almost silent on issue.

- **IMC 304.1 General.** Equipment and appliances shall be installed as required by the terms of their approval, in accordance with the conditions of the listing, the manufacturer's installation instructions and this code. Manufacturer's installation instructions shall be available on the job site at the time of inspection.

Is water treatment required by Code?

Boiler Installation Example:

Cleaning, Flushing System

Prior to commissioning the boiler/s, the piping/system must be cleaned and flushed to prevent contaminants from settling back into the boiler and fouling the heat exchanger. Isolate the boiler from the system prior to the cleaning process. Fill the system with water, add the cleaning solution and circulate per the chemical supplier's instructions until the system TDS is within 10% of the city water TDS. Add the corrosion inhibitor to the system and follow the chemical supplier's instructions.

Is water treatment required by Code?

Boiler Installation Example:

Water Treatment

This boiler was designed to operate in a closed loop heating system. Water treatment is required when fill or make-up water contains dissolved solids greater than 200 ppm or if PH level is not within the 6.5-11 range.



Is water treatment required by Code?

Chiller Installation Example

Water Treatment

Since the use of untreated or improperly treated water in a may result in inefficient operation and possible tube damage, be sure to engage the services of a qualified water treatment specialist if needed. A label with the following disclamatory note is affixed to each water chiller:

Customer Note: "The use of improperly treated or untreated water in this equipment may result in scaling, erosion, corrosion, algae or slime. The services of a qualified water treatment specialists should be engaged to determine what treatment, if any, is advisable. The warranty specifically excludes liability for corrosion, erosion, or deterioration of our equipment, The manufacturer assumes no responsibilities for the results of the use of untreated or improperly treated water, or saline or brackish water."

CAUTION

Water Treatment!

Do not use untreated or improperly treated water, or equipment damage may occur.

Is water treatment required by Code? Chiller Installation Example



Is water treatment required by Code? Chiller Installation Example



Is water treatment required by Code? Chiller Installation Example



Is water treatment required by Code? Chiller Installation Example



Is water treatment required by Code? Chiller Piping Example



Is water treatment required by Code? Chiller Piping Example



Is water treatment required by Code? Chiller Piping Example



With Steam or Hot Water

- Water Treatment is key...





1500' of leaky
pipe lost 9,600
lbs of
condensate /hr
(\$28,000/year)

Can condensate from a fuel burning appliance be dumped into a floor drain?

IMC 307.1 Fuel-burning appliances. Liquid combustion by-products of condensing appliances shall be collected and discharged to an approved plumbing fixture or disposal area in accordance with the manufacturer's installation instructions. Condensate piping shall be of approved corrosion-resistant material and shall not be smaller than the drain connection on the appliance. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

Can condensate from a fuel burning appliance be dumped into a floor drain?

Minnesota Plumbing Code

4715.1600 CHEMICAL WASTES.

Chemical or industrial liquid wastes which are likely to damage or increase maintenance costs on the drainage system, shall be pretreated to render them innocuous prior to discharge into the drainage system, when required by the administrative authority. ...

Can condensate from a fuel burning appliance be dumped into a floor drain?

Boiler Installation Manual:

CONDENSATE PIPING

The condensate trap provided with the boiler must be attached to the bottom pan and piped to a suitable floor drain (consult local code) or condensate pump. If a condensate neutralization device is required by local code, it must be positioned prior to boiler room drain. Fill the condensate trap with water, check and maintain water level in trap during operation and prior to start-up.

Can condensate from a fuel burning appliance be dumped into a floor drain?

Furnace Installation Manual:

CONDENSATEDRAIN/NEUTRALIZER

If local codes require, install a condensate neutralizer cartridge in the drain line. Install cartridge in horizontal position only...

Can condensate from a fuel burning appliance be dumped into a floor drain?



Sprinkler piping leaks

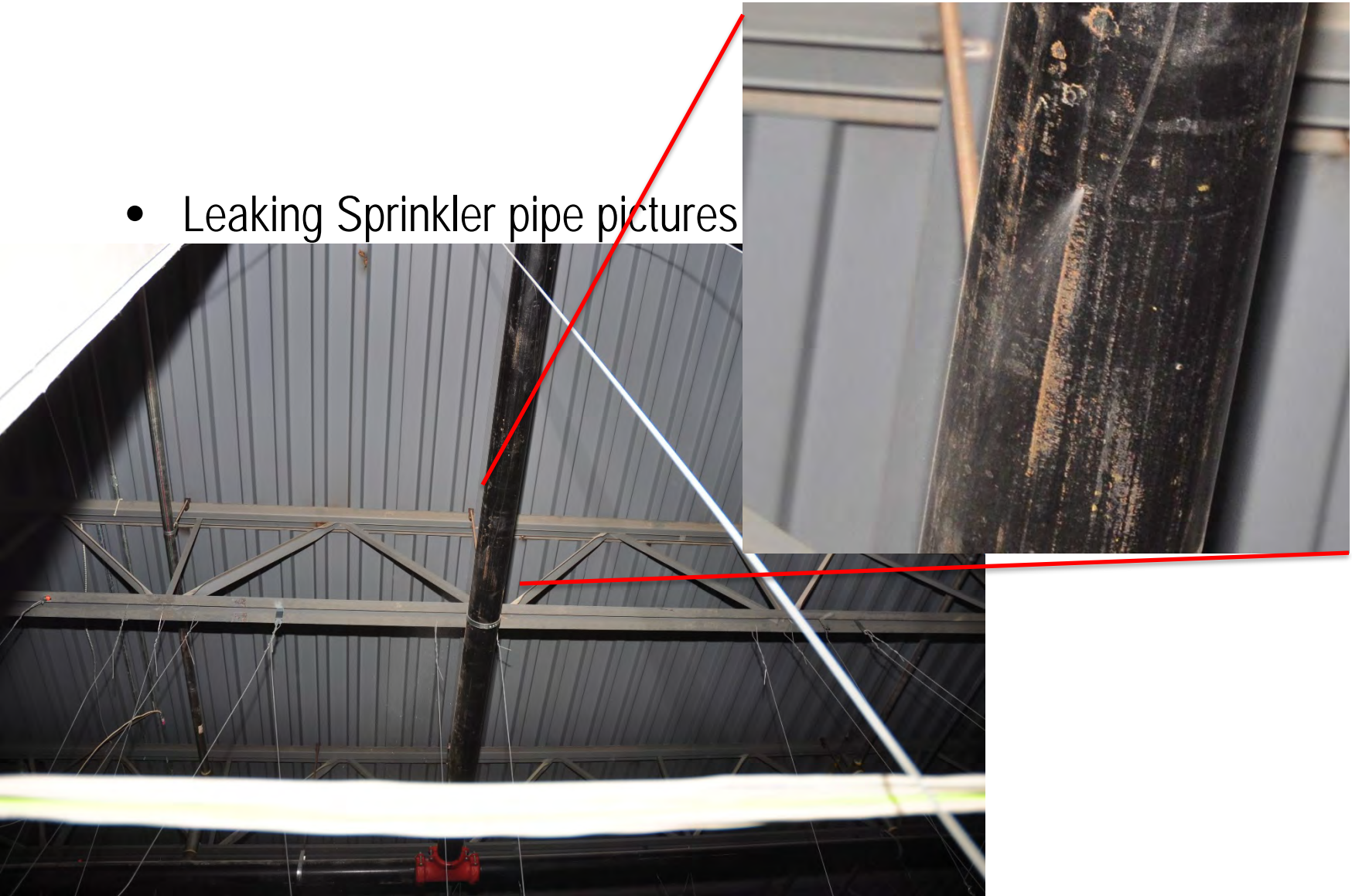
IFC 901.6 Fire protection Systems shall be inspected, tested and maintained in accordance with the referenced standards listed in table 901.6.1

**TABLE 901.6.1
FIRE PROTECTION SYSTEM MAINTENANCE STANDARDS**

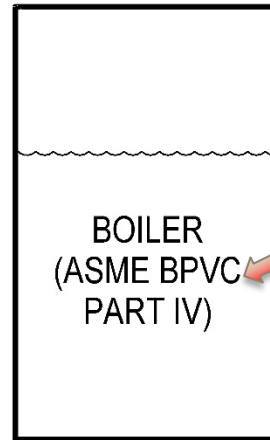
SYSTEM	STANDARD
Portable fire extinguishers	NFPA 10
Carbon dioxide fire-extinguishing system	NFPA 12
Halon 1301 fire-extinguishing systems	NFPA 12A
Dry-chemical extinguishing systems	NFPA 17
Wet-chemical extinguishing systems	NFPA 17A
Water-based fire protection systems	NFPA 25
Fire alarm systems	NFPA 72
Water-mist systems	NFPA 750
Clean-agent extinguishing systems	NFPA 2001

