Introduction to Steam Boilers & Systems

Hosted by:
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Objectives:

Basic Objectives of this discussion:

- Steam uses & safety
- Boiler types & designs
- Boiler room operations & safety
- Boiler maintenance considerations

A little bit about me…

- Started w/PBBS in Jan. 2001
- My Father worked for PBBS starting in 1975
- Worked as a Service Technician until 2013
- Transitioned to Service Manager position starting in 2012

PBBS
EQUIPMENT CORPORATION

Steam use in Healthcare

- Sterilization
- Chilled water systems – absorption chillers
- Domestic hot water heating
- Heating & Humidification systems

Boiler Construction

- Just a heat exchanger with a burner attached
- Firetube Pressure Vessel
  - Shell
  - Furnace
  - Tubesheets
  - Tubes
- Watertube pressure vessel
  - Drums - mud and steam
  - Tubes

ASME Code

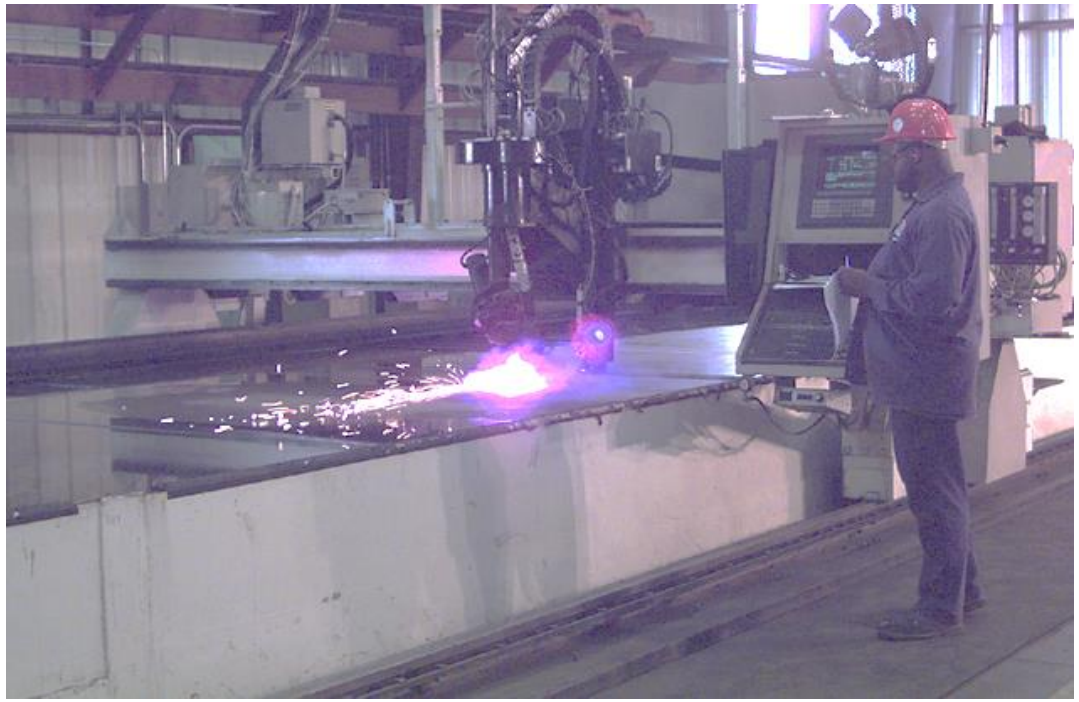
- Section I or Power boilers
  - High pressure - Steam boilers above15 psi.
  - Hot water boilers above 160 psi and/or 250^{O} F.
- Section IV or Heating Boilers
  - Low pressure - Steam boilers less than 15 psi.
  - Hot water boilers less than 160 psi and/or 250^{O} F.

ASME Code

- Section VIII
  - Unfired pressure vessels
    - Deaerators or pressurized tanks
    - Requires non destructive testing every 5 years

Pressure Vessel Construction

- Flat ASME grade steel enters the plant.
- Goes to the Plasma arc cutting table.
- All openings for fittings, handholes, etc, are cut using flat steel.



Rolling the Shell

- Flat steel from plasma cutter is rolled into a cylinder.
- Thickness of shell varies with pressure vessel design pressure.

Rolling the Shell

- The longitudinal seam is tacked and then welded

Rolling the Shell

- The finished shell course is then removed from the rolls to have more courses added.

Rolling the Shell

- Several courses may be used to make one particular size boiler shell.
- Welding of circumferential joints is done by rotating shell under welding head.

Tubesheets

- Tubesheets are also cut with plasma cutter.
  - Outside circumference.
  - Furnace and stay brace holes.
- Sheets are loaded into the drilling machine.

Tubesheets

- Sheets can be drilled individually or stacked and drilled.

Tubesheets

- Finished tubesheets are then tacked to the shells for welding in pit

Tubesheets

- In the special welding pit the front tubesheet to shell weld is put in.
- Rear tube sheet may be knuckled or flat.

Fittings

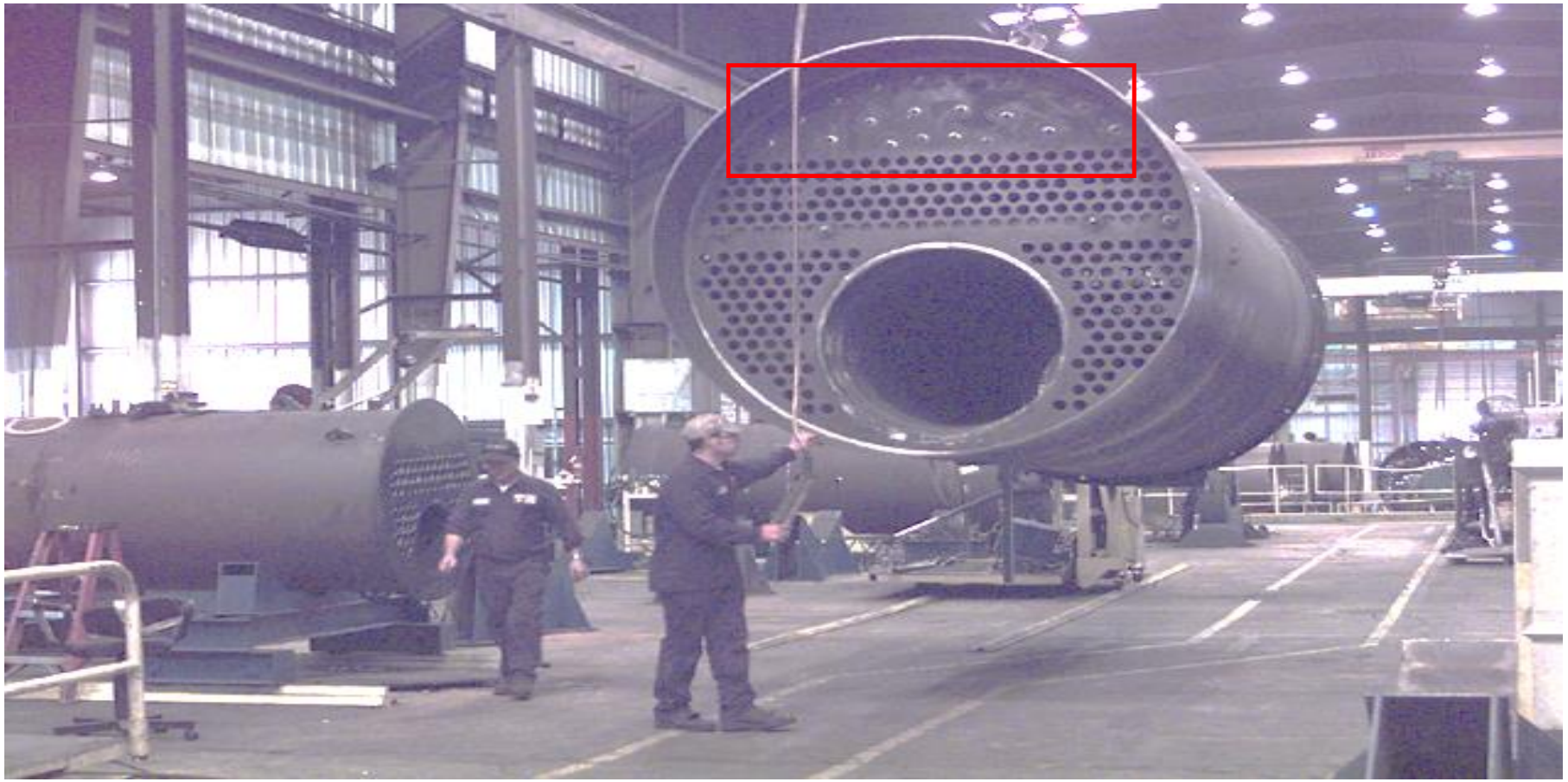
- After tubesheets are installed.
  - Studdery, couplings and manhole rings are installed.

Furnace

- Depending upon design pressure some furnaces are corrugated.
- Changes in code allow straight furnaces where we once used corrugated.

Furnace & Stays

- After the furnace is installed the stay braces (if any) are welded in.



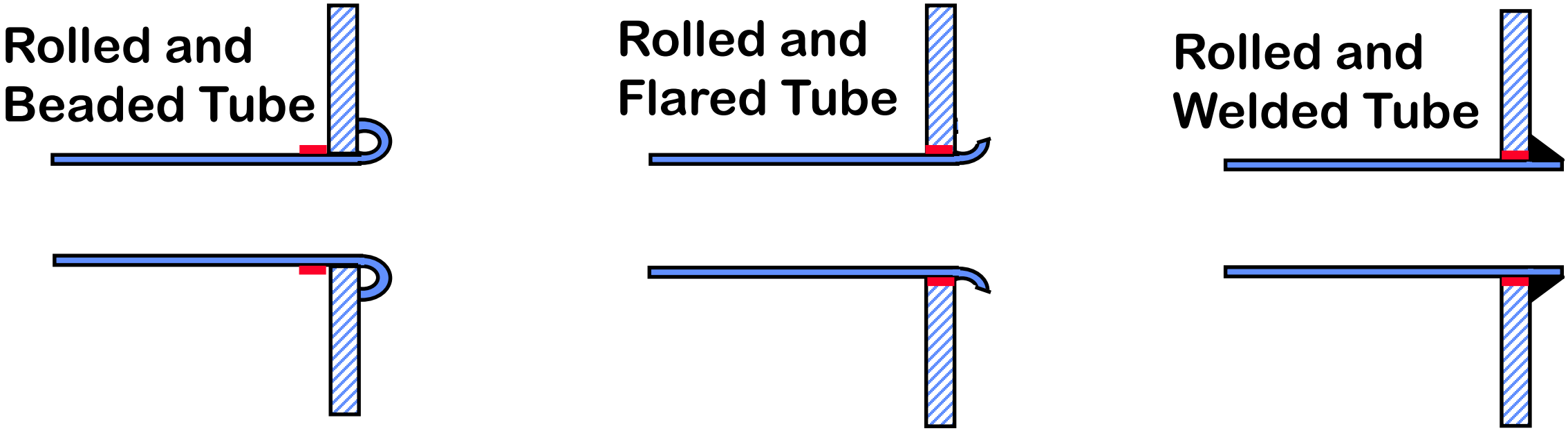
Stress Relieving

- After all pressure vessel welding is completed the entire assembly is stress relieved.

Tubing & Hydro

- Tubes are installed as specified for a particular size and pressure.
  - Rolled & beaded.
  - Rolled & flared.
  - Rolled & welded.
- After tubing is a hydrostatic test.
  - 1 1/2 times the maximum allowable working pressure.

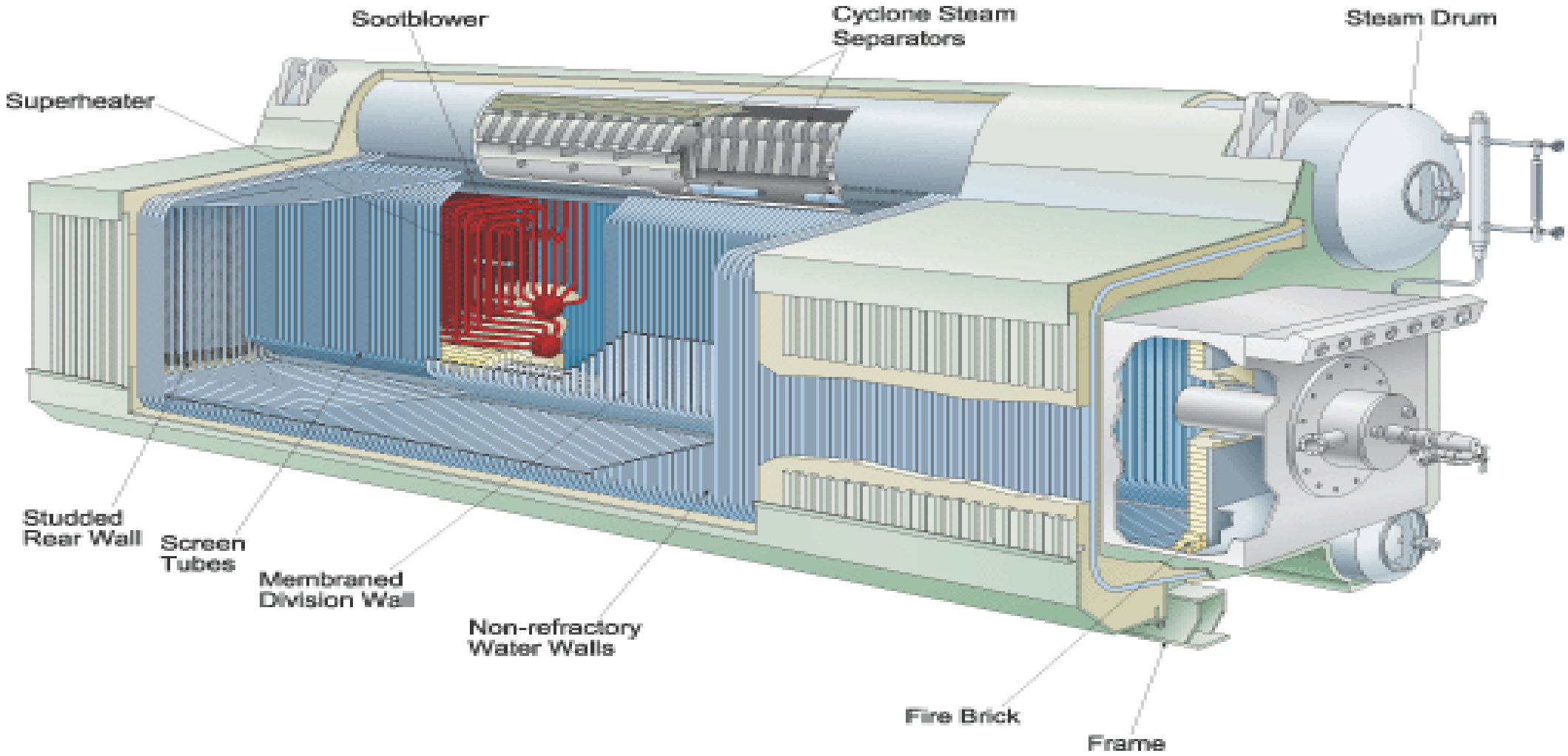
Tube Attachment



The tube is first rolled which is what seals the tube to the tube sheet.

The Bead, Weld or the Flare is for helping get rid of the heat

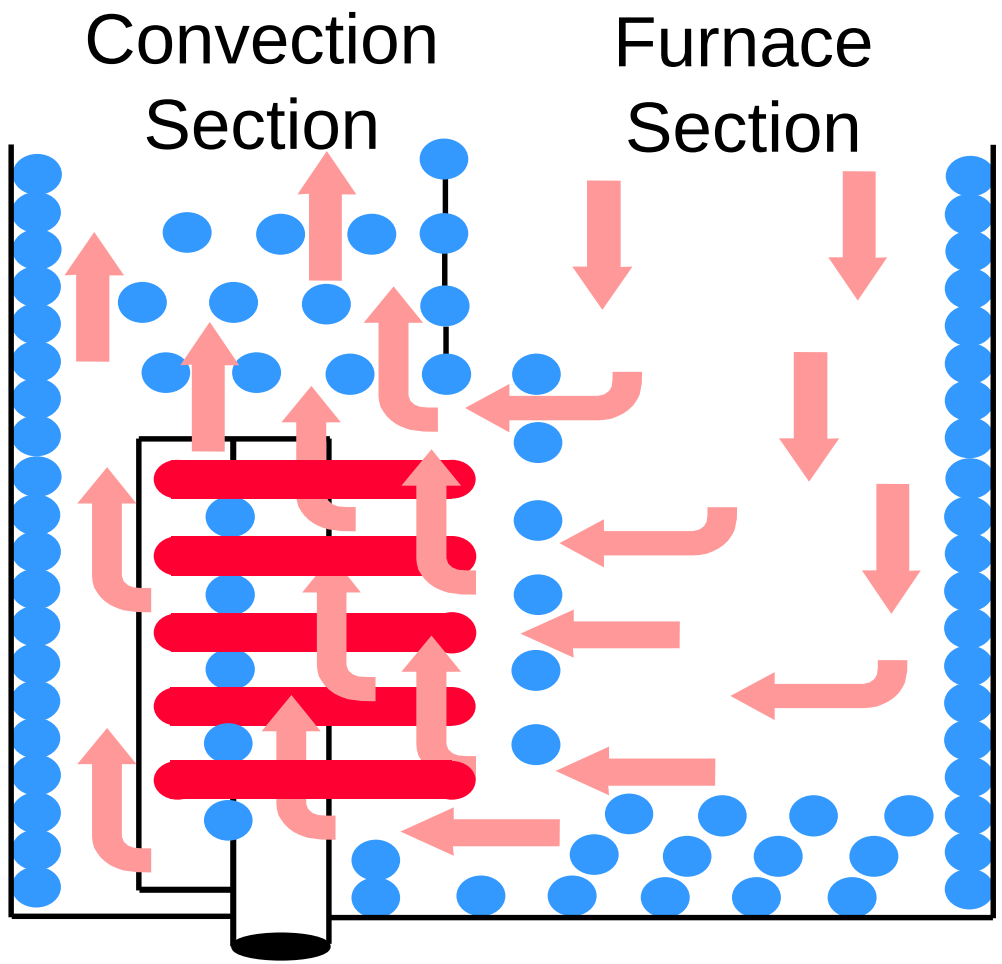
Water Tube Boiler Construction



Convection Superheater “D” Style

- Saturated Steam.
  - 150 Psi, 366^0 F.
  - 1 ppm dry steam.

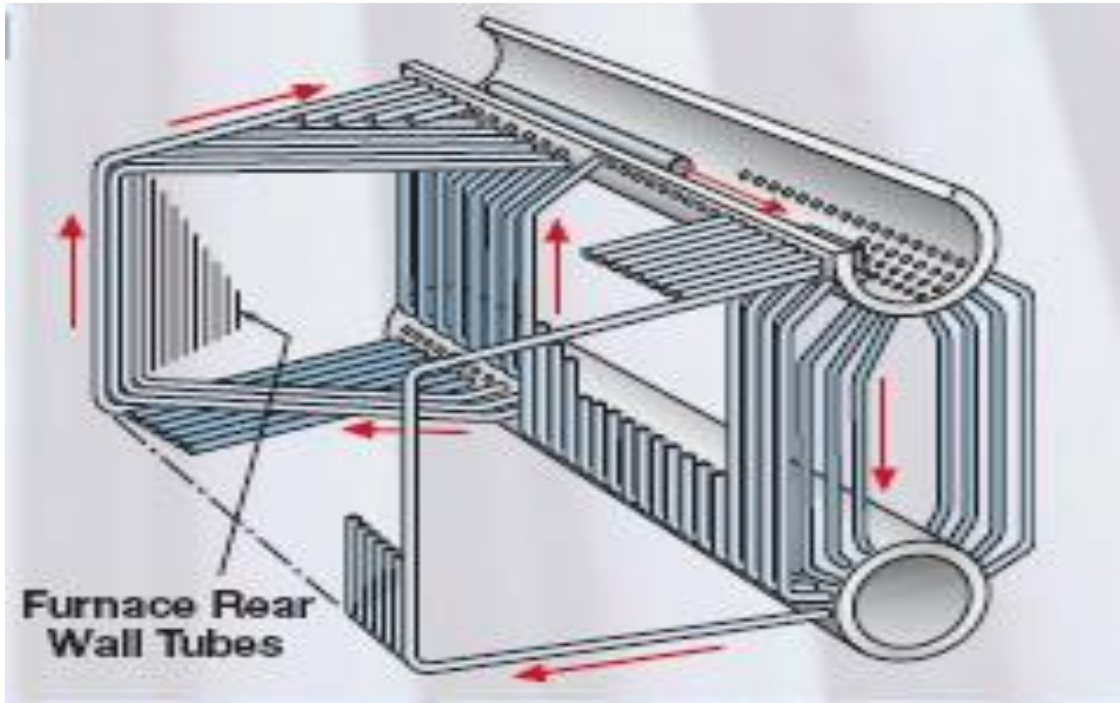
- Superheated Steam.
  - 145 Psi, 500^0 F.
  - 1 ppm dry steam



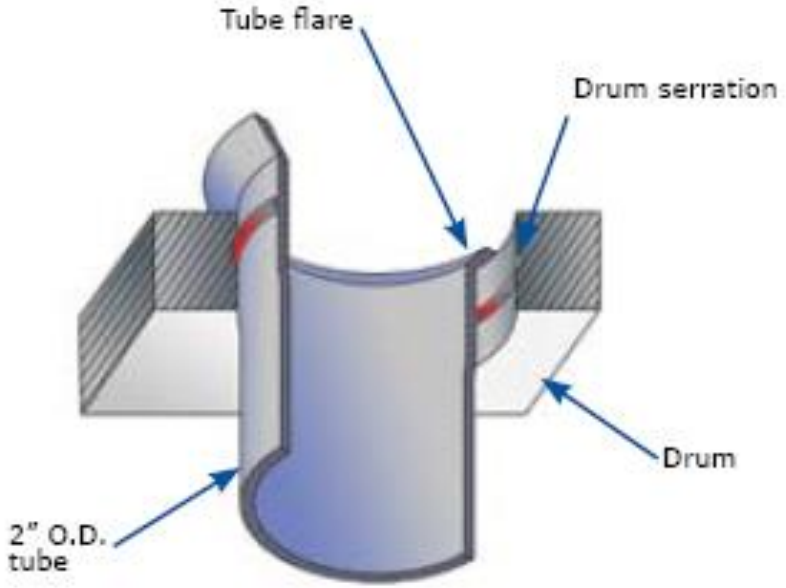
Furnace wall water cooling

- The side, roof, floor, front and rear wall tubes are included.
- Each rear wall tube is a single flow path between drums to assure proper circulation and cooling.

- Downcomer tubes allow for the cooler water to circulate back down to the water drum.



Tubes are rolled into Drums

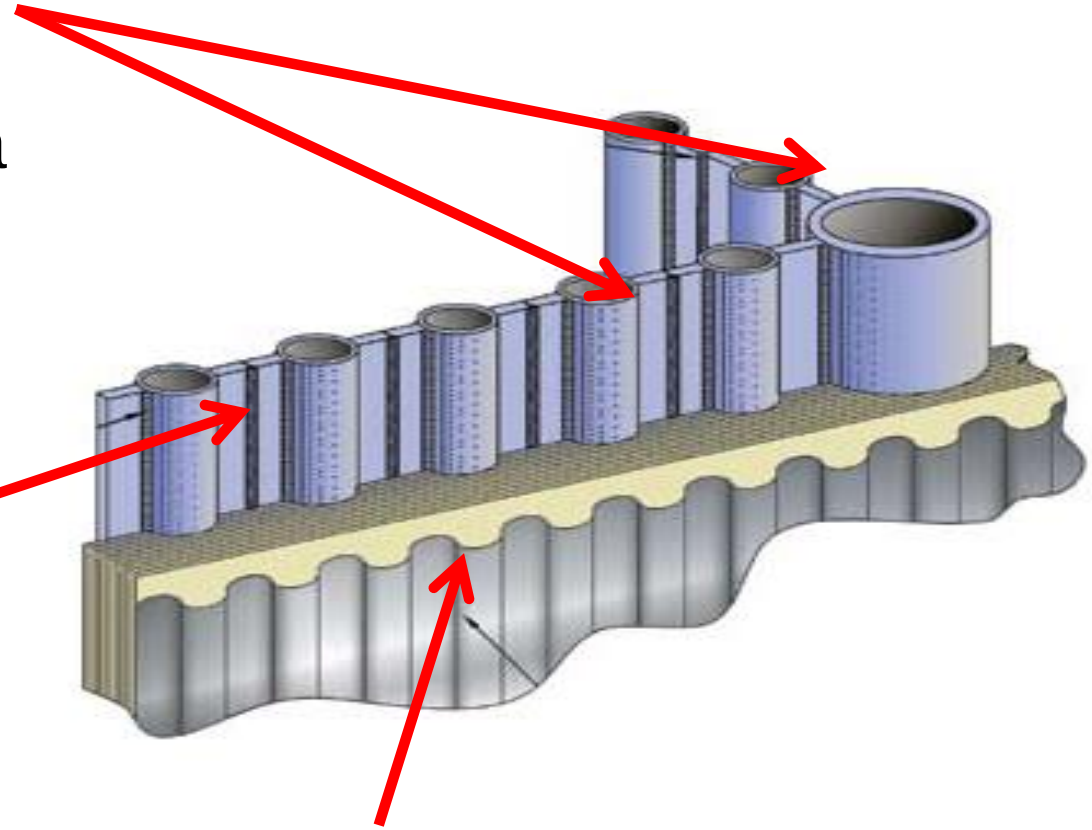


Torque-controlled, roller-expanded, tube-drum connections feature machined serrations for added strength. Welded connections are available for severe-duty service

Membrane walls

- Adjacent fins of all furnace, and outside convection tubes are continuously seal welded to form a pressure tight water cooled panel.

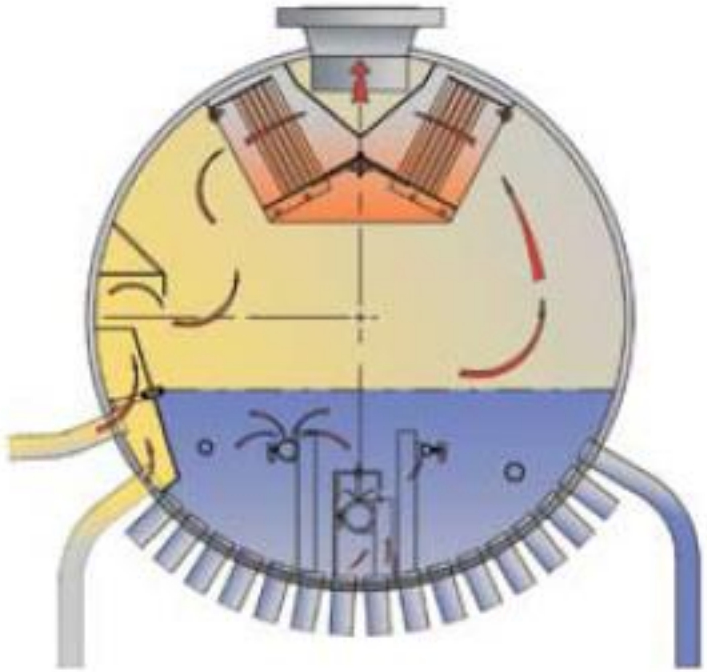
- Fins are dual-welded to tubes



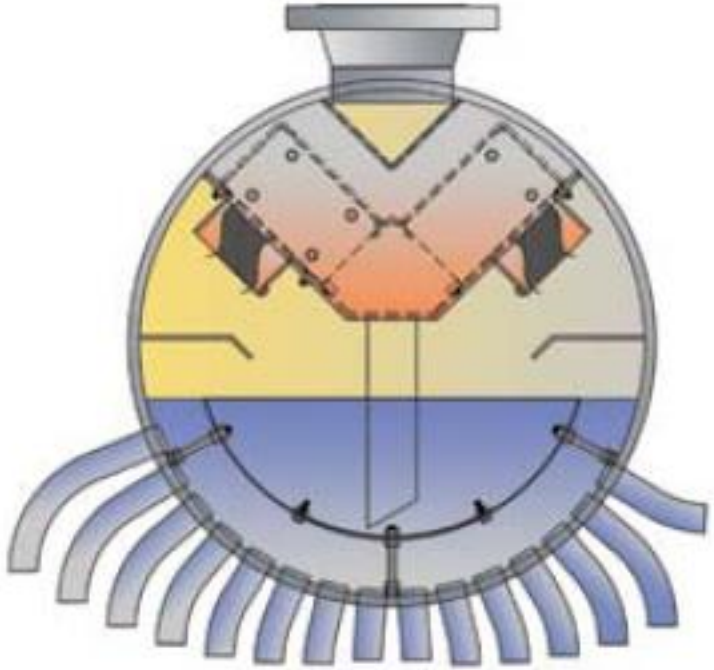
Mineral wool insulation

Steam quality

- Guaranteed at 0.5% moisture with standard steam drum internals.
- Optional internals will reduce solids in the steam to 1 PPM.

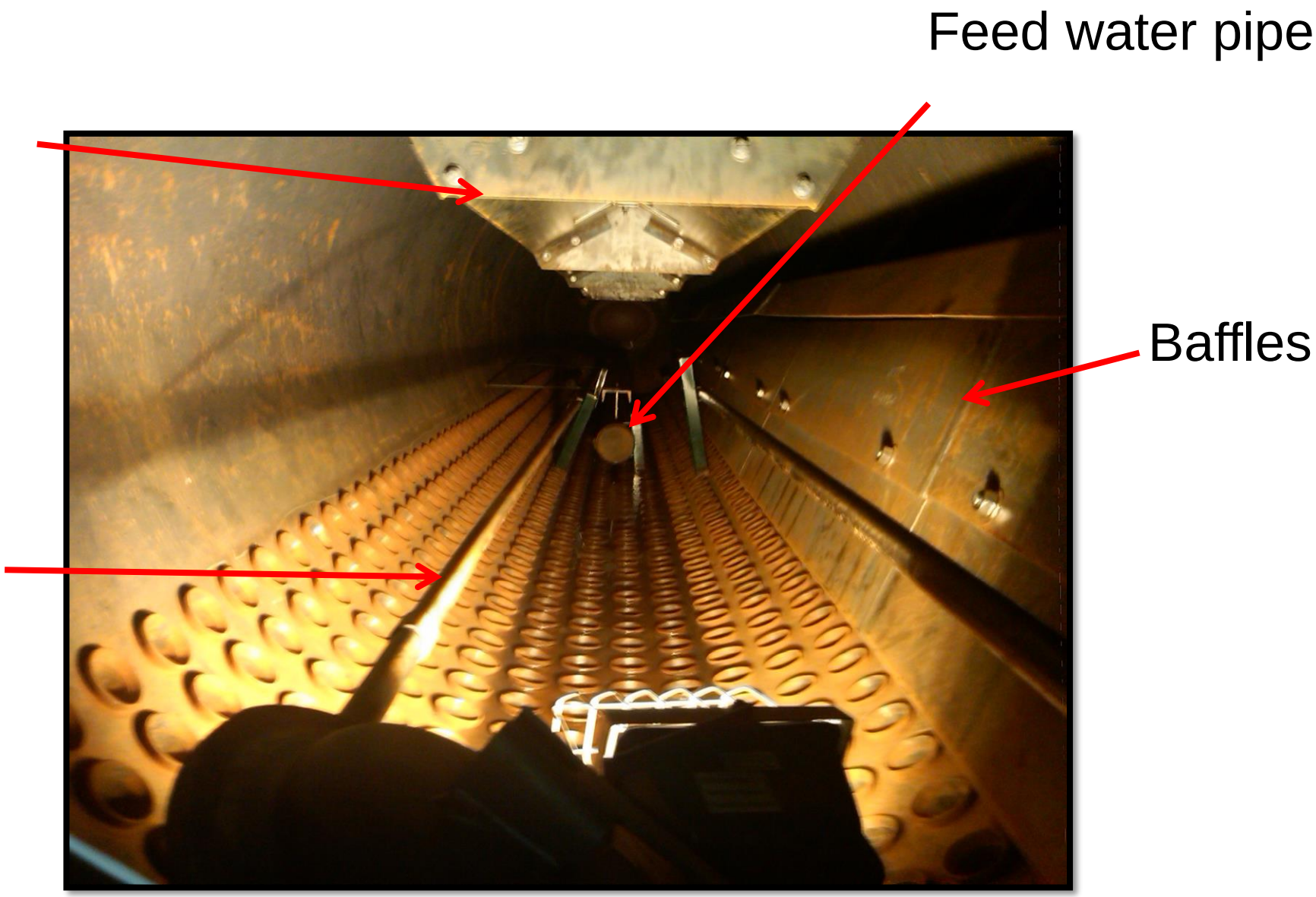


Baffled impingement primary steam separation and labyrinth steam dryers are utilized to ensure dry steam delivery



Optional steam separation equipment, such as chevron separators, are available

Steam Drum Internals



Firebox

- Boiler with front and rear Refractory walls.
- Membrane Generating tube wall.
- Refractory on steam and mud drum.

Firebox No Refractory

- Boiler with Membrane wall on all tubes.
- Limiting the need for Refractory.
- Manways located on the Steam and Water drums.
- May be hinged.

