

# **Boiler Safety Checklist & Preventative Maintenance**

Radiant Realities

Tim Blomdahl

# Pressure Vessel Construction Codes

Boiler MAWP (maximum allowable working pressure) equals the design pressure & maximum safety valve setting of the pressure vessel

## ASME Section 1 Power Boilers

**MAWP Above**

15 PSI Steam

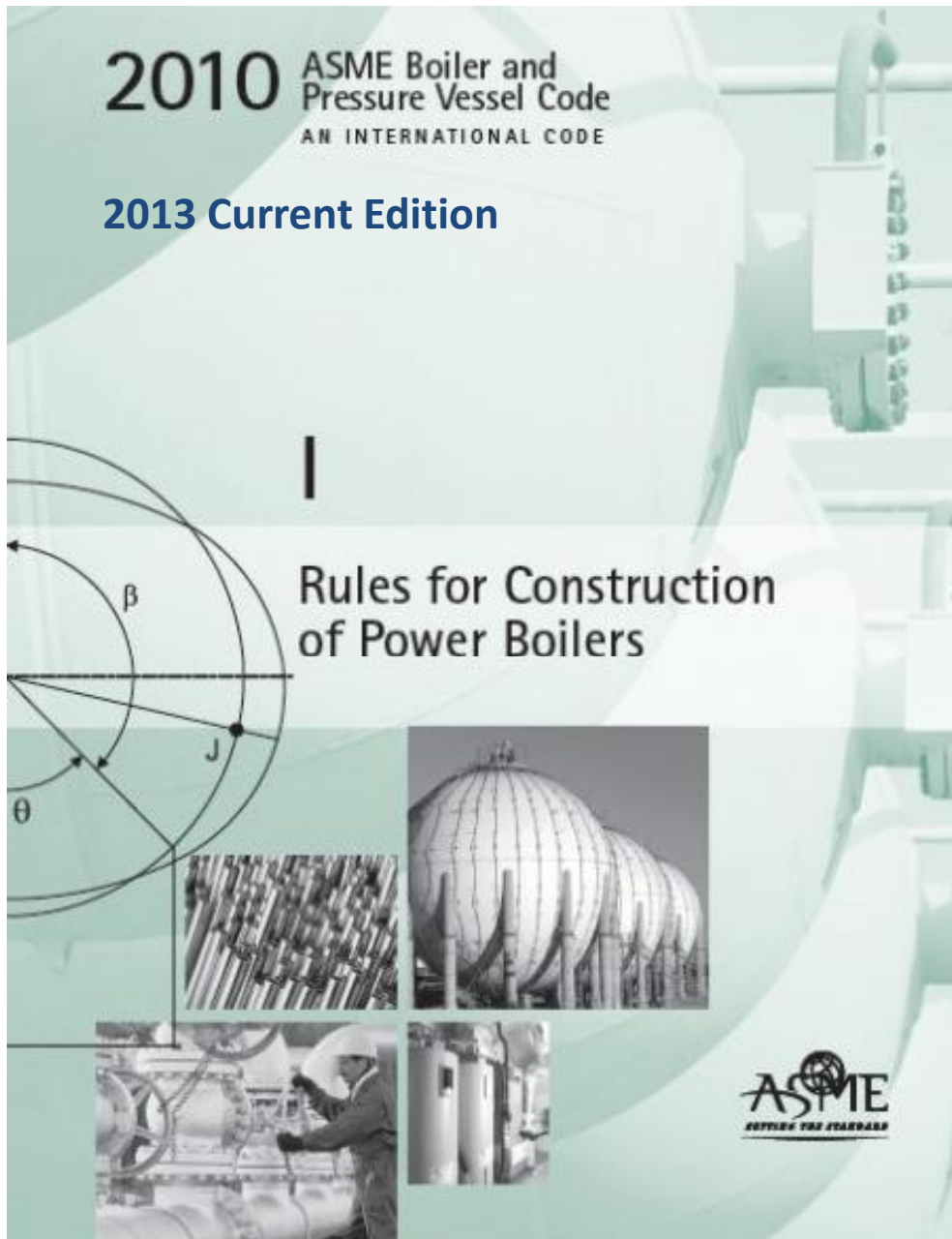
160 PSI Hot Water

250 DEG. F. Hot Water

## ASME Section 4 Heating Boilers

**MAWP Below** 15 Psi Steam





To View Code: Google  
**asme.bpvcl.a.2011.pdf**  
Choose Site  
[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

### Section I- Power Boilers

Has rules for construction of power, electric, and miniature boilers; high temperature water boilers for stationary service; and power boilers for locomotive, portable, and traction service.

CODE  
SYMBOL  
STAMP



**PP: PRESSURE PIPING**  
**S: POWER BOILERS**

**2013** ASME Boiler and  
Pressure Vessel Code  
AN INTERNATIONAL CODE

# IV

## Rules for Construction of Heating Boilers



ASME  
SAFETY THROUGH INNOVATION

To View 2007 Code: [Google](#)  
**[asme.bpvc.iv.2007.pdf](#)**

Choose Site

[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

### Section IV - Heating Boilers

Provides rules for design, fabrication, installation and inspection of steam generating boilers, and low pressure hot water boilers that are directly fired by oil, gas, electricity, or coal.

CODE  
SYMBOL  
STAMP



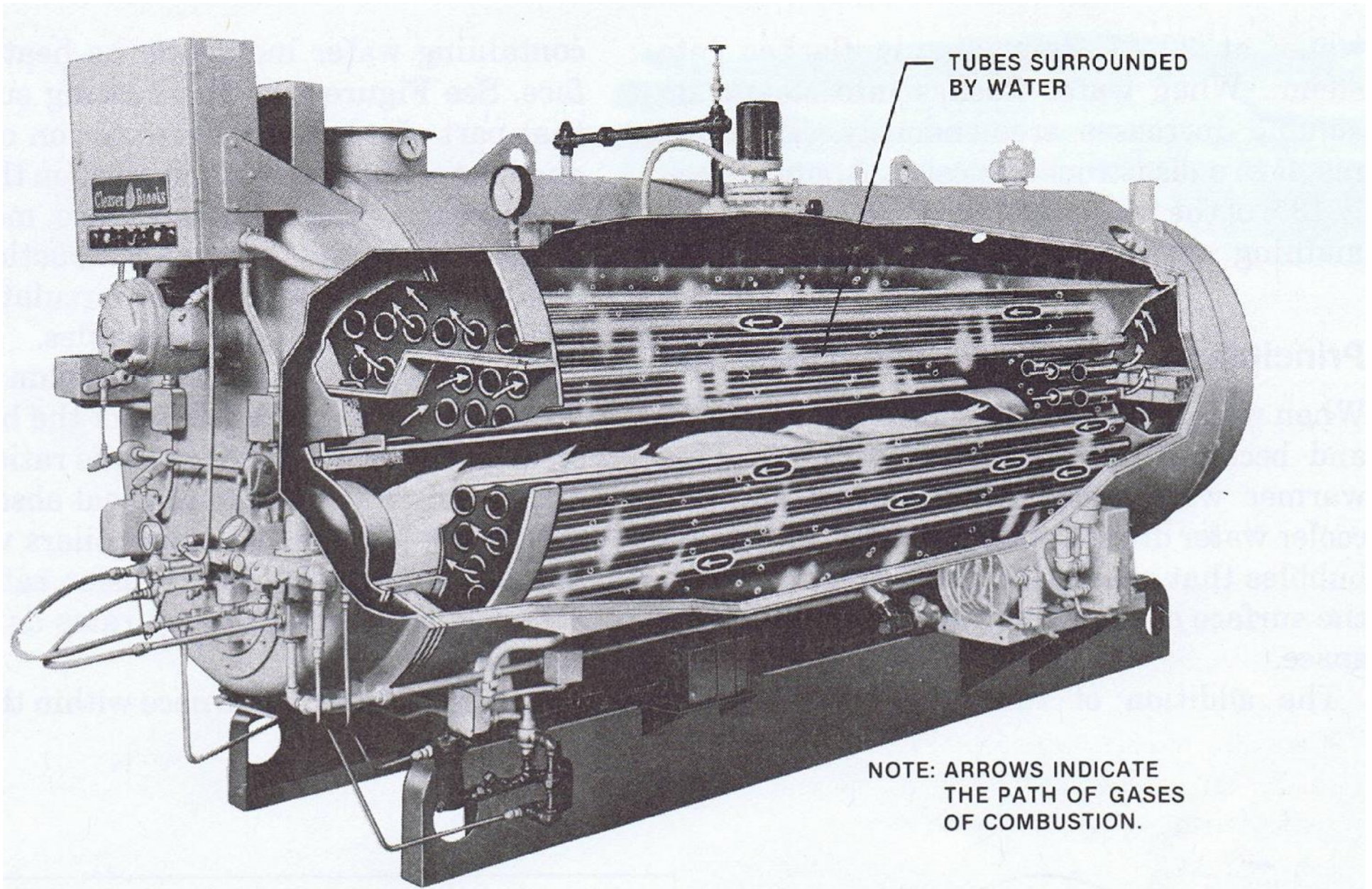
**H: HEATING BOILERS EXCEPT CAST IRON**

**HLW: LINED POTABLE WATER HEATERS**



# Firetube Boilers

# Scotch Marine Firetube Boiler



# **Cleaver Brooks 200 hp Firetube Boiler**

## **Scotch Marine Type**

- Combustion gas travels inside of the tubes
- Two, three or four construction
- 5 sq. ft. of heating surface per boiler hp
- 1000 sq. ft. of fireside heating surface = 200hp
- Natural gas or light oil fired (Typically dual fuel)
- Forced draft burner
- 16,300 lb shipping weight
- 60" diameter shell x 15'-0" long

# Typical 200 hp Boiler Rating

## Firetube Boilers Are Rated By Horsepower (hp)

### Boiler hp is steam output

- 1 boiler hp evaporates 34.5 lbs of water per hour
- 200 hp boiler output ( $200\text{hp} \times 34.5\text{lbs/hr} = 6900$ )
- 6900 lbs of steam per hour output

### Burner Input 42,000 btu per hp

- 8,165,000 Btu fuel input at rated capacity
- 81.7 Therms of gas (100,000 btus per therm)
- 58.3 Gph of light oil (@ 140,000 btus per gal)



# Factor Of Evaporation

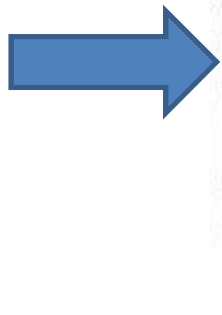
- A 200 hp boiler can evaporate 6900 lbs/hr at 0 psi operating steam pressure and when 212F. Feedwater is supplied to the boiler
- The amount of steam that a boiler can generate is based upon the pressure that it operates at and the temperature of the water that it receives.
- A 200 hp boiler operating at 120psi and 170F. Feedwater= evaporates 31.7lbs/hr=6340 lbs/hr
- $6340/6900 = .918$  @ 92% of its rated capacity



Table I4-10. Factor of Evaporation

Opsig gauge pressure & 212 F. Feedwater = 34.5 lbs/hr of steam per boiler horsepower

| Feed-Water Temp. | Gauge Pressure — psig |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|------------------|-----------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                  | 0                     | 2    | 10   | 15   | 20   | 40   | 50   | 60   | 80   | 100  | 120  | 140  | 150  | 160  | 180  | 200  | 220  | 240  |
| 30               | 29.0                  | 29.0 | 28.8 | 28.7 | 28.6 | 28.4 | 28.3 | 28.2 | 28.2 | 28.1 | 28.0 | 28.0 | 27.9 | 27.9 | 27.9 | 27.9 | 27.9 | 27.8 |
| 40               | 29.3                  | 29.2 | 29.1 | 29.0 | 28.9 | 28.7 | 28.6 | 28.5 | 28.4 | 28.3 | 28.2 | 28.2 | 28.2 | 28.2 | 28.2 | 28.1 | 28.1 | 28.1 |
| 50               | 29.6                  | 29.5 | 29.3 | 29.2 | 29.1 | 28.9 | 28.8 | 28.8 | 28.7 | 28.6 | 28.5 | 28.5 | 28.4 | 28.4 | 28.4 | 28.3 | 28.3 | 28.3 |
| 60               | 29.8                  | 29.8 | 29.6 | 29.5 | 29.4 | 29.2 | 29.1 | 29.0 | 28.9 | 28.8 | 28.8 | 28.7 | 28.7 | 28.6 | 28.6 | 28.6 | 28.6 | 28.5 |
| 70               | 30.1                  | 30.0 | 29.9 | 29.8 | 29.7 | 29.5 | 29.4 | 29.3 | 29.2 | 29.1 | 29.0 | 29.0 | 28.9 | 28.9 | 28.9 | 28.8 | 28.8 | 28.8 |
| 80               | 30.4                  | 30.3 | 30.1 | 30.0 | 30.0 | 29.8 | 29.6 | 29.6 | 29.5 | 29.3 | 29.2 | 29.2 | 29.2 | 29.2 | 29.1 | 29.1 | 29.1 | 29.0 |
| 90               | 30.6                  | 30.6 | 30.4 | 30.3 | 30.2 | 30.0 | 29.9 | 29.8 | 29.7 | 29.6 | 29.5 | 29.5 | 29.4 | 29.4 | 29.4 | 29.3 | 29.3 | 29.3 |
| 100              | 30.9                  | 30.8 | 30.6 | 30.6 | 30.5 | 30.3 | 30.2 | 30.1 | 30.0 | 29.8 | 29.8 | 29.8 | 29.7 | 29.7 | 29.7 | 29.6 | 29.6 | 29.6 |
| 110              | 31.2                  | 31.2 | 30.9 | 30.8 | 30.8 | 30.6 | 30.4 | 30.3 | 30.2 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 29.9 | 29.9 | 29.8 | 29.8 |
| 120              | 31.5                  | 31.4 | 31.2 | 31.2 | 31.1 | 30.8 | 30.7 | 30.6 | 30.5 | 30.4 | 30.3 | 30.3 | 30.2 | 30.2 | 30.2 | 30.1 | 30.1 | 30.1 |
| 130              | 31.8                  | 31.7 | 31.5 | 31.4 | 31.4 | 31.1 | 31.0 | 30.9 | 30.8 | 30.7 | 30.6 | 30.6 | 30.5 | 30.5 | 30.4 | 30.4 | 30.4 | 30.4 |
| 140              | 32.1                  | 32.0 | 31.8 | 31.7 | 31.6 | 31.4 | 31.3 | 31.2 | 31.1 | 31.0 | 30.9 | 30.8 | 30.8 | 30.8 | 30.8 | 30.7 | 30.7 | 30.6 |
| 150              | 32.4                  | 32.4 | 32.1 | 32.0 | 31.9 | 31.7 | 31.6 | 31.5 | 31.4 | 31.2 | 31.2 | 31.2 | 31.1 | 31.1 | 31.0 | 31.0 | 30.9 | 30.9 |
| 160              | 32.7                  | 32.7 | 32.4 | 32.4 | 32.3 | 32.0 | 31.9 | 31.8 | 31.7 | 31.5 | 31.4 | 31.4 | 31.4 | 31.4 | 31.3 | 31.3 | 31.2 | 31.2 |
| 170              | 33.0                  | 33.0 | 32.7 | 32.6 | 32.6 | 32.3 | 32.2 | 32.1 | 32.0 | 31.8 | 31.7 | 31.7 | 31.7 | 31.6 | 31.6 | 31.6 | 31.5 | 31.5 |
| 180              | 33.4                  | 33.3 | 33.0 | 33.0 | 32.9 | 32.6 | 32.5 | 32.4 | 32.3 | 32.2 | 32.1 | 32.0 | 32.0 | 32.0 | 31.9 | 31.9 | 31.8 | 31.8 |
| 190              | 33.8                  | 33.7 | 33.4 | 33.3 | 33.2 | 32.9 | 32.8 | 32.7 | 32.6 | 32.5 | 32.4 | 32.4 | 32.3 | 32.3 | 32.2 | 32.2 | 32.1 | 32.1 |
| 200              | 34.1                  | 34.0 | 33.7 | 33.6 | 33.5 | 33.2 | 33.1 | 33.0 | 32.9 | 32.8 | 32.7 | 32.6 | 32.6 | 32.6 | 32.6 | 32.5 | 32.4 | 32.4 |
| 212              | 34.5                  | 34.4 | 34.2 | 34.1 | 33.8 | 33.6 | 33.5 | 33.4 | 33.3 | 33.2 | 33.1 | 33.0 | 33.0 | 33.0 | 32.9 | 32.9 | 32.8 | 32.8 |
| 220              | 34.8                  | 34.7 | 34.4 | 34.3 | 34.2 | 33.9 | 33.8 | 33.7 | 33.5 | 33.4 | 33.3 | 33.3 | 33.2 | 33.2 | 33.1 | 33.1 | 33.1 | 33.0 |
| 227              | 35.0                  | 34.9 | 34.7 | 34.5 | 34.4 | 34.1 | 34.0 | 33.9 | 33.8 | 33.7 | 33.6 | 33.5 | 33.5 | 33.4 | 33.4 | 33.3 | 33.3 | 33.3 |
| 230              | 35.2                  | 35.0 | 34.8 | 34.7 | 34.5 | 34.2 | 34.1 | 34.0 | 33.9 | 33.8 | 33.7 | 33.6 | 33.6 | 33.5 | 33.5 | 33.4 | 33.4 | 33.4 |



# **200 hp Boiler Water Side**

## **At Normal operating water level (NOWL)**

- A Cleaver Brooks boiler holds 8,625 pounds of water or 1,034 gallons.
- The minimum safe operating water level is typically 3" above the tubes. (Any less compromises the structural integrity of the boiler).

# Boiler Evaporation Rate

- 200 hp boiler can evaporate 831 gals per hour or 13.85 gpm.
- $831\text{gals}/1034\text{ gals in the boiler} = .8036$
- 80% of boilers total water volume could be evaporated in one hour at the boilers rated output capacity if no water was added to the boiler.



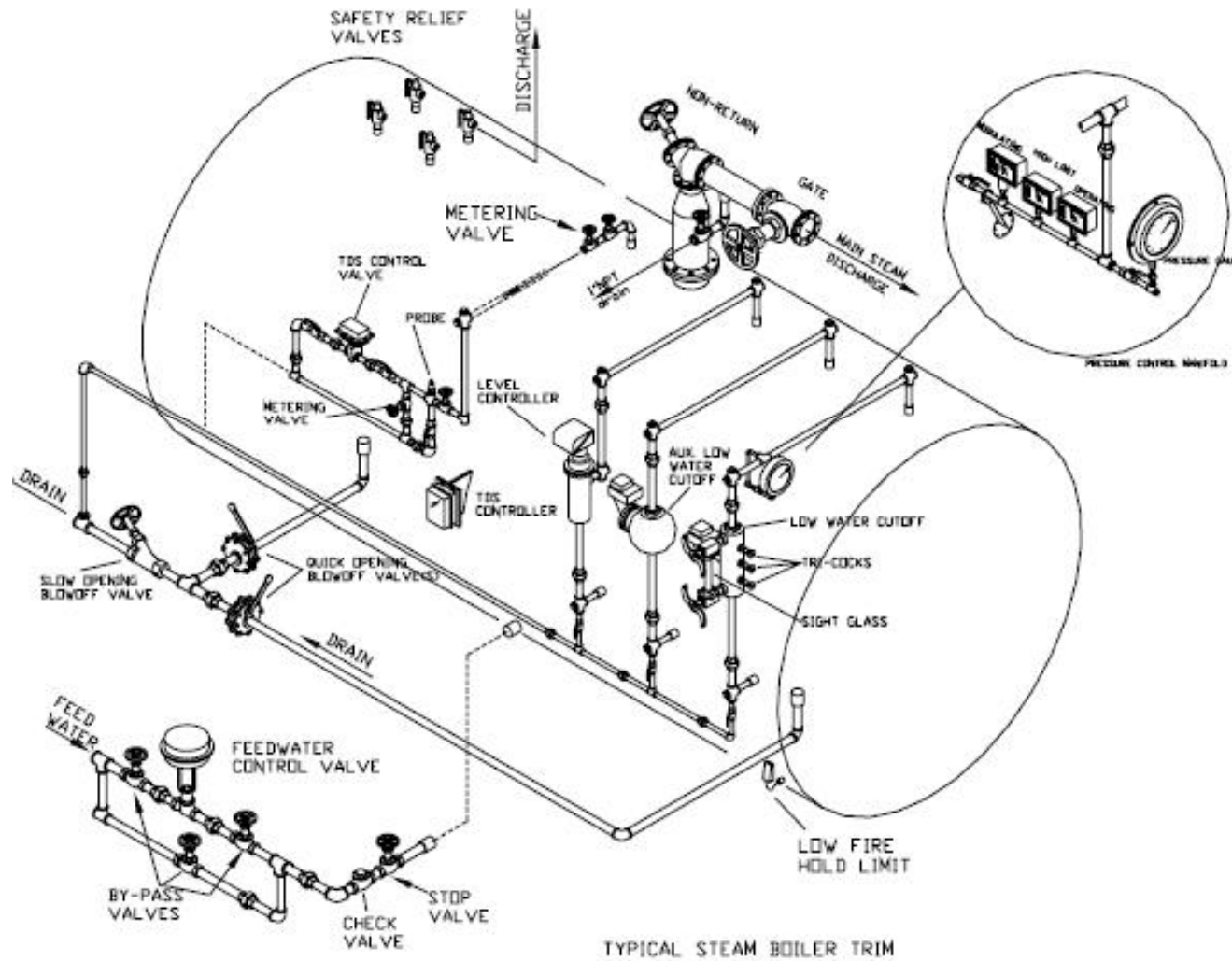








# Steam and Water Trim



# Steam Boiler

## Ancillary Equipment

Water Filters  
Water Softeners  
Chemical Feeders  
Packaged Feedwater Systems  
Blowdown Separators

# Fresh Water & Water Treatment

**Most steam systems need fresh water make-up**

- Water filters are used to remove impurities
- Water softeners are used to remove hardness
- Chemicals are also used to remove hardness

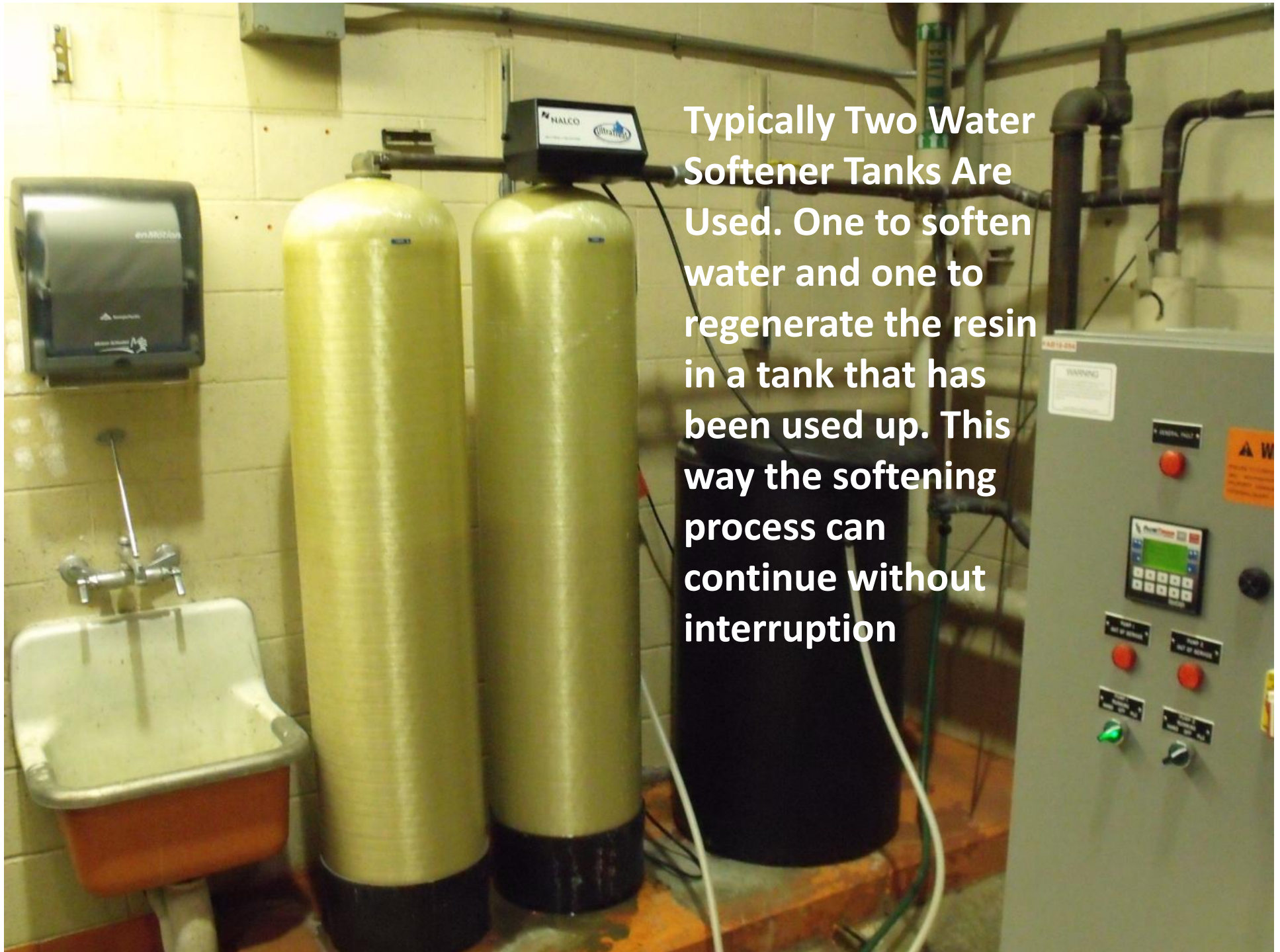




**Figure 1-24: Water Filter**



**Figure 1-25: Water Conditioners**



Typically Two Water Softener Tanks Are Used. One to soften water and one to regenerate the resin in a tank that has been used up. This way the softening process can continue without interruption



Salt for regeneration



## Water Softeners

Water hardness or (calcium and magnesium) is an issue.

- A water softer is an ion exchange system. The water leaves the softener with sodium compounds verses calcium and magnesium.
- A very common water softener has a resin material in it that is changed to calcium and magnesium zeolite and is **regenerated with salt** or sodium chloride for the zeolite.

## Treat water per mfg. recommendations

Typical water hardness allowed. (Firetube boilers)

- 50-75ppm for 100psi steam
- 20ppm for 200psi steam

## Definition of 75 parts per million (ppm)

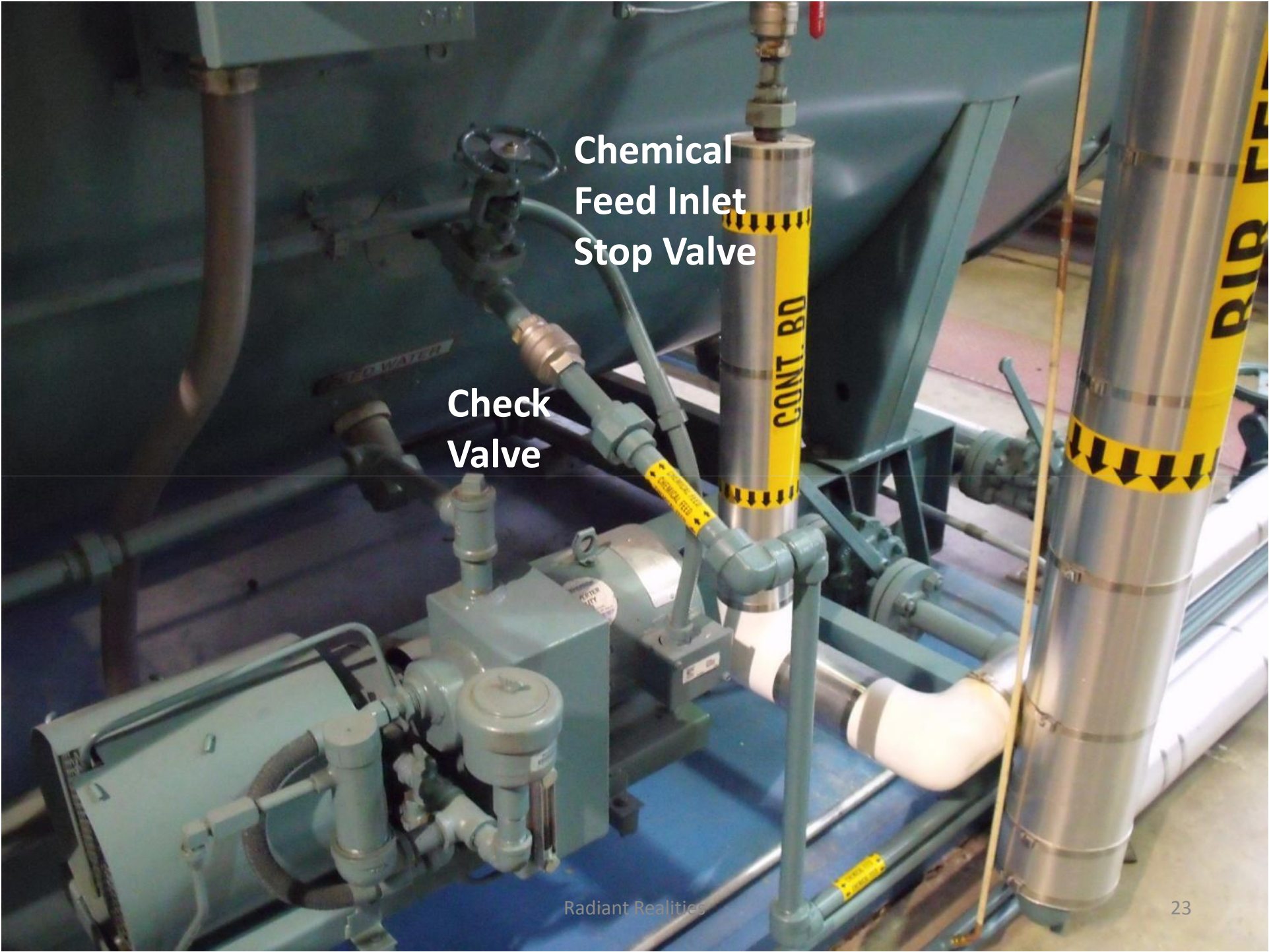
For every million pounds of water, 75 lbs of dry solids are dissolved in the water.



# Packaged Chemical Feed System

- Storage Tank
- Electric motorized agitator
- Low flow high head chemical metering pump





Chemical  
Feed Inlet  
Stop Valve

The image shows a complex industrial setup. A large vertical stainless steel pipe is the central feature, with a yellow label that reads 'CONT. BD' and a black and white hazard symbol. To its left, a network of pipes and valves is visible, including a check valve. The entire system is mounted on a blue base. The background is a dark, industrial environment.

Check  
Valve



## **Chemicals Used To Treat Water Hardness**

- Caustic soda and phosphate is used to change calcium and magnesium scale forming components into non-adhering sludge that falls to the bottom of the boiler for removal by bottom blowdown.

## **Scale**

- 1/16" scale = 15% fuel increase.
- Scale slows down heat transfer through the tubes, the tubes overheat and shorten the operating life of the tubes.



# Chemicals Are Used To Minimize Oxygen Corrosion

## Air in ambient temperature water is an issue!

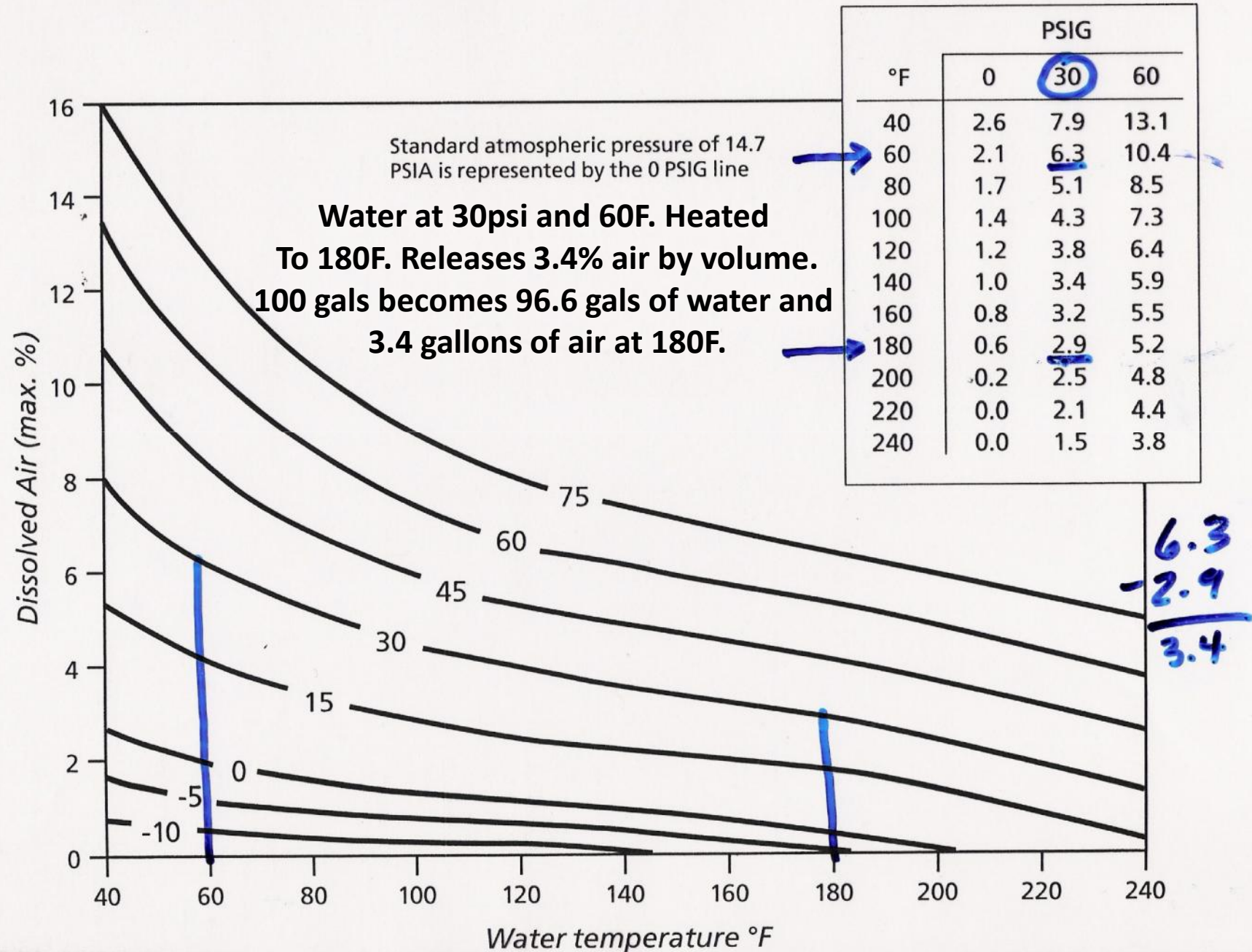
- Untreated water contains dissolved oxygen and other gasses that promote corrosion and pitting of metal boiler components.
- **Heat also helps removes dissolved oxygen in water.**

When water is heated air comes out of solution.

- **Sodium sulfite** oxygen scavengers combine with oxygen to form harmless compounds. Sodium sulfite forms sodium sulfate and is removed by bottom blowdown.