Sprinkler piping

- Leaking Sprinkler pipe pictures



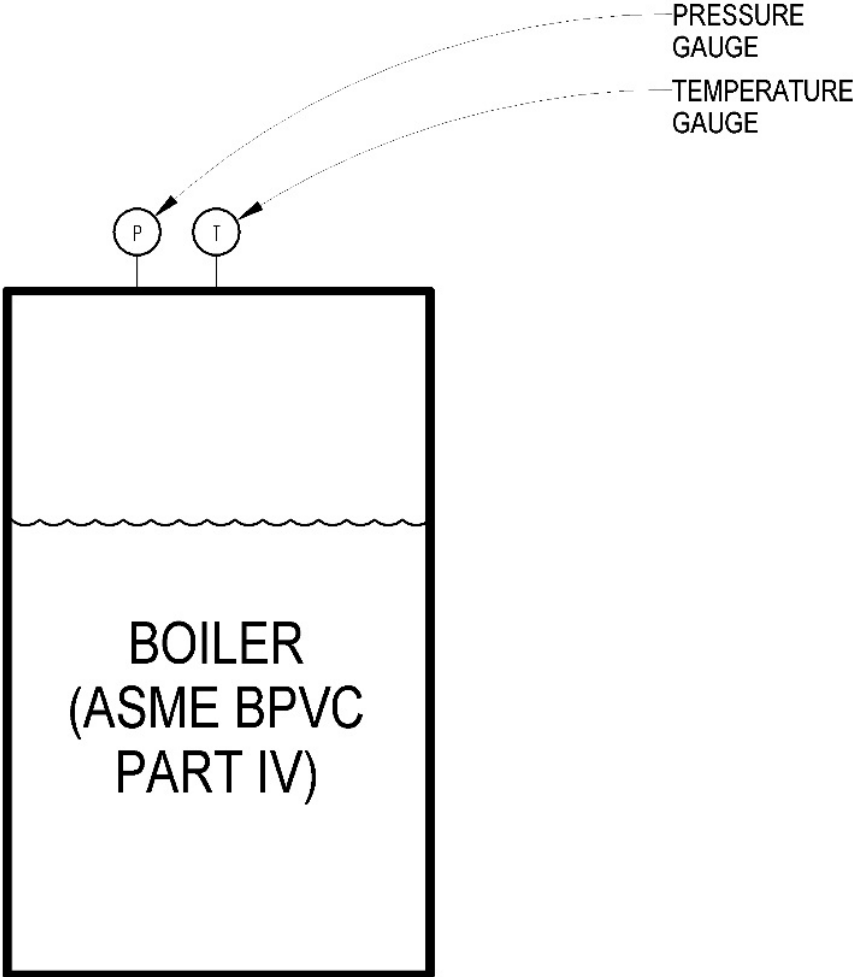
Boiler Piping



ANSI Z21.13 or UL 795

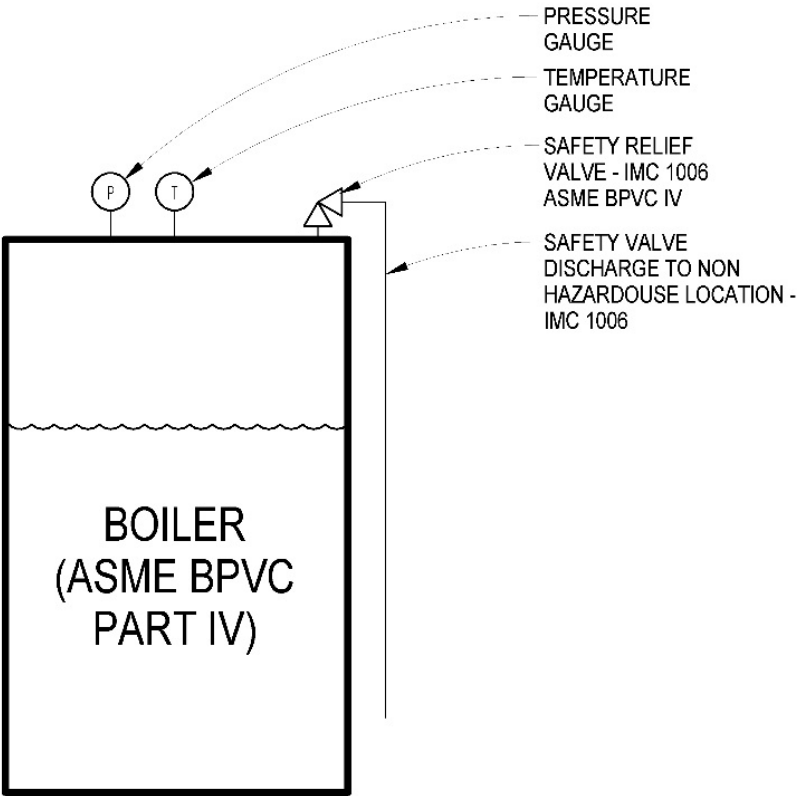
Typical Residential Boilers





Typical gage





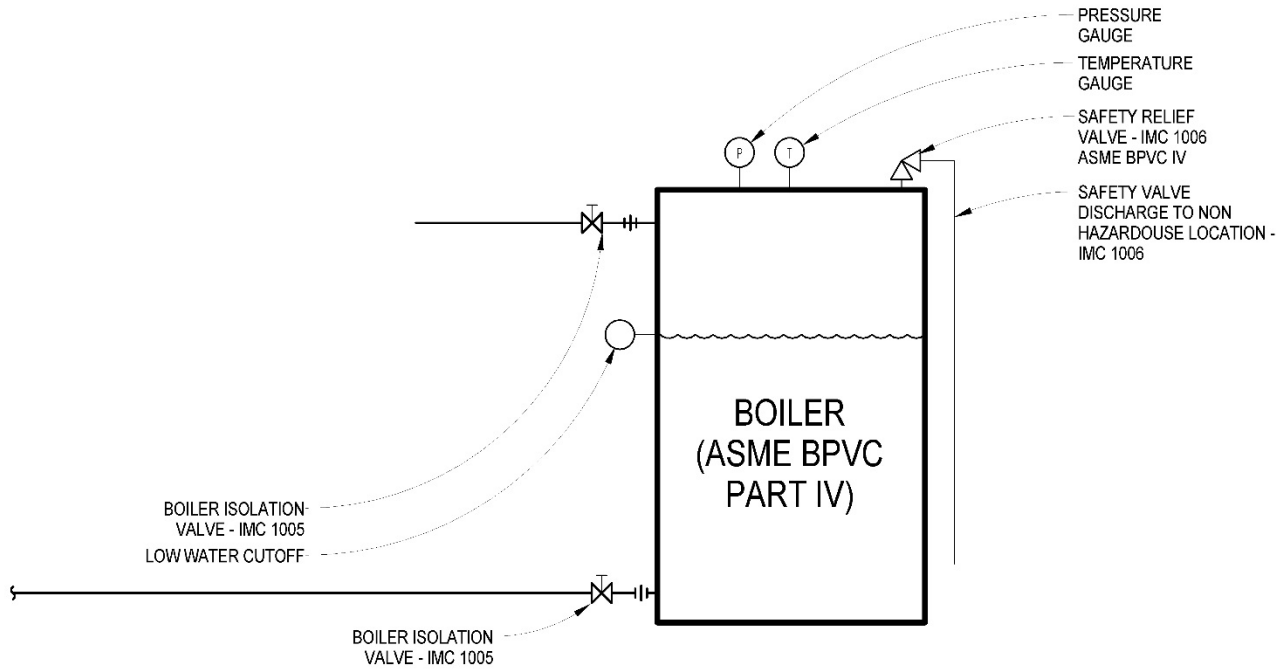


Boiler relief valve piping

Is this a non hazardous location?