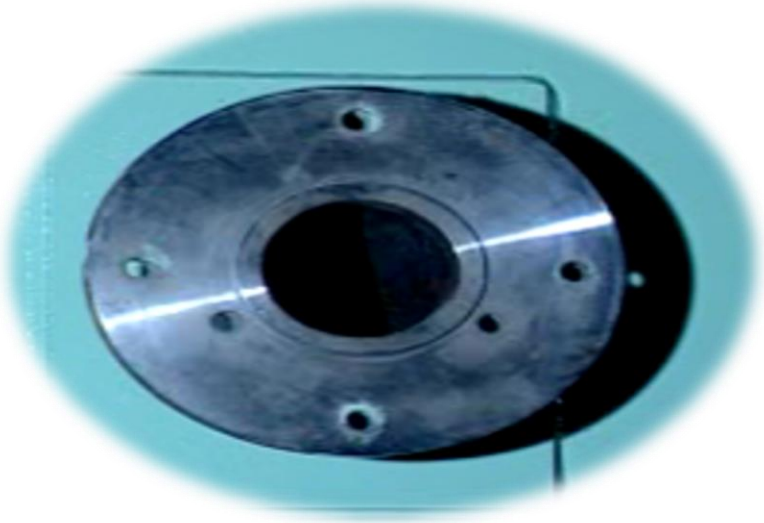
Tube Rolling

- Tubes are rolled into the steam and water drums.
- If you get a leak on a tube you can replace it.
- Depending on the location you might be able to plug the tube.

Consult with the manufacturer on what percent of tubes you can plug.

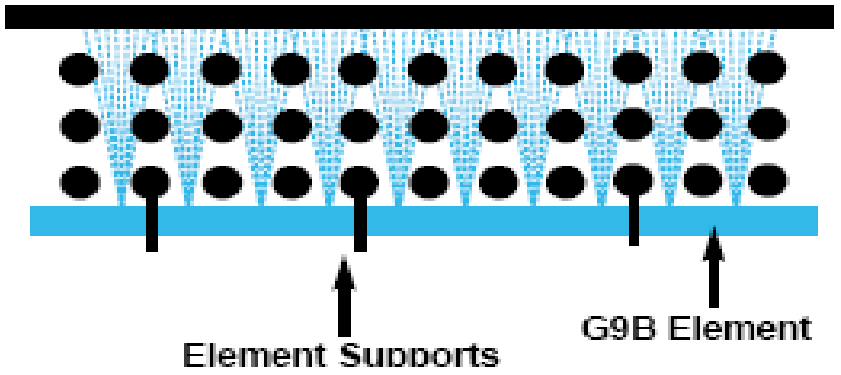
Sootblower

- For oil-fired applications, soot blowers are a typical feature.
- The soot blower supply and super heater outlet connection are shown in this picture



Sootblower

- Nozzles are registered with tube lanes so the element can be located immediately next to the tube bank.
- This arrangement is generally used in boiler convection-sections.



Flexible Watertube Construction

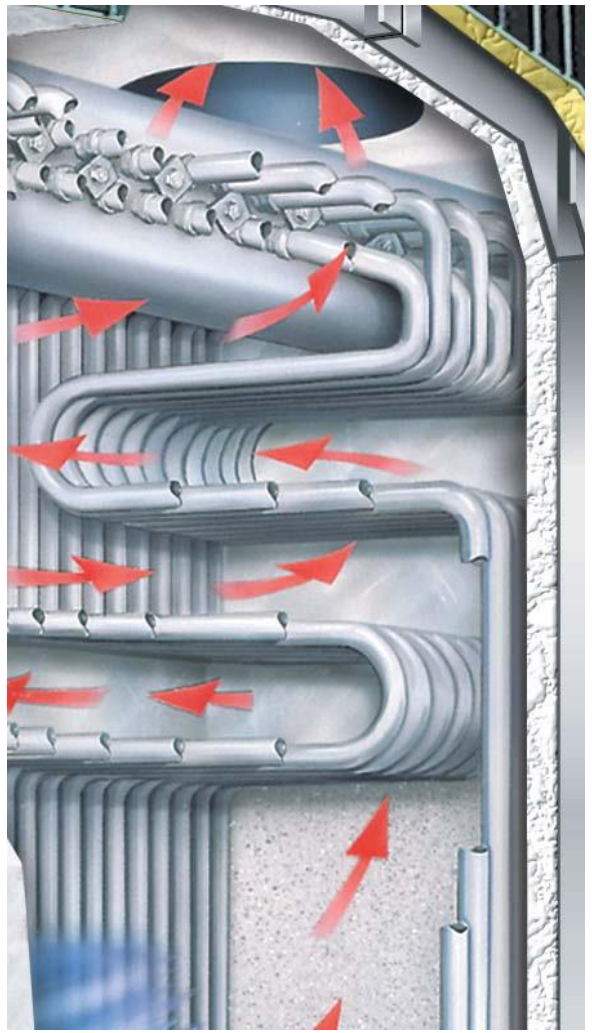
5th Pass

4th Pass

3rd Pass

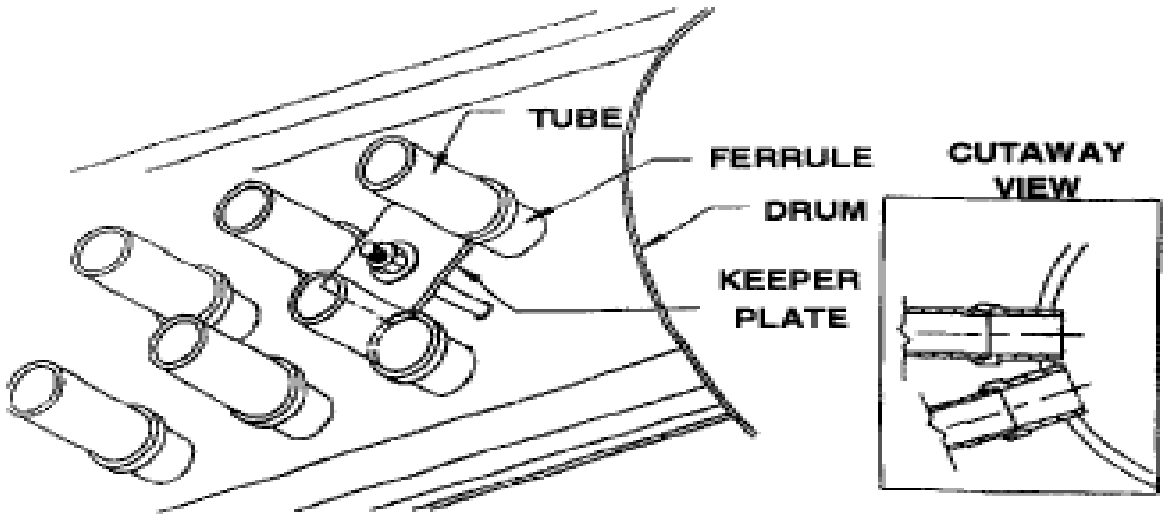
2nd Pass

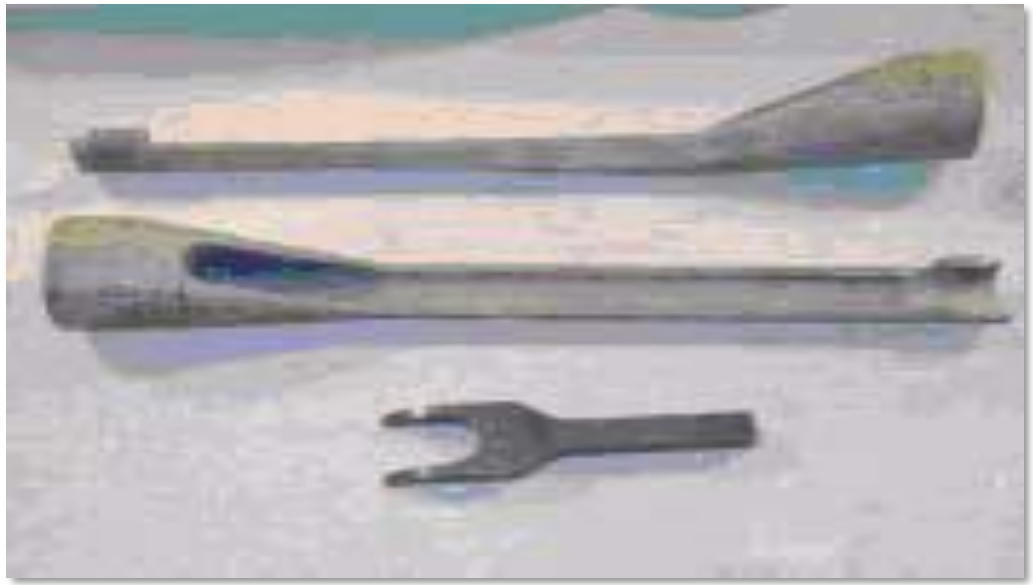
1ST Pass



Flex Tube Boiler Tools

- No welding required.

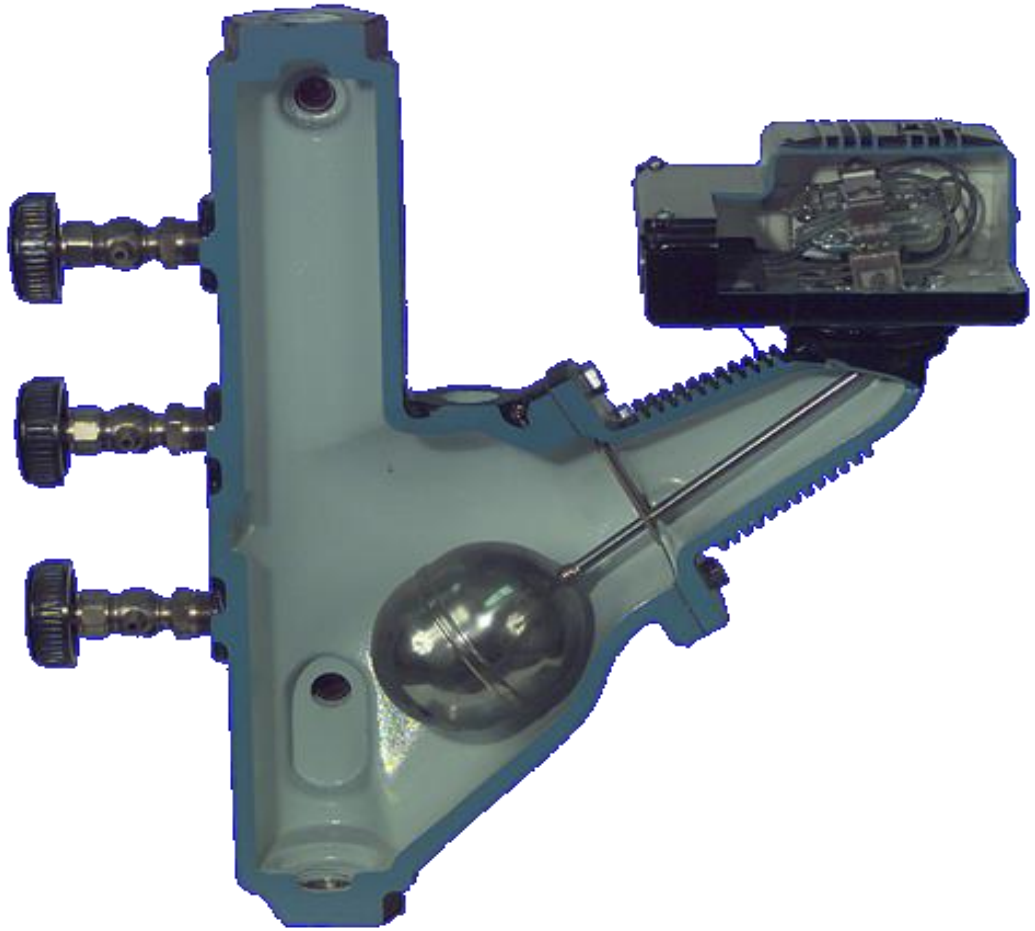




Boiler Controls - Low Water Cutout

- The LWCO is the most important control on the boiler.
- Boiler should never be operated without the LWCO functional.

Typical float type LWCO for a Firetube boiler.

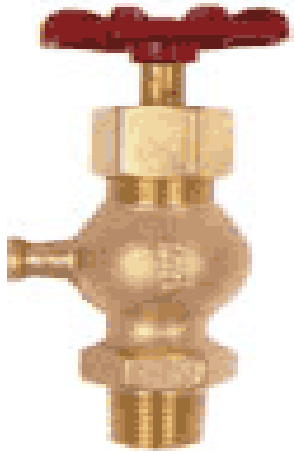


Water Columns

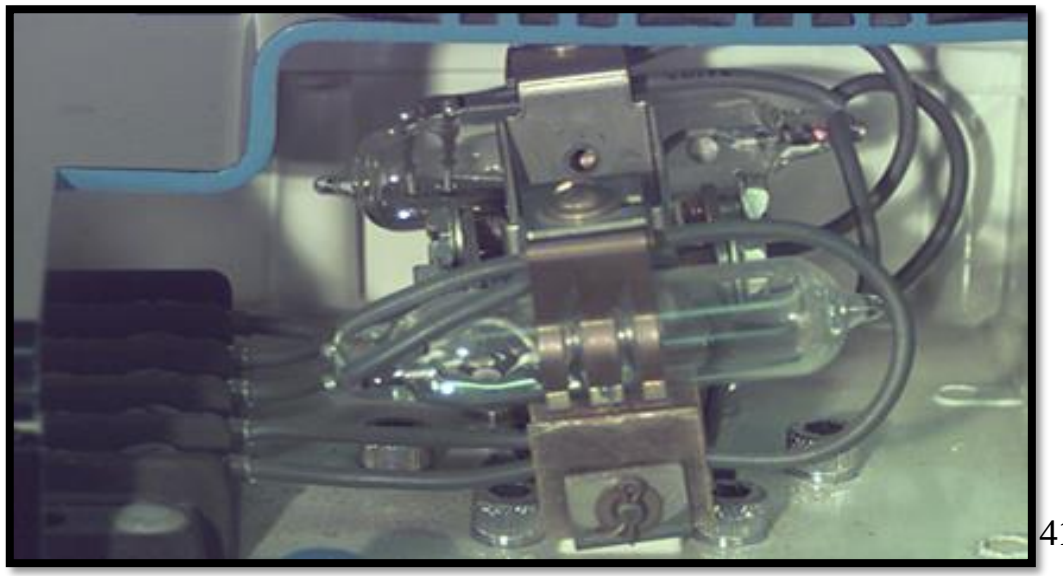
- Most common controls
  - LWCO - M & M 150/157 good to 150 PSI
- Pump control switch
  - Start and stop turbine feed pump
  - Open - close feed water valve
    - End switch
  - Modulating feed water valve
    - Centrifugal pumps
- LWCO switch
  - Shut off burner, illuminate an indicating light and sound an alarm

Water Columns

- Tricocks
  - No longer required by ASME code
    - High pressure boilers
    - Option - for local codes or customer request
  - Check water level



- Early versions of the 150 units with mercury bulb switches were able to be adjusted. These units had knurled adjustment screws that could be used to raise, lower or widen the set points.
- The Mercury type style is no longer available
- Later versions of the 150 with mercury bulb switches and all snap switch units are not adjustable in the field.

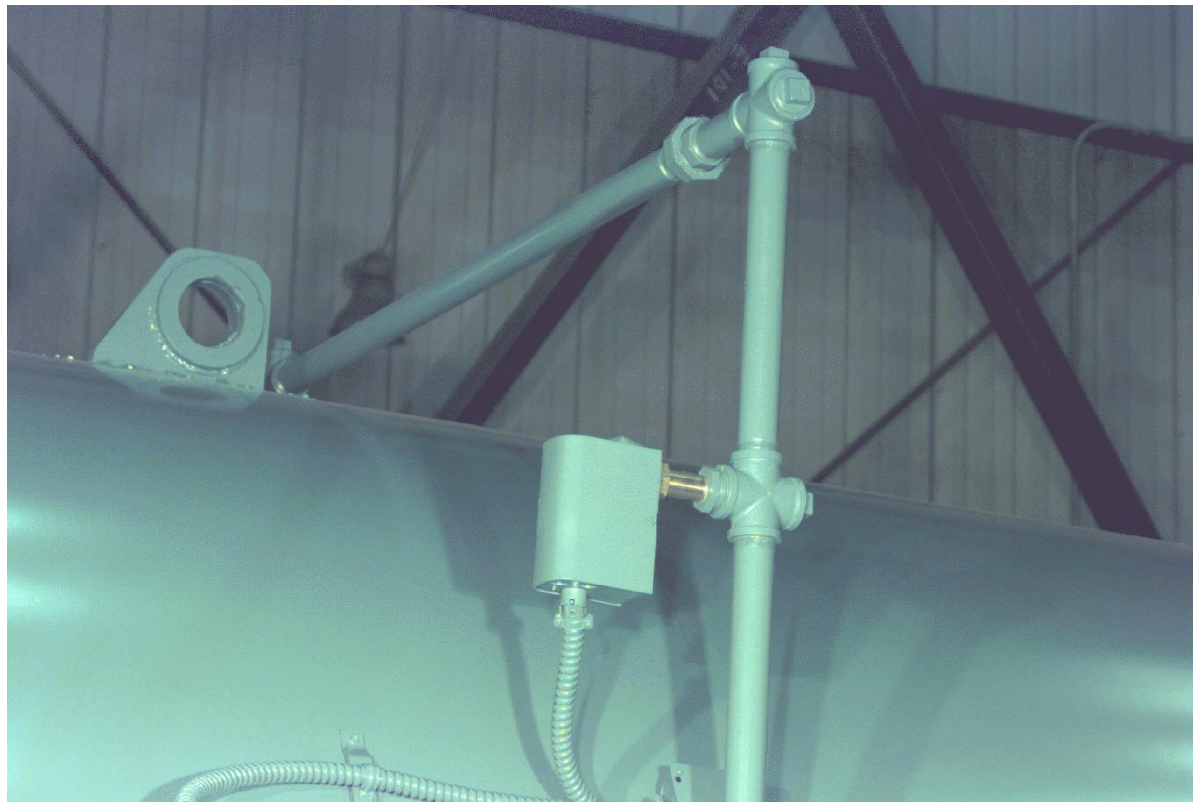


Series 150S controls

- Systems with relatively stable or small fluctuations in water line
- When no new electrical wiring is desired or possible when boiler feed pump is balanced to system requirements.

Water Columns

- Auxiliary low water cut-off
  - M & M 150
  - External probe
- LWCO or ALWCO may be manual reset
  - State or local code



Primary LWCO for Water tube Boilers

- Probe type

Series 1

300 Volt secondary
To probe

Discontinued

Primary LWCO for Water tube Boilers

Series 26
Low Water Cutoff – Standoff Mount

- Meets CSD1 Requirements
- Non Powered Contacts
- Time Delays Available
- LED Monitoring
- Test Feature
- AC Current Minimizes Electrolysis
- Optional Dirty Electrode Detection
- Snap-Thru Standoff Mounting
- Compact Size
- Power Outage Feature
- U.L. "Limit Control"

Applications

- Low-Water Cutoff
- Point Level
- Valve Control
- Single-Level Service
- Alarms
- Pump Control

Series 26 for boiler application
Wired in the limit circuit

Primary LWCO for Water tube Boilers

Sensitivities vs Maximum Probe Wire Distance*

SENSITIVITY CHARACTER	SENSITIVITY (KOHMS)	DISTANCE (FT)
A	4.7	900
B	10	600
C	26	250
D	50	100
E	100	50

* Based on type MTW or THHN wire, #14 or #16 Awg

Same Probe

What is recommended to use for boiler applications

Warrick Troubleshooting Guide

ELECTRONICS Series 16, 26, DF, 27, 37

1. Failure of relay to change state when liquid touches probes. (Condition shows electrodes are dry)

- •Check connection of electrodes – are there any shorts?
- •Check wiring between probes and relay for correctness and continuity.
- •Check electrodes to make sure they are clean.
- •Check to be sure liquid is actually touching the electrodes.
- •Does the supply voltage match that of the control?
- •Do you have the correct sensitivity for the liquid you are using? The relay may not be sensitive enough for the media.
- •Is the media conductive? Hydrocarbons (Oil, gasoline, solvents) are not conductive.
- •What is the load you are switching? If the load exceeds what the control is listed for, the contacts may have fused.
- •Check to see if the distance between the tank and where the control is mounted exceeds the distance parameters **(see chart p. E2)**
- •Make sure the high electrode is not further than 4 feet from the ground reference electrode. If the customer has an application like this, they can drop a second reference electrode next to the high probe. Simply connect another reference probe to the ground reference. This also applies if customer is using the control as a single point level service (only using the H and G probes) if the ground reference is greater than 4 feet, the signal may be lost.

- •Found on gems sensors website

Primary LWCO for Water tube Boilers

Series 26 Modules
Low-Water Cutoff – Plug-In Modules

- Powered Contacts
- Modular Plug-In Design
- Low Voltage Sensor
- 11-Pin Socket
- U.L. "Limit Control"
- Solid State Reliability
- LED Monitoring
- Time Delays Available
- Meets CSD1 Requirements
- Optional Test Feature
- Optional Dirty Electrode Detection
- Optional Manual Reset Button Feature.
  If Level Drops, Control is Deactivated Until Liquid Level Returns to Normal and Pushbutton is Depressed
- Optional Power Outage Feature Ignores Nuisance Outages and Resets When Power is Restored

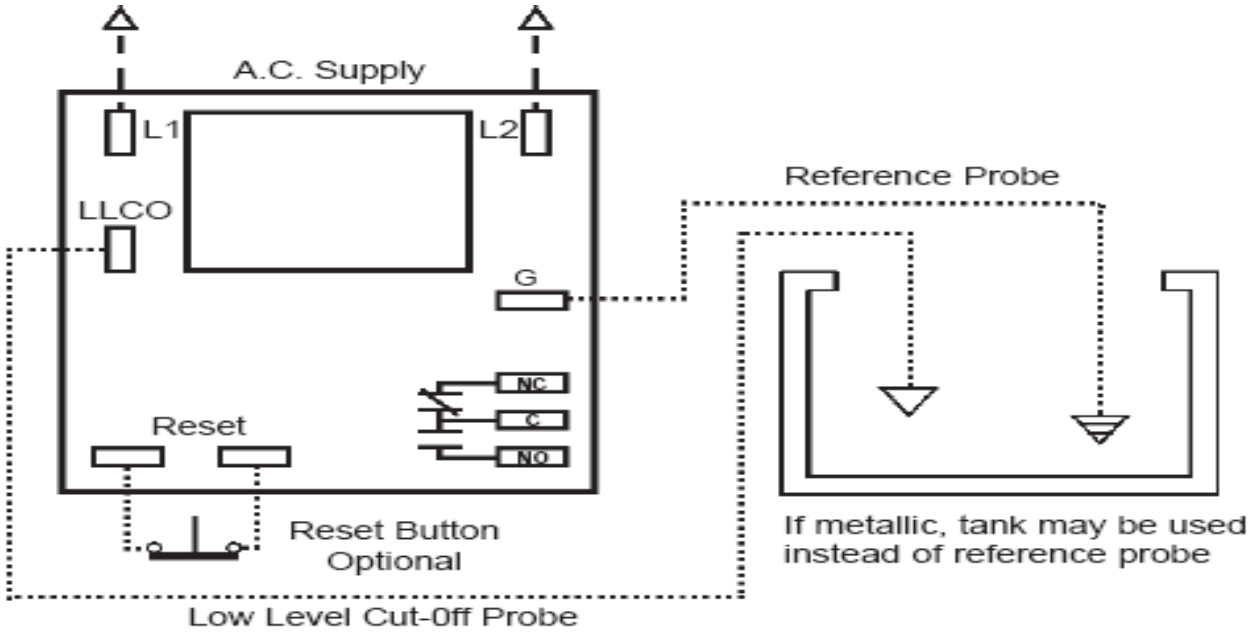
No low water alarm when limit circuit is off

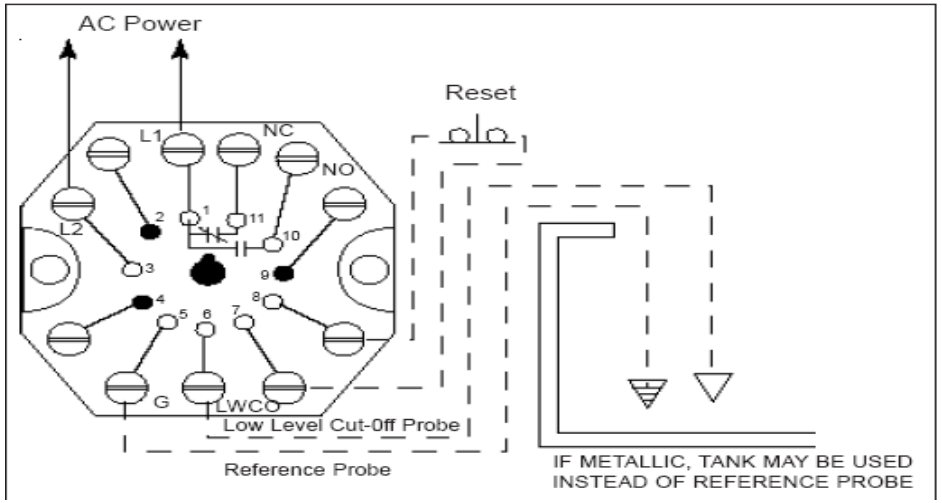
Primary LWCO for Water tube Boilers

- Primary Voltage
- 120 VAC,
- 240 VAC1
  - 240 VAC and 208/240 VAC units do not carry U.L. Limit Control recognition
- 24 VAC, 208/240 VAC (+10%/-15%) 50/60 Hz

- Secondary Voltage
- 12 VAC, 1.5 mA

Primary LWCO for Water tube Boilers





Primary LWCO for Water tube Boilers

- **DIRTY ELECTRODE DETECTION**
- **The LED will flash every half-second**
- once the probe resistance reaches a value greater than the nominal control sensitivity rating.
- The relay state will not change until it exceeds the nominal sensitivity by more than 25% (typically) at nominal input voltage.
- At which time the LED and relay contact return to the dry state.
- Such a condition may suggest electrode maintenance is required.

Added Feature

Probe Install

The probe installation in Figure 4 is INCORRECT!!

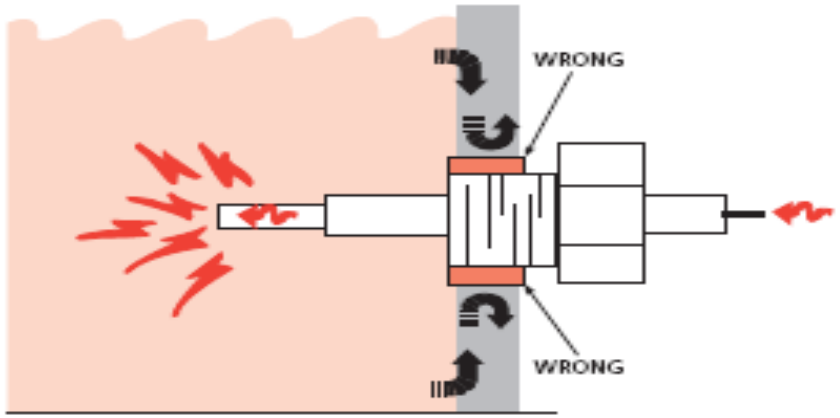


Figure 4

Insulating sealant or Teflon® tape blocks the continuity path, resulting in a weak electrical signal and a false low-water-level indication.

Installing the LWCO in the piping external to the boiler can have pitfalls:

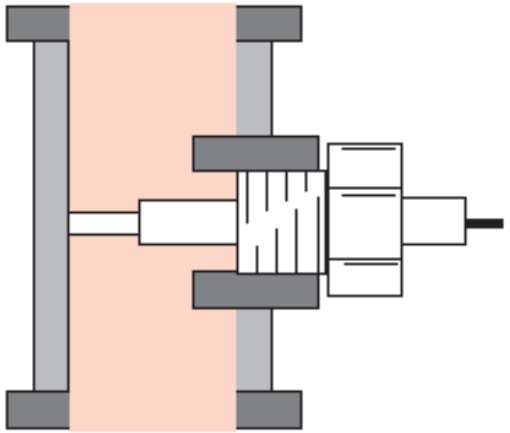


Figure 5

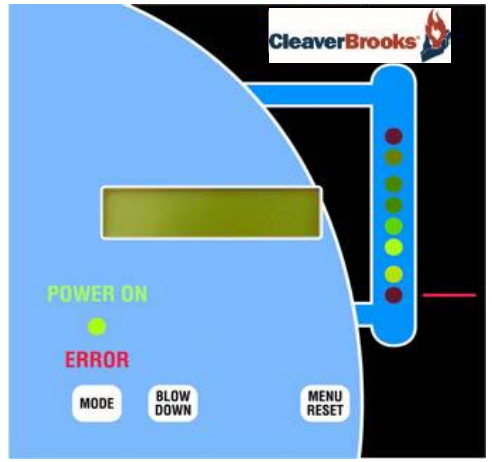
Probe too long - One potential problem may be the probe is too long for the installed location and the probe lacks proper clearance. Contact between the probe and pipe results in a shorted electrical path (Figure 5). If the probe touches the wall of the pipe, the circuit is completed and the LWCO "thinks" there is water in the system whether there is or not. If the water level drops below the level of the probe in this situation, the burner circuit will not be interrupted and a dry fire could occur.

Probe Install

- The probes may need to be inspected and cleaned more frequently on systems where there is the potential of coating build-up on the probes. This includes systems:
  - High quantities of raw water make-up
  - No condensate return
  - Untreated boiler water
  - Inconsistent or infrequent boiler-water chemical treatment
  - Where significant changes have been made to the boiler-water chemical treatment process
  - Oil in the boiler water

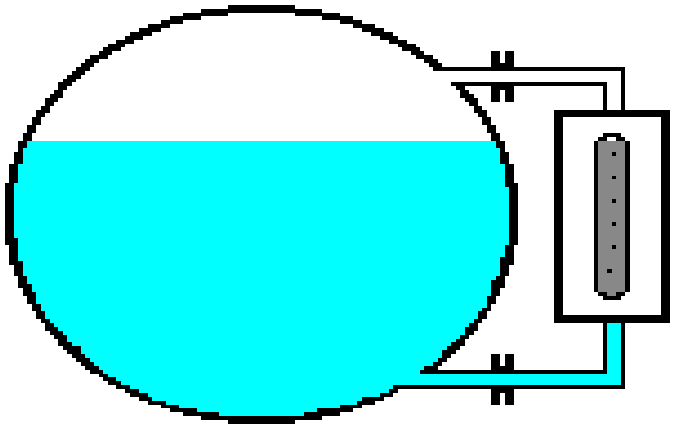
Level Master

- Magnetostrictive technology
- Non-contact, non-wearing
- No switches, no mercury
- Features
  - Level indication
  - Low water cutoff & alarm
  - High water alarm
  - Low & high-water warning
  - On/off & modulating feed control in one unit
  - Continuous dynamic probe monitoring
  - Auto and manual reset
  - Real time clock



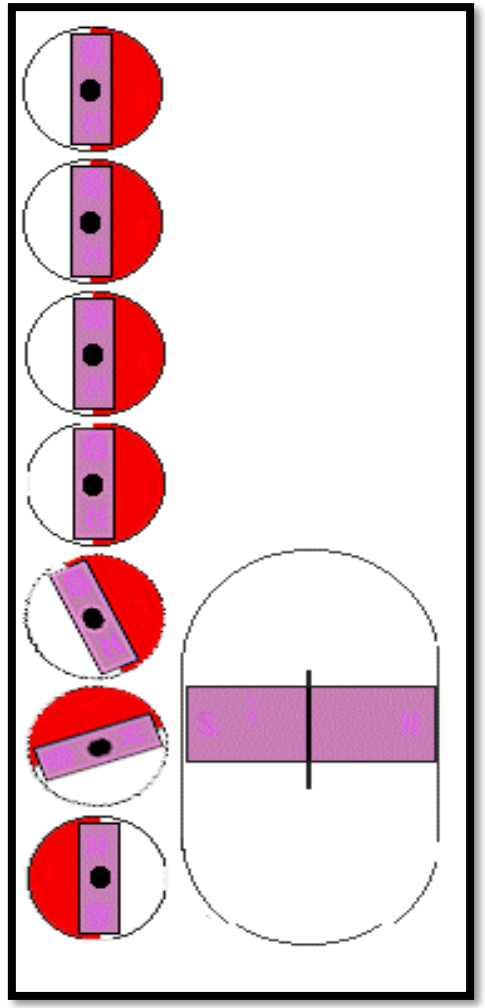
Water Columns

- Gauge glass
  - Tubular - standard
    - Etching
    - Packing
    - Alignment
  - Prismatic
    - Very high pressure
    - Customer request
    - Special water column
    - Fluid level indication is the result of the different transparency property of the two media (i.e. liquid and air or vapor

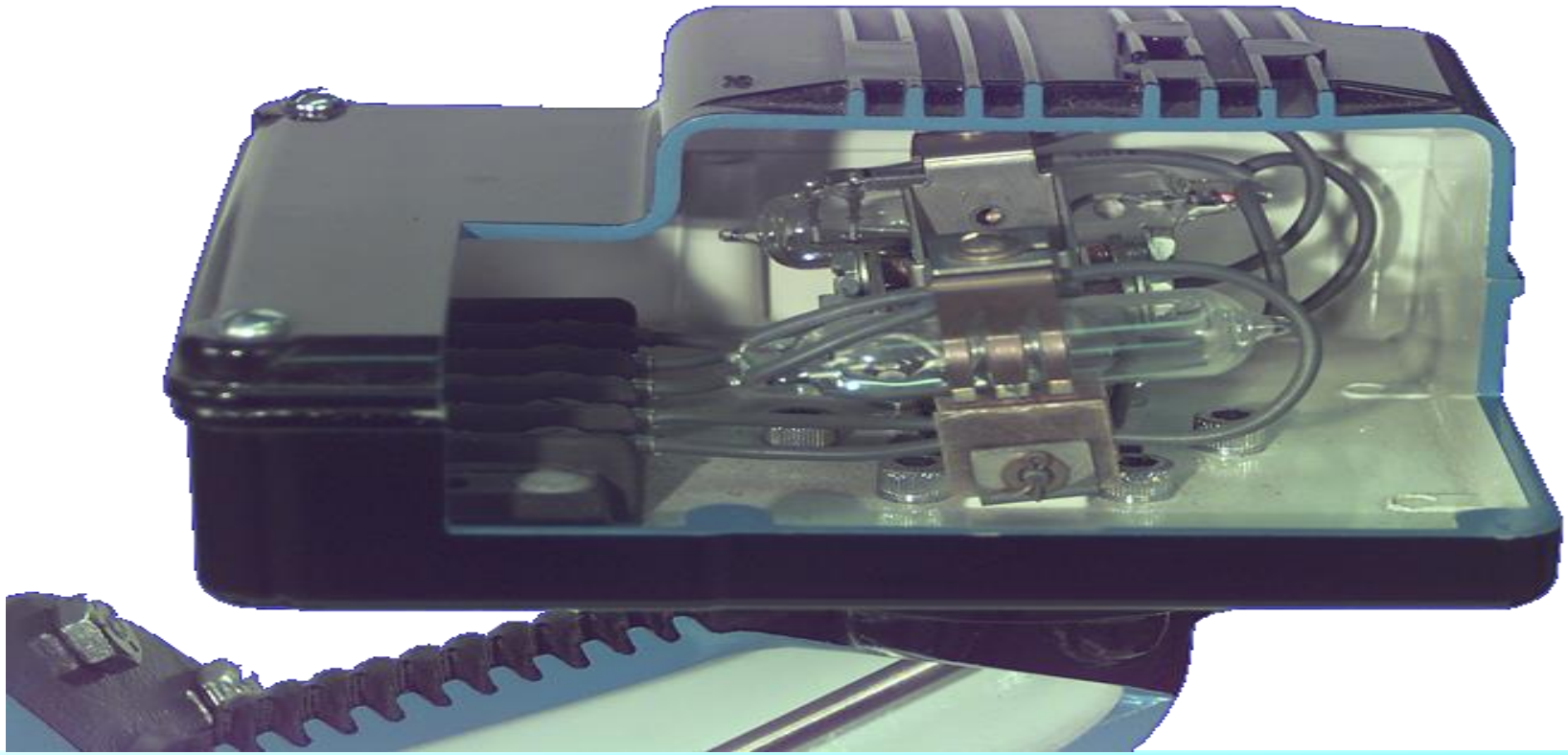


Magnetic Type Level Indicator

- Requirement is you need to see water in the gage glass.
- Tanks are ok.
- Boilers are not unless second device.