# Solubility of Air in Water

as a function of temperature and pressure



## **Boiler pH**

- Maintain Boiler pH between 9-10.5
- Alkalinity should be kept below **11** to prevent priming and foaming

## **Condensate Return pH**

- Maintain Condensate return pH between 7.4-8.4 alkalinity

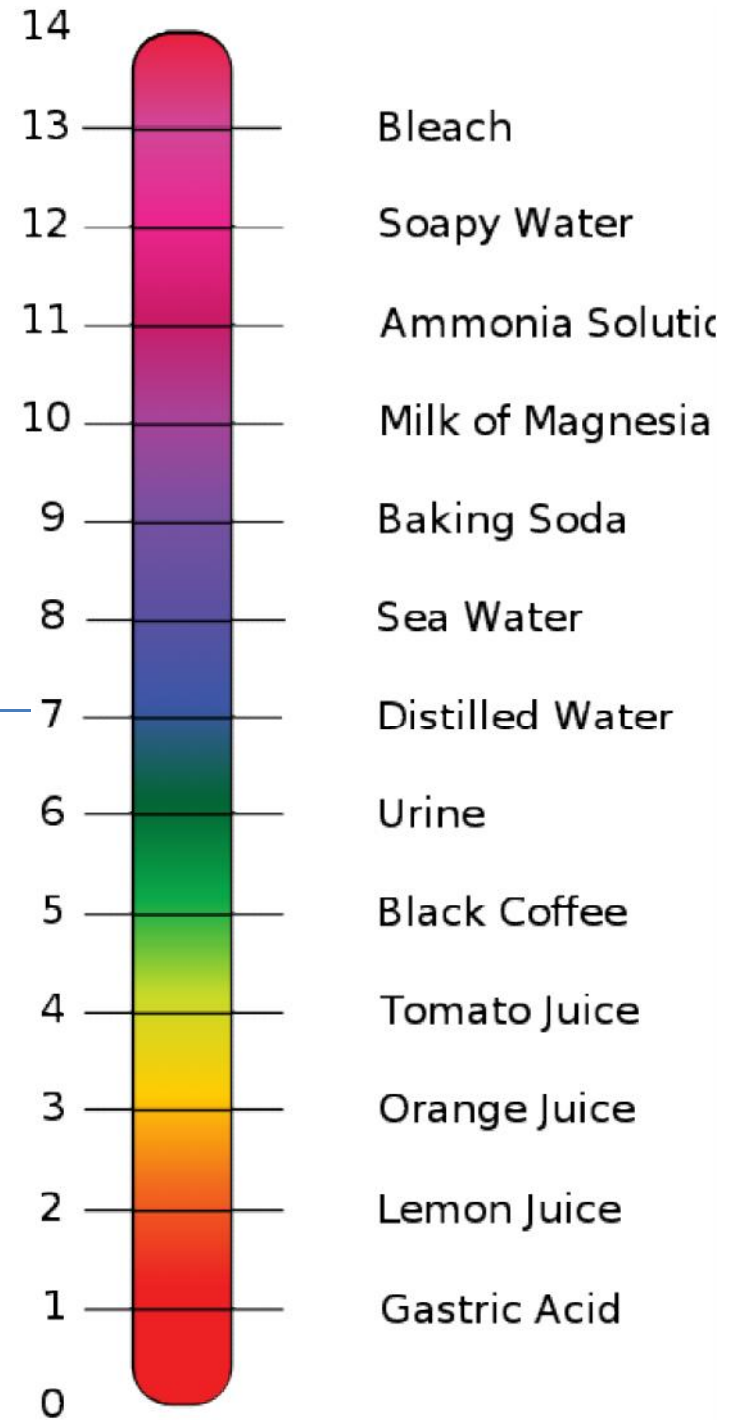


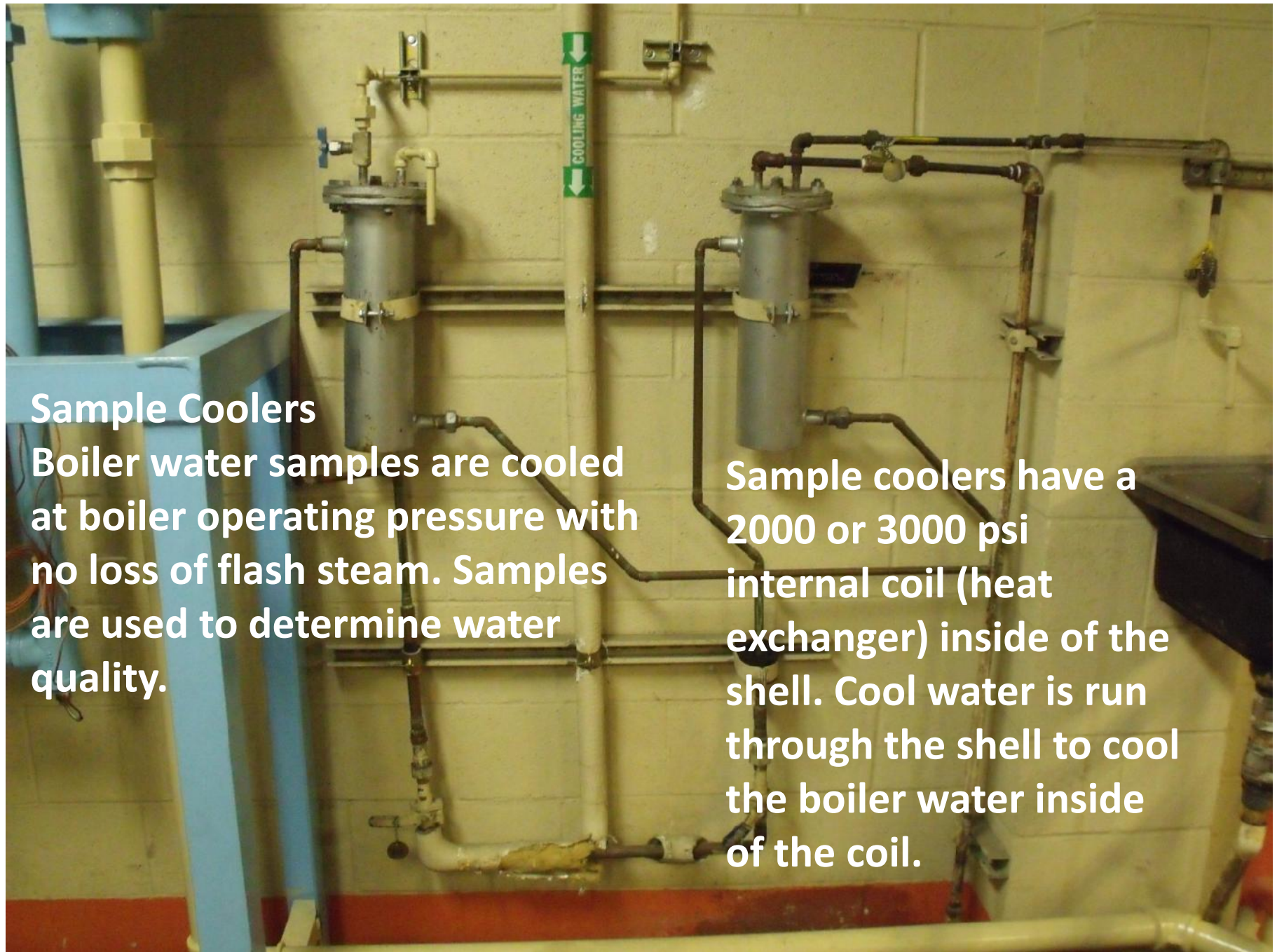
# pH Scale

PH 7 is Neutral

Alkalinity

Acidity





## Sample Coolers

Boiler water samples are cooled at boiler operating pressure with no loss of flash steam. Samples are used to determine water quality.

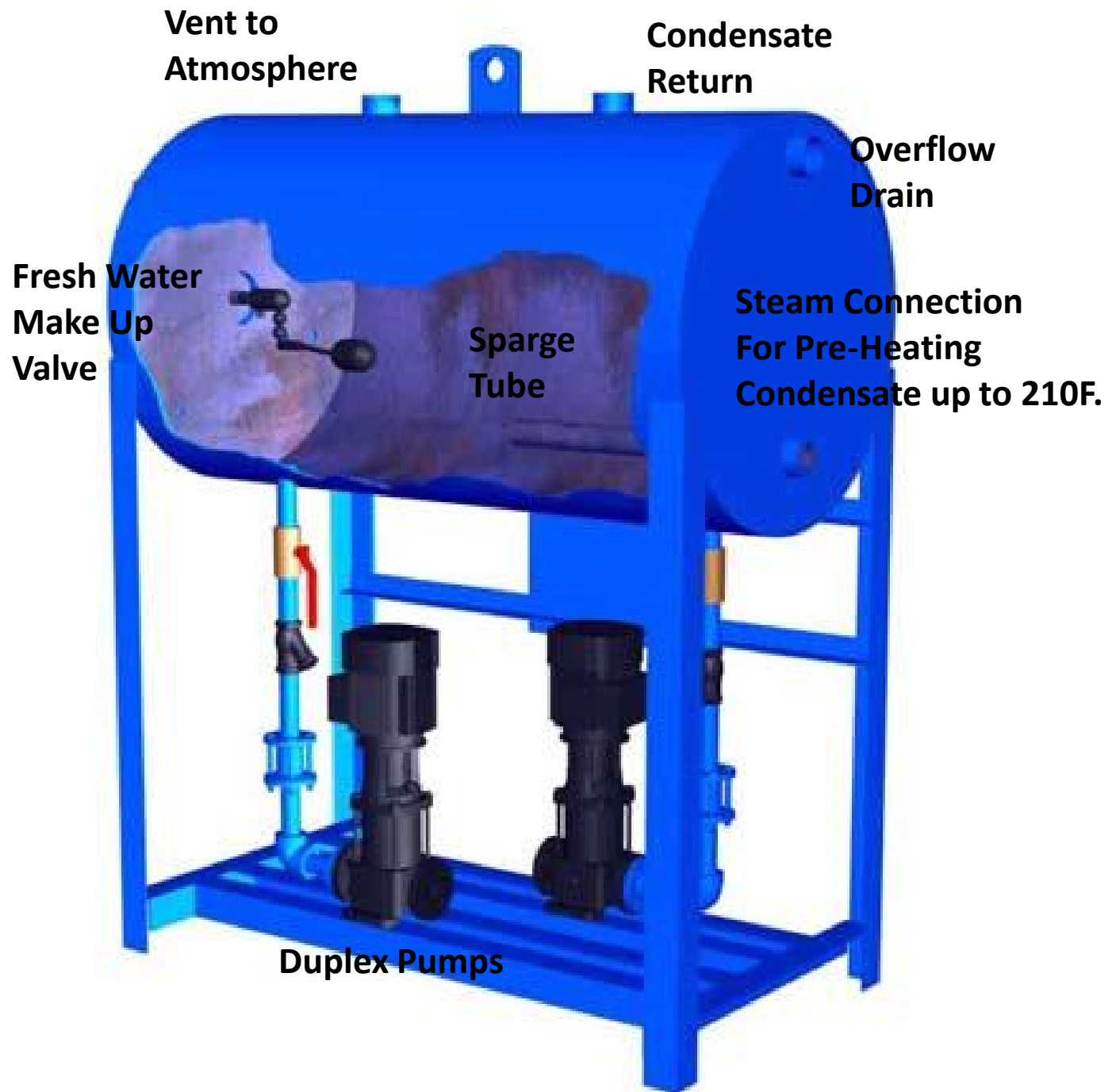
Sample coolers have a 2000 or 3000 psi internal coil (heat exchanger) inside of the shell. Cool water is run through the shell to cool the boiler water inside of the coil.

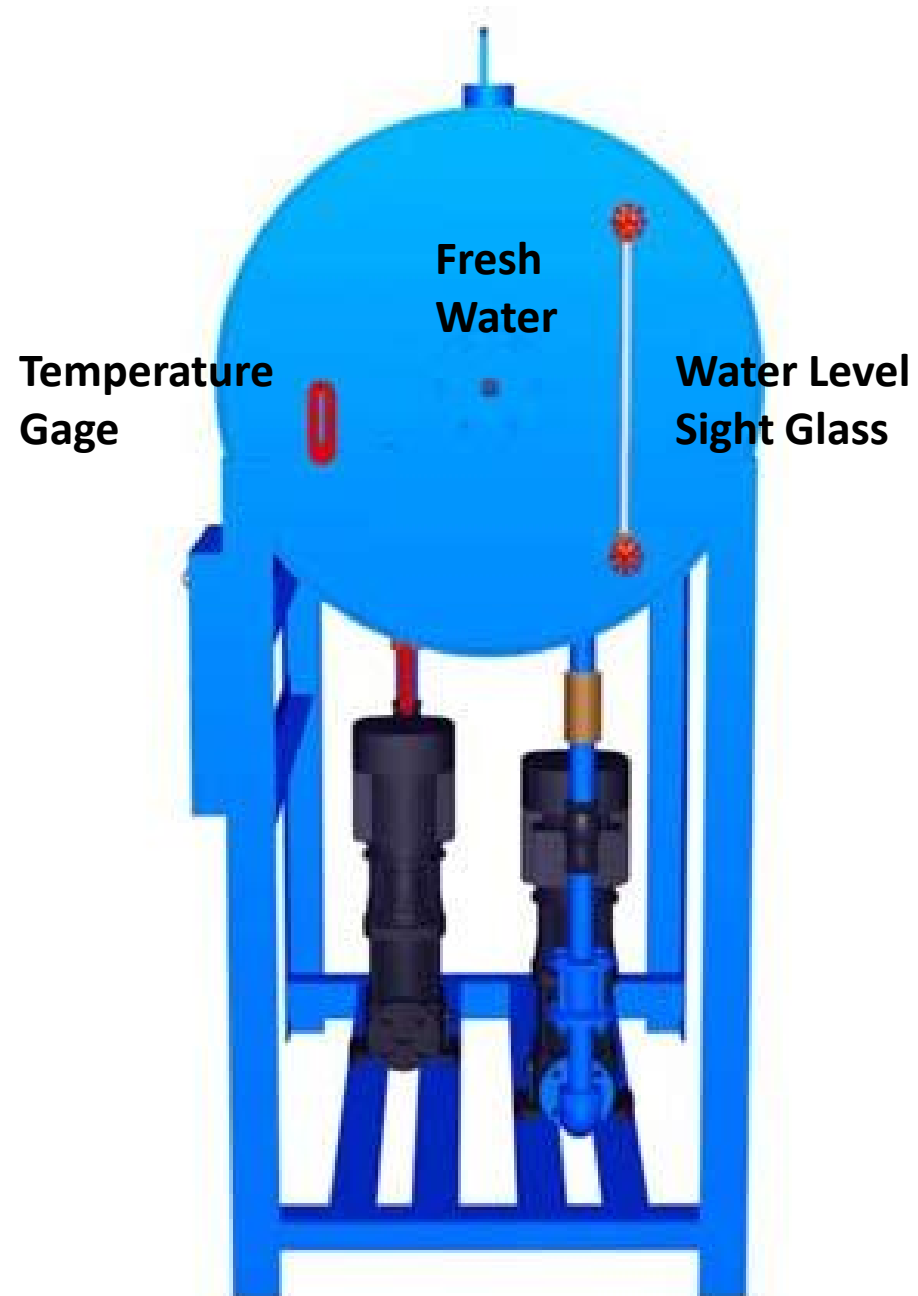
**Vented  
Condensate  
Tank With  
Duplex Pump  
Assembly**

**Vent tank to outdoors**  
Never operate tank above "0" psi















***Figure 1-22: Feed Water System***

# Condensate Tank Sizing

- **Condensate tanks** are typically sized for 15 minutes of maximum boiler evaporation. (What the boiler can evaporate in 15 minutes at high fire.)
- **200 hp Boiler** with 212 F. feed water operating at 0 psi evaporates = **6900 lbs/hr**  
( $6900/4 = 1725$  lbs)
- **1725 lbs every 15 min.** ( $1725\text{lbs}/(8.33\text{lbs per gal}) =$  **207.08 gal. tank**)
- *Typically a storage tank sized for 1 gallon per boiler hp is large enough to receive the condensate generated by the boiler.*
- *Other factors may require that a larger storage tank be used.*
- **1 gal. per hp. 200 hp boiler = 200 gal. tank**

## Code Requires That Tanks Maintain A Minimum Amount Of Water

- **A 10 minute minimum supply** of water must be available for delivery to the boiler at all times.
- $207.8 * (2/3) = (10 \text{ minute supply})$
- 10 Minute supply = 138.53 gal minimum supply of water for a 200 hp boiler.

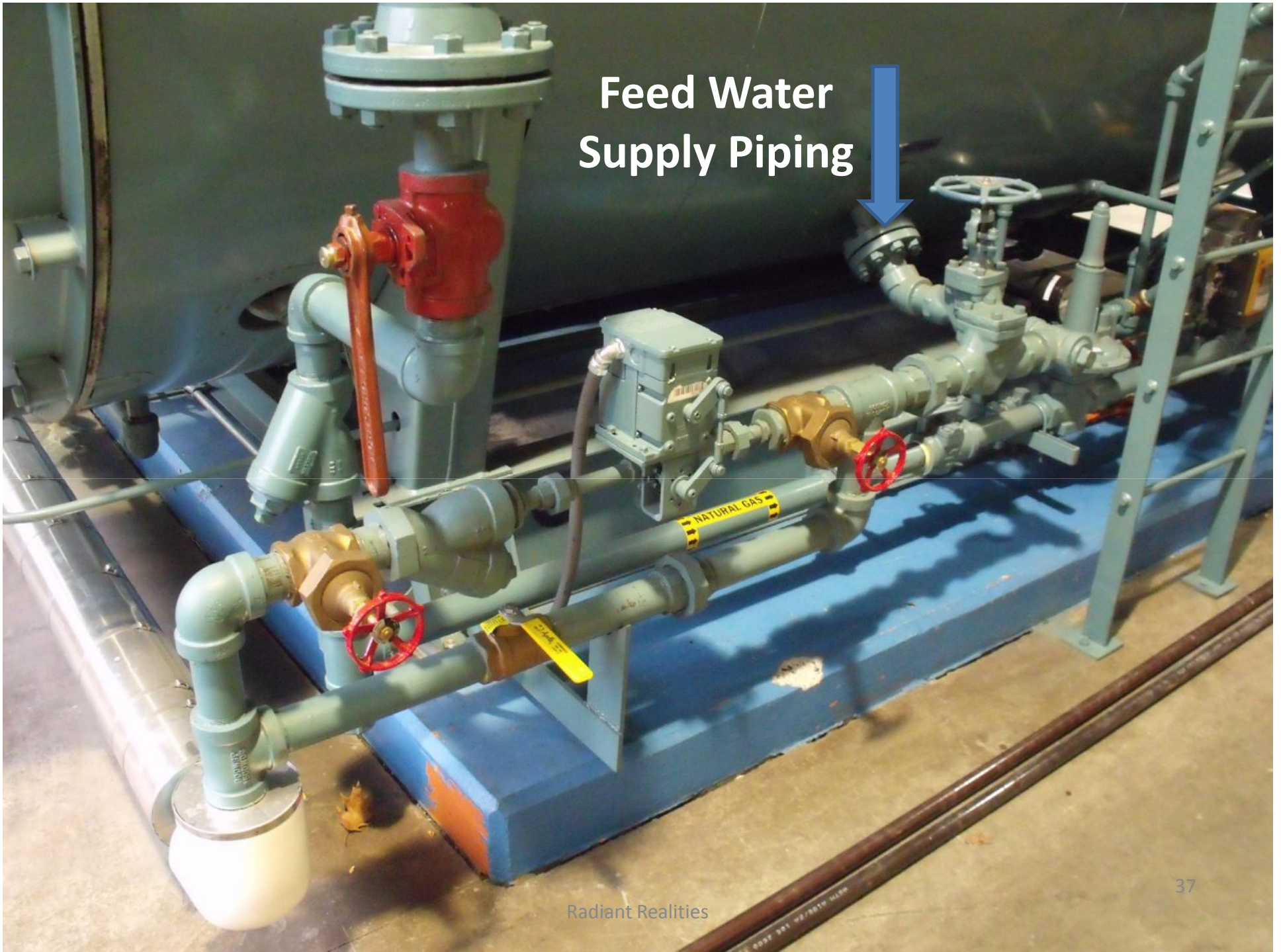
# Boiler Feed Water Pumps

- **Boilers with over 500 sq ft** of heating surface require two separate means of feeding water to the boiler. (Two pumps for power boilers)
- **1 boiler hp** = 5 sq. ft. of heating surface (For most firetube boilers)
- Boilers over 100 hp or (3450 lbs/hr output) require two pumps
- Start stop pumps are typically sized to deliver double what the boiler can evaporate per hour.
- **200 hp boiler** can evaporate 6900 lbs/hr ( $34.5 * 200 = \underline{6900 \text{ lbs/hr output}}$ )
- Divide the known lbs/hr output by 500 to get gpm.  **$6900/500=13.8 \text{ gpm}$**
- Size the start/stop pump for twice the boiler evaporation rate.
- $13.8 \text{ gpm} * 2 = \underline{\mathbf{27.6 \text{ gpm}}}$

## Pump discharge pressure

- **The quantity of water delivered must be at a pump pressure that is no less than 3% above the relief valve setting of the boiler at all times.**
- If the boiler RV is set at 150 psi the pump must be able to develop a minimum of **154.6 psi**

Feed Water  
Supply Piping





# Boiler Feed Water Inlet

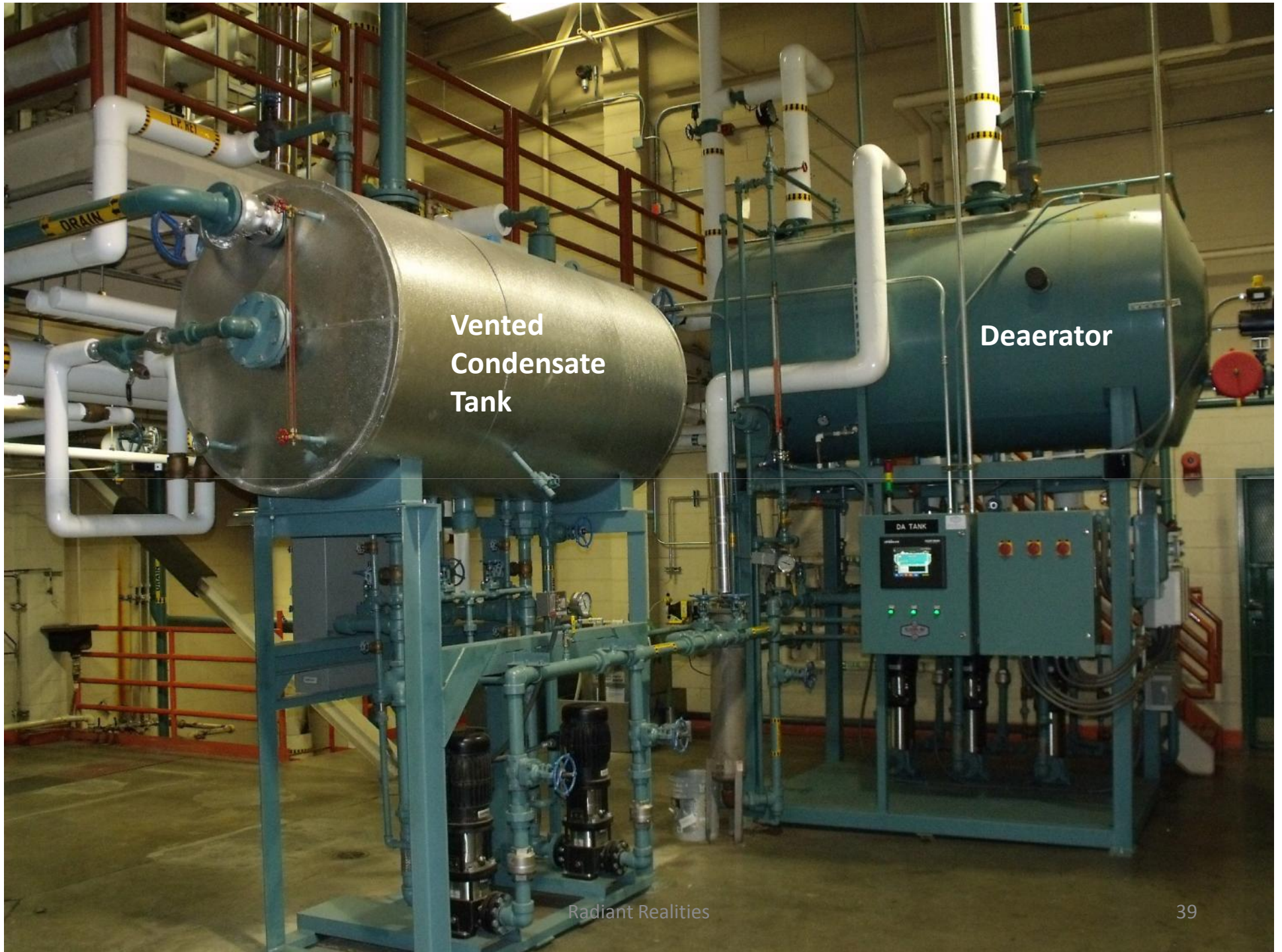
Modulating feed water valve

Stop valve, or globe valve must be the same size as the boiler inlet connection

Check Valve

ASME Section 1  
Feed water piping  
PG-58.3.3 BEP



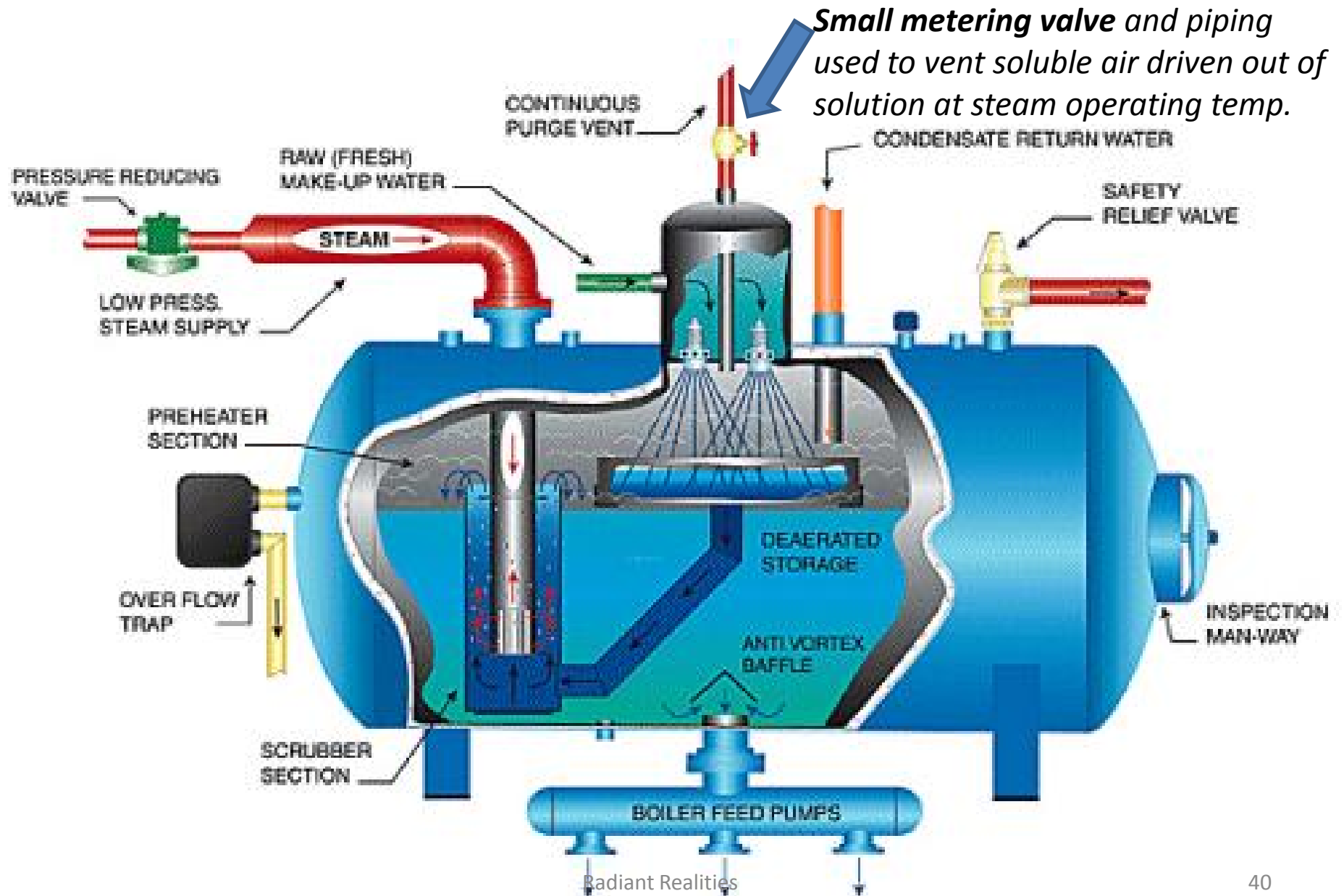


Vented  
Condensate  
Tank

Deaerator

## Deaerators are an ASME Section 8 Unfired Pressure Vessel

DA Typically Operates At 5psi to 12psi Steam Pressure





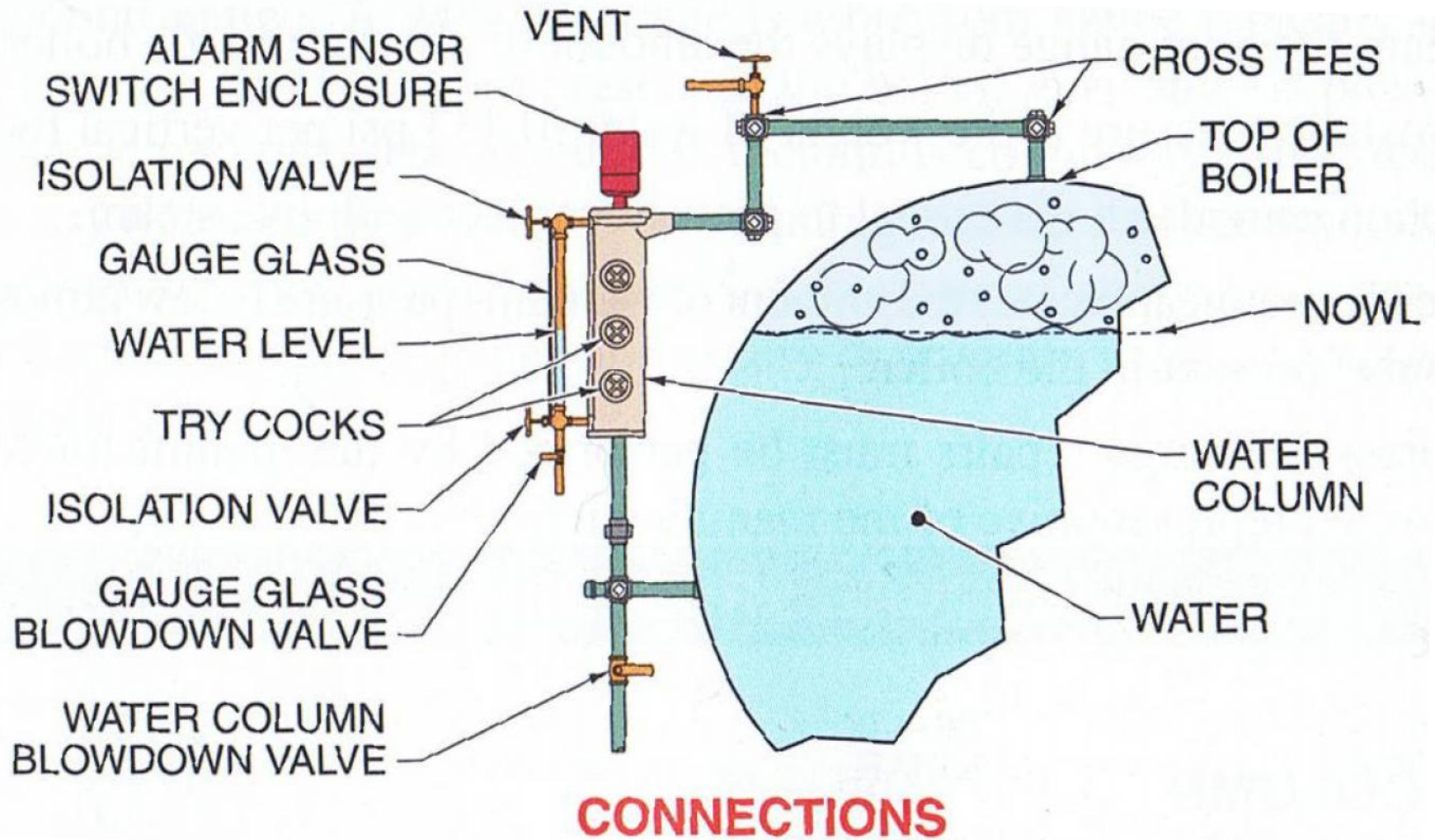
**Column Type  
Deaerator**



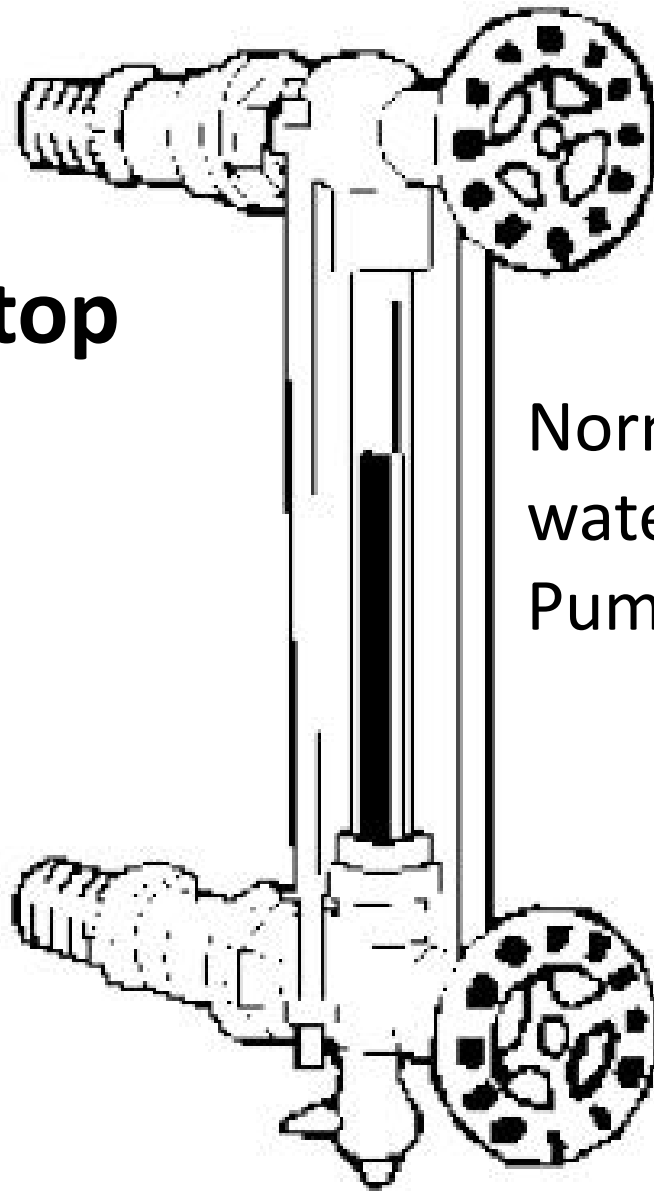
**Spray Type  
Deaerator**



# Steam Boiler Water Level



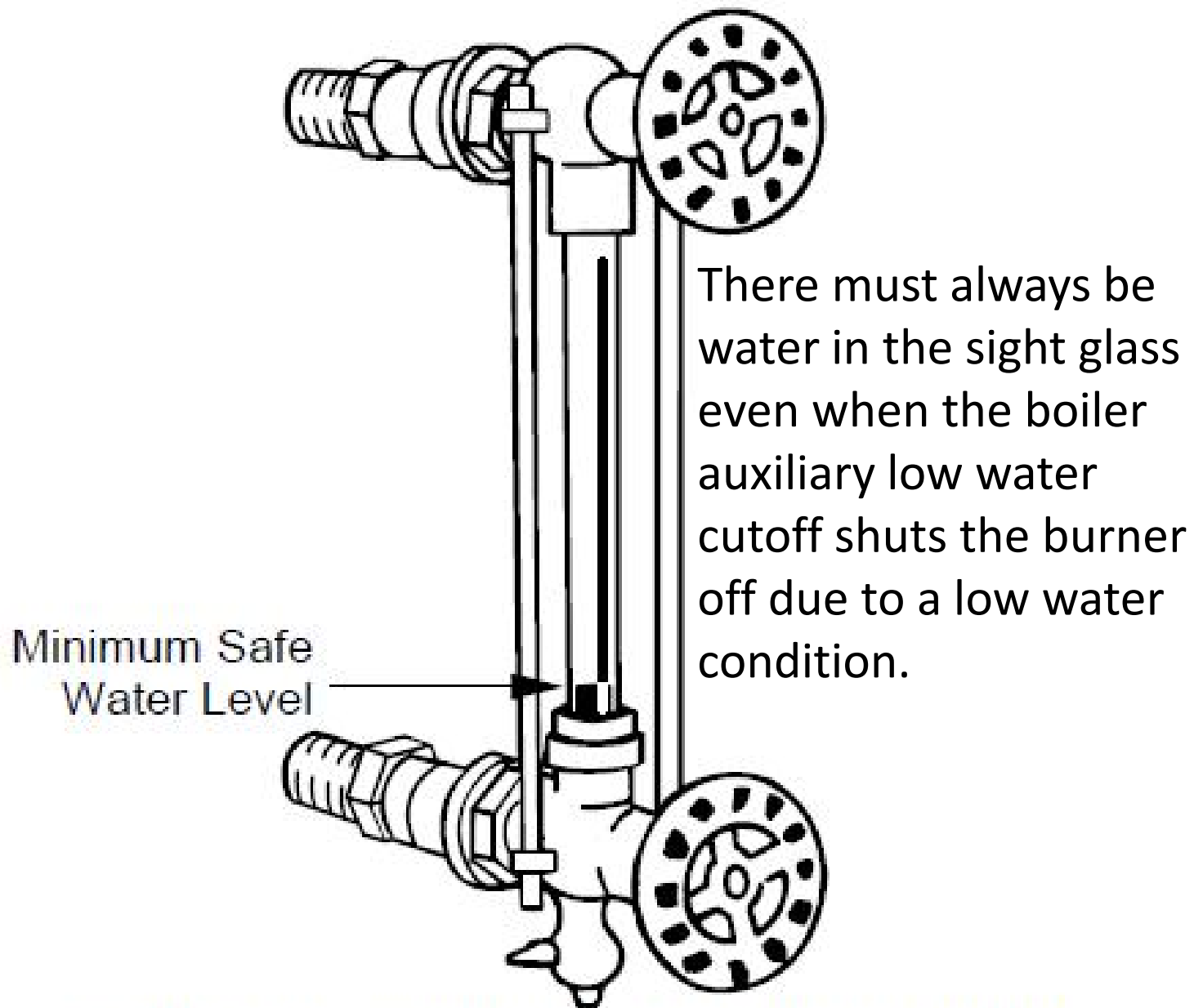
## Start Stop Pumps



Normal operating  
water level.  
Pump off.....