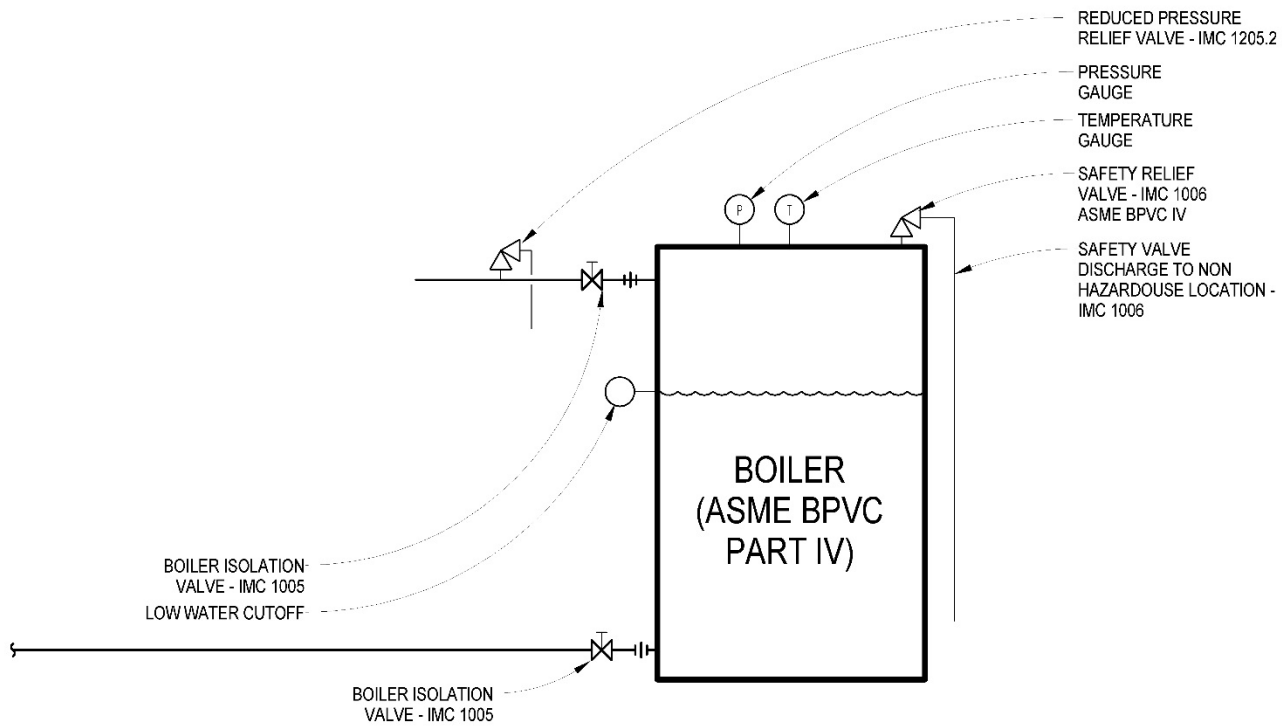






Boiler low water cut off



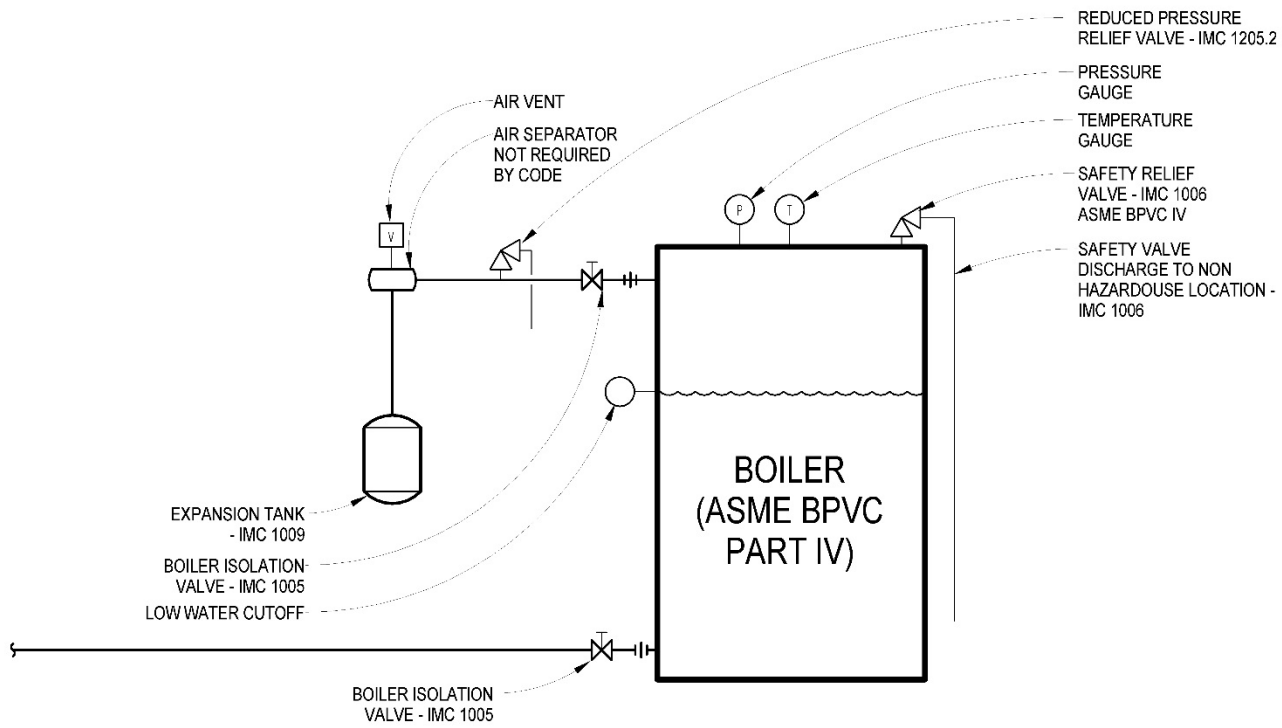


Pressure relief valve

Pressure relief valve

Safety relief valve







Old Fashion Expansion Tank

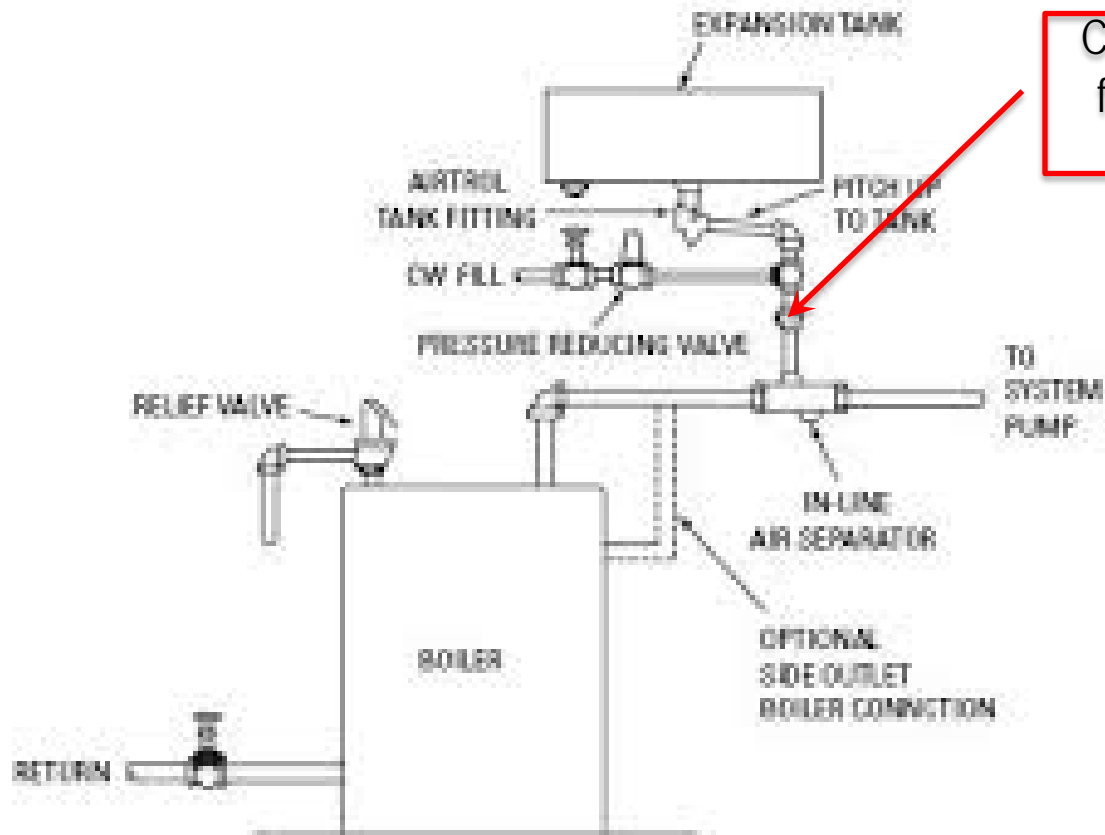
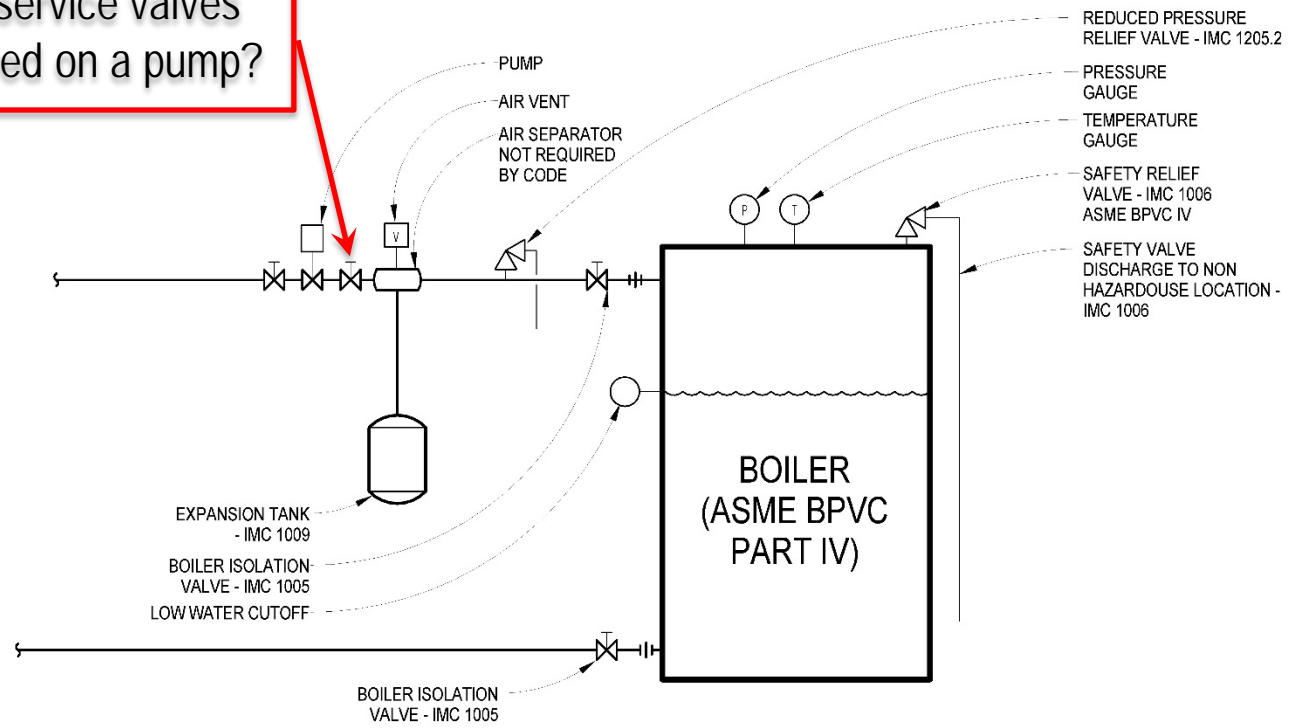


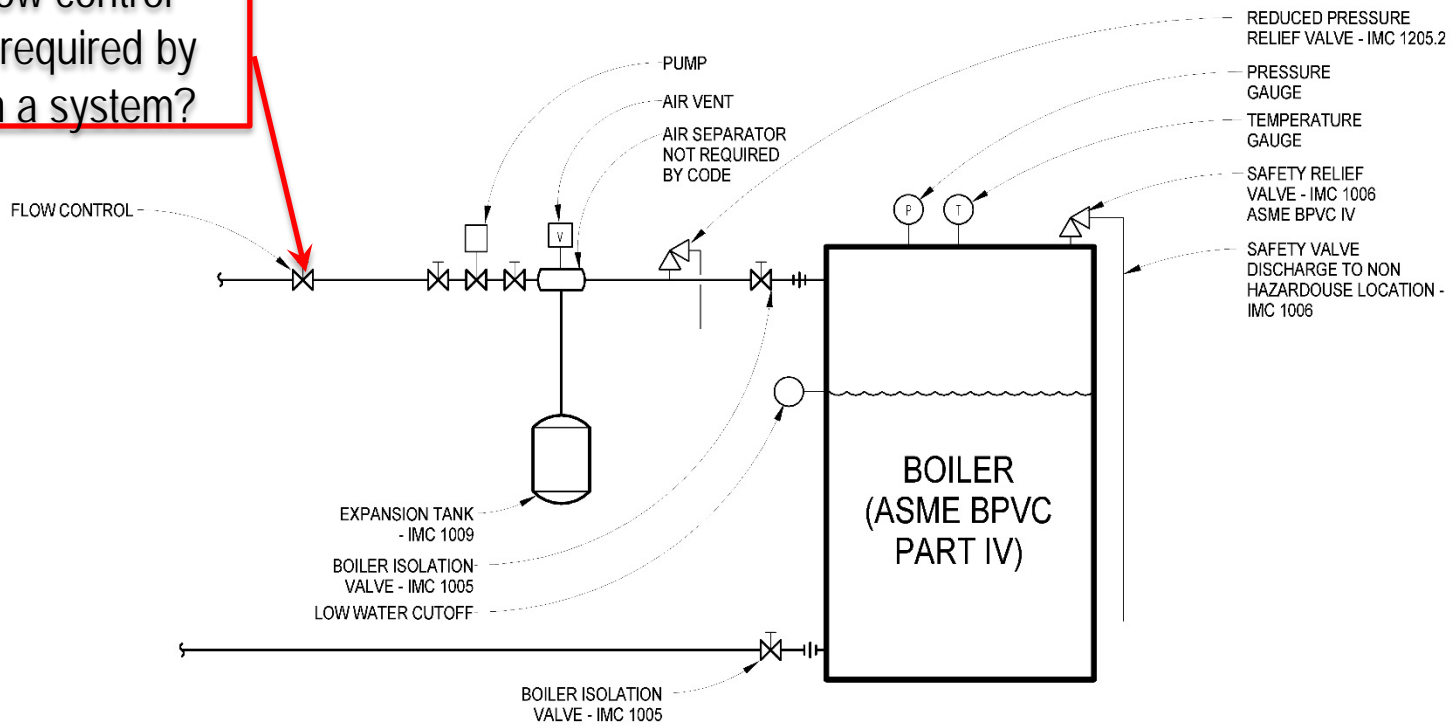
Figure 10-41 In-line air separator with conventional expansion tank.