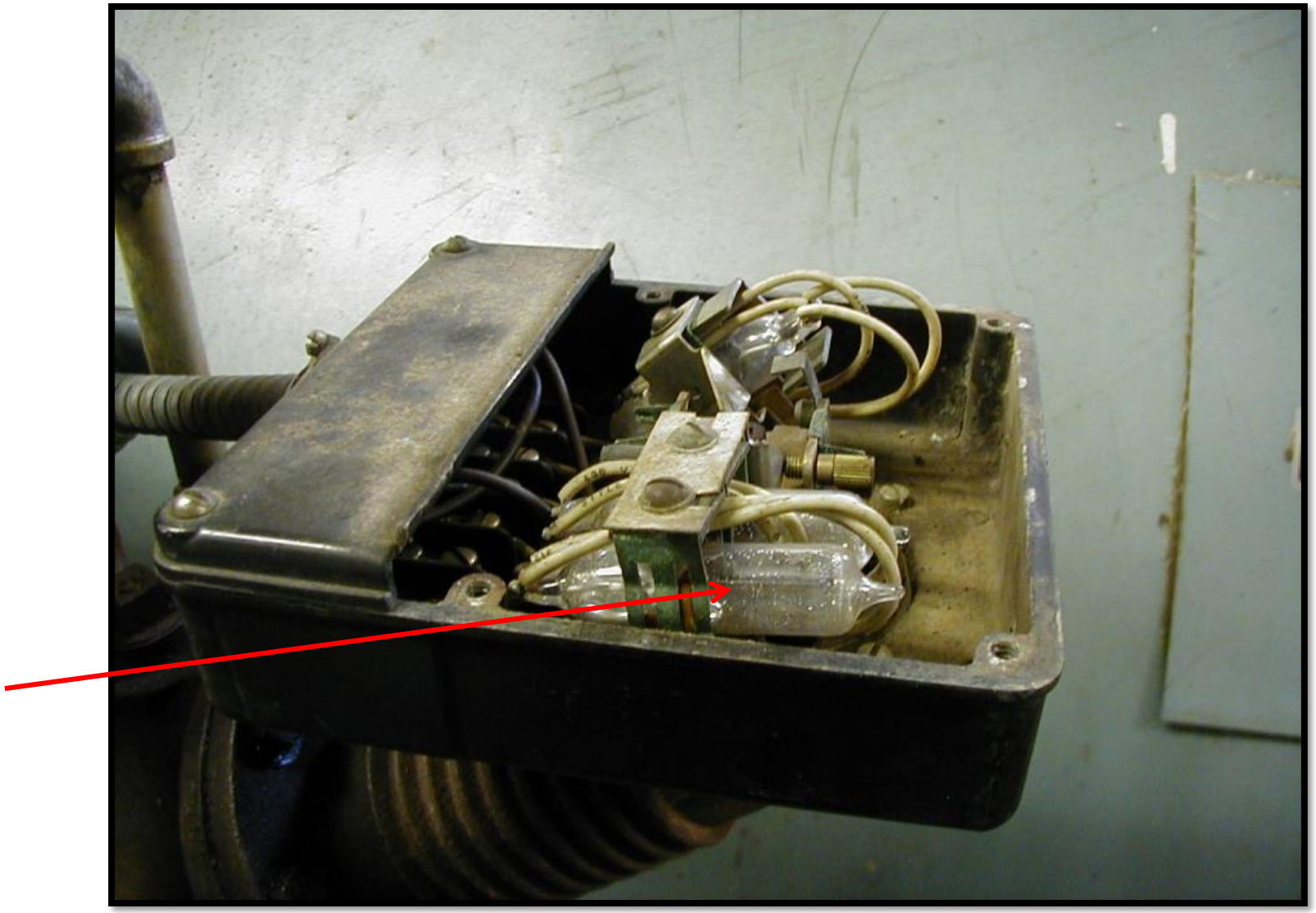
What to look out for



Proper Maintenance of LWCO

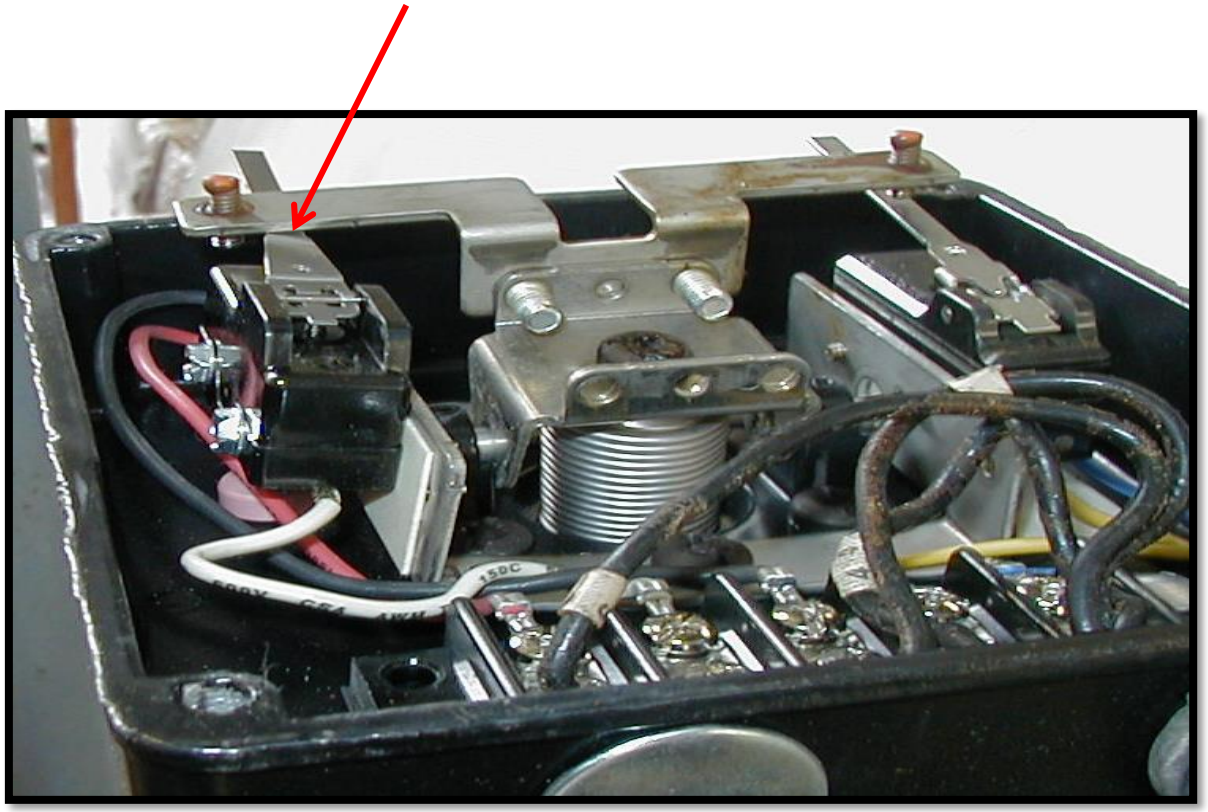
- Replace the Head mechanism every 5 years
- Replace Head when Switches don’t work properly.
- Disassemble and inspect annually – including float chamber and equalizing piping

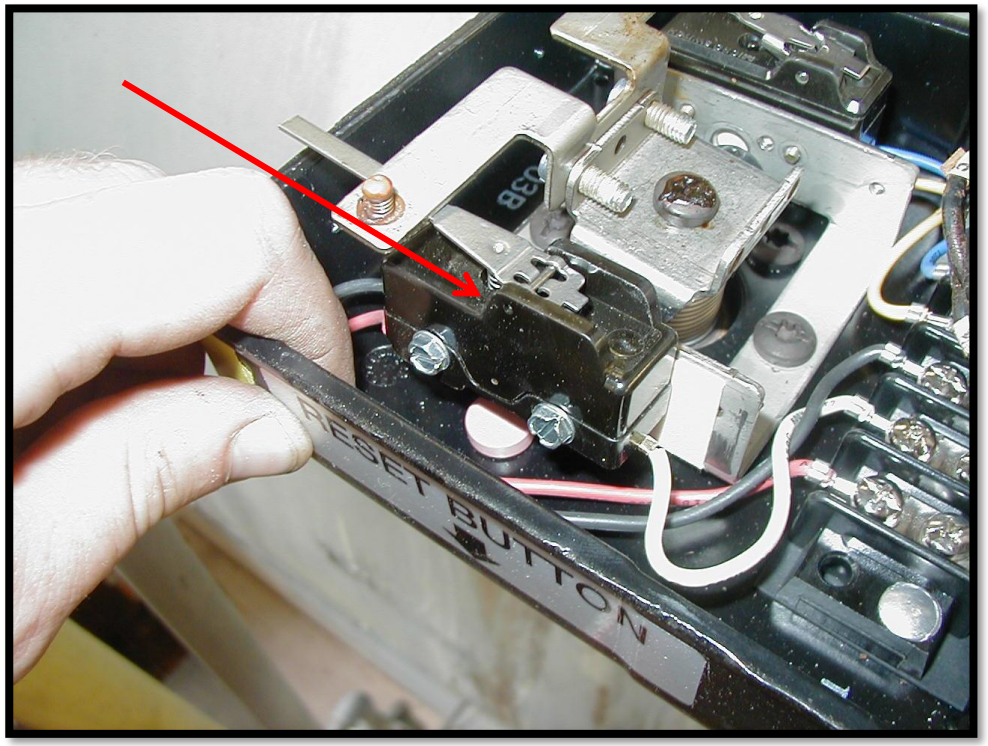
Inspect Mercury Switches



Inspect

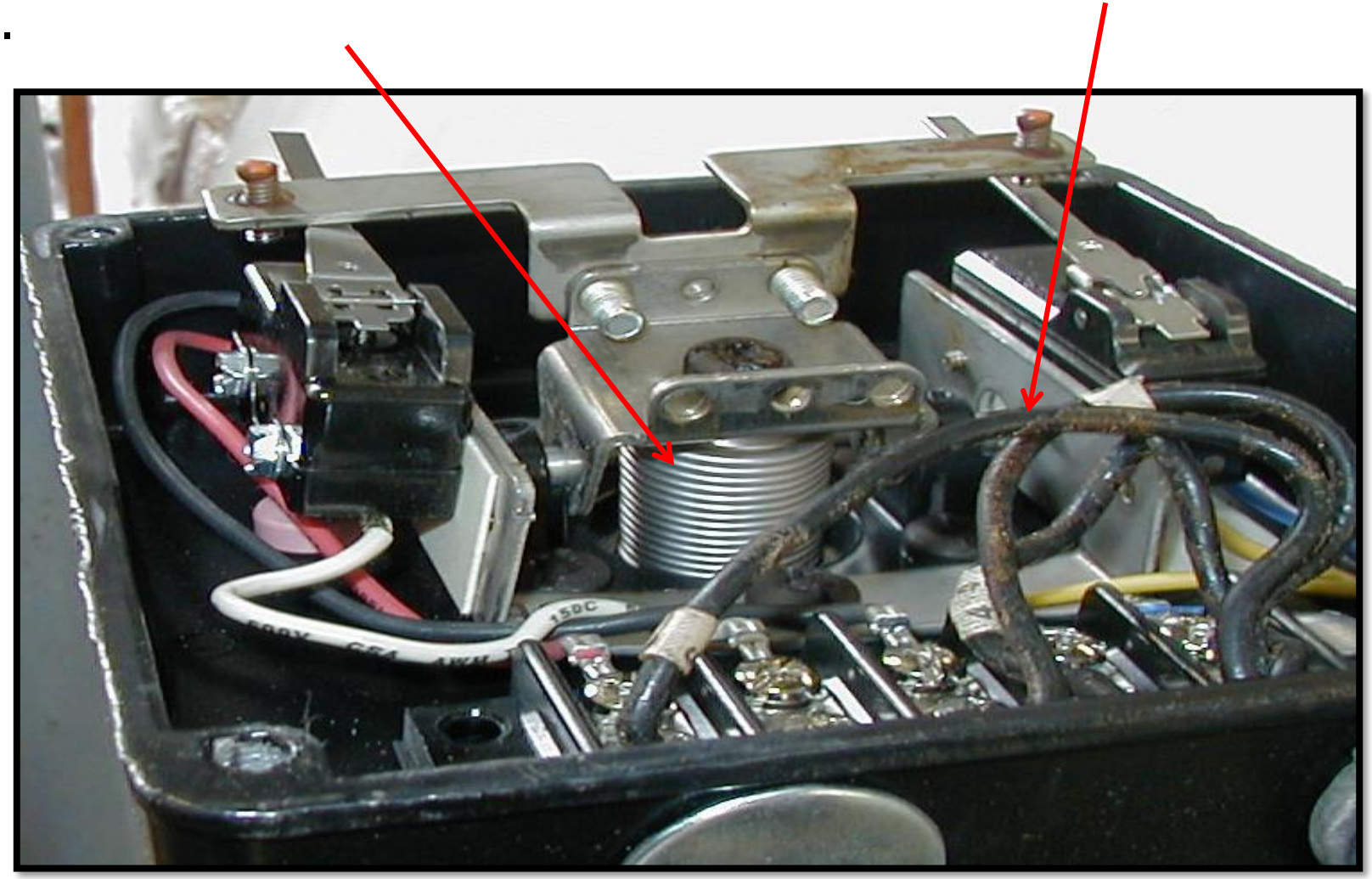
- Snap switches.



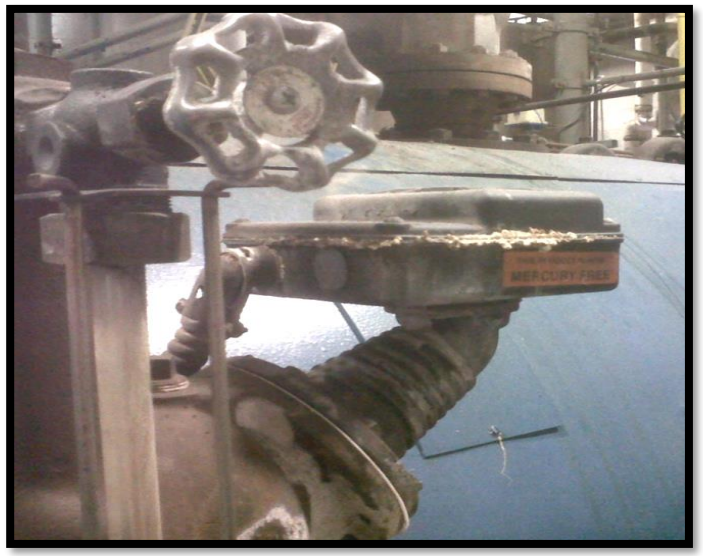


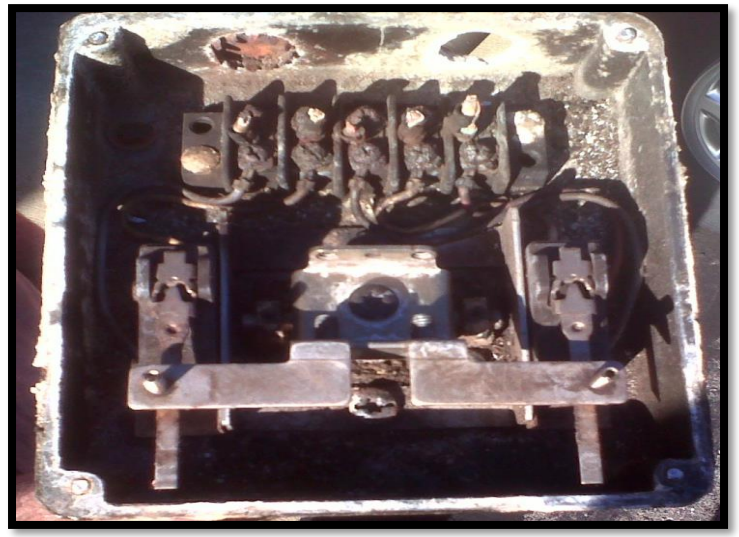
Inspect

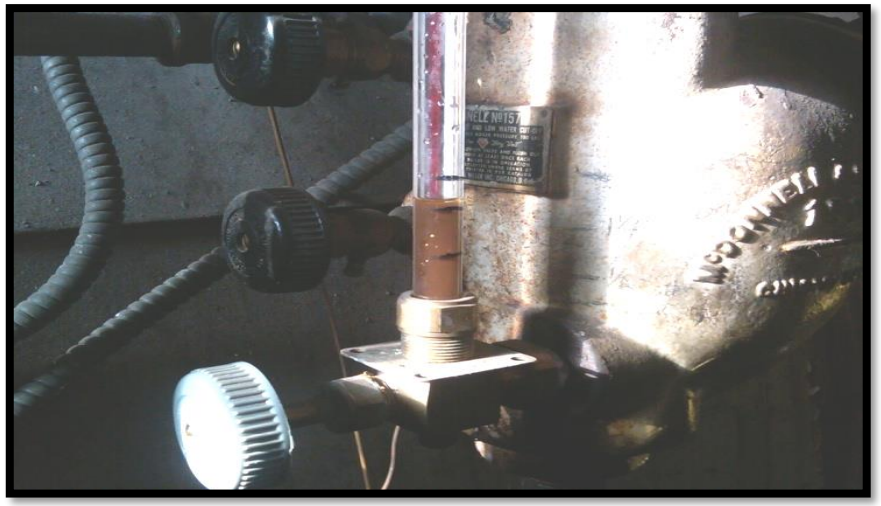
- Bellows.
- Wires.



Remove Covers for Inspection







- Rod out pipe
  - Once a year
  - Steam & water side
  - Water columns
  - Pressure controls
- Match mark piping
  - Ensure they are put back at the proper level

LWCO Piped

Steam

Top pipe can be common.

Bottom pipe needs to be separate.

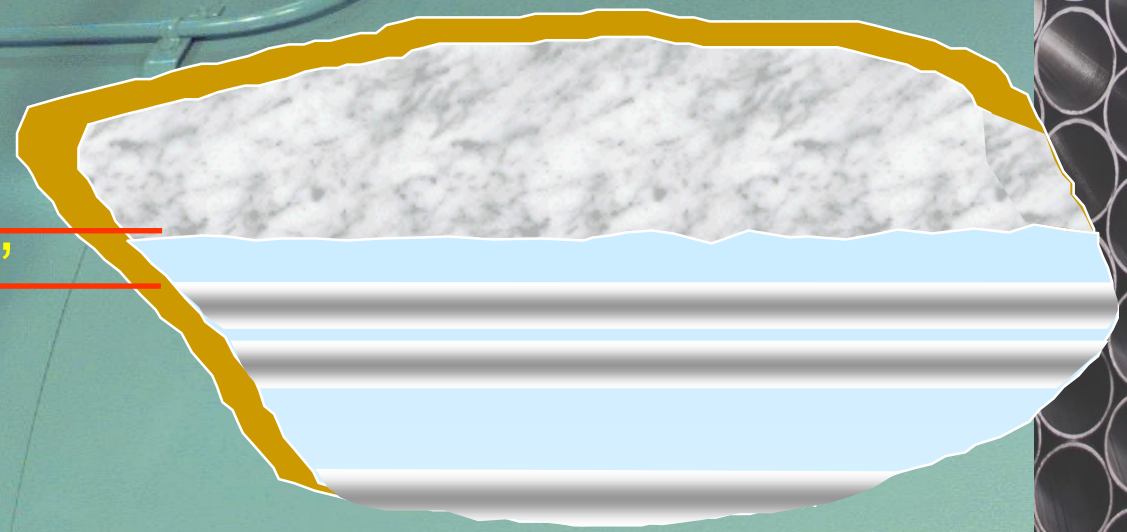
Hot Water

Section IV - Heating Boilers, 15 psi

Low water cutoff point is 0” - 1/4” above top row of tubes

Section I - Power Boilers, Above 15 psi

1st visible point of water in the gauge glass is 3” above top row of tubes



Blowing down Water Columns

- When blowing down a control at pressure, the blow down valve should be opened slowly.

- The piping needs to be warmed up and stagnant water in the drain piping needs to be pushed out. Suddenly opening a blow down valve causes steam to condense, which creates water hammer.

- Crushed floats and damaged linkages can occur when water hammer occurs due to improper blow down piping.

Right in the Instruction Manual

BLOW DOWN PROCEDURE:

⚠ CAUTION

To prevent serious personal injury from steam pipe blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge.

Failure to follow this caution could cause personal injury.

When blowing down a control at pressure, the blow down valves should be opened slowly. The piping needs to be warmed up and stagnant water in the drain piping needs to be pushed out. Suddenly opening a blow down valve causes steam to condense, which can create water hammer. Damage to components can occur when water hammer occurs due to improper blow down piping. For these reasons, McDonnell & Miller recommends a dual valve blow-down system for each control.

Blow down the control when the water in the boiler is at its normal level and the burner is on.

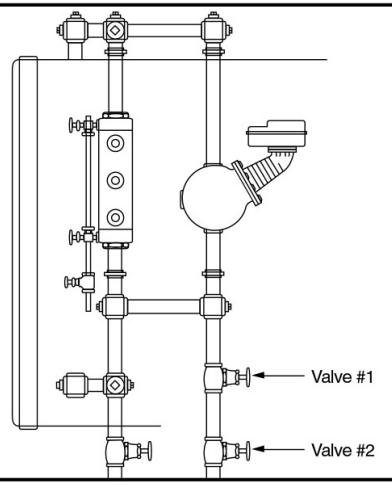
NOTE: Refer to page 2 for switch operating points.

- Open upper valve (#1)
- Slowly open the lower valve (#2)
- Water in the sight glass should lower.
- As the water in the sight glass lowers, the pump should turn on.
- As the water continues to lower in the sight glass, the burner should turn off.
- Slowly close the lower valve (#2).
- Close the upper valve (#1)
- The water level in the sight glass should rise, first turning on the burner and then turning off the pump.

NOTE: On manual reset models, the reset button will need to be pressed after the water level has been restored before the burner will operate.

NOTE

If this sequence of operation does not occur as described, immediately close all the valves, turn off the boiler and correct the problem. Inspection/cleaning of the float mechanism may be required to determine why the control was not working properly. Retest the control after the problem has been identified and corrected.



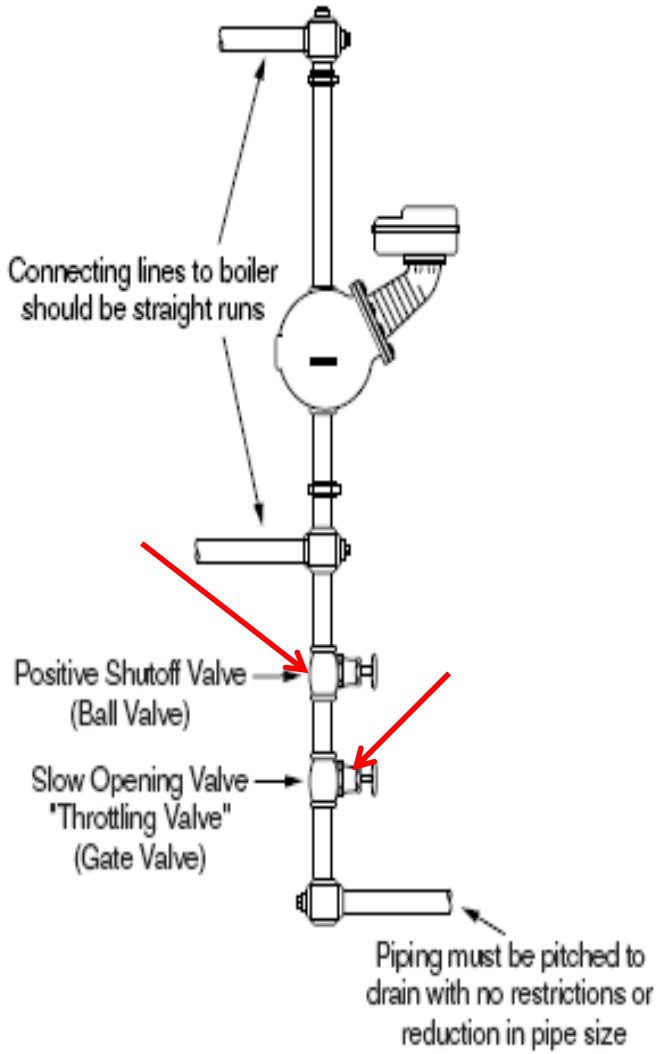
Test the Low Water Cutoff

- Monitor water level in the gauge glass
- Burner must shut off when water level reaches the marking on the casting of the Low Water Cutoff
- If burner does not shut off at the low water cutoff point:
  - Turn the burner switch off
  - Cool down the boiler and inspect the Low Water Cutoff

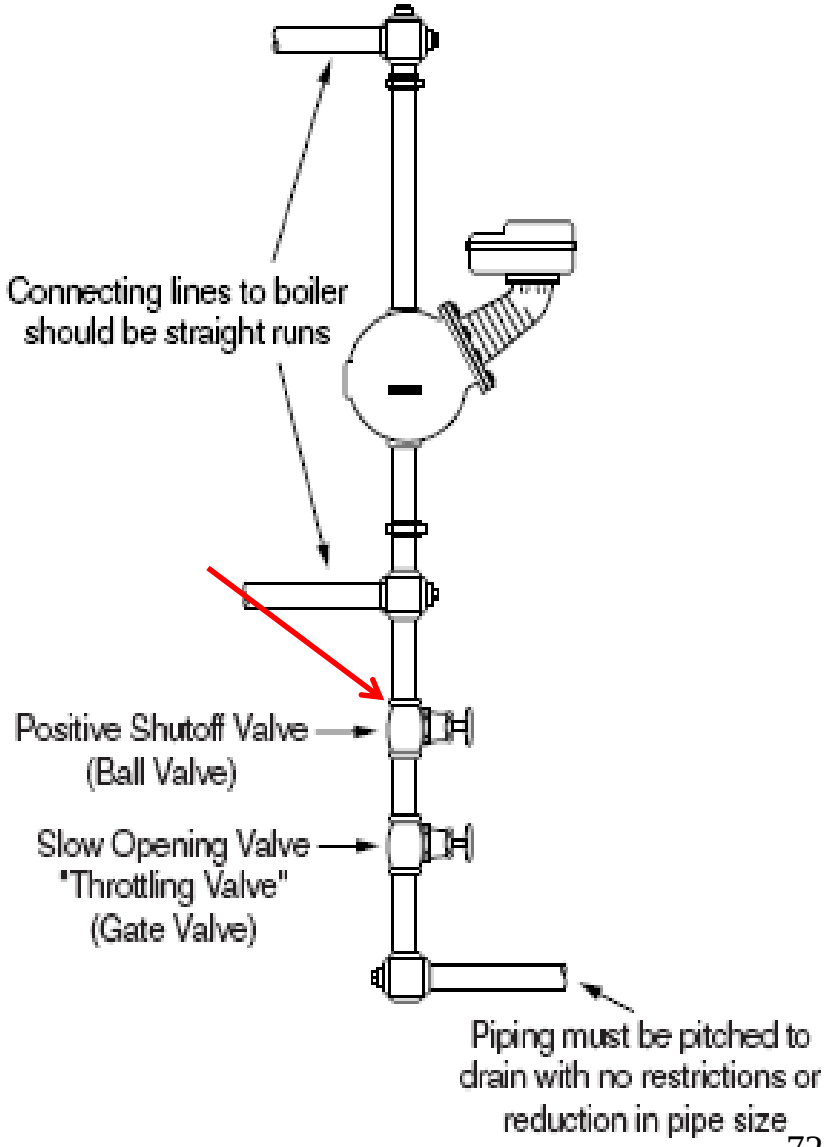
Test the Low Water Cutoff

- Evaporation
  - Boiler steams off naturally
- Under constant attendance and burner at low fire:
  - Stop feedwater flow to the boiler
    - Shut off pump
    - Close a valve - Use caution
- Alternative
  - Slow drain test with bottom blow.

1. With water in the boiler at its normal level, open “Positive Shut-off Ball Valve”.
2. Open “Throttling Gate Valve” slowly until drair piping heats up and then open fully. Observe that the water level starts falling in the gauge glass.
3. Close “Throttling Gate Valve” after verifying that the pump contacts have closed and the burner contacts have opened thus shutting down the boiler. **Note: If this does not happen, immediately close all** valves, turn off burner and correct the problem.