**Gauge Glass Two-Thirds Full**

Radiant Realities



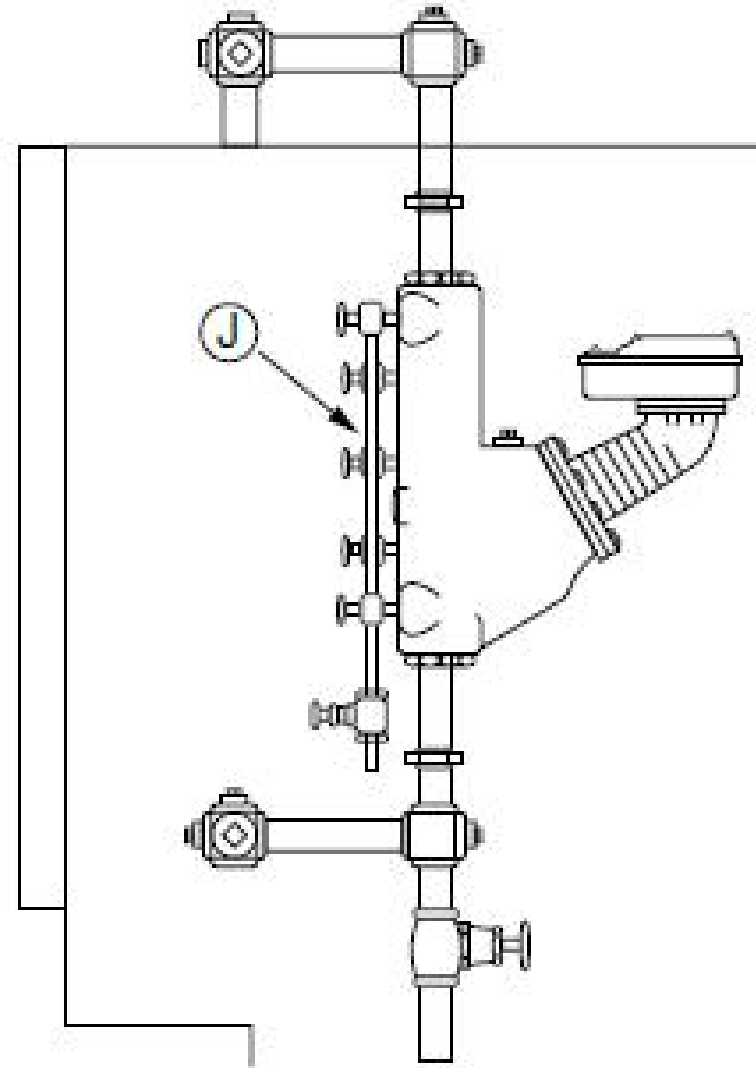
**Gauge Glass Minimum Safe Water Level**

# Primary Low Water Cut-Off Pump Control

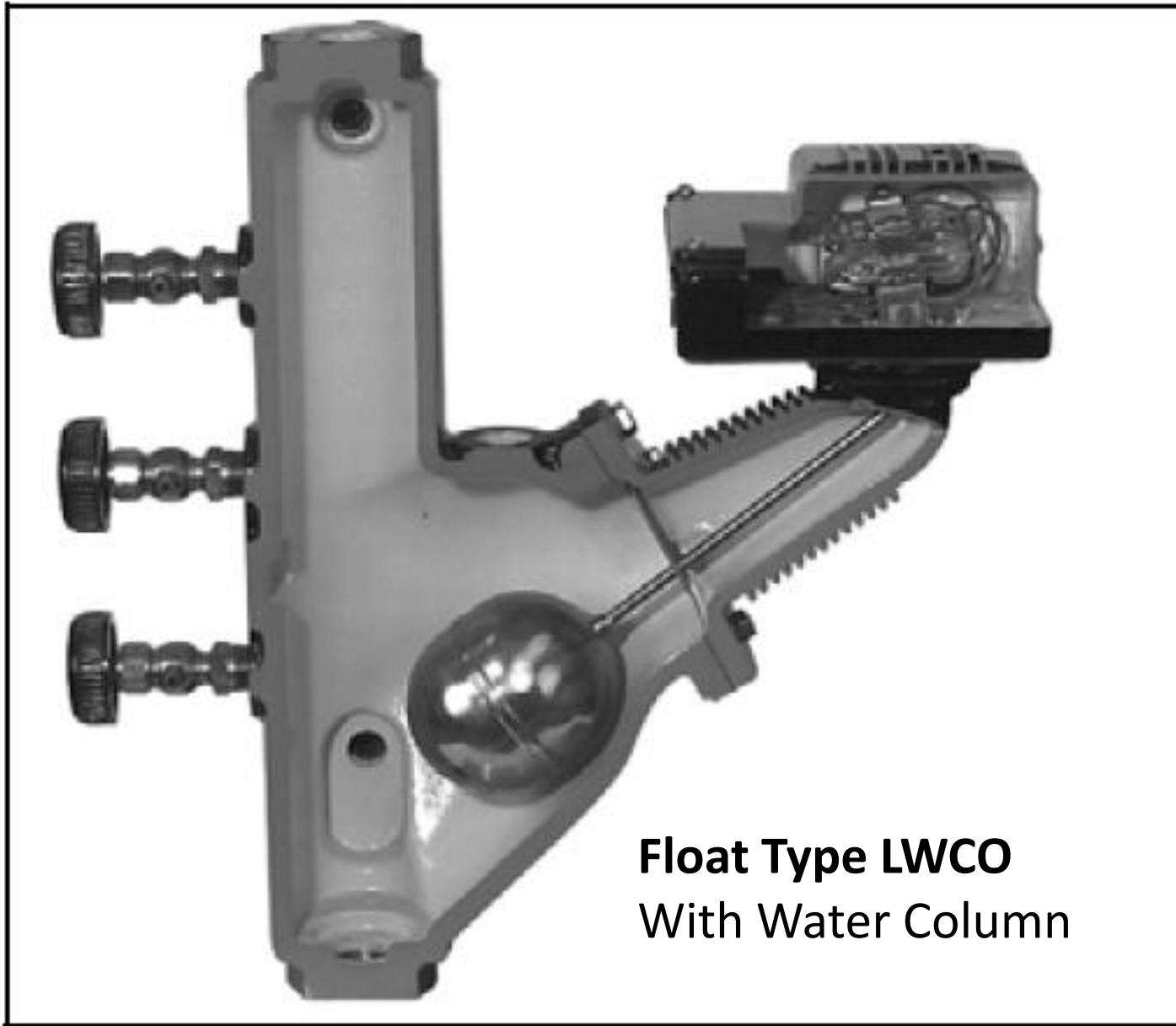
Float type start stop  
pump control with  
automatic reset

- ❖ Maintains the boiler normal operating water level
- ❖ Turns a pump on
- ❖ Turns a pump off
- ❖ Turns off the burner if a low water condition exists
- ❖ Sounds an alarm

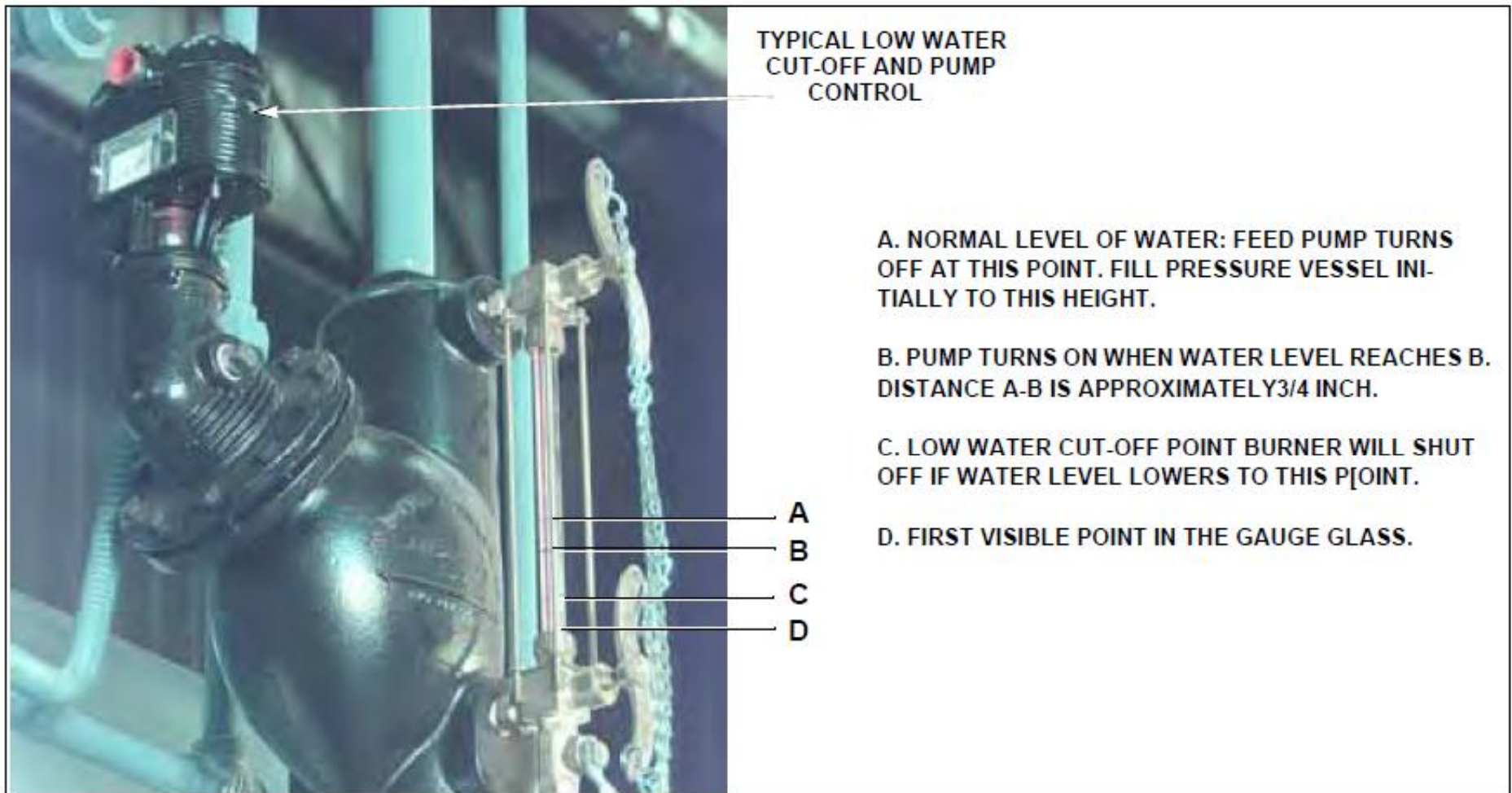
## Series 157S





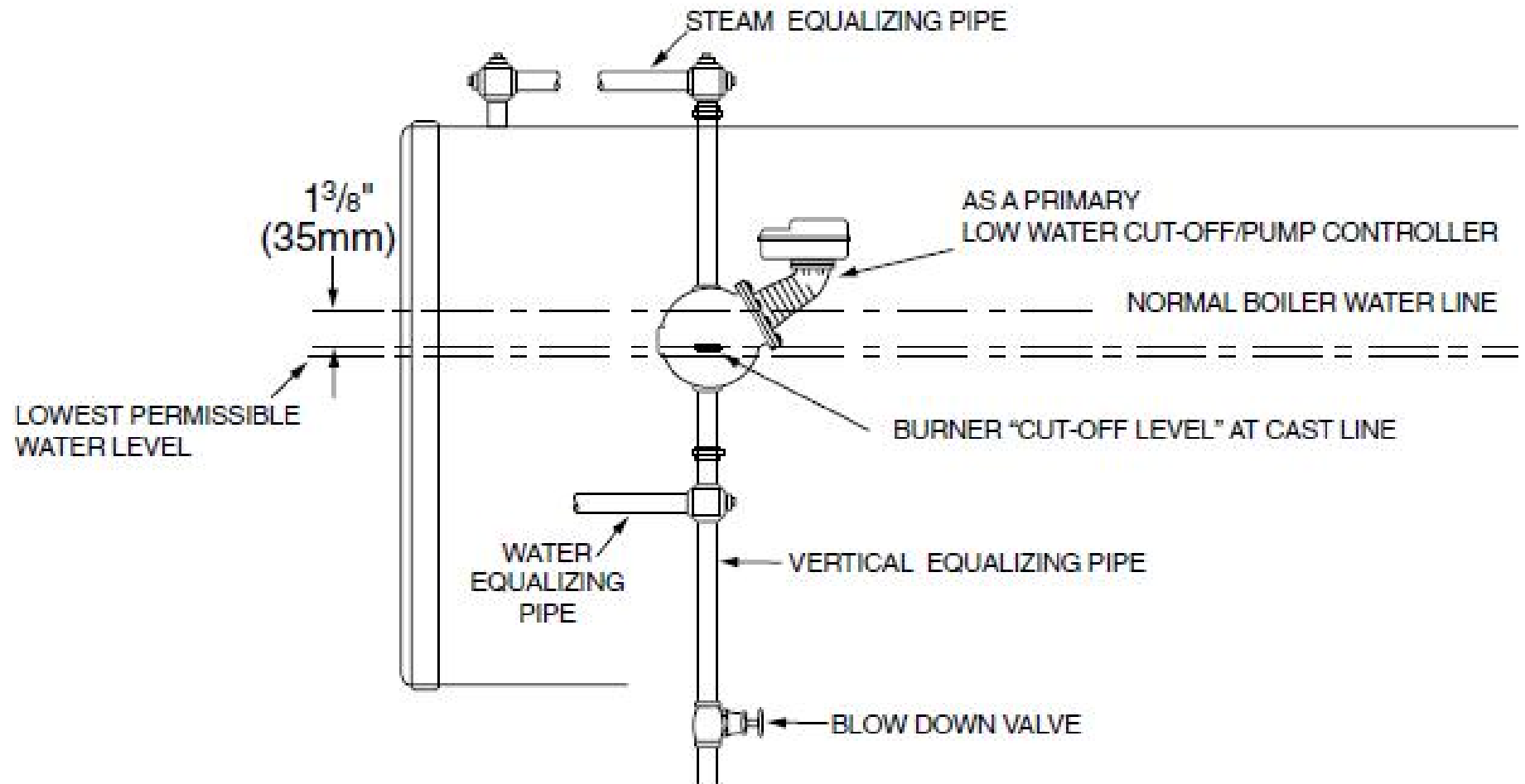


**Float Type LWCO**  
With Water Column



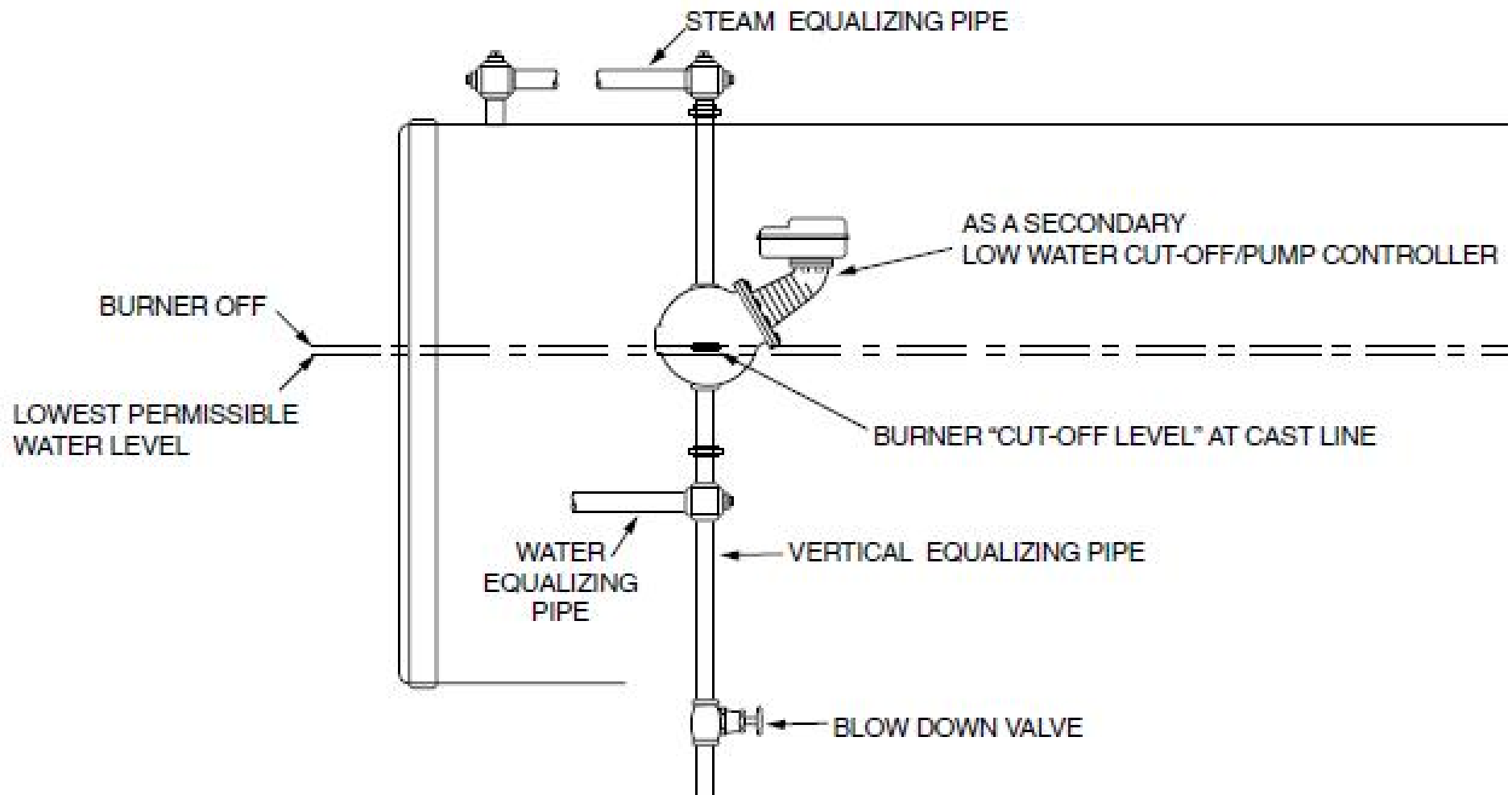
**Figure 3-2 Low Water Cut Off Sight Gauge**

# Primary Low Water Cut-Off



# Auxiliary or Secondary LWCO

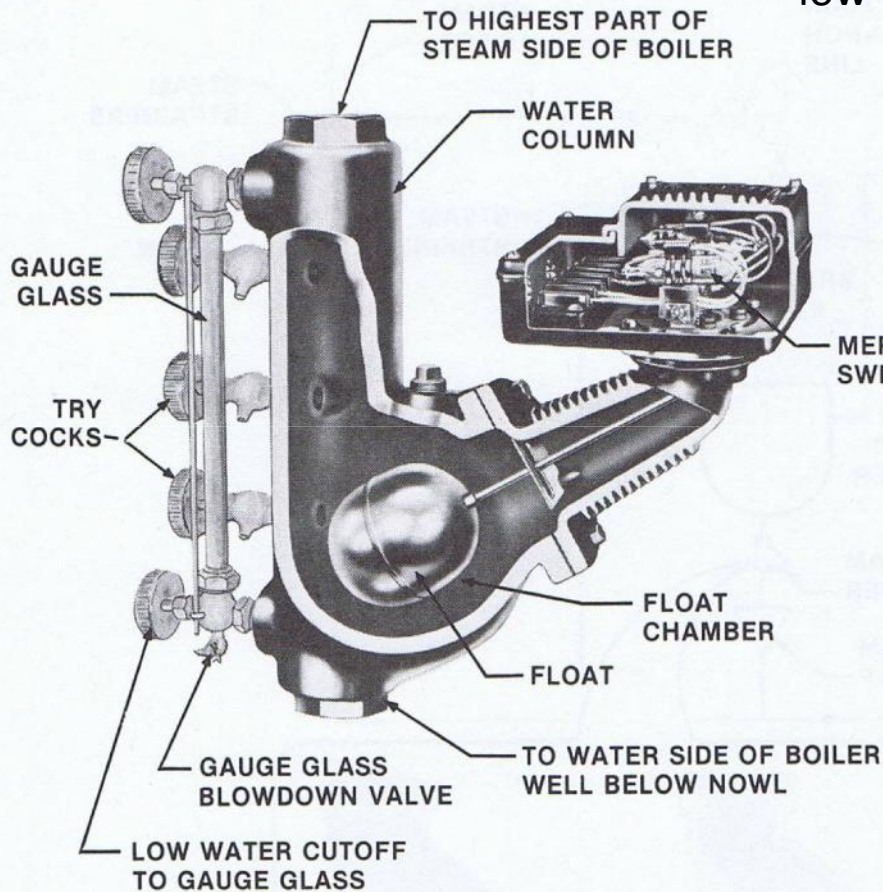
Locate  $\frac{1}{2}$ " below Primary burner cut-off cast line





## Primary LWCO Float Type

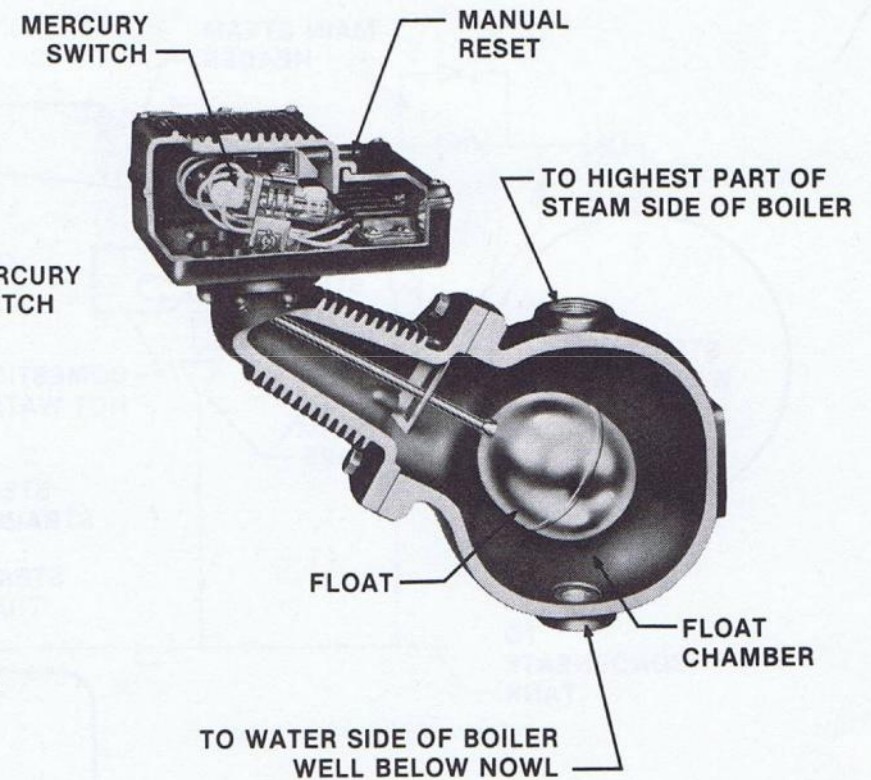
Start stop pump control with combined water column & typical automatic reset



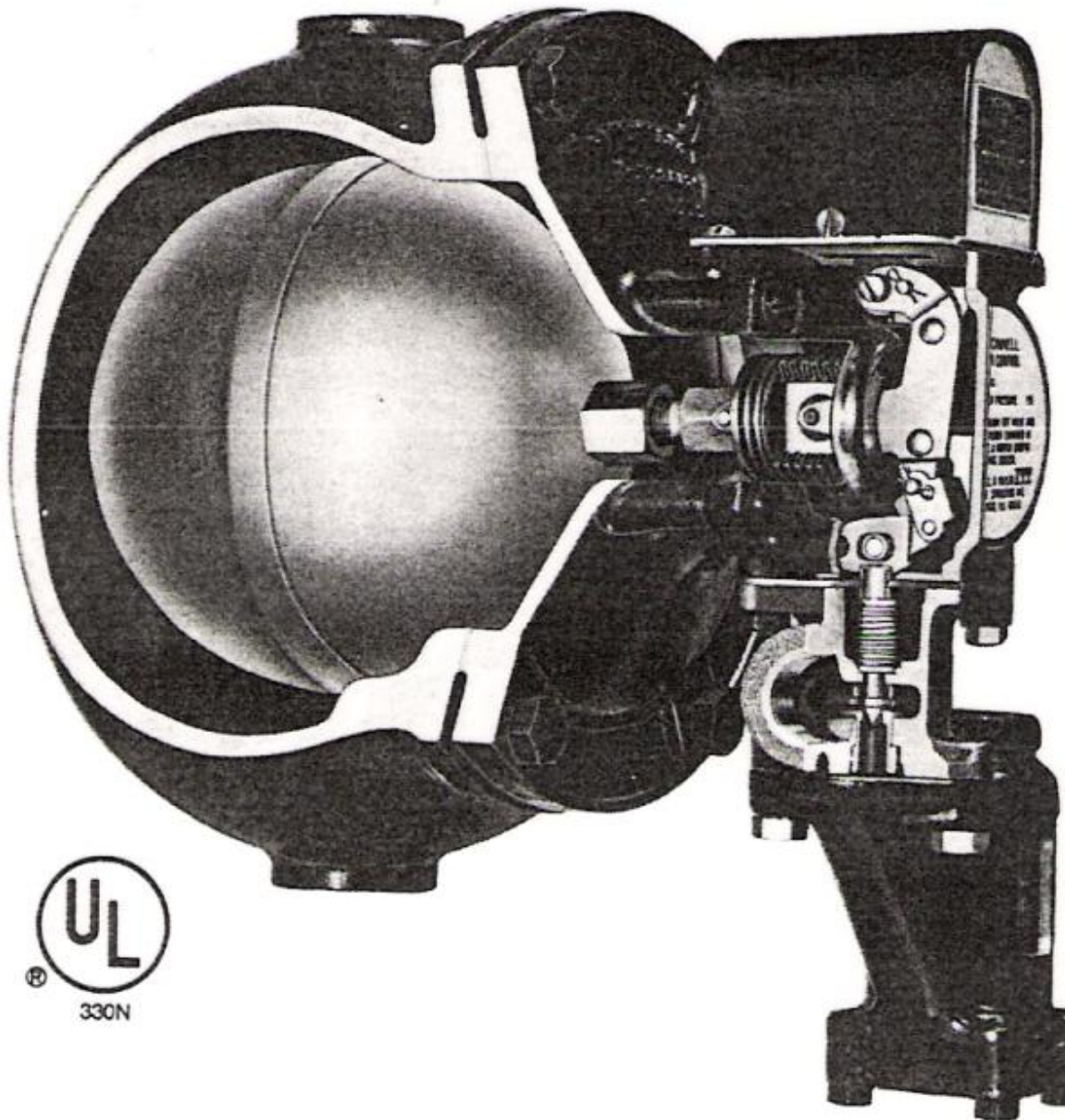
INSTALLED INSIDE THE WATER COLUMN

## Auxiliary LWCO Float Type

A manual reset switch is required on all "Auxiliary" low water cut-off controls



INSTALLED OUTSIDE THE WATER COLUMN



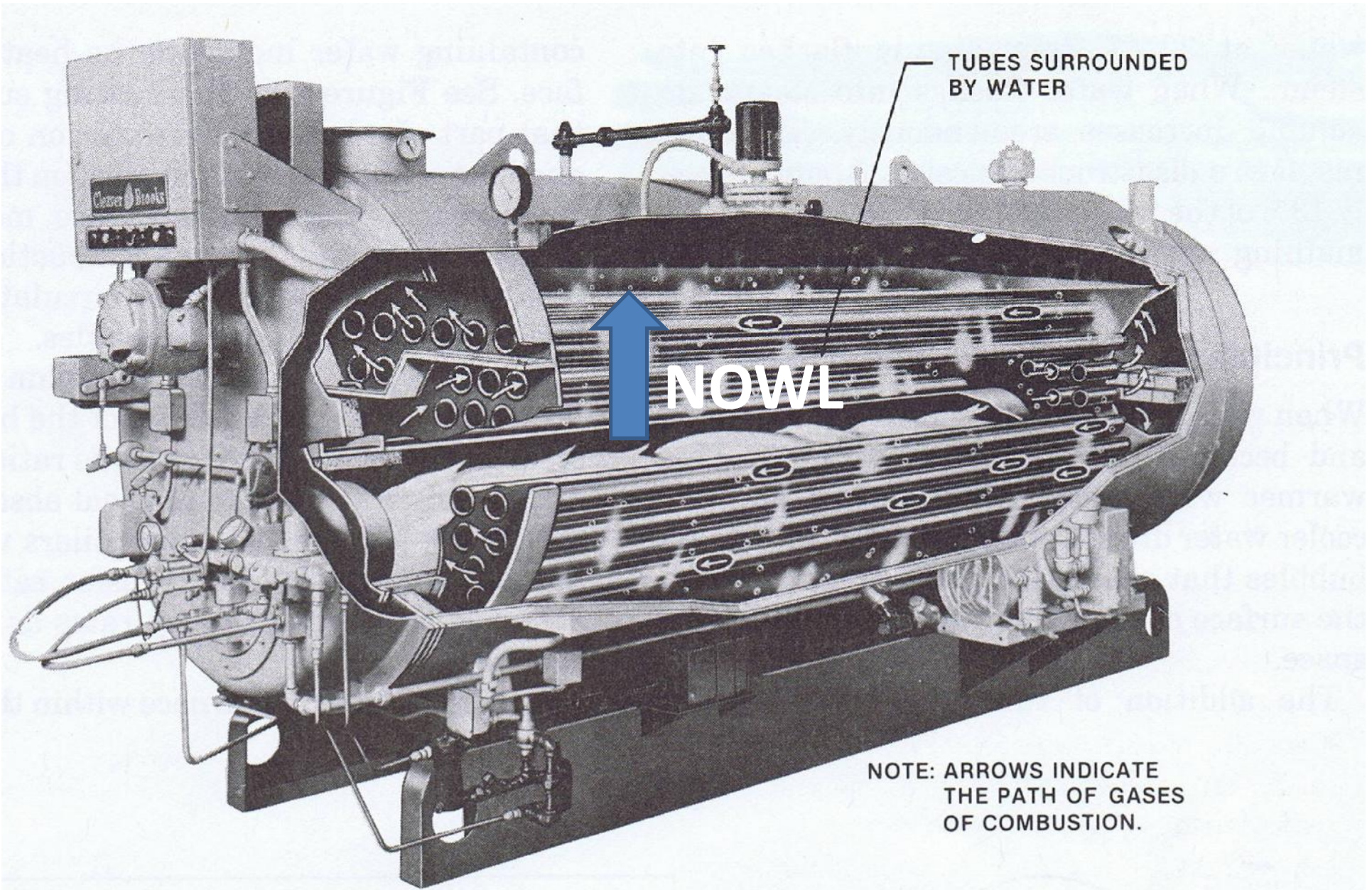
**Low pressure steam** systems can use the motive force of city water pressure to get water into the boiler verses using pumps if city water pressure is high enough.

**Water feeder and low-water cut-off combination control.**

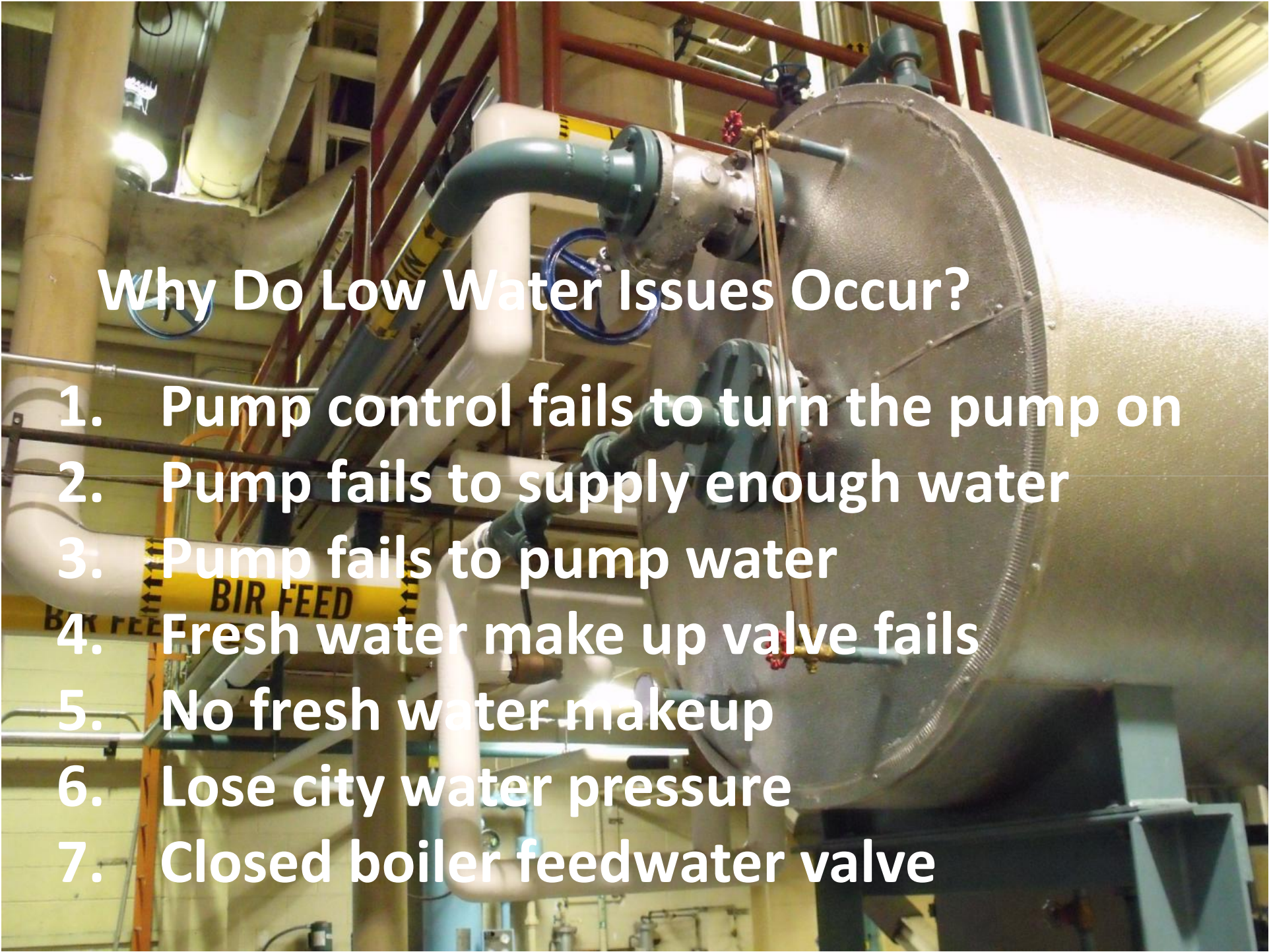
No. 51-S-2 Feeder Cut-off Combination



**Normal Operating Water Level does not leave much room for steam.**  
High water levels need to be addressed immediately.





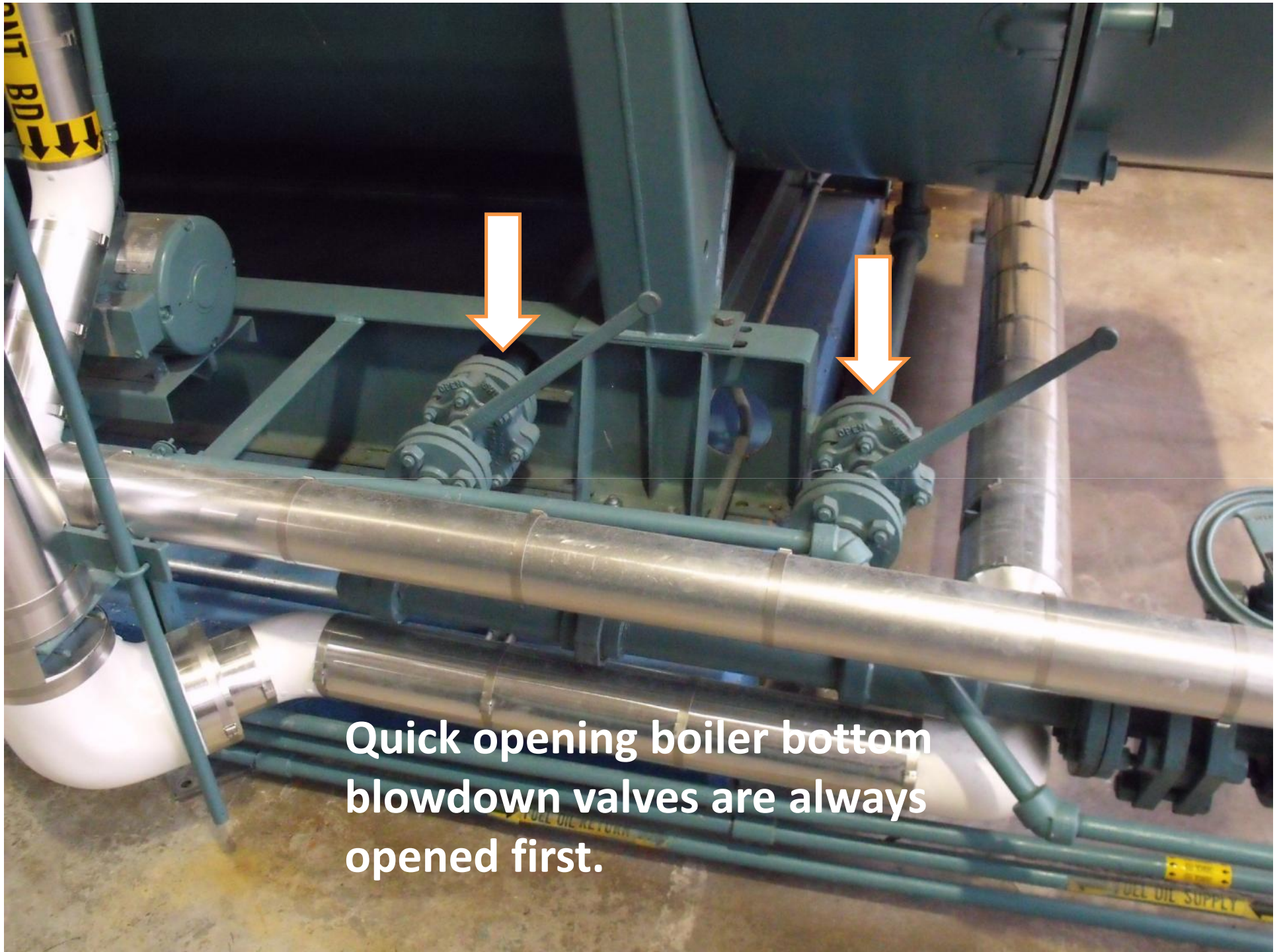
A photograph of an industrial facility, likely a power plant, showing a large cylindrical boiler or steam generator. The boiler is surrounded by a network of pipes, valves, and railings. A yellow pipe with the text "BIR FEED" is visible. The scene is lit by overhead industrial lights.