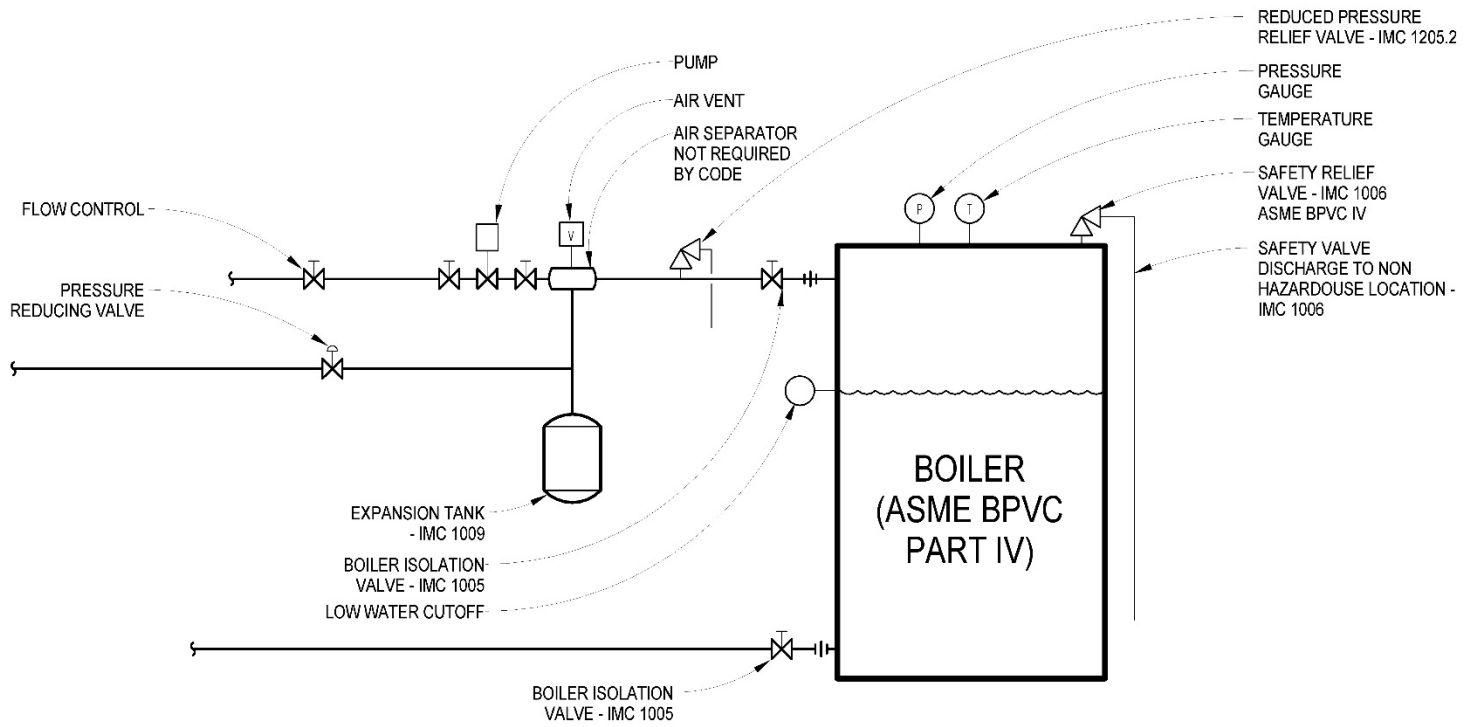
(Courtesy ITT Bell & Gossett)

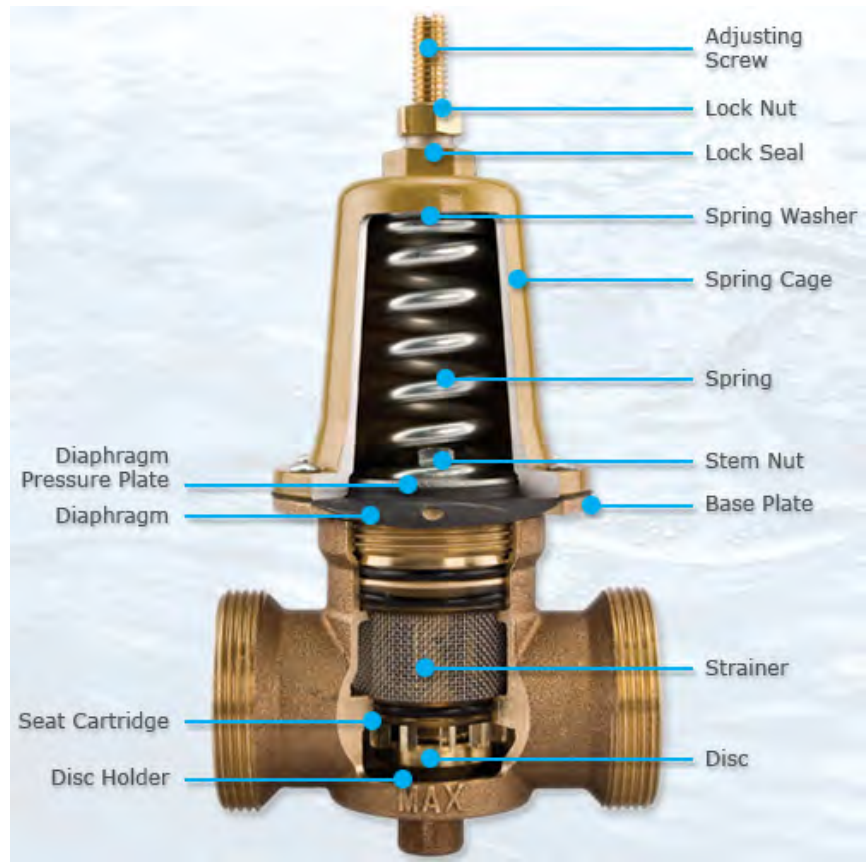
Are service valves required on a pump?

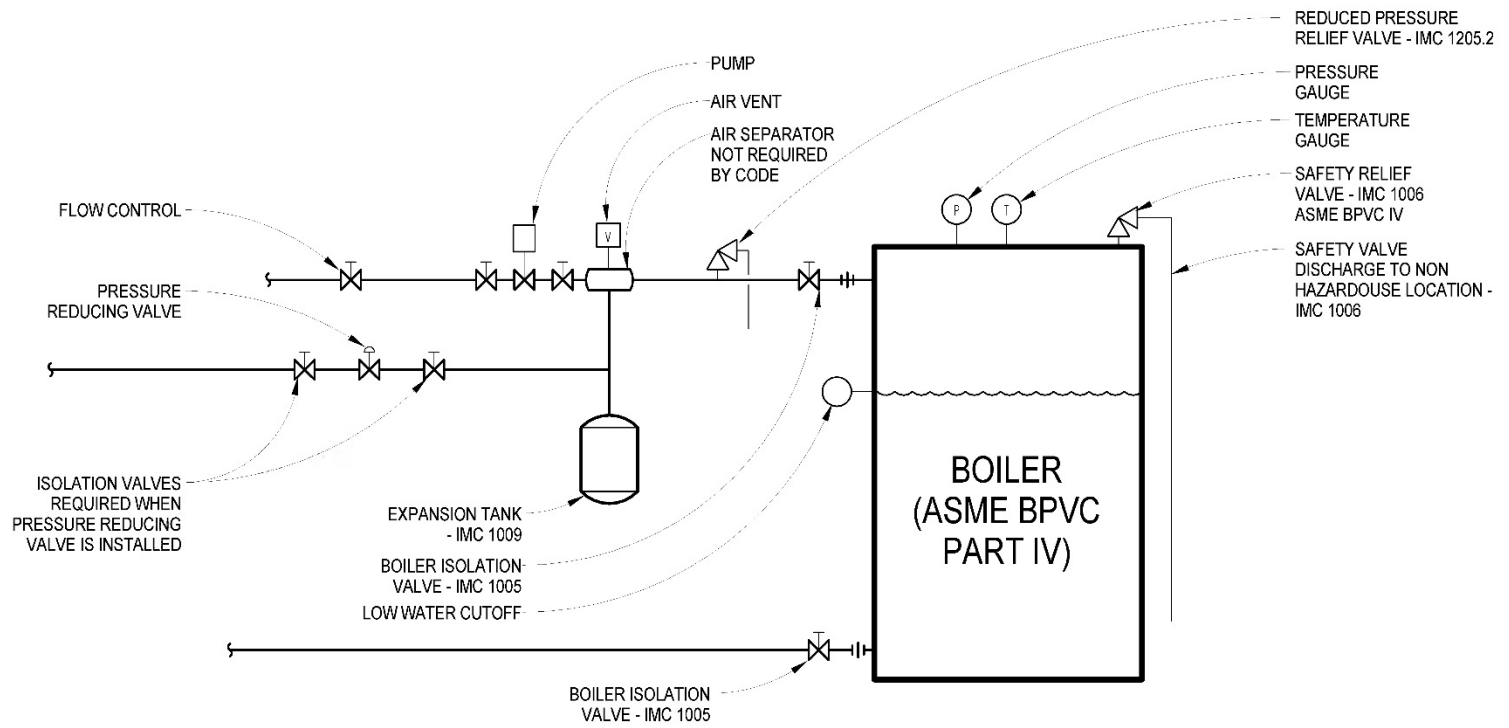


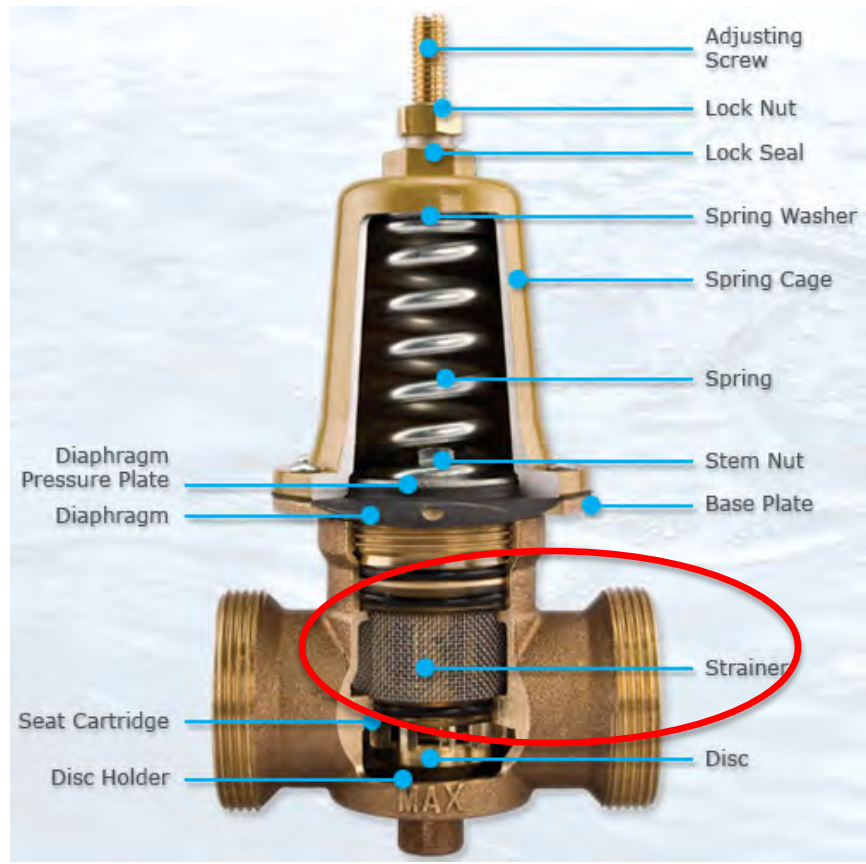
Are flow control valves required by code in a system?