4. Close “Positive Shut-off Ball Valve”.
5. Observe that the water level returns to its normal level.



Low Water Cutoff

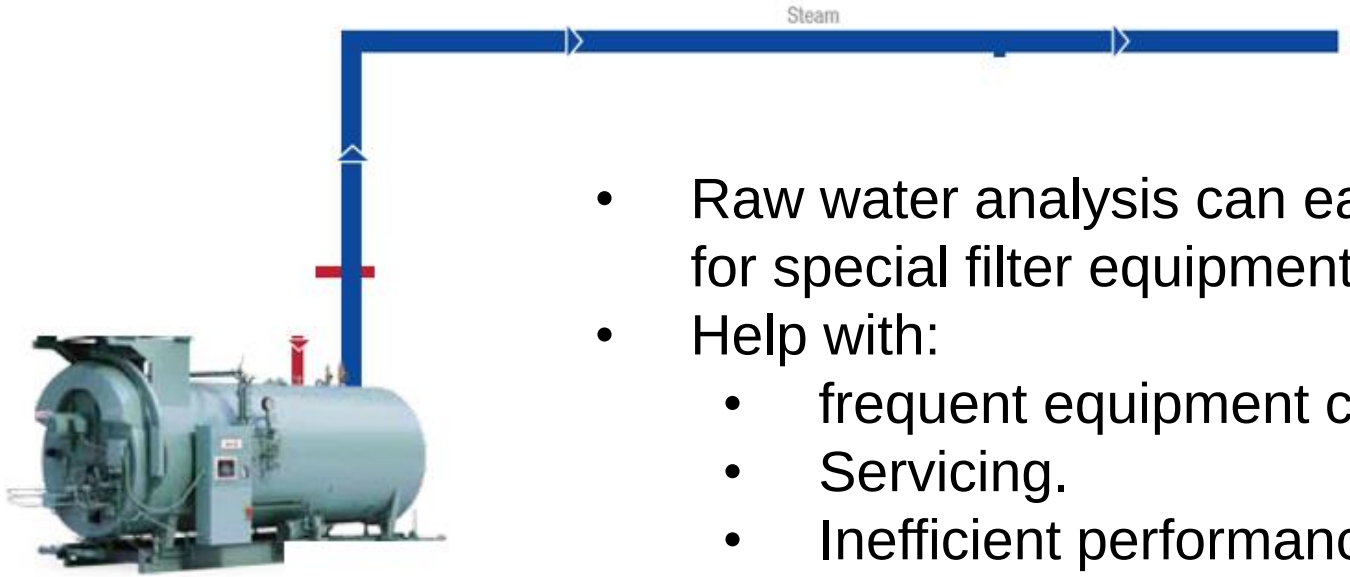
- Boiler running and no water visible in the gauge glass
  - SECURE WATER SUPPLY TO THE BOILER - DO NOT LET ANY WATER GET INTO THE BOILER
  - Shut off burner
  - Cool down boiler, open it up and inspect for damage

Steam System Components

System Efficiency

- Typical losses
  - Blowdown
  - Venting/steam leaks
  - Wasting condensate
  - Radiation
    - Piping
    - Tanks
    - Boilers

Water Filter

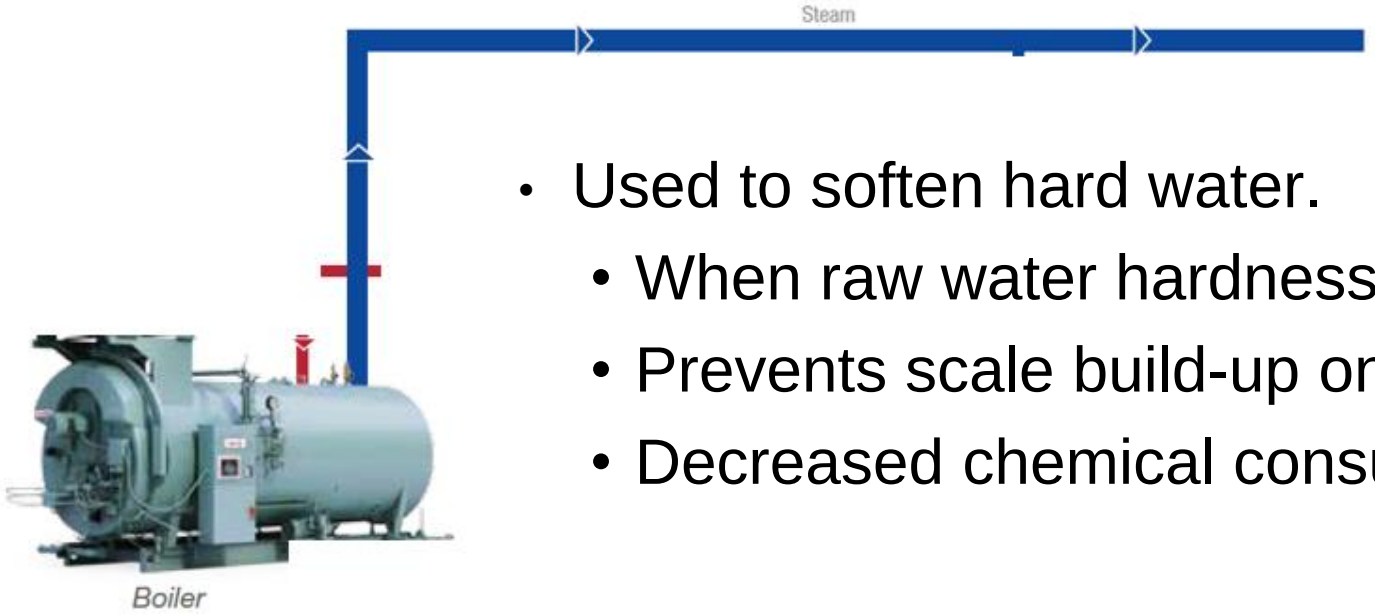


Boiler

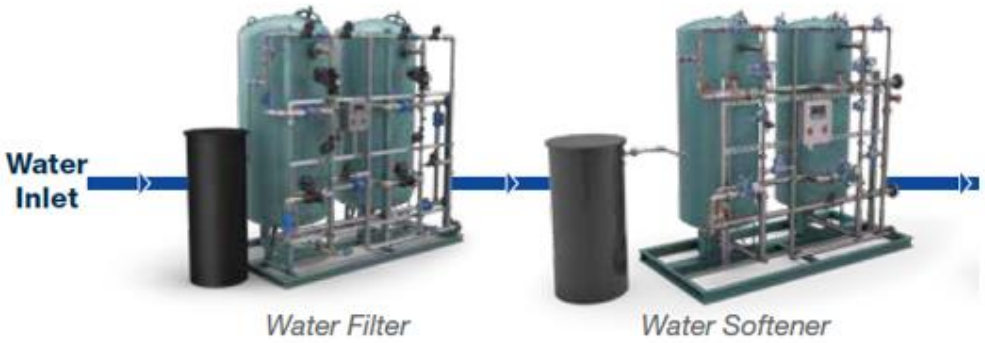
- Raw water analysis can easily determine the need for special filter equipment for removal of impurities.
- Help with:
  - frequent equipment cleaning.
  - Servicing.
  - Inefficient performance.
  - Damage to system components.
  - Premature equipment failure.

Water Filter

Water Softener



- Used to soften hard water.
  - When raw water hardness exceeds 5 ppm.
  - Prevents scale build-up on heat transfer surfaces.
  - Decreased chemical consumption.

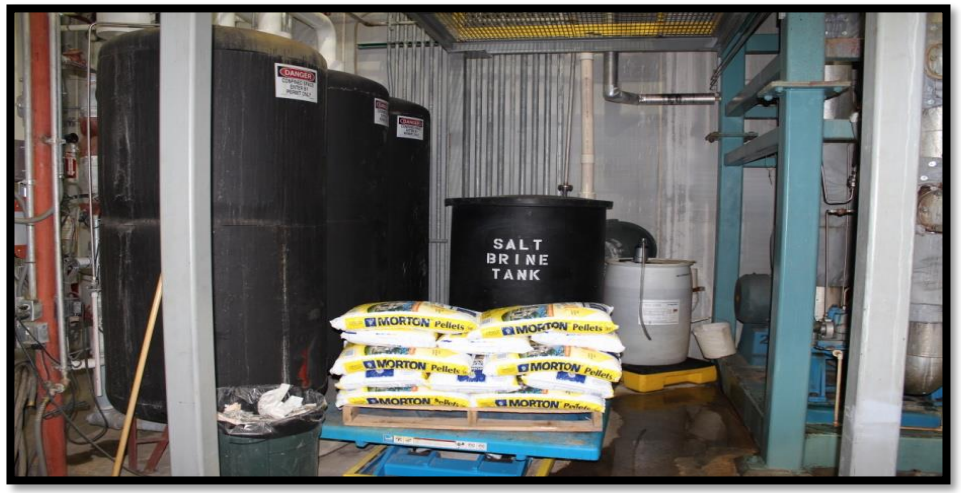


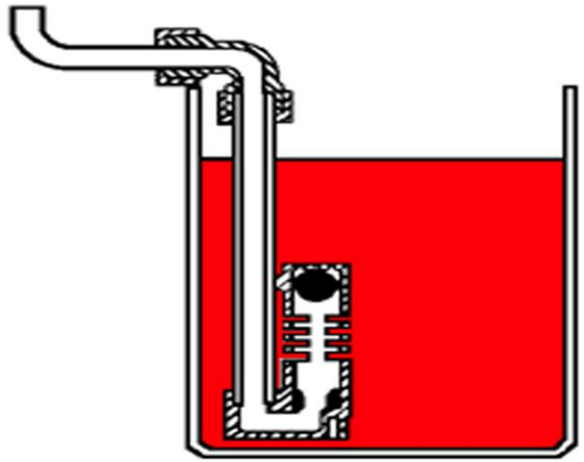
Water Softener

- Removes hardness using the sodium zeolite process.
  - Ion exchange process.
  - Replaces hardness with highly soluble sodium ions.
- Requires regeneration.
- Available in single, twin, or triple units.

Brine Tank

- Salt required.
  - 15 Lbs per cubic foot of resin.
- Salinity.
  - 98% In brine tank.
- 50% During brine draw.
- Use pelletized salt.
  - 99.5% Purity or better.
- Rock salt.
  - Get Sludge build up.
- Granulated salt.
  - Requires a Platform screen.

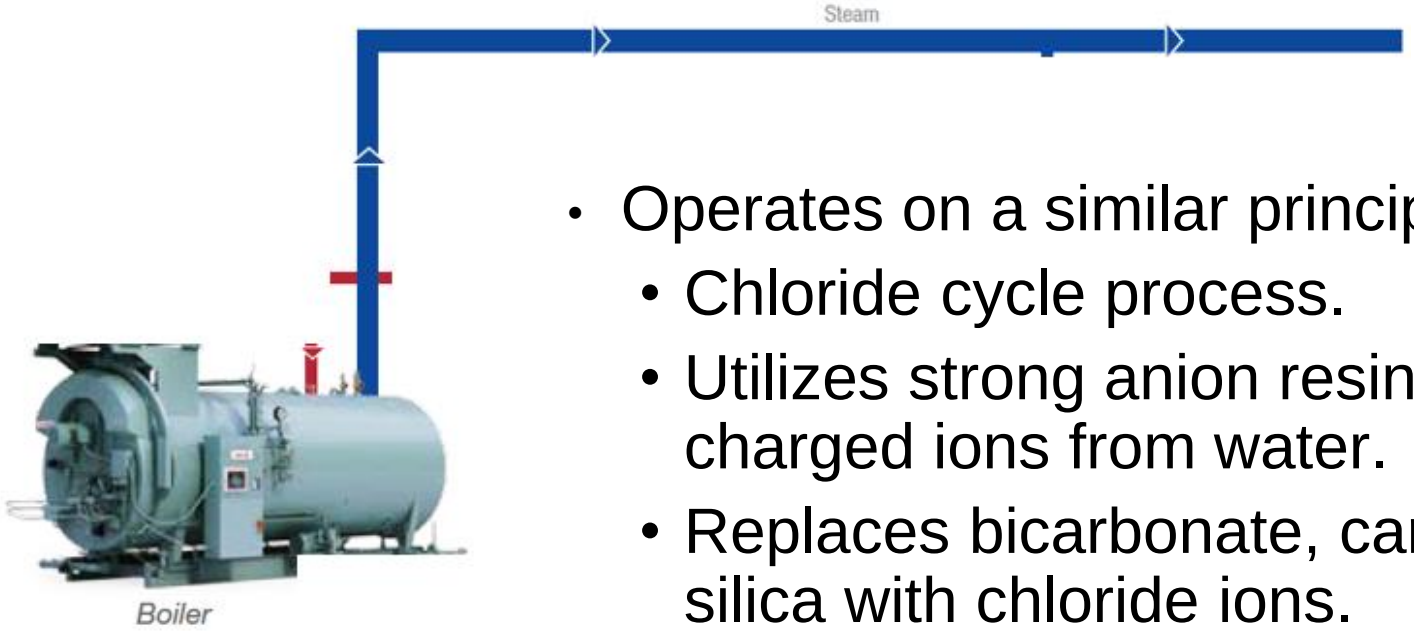




Brine Tank

- Brine.
  - 6 To 8 hours to make.
- Water level.
  - 1/4" To 3/4" above platform.
  - Contact of water with salt.
  - Higher level uses more salt.

Dealkalizers

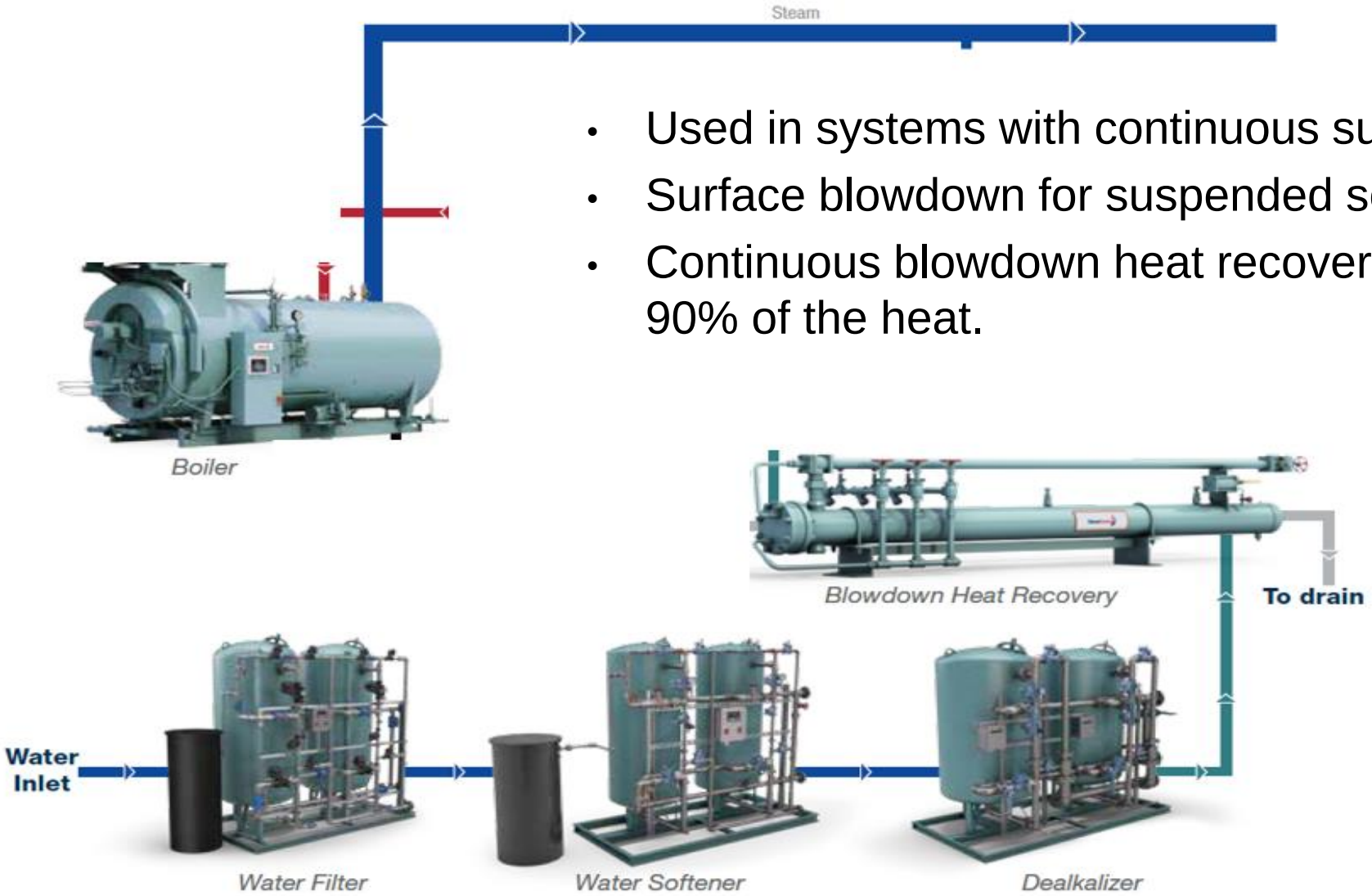


- Operates on a similar principle to the water softener.
  - Chloride cycle process.
  - Utilizes strong anion resin to remove negatively charged ions from water.
  - Replaces bicarbonate, carbonate, sulfate, nitrate, and silica with chloride ions.

Dealkalizers

- Reduces bicarbonate alkalinity.
  - Minimizes carbon dioxide production which is a major cause of condensate line corrosion.
  - Decreases chemical consumption.
  - Lower blow down rates/reduces fuel consumption.

Blowdown Heat Recovery



- Used in systems with continuous surface blowdown.
- Surface blowdown for suspended solids.
- Continuous blowdown heat recovery systems can reclaim 90% of the heat.

Blowdown Heat Recovery

- Up to 22 gpm blowdown.
- Up to 180 gpm makeup.
- Continuous boiler surface blowdown heat recovery (BDHR) is the most effective method of purging destructive solids from any steam boiler system.

Blowdown Heat Recovery

- System is automatic.
  - Regulates blowdown flow to accommodate the boiler's make-up water loads.
  - Potential increase of suspended solids.
  - Maintains preheat temperature of make-up water.
  - Continuous boiler surface blowdown heat recovery (BDHR) is the most effective method of purging destructive solids from any steam boiler system.

Blowdown Savings

- 500 Hp load (17,250 #/hr)
  - 2000 ppm TDS in boiler
  - 200 ppm TDS in make-up
  - 50% make-up (8625 #/hr)
  - Blowdown rate 1.92 gpm (960 #/hr)
- At 100 psi operating pressure
  - Recover 2.5 therms/hr (90% recovery)
    - At 80% boiler efficiency – 3.1 therms per hour saved
  - Increases make-up water temperature 26^{o}F

Heat Recovery Savings

6.0 Calculations of Heat Recovery and Savings

6.1 Net MU at Normal Steaming Rates =

= (normal lbs/hr) x (1 - condensate returned)

= (para 2.4) x (1 - para 2.10)

= (17,250) x (1 - 0.5) = 8625 lbs/hr

6.2 Normal BD = (Net MU) / (C-1) = (para 6.1) / (para 3.1)-1 = (8625) / (9) = 958 lbs/hr

6.3 Heat Recovery Efficiency = Use para 6.2 and refer to efficiency curves

Para 5.0 = 0.9

6.4 Heat Recovery = (efficiency) x (normal BD lbs/hr) x (operating temp-MU temp) / 100,000

= (para 6.3) x (para 6.2) x (para 2.7 - para 2.8) / 100,000

= (0.9) x (958) x (338 - 50) / 100,000 = 2.5 therms/hr

6.5 Energy Saved

= (heat recovered) ÷ (boiler efficiency)

= (para 6.4) ÷ (para 2.11)

= (2.5) ÷ (0.8) = 3.1 therms/hr

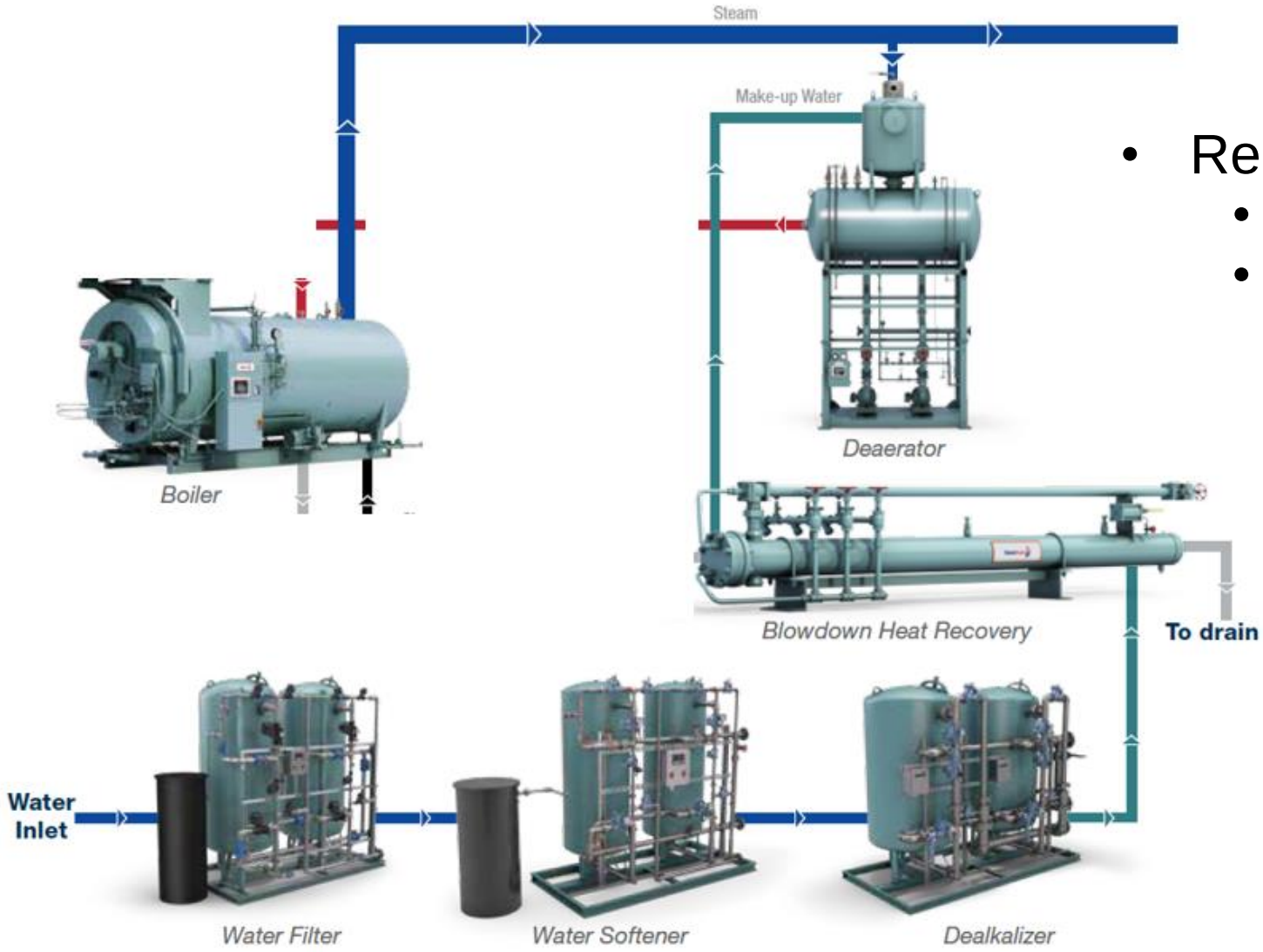
6.6 $ Savings/Year

= (energy saved) x (operating hrs/yr) x (fuel cost/therm)

= (para 6.5) x (para 2.9) x (para 2.14 gas or oil)

= (3.1) x (4800) x (.45) = $6696 /yr

Boiler Feed Systems & Deaerators



- Removes:
  - Oxygen
  - Carbon dioxide

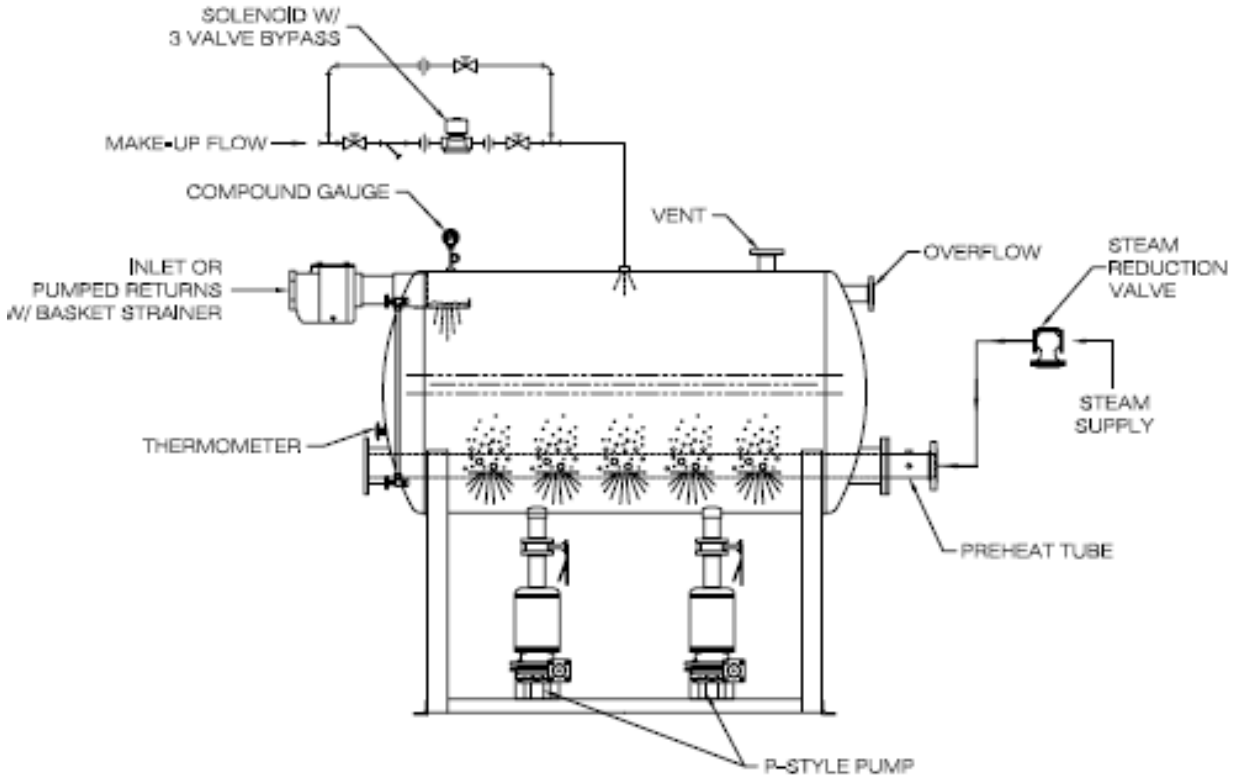
Packaged Feed Systems & Deaerators

Packaged Feed System

- Atmospheric tanks.
  - 180 To 200^{O} F range.
  - 210^{O} F maximum.
- Steel tanks.
  - If epoxy-lined it is not field repairable.
- Size of tank.
  - What is the required storage capacity.

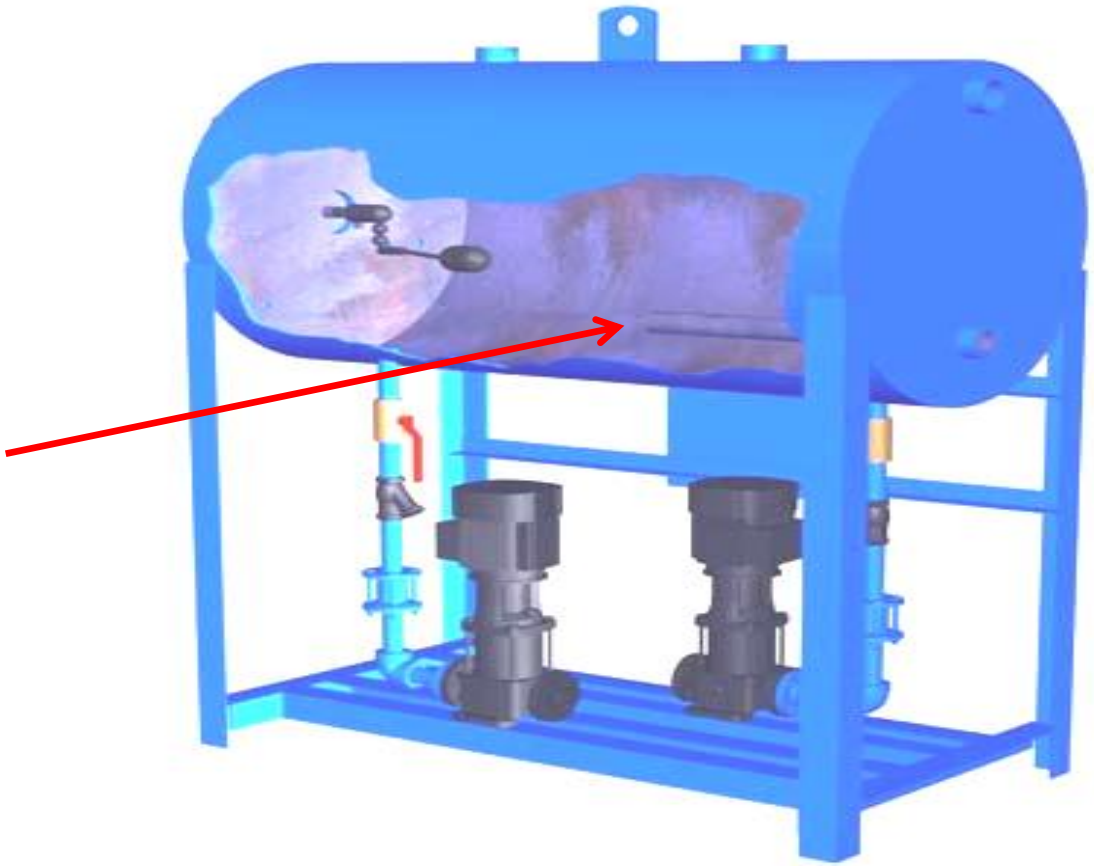
Packaged Feed System

- High temperature condensate return diffuser.
- Steam pre-heat diffuser.
- Tank pressure.
  - Atmospheric.
  - Venting.
  - Cause lining damage or tank failure



Packaged Feed System

- Stand height
  - What is NPSH required for the pump
- Can include
  - Pumps and motors
    - What is the overall system
  - Gauge glass
  - Make up valve
  - Thermometer
  - Steam sparge tube



Packaged Feed System

The primary cause of failure is vessel corrosion due to high levels of raw water make up in a vessel using a steam sparge tube to heat the feed water in the vessel.

If oxygen corrosion caused the vessel to fail in 3 or 4 years, you should consider replacing the vessel with a corrosion resistant vessel.

The initial higher cost of a stainless-steel replacement vessel will be offset by its extended life.

Deaerator

- Why remove oxygen?
  - Oxygen pitting in boiler.
- Oxygen can be reduced by chemical treatment.
  - May not be cost effective.
  - Increased boiler blowdown.
  - Chemical costs.

Corroded Boiler Tubes

Firetube

Watertube

Holes

Blisters

Types Of Deaerators

- Packed column type.
- Spray type.
- Tray type.
- All operate under the same principle

Deaeration Methods

- Mechanical – Agitation.
- Heating – Separation.
- Scrubbing – Removal.

Heat

Agitate

Liberate

Packed Column DA

- Water spray head.
- Column packed with stainless steel rings.
- Storage tank.

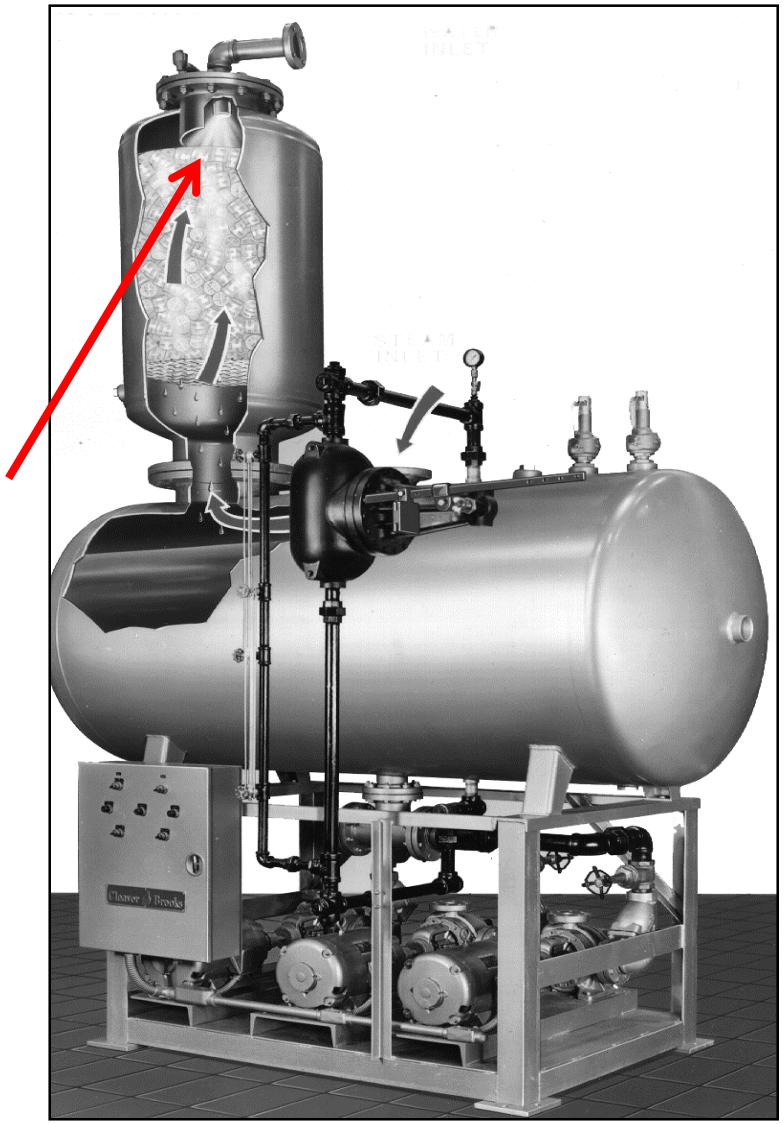
Deaerator Operation

- Water enters the top through a spring loaded, self-cleaning spray nozzle which sprays the water into the vent condensing section.
- The temperature of the water is raised to within 2 or 3 degrees of the saturated steam temperature here.
- Approximately 90% of the deaeration is done at this point.

Deaerator Operation

When the water drops into the storage tank, it is at the zero oxygen level and at full saturation temperature of the steam at the operating pressure.

The released non-condensable gases are vented to atmosphere at the top of the column.

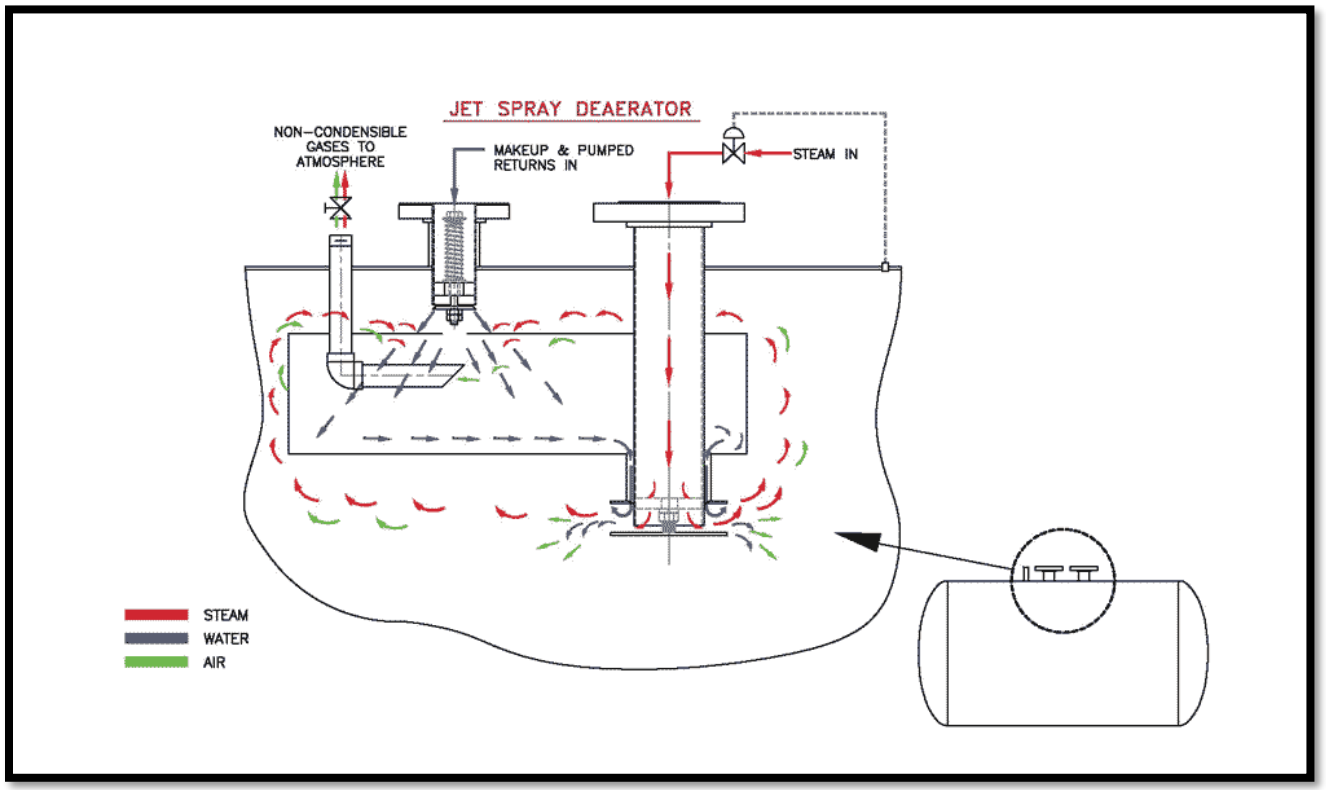


Spray Type

Spray Type

Best stand-alone application is less than 30% condensate return and loads that are **constant**.