## Why Do Low Water Issues Occur?

1. Pump control fails to turn the pump on
2. Pump fails to supply enough water
3. Pump fails to pump water
4. Fresh water make up valve fails
5. No fresh water makeup
6. Lose city water pressure
7. Closed boiler feedwater valve



# Boiler Blowdown



Quick opening boiler bottom  
blowdown valves are always  
opened first.



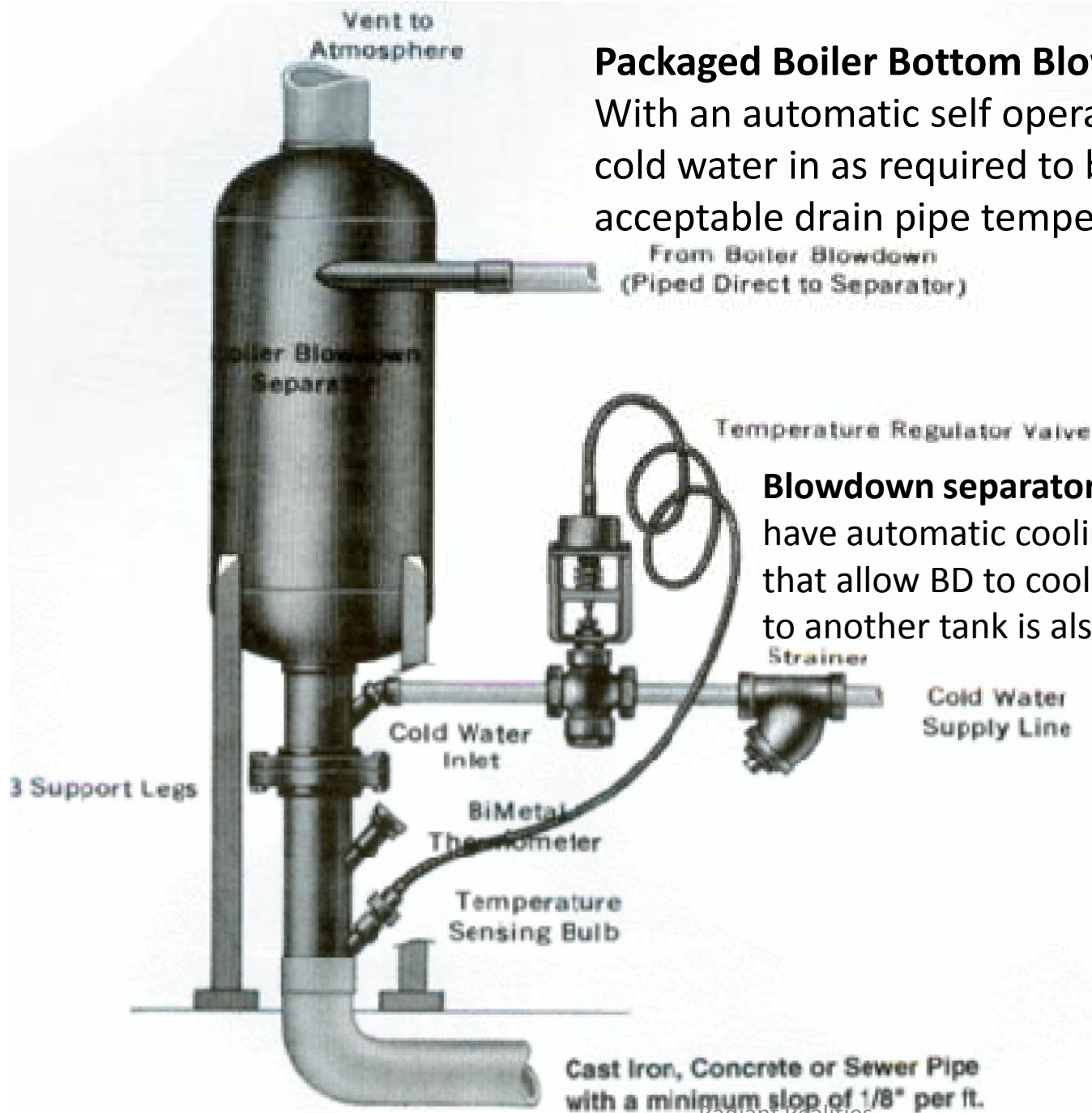


Slow opening blowdown  
valve minimum five  
turns to open.

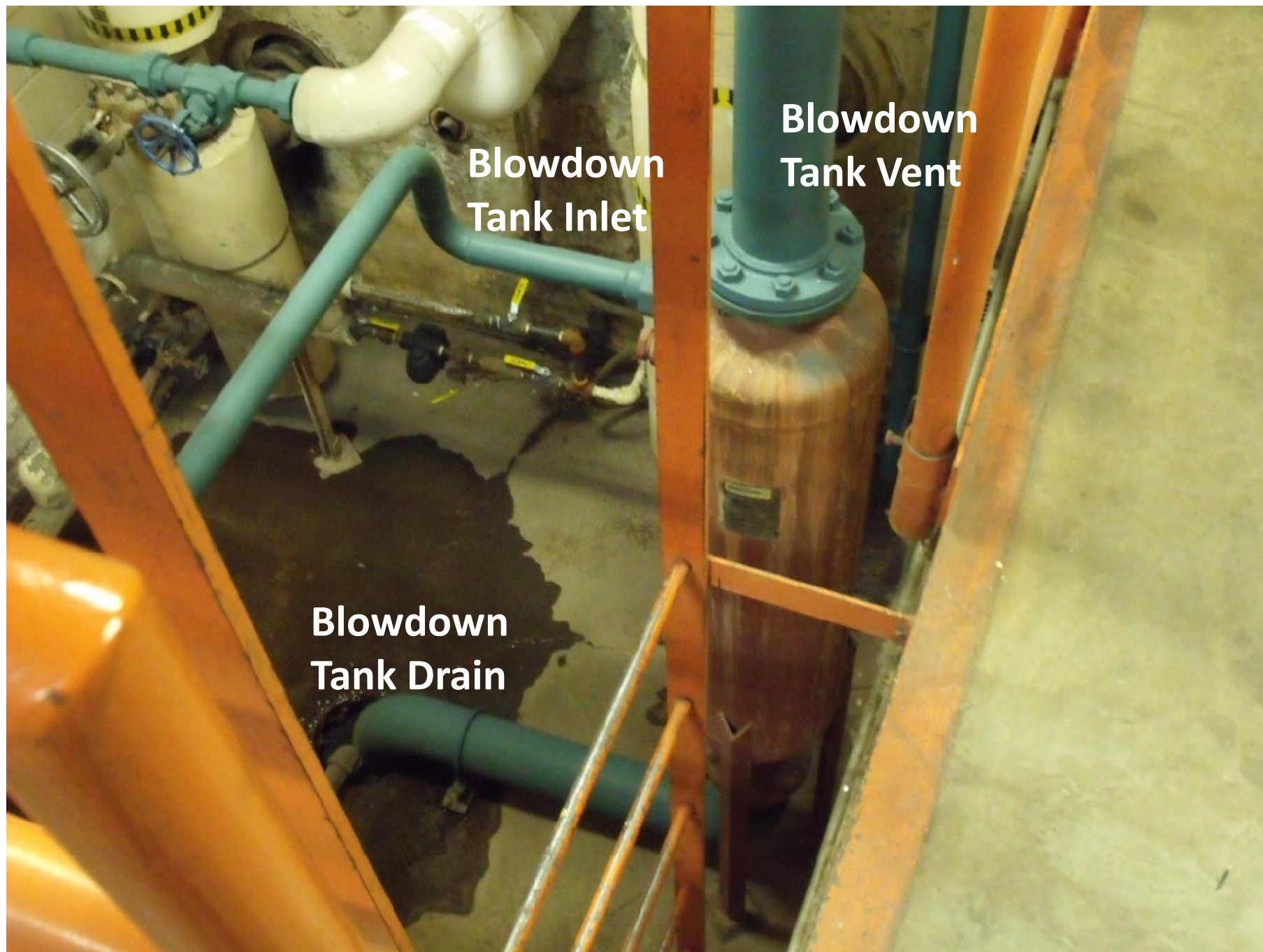


## Packaged Boiler Bottom Blowdown Separator

With an automatic self operating regulator that allows cold water in as required to bring BD going to drain to acceptable drain pipe temperature.



**Blowdown separator tanks** are not required to have automatic cooling. Tanks with drain valves that allow BD to cool in the tank or BD drained to another tank is also acceptable by code.



**Blowdown  
Tank Inlet**

**Blowdown  
Tank Vent**

**Blowdown  
Tank Drain**





Auto  
Cooling  
Water  
Supply



# Boiler Bottom Blowdown

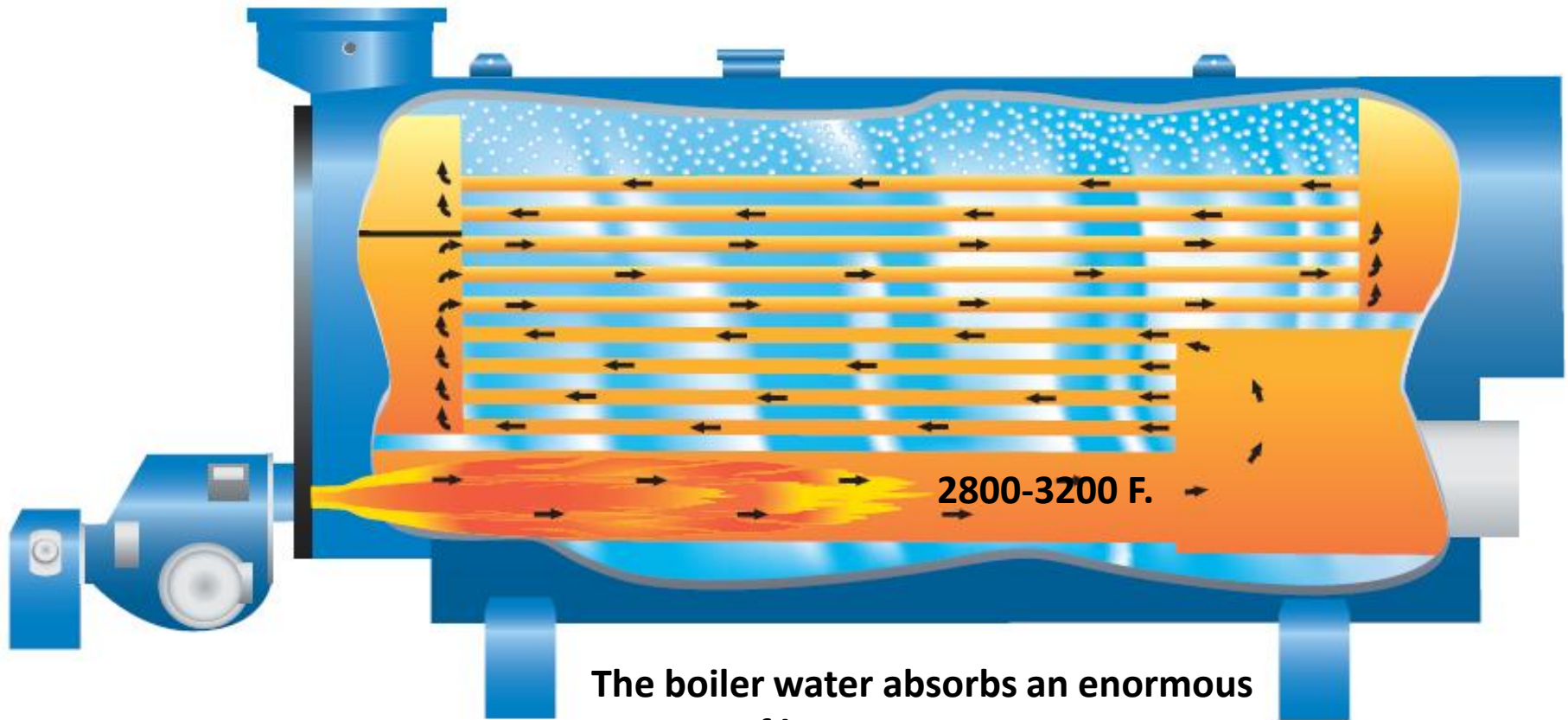
Boilers over 100 psi working steam pressure  
Require two blowdown valves. Two slow opening or  
one quick opening & one slow opening valve.

## Pipe and Fittings

- Piping must be steel, Sch. 80 Minimum
- Fittings must be steel
- Threaded fittings must be forged steel fittings
- Maximum pipe size allowed 2-1/2" on any sized boiler

# Combustion

Stack temperature is 120 F. Above steam operating temperature. 125psi steam operates at 353F. So an efficient boiler stack temperature would be 475F.



**The boiler water absorbs an enormous amount of heat energy. 3000F. Down to less than 500F. In a very efficient boiler.**

## MELTING POINTS OF METALS

|                   | Degrees °F |                                                                                           | Degrees °F |
|-------------------|------------|-------------------------------------------------------------------------------------------|------------|
| Aluminum          | 1220       | Iron (Cast) Gray                                                                          | 2460-2550  |
| Antimony          | 1167       | Iron (Cast) White                                                                         | 1920-2010  |
| Bismuth           | 520        | Iron, Wrought                                                                             | 2460-2640  |
| Brass (Red)       | 1870       | Lead                                                                                      | 622        |
| Bronze            | 1900       | Silver (Pure)                                                                             | 1761       |
| Copper            | 1981       | Steel  | 2370-2550  |
| Glass             | 2377       | Tin                                                                                       | 449        |
| Gold (Pure)       | 1945       | Zinc                                                                                      | 787        |
| Solder (Lead-Tin) | 250-570    |                                                                                           |            |

**Steel begins to melt at 2370F.**

**Water is in the boiler to protect the steel heat exchanger**



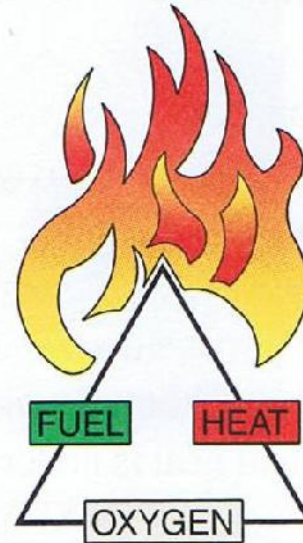
# The By-Products of Combustion

- **Natural Gas is primarily methane**
- The primary products of combustion are  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . (**Carbon Dioxide and Water**)
- **Water within the products of combustion is totally vaporized and above the dew point**

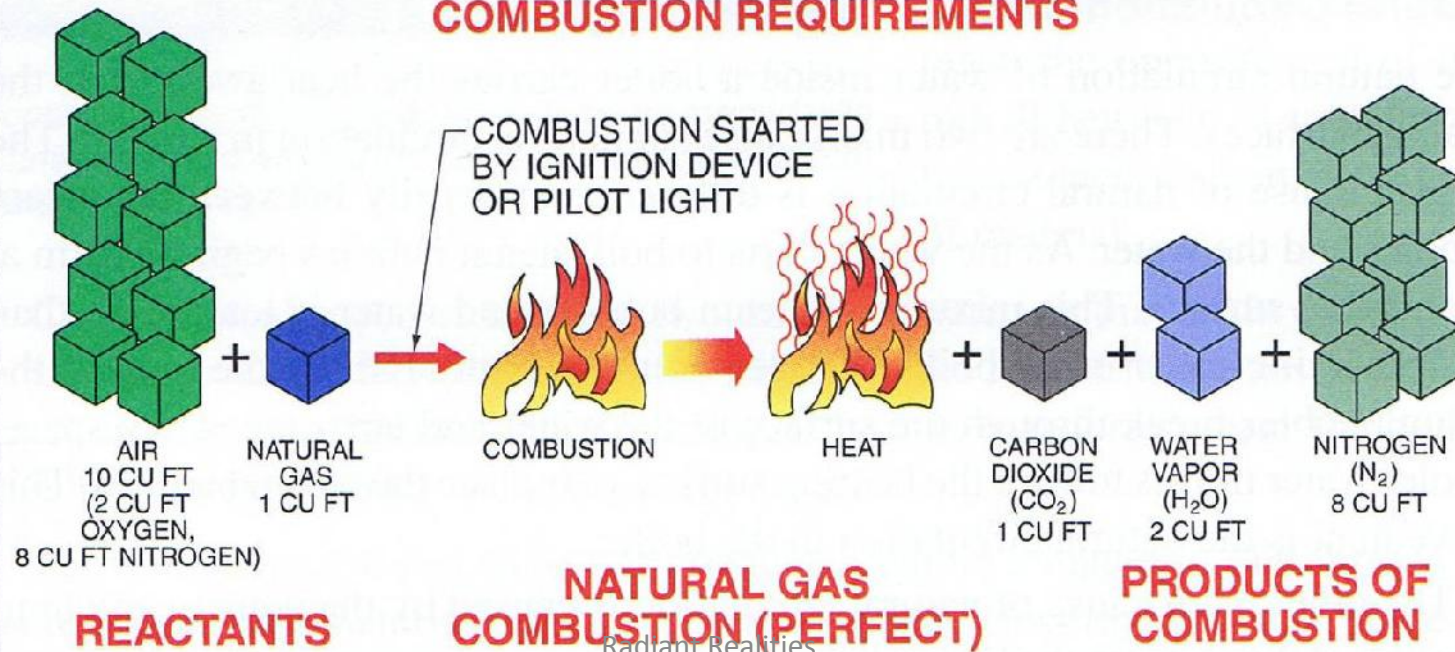
Products of combustion below the dew point

- $\text{CO}_2$  plus Heat + Moisture = **carbonic acid**
  - $\text{SO}_2$  plus Heat + Moisture = **sulfuric acid**
- Oil contains sulfur

# COMBUSTION



## COMBUSTION REQUIREMENTS



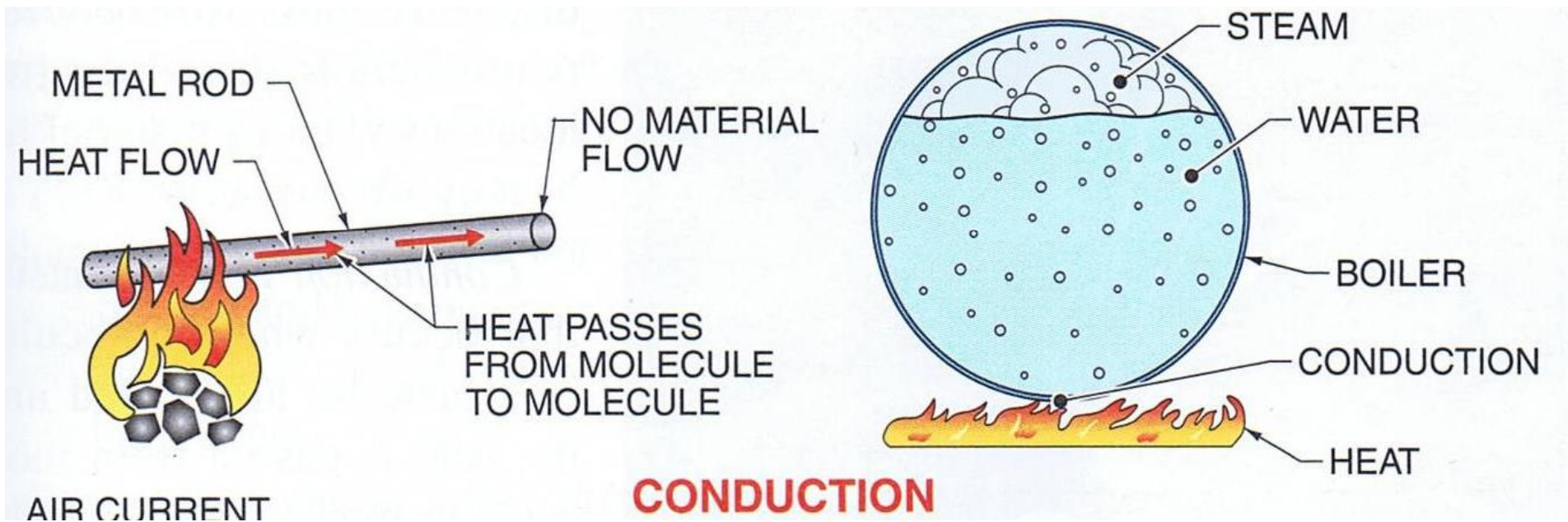
Radiant Realities

- **Combustion Efficiency** is the effectiveness of the burner only and relates to its ability to completely burn the fuel. The Boiler has little bearing on combustion efficiency. A well designed burner will operate with as little as 15-20% excess air, while converting all combustibles in the fuel to thermal energy.
- **CO<sub>2</sub> 8.5-10.5%**

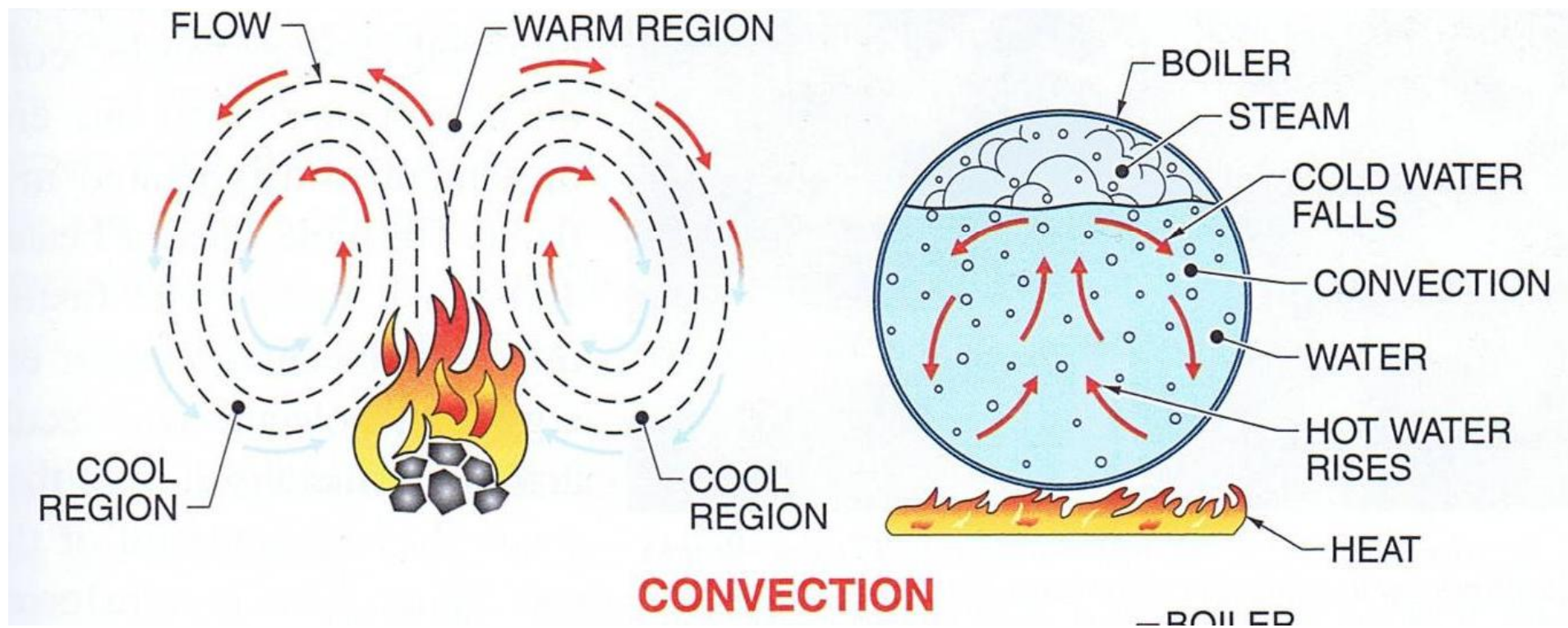


# Heat Absorption In the Boiler

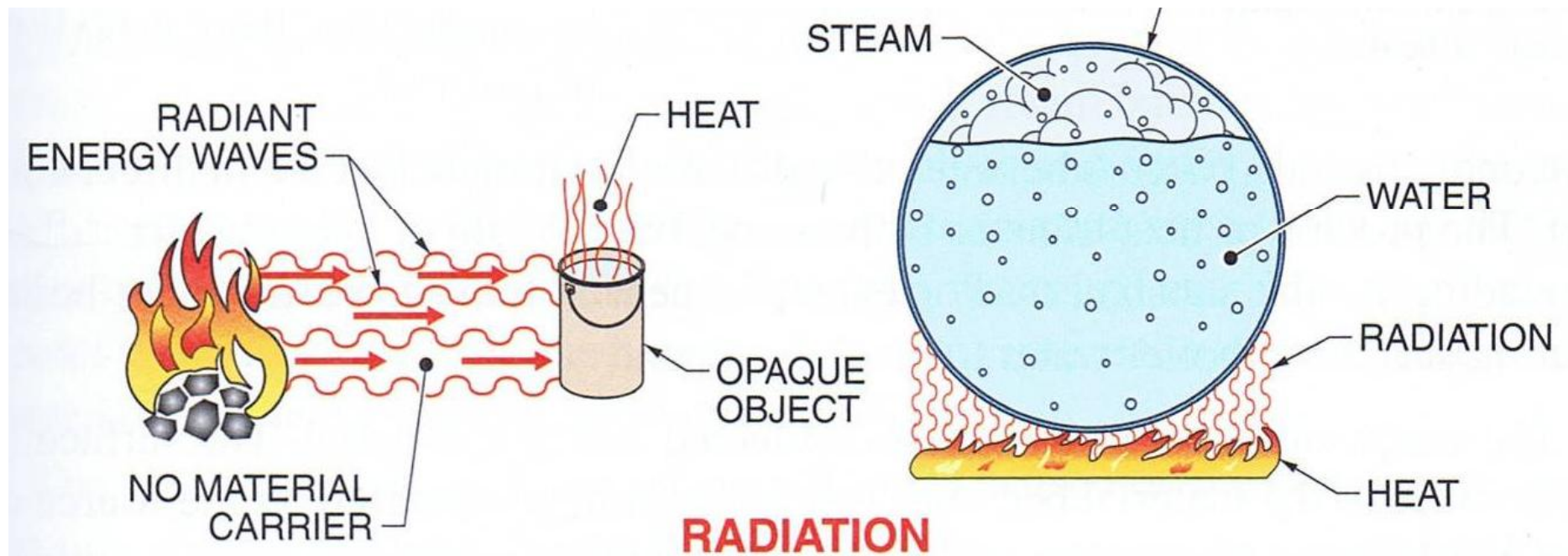
Heat moves by conduction convection and radiation



# Heat Absorption In the Boiler

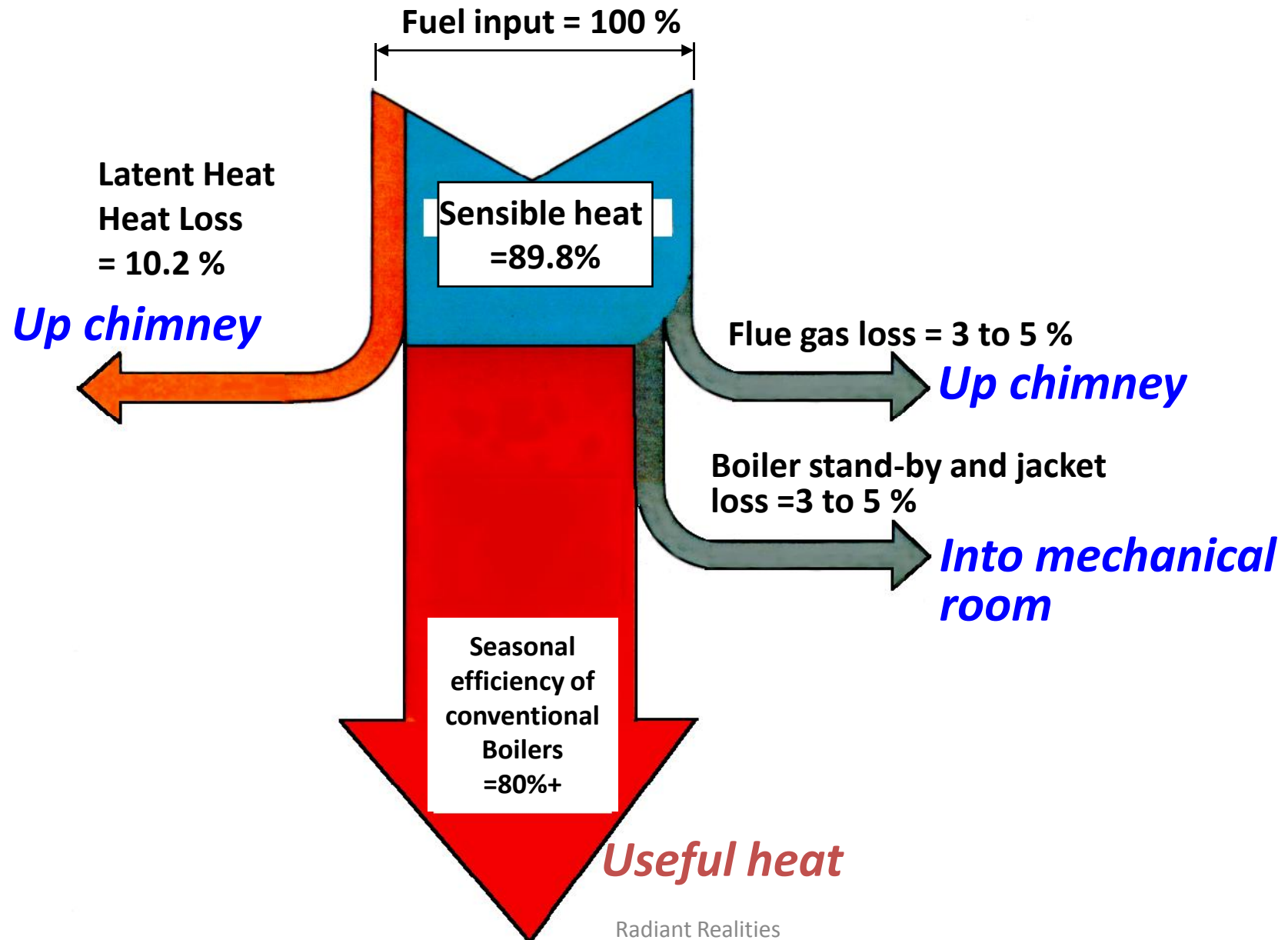


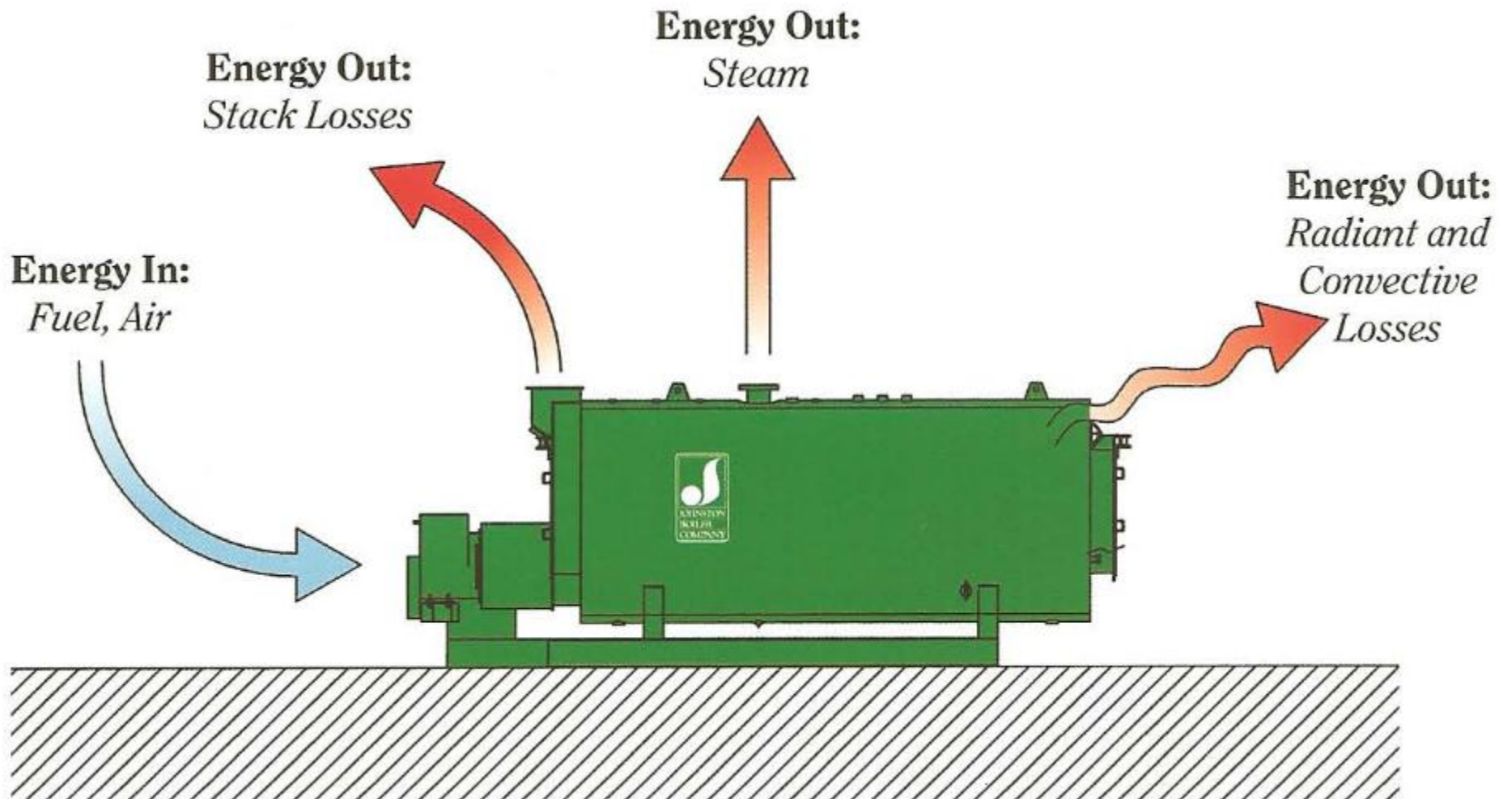
# Heat Absorption In the Boiler





# Conventional Boilers Are Typically 80% Efficient







# British Thermal Unit



- A BTU is defined as the amount of thermal heat energy required to heat 1 lb. of **WATER** 1 deg. F.