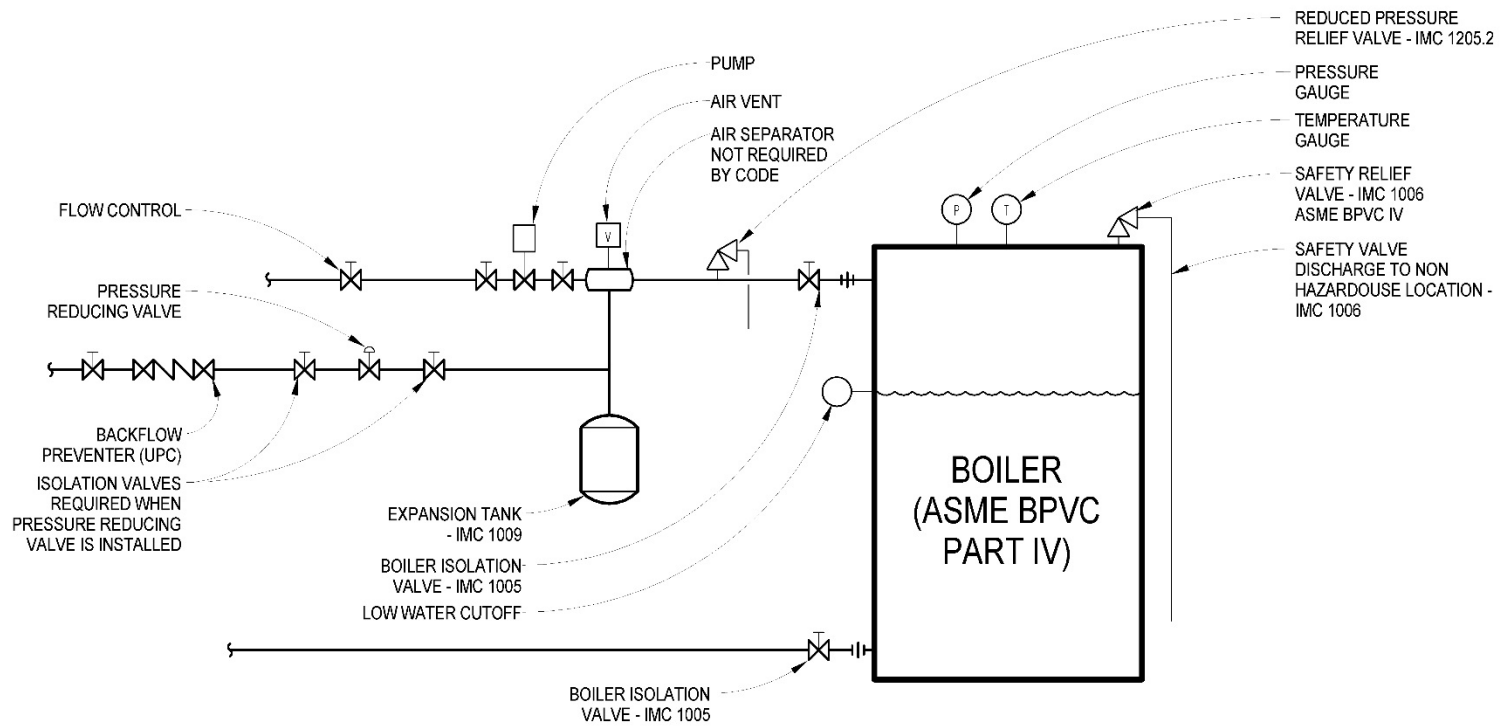




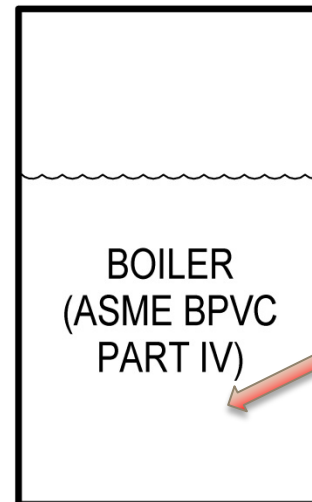








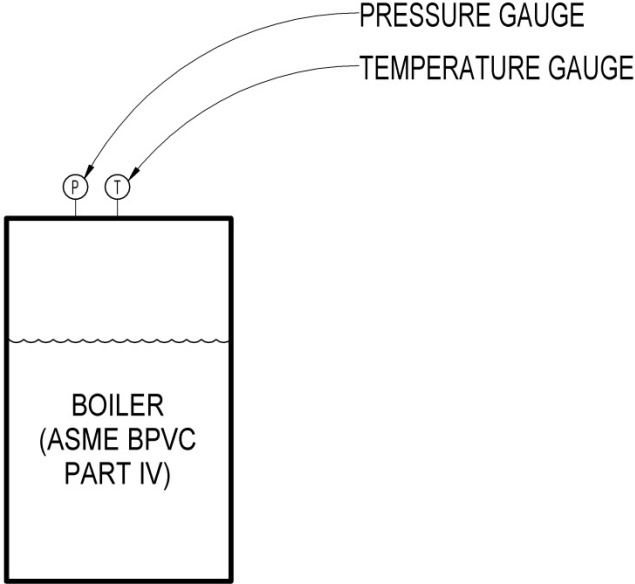
Boiler Piping



ANSI Z21.13 or UL 795

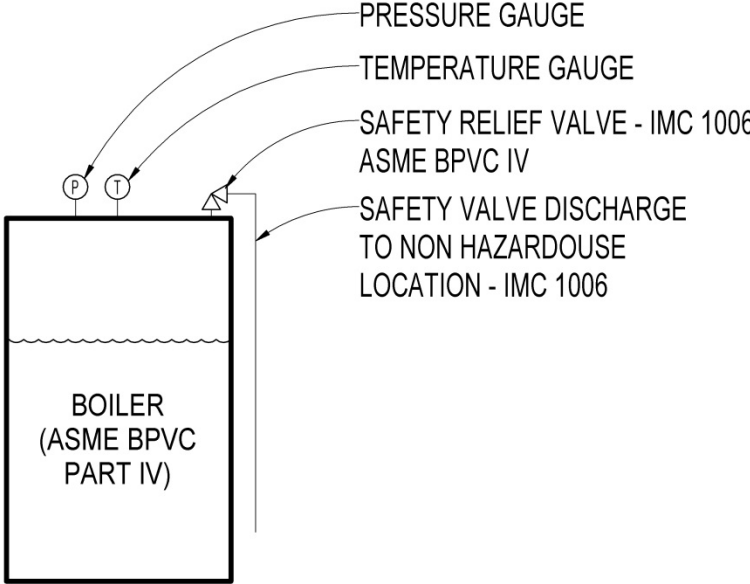
Typical Residential Boilers





Typical gage





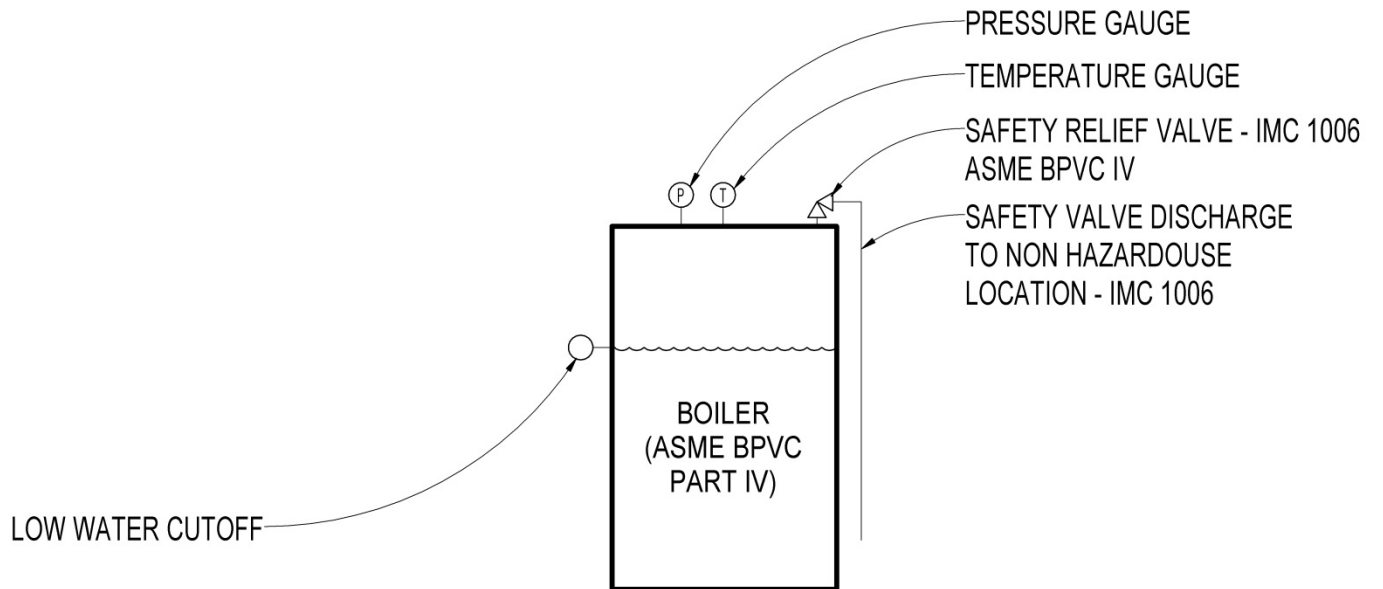


Boiler relief valve piping

Is this a non hazardous location?