For system exceeding 30% condensate return, this system frequently is paired with a surge tank.

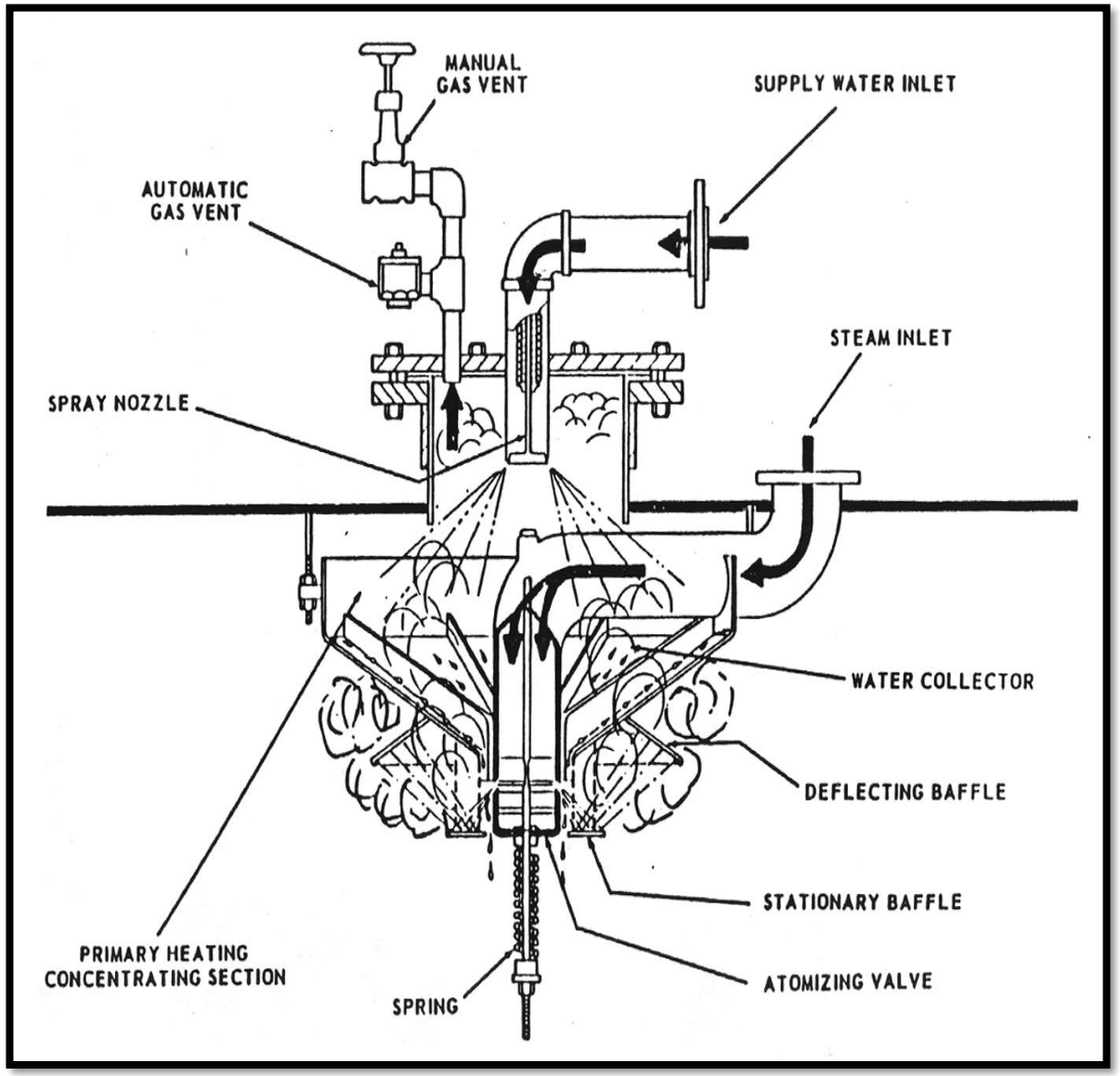


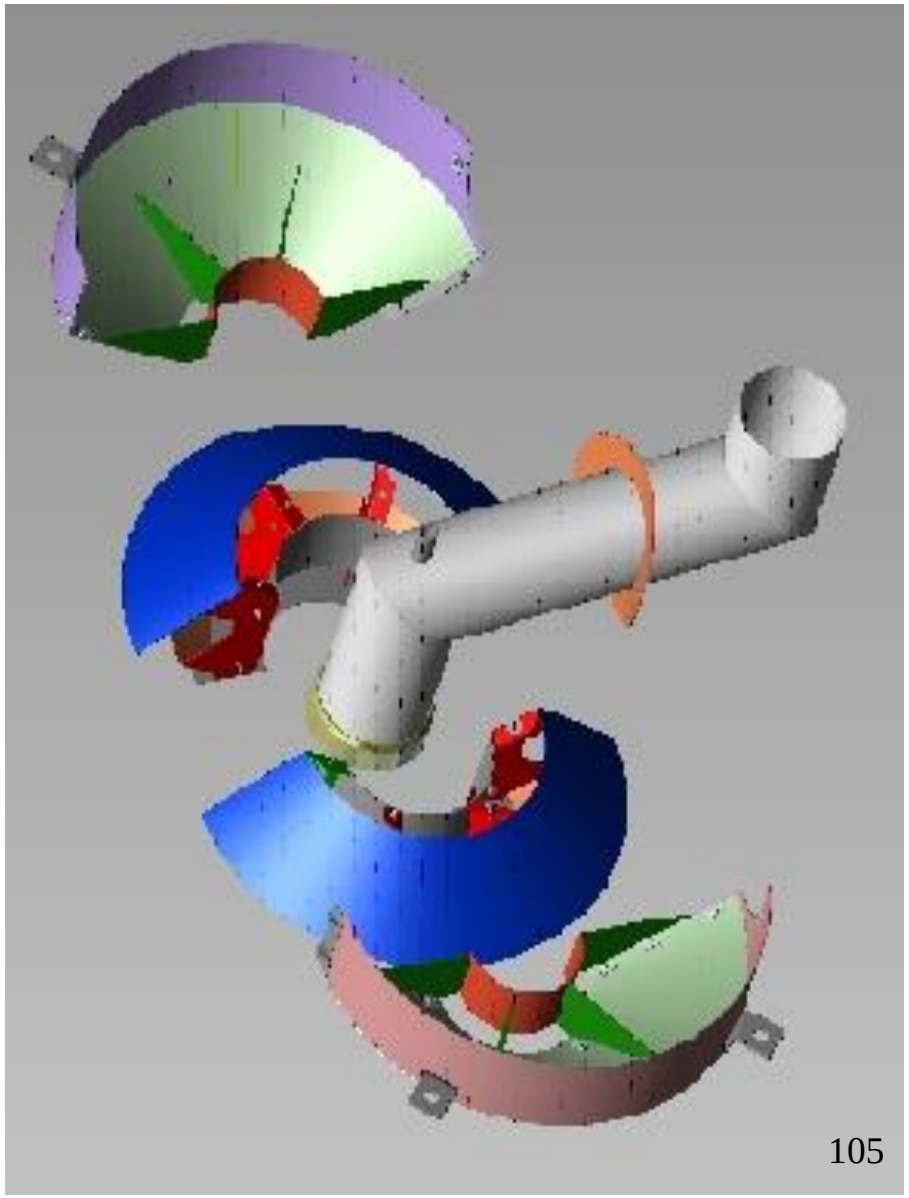
Spray Type DA

- Internal collector cone assembly
- Steam spray valve
- Water spray valve
- Storage tank

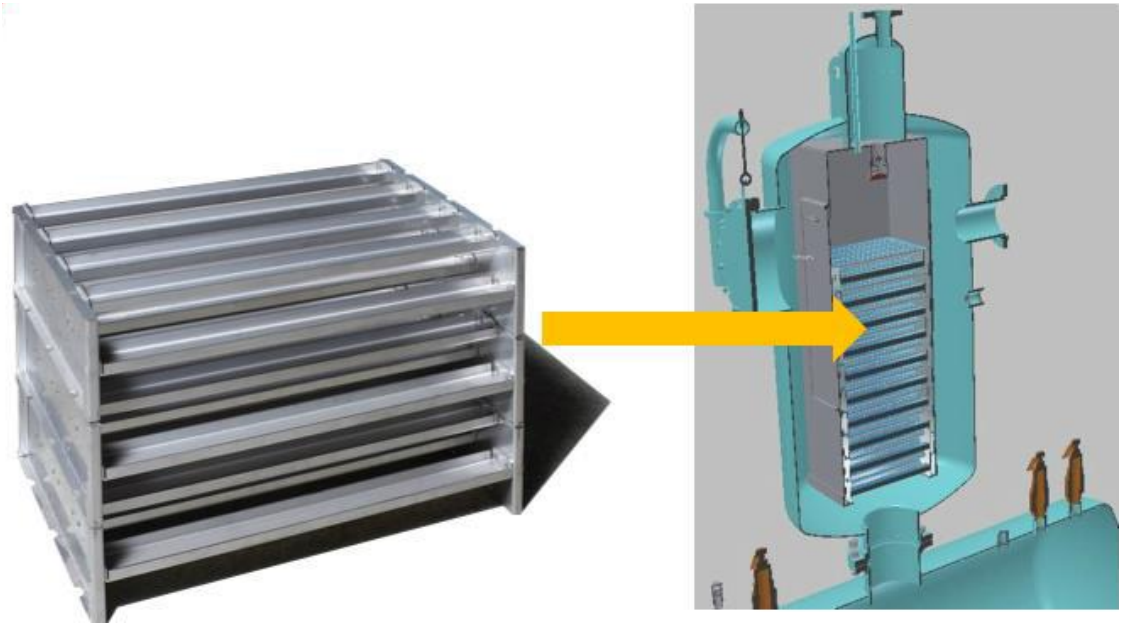
Internal Cone Assembly

- Check cone assembly.
- Check spring tension.
- Refer to manual.


MANUAL
GAS VENT
SUPPLY WATER INLET
AUTOMATIC
GAS VENT
STEAM INLET
SPRAY NOZZLE
WATER COLLECTOR
DEFLECTING BAFFLE
STATIONARY BAFFLE
PRIMARY HEATING
CONCENTRATING SECTION
SPRING
ATOMIZING VALVE

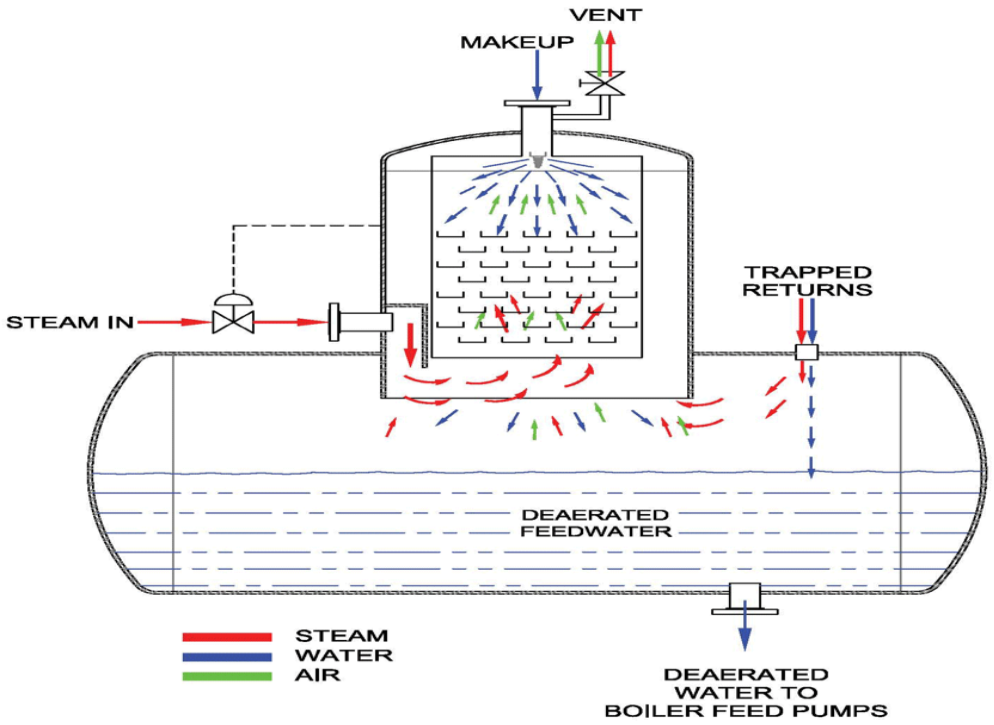


Tray Type



Tray Type

- Applications range from large power industry to small commercial buildings.
- Best application is when condensate return is less than 50% and loads are constant.

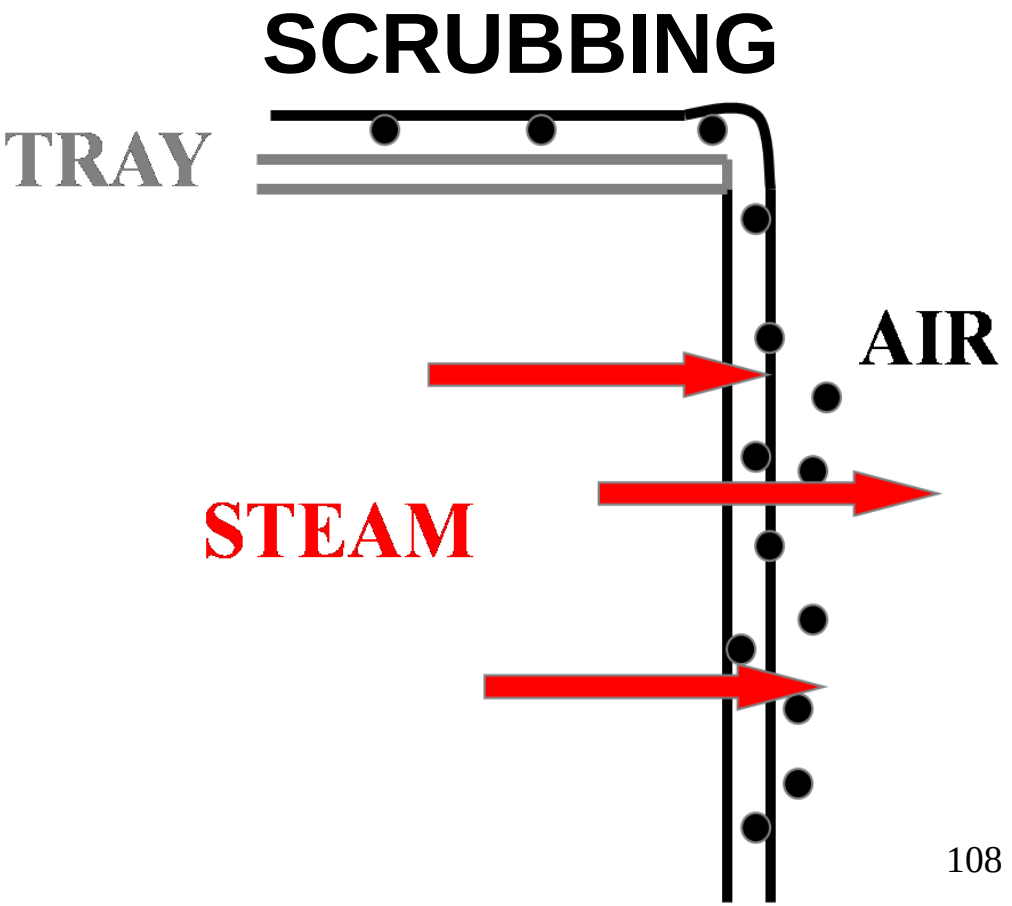


TRAY THEORY

Thin water film reduces gas bubble surface tension.

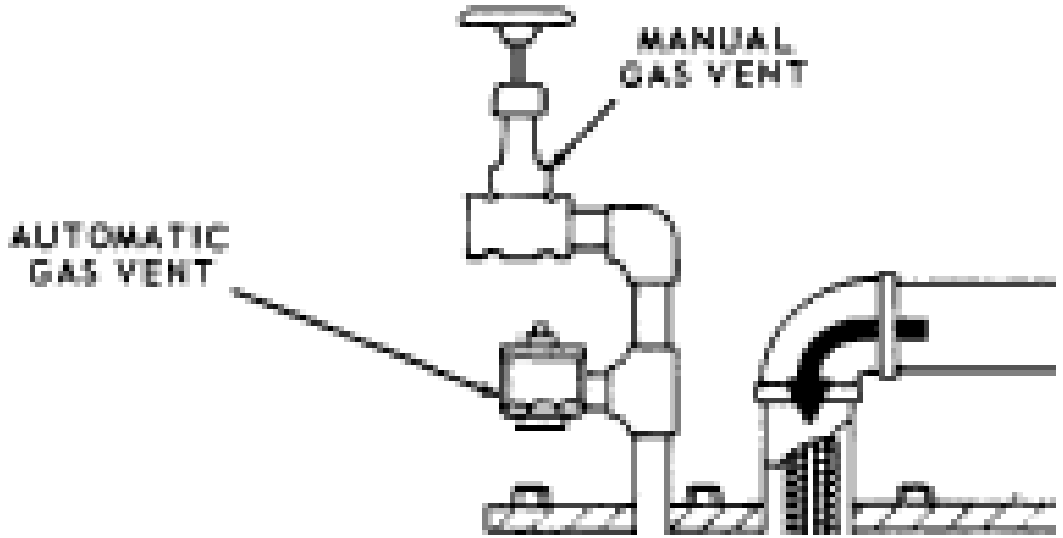
Helps bubble exit liquid.

THIN FILM



OPERATION FOR ALL DA TANKS

- Gas vent is sized by the Manufacturer.
- Do not replace vent valve with a standard valve.
- Typical plume is 24”.
- 1/10 of 1 % capacity.



Advantages & Disadvantages

Type	Advantages	Disadvantages
Spray	• Head room • Weight • Price • Capacity	• Mechanical components • Critical adjustments to steam nozzle • Limited HP returns
Column	• DA consistency • Reliable • HP returns	• Head room • Weight • Limited capacity • Price
Tray	• DA consistency • Reliable • HP returns • Highest capacity	• Head room • Weight • Price

Deaerator

- Removes dissolved gasses.
  - Oxygen (O_2).
  - Carbon dioxide (CO_2).
- Heats water to:
  - 227^{O} F @ 5 psi of pressure in tank
- Typical oxygen reduced to:
  - .005 cc / liter.
  - 7 Parts per billion.
  - Depends on manufacturer.
- Storage of feed water & recovery of condensate.
- Provides a NPSH to pump.
- Improves equipment longevity.

Deaerator

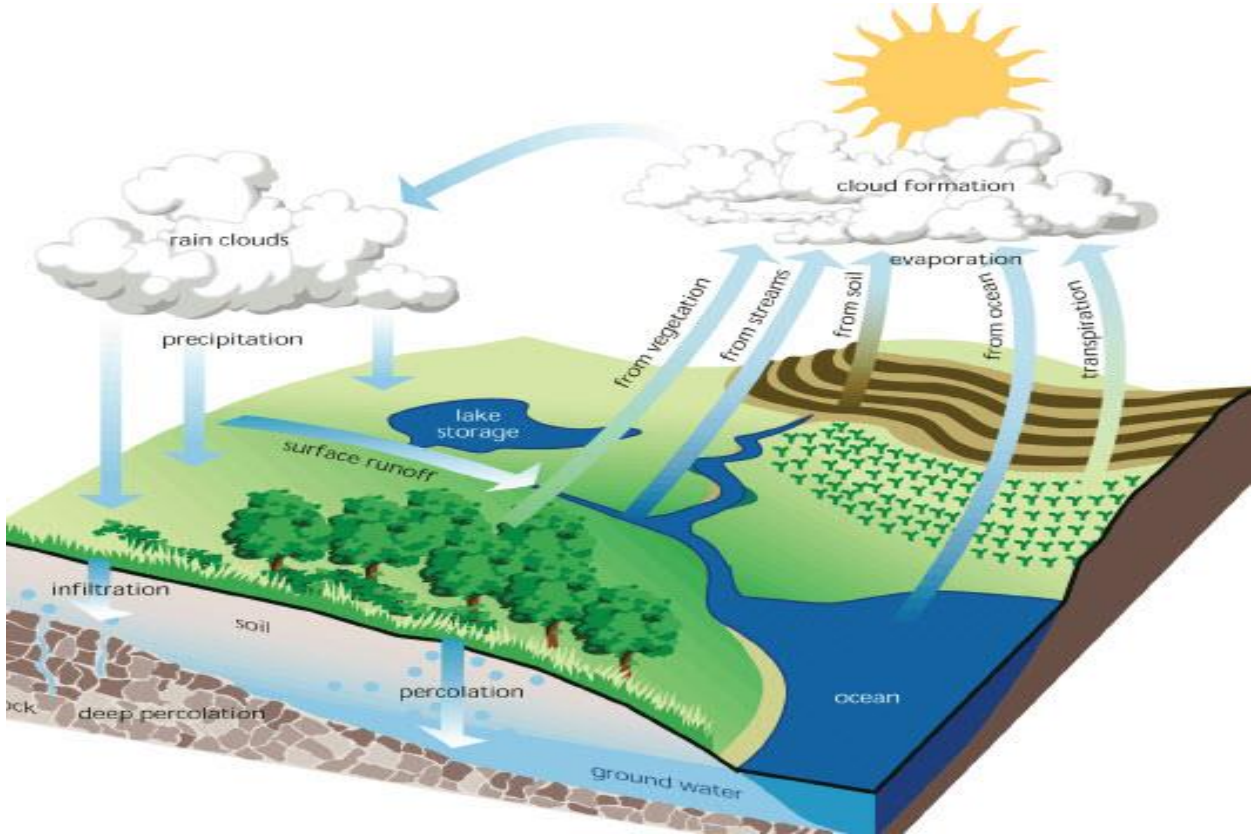
- Carbon dioxide removed to:
  - Practical zero.
- Why remove carbon dioxide.
  - Help reduce corrosion in condensate return lines.
- Treat condensate return lines.
  - Filming amines.
  - Neutralizing amines.

Deaerator

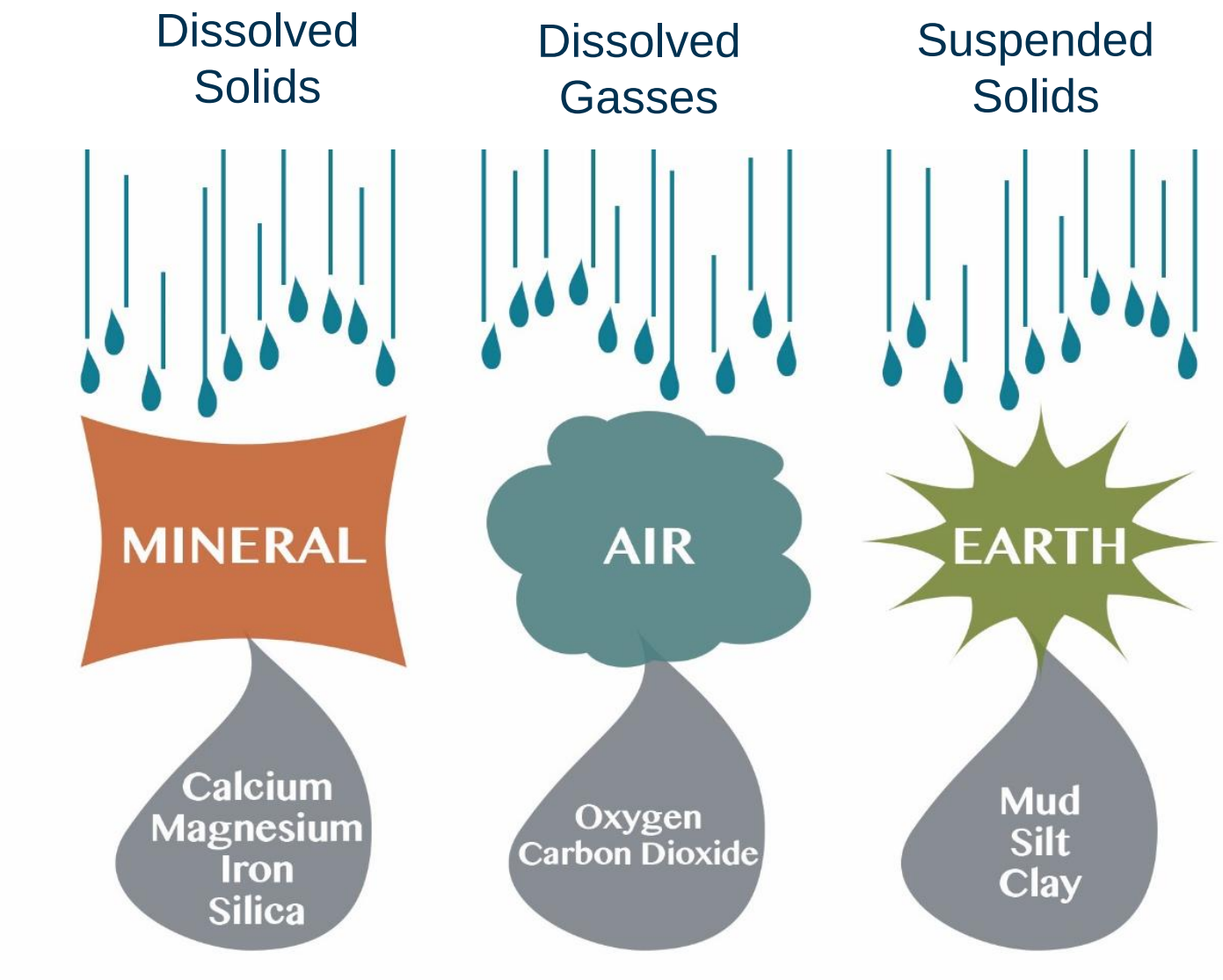
- When should a deaerator be considered:
  - Operating pressure at 75 psi and over
  - Plants with limited stand-by capacity
  - Plants with 25% or more cold water make-up
  - Plants where production depends on continuous boiler operation

The Hydrologic Cycle

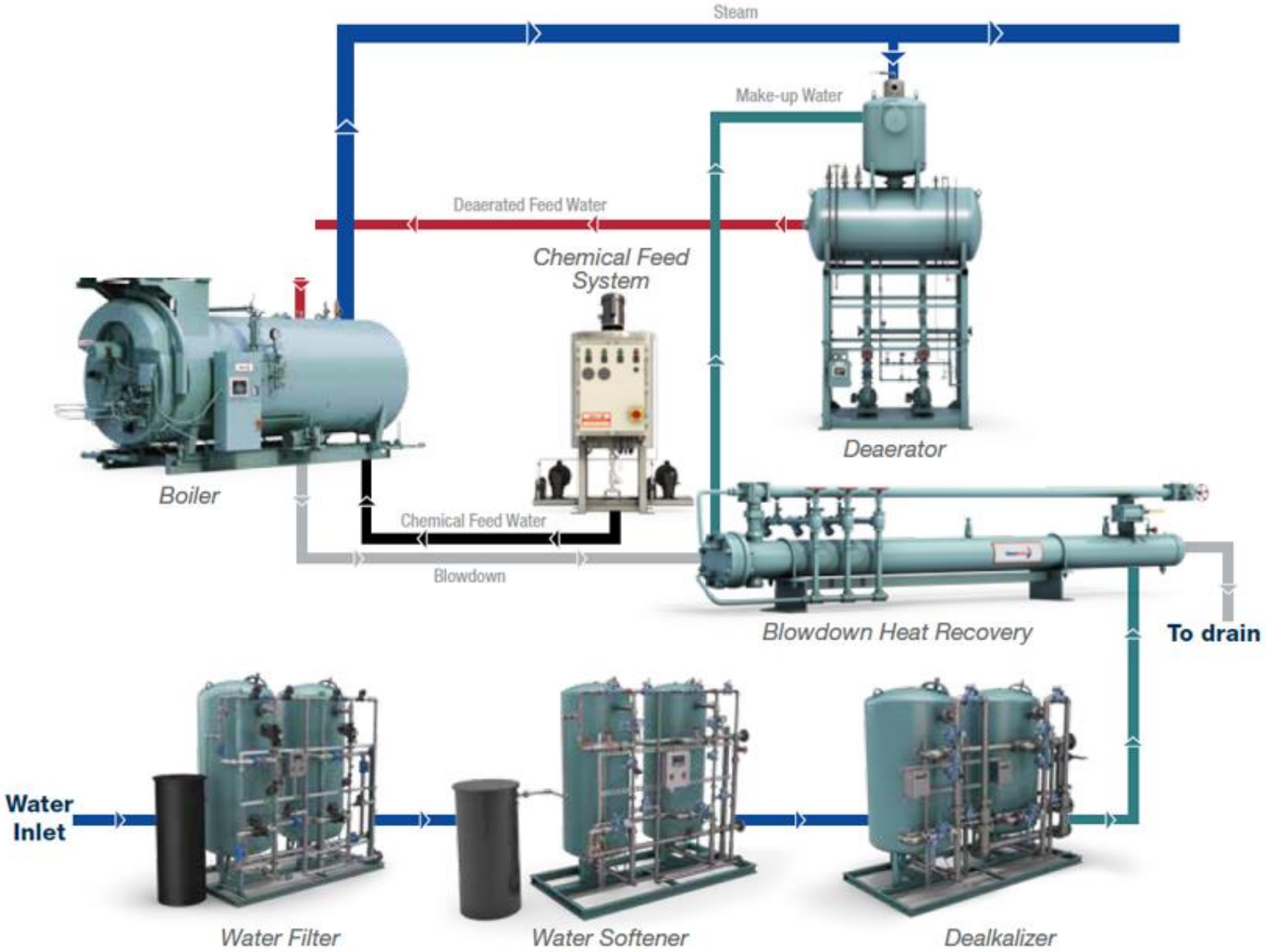
- Water evaporates from:
  - Plants, soil, streams and the ocean.
  - Then condenses to form clouds.
- Water falls to the surface as rain or snow.
  - Some of the water forms rivers and flows back to the oceans.
  - Some of it percolates down through the soil to the zones of saturation.
- Why do we care?
  - That ground water is put into the boiler as makeup water.



Water the Universal Solvent



Chemical Feed System



Chemical Feed System

- Located between deaerator and boiler.
- Two types of chemical feed systems.
  - Manual shot feeder.
    - Smaller boiler plants.
    - Batch type of feed system.
    - Closed loop or low make-up water system.
  - Chemical feed system/metering pumps.
    - More complex systems.
    - Inject chemicals at a predetermined rate.
    - Generally used for oxygen removal and ph adjustment to prevent deposits/corrosion.

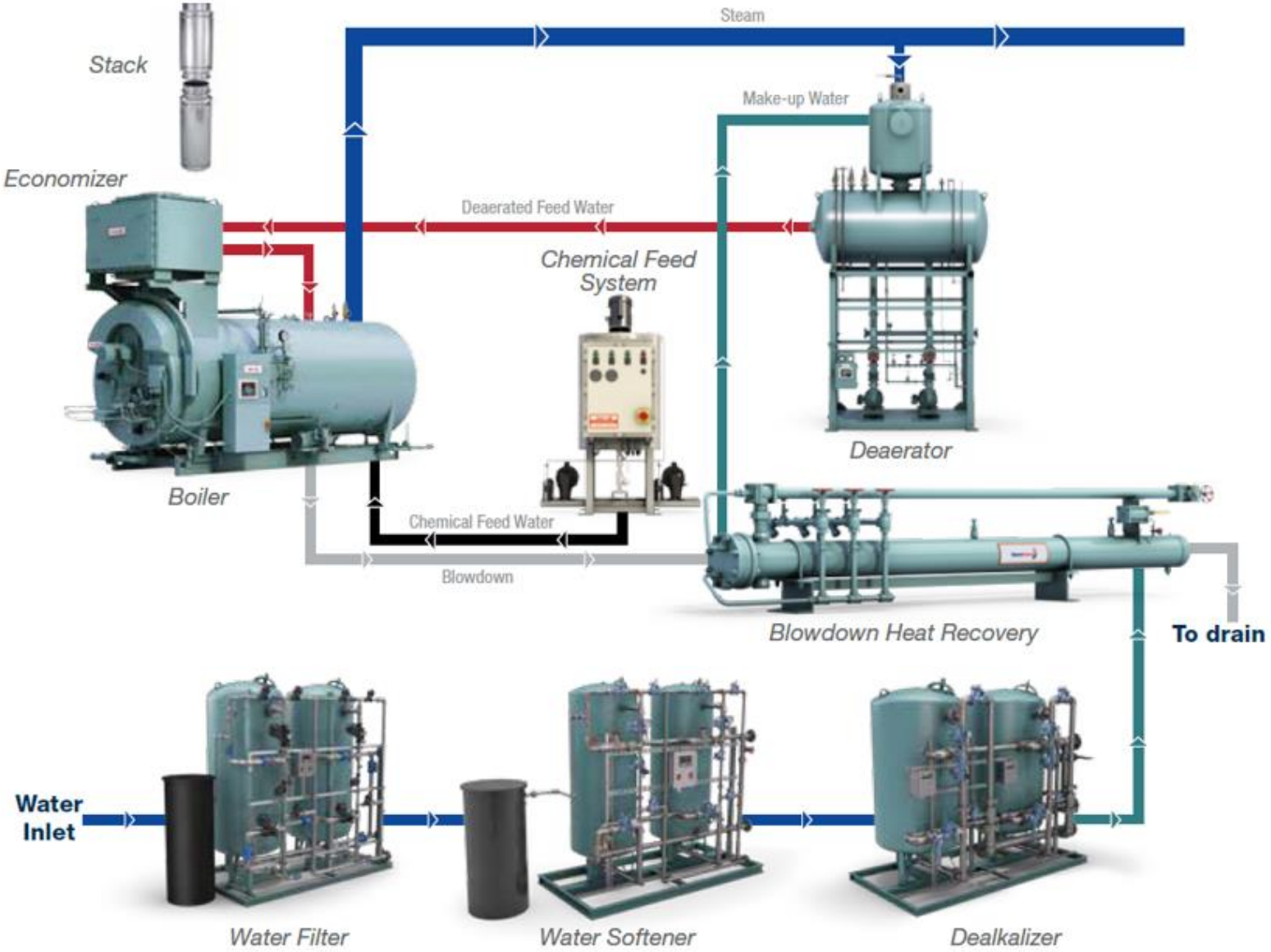
Sample Cooler

- Used when obtaining daily samples of boiler water to test treatment.
- Located on the surface blowdown line.
- Makes it possible to obtain a sample without shutting down the boiler.
- Enables a sample to be drawn at a low pressure.
- Cools the boiler water sample to a temperature that is acceptable to use with the water testing equipment.