# Water Boiling Point

The weight of air in the atmosphere exerts 14.7 pounds per square inch on Earth at sea level

- **Water at 14.7 psia (absolute) or 0 psig (gauge) boils at 212 F.**
- Water at 1 mile high boils at 202 F.
- Water on top of Mt Everest boils at 154 F.
- Water at .28 psia boils at 60 F.
- **Water at 100 psig boils at 337.90 F.**

Pressure Determines Boiling Point Temperature

**Table CG-1. Properties of Saturated Steam**  
(Abstracted from Keenan and Chao, THERMODYNAMIC PROPERTIES OF STEAM,  
by permission of John Wiley & Sons, Inc.)

|                  | Col. 1<br>Gauge<br>Pressure | Col. 2<br>Absolute<br>Pressure<br>(psia) | Col. 3<br>Steam<br>Temp.<br>(F°) | Col. 4<br>Heat of<br>Sat. Liquid<br>(Btu/lb) | Col. 5<br>Latent<br>Heat<br>(Btu/lb) | Col. 6<br>Total Heat<br>of Steam<br>(Btu/lb) | Col. 7<br>Specific<br>Volume of<br>Sat. Liquid<br>(cu ft/lb) | Col. 8<br>Specific<br>Volume of<br>Sat. Steam<br>(cu ft/lb) |
|------------------|-----------------------------|------------------------------------------|----------------------------------|----------------------------------------------|--------------------------------------|----------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------|
| Inches of Vacuum | 29.743                      | 0.08854                                  | 32.00                            | 0.00                                         | 1075.8                               | 1075.8                                       | 0.096022                                                     | 3306.00                                                     |
|                  | 29.515                      | 0.2                                      | 53.14                            | 21.21                                        | 1063.8                               | 1085.0                                       | 0.016027                                                     | 1526.00                                                     |
|                  | 27.886                      | 1.0                                      | 101.74                           | 69.70                                        | 1036.3                               | 1106.0                                       | 0.016136                                                     | 333.60                                                      |
|                  | 19.742                      | 5.0                                      | 162.24                           | 130.13                                       | 1001.0                               | 1131.0                                       | 0.016407                                                     | 73.52                                                       |
|                  | 9.562                       | 10.0                                     | 193.21                           | 161.17                                       | 982.1                                | 1143.3                                       | 0.016590                                                     | 38.42                                                       |
|                  | 7.536                       | 11.0                                     | 197.75                           | 165.73                                       | 979.3                                | 1145.0                                       | 0.016620                                                     | 35.14                                                       |
|                  | 5.490                       | 12.0                                     | 201.96                           | 169.96                                       | 976.6                                | 1146.6                                       | 0.016647                                                     | 32.40                                                       |
|                  | 3.454                       | 13.0                                     | 205.88                           | 173.91                                       | 974.2                                | 1148.1                                       | 0.016674                                                     | 30.06                                                       |
|                  | 1.418                       | 14.0                                     | 209.56                           | 177.61                                       | 971.9                                | 1149.5                                       | 0.016699                                                     | 28.04                                                       |
|                  | 0.0                         | 14.696                                   | 212.00                           | 180.07                                       | 970.3                                | 1150.4                                       | 0.016715                                                     | 26.80                                                       |
|                  | 1.3                         | 16.0                                     | 216.32                           | 184.42                                       | 967.6                                | 1152.0                                       | 0.016746                                                     | 24.75                                                       |
|                  | 2.3                         | 17.0                                     | 219.44                           | 187.56                                       | 965.5                                | 1153.1                                       | 0.016768                                                     | 23.39                                                       |
|                  | 5.3                         | 20.0                                     | 227.96                           | 196.16                                       | 960.1                                | 1156.3                                       | 0.016830                                                     | 20.09                                                       |
|                  | 10.3                        | 25.0                                     | 240.07                           | 208.42                                       | 952.1                                | 1160.6                                       | 0.016922                                                     | 16.30                                                       |
|                  | 15.3                        | 30.0                                     | 250.33                           | 218.82                                       | 945.3                                | 1164.1                                       | 0.017004                                                     | 13.75                                                       |
|                  | 20.3                        | 35.0                                     | 259.28                           | 227.91                                       | 939.2                                | 1167.1                                       | 0.017078                                                     | 11.90                                                       |
|                  | 25.3                        | 40.0                                     | 267.25                           | 236.03                                       | 933.7                                | 1169.7                                       | 0.017146                                                     | 10.50                                                       |
|                  | 30.3                        | 45.0                                     | 274.44                           | 243.36                                       | 928.6                                | 1172.0                                       | 0.017209                                                     | 9.40                                                        |
|                  | 40.3                        | 55.0                                     | 287.07                           | 256.30                                       | 919.6                                | 1175.9                                       | 0.017325                                                     | 7.79                                                        |
|                  | 50.3                        | 65.0                                     | 297.97                           | 267.50                                       | 911.6                                | 1179.1                                       | 0.017429                                                     | 6.66                                                        |
|                  | 60.3                        | 75.0                                     | 307.60                           | 277.43                                       | 904.5                                | 1181.9                                       | 0.017524                                                     | 5.82                                                        |
|                  | 70.3                        | 85.0                                     | 316.25                           | 286.39                                       | 897.8                                | 1184.2                                       | 0.017613                                                     | 5.17                                                        |
|                  | 80.3                        | 95.0                                     | 324.12                           | 294.56                                       | 891.7                                | 1186.2                                       | 0.017696                                                     | 4.65                                                        |
|                  | 90.3                        | 105.0                                    | 331.36                           | 302.10                                       | 886.0                                | 1188.1                                       | 0.017775                                                     | 4.23                                                        |
|                  | 100.0                       | 114.7                                    | 337.90                           | 308.80                                       | 880.0                                | 1188.8                                       | 0.017850                                                     | 3.88                                                        |
|                  | 110.3                       | 125.0                                    | 344.33                           | 315.68                                       | 875.4                                | 1191.1                                       | 0.017922                                                     | 3.59                                                        |
|                  | 120.3                       | 135.0                                    | 350.21                           | 321.85                                       | 870.6                                | 1192.4                                       | 0.017991                                                     | 3.33                                                        |
|                  | 125.3                       | 140.0                                    | 353.02                           | 324.82                                       | 868.2                                | 1193.0                                       | 0.018024                                                     | 3.22                                                        |

At sea level water  
boils at 212F. 0 psig  
Or 14.7 psia absolute.  
**Steam and saturated  
water have the exact  
same temperature.**

The liquid cannot hold  
any more heat energy  
and every additional  
BTU converts 1 pound  
of liquid to 1 pound of  
steam.

**The lower the steam  
pressure the more  
latent heat energy the  
steam contains and  
has to give up at the  
heat emitter.**

Latent heat quantity  
goes down as steam  
pressure goes up....

**Temperature goes up  
as steam pressure  
goes up.**

## PERCENT (%) FLASH STEAM

Produced when condensate is discharged to atmosphere or into a flash tank controlled at various pressures

| Condensate Pressure (PSIG) | Flash Tank Pressure (PSIG) |      |      |      |      |      |      |      |      |  |
|----------------------------|----------------------------|------|------|------|------|------|------|------|------|--|
|                            | 0                          | 10   | 20   | 30   | 40   | 60   | 80   | 100  |      |  |
| 5                          | 1.6                        | 0.0  |      |      |      |      |      |      |      |  |
| 10                         | 2.9                        | 1.3  | 0.0  |      |      |      |      |      |      |  |
| 15                         | 3.9                        | 2.4  | 1.1  |      |      |      |      |      |      |  |
| 20                         | 4.9                        | 3.3  | 2.1  | 0.0  |      |      |      |      |      |  |
| 30                         | 6.5                        | 5.0  | 3.7  | 1.7  | 0.0  |      |      |      |      |  |
| 40                         | 7.8                        | 6.3  | 5.1  | 3.0  | 1.4  | 0.0  |      |      |      |  |
| 60                         | 10.0                       | 8.5  | 7.3  | 5.3  | 3.7  | 2.3  | 0.0  |      |      |  |
| 80                         | 11.8                       | 10.3 | 9.1  | 7.1  | 5.5  | 4.2  | 1.9  | 0.0  |      |  |
| 100                        | 13.3                       | 11.8 | 10.6 | 8.7  | 7.1  | 5.8  | 3.5  | 1.6  | 0.0  |  |
| 125                        | 14.9                       | 13.5 | 12.3 | 10.4 | 8.8  | 7.5  | 5.3  | 3.4  | 1.8  |  |
| 150                        | 16.3                       | 14.9 | 13.7 | 11.8 | 10.3 | 9.0  | 6.8  | 4.9  | 3.3  |  |
| 200                        | 18.7                       | 17.3 | 16.2 | 14.3 | 12.8 | 11.5 | 9.4  | 7.6  | 6.0  |  |
| 250                        | 20.8                       | 19.4 | 18.2 | 16.4 | 14.9 | 13.7 | 11.5 | 9.8  | 8.2  |  |
| 300                        | 22.5                       | 21.2 | 20.0 | 18.2 | 16.8 | 15.5 | 13.4 | 11.7 | 10.2 |  |
| 350                        | 24.1                       | 22.8 | 21.7 | 19.9 | 18.4 | 17.2 | 15.1 | 13.4 | 11.9 |  |
| 400                        | 25.6                       | 24.2 | 23.1 | 21.4 | 19.9 | 18.7 | 16.7 | 15.0 | 13.5 |  |

For every pound of condensate at 125 psi sent to a 0 psi vented condensate receiver 14.9% of it's liquid volume flashes to steam



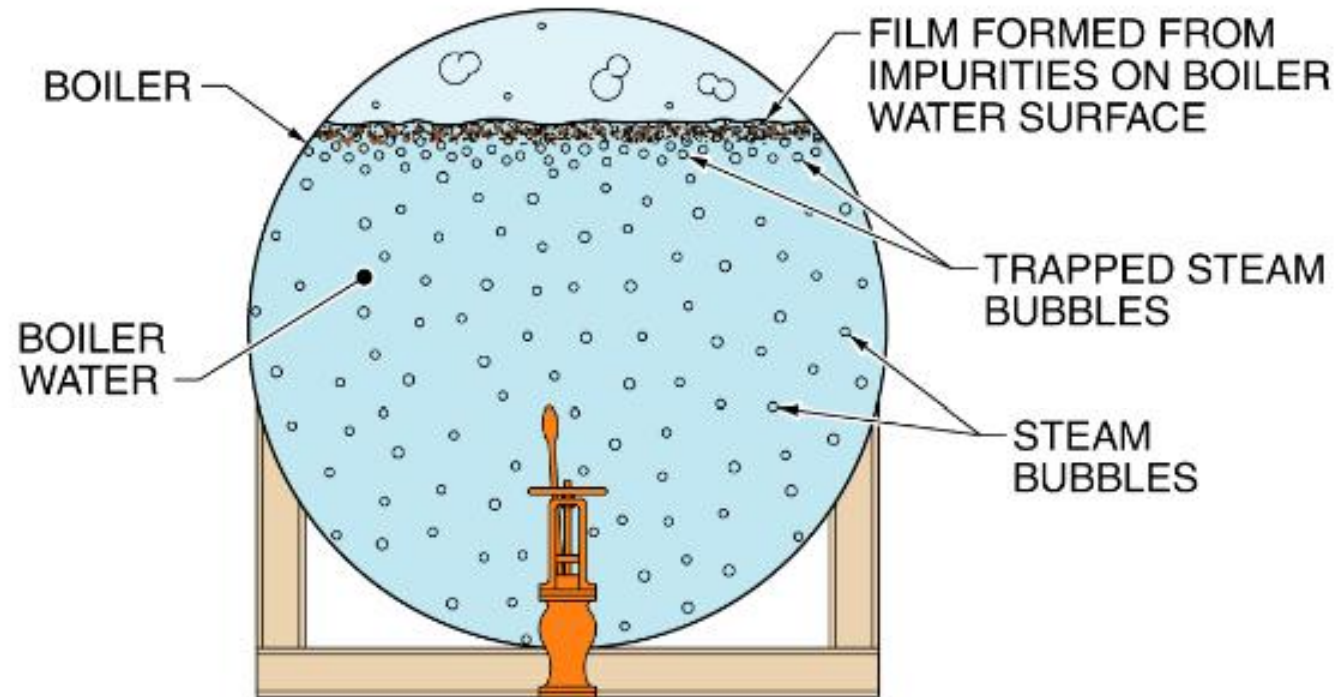
# **High Temperature Water At Mother Nature's Pressure**

- At sea level's atmospheric pressure of 14.7psia absolute (Or 0 psig gage) mother nature will not allow water to exist as a liquid above 212 degrees F.
- **A percentage of every pound of water above 212 F. has to flash to steam based upon the pressure environment that it exits in.**

# Steam Quality & Purity

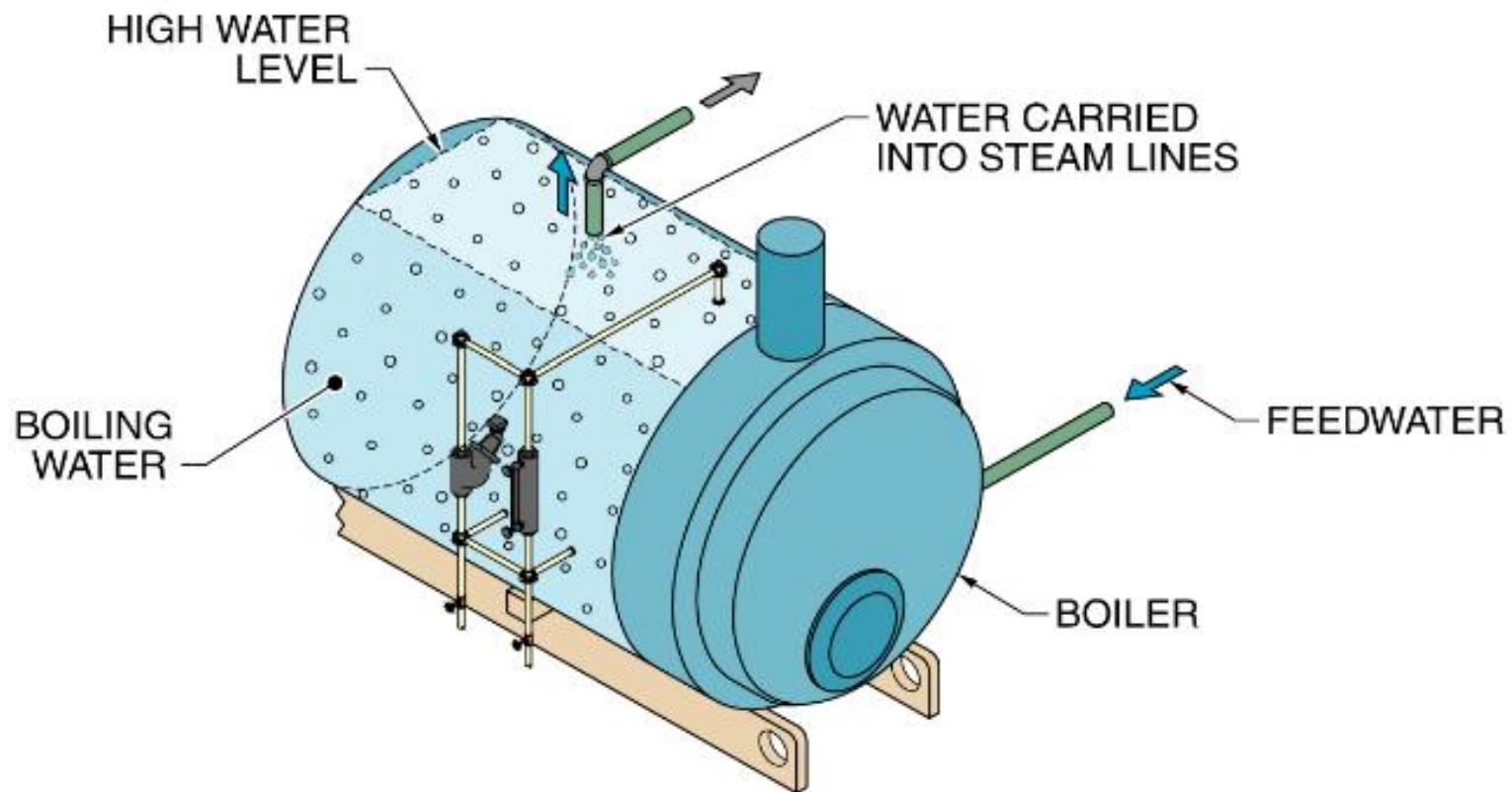
- **Steam quality** has to do with the amount of moisture in the steam.
- **Steam purity** refers to the amount of solids, liquid, or vaporous contamination in the steam. Solids content.
- **Carryover:** Any solid, liquid or vaporous contaminant that leaves a boiler along with the steam. Entrained boiler water, which may contain dissolved or suspended solids is the most common.

# FOAMING





## PRIMING AND CARRYOVER

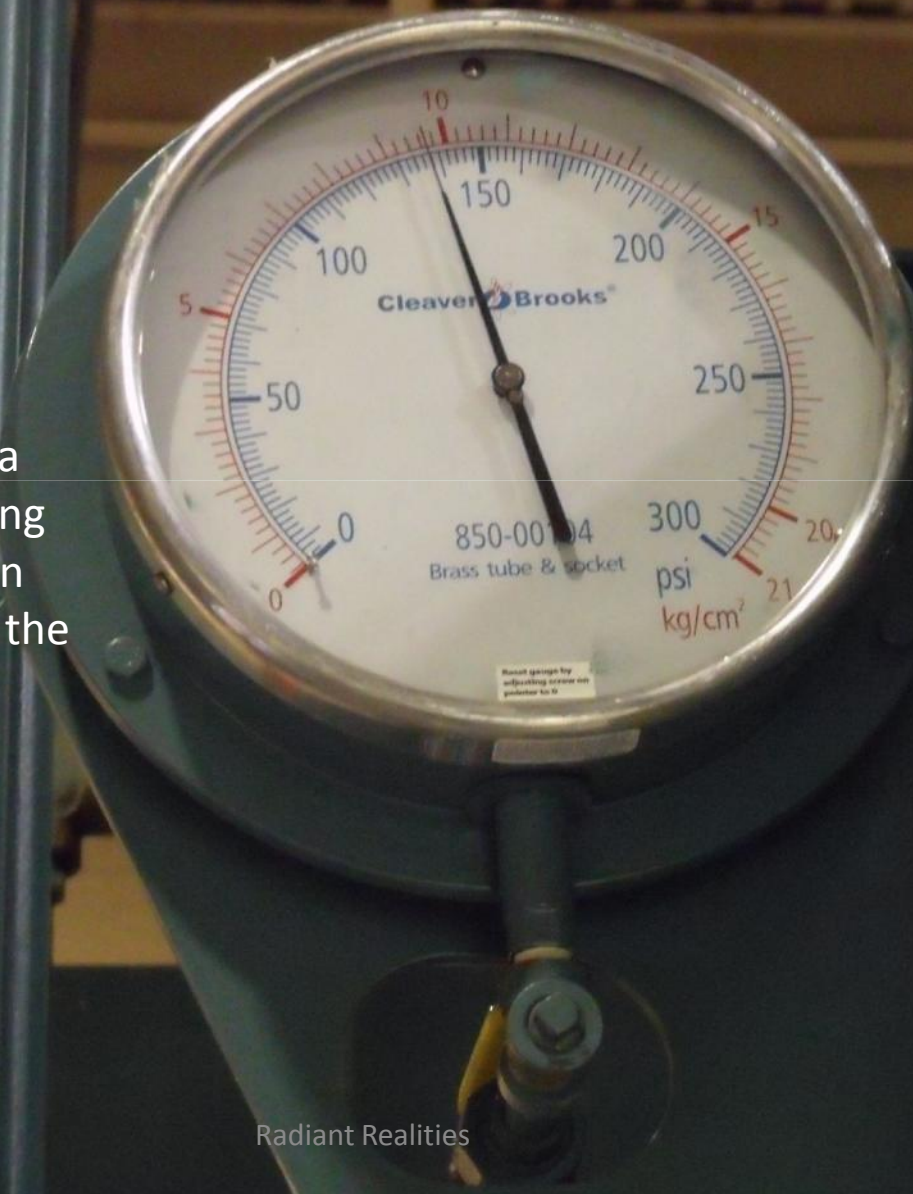


## **Water droplets in high velocity steam can be as abrasive as sand particles**

- They can erode pipe fittings and rapidly eat away at valve seats.
- If a puddle of water is allowed to accumulate it will eventually be picked up by high velocity steam and accelerated to near steam velocity.
- Causes water hammer, loosens pipe fittings and supports.

# MAWP

Boilers are constructed to a maximum allowable working pressure. (This is the design pressure of the vessel and the maximum set point of a safety valve).



# Steam Systems Operate By Pressure

- Pressure controls operate the burner and establish system operating pressure.
- The pressure environment allows pressure to build and be maintained.
- The burners job is to maintain steam pressure by delivering heat energy. It typically modulates within a range to satisfy pressure demands.
- Based upon the **steam load**, pressure can be fairly stable or drop. The burner firing rate is increased or decreased to maintain the pressure control set point.



# Balanced Pressure System

**Delta P** or change in pressure allows steam to flow. Steam condenses, takes up less space, pressure drops accordingly.

**A steam system seeks a balanced pressure condition**

**Or steady state condition**

- In a steady state condition fuel is burned at a steady rate. Steam is used at a steady rate. Equilibrium is obtained.
- What upsets equilibrium?
- Additional Steam load.

**What happens when a steam control valve is opened?**

- The pressure drops in the boiler over the saturated water surface. Heat energy is added to make steam as required to satisfy the pressure switch set point.

## **ASME CSD-1** CW-300

### **Pressure Controls**

- One operating pressure control minimum. (More can be used if desired).
- One high limit pressure control with manual reset is required. On all steam boilers
- Siphon or equivalent means of maintaining a water seal at the control is required.

# PRESSURE CONTROLS

Operating

High Limit w/ Manual  
Reset

Modulating

Radiant Heaters

**CAUTION**  
HAZARD OF ELECTRIC SHOCK  
More Than One Disconnect Switch May  
Be Required To DISCONNECT ALL POWER  
Other Than NEC Class 2.

CLEAVER BROOKS

ELECTRICAL EQUIPMENT

MADE IN THE U.S.A.

**Boilers must have at least one  
steam operating pressure switch**





Boilers must have one high limit safety pressure switch to shut off the burner if the primary operating switch fails.  
**(This control must have a manual reset switch)**



## **Modulating pressure control**

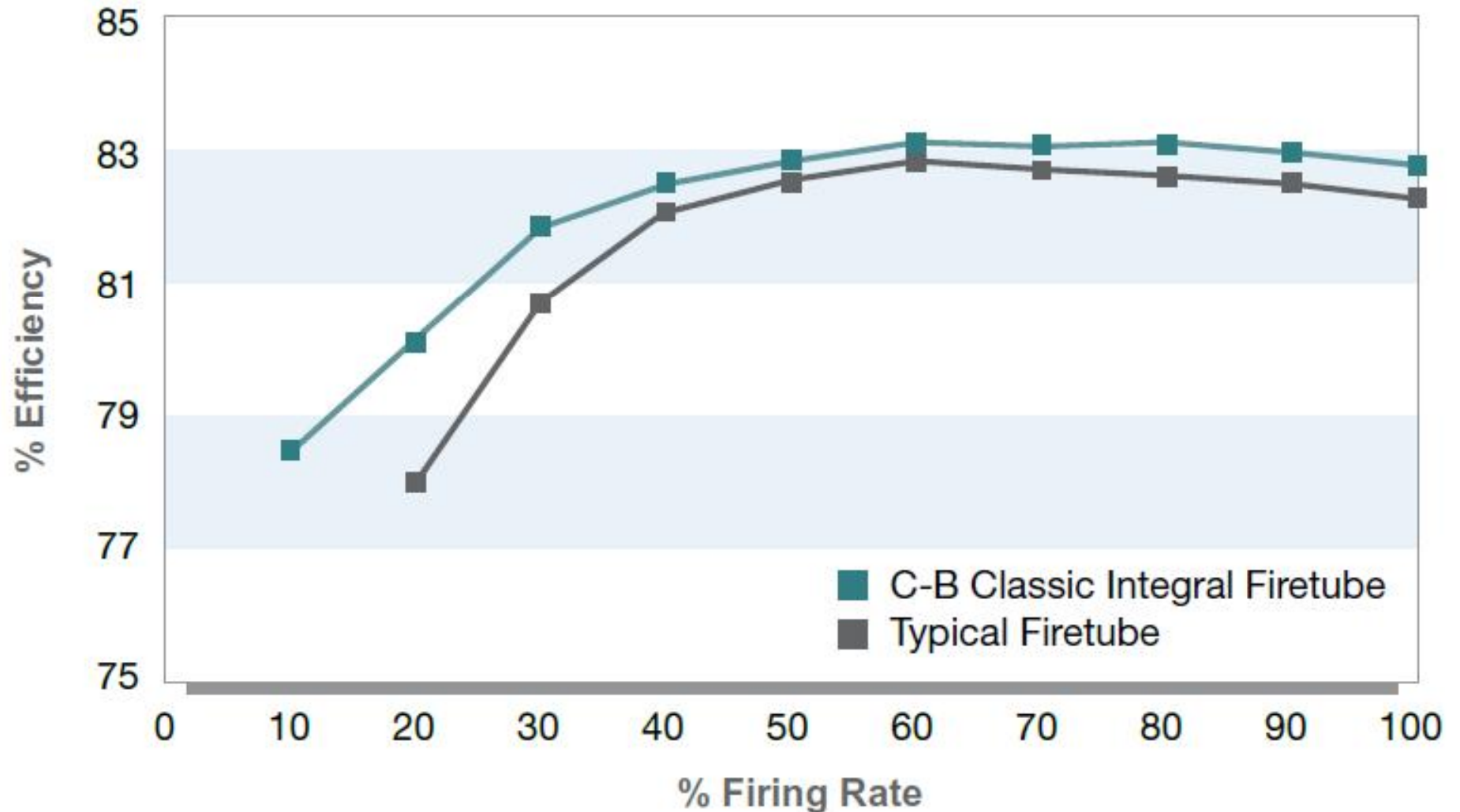
If used, controls firing rate from a minimum fire to a maximum firing rate in response to steam pressure.



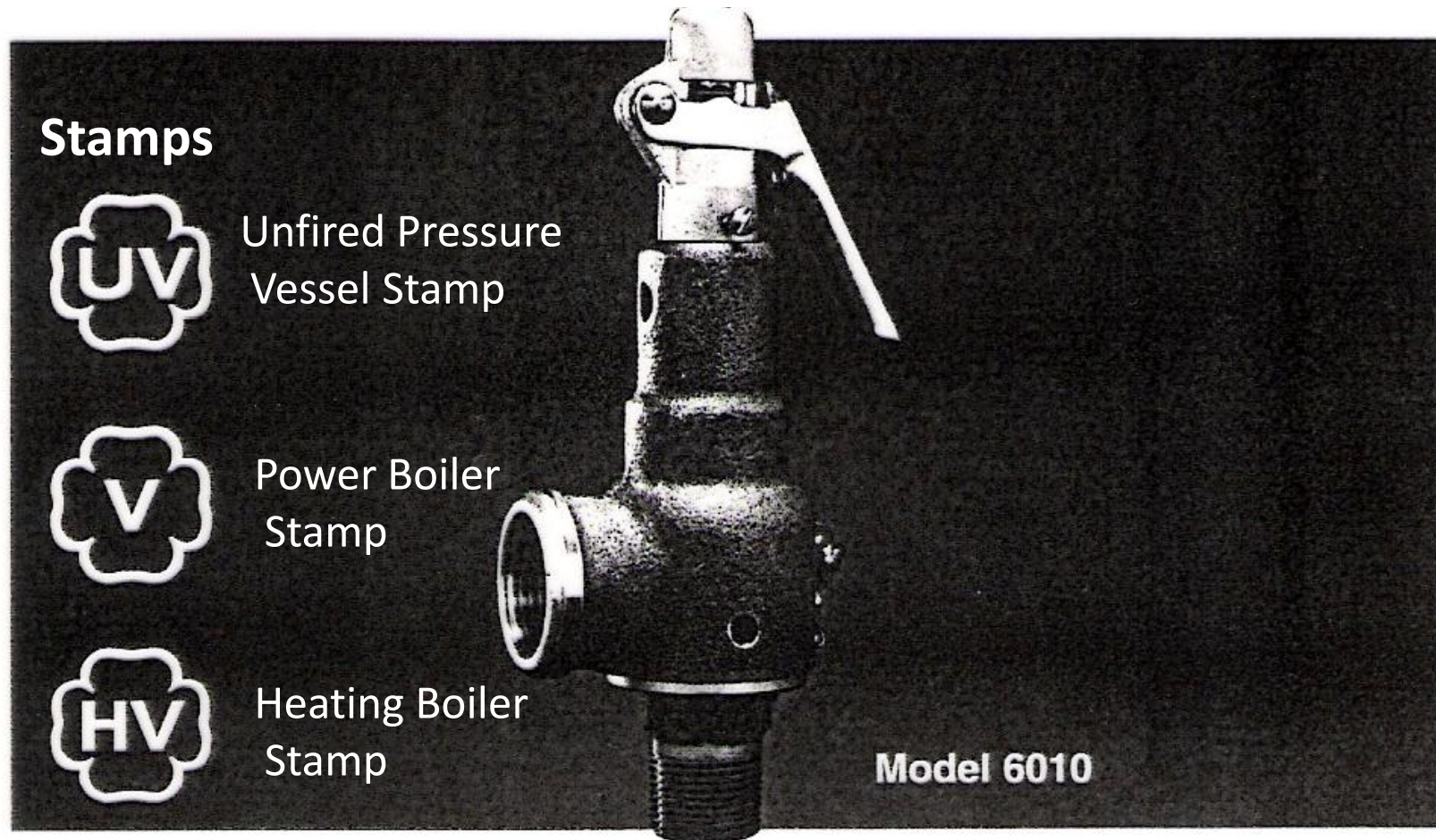
## Modulating Burners

Burners fire within a minimum range 10% or 20% to the maximum designed burner input rating. (Low fire to high fire input.)

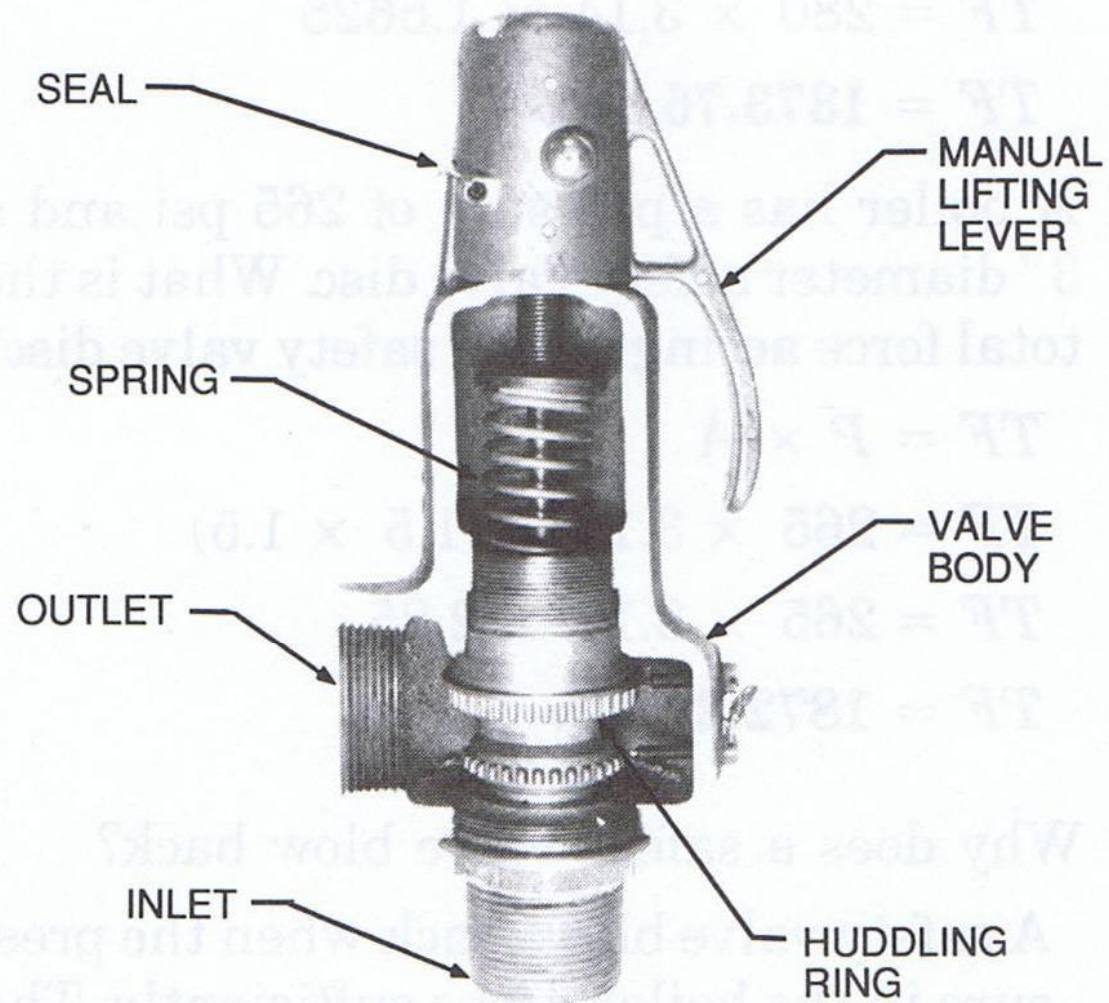
This chart details efficiency based upon the firing rate.



# Safety Valves



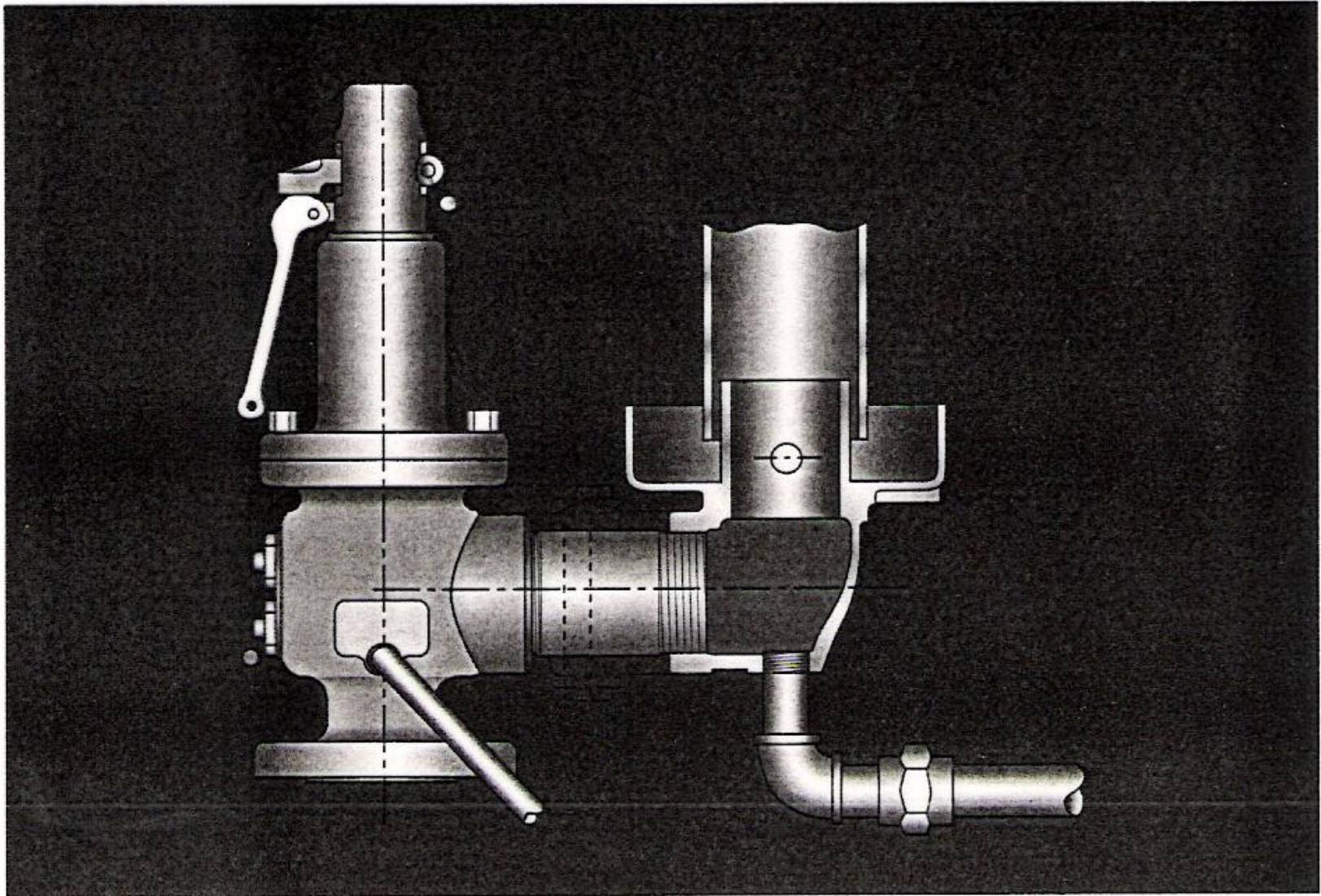




**Figure 3-1.** The safety valve is the most important valve on a boiler.

Radiant Realities

# Safety Valve Drip Pan Elbow







# SV Set Pressure Vs. Boiler Operating Pressure

ASME Section 1 Power Boilers

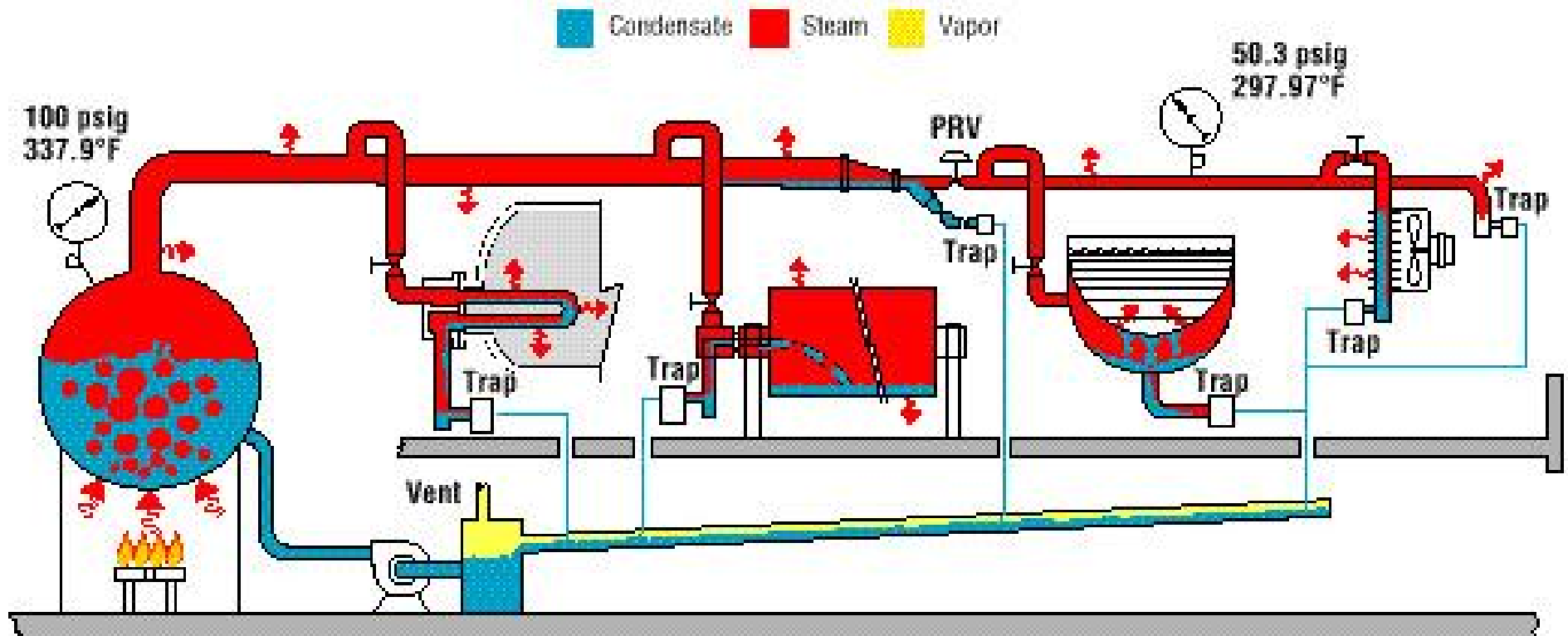
Within 10% of safety valve setting or no closer than 7 psi.