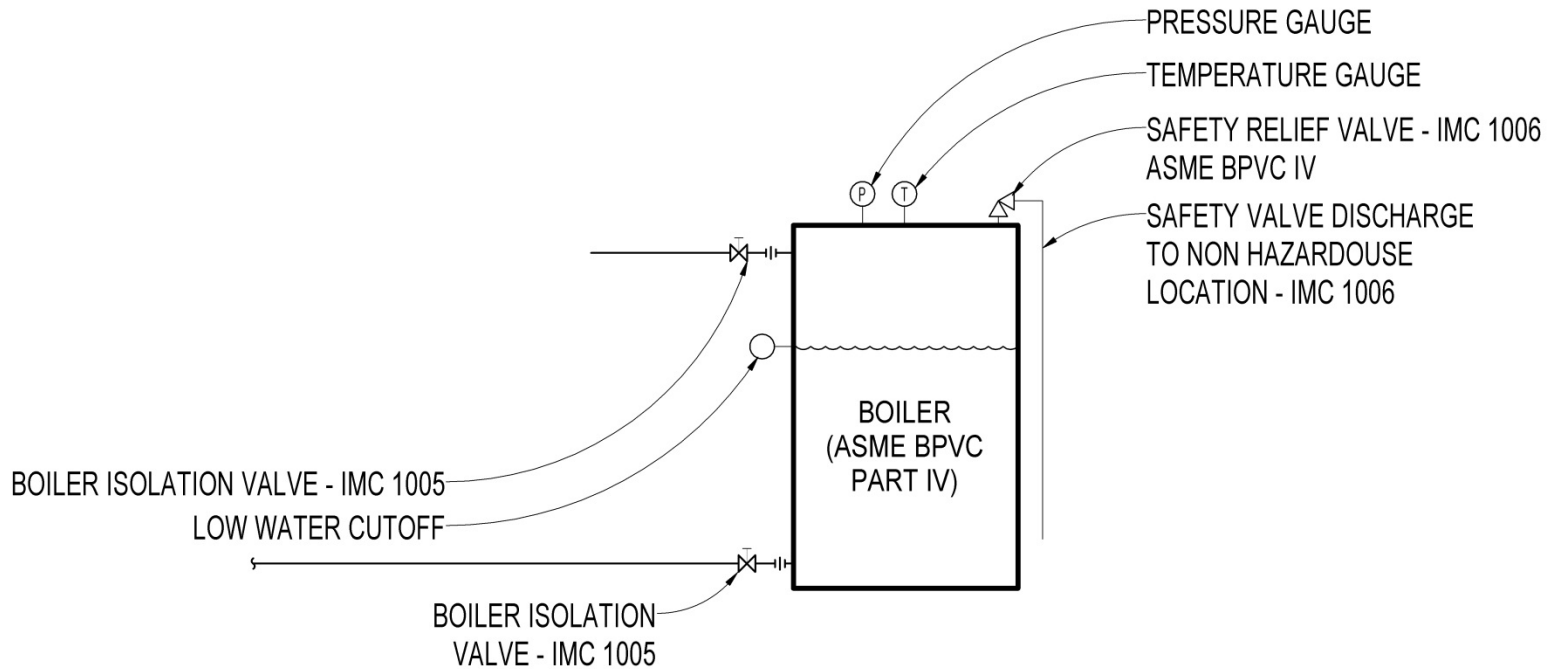


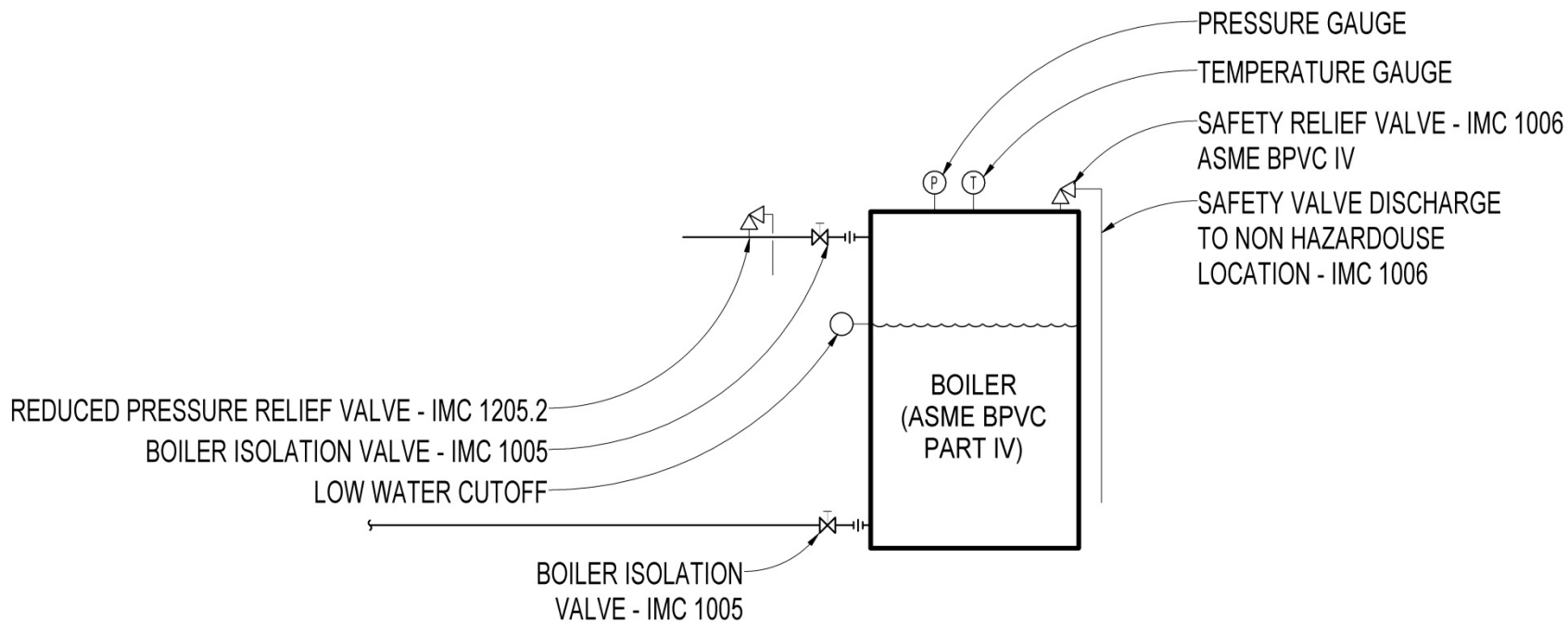




Boiler low water cut off





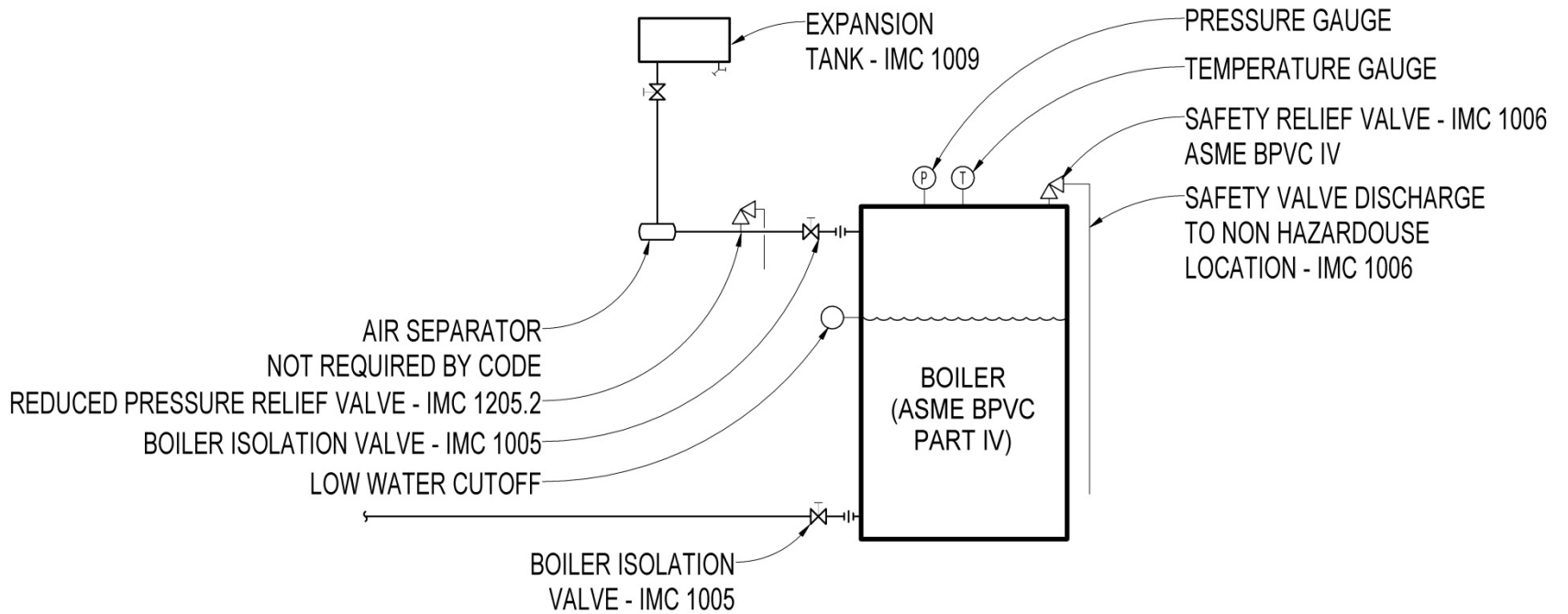


Pressure relief valve

Pressure relief valve

Safety relief valve







Old Fashion Expansion Tank

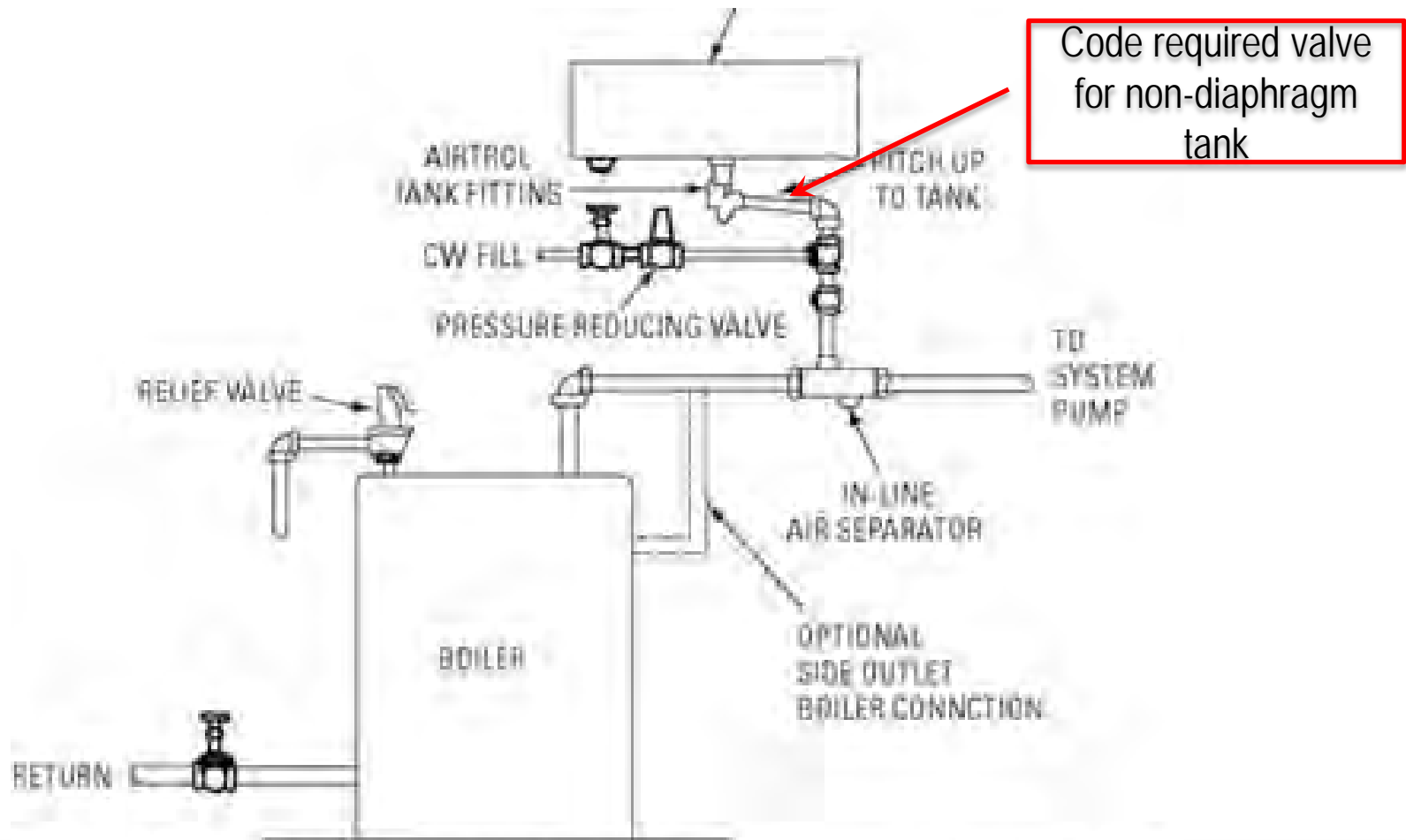