Blowdown Separator

- Located on the bottom blowdown and/or surface blowdown line.
- Sediment and heavy solids will migrate to bottom of boiler.
- Total dissolved solids (TDS) will be suspended on the surface.
- Boiler must be blown down to prevent build-up of harmful solids leading to sludge.
- After cooler reduces the temperature of the bottom blowdown to a temperature safe for the sewer system.

Economizers



Economizers

- Heat exchanger utilizing the exhaust gas heat to pre-heat boiler feedwater or possibly another process requiring heated water.
- Preheats feedwater to a higher temperature than delivered from the deaerator.
- Finned tube heat exchanger.
- Increases overall system efficiency (2% - 4%)

Condensing Economizers

- Recover sensible and latent heat.
- Saturation temperature.
- Natural gas ~135ºF.
- Condense on natural gas only – impurities in other fuels.
- Applications – water temperature less than ~120ºF.
  - Cold make-up water.
  - Process flow (lower temperature)
  - Hot water return.

2 Stage Condensing Economizers

- 2 Stages
- 1st stage – sensible heat recovery
- Standard (non-condensing) economizer
- 2nd stage – sensible and latent heat Condensing economizer
- Condense on natural gas only
- Applications 1st stage
- Preheat boiler feedwater
- On/off feedwater control
- 2nd stage
- Any cool liquid stream (50-120ºF)
- Make-up water
- Process water

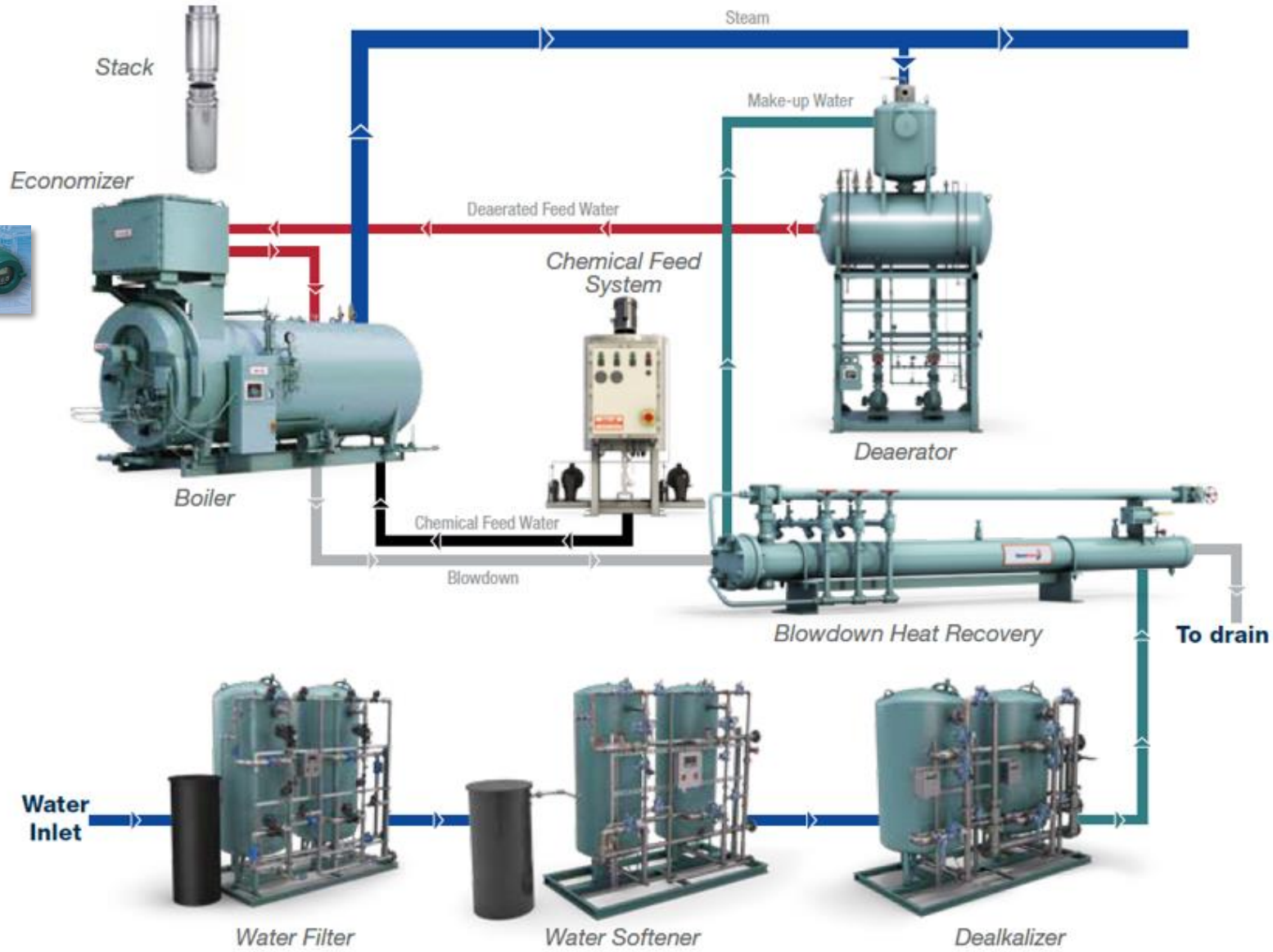
Economizer Savings

- 500 Hp boiler
  - 400°F stack temperature
  - 220°F feedwater temperature
  - 509,000 Btu/hr recovered heat
  - Feedwater temperature
    - 29.5°F rise
  - Flue gas temperature – 305°F

Economizer Savings

- 509,000 Btu/hr recovered heat
- Boiler originally 80% efficient
  - 636,250 Btu/hr less input
  - 6.4 therms per hour saved
- Using stack loss chart
  - 100^{o}F drop in stack temperature is 2.5% to 3.0% efficiency change

O2 Trim Systems



Steam Traps

Steam Traps

- The job of the steam trap is to get condensate, air and CO_2 out of the steam system as quickly as they accumulate.
- They must provide:
  - Minimal steam loss
  - Long life and dependable service
  - Corrosion resistance
  - Air venting
  - CO_2 venting
  - Operation against back pressure
  - Freedom from dirt problems

Steam Traps

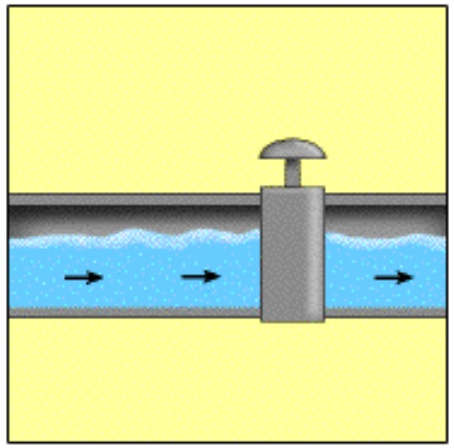
A steam trap consists of one or two self-actuating valves that remain closed in the presence of steam, but open to discharge non condensable gases, air and condensate.

Effects of Condensate in a Steam System

- Condensate lacks latent heat, so it always has a lower heat content than the steam from which it was formed.
- Incompressible as a solid. If a mass of water is accelerated, it can exert a great deal of force when it strikes another object.
- Collects on the bottom of steam lines, out of the flow path, so it requires some external means, like gravity for instance, to move it through the system

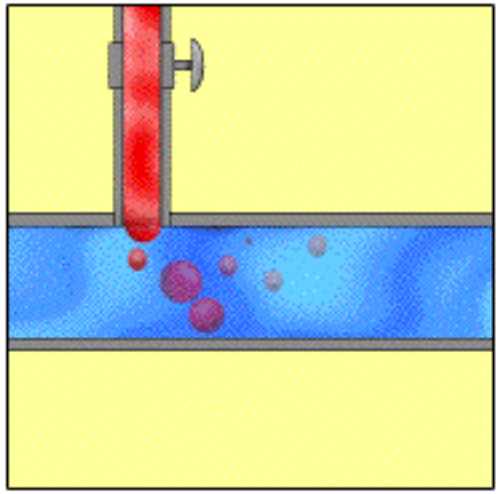
Hydraulic Shock

- You may have experienced this effect in your home when you slam the water faucet closed a little too forcefully and you hear a distinct hammering sound from your pipes.
- This same effect can occur in a steam system whenever a manual or automatic valve is slammed shut in a flooded line.
- If the valve suddenly impedes a flow of condensate, a portion of that flow is reversed, causing a pressure wave that reflects off the piping and off equipment until its force is dissipated.



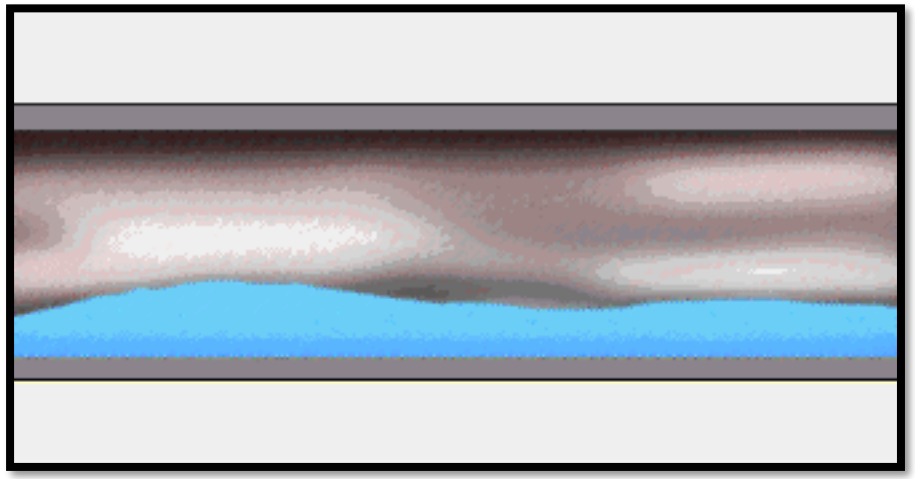
Thermal Shock

- This kind of shock is temperature related.
- Thermal shock can occur when steam is discharged into a body of cool condensate.
- A void is instantly created as the steam condenses. Liquid rushes into the void, colliding in the center, causing shock waves through the condensate, and the resulting waves collide with piping and equipment until the energy is depleted

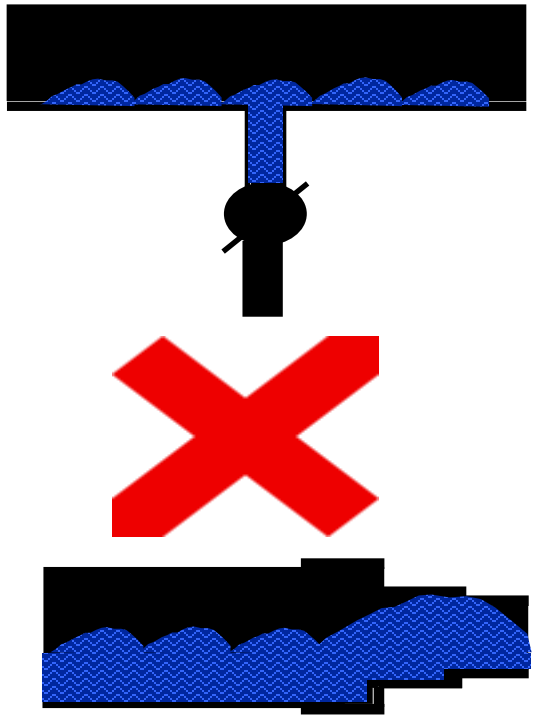


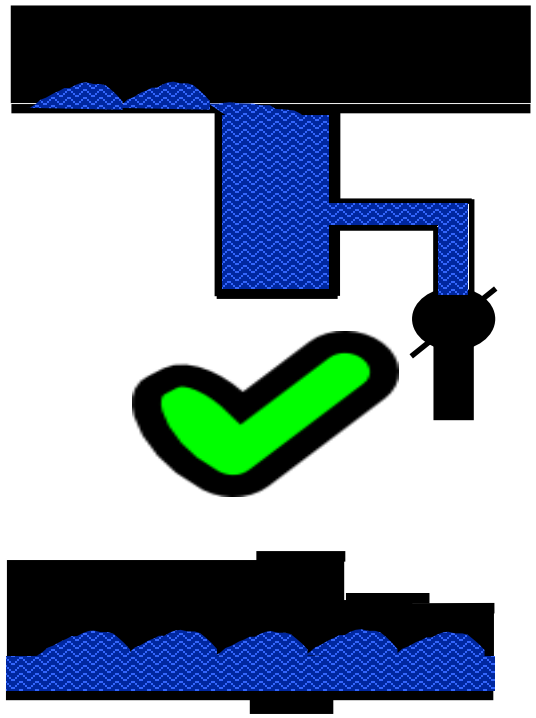
Differential Shock

- This kind of shock is temperature related.
- Thermal shock occurs when steam is discharged into a body of cool condensate. A void is instantly created as the steam condenses.
- Liquid rushes into the void, colliding in the center, causing shock waves through the condensate, and the resulting waves collide with piping and equipment until the energy is depleted.



Steam Traps





Make sure trap is piped correctly

Steam Traps

- Pressure upstream of the trap must be higher than the pressure downstream.
- If pressure upstream gets lower than the downstream pressure, the system could pull a vacuum.
- A vacuum breaker may be required.

Trap/Operator Types

Thermodynamic

Steam (flash) –flow operates valve

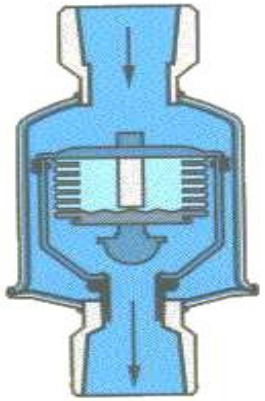
Mechanical

Use difference in density between steam and condensate to operate valve. A float operates the valve.

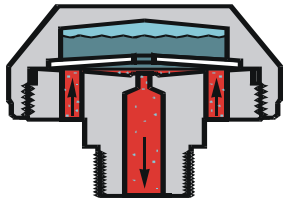
Thermostatic

Sense temperature change of condensate to operate valve

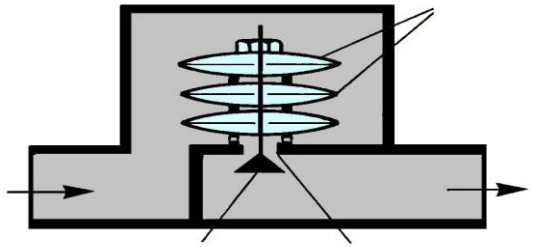
Thermostatic Trap Types



- Bellows balanced pressure
  - High capacity

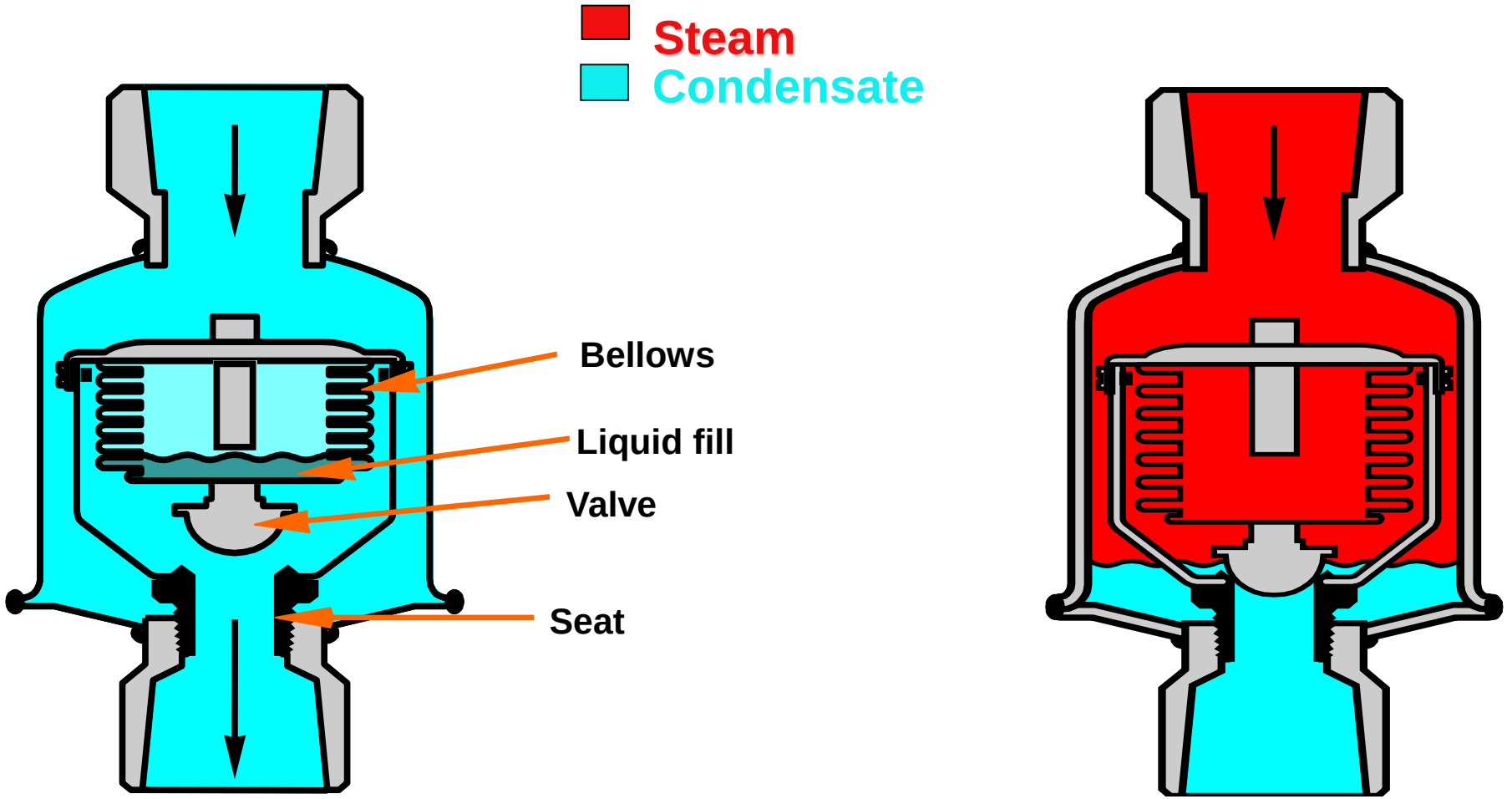


- Wafer/Diaphragm balanced pressure
  - Low capacity



- Bi-metallic
  - High and low capacity

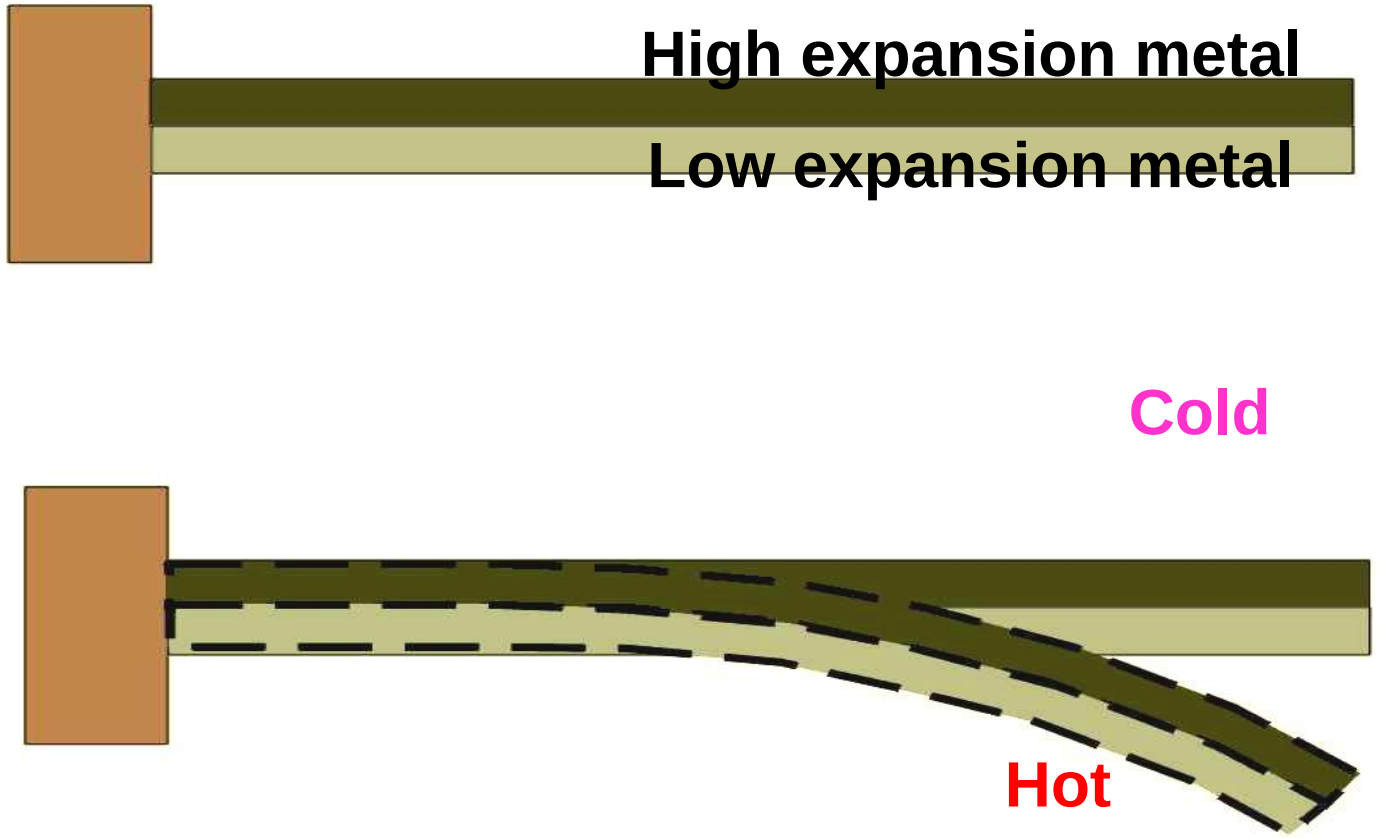
Bellows Balanced Pressure



Bellows Balance Pressure

	Bellows Balance Pressure			
Modulation	Poor			
Backpressure	Good			
Dirt	Fair			
Wear	Fair			
Water Hammer	Poor			
Freezing	Good			

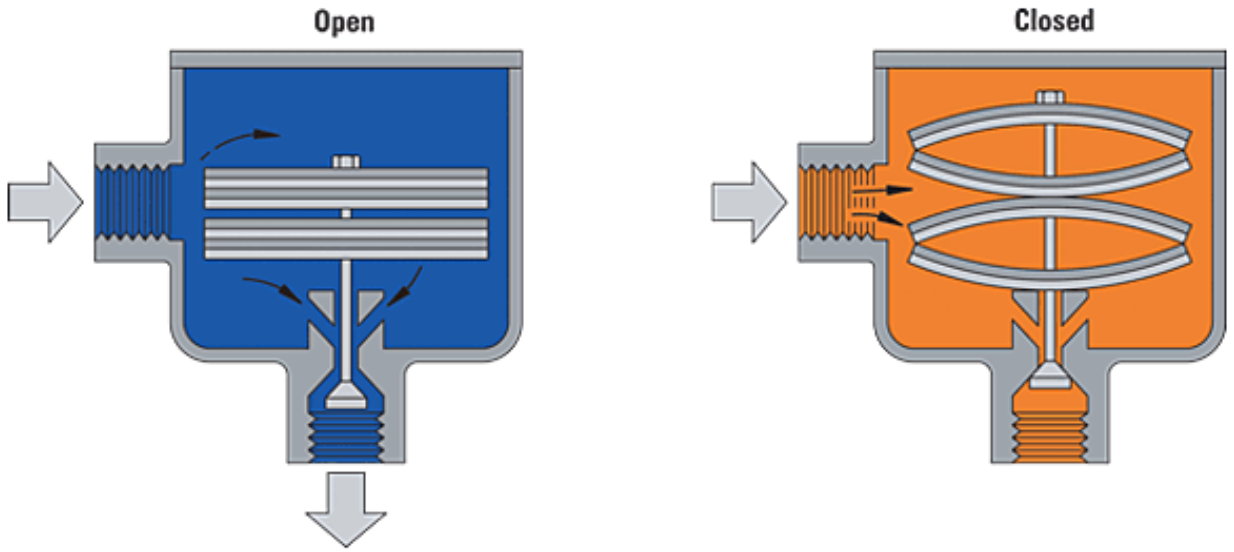
Simple Bi-Metal Element



Bi-Metal Disks

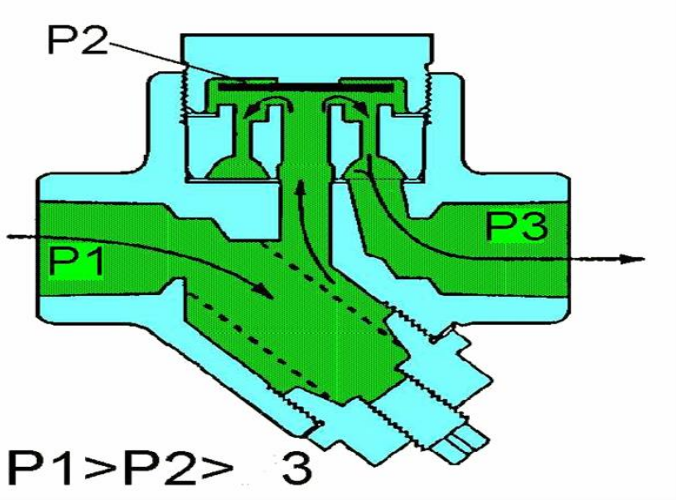
Valve in outlet

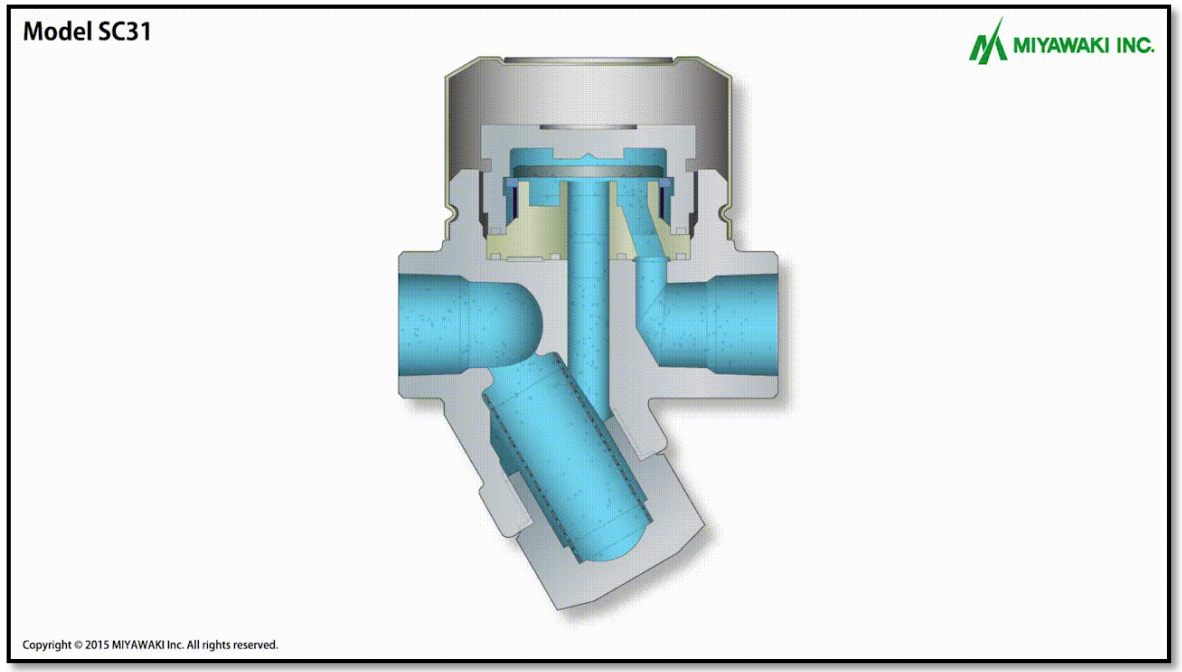
- Pressure opposes closing.
- Does not toggle.
- Some thermodynamic action; roughly follows steam saturation curve.
- Acts as check valve when pressure is lost.
- Good for use in super-heated applications.



Disk Trap Operation

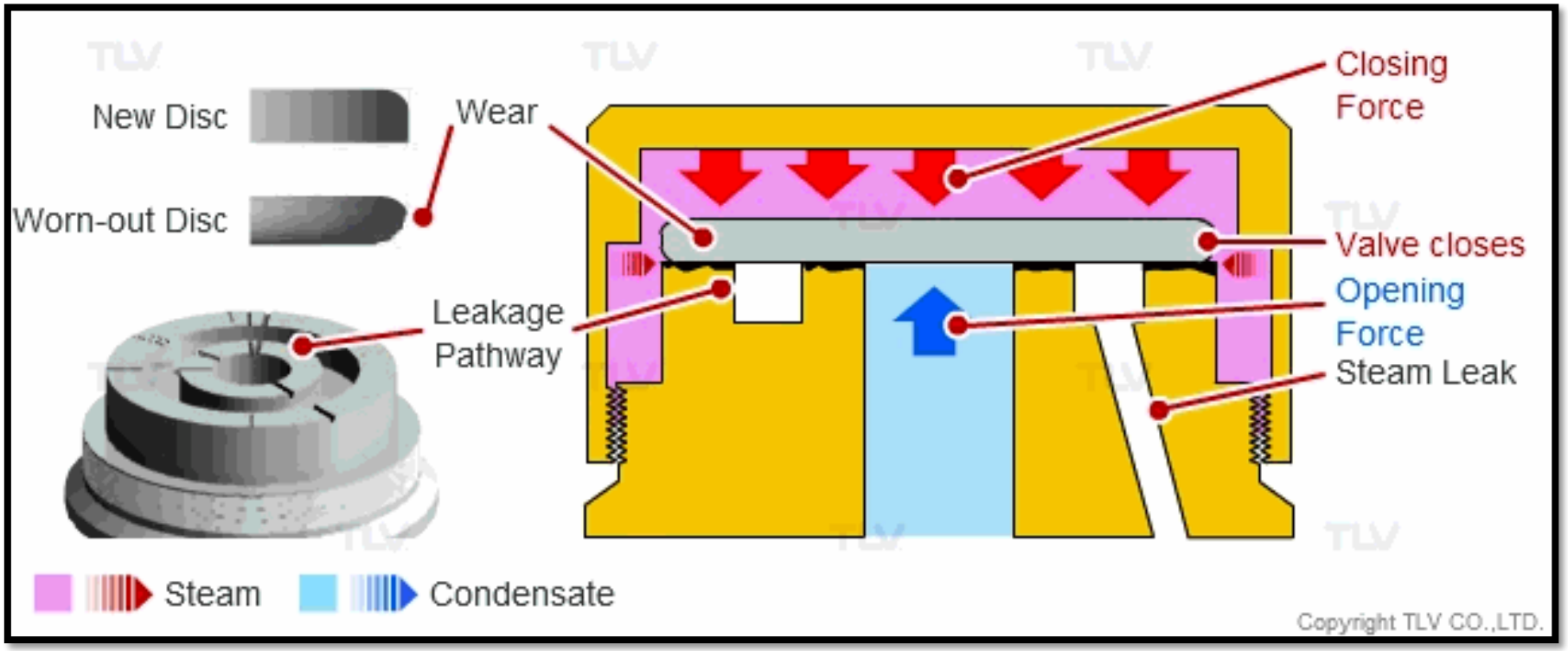
- When steam rapidly flows under the valve disc, the pressure under the disc decreases.
- The valve disc is then "pushed" onto the valve seat because of the greater pressure within the chamber. This closes the valve.
  - This steam acting to open and close the valve is known as Control Steam.





Disk and Seat Wear

- Disk slammed hard onto seats and rolls as it seats.
  - Edge of disk and outer seat ring wears rapidly.
- High velocity flow of condensate flash steam and dirt between disk and inner seat ring.
  - Inner seat ring wears and disk surface erodes rapidly.