Low Pressure Steam Boiler: 5psi

15psi Boiler not operated above 10psi



# Steam demand & burner Loading



# Burner Loading

- **Unloaded**
- No steam demand, burner is off.
- **Loaded**
- Burner is on and firing.
- **Over Loaded**
- Burner cannot add enough heat energy to maintain the steam pressure.
- Too many steam users are turned on.
- **Under Loaded**
- Not enough steam load. Steam pressure rises. Burner shuts off.

# Steam Distribution Piping

## What's happening in the steam piping?

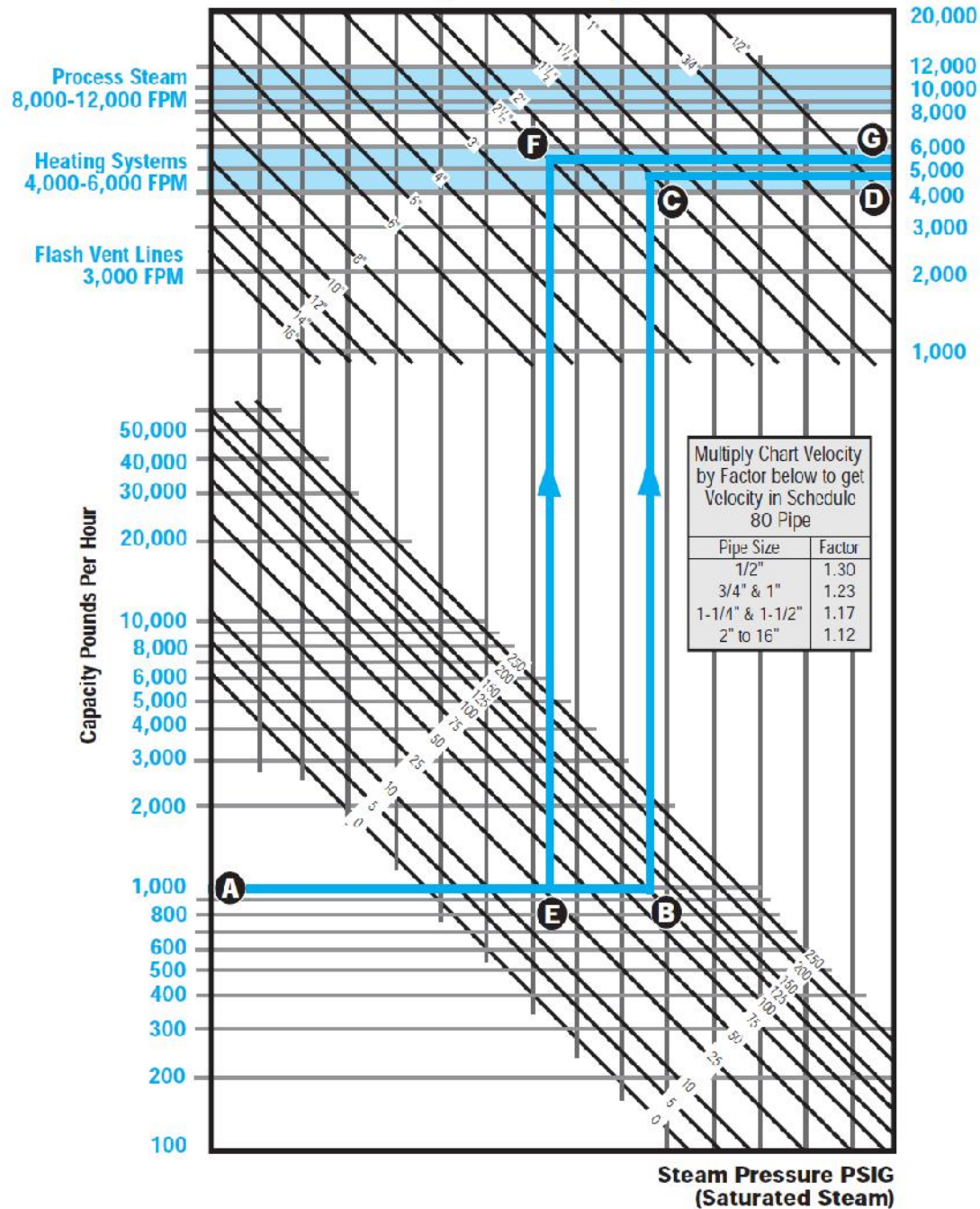
- Flow
- Velocity
- Pressure Drop
- Temperature
- Pressure
- Condensing
- Expansion
- Contraction
- Vacuum (When cools)

# Steam Pipe Sizing

- Steam piping is sized based upon pressure drop & velocity
- Typical heating system steam velocity is 4000 to 6000 fpm
- Typical industrial system steam velocity is 6000 to 12000 fpm
- Velocity equals pressure drop, noise, and erosion
- **It's best to keep velocity on the low side.....**
- Noise is more acceptable in industrial plants vs. heating plants so higher velocities are used.



**STEAM VELOCITY CHART**  
(Schedule 40 Pipe)



**Steam Velocity**

**Heating Systems**

**4000-6000 FPM**

**Process Steam**

**8000-12000 FPM**

# Steam Velocity

**Does steam move faster at low pressure or high pressure?**

**Example:**

**Move 6900 lbs of steam through 4" pipe to the user in one hour. Using 70 psi and 125 psi steam**

$$\text{Velocity (fpm)} = \frac{2.4 * Q * V_s}{A}$$

**Q=lbs/hr**

**Vs=Sp. Volume (cubic feet)**

**A= Internal pipe area (square in.)**

**70 psi = 6725 fpm**

**125 psi = 4188 fpm**

**Steam piping** does not determine how fast steam moves through it. The amount of steam that the steam user is asking for, and the operating pressure determines the speed of the steam in piping.

**If 6900 lbs per hour of steam is needed by the user.**

**4" pipe at 125 psi** will have a steam velocity of 4188 fpm.

**4" pipe at 70 psi** will have a steam velocity of 6725 fpm.

**A 37% increase in velocity at lower pressure.**

# Saturated steam velocity

SATURATED STEAM (lbs/hr) at 6000 ft/min (velocity) in iron or steel pipe



| Pipe Size<br>(Inches) | PRESSURE PSI (GAUGE) |       |       |       |       |       |       |       |        |        |
|-----------------------|----------------------|-------|-------|-------|-------|-------|-------|-------|--------|--------|
|                       | 5                    | 10    | 15    | 30    | 50    | 75    | 100   | 125   | 200    | 250    |
| ½                     | 30                   | 40    | 45    | 60    | 90    | 120   | 150   | 180   | 270    | 330    |
| ¾                     | 55                   | 70    | 80    | 110   | 160   | 220   | 280   | 340   | 510    | 620    |
| 1                     | 90                   | 110   | 125   | 180   | 270   | 390   | 460   | 560   | 840    | 1020   |
| 1¼                    | 160                  | 200   | 225   | 325   | 480   | 650   | 820   | 990   | 1490   | 1830   |
| 1½                    | 220                  | 270   | 300   | 450   | 650   | 900   | 1100  | 1300  | 2060   | 2550   |
| 2                     | 370                  | 455   | 520   | 750   | 1100  | 1500  | 1900  | 2300  | 3450   | 4200   |
| 2½                    | 525                  | 650   | 750   | 1050  | 1600  | 2175  | 2750  | 3300  | 4950   | 6050   |
| 3                     | 800                  | 950   | 1350  | 1600  | 2500  | 3350  | 4250  | 5150  | 7700   | 9450   |
| 3½                    | 1100                 | 1350  | 1550  | 2200  | 3300  | 4550  | 5700  | 6900  | 10200  | 12700  |
| 4                     | 1450                 | 1800  | 2000  | 2900  | 4300  | 5850  | 7400  | 8900  | 13450  | 16400  |
| 5                     | 2300                 | 2800  | 3200  | 4600  | 6900  | 9300  | 11700 | 14100 | 21200  | 26000  |
| 6                     | 3200                 | 3900  | 4500  | 6400  | 9800  | 13200 | 16800 | 20300 | 30800  | 36900  |
| 8                     | 5700                 | 7000  | 8000  | 11400 | 17200 | 23300 | 29300 | 35400 | 53100  | 65200  |
| 10                    | 9300                 | 11400 | 13000 | 18900 | 28200 | 38000 | 48100 | 58100 | 87100  | 106500 |
| 12                    | 13500                | 16600 | 18900 | 27000 | 40800 | 55300 | 69700 | 84200 | 126500 | 154700 |



**4" pipe can move 8,900 lbs of steam per hour at 125 psi, and velocity of 6000 ft per minute.**

*4" pipe can only move 1,800 lbs of steam per hour at 10 psi and a velocity of 6000 ft per minute.*



# Steam Plant Checklists And Preventative Maintenance





**ASME CSD-1  
CG-400**

Requires that boiler  
manufacturers provide  
comprehensive  
maintenance and  
testing procedures

***Model CB-LE  
Packaged Boiler***

***125 - 200 HP***

and Model CB Ohio Special 125-225 HP

**Operation, Service, and Parts Manual**



750-184  
04/09

**2012 Current Edition**

**ASME CSD-1-2009**

(Revision of ASME CSD-1-2006)

# **Controls and Safety Devices for Automatically Fired Boilers**

AN AMERICAN NATIONAL STANDARD



Copyright © 2009 by the American Society of Mechanical Engineers.  
No reproduction may be made of this document without written consent of ASME.

**2009 ASME CSD-1**

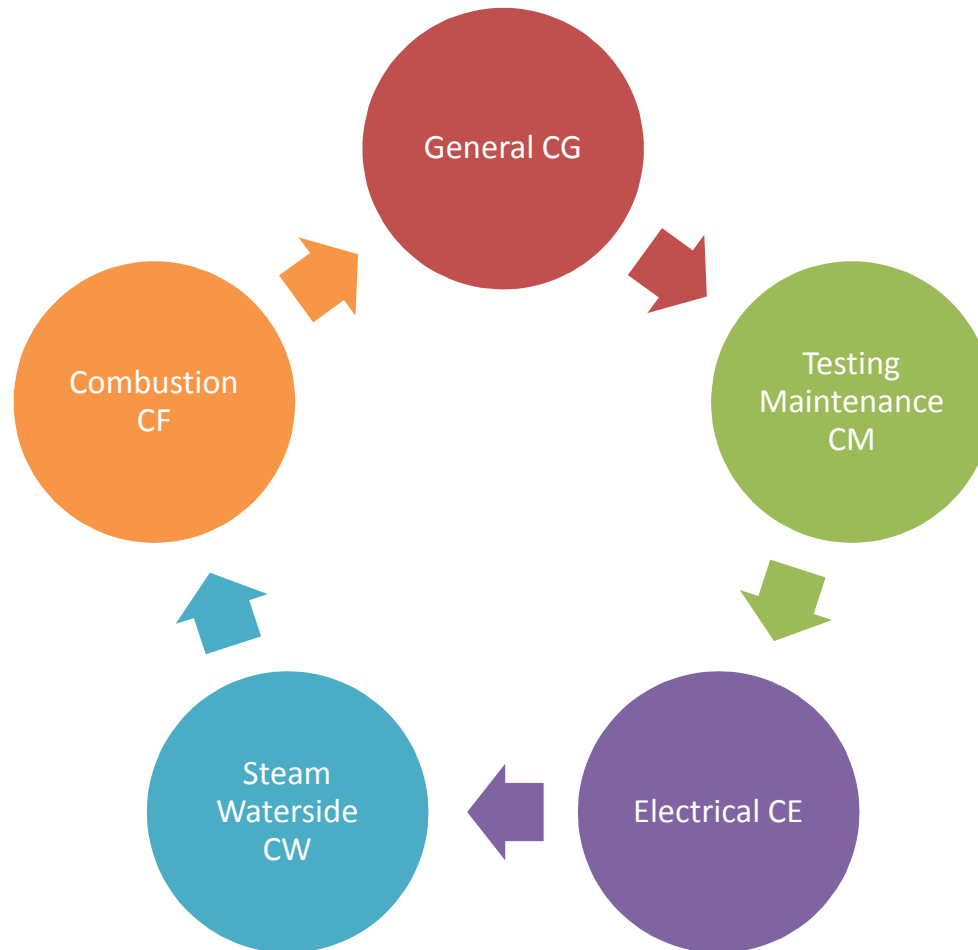
## **2012 ASME CSD-1**

Boilers up to 300 Hp

- Assembly
- Installation
- Maintenance
- Operation

# ASME CSD-1

## Five Sections



**Table D-1 Periodic Testing Recommended Checklist (See Manufacturer's Instructions)**

| Frequency [Note (1)] |     |     |     |     |     | Component/Item                                        | Recommended Test                                                                                                                                                                                          | Accomplished By |                    |
|----------------------|-----|-----|-----|-----|-----|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|
| D                    | W   | M   | S/A | A   | A/R |                                                       |                                                                                                                                                                                                           | Boiler Operator | Service Technician |
| X                    | ... | ... | ... | ... | ... | Gages, monitors, and indicators                       | Make visual inspection and record readings in boiler log.                                                                                                                                                 | X               | ...                |
| ...                  | ... | ... | X   | ... | ... | Gages, monitors, and indicators                       | Recalibrate all indicating and recording gages.                                                                                                                                                           | ...             | X                  |
| X                    | ... | ... | ... | ... | ... | Instrument and equipment settings                     | Make visual check against factory-recommended specifications.                                                                                                                                             | X               | ...                |
| X                    | ... | ... | ... | ... | ... | Low-water fuel cut-off device (high-pressure boilers) | Test low-water fuel cut-off device according to manufacturer's instructions.                                                                                                                              | X               | ...                |
| ...                  | X   | ... | ... | ... | ... | Low-water fuel cut-off device (low-pressure boilers)  | Test low-water fuel cut-off device according to manufacturer's instructions.                                                                                                                              | X               | ...                |
| ...                  | ... | ... | X   | ... | ... | Low-water fuel cut-off device (steam boilers)         | For steam boilers, perform a slow drain test in accordance with ASME Boiler and Pressure Vessel Code, Section VI.                                                                                         | ...             | X                  |
| ...                  | ... | ... | ... | ... | X   | Low-water fuel cut-off device                         | Recondition or replace low-water fuel cut-off device.                                                                                                                                                     | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Operating and/or limit controls                       | Test high-limit and operating temperature or steam pressure controls.                                                                                                                                     | ...             | X                  |
| ...                  | ... | ... | ... | ... | X   | Safety/safety relief valves                           | Test safety/safety relief valves in accordance with ASME Boiler and Pressure Vessel Code, Sections VI and VII.                                                                                            | ...             | X                  |
| ...                  | ... | X   | ... | ... | ... | Flue, vent, stack, or outlet dampers                  | Make visual inspection of linkage, and check for proper operation.                                                                                                                                        | X               | ...                |
| X                    | ... | ... | ... | ... | ... | Burner flame                                          | Make visual inspection of burner flame [Note (2)].                                                                                                                                                        | X               | ...                |
| ...                  | X   | ... | ... | ... | ... | Igniter                                               | Make visual inspection, and check flame signal strength if meter-fitted.                                                                                                                                  | X               | ...                |
| ...                  | X   | ... | ... | ... | ... | Flame signal strength                                 | If flame signal meter is installed, read and log. For both pilot and main flames, notify service organization if readings are very high, very low, or fluctuating (refer to manufacturer's instructions). | X               | ...                |
| ...                  | X   | ... | ... | ... | ... | Flame failure detection system                        | Close manual fuel supply for (1) pilot, (2) main fuel cock, and/or (3) valve(s). Check safety shutdown timing, and log.                                                                                   | X               | ...                |



**Table D-1 Periodic Testing Recommended Checklist (Cont'd)**

| Frequency [Note (1)] |     |     |     |     |     | Accomplished By                                              |                                                                                                                                                                        |                 |                    |
|----------------------|-----|-----|-----|-----|-----|--------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|
| D                    | W   | M   | S/A | A   | A/R | Component/Item                                               | Recommended Test                                                                                                                                                       | Boiler Operator | Service Technician |
| ...                  | ... | ... | X   | ... | ... | Flame failure detection system                               | Check flame failure detection system components, such as vacuum tubes, amplifier, and relays.                                                                          | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Flame failure detection system                               | Replace vacuum tubes, scanners, or flame rods in accordance with manufacturer's instructions.                                                                          | ...             | X                  |
| ...                  | ... | ... | ... | X   | X   | Flame failure detection system (pilot turndown test)         | Conduct pilot turndown test according to manufacturer's instructions. This test is required annually and after any adjustments to flame scanner mount or pilot burner. | ...             | X                  |
| ...                  | ... | ... | ... | X   | X   | Flame failure detection system (hot refractory hold in test) | Test for hot refractory hold in. This test is required annually and after any adjustments to the flame scanner mount or pilot burner.                                  | ...             | X                  |
| ...                  | X   | ... | ... | ... | ... | Firing rate control                                          | Check firing rate control, and verify factory settings (refer to manufacturer's instructions).                                                                         | X               | ...                |
| ...                  | ... | ... | X   | ... | ... | Firing rate control                                          | Check firing rate control, and verify factory settings (refer to manufacturer's instructions).                                                                         | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Firing rate control                                          | Conduct a combustion test, and verify settings are in accordance with manufacturer's instructions.                                                                     | ...             | X                  |
| ...                  | X   | ... | ... | ... | ... | Pilot and/or main fuel valves                                | Open limit switch, and make aural and visual check. Check valve position indicators, and check fuel meters if so fitted.                                               | X               | ...                |
| ...                  | ... | ... | ... | X   | ... | Pilot and/or main fuel valves                                | Check all coils and diaphragms. Test other operating parts of all safety shutoff and control valves.                                                                   | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Pilot and/or main fuel valves                                | Test fuel valve interlock switch in accordance with manufacturer's instructions.                                                                                       | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Pilot and/or main fuel valves                                | Perform leakage test on pilot and main gas and/or oil fuel valves, in accordance with manufacturer's instructions.                                                     | ...             | X                  |
| ...                  | ... | X   | ... | ... | ... | Low draft, fan, air pressure, and damper position interlocks | Test low draft, fan, air pressure, and damper position interlocks according to manufacturer's instructions.                                                            | X               | ...                |
| ...                  | ... | ... | ... | X   | ... | Low draft, fan, air pressure, and damper position interlocks | Test purge switch in accordance with manufacturer's instructions.                                                                                                      | ...             | X                  |

**Table D-1 Periodic Testing Recommended Checklist (Cont'd)**

| Frequency [Note (1)] |     |     |     |     |     | Component/Item                          | Recommended Test                                                                                                                    | Accomplished By |                    |
|----------------------|-----|-----|-----|-----|-----|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|
| D                    | W   | M   | S/A | A   | A/R |                                         |                                                                                                                                     | Boiler Operator | Service Technician |
| ...                  | ... | X   | ... | ... | ... | Low-fire start interlock                | Check low-fire start interlock according to manufacturer's instructions.                                                            | X               | ...                |
| ...                  | ... | ... | ... | X   | ... | Low-fire start interlock                | Test low-fire start interlock in accordance with manufacturer's instructions.                                                       | ...             | X                  |
| ...                  | ... | X   | ... | ... | ... | Oil pressure and temperature interlocks | Test high and low oil pressure and temperature interlocks according to manufacturer's instructions.                                 | X               | ...                |
| ...                  | ... | X   | ... | ... | ... | Gas pressure interlocks                 | Test high and low gas pressure interlocks according to manufacturer's instructions.                                                 | X               | ...                |
| ...                  | ... | ... | X   | ... | ... | Interlocks and valves                   | Check piping and wiring of all interlocks, and shutoff valves.                                                                      | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Atomizing air/steam interlock           | Test air/steam interlock in accordance with manufacturer's instructions.                                                            | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Burner position interlock               | Test burner position interlock in accordance with manufacturer's instructions.                                                      | ...             | X                  |
| ...                  | ... | ... | ... | X   | ... | Rotary cup burner interlock             | Test rotary cup interlock in accordance with manufacturer's instructions.                                                           | ...             | X                  |
| ...                  | ... | ... | X   | ... | ... | Burner components                       | Inspect burner components according to manufacturer's instructions.                                                                 | ...             | X                  |
| ...                  | ... | ... | ... | X   | X   | Burner components                       | Check dual fuel change over control. If automatically controlled by gas utility, perform test under the supervision of gas utility. | ...             | X                  |
| ...                  | ... | ... | ... | ... | X   | Burner components                       | For oil-fired burners, clean atomizers and oil strainers.                                                                           | ...             | X                  |
| ...                  | ... | ... | ... | ... | X   | Burner components                       | For gas-fired burners, check sediment trap and gas strainer.                                                                        | ...             | X                  |

**NOTES:**

(1) D, daily; W, weekly; M, monthly; S/A, semi-annually; A, annually; A/R, as-required.

(2) Caution should be used when viewing burner flame. Personal protective equipment, such as filtered eyewear, may be necessary.

# NFPA® 85

## Boiler and Combustion Systems Hazards Code

2011 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471  
An International Codes and Standards Organization

## Boilers and Burners Above 12,500,000 Btus (@ 300 Hp)

[www.nfpa.org/freeaccess](http://www.nfpa.org/freeaccess)

# Steam Plant Checklists

**Procedures should be established according to the manufacturer's recommendations**

**Use checklists and keep logs in the boiler room**

**Two separate logs**

- Daily operations**
- Maintenance activities**



# Boiler Room Logs and Records

## The simple and basic reason for maintenance

Maintain top efficiency

Extend operational life of the equipment

Promote safety

1. Maintain complete records. Document each individual component, model, serial number, part number, and date installed.
2. Establish a detailed startup procedure.
3. Establish a written operating procedure.

# General Safety

- Sufficient lighting
- Good housekeeping (Not a storage area)
- Adequate fresh air supply
- Heat room to acceptable ambient air temperature
- Keep electrical equipment clean
- Confirm no smell of gas or leaks exist
- Confirm that steam or water leaks have been referred to maintenance staff for action
- Note any unusual boiler conditions
- Note changes in equipment status and why

# Daily Operation Safety Checklist

- Water level
- Steam pressure
- Burner firing rate
- Main gas pressure
- Burner supply gas pressure
- Burner flame condition
- Flue temperature
- Feedwater temperature
- Feedwater tank water level
- Feed pump discharge pressure
- Makeup water usage
- Control settings
- Boiler cycles

# Power Boiler Daily Duties

- Insure adequate supply of combustion air
- Take a water sample
- Treat water as required
- Blowdown water column
- Blowdown sight glass
- Blowdown/Test primary low water cut-off
- Blowdown/Test auxiliary low water cut-of
- Blowdown the boiler



# Testing LWCO/Pump Control

## Three Ways To Test LWCO's

### **Open LWCO drain valve** (Perform test daily)

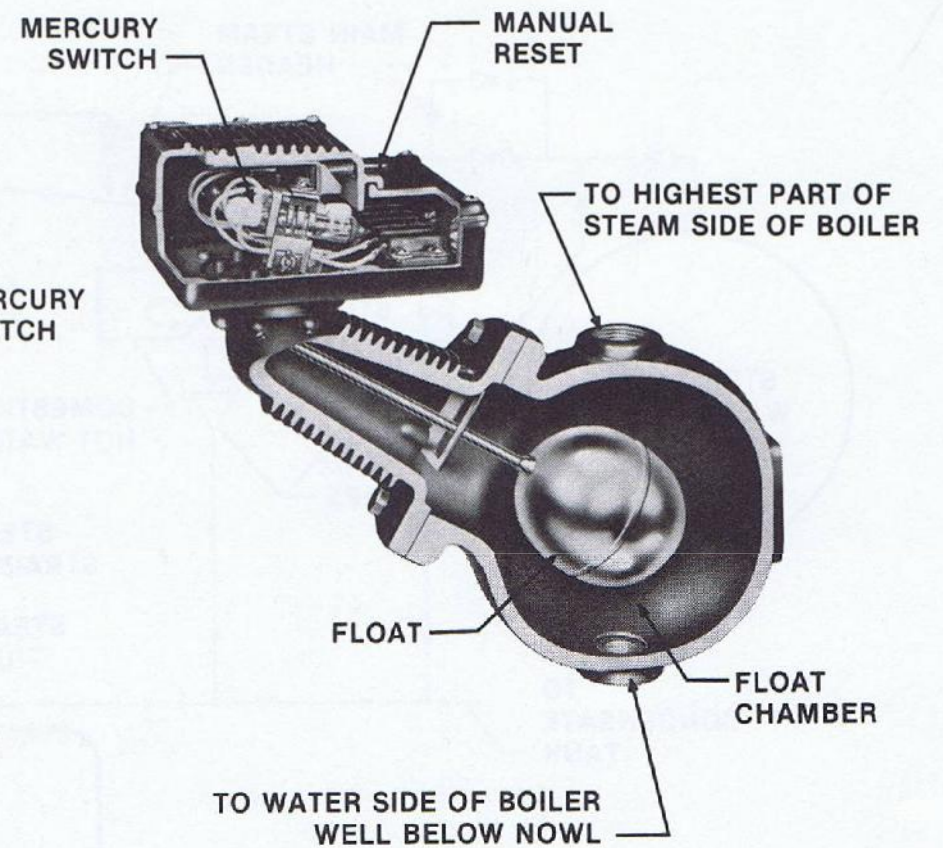
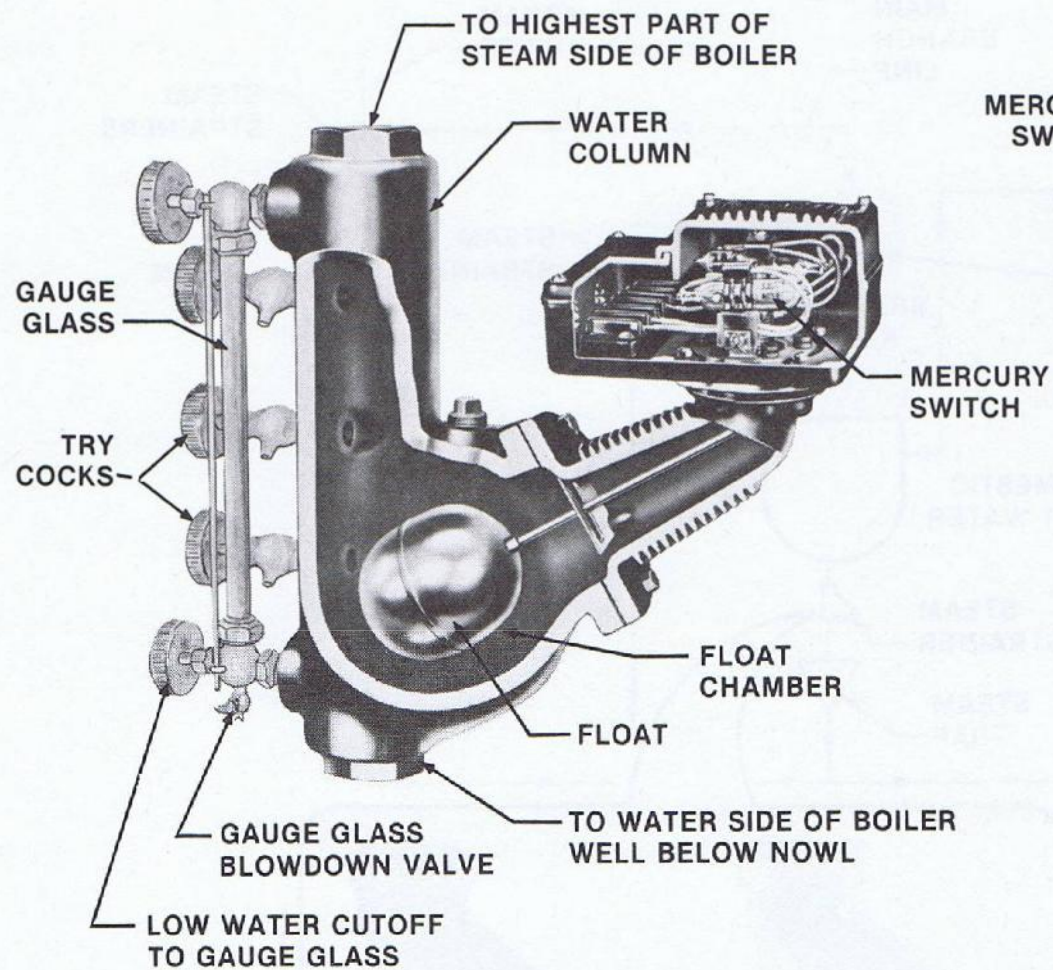
- Burner should shut off
- Pump should come on
- (Not the best test for a float that may be sticking)

### **Slow drain test**

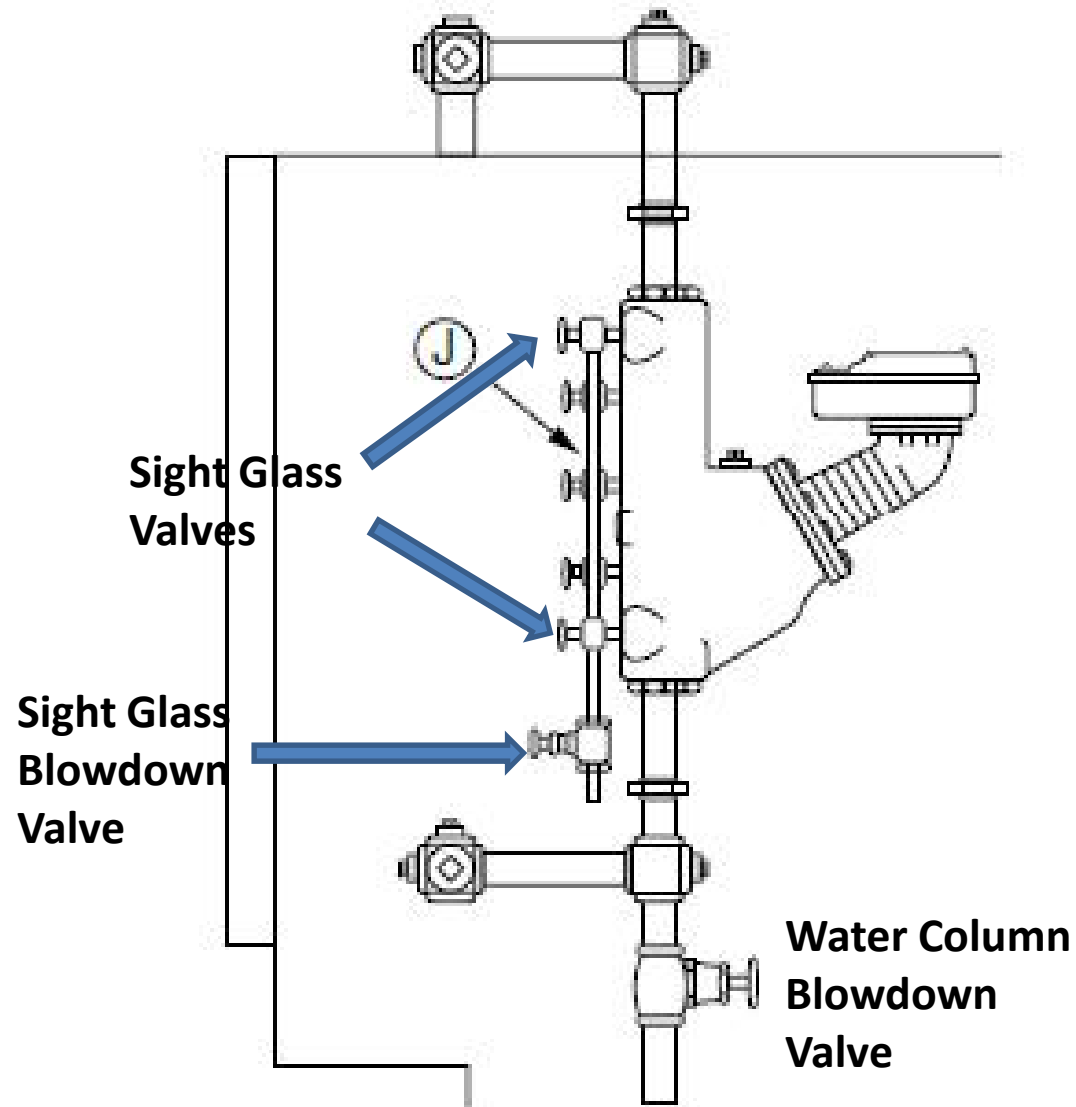
- Partially open boiler bottom blowdown valve
- Perform test twice a year

### **Evaporation test**

- Shut off the valve that supplies water to the boiler
- Turn off the pumps



## Series 157S



# **Water Column & Sight Glass Blowdown**

## **Daily for power boilers**

- Operator should monitor the action of the water in the gauge glass. It should enter the glass quickly indicating that the lines are free of sludge and sediment or scale buildup.