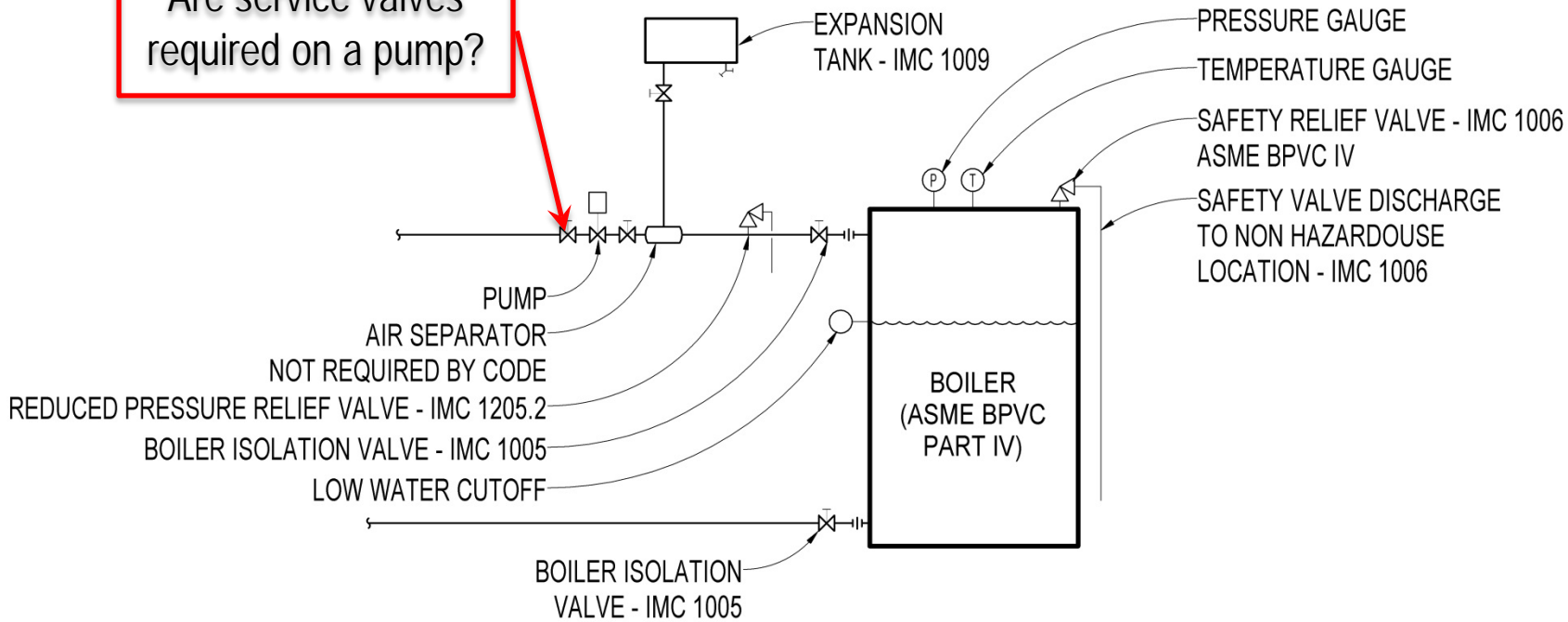
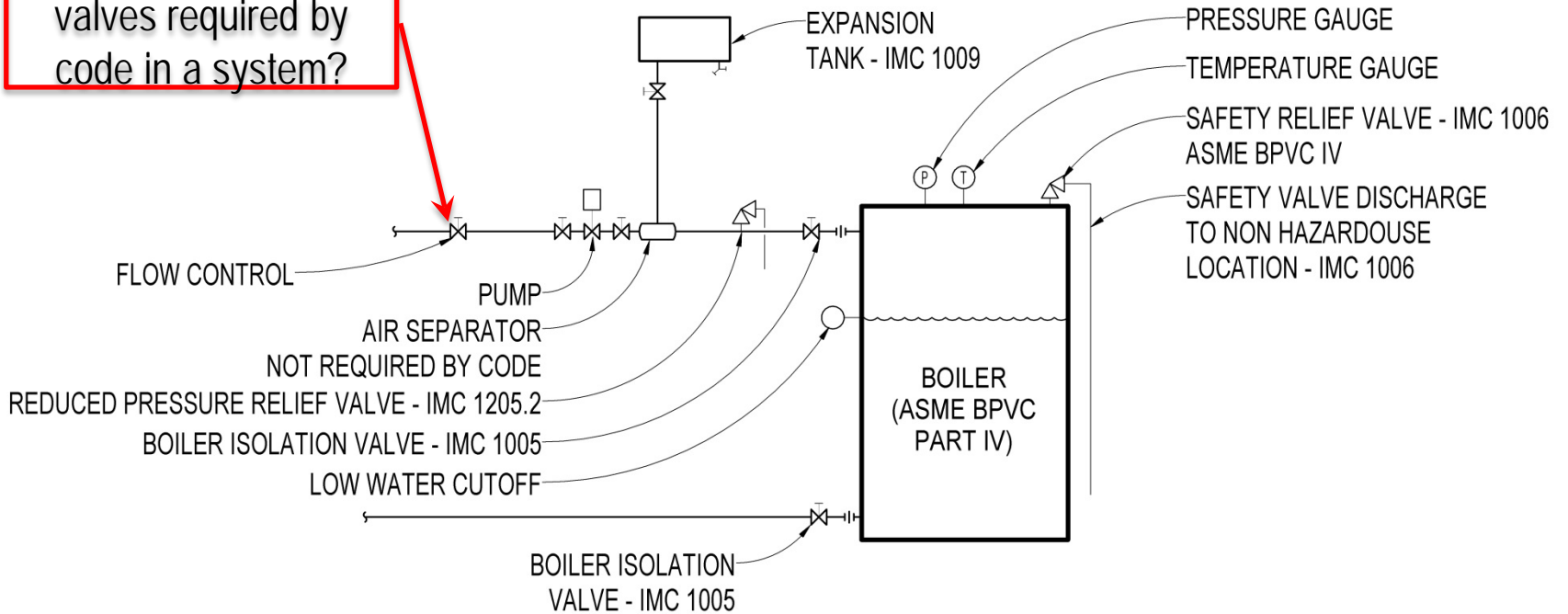


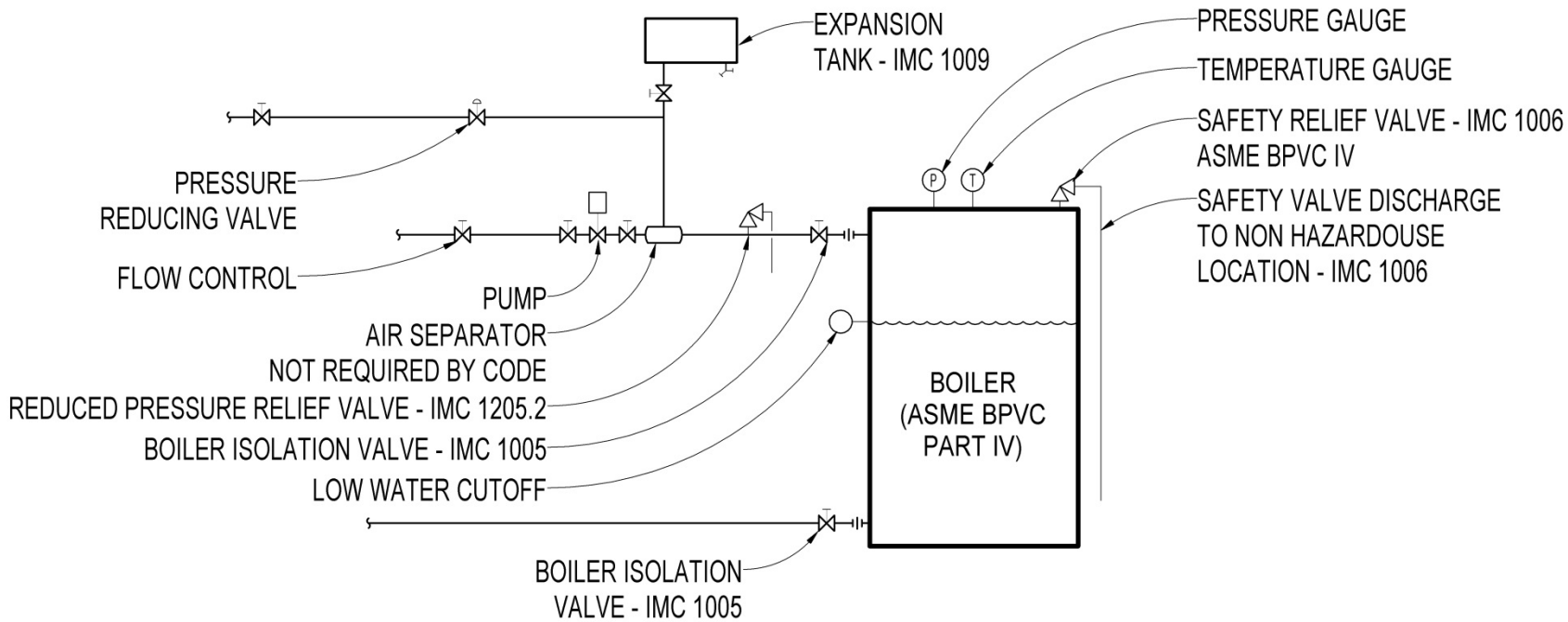
Figure 10-41 Inline air separator with conventional expansion tank.

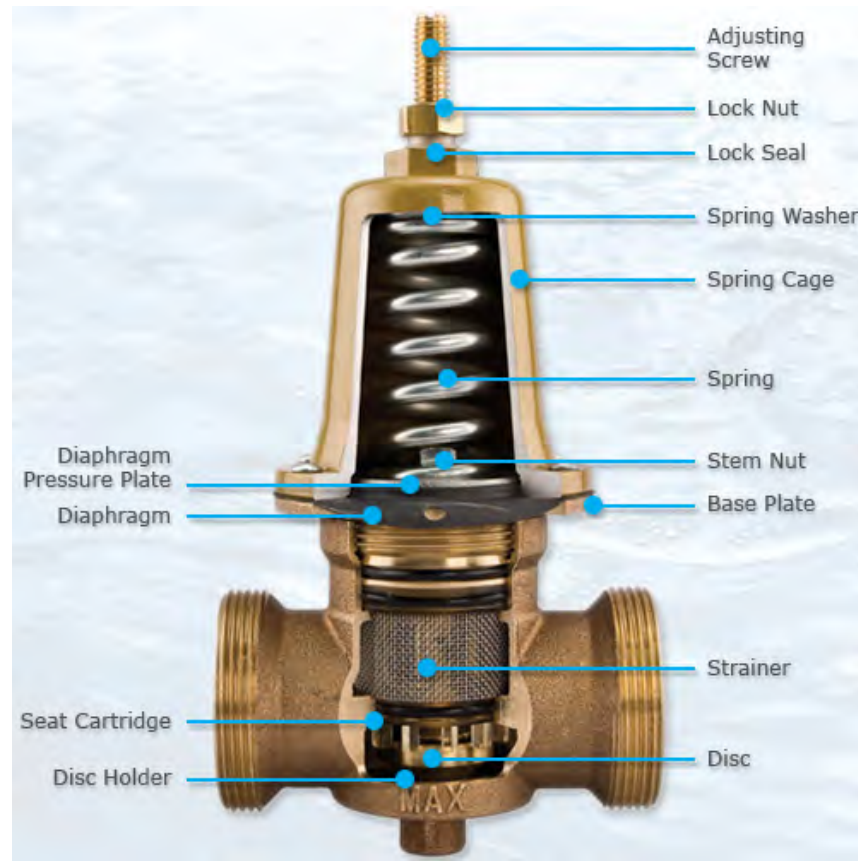
Are service valves required on a pump?