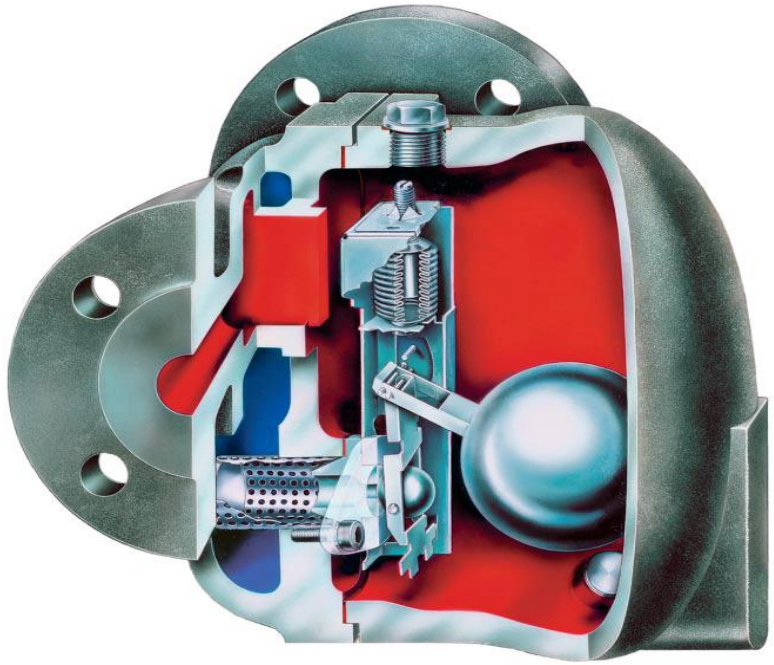


Thermodynamic Traps

	Bellows Balance Pressure	Thermodynamic Traps		
Modulation	Poor	Fair		
Backpressure	Good	Poor		
Dirt	Fair	Poor		
Wear	Fair	Poor		
Water Hammer	Poor	Good		
Freezing	Good	Good		

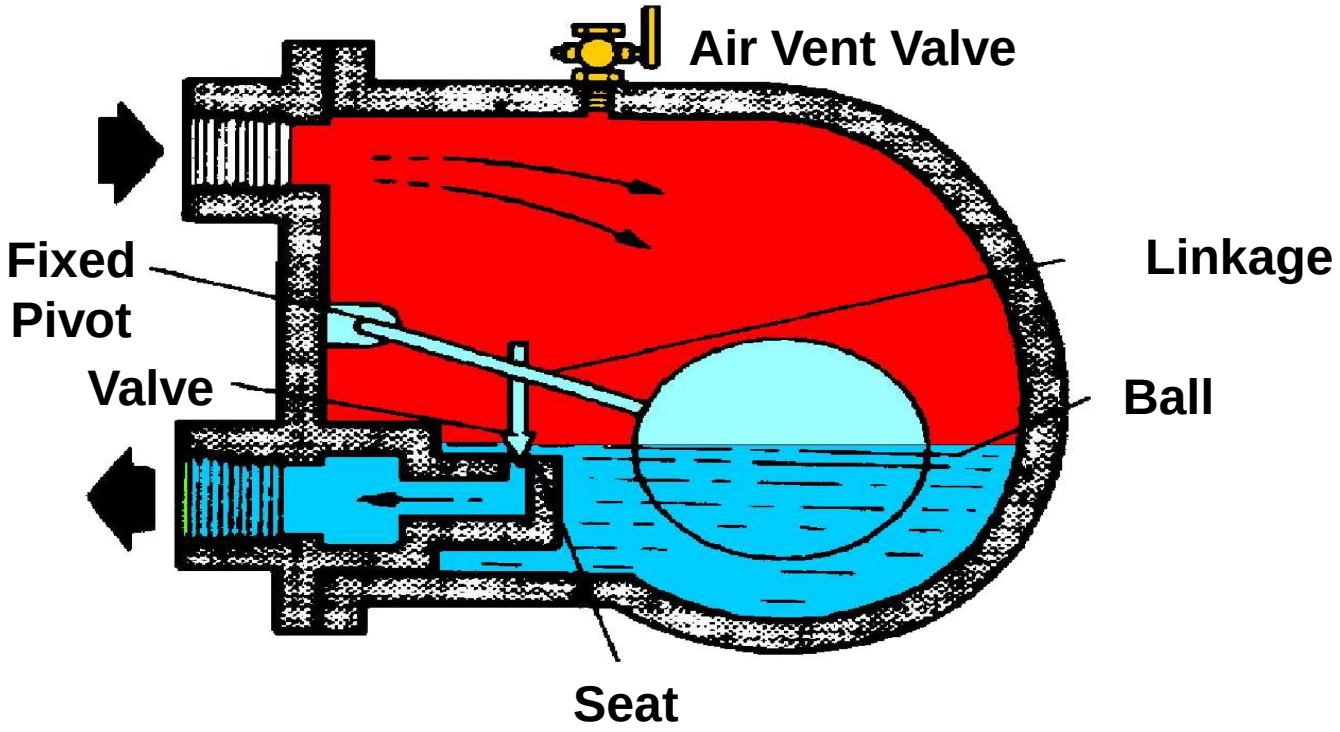
Mechanical Steam Traps

- Float and thermostatic is a mechanical trap that operates on both density and temperature principles.
- Float and thermostatic traps provide high air-venting capacity and are suitable for both industrial and HVAC applications.

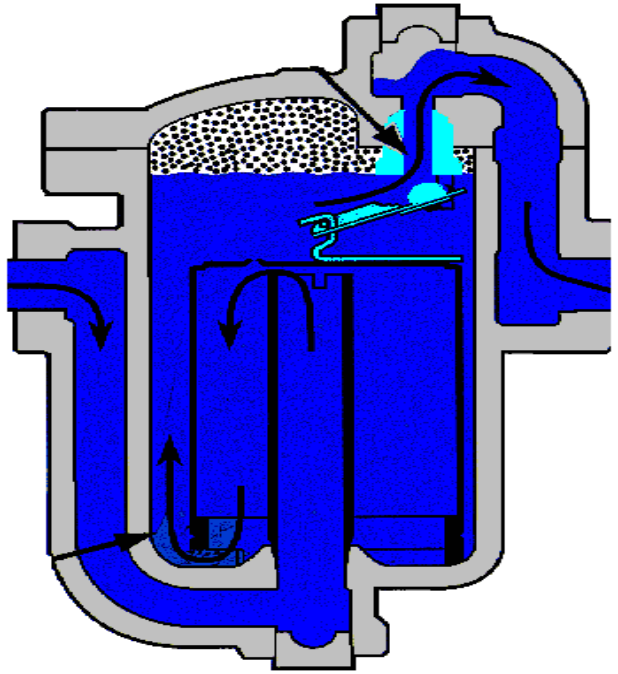


Mechanical Types

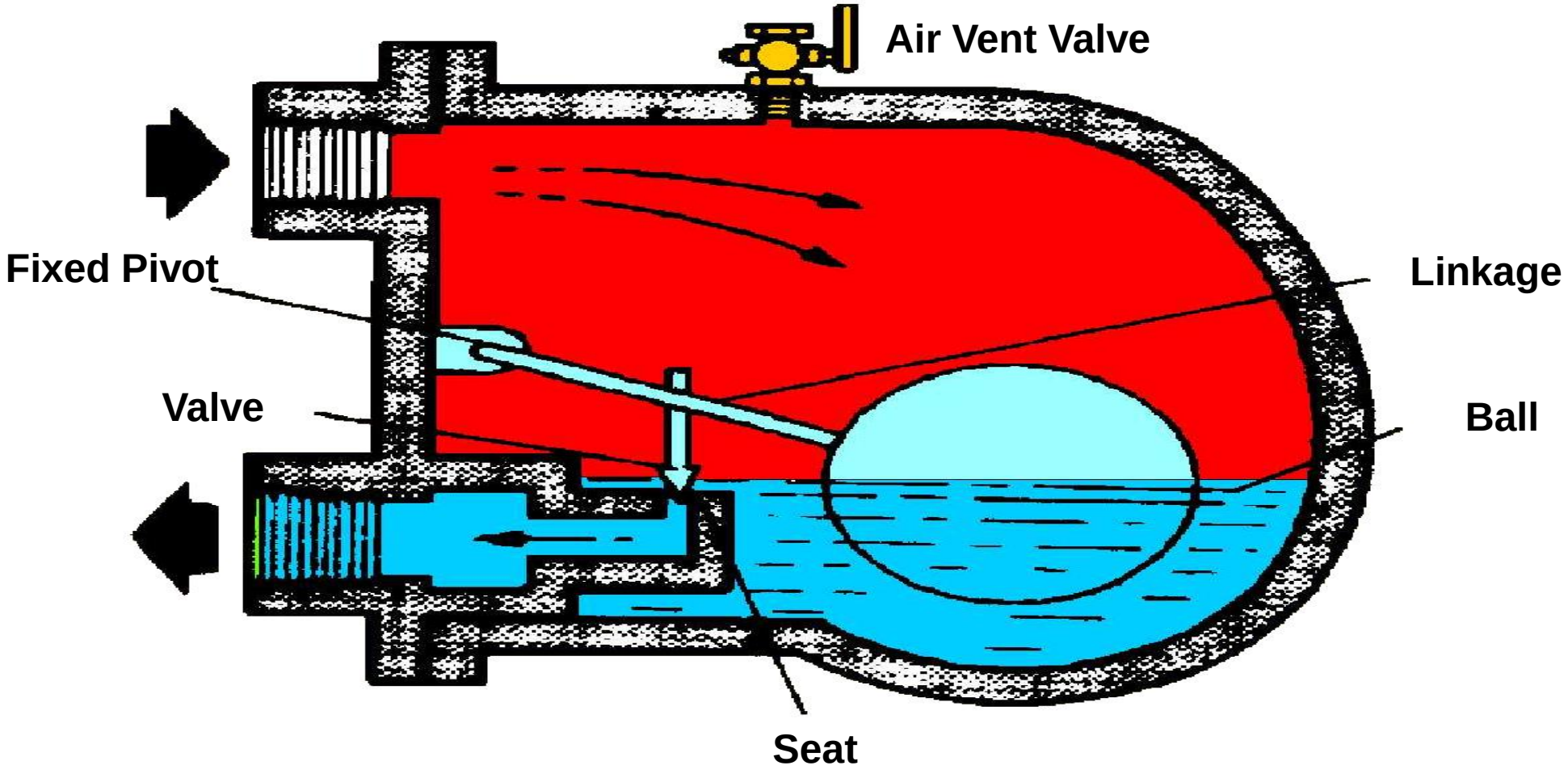
Float & Thermostatic



Inverted Bucket



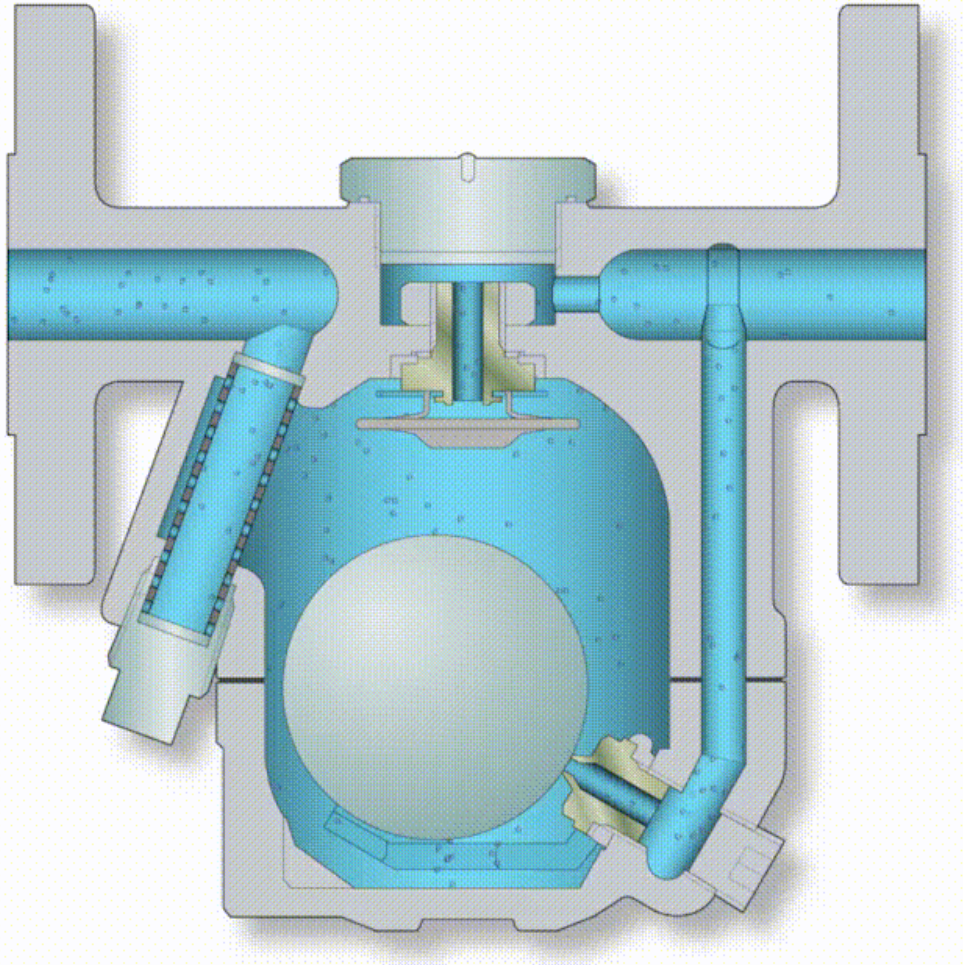
Simple Float Trap



Float and Thermostatic

Model G20

MIYAWAKI INC.

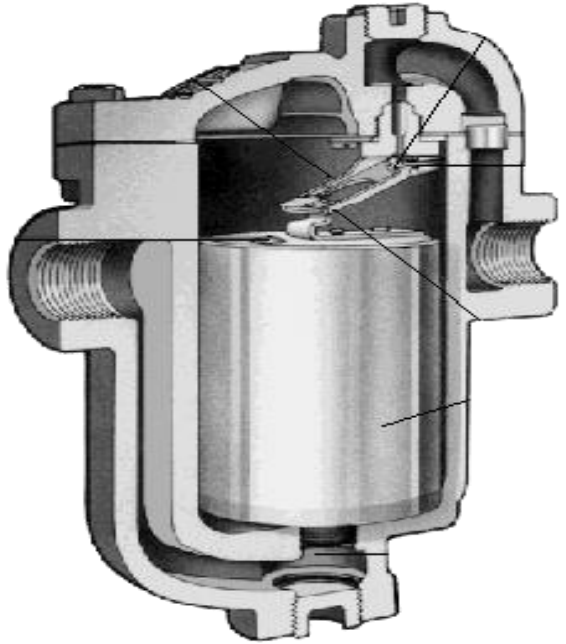


F&T Traps

	Bellows Balance Pressure	Thermodynamic Traps	F&T Traps
Modulation	Poor	Fair	Good
Backpressure	Good	Poor	Good
Dirt	Fair	Poor	Poor
Wear	Fair	Poor	Good
Water Hammer	Poor	Good	Poor
Freezing	Good	Good	Poor

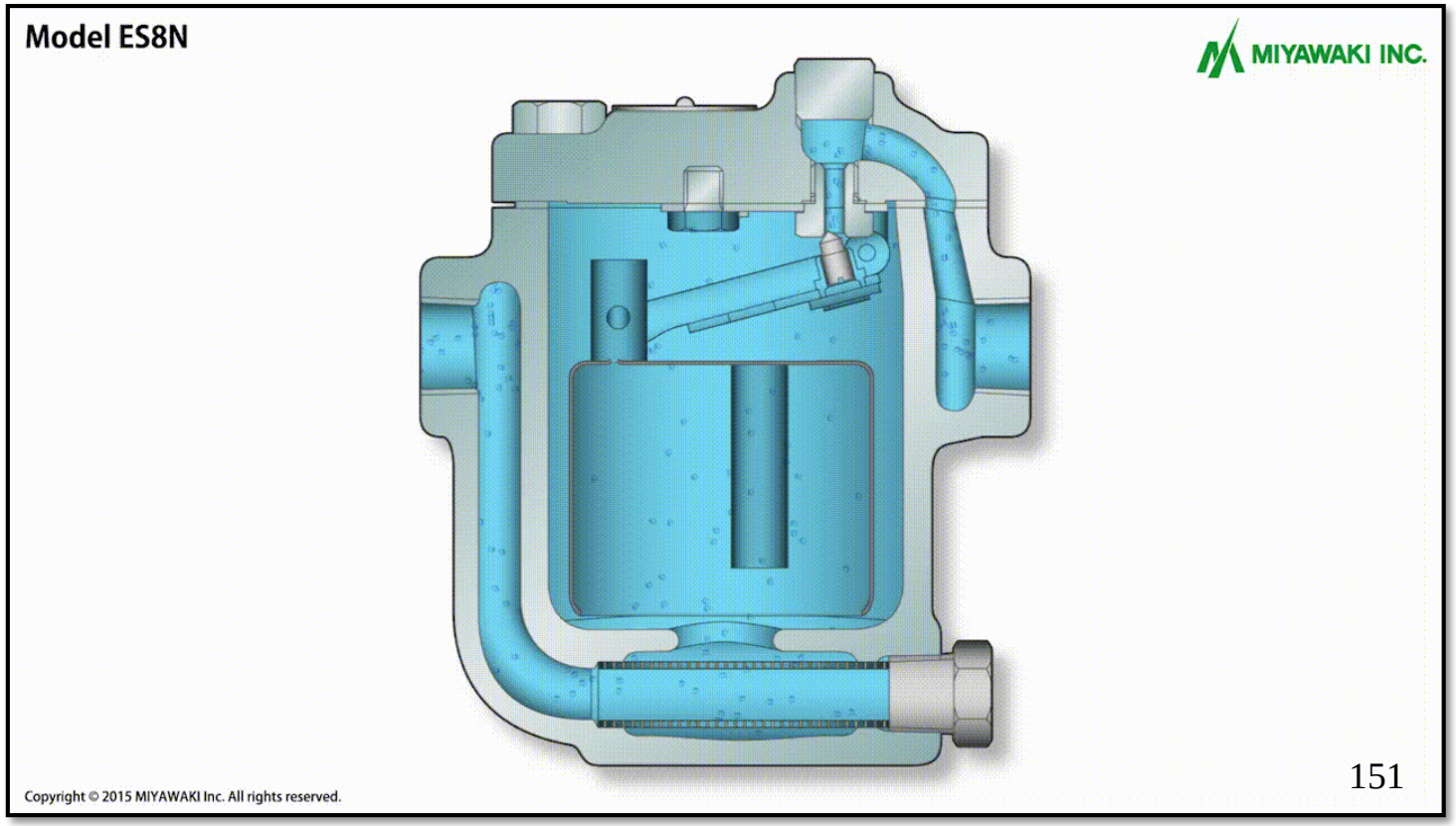
Mechanical Steam Traps

Inverted submerged bucket steam trap is a mechanical trap that operates on the principle of the difference in density between steam and water



Inverted Bucket

- Inverted Bucket.
- Valve on linkage.
  - Sized for maximum flow at maximum pressure difference
- Air Vent
- Body material based on operating pressure and cost



Inverted Bucket

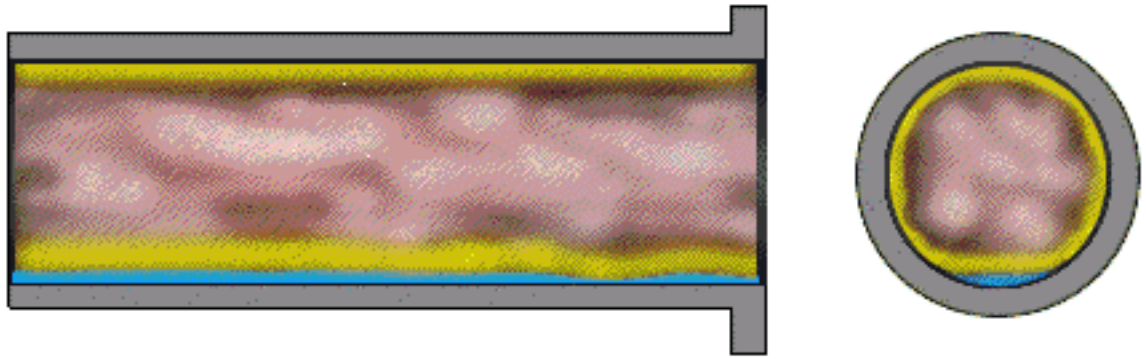
	Bellows Balance Pressure	Thermodynamic Traps	F&T Traps	Inverted Bucket
Modulation	Poor	Fair	Good	Good
Backpressure	Good	Poor	Good	Good
Dirt	Fair	Poor	Poor	Good
Wear	Fair	Poor	Good	Good
Water Hammer	Poor	Good	Poor	Good
Freezing	Good	Good	Poor	Good

Corrosion

Corrosion occurs in systems where non-condensables are allowed to combine with retained condensate. The most familiar form of corrosion results from the oxidation of iron in the presence of water to form ferric acid. You probably know it as common rust.

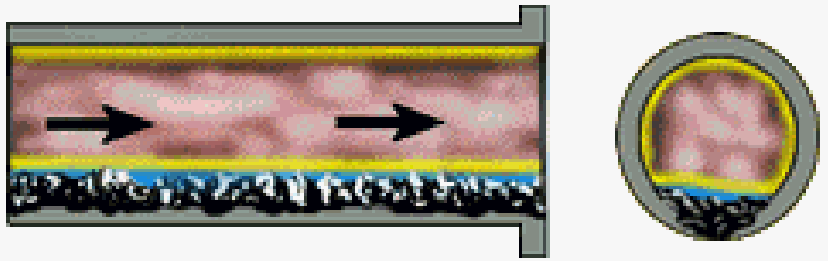
Rust

In a steam heating system, differences in temperature increase electron flow. Because water is an electrolyte, it conducts electrons from the anode to the cathode, polarizing them chemically and electrically. The ions of the water combine with the ions of the metal at its surface. Ferrous oxide is formed at the anode, then combines with atmospheric oxygen to form ferric acid, or **rust**

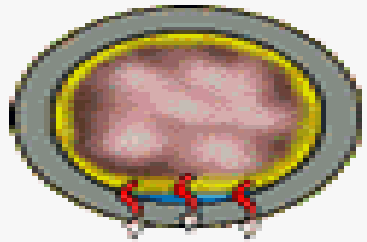


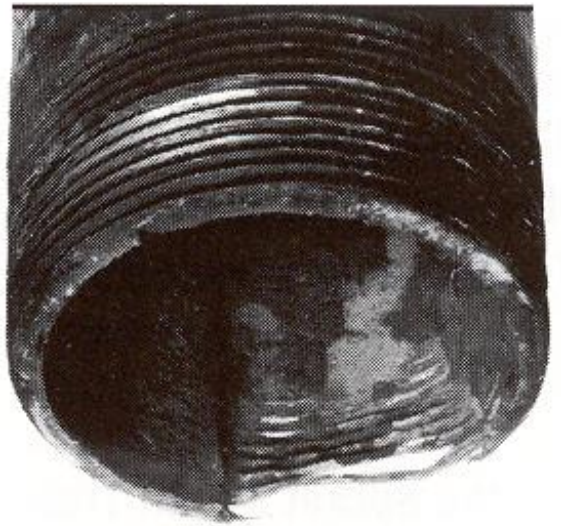
Pitting and Scaling

Corrosion can occur in several ways, depending on the oxygen content, alkalinity, temperature and other factors of the water. The damage caused by corrosion can range from pitting in certain areas to scaling, in which the entire surface area becomes affected. Large pieces of scale can flake off, drifting downstream until they become lodged in small orifices and cause blockage



Carbonic Acid





As long as the condensate remains hot, carbonic acid is not formed. The carbon dioxide behaves like any other non-condensable

Steam Traps
Trap Inspection Schedule

- Trap failure rate
  - Over 10%
  - 5 - 10%
  - Less than 5%
- Inspection frequency
  - Two months
  - Three months
  - Six months

Steam Traps
Trap Inspection Schedule

- Pressure (Psi)
  - 0 - 30
  - 30 - 100
  - 100 - 250
  - Over 250

- Inspection frequency
  - Annual
  - Semiannual
  - Quarterly or monthly
  - Monthly or weekly

Steam Traps Cost Of Steam Leaks

A good rule of thumb

No survey or maintenance program
up to 50% of a system's traps can be blowing live steam.

Survey done annually; this figure drops to about 25%.

A bi-annual survey will reduce this
even further to less than 12%.

Steam Traps Cost Of Steam Leaks

Dollars/Year at 100 Psig

Equivalent Orifice Diameter	Lbs./Yr. Steam Loss	Steam Cost Per 1000 Lbs. $5.00	$7.50	$10.00
1/16”	115,630	$578	$867	$1,156
1/8”	462,545	$2,313	$3,469	$4,625
1/4”	1,848,389	$9,242	$13,863	$18,484
1/2”	7,393,432	$36,967	$55,451	$73,934

Cost Multipliers For Other Steam Pressures:

16 Psig -. 26 50 Psig - .56 150 Psig - 1.43
200 Psig - 1.87 300 Psig - 2.74 600 Psig - 5.35

Steam Trap Survey

The portable ultrasonic detector is specially designed for detecting steam loss through steam traps and stop valves.

Trap Inspection

- As part of any predictive maintenance routine, knowledge of the system is critical. For this reason, before inspection begins, a map or some diagram of the location of all the steam traps and valves in a facility should be available.
- All traps should be tagged or coded and referenced on the map/diagram.
- The trap inventory should include the trap type, size, manufacturer, and application & possibly even repair part info.
- There are commercial steam trap management software programs available.

Ultrasonic Inspection Method

- There are basically two main types: continuous flow and intermittent (on/off).
- On/off traps will have a basic hold-discharge-hold pattern.
  - Inverted Buckets
  - Thermodynamic
  - Thermostatic (Bellows)
  - Bi-Metallic

Ultrasonic Inspection Method

- Continuous flow traps discharge condensate continuously.
  - Float and Thermostatic trap
  - Fixed Orifice

- Each type of trap has its' own unique pattern that is described below. It is recommended that you listen to a number of traps to determine a "normal" operation in your particular situation before you proceed with your survey.
- Generally, when checking a trap ultrasonically, a continuous rushing sound will often be the key indicator of live steam passing through.

PBBS EQUIPMENT CORPORATION

Boiler Maintenance

General Maintenance

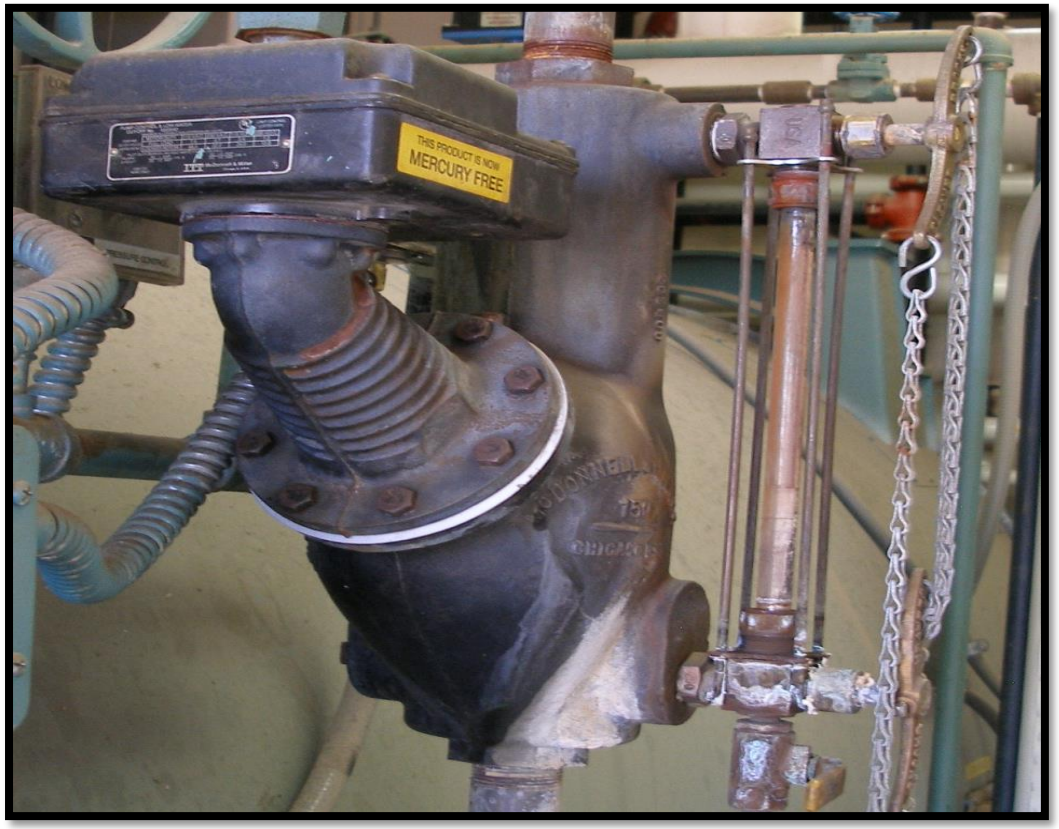
- Boiler room equipment biography
- Keep written operating procedures
- Good housekeeping is a must
- Keep electrical equipment clean
- Keep fresh air supply adequate
- Keep accurate fuel records

General Maintenance

- Establish a regular schedule
- Use a log sheet – daily, weekly, monthly
- SAFETY - SAFETY - SAFETY

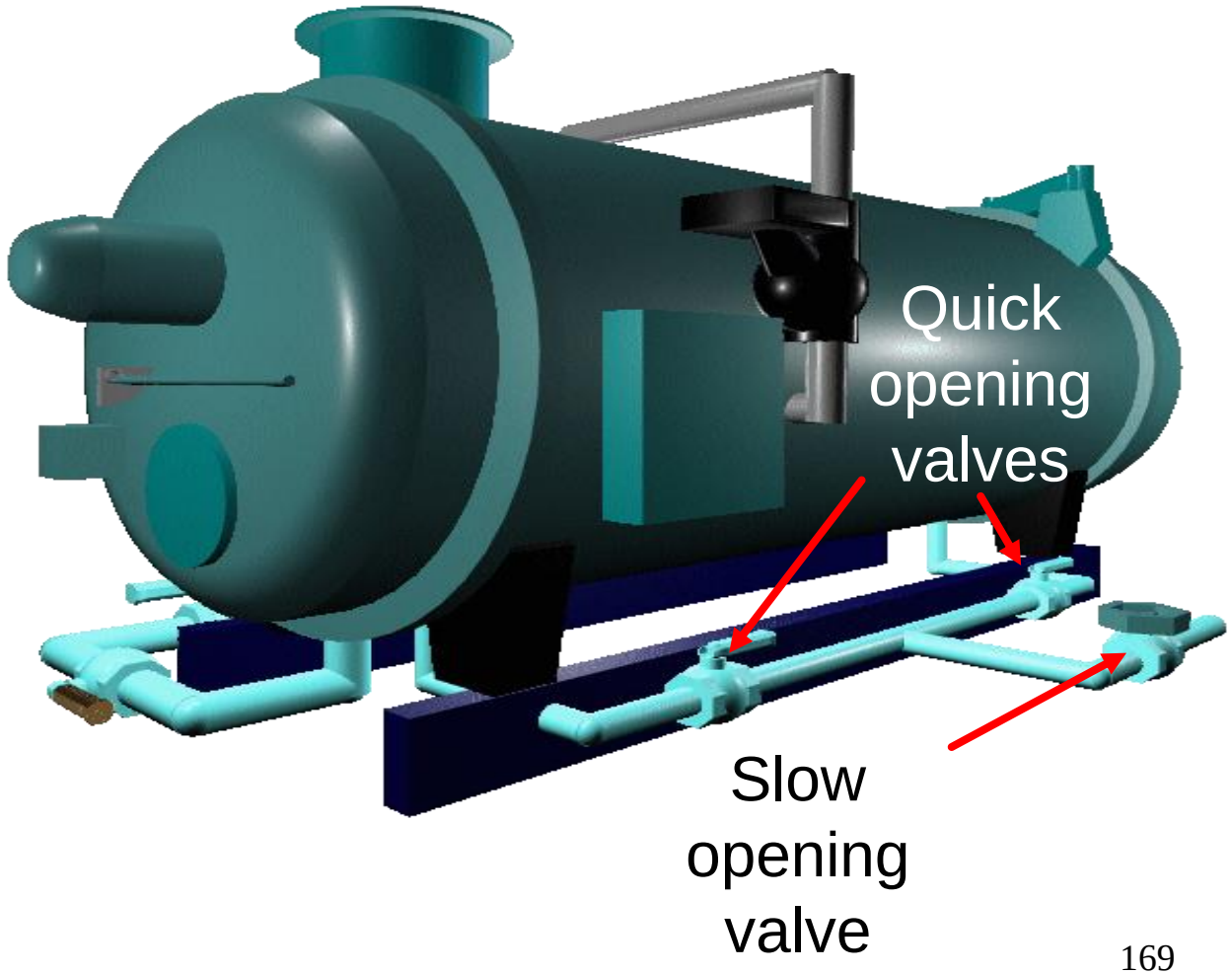
Daily Maintenance

- Check water level
  - No water in glass?
    - Shut off burner
    - Secure water supply to the boiler - DO NOT LET ANY WATER GET INTO THE BOILER
    - Cool down boiler, open it up and inspect for damage



Daily Maintenance

- Blowdown boiler
  - Bottom blowdown
    - Primarily sludge removal
    - Proper sequence
    - Quick opening - open first, close last
    - Slow opening - open and close with flow
  - Surface blowdown
    - TDS control