## **Boiler bottom blowdown**

### **Daily for power boilers**

- Perform bottom blowdown when the boiler is operating at a light load. Typically ½" in sight glass. (Based upon water treatment)



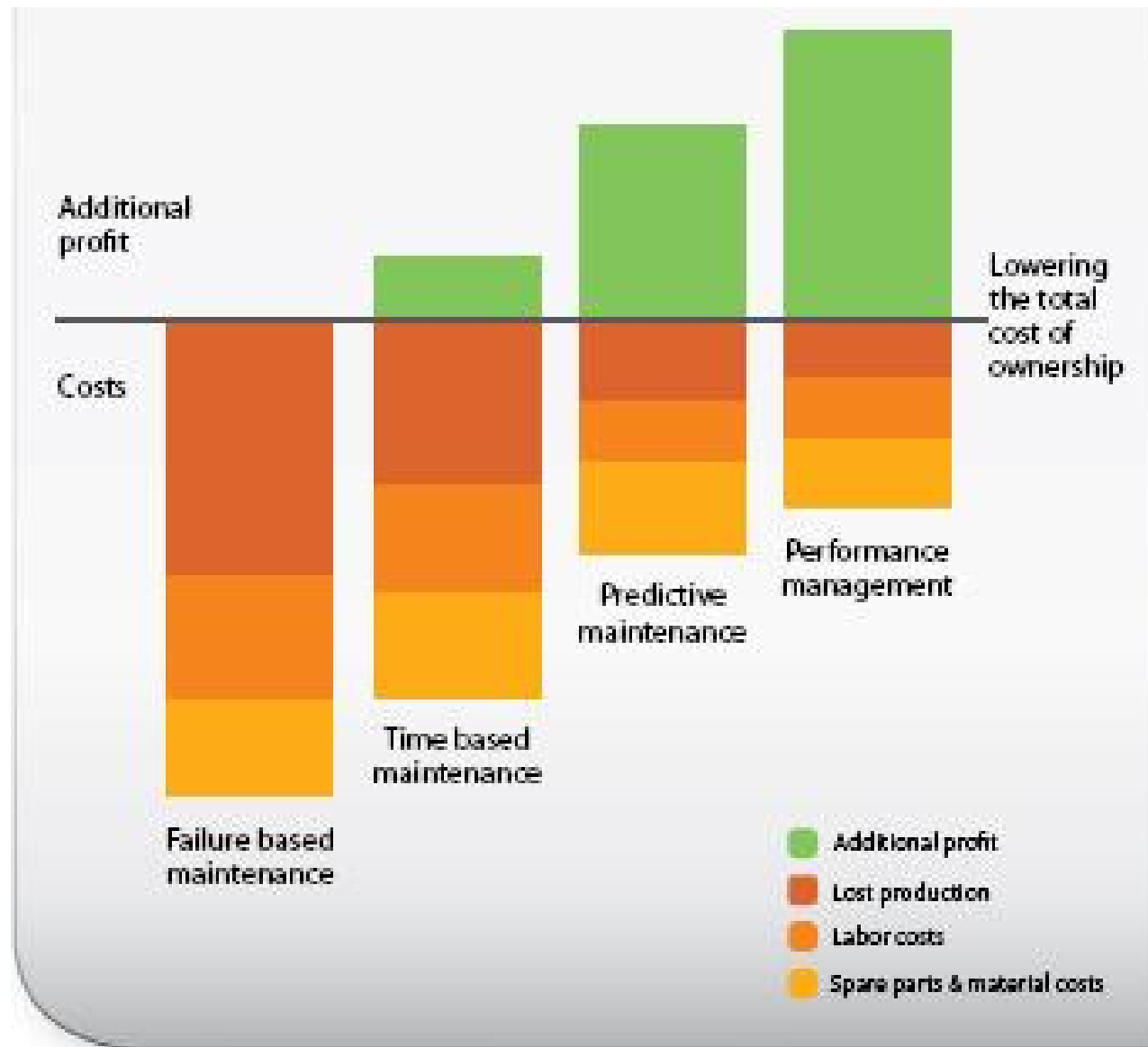
## **Condition of the Burner Flame**

1. Observe the condition of the flame to determine it is even and not off color.
2. Gas flame should be translucent blue with varying amounts of yellow on the flame ends depending upon firing rate. The flame should be even around the burner.
3. Oil burner flame should be bright yellow without dark trails off the end of the flame.
4. Record stack temperature

# Boiler Feedwater System Checklist

1. Feed water tank temperature
  1. Warmer the better
  2. Normal tank temperature
  3. High temperature (always below 212F.)
    1. Leaking steam traps
    2. High volume of condensate return
    3. Undersized vent piping
  4. Lower than normal tank temperature
    1. Leaking cold water makeup valve
    2. Less condensate returned to tank
    3. Cooled condensate
2. Feed water tank level
3. Feed pump discharge pressure
4. Tank vent plume
5. Tank leaks, corrosion

# Performance Management



# **2015 OBPVSC**

## **Oregon Boiler & Pressure Vessel Specialty Code**

Radiant Realities

Tim Blomdahl



STATE OF OREGON  
BOILER AND PRESSURE  
VESSEL LAW



OREGON REVISED STATUTES – CHAPTER 480 (2013)  
OREGON ADMINISTRATIVE RULES – CHAPTER 225 (2015)

## **Purpose of Oregon Adopted Boiler Law**

- Protect the public
- Protect property in Oregon
- Ensure safe construction
- Safe installation
- Safe maintenance
- Safe repair of boilers & pressure vessels



## Notice of Permanent Rule

*April 1, 2015*

### **Adoption of 2015 Oregon Boiler & Pressure Vessel Specialty Code**

#### **Purpose of the rule:**

These rules adopt the 2015 Oregon Boiler and Pressure Vessel Specialty Code. This code consists of model codes and standards with Oregon amendments for the safe installation and operation of boilers and pressure vessels in Oregon. These codes and standards are necessary to protect the public and property in Oregon by ensuring safe construction, installation, maintenance and repair of boilers and pressure vessels. Additionally, the proposed rules include housekeeping changes that delete outdated provisions and clarify the scope of the division's rules.

#### **Citation:**

Amend: 918-225-0430, 918-225-0435, 918-225-0570, 918-225-0600, & 918-225-0606; Repeal: 918-225-0220, 918-225-0345, 918-225-0390, & 918-225-0400

These rules and the codes become effective April 1, 2015.

#### **Effect:**

The Boiler and Pressure Vessel Specialty Code consists the following codes with Oregon amendments:

- 2013 ASME Boiler and Pressure Vessel Code ← Volumes 1,2,4,5,8,9,10
- 2012 ANSI/ASME B31.1 Power Piping Code
- 2012 ANSI/ASME B31.3 Process Piping Code
- 2013 ANSI/ASME B31.5 Refrigeration Piping Code
- 2011 ANSI/ASME B31.9 Building Service Piping Code
- 2013 National Board Inspection Code ANSI/NB 23
- 2011 NFPA 85 Boiler and Combustion Systems Hazards Code
- 2012 ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers

# 2013 ASME Code Sections

- **Section 1** Rules for Construction of Power Boilers
- **Section 2** Materials Parts A,B,C,D
- **Section 4** Rules for Construction of Heating Boilers
- **Section 5** Non-Destructive Examination
- **Section 8** Unfired Pressure Vessels Div 1, 2,3
- **Section 9** Welding & Brazing Qualifications
- **Section 10** Fiber Reinforced Plastic Pressure Vessels
- **Section 6** Recommended Rules Const of Heating Blrs
- **Section 7** Recommended Rules Const of Power Blrs



# 2010 ASME Boiler and Pressure Vessel Code AN INTERNATIONAL CODE

2013 Current Edition

## I Rules for Construction of Power Boilers



To View Code: [Google](http://www.google.com)  
**asme.bpvcl.a.2011.pdf**  
Choose Site  
[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

### Section I- Power Boilers

Has rules for construction of power, electric, and miniature boilers; high temperature water boilers for stationary service; and power boilers for locomotive, portable, and traction service.

CODE  
SYMBOL  
STAMP



**PP: PRESSURE PIPING**  
**S: POWER BOILERS**

# ASME Section 1 Boiler Construction Code

Designed to a **MAWP** (Maximum allowable working pressure)  
High Pressure Boilers

## ASME Section 1

### Power Boilers

**OPERATE ABOVE**

15 psi steam pressure

160 psi hot water

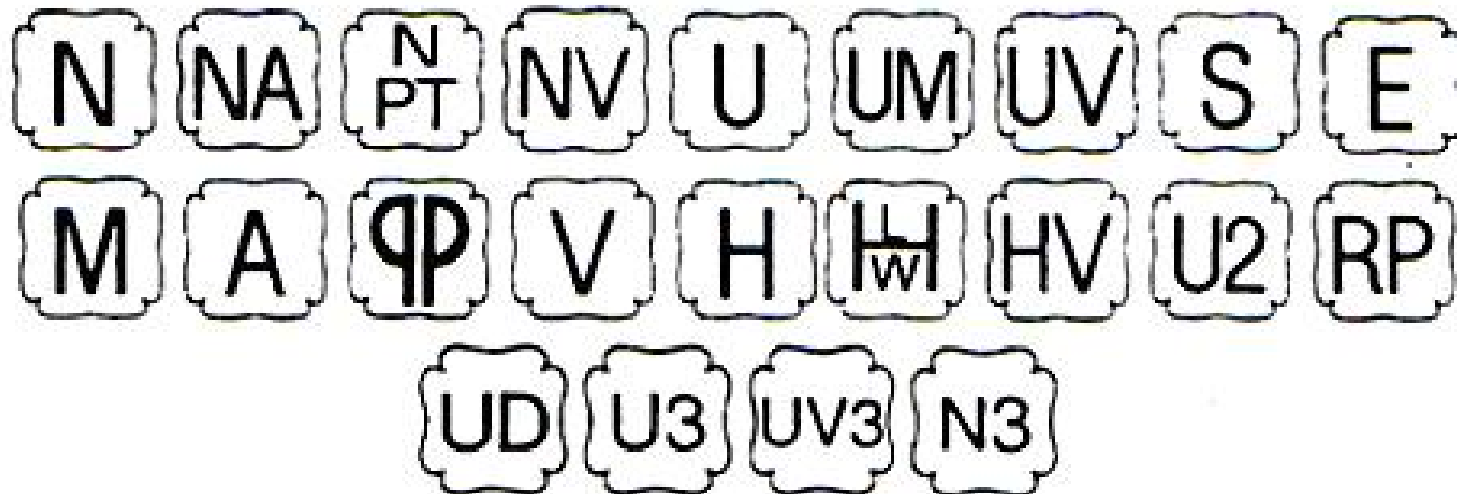
250 deg. F. hot water

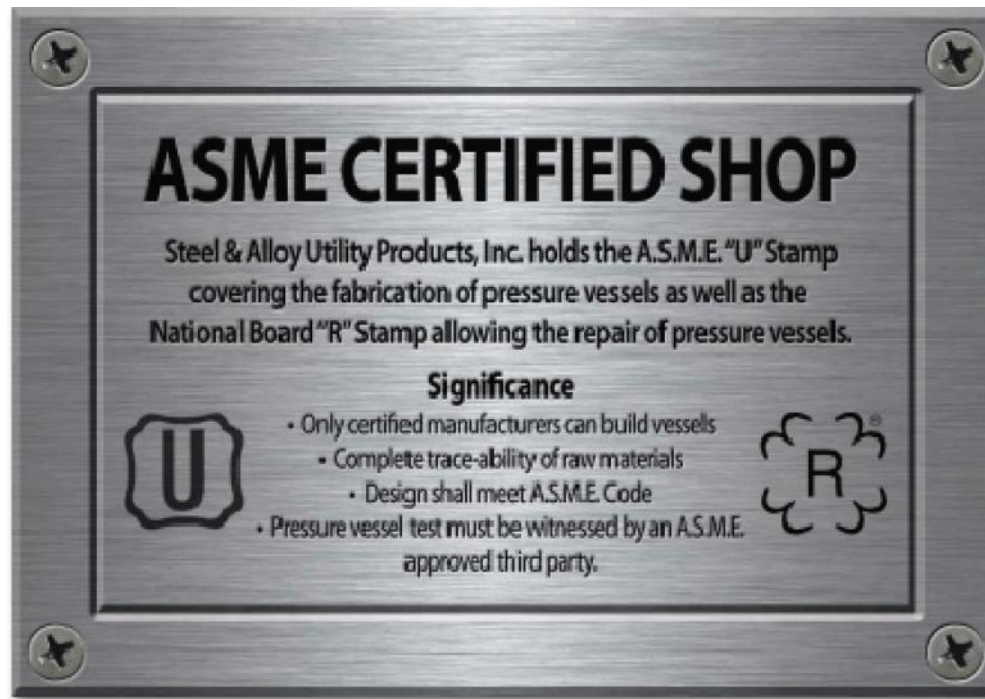


## ASME Boiler & Pressure Vessel Code Stamps



ASME collective membership mark









# CERTIFICATE OF AUTHORIZATION

This certificate accredits the named company as authorized to use the indicated symbol of the American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the Code symbol and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.

COMPANY:

SunBo Ind. Co., Ltd  
#1517-2 Dadae-Dong, Saha-Gu  
Busan 604-050  
South Korea

SCOPE:

Manufacture of pressure vessels at the above location and field sites controlled by the above location

AUTHORIZED:

EXPIRES:

CERTIFICATE NUMBER:

April 13, 2009  
April 13, 2012  
38,473

*John F. ...*  
Chairman of The Boiler  
And Pressure Vessel Committee

*Alan Ba*  
Director, Accreditation and Certification



# CERTIFICATE OF AUTHORIZATION

This certificate accredits the named company as authorized to use the indicated symbol of the American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the Code symbol and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.

COMPANY:

SunBo Ind. Co., Ltd  
#1517-2 Dadae-Dong, Saha-Gu  
Busan 604-050  
South Korea

SCOPE:

Manufacture and assembly of power boilers at the above location and field sites controlled by the above location

AUTHORIZED:

EXPIRES:

CERTIFICATE NUMBER:

April 13, 2009  
April 13, 2012  
38,472

*John F. ...*  
Chairman of The Boiler  
And Pressure Vessel Committee

*Alan Ba*  
Director, Accreditation and Certification



CODE  
SYMBOL  
STAMP



**Miniature Boiler Limits**  
100 Psi MAWP  
5 Cu. Ft. Gross Volume  
16" Diameter Shell Max  
20 Sq. Ft. Of Heating Surface

## ASME Section 1 Power Boiler Code Stamps

**M: MINIATURE BOILERS**

CODE  
SYMBOL  
STAMP



**E: ELECTRIC BOILERS**

CODE  
SYMBOL  
STAMP



**A: ASSEMBLY OF POWER BOILERS**

2013 Current Adopted Edition

AN INTERNATIONAL CODE

## 2010 ASME Boiler & Pressure Vessel Code

2010a Addenda

July 1, 2011

# II

## Part A

### Ferrous Material Specifications (SA-451 to End)

### MATERIALS

ASME Boiler and Pressure Vessel Code: Materials



The American Society of  
Mechanical Engineers

300 North Zeeb Road • Fairfield, NJ • 07004-2099

BOOK 1

## ASME Section 2 Materials (4 Parts A,B,C,D)

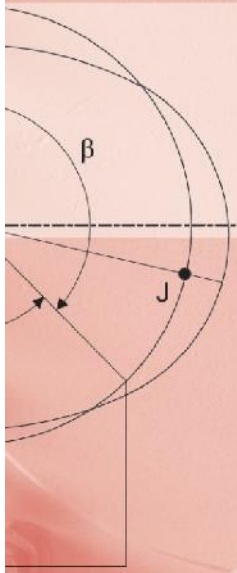
### Section II Part A – Ferrous Material Specifications

Provides material specifications for ferrous materials adequate for safety for pressure equipment. Includes requirements for mechanical properties, test specimens, and methods of testing.

**2013** ASME Boiler and  
Pressure Vessel Code  
AN INTERNATIONAL CODE

## II Materials

### Part B Nonferrous Material Specifications



ASME  
AMERICAN SOCIETY OF MECHANICAL ENGINEERS

**Section II Part B –  
Nonferrous Material Specifications**  
Provides material specifications for  
nonferrous materials adequate for  
safety for pressure equipment, including  
requirements for mechanical properties,  
test specimens, and methods of testing.



**2013** ASME Boiler and  
Pressure Vessel Code  
AN INTERNATIONAL CODE

## II Materials

### Part C Specifications for Welding Rods, Electrodes, and Filler Metals



ASME  
SETTING THE STANDARD

### Section II Part C – Specifications for Welding Rods, Electrodes and Filler Metals

Has material specifications for manufacture, acceptability, testing requirements and procedures, operating characteristics, and intended uses for welding rods, electrodes and filler metals.

### Section II Part D – Properties (Customary)

A service Code for reference by boiler and pressure vessel construction Codes having tables of design stress, tensile and yield strength values, and tables and charts of material properties.

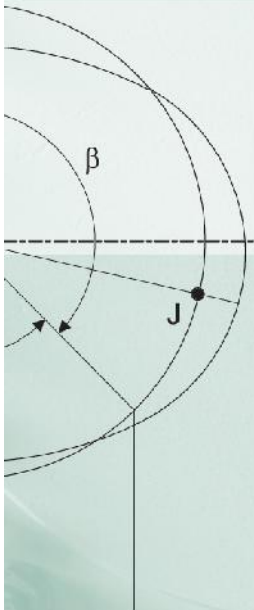
### Section II Part D – Properties (Metric)

A service Code for reference by boiler and pressure vessel construction Codes having tables of design stress, tensile and yield strength values, and tables and charts of material properties.

**2013** ASME Boiler and  
Pressure Vessel Code  
AN INTERNATIONAL CODE

# IV

## Rules for Construction of Heating Boilers



ASME  
SAFETY FOR THE WORLD

To View 2007 Code: [Google](#)  
**[asme.bpvc.iv.2007.pdf](#)**

Choose Site

[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

### Section IV - Heating Boilers

Provides rules for design, fabrication, installation and inspection of steam generating boilers, and low pressure hot water boilers that are directly fired by oil, gas, electricity, or coal.

CODE  
SYMBOL  
STAMP



H

**H: HEATING BOILERS EXCEPT CAST IRON**

**HLW: LINED POTABLE WATER HEATERS**



# ASME Section IV Pressure Vessel Construction Code

**MAWP** Maximum Allowable Working Pressure  
Design Pressure & “Safety Valve Setting”

## ASME Section IV “H” Steam Boilers

Operate below 15 psi

**Hot Water Heating Boilers**

**Hot Water Supply Boilers**

Operate below 160 psi

Operate below 250 deg F.

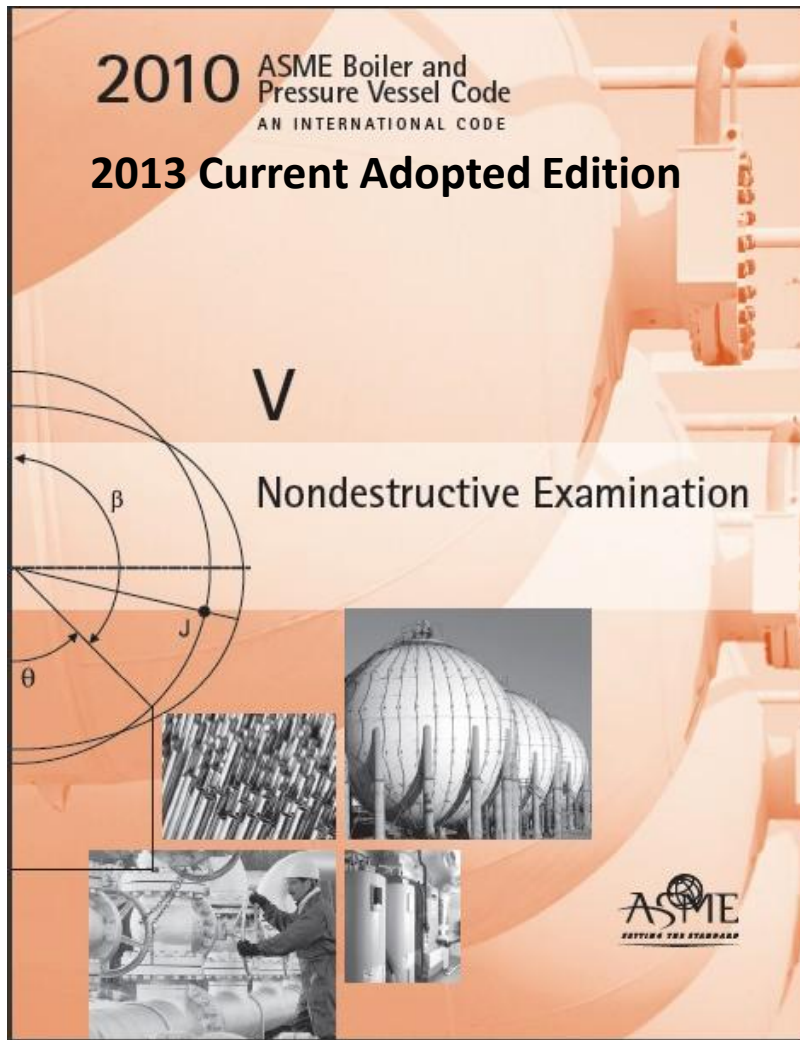
## ASME Section IV “HLW” Potable Hot Water Boilers

Operate below 160 psi

Operate below 210 deg F.



Cleaver Brooks



To View Code: Google  
**asme.bpvc.v.2010.pdf**

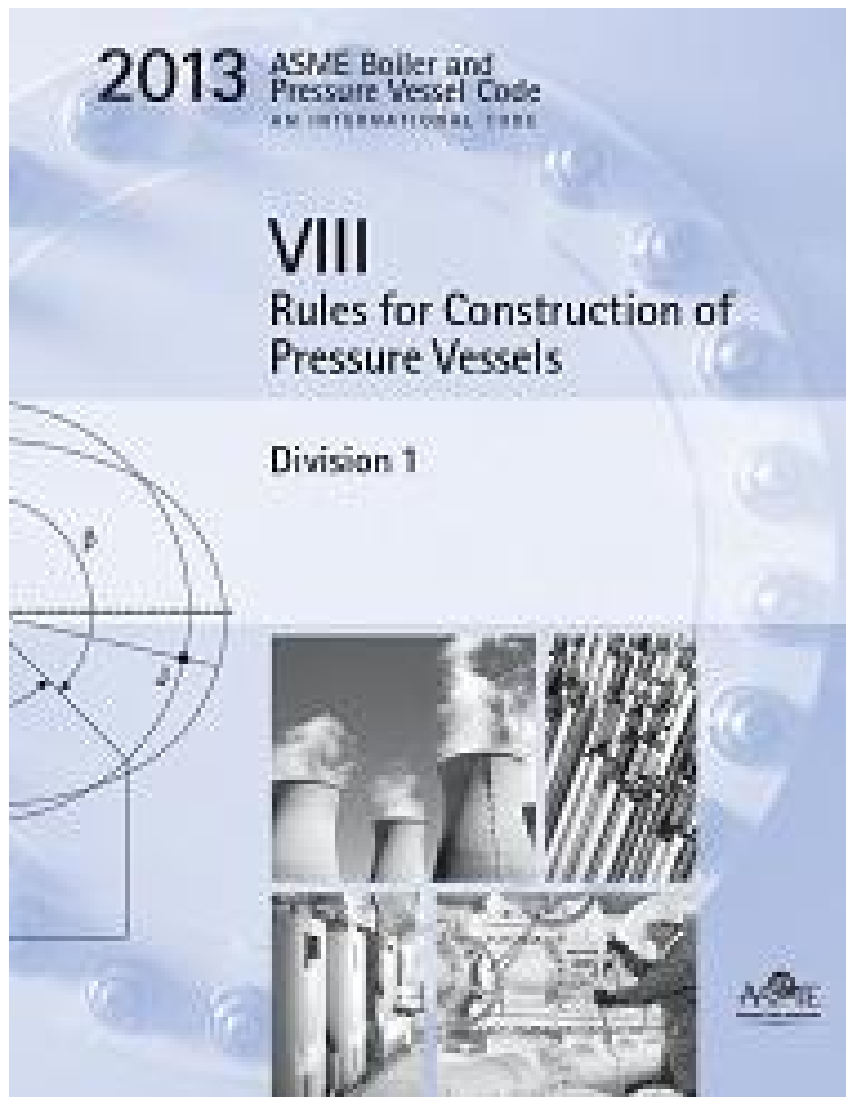
Choose Site

[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

## Section V - Nondestructive Examination

Contains radiographic, ultrasonic and liquid penetrant methods required by other Code Sections, which detect discontinuities in materials, welds, and fabricated parts and components.





# Unfired Pressure Vessels

## Three Divisions

### Section VIII - Pressure Vessels:

#### Section VIII Division 1

Provides requirements for design, fabrication, inspection, testing, and certification of fired or unfired pressure vessels operating at pressures exceeding 15 psig.

CODE  
SYMBOL  
STAMP



**U: PRESSURE VESSELS (DIV. I)**

**UM: MINIATURE PRESSURE VESSELS**

## 2013 Current Adopted Edition



# VIII

## RULES FOR CONSTRUCTION OF PRESSURE VESSELS

### Division 2

### Alternative Rules

ASME Boiler and Pressure Vessel Committee  
on Pressure Vessels



**Section VIII Division 2 – Alternative Rules**  
Has requirements for construction and certification of pressure vessels operating at pressures over 15 psig using design by analysis methods, and design stresses higher than Division 1.

CODE  
SYMBOL  
STAMP



**U2: PRESSURE VESSELS (DIV. 2)**

## 2013 Current Adopted Edition



# VIII

## Division 3

### **Alternative Rules for Construction of High Pressure Vessels**

### **RULES FOR CONSTRUCTION OF PRESSURE VESSELS**

ASME Boiler and Pressure Vessel Committee on Pressure Vessels



## Section VIII Division 3 – Alternative Rules for the Construction of High Pressure Vessels

Provides requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures above 10,000 psi.

CODE  
SYMBOL  
STAMP



**U3: PRESSURE VESSELS (DIV 3)**



**2013** ASME Boiler and  
Pressure Vessel Code  
AN INTERNATIONAL CODE

## IX

### Welding, Brazing, and Fusing Qualifications

Qualification Standard for Welding,  
Brazing, and Fusing Procedures;  
Welders; Brazers; and Welding,  
Brazing, and Fusing Operators



To View Code: Google  
**asme.bpvc.ix.2010.pdf**

Choose Site

[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

### Section IX - Welding and Brazing Qualifications

Has rules for qualification of welding and brazing procedures and welders, brazers, and welding and brazing operators for component manufacture. Data cover variables for the process used.



**2010** ASME Boiler and  
Pressure Vessel Code  
AN INTERNATIONAL CODE

**2013 Current Adopted Edition**

**X**

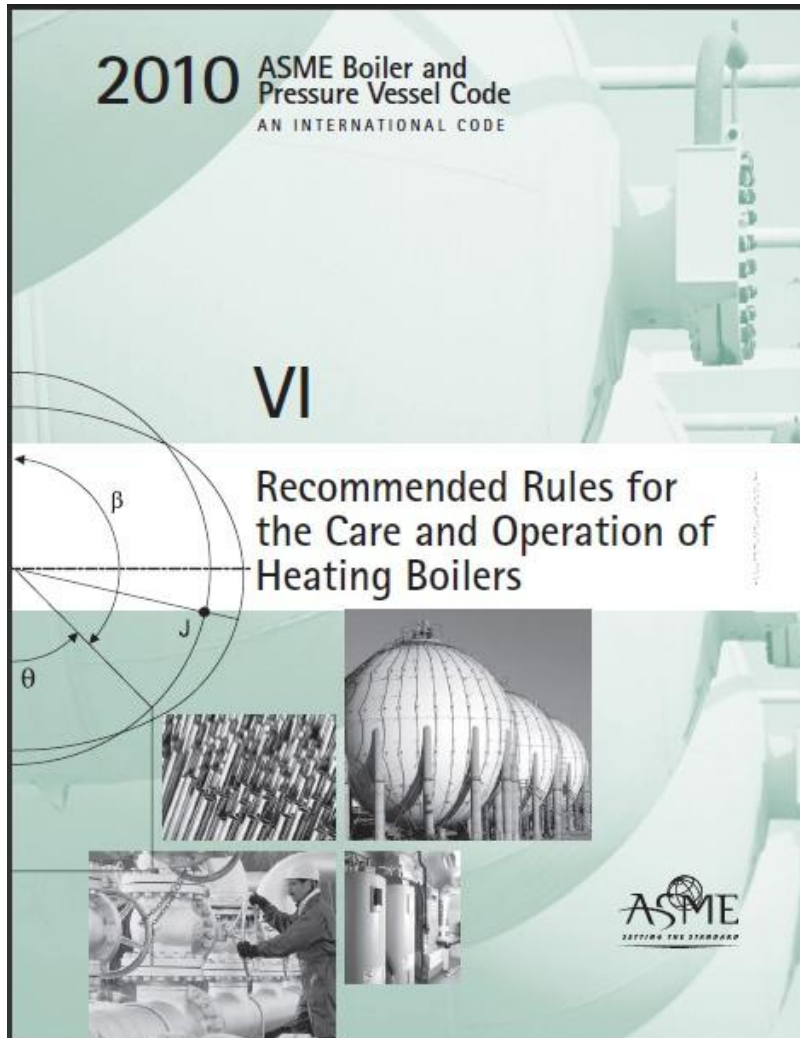
Fiber-Reinforced Plastic  
Pressure Vessels



**ASME**  
SETTING THE STANDARD

## Section X - Fiber-Reinforced Plastic Pressure Vessels

Has requirements for construction of an FRP pressure vessel including production, processing, fabrication, inspection and testing methods required for two Classes of vessel design.



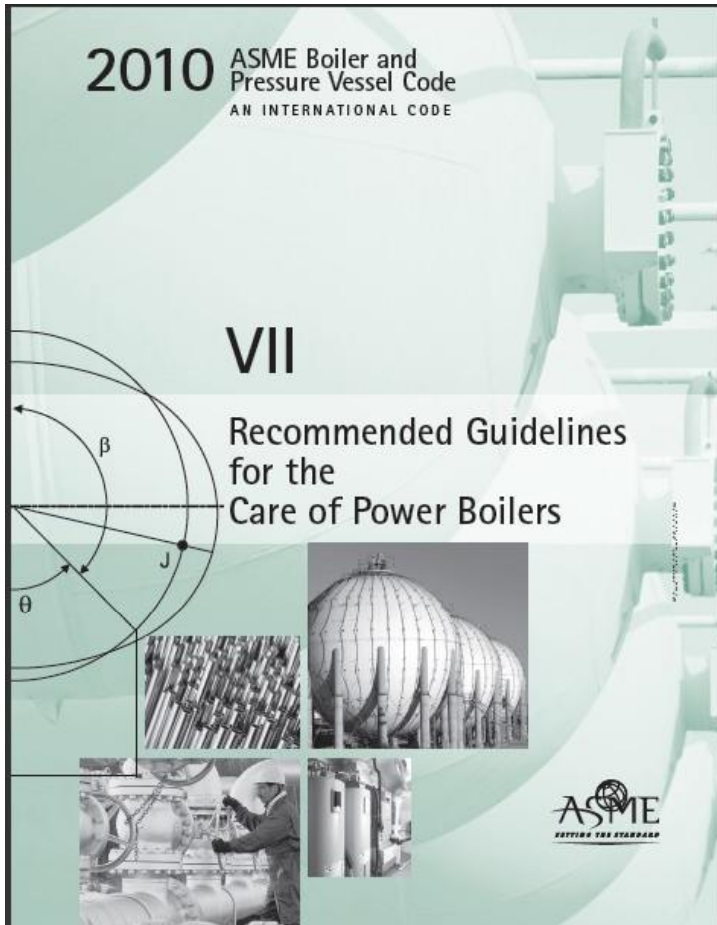
To View Code: Google  
**asme.bpvc.vi.2010.pdf**

Choose Site

[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

## **Section VI - Recommended Rules for the Care and Operation of Heating Boilers**

Has guidelines applicable to steel and cast iron boilers within the operating range for Section IV Heating Boilers, including associated controls and automatic fuel burning equipment.



To View Code: Google  
**asme.bpvc.vii.2010.pdf**

Choose Site  
[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

## Section VII - Recommended Guidelines for the Care of Power Boilers

Has guidelines applicable to stationary, portable, and traction type boilers within the operating range for Section I Power Boilers, to assist operators in maintaining plant safety.

CODE  
SYMBOL  
STAMP



**PP: PRESSURE PIPING**  
**S: POWER BOILERS**

CODE BOOKS REQUIRED:

|                     |                                                                  |
|---------------------|------------------------------------------------------------------|
| <b>Section I -</b>  | <b>Power Boilers</b>                                             |
| <b>Section II -</b> | <b>Materials</b>                                                 |
| Part A              | Ferrous Materials Specifications                                 |
| Part B              | Nonferrous Materials Specifications                              |
| Part C              | Specifications for Welding Rods,<br>Electrodes and Filler Metals |
| Part D              | Properties (Customary or Metric)                                 |
| <b>Section V-</b>   | <b>NonDestructive Examination</b>                                |
| <b>Section IX -</b> | <b>Welding &amp; Brazing Qualifications</b>                      |
| <b>B31.1-2007 -</b> | <b>Power Piping</b>                                              |

ORDER NO. BPVCA \$4,565.00

**ASME** to lower it's international operating costs has implemented a single ASME stamp for all pressure vessels verses the individual stamped letters used before 2010.

**Typical ASME stamp and letter designation below.**





# Boiler Safety Relief Valve Stamps

If it has a “V” in the stamp it applies to Boiler safety relief valves

CODE  
SYMBOL  
STAMP



**V: BOILER SAFETY VALVES**

Power Boilers

CODE  
SYMBOL  
STAMP



**HV: HEATING BOILER SAFETY VALVES**

# Unfired Pressure Vessel Relief Valve Stamps

CODE  
SYMBOL  
STAMP



**UV: PRESSURE VESSELS SAFETY VALVES**

CODE  
SYMBOL  
STAMP



**UV3: PRESSURE VESSELS SAFETY VALVES**

2012 Current Adopted Edition

**ASME B31.1-2010**  
(Revision of ASME B31.1-2007)

# Power Piping

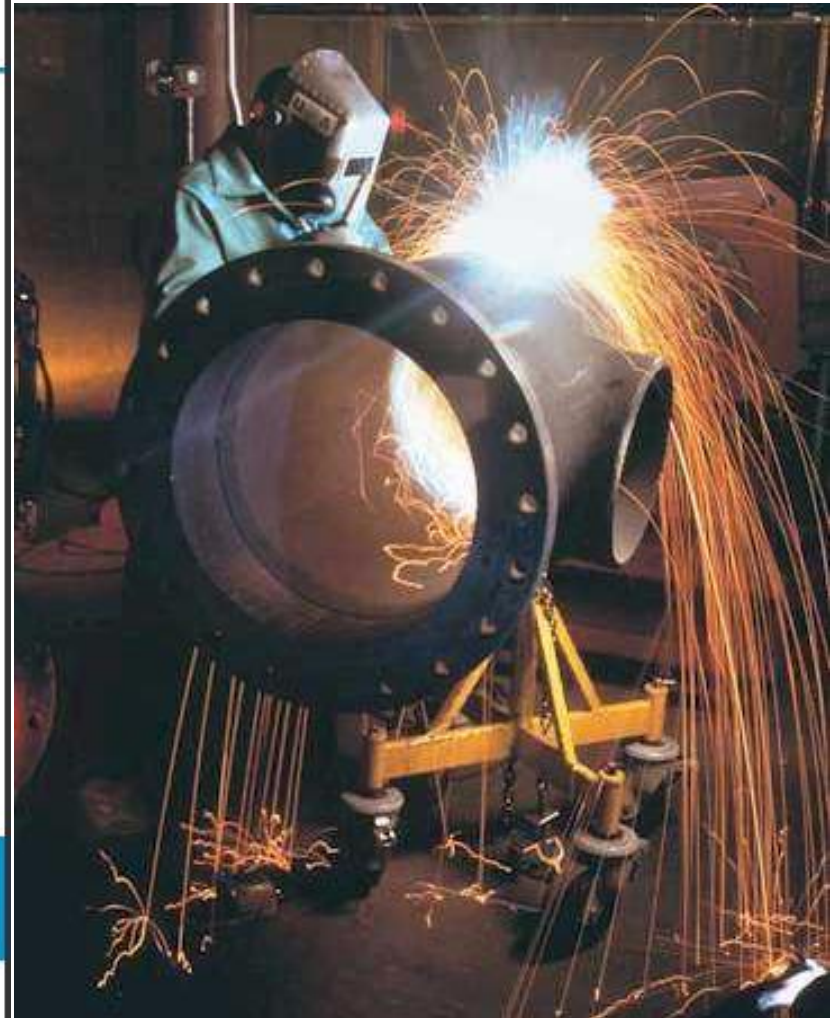
**ASME Code for Pressure Piping, B31**

To View Code: Google  
**asme.b31.1.2007.pdf**  
Choose Site  
[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

AN AMERICAN NATIONAL STANDARD



**No Pressure Limit.** Rules  
For High Pressure Piping



2012 Current Adopted Edition

ASME B31.3-2008  
(Revision of ASME B31.3-2006)

# Process Piping

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD



The American Society of  
Mechanical Engineers

ASME  
SETTING THE STANDARD





2012 Current Adopted Edition

**ASME B31.5-2010**  
(Revision of ASME B31.5-2006)

# Refrigeration Piping and Heat Transfer Components

ASME Code for Pressure Piping, B31



AN AMERICAN NATIONAL STANDARD



2012 Current Adopted Edition

ASME B31.9-2008  
(Revision of ASME B31.9-2004)

# Building Services Piping

ASME Code for Pressure Piping, B31

To View Code: Google  
**asme.b31.9.2008.pdf**  
Choose Site  
[law.resource.org/pub/us/code](http://law.resource.org/pub/us/code)

AN AMERICAN NATIONAL STANDARD



## Pressure Piping Rules Up To 150 Psig



**2012 Current Edition**

**ASME CSD-1-2009**

(Revision of ASME CSD-1-2006)

# **Controls and Safety Devices for Automatically Fired Boilers**

AN AMERICAN NATIONAL STANDARD



Copyright © 2009 by the American Society of Mechanical Engineers.  
No reproduction may be made of this document without written consent of ASME.