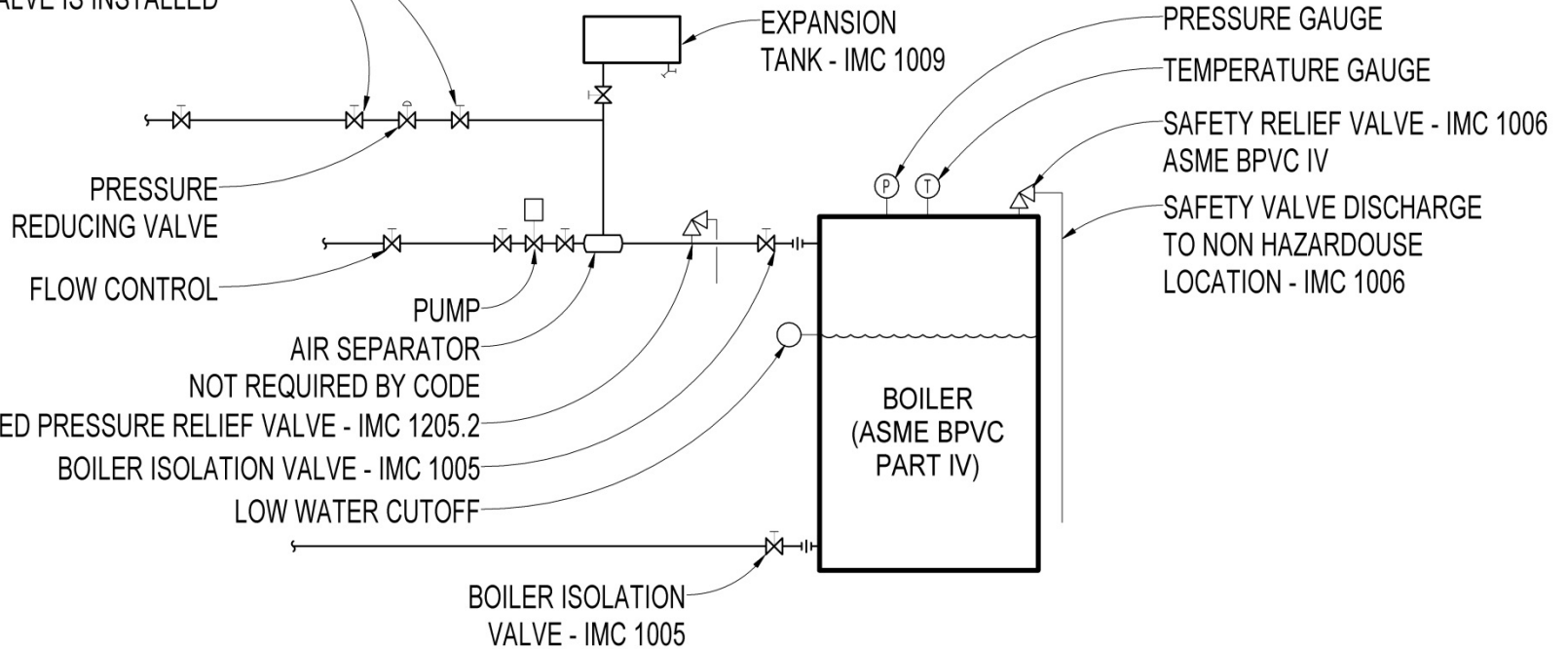
Are flow control valves required by code in a system?

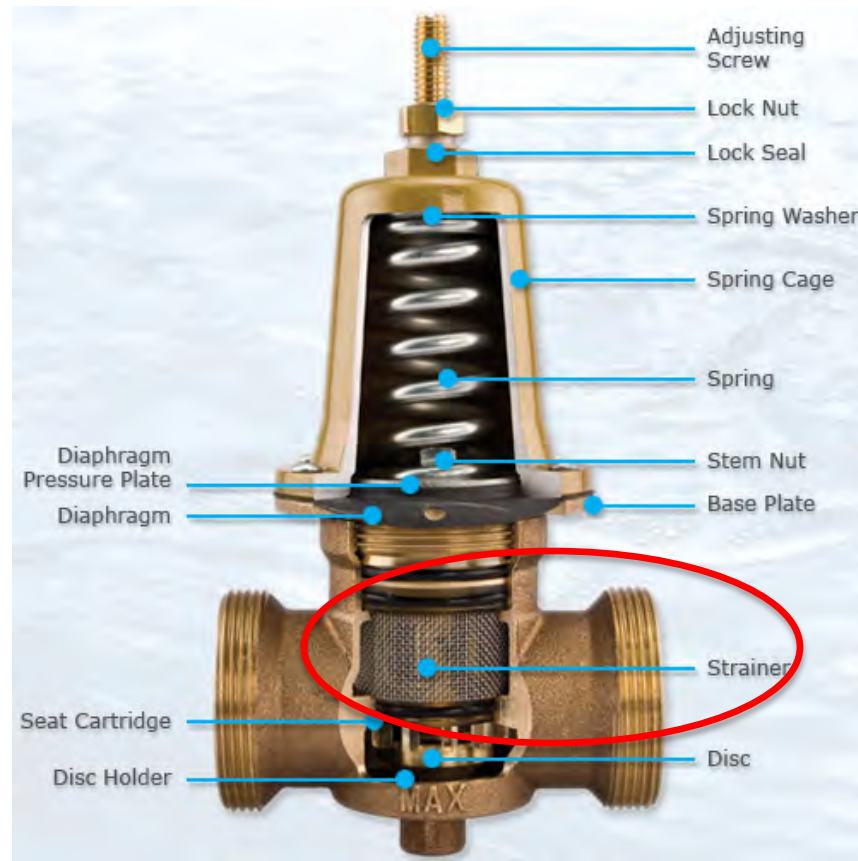


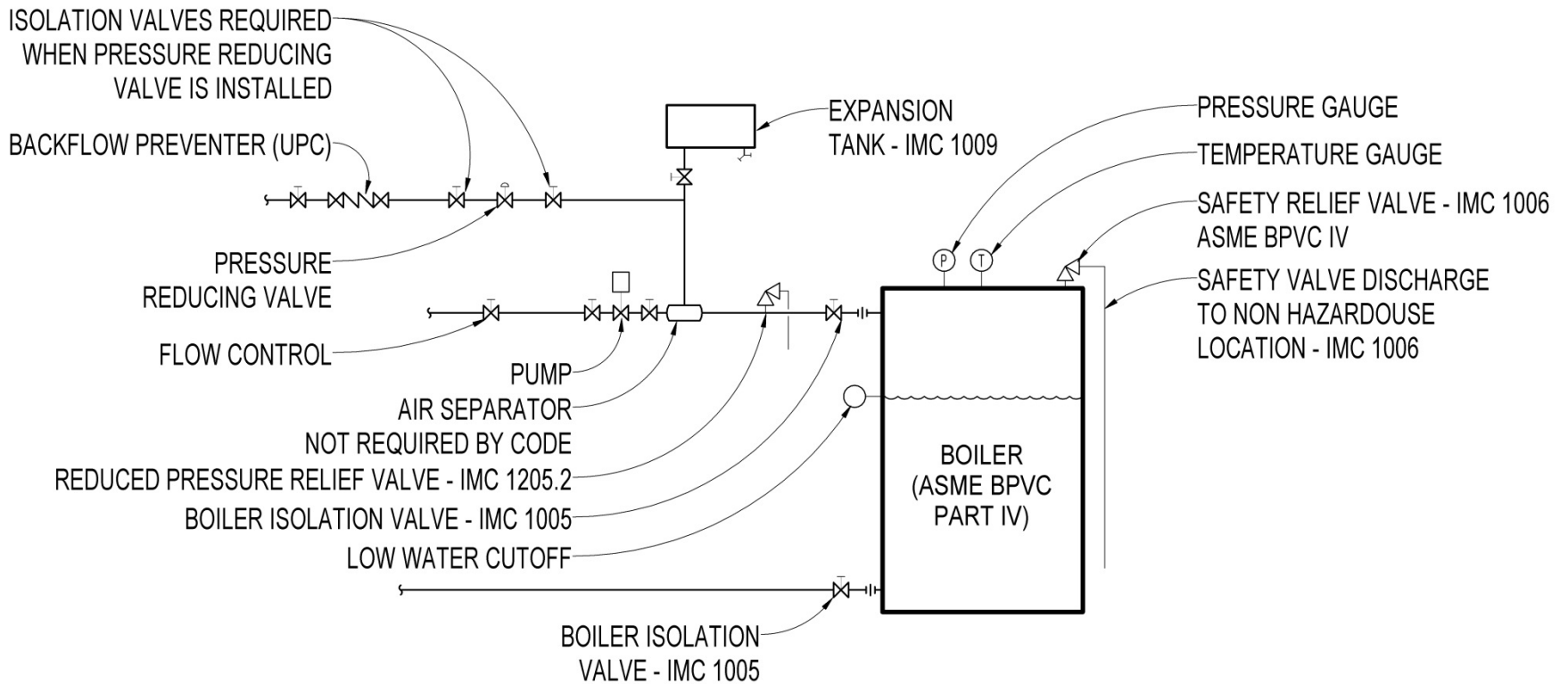




ISOLATION VALVES REQUIRED
WHEN PRESSURE REDUCING
VALVE IS INSTALLED







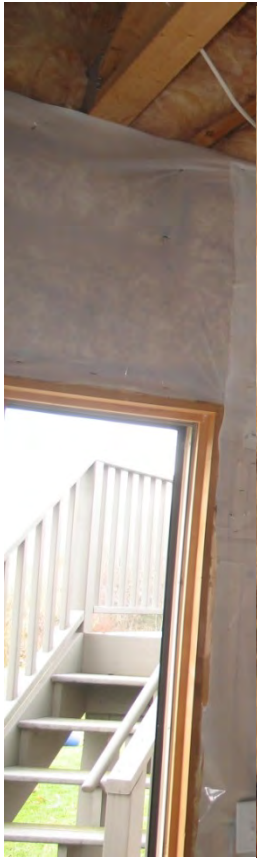
Roof Line



Roof Line



Roof Line



Roof Line