**2009 ASME CSD-1**

## **2012 ASME CSD-1**

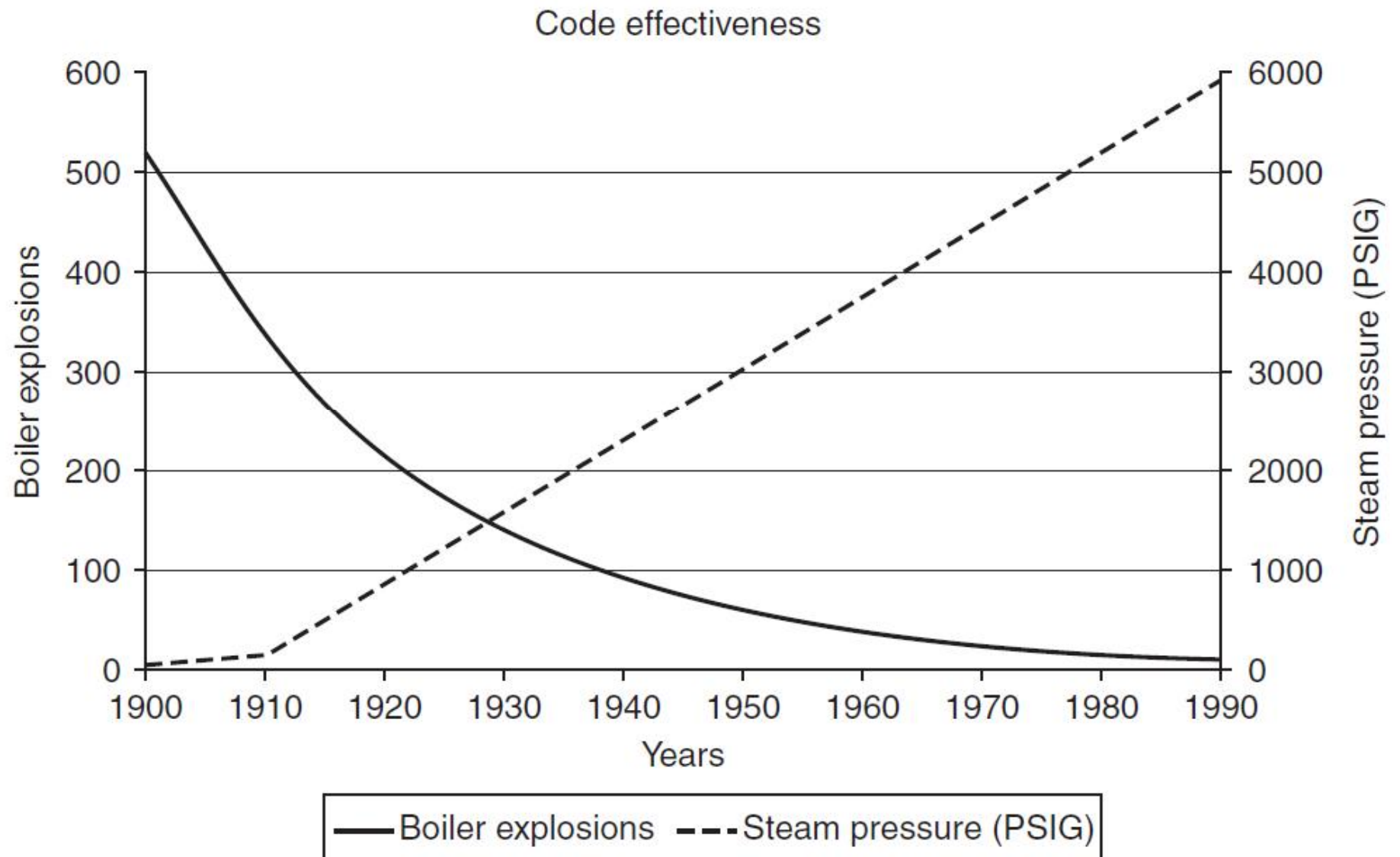
Boilers up to 300 Hp

- Assembly
- Installation
- Maintenance
- Operation

# ASME Code History

- 1911 Standards & rules for construction
- 1915 Section 1 Power Boilers Adopted
- 1920 Adopted by the State of Oregon
- ASME Section 1 set's the rules for construction of boilers that operate over 15 psi steam, including, internal piping, external piping, the valves, and the boiler external piping to the valves, which make up the complete boiler unit.





**Figure 1.1** Effect of codes on pipeline safety.

# NFPA® 85

## Boiler and Combustion Systems Hazards Code

2011 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471  
An International Codes and Standards Organization

## Boilers and Burners Above 12,500,000 Btus (@ 300 Hp)

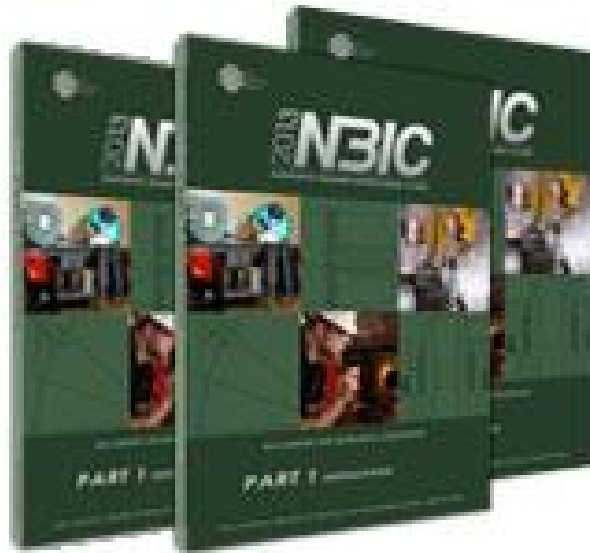
[www.nfpa.org/freeaccess](http://www.nfpa.org/freeaccess)

Purchase for \$63.00

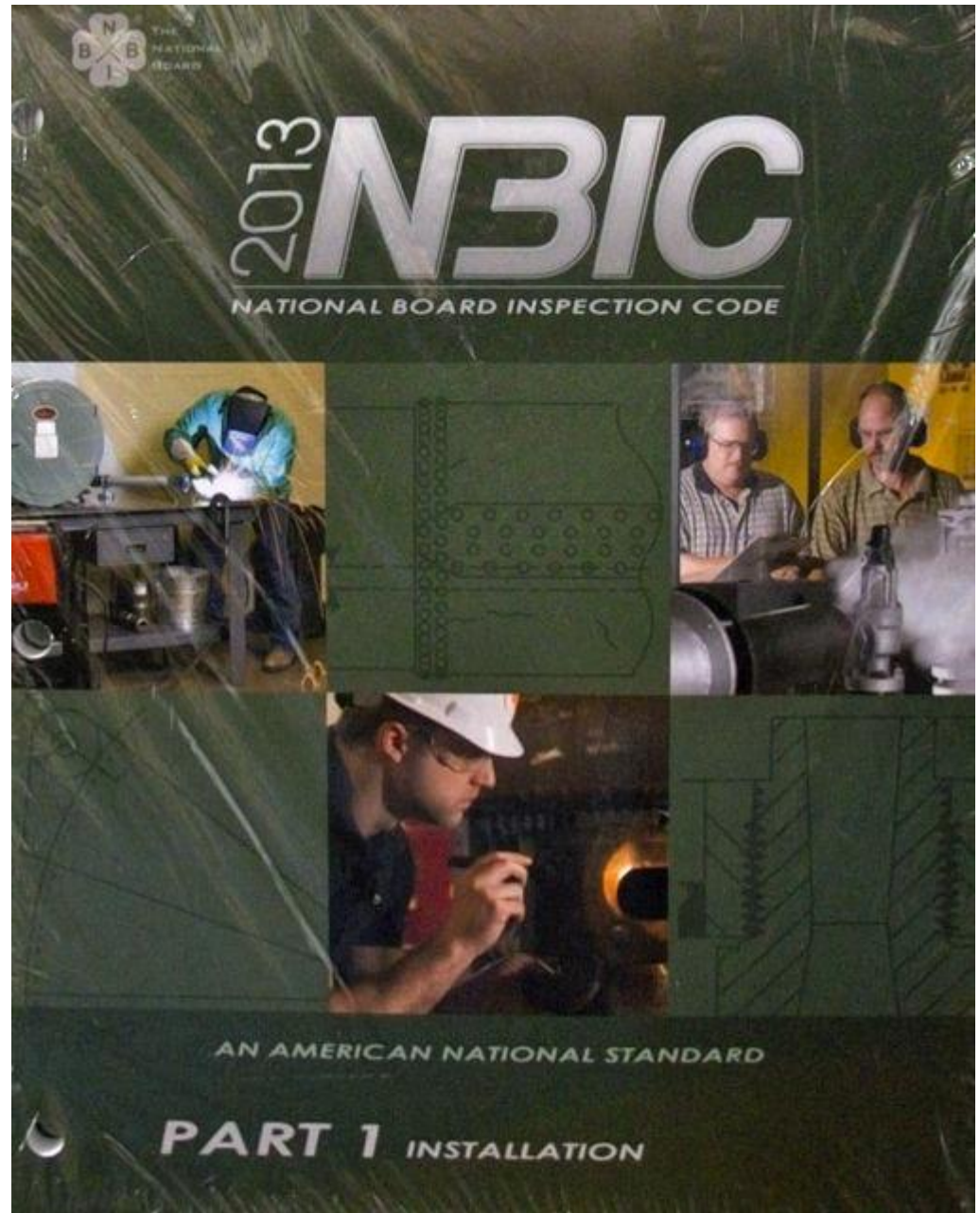
## 2013 NBIC

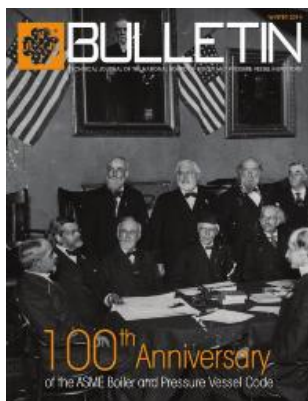
### National Board Inspection Code

- Part 1 Installation
- Part 2 Inspection
- Part 3 Repairs/Alterations



Nationalboard.org





# NBIC Part 1, Section 3-Controls

## Hot Water Supply Boilers Versus Potable Water Heaters

BY ROBERT FERRELL, SENIOR STAFF ENGINEER

Table 2: NBIC Part 1 Requirements

| NBIC Part 1 Installation Requirements                                                                                                                                                  |                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hot Water Supply (Para. 3.8.2)                                                                                                                                                         | Potable Water Heater (Para. 3.8.3)                                                                                                                                                      |
| One pressure gage required (Para. 3.8.2.1)                                                                                                                                             | No pressure gage required                                                                                                                                                               |
| One thermometer required (Para. 3.8.2.2)                                                                                                                                               | One thermometer required (Para. 3.8.3.2)                                                                                                                                                |
| One operating temperature control for a maximum temperature of 250°F (Para. 3.8.2.3 a))                                                                                                | One operating temperature control for a maximum temperature of 210°F (Para. 3.8.3.1)                                                                                                    |
| One limit temperature control for a maximum temperature of 250°F (Para. 3.8.2.3 b))                                                                                                    | One limit temperature control for a maximum temperature of 210°F (Para. 3.8.3.1)                                                                                                        |
| At least one safety relief valve is required (Para. 3.9.3). A temperature/pressure relief (T&P) valve may be used if the maximum water temperature is limited to 210°F (Para. 3.9.1.6) | At least one temperature/pressure relief (T&P) valve is required (Para. 3.9.4)<br><b>Note:</b> Section IV permits safety relief valves as well as T&P valves. Consult the jurisdiction. |
| One low-water fuel cutoff with manual reset required (Para. 3.8.2.4)                                                                                                                   | No low-water fuel cutoff required                                                                                                                                                       |

Everyone should remember that in all installations the jurisdictional rules apply, as well as the manufacturer's instructions. •



**TABLE 1: ASME Construction Code Requirements**

| ASME B&PVC Section IV<br>Two codes in one book | Code #1 (H stamp)<br>Heating Water Heaters  | Code #2 (HLW Stamp)<br>Potable Water Heaters  |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Design Margin                                  | 5                                                                                                                              | 4                                                                                                                                |
| Maximum Temperature                            | 250°F                                                                                                                          | 210°F                                                                                                                            |
| Minimum Design Pressure                        | 30 psi                                                                                                                         | 100 psi                                                                                                                          |
| Pressure Gage                                  | One required; range 1-1/2 to 3-1/2 times low PRV set pressure                                                                  | Not required                                                                                                                     |
| Pressure Relief Device                         | "V" or "HV" valve                                                                                                              | "V" or "HV" valve – normally a temperature/pressure type                                                                         |
| Pressure or Altitude Gage                      | Minimum one required                                                                                                           | Not required                                                                                                                     |
| Water Gage Glass                               | Not required                                                                                                                   | Not required                                                                                                                     |
| Pressure Controls                              | Not required                                                                                                                   | Not required                                                                                                                     |
| Temperature Controls                           | Two temperature controls, one operating and one limit set at no higher than 250°F                                              | One required with maximum setting 210° F                                                                                         |
| Thermometer                                    | One required                                                                                                                   | One required                                                                                                                     |
| Protection Against Water Contamination         | No                                                                                                                             | Yes                                                                                                                              |
| Low-Water Fuel Cutoff                          | One on units over 400,000 Btu/hr                                                                                               | Not required                                                                                                                     |
| Heat-Generating Apparatus                      | ANSI Z21.13, ASME CSD-1, UL standards                                                                                          | ANSI/UL 732, ANSI Z21.10.3/ CSA 4.3, and several UL standards                                                                    |
| Maximum Allowable Working Pressure             | 160                                                                                                                            | 160                                                                                                                              |

*Chart by Robert Schueler, 2013*



## 2014 Report of Violation Findings

The National Board Annual Violation Tracking Report identifies specific violations (per device type) commonly found on five types of pressure equipment during jurisdiction-required inspections. The following data reflects the reporting period of 1/1/2014 – 12/31/2014 as reported by participating member jurisdictions.

The Violation Tracking Report indicates problem areas and trends related to boiler and pressure vessel operation, installation, maintenance, and repair. The data also identifies problems before adverse conditions occur. This report serves as an important source of documentation for jurisdictional officials, providing statistical data to support the continued funding of inspection programs.

### Overall Totals for Each Type of Pressure Equipment

| Type of Pressure Equipment                         | Total Number of Inspections | Total Number of Violations | Percent of Violations |
|----------------------------------------------------|-----------------------------|----------------------------|-----------------------|
| ■ High-Pressure/High-Temperature Boilers (S)(M)(E) | 72,279                      | 5,129                      | 7.10%                 |
| ■ Low-Pressure Steam Boilers (H)                   | 49,546                      | 8,570                      | 17.30%                |
| ■ Hot Water Heating/Supply Boilers (H)             | 266,992                     | 35,743                     | 13.39%                |
| ■ Pressure Vessels (U)(UM)                         | 223,081                     | 7,273                      | 3.26%                 |
| ■ Potable Water Heaters (HLW)                      | 52,089                      | 5,483                      | 10.53%                |
| <b>Totals</b>                                      | <b>663,987</b>              | <b>62,198</b>              | <b>9.37%</b>          |

**Number of Jurisdictional Reports: 117**

## High-Pressure/High-Temperature Boilers (S)(M)(E)

| Device Type                                                                               | Number of Violations | *V/I  | **V/V  |
|-------------------------------------------------------------------------------------------|----------------------|-------|--------|
| 1) Safety Relief Devices                                                                  | 763                  | 1.06% | 14.88% |
| 2) Low-Water Cutoffs/Flow Sensing Devices                                                 | 256                  | 0.35% | 4.99%  |
| 3) Pressure Controls                                                                      | 158                  | 0.22% | 3.08%  |
| 4) Temperature Controls – Operator or High Limit                                          | 41                   | 0.06% | 0.80%  |
| 5) Burner Management                                                                      | 626                  | 0.87% | 12.21% |
| 6) Level Indicators – Gage Glasses, Bulls Eyes, and Fiber Opticals                        | 266                  | 0.37% | 5.19%  |
| 7) Pressure/Temperature Indicators                                                        | 106                  | 0.15% | 2.07%  |
| 8) Pressure-Retaining Items (PRI) / Boiler-Piping, Pumps, Systems Valves, Expansion Tanks | 2,913                | 4.03% | 56.79% |

### Summary:

- Number of Jurisdiction Reports: 117
- Total Number of Inspections: 72,279
- Total Number of Violations: 5,129
- Percent Violations: 7.0%

**\*V/I** Total number of Violations for Category divided by Total Inspections for this device type

**\*\*V/V** Total number of Violations for Category divided by Total Violations for this device type

## Low-Pressure Steam Boilers (H)

| Device Type                                                                               | Number of Violations | *V/I  | **V/V  |
|-------------------------------------------------------------------------------------------|----------------------|-------|--------|
| 1) Safety Relief Devices                                                                  | 1,229                | 2.48% | 14.34% |
| 2) Low-Water Cutoffs/Flow Sensing Devices                                                 | 653                  | 1.32% | 7.62%  |
| 3) Pressure Controls                                                                      | 616                  | 1.24% | 7.19%  |
| 4) Temperature Controls – Operator or High Limit                                          | 134                  | 0.27% | 1.56%  |
| 5) Burner Management                                                                      | 1,187                | 2.40% | 13.85% |
| 6) Level Indicators – Gage Glasses, Bulls Eyes, and Fiber Opticals                        | 630                  | 1.27% | 7.35%  |
| 7) Pressure/Temperature Indicators                                                        | 279                  | 0.56% | 3.26%  |
| 8) Pressure-Retaining Items (PRI) / Boiler-Piping, Pumps, Systems Valves, Expansion Tanks | 3,842                | 7.75% | 44.83% |

### Summary:

- Number of Jurisdiction Reports: 117
- Total Number of Inspections: 49,546
- Total Number of Violations: 8,570
- Percent Violations: 17%

**\*V/I** Total number of Violations for Category divided by Total Inspections for this device type

**\*\*V/V** Total number of Violations for Category divided by Total Violations for this device type



## Hot Water Heating/Supply Boilers (H)

| Device Type                                                                               | Number of Violations | *V/I  | **V/V  |
|-------------------------------------------------------------------------------------------|----------------------|-------|--------|
| 1) Safety Relief Devices                                                                  | 7,447                | 2.79% | 20.83% |
| 2) Low-Water Cutoffs/Flow Sensing Devices                                                 | 2,147                | 0.80% | 6.01%  |
| 3) Pressure Controls                                                                      | 169                  | 0.06% | 0.47%  |
| 4) Temperature Controls – Operator or High Limit                                          | 2,742                | 1.03% | 7.67%  |
| 5) Burner Management                                                                      | 5,692                | 2.13% | 15.92% |
| 6) Level Indicators – Gage Glasses, Bulls Eyes, and Fiber Opticals                        | 730                  | 0.27% | 2.04%  |
| 7) Pressure/Temperature Indicators                                                        | 1,201                | 0.45% | 3.36%  |
| 8) Pressure-Retaining Items (PRI) / Boiler-Piping, Pumps, Systems Valves, Expansion Tanks | 15,615               | 5.85% | 43.69% |

### Summary:

- Number of Jurisdiction Reports: 117
- Total Number of Inspections: 266,992
- Total Number of Violations: 35,743
- Percent Violations: 13%

**\*V/I** Total number of Violations for Category divided by Total Inspections for this device type

**\*\*V/V** Total number of Violations for Category divided by Total Violations for this device type

## Potable Water Heaters (HLW)

| Device Type                                                                               | Number of Violations | *V/I  | **V/V  |
|-------------------------------------------------------------------------------------------|----------------------|-------|--------|
| 1) Safety Relief Devices                                                                  | 1,411                | 2.71% | 25.73% |
| 2) Low-Water Cutoffs/Flow Sensing Devices                                                 | 109                  | 0.21% | 1.99%  |
| 3) Pressure Controls                                                                      | 4                    | 0.01% | 0.07%  |
| 4) Temperature Controls – Operator or High Limit                                          | 72                   | 0.14% | 1.31%  |
| 5) Burner Management                                                                      | 1,082                | 2.08% | 19.73% |
| 6) Level Indicators – Gage Glasses, Bulls Eyes, and Fiber Opticals                        | 2                    | 0.00% | 0.04%  |
| 7) Pressure/Temperature Indicators                                                        | 722                  | 1.39% | 13.1%  |
| 8) Pressure-Retaining Items (PRI) / Boiler-Piping, Pumps, Systems Valves, Expansion Tanks | 2,081                | 4.00% | 37.95% |

### Summary:

- Number of Jurisdiction Reports: 117
- Total Number of Inspections: 52,089
- Total Number of Violations: 5,483
- Percent Violations: 11%

**\*V/I** Total number of Violations for Category divided by Total Inspections for this device type

**\*\*V/V** Total number of Violations for Category divided by Total Violations for this device type

## Pressure Vessels (U) (UM)

| Device Type                                                                               | Number of Violations | *V/I  | **V/V  |
|-------------------------------------------------------------------------------------------|----------------------|-------|--------|
| 1) Safety Relief Devices                                                                  | 3,236                | 1.45% | 44.49% |
| 2) Low-Water Cutoffs/Flow Sensing Devices                                                 | 2                    | 0.00% | 0.03%  |
| 3) Pressure Controls                                                                      | 24                   | 0.01% | 0.33%  |
| 4) Temperature Controls – Operator or High Limit                                          | 3                    | 0.00% | 0.04%  |
| 5) Burner Management                                                                      | 26                   | 0.01% | 0.36%  |
| 6) Level Indicators – Gage Glasses, Bulls Eyes, and Fiber Opticals                        | 9                    | 0.00% | 0.12%  |
| 7) Pressure/Temperature Indicators                                                        | 199                  | 0.09% | 2.74%  |
| 8) Pressure-Retaining Items (PRI) / Boiler-Piping, Pumps, Systems Valves, Expansion Tanks | 3,774                | 1.69% | 51.89% |

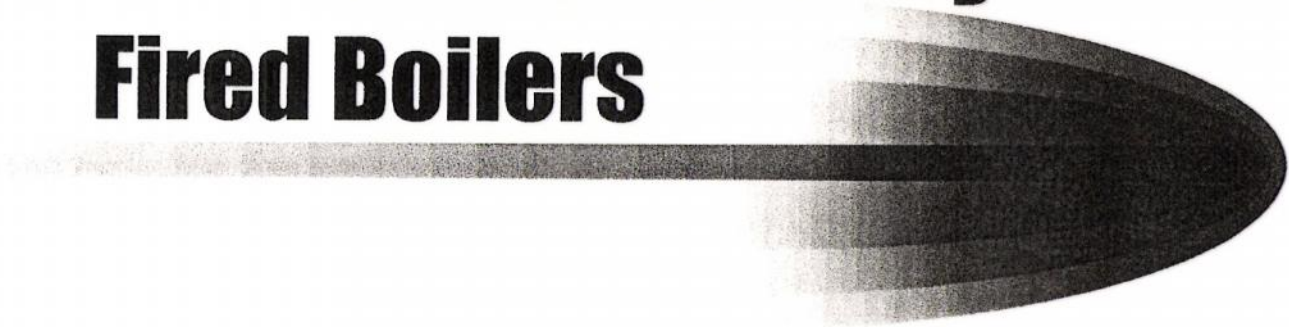
### Summary

- Number of Jurisdiction Reports: 117
- Total Number of Inspections: 223,081
- Total Number of Violations: 7,273
- Percent Violations: 3%

**\*V/I** Total number of Violations for Category divided by Total Inspections for this device type

**\*\*V/V** Total number of Violations for Category divided by Total Violations for this device type

# **Major Perils of Automatically Fired Boilers**



- Loss of water
- Furnace explosion
- Over temperature
- Overpressure



# **Principal Causes of Accidents**

- Lack of proper controls & safety devices
- Lack of adequate maintenance
- Improperly trained operators
- Failure to test controls & safety devices
- Complacency on the part of the operator due to long periods of trouble free operation.

# Human Factor

- Operation, maintenance, and people issues are by far the biggest combustion safety issue
- 40% of all deaths and accidents are caused by human error or poor maintenance.
- Codes offer very little specific direction in regards to training, other than to say training it is required and should be done regularly.

## **Preventative Maintenance**

- Combustion equipment can become less safe with every minute of operation.
- Dust, dirt, debris accumulate in combustion air fans and burners, changing air/fuel ratios
- Some gas control valves get a little more sloppy every time they are cycled.
- Pressure switch diaphragms and contacts age
- Water level controls accumulate sludge.



# **2014 OREGON MECHANICAL SPECIALTY CODE**

Based on the 2012 International  
Mechanical Code® and the 2012  
International Fuel Gas Code®

## **2014 Oregon Mechanical Specialty Code**

Based upon  
2012 International Mechanical Code  
2012 International Fuel Gas Code



## State of Oregon Permits

(22) "Repair" means:

(a) Welded or Riveted Repairs, meaning welding or riveting within or on the pressure boundaries of a boiler, pressure vessel or related appurtenance to restore the vessel or appurtenance to a safe and satisfactory operating condition, or any work that might impair the integrity of the pressure retaining item;

(b) Non-welded Major Repairs, meaning work performed on a boiler or pressure vessel and its related appurtenances by non-welded means to restore the vessel or appurtenance to a safe and satisfactory operating condition, including but not limited to the replacement of burners, tubes and cast iron sections; and

(c) Minor Repairs, meaning the non-welded replacement of safety devices, including but not limited to, low water cut-offs, pressure relief valves, safety valves, safety switches, rupture discs, high pressure or temperature limits, low pressure or temperature limits, fuel train components, flame detectors, flame safeguards, heat exchanger elements, and burner components.

# ASME Code Rules

- ASME code rules are not mandatory unless they are adopted into the laws of a government.
- Usually referred to as a “Jurisdiction”.  
Government authority.
- **Example:** Wyoming did not want to add the expense of boiler rules to their governing costs.

# How Is The Code Funded In Oregon

- Permits are required to **install** boilers and unfired pressure vessels. Unless exempt.
- Permits are required to **operate** pressure vessels and be inspected.
- Permits for repairs, non-welded repairs and minor repairs (replacement of safety controls)
- Business licensing to install boilers
- Class 1-6 Boiler & Pressure Vessel Licensing
- Fees for continuing education added to license



# **Request for Boiler/Pressure Vessel Permit for Installation, Alteration, or Repair**

Department of Consumer and Business Services  
Building Codes Division • Boiler Section  
1535 Edgewater NW, Salem, OR  
Mailing address: P.O. Box 14470, Salem, OR 97309-0404  
503-373-7538, Fax: 503-378-4101  
Web: [bcd.oregon.gov](http://bcd.oregon.gov)

Mail payment to:  
DCBS – Fiscal Services  
P.O. Box 14610  
Salem, OR 97309-0445

## **DEPARTMENT USE ONLY**

|                                   |                                 |
|-----------------------------------|---------------------------------|
| Permit no.:                       |                                 |
| <input type="checkbox"/> Accepted | <input type="checkbox"/> Denied |
| Date:                             | By:                             |

## **APPLICANT INFORMATION**

|                                                                                                                                                                                 |          |                |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------|------|
| Applicant's business name:                                                                                                                                                      |          |                |      |
| Address 1:                                                                                                                                                                      |          | Address 2:     |      |
| City:                                                                                                                                                                           |          | State:         | ZIP: |
| Phone: - -                                                                                                                                                                      | Fax: - - | E-mail:        |      |
| Boiler/pressure vessel contractor business license no.:                                                                                                                         |          | R stamp no.:   |      |
| Construction Contractors Board registration no.:                                                                                                                                |          | O stamp no.:   |      |
| List names and Oregon license numbers below of <i>all</i> Class 1 through Class 6 mechanics who will perform work on this project.<br>(Attach additional sheets, if necessary.) |          |                |      |
| Name                                                                                                                                                                            |          | License number |      |
|                                                                                                                                                                                 |          |                |      |
|                                                                                                                                                                                 |          |                |      |

## **OWNER/USER INFORMATION**

|                              |                                                                               |
|------------------------------|-------------------------------------------------------------------------------|
| Owner's name:                | Phone: - -                                                                    |
| Address and vessel location: |                                                                               |
| City:                        | ZIP: <input type="checkbox"/> Commercial <input type="checkbox"/> Residential |

## **INSTALLATION, ALTERATION, OR REPAIR INFORMATION**

|                                                                                                                                                                 |                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Check all that apply. (If altered, submit drawings/calculations.)                                                                                               |                  |
| Type of work: <input type="checkbox"/> Boiler <input type="checkbox"/> Pressure vessel <input type="checkbox"/> Beverage service tank                           | Job start date:  |
| <input type="checkbox"/> Install <input type="checkbox"/> Repair <input type="checkbox"/> Alter <input type="checkbox"/> Weld <input type="checkbox"/> Non-weld |                  |
| Description of vessel:                                                                                                                                          | NB/State number: |
| Size and length of piping:                                                                                                                                      |                  |
| Describe nature of work (attach additional sheets if necessary):                                                                                                |                  |
|                                                                                                                                                                 |                  |
| Applicant's name (print):                                                                                                                                       | Signature: Date: |

**Permit fee:** For the appropriate fee, see instructions on Page 2. Failure to determine the appropriated fee may result in processing delays. **Permit fees are nonrefundable.**

|                                                                                    | Fiscal code      |                      | Surcharge code    | Total each |
|------------------------------------------------------------------------------------|------------------|----------------------|-------------------|------------|
| <input type="checkbox"/> Boiler, state-inspected site .....                        | \$175 70311/1195 | plus 12% surcharge = | \$21 70311/1291   | \$ 196.00  |
| <input type="checkbox"/> Pressure vessel, state-inspected site .....               | \$125 70311/1195 | plus 12% surcharge = | \$15 70311/1291   | \$ 140.00  |
| <input type="checkbox"/> Boiler or pressure vessel, insurance-inspected site ..... | \$40 70311/1195  | plus 12% surcharge = | \$4.80 70311/1291 | \$ 44.80   |
| <input type="checkbox"/> Beverage service tank, over 5 cubic feet in volume .....  | \$50 70311/1195  | plus 12% surcharge = | \$6 70311/1291    | \$ 56.00   |

**Secure fax for credit card payments: 503-947-2333**

If paying by credit card, applicant must sign credit card information box.

|                                                                                                     |                  |
|-----------------------------------------------------------------------------------------------------|------------------|
| <input type="checkbox"/> Visa <input type="checkbox"/> MasterCard <input type="checkbox"/> Discover | Phone:           |
| Credit card number:                                                                                 | Expiration date: |
| Name of cardholder as shown on credit card                                                          |                  |
| Cardholder signature                                                                                | \$ Amount        |

**Make check or money order payable to Department of  
Consumer and Business Services. Do not send cash.**

**DCBS FISCAL USE ONLY**



440-2502A (1/09/COM)





## Boiler & Pressure Vessel Registration

Department of Consumer & Business Services  
Building Codes Division • 1535 Edgewater NW, Salem, OR  
Mailing address: PO Box 14470, Salem, OR 97309-0404  
(503) 373-7499, Fax: (503) 378-2322  
www.oregonbcd.org

**This temporary operation permit is valid for 90 days from the inspection date. ORS 480.585(3) states no person shall operate a boiler or pressure vessel without a valid permit; a violation may result in fines up to \$1,000 (ORS 480.665).**

### OWNER/RESPONSIBLE PARTY INFORMATION

|                               |  |                        |      |
|-------------------------------|--|------------------------|------|
| Owner/responsible party name: |  | Responsible party no.: |      |
| Address (street or P.O. box): |  |                        |      |
| City:                         |  | State:                 | ZIP: |
| Contact name:                 |  | Phone:                 |      |

### SITE INFORMATION

|                               |  |           |      |
|-------------------------------|--|-----------|------|
| Site name:                    |  | Site no.: |      |
| Address (street or P.O. box): |  |           |      |
| City:                         |  | State:    | ZIP: |
| Contact name:                 |  | Phone:    |      |

### PERMIT / VESSEL INFORMATION

|                         |                  |                    |         |                |  |
|-------------------------|------------------|--------------------|---------|----------------|--|
| Location:               |                  | Vessel permit no.: |         | Expires:       |  |
| Agency of record:       |                  | Code:              | Type:   | Service:       |  |
| Mfr. name:              |                  | Year of mfg.:      |         | Code symbol:   |  |
| NB no.:                 |                  | Serial no.:        |         | OR State no.:  |  |
| DLA (inches):           | Length (inches): | Volume:            |         | KW:            |  |
| Boiler design capacity: |                  | Boiler horsepower: |         |                |  |
| MAWP:                   |                  | SV SET:            | SV CAP: | Fired/unfired: |  |
| Fixed/port:             | PA:              | Manned:            | Alarm:  | Fuel:          |  |
| Installation company:   |                  |                    |         | Permit no.:    |  |
| Special instructions:   |                  |                    |         |                |  |

### INSPECTION INFORMATION

|                                                                             |  |                                                                               |  |                                                                                                       |  |
|-----------------------------------------------------------------------------|--|-------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------|--|
| I/L:                                                                        |  | Replacement in kind: <input type="checkbox"/> Yes <input type="checkbox"/> No |  | CSD-1 verified: <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |  |
| Issue permit: <input type="checkbox"/> Minor req.: <input type="checkbox"/> |  | Inspection time:                                                              |  | Travel time:                                                                                          |  |
| Inspector signature:                                                        |  | Insp. no.:                                                                    |  | Date:                                                                                                 |  |

## **Flat Rate Boiler Permits**

**Effective January 1, 2010**

Boiler installation permits are \$175.00 with  
12% surcharge

**Total cost \$196.00**

# Responsibility of Inspectors

- For new boilers, the inspector shall verify that the controls and safety devices required by ASME CSD-1 or other construction codes are installed and function as designed in accordance with manufacturers instructions.

# Inspectors

- All inspectors witnessing installation, repair or alteration of boilers, pressure vessels or pressure piping shall verify that the contractor and workers performing the work are appropriately licensed and hold valid permits as required by ORS 480.630



# State Of Oregon Boiler Licenses

## Class 1-6 Licenses

### Class 1

Trainee helper boiler installer by non-welding methods.

### Class 2

Unfired pressure vessel installer non-welded.

### Class 3

Building service mechanic. Install or repair boilers and unfired pressure vessels by non-welding methods.

## Class 4

Boilermaker. Install alter or repair boilers & pressure vessels (excluding non-boiler external piping) by welding or other methods of attachment.

## Class 5

Pressure piping mechanic. Fabricate install alter repair pressure piping boilers and pressure vessels by welded & non-welded methods.

**Class 5A** Process piping mechanic limited

**Class 5 B** Refrigeration piping mechanic

## Class 6

Welder supervised by class 4,5,5a 5b and  
Non-welded under direct supervision

# Direct Supervision

- Means the person supervised is in the physical presence of a qualified licensed person at the job site and the person doing the supervision is directly assigned to monitor and direct the activities of the person supervised. Direct supervision must be on a ratio of one qualified licensed person to one trainee helper.
- Applies to class 3 helper/trainees. Non-weld

# Supervision

- Means the individual person assigned to perform supervision is directly and specifically assigned to monitor and direct the activities of the person being supervised. **Both the person performing supervision and those being supervised shall be prepared to identify each other.** Applies to class 5 supervision attachment by welding. **More than 1** class 6 can be supervised. A class 6 license can install by non-welded methods, direct supervision rules apply.



**TABLE 1-A****BOILER & PRESSURE VESSEL OPERATING PERMIT PERIODS**

|                         |                                                                                                                                                                                                                                                                                                                                       |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1-year operating permit | Power boilers                                                                                                                                                                                                                                                                                                                         |
| 2-year operating permit | Cast iron boilers<br>Low pressure steam boilers<br>Hot water heating & supply boilers<br>Air tanks (greater than 20cf, 200 psi)<br>CO2 tanks (greater than 20cf, 300 psi)<br>CO2 tanks (20cf, 300 psi or less, located in places of public assembly)<br>Unfired pressure vessels (not classified in OAR 918-225-0570(5), (6) and (7)) |
| 3-year operating permit | Anhydrous ammonia pressure vessels for farm use                                                                                                                                                                                                                                                                                       |
| 5-year operating permit | Fixed air tanks (20 cf, 200 psi or less)<br>CO2 tanks (20cf, 300 psi or less, not located in places of public assembly)                                                                                                                                                                                                               |

**Table 1-B****BOILER & PRESSURE VESSEL INSPECTION CYCLES**

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1-year inspection cycle | Power boilers, internal and external                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2-year inspection cycle | Cast iron boilers, external<br>Low pressure steam boilers, internal and external<br>Hot water heating & supply boilers, external<br>Pressure vessels subject to internal corrosion or erosion, internally (may be waived) and externally<br>Pressure vessels not subject to internal corrosion or erosion but containing a hazardous substance, internally (may be waived) and externally<br>Pressure vessels not subject to internal corrosion or erosion but located in a place of public assembly, internally (may be waived) and externally |
| 3-year inspection cycle | Pressure vessels containing anhydrous ammonia for use as fertilizer                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 4-year inspection cycle | Pressure vessels not subject to internal corrosion or erosion, internally (may be waived) and externally                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 6-year inspection cycle | Hot water heating & hot water supply boilers, internally (when physical construction of the boiler allows)<br>Fixed pressure vessels, containing only air (not in public assembly; 20 cf and 200 psi or less), internally (may be waived) and externally                                                                                                                                                                                                                                                                                        |

**Table 3-B****BOILER & PRESSURE VESSEL PERMIT FEES****Installation Permit Fees:**

|                                                            |          |
|------------------------------------------------------------|----------|
| Boilers .....                                              | \$175.00 |
| Pressure Vessels .....                                     | \$125.00 |
| Beverage Service Tanks .....                               | \$50.00  |
| Installation permit fee for insurance-inspected site ..... | \$40.00  |

**Operating Permit Fees:**

|                                                               |          |
|---------------------------------------------------------------|----------|
| Boilers on a 1-year inspection cycle .....                    | \$110.00 |
| Boilers on a 2-year inspection cycle .....                    | \$110.00 |
| Pressure vessels on a 2-year or 4-year inspection cycle ..... | \$100.00 |
| Pressure vessels on a 6-year inspection cycle .....           | \$100.00 |
| Boiler bulk rate permits (each) .....                         | \$75.00  |
| Pressure vessels bulk rate permits (each) .....               | \$75.00  |
| Operating permit fee for insurance-inspected site .....       | \$40.00  |

**Other related fees:**

|                                                              |         |
|--------------------------------------------------------------|---------|
| Reinspection fee .....                                       | \$75.00 |
| Boiler or pressure vessel plans or data submission fee ..... | \$78.00 |
| Hourly rate for other inspections not listed above .....     | \$75.00 |

# Thank You!

Tim Blomdahl