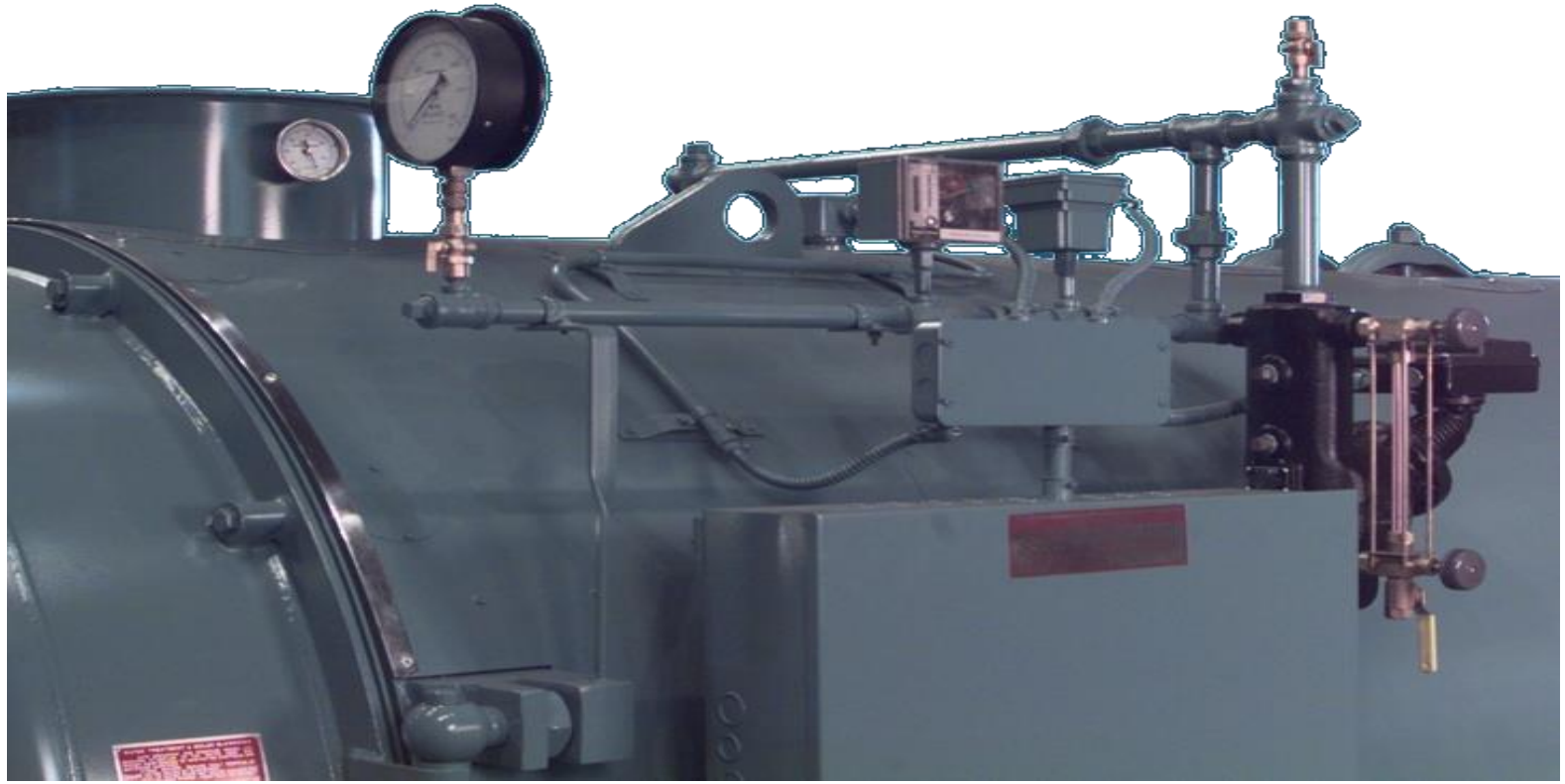


Daily Maintenance

- Blowdown water columns

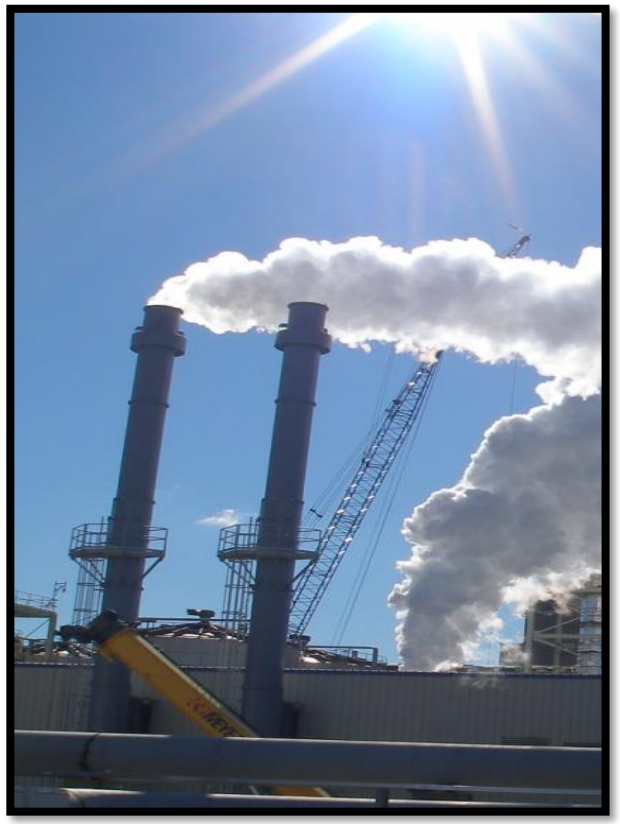
Daily Maintenance

- Check boiler pressure or temperature
  - Higher or lower than normal



Daily Maintenance

- Check & record stack temperature
  - 50^{O} - 100^{O}F above steam or water temperature
  - Reference firing rate

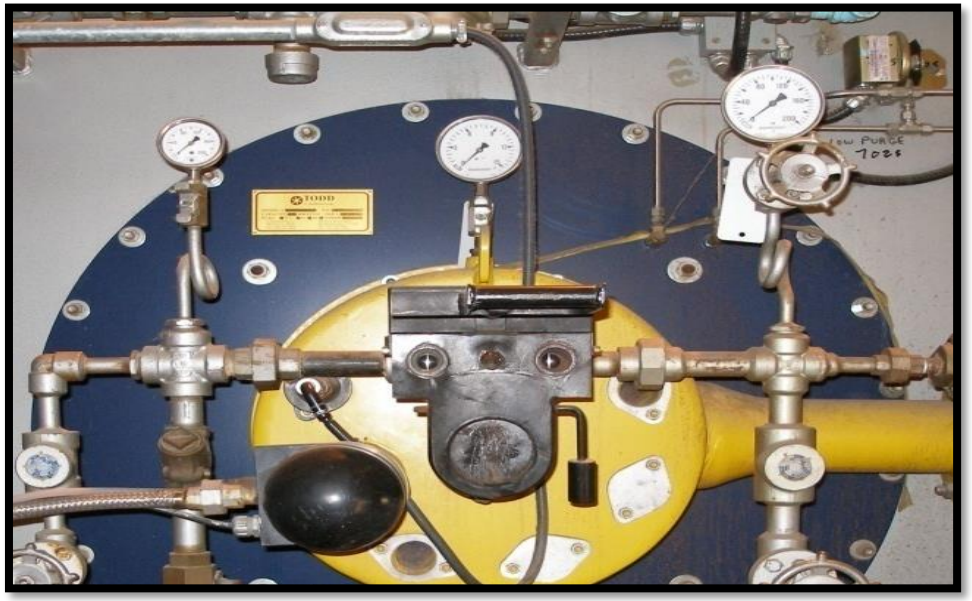


Daily Maintenance

- Record feedwater pressure / temp.
  - DA - pressure and temperature in tank should correspond.
    - 5 – 10 psi - 227^{O}F
  - Feed system - vented tank, variable temp.

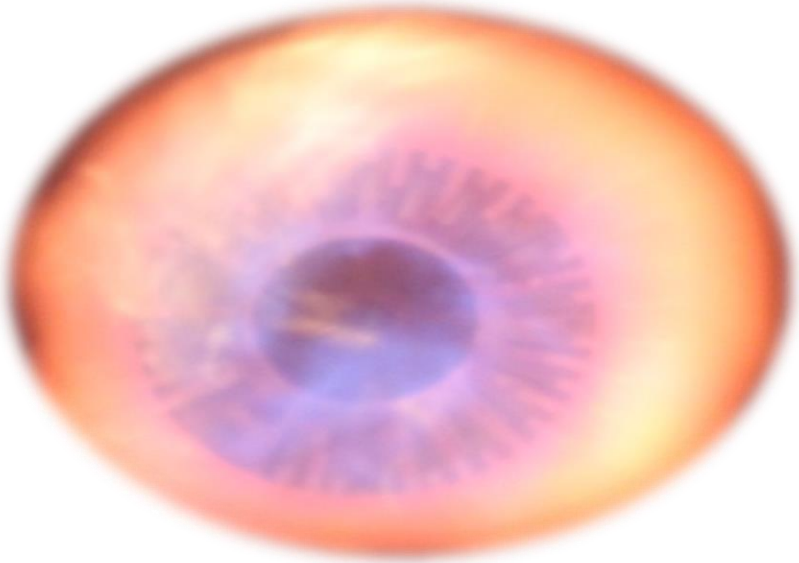
Daily Maintenance

- Record gas pressure.
  - Inlet to regulator.
  - Outlet from regulator.
  - Manifold (elbow) pressure.



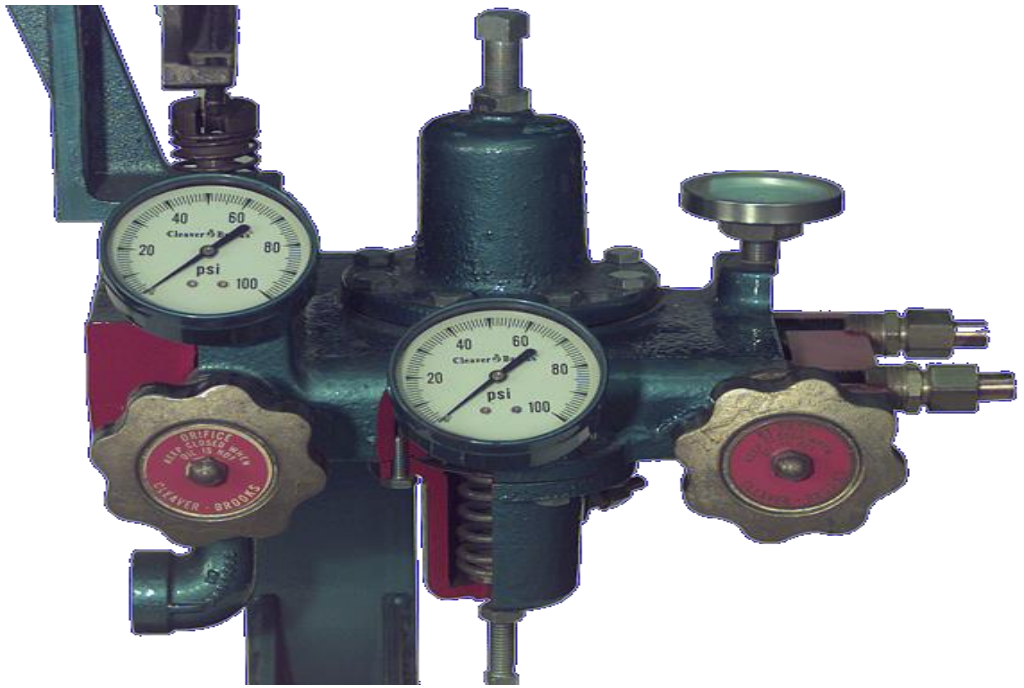
Daily Maintenance

- Record makeup water usage – check treatment
- Check general burner operation and flame pattern
- Check operation of any auxiliary equipment



Daily Maintenance

- Record oil pressure and temperature
  - Base-rail pressure
  - Supply pressure
  - Return pressure
  - Heavy oil - temperature

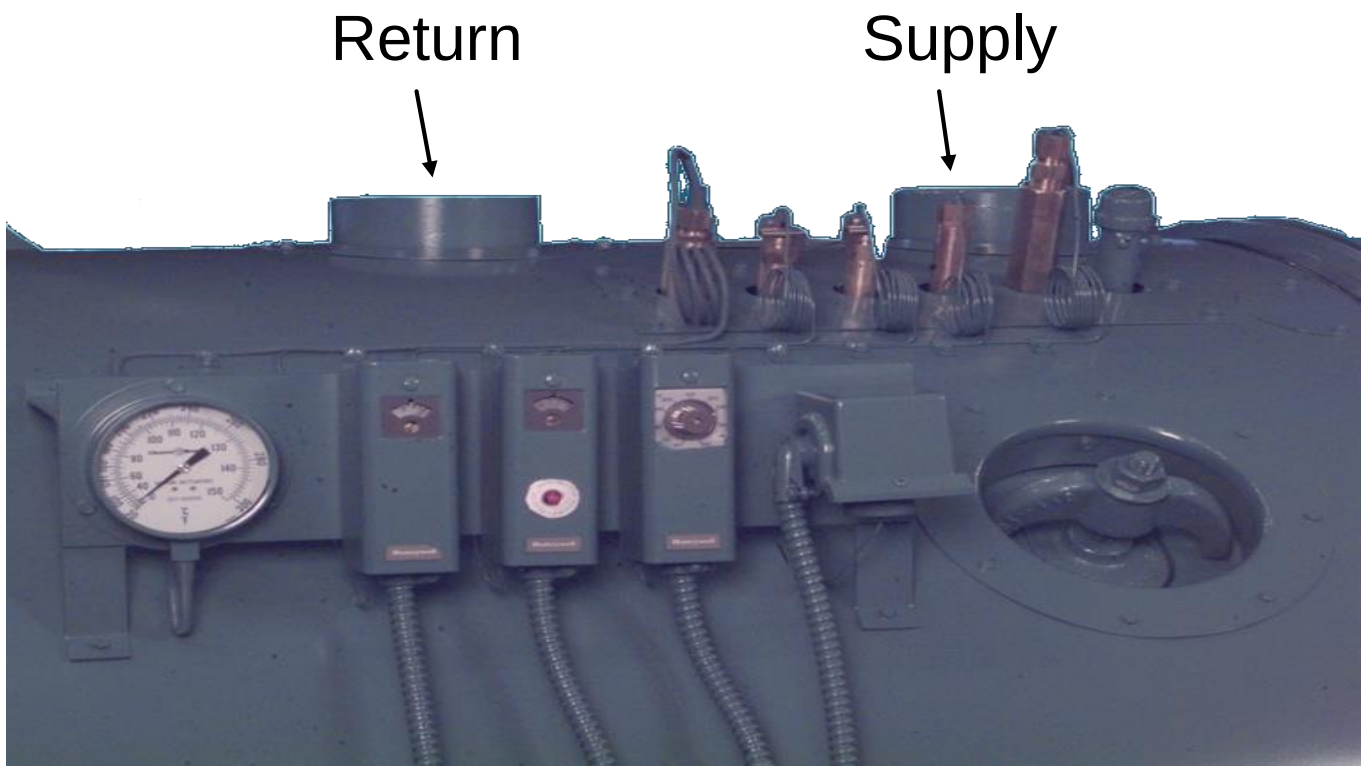


Daily Maintenance

- Record oil atomizing pressure
  - Varies with burner firing rate
  - Approx. 7 psi with no fuel flow to 25 psi at high fire
  - Low pressure
    - Problem with gun or air pump

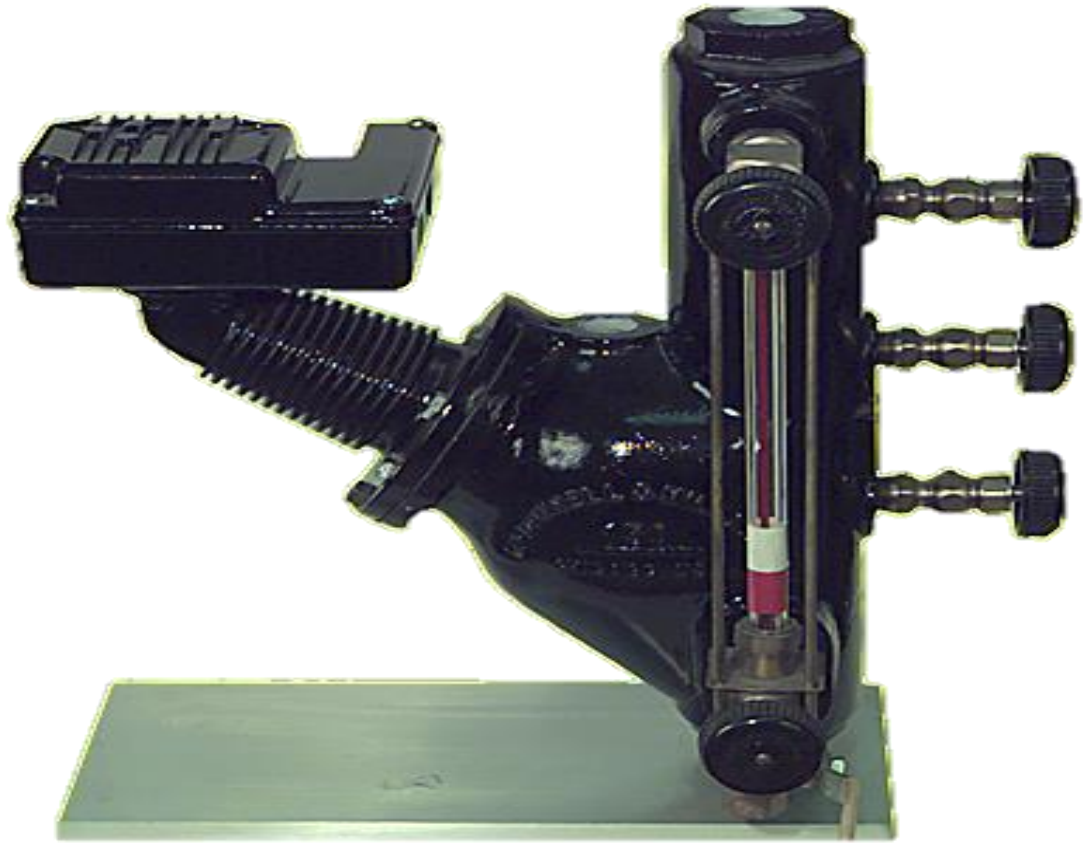
Daily Maintenance

- Record boiler water supply and return temperatures
  - Watch for widely varying return temperatures



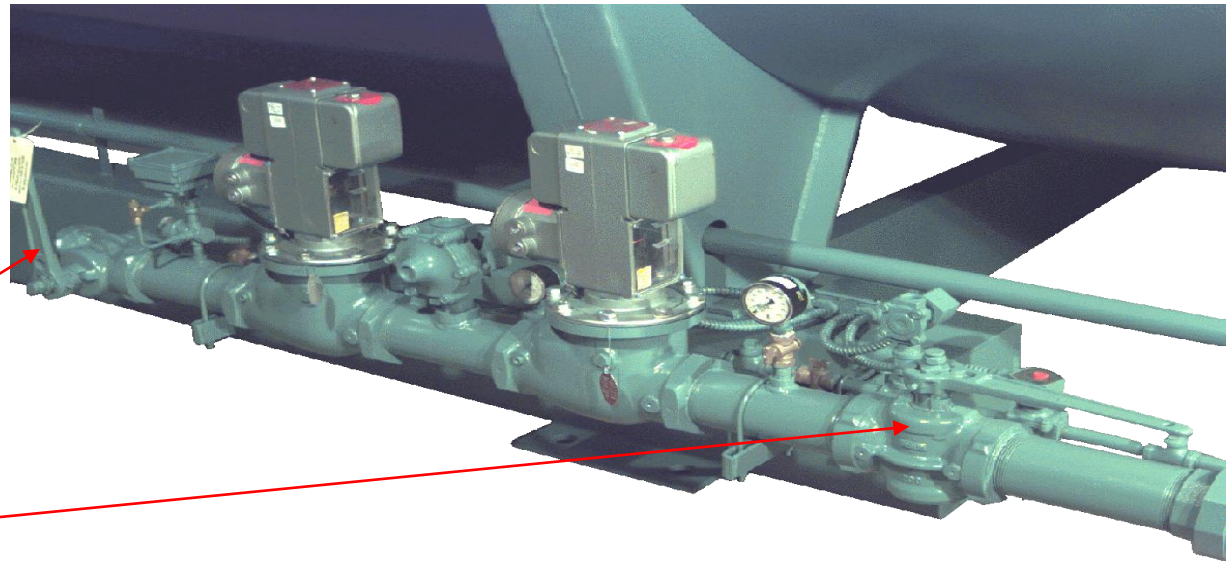
Weekly Maintenance

- Check operation of water level controls
  - Evaporation or slow-drain test



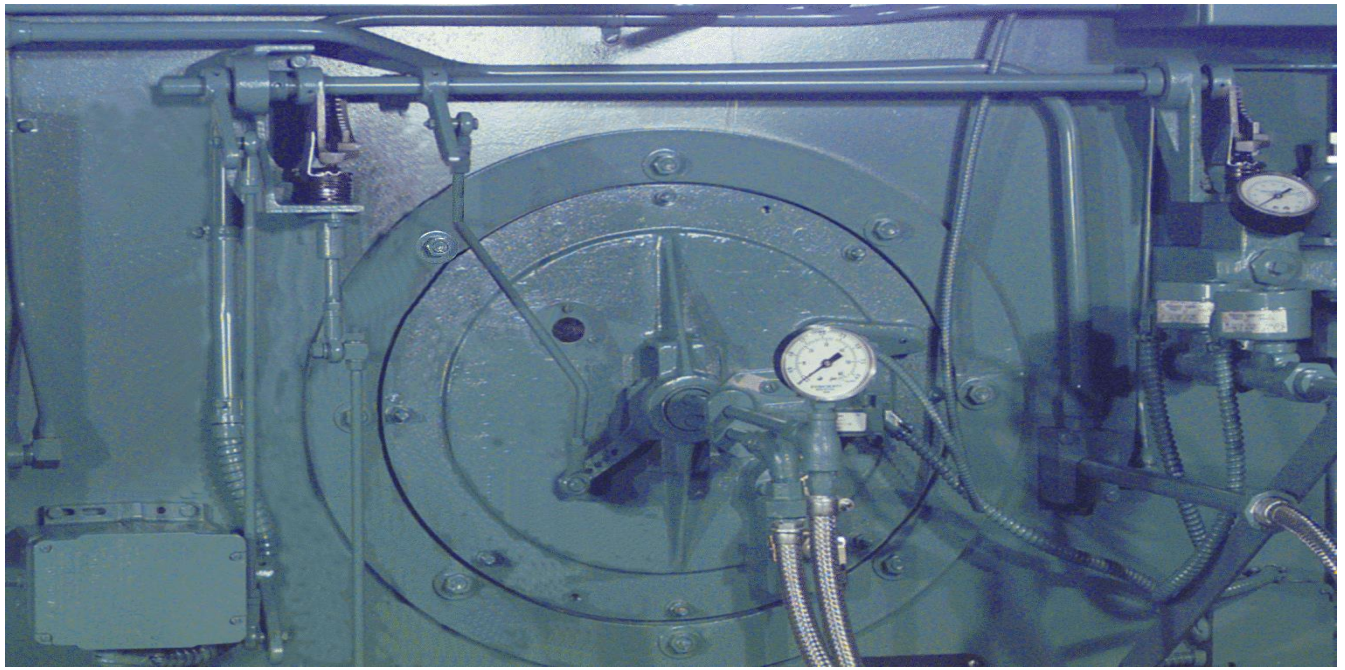
Weekly Maintenance

- Check fuel valves
  - Open & Close visual check
  - Vent valve leaks
  - Manual plug cock operation



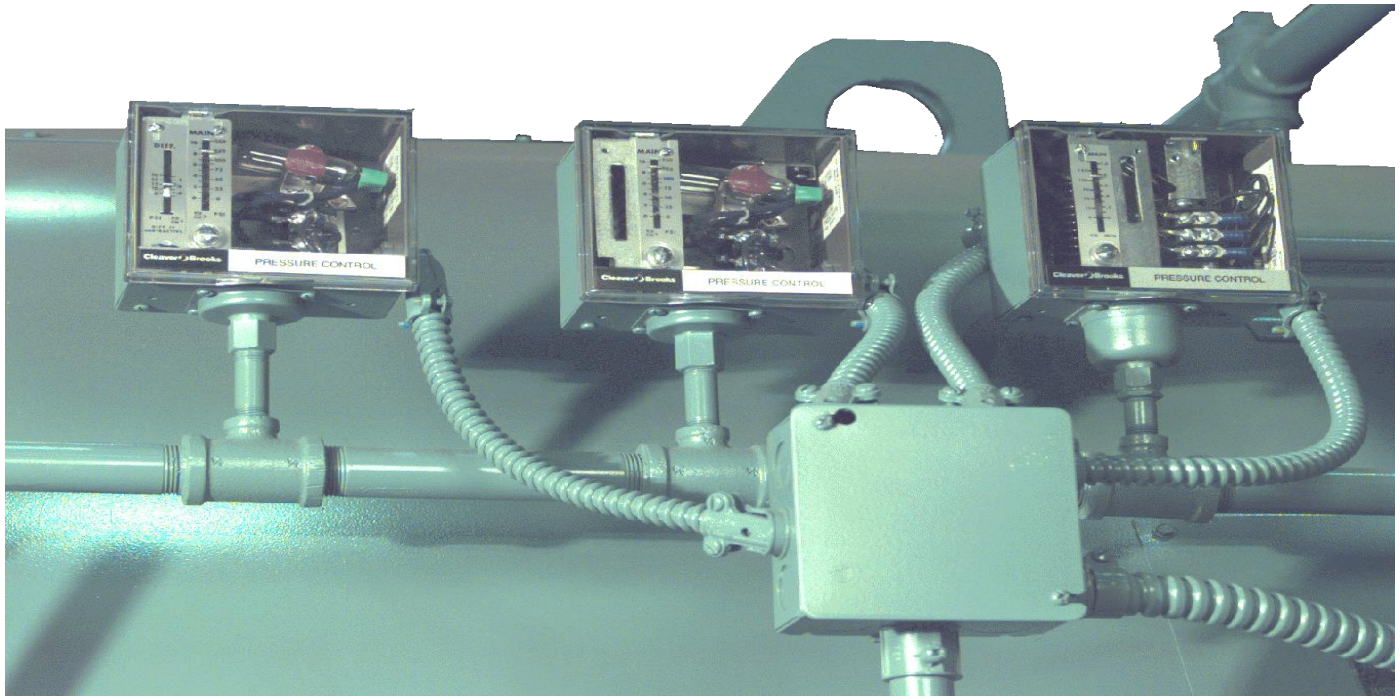
Weekly Maintenance

- Check fuel and air linkage
  - Smooth movement
  - Tight connections
  - Check set screws
  - Spray with light lubricant



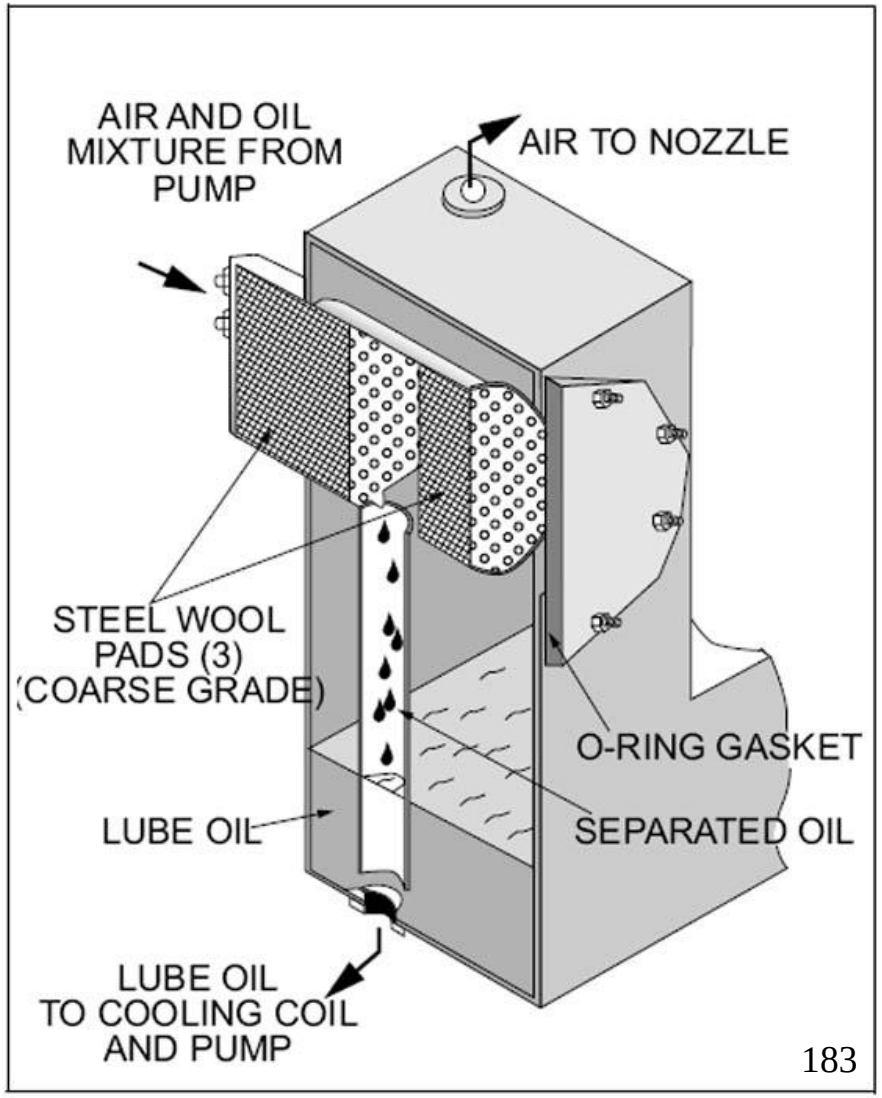
Weekly Maintenance

- Check operating and limit controls
  - Are they level
  - Free movement of mercury switches
  - Turn on & off at settings



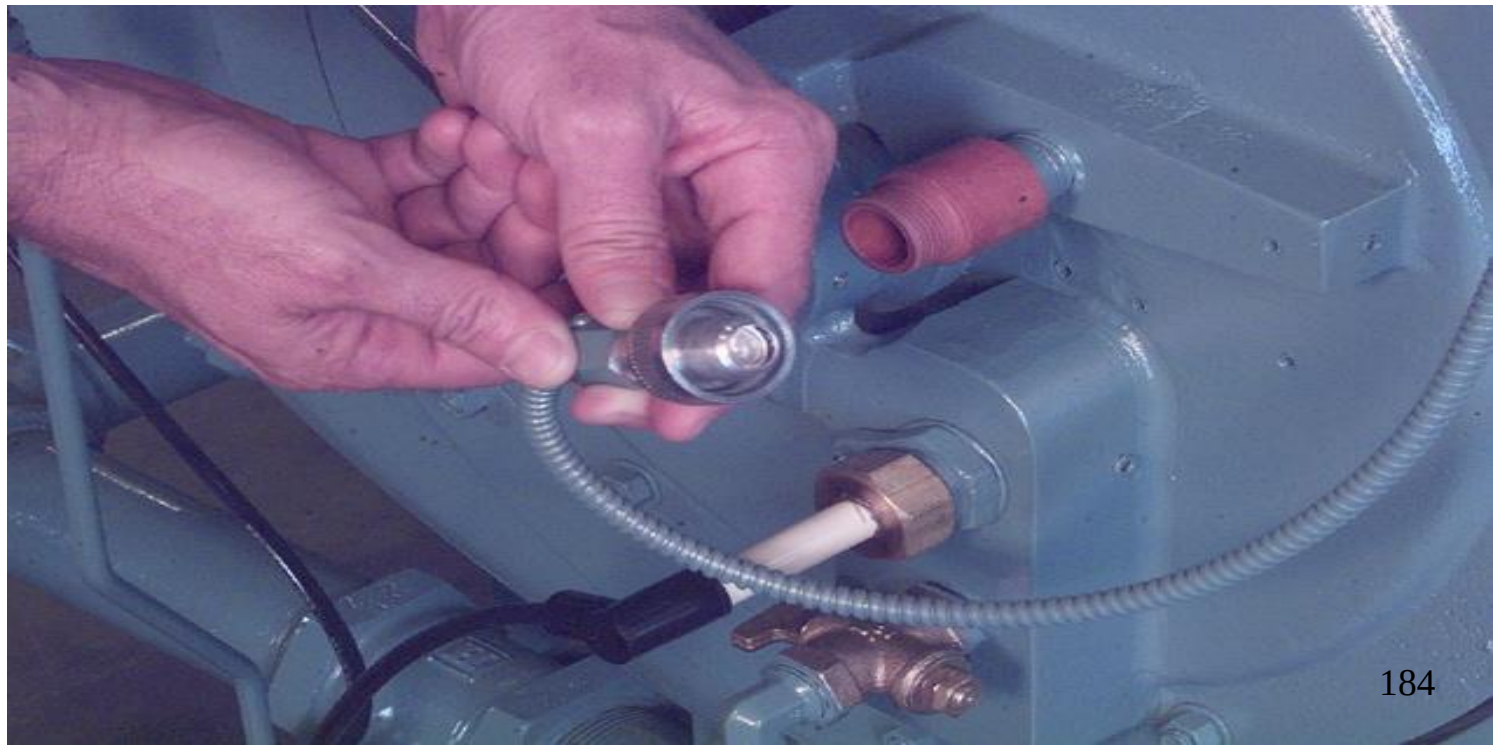
Weekly Maintenance

- Check lubricating levels
  - Air pump lube oil tank
    - Lower half of sight glass
  - Motor lubrication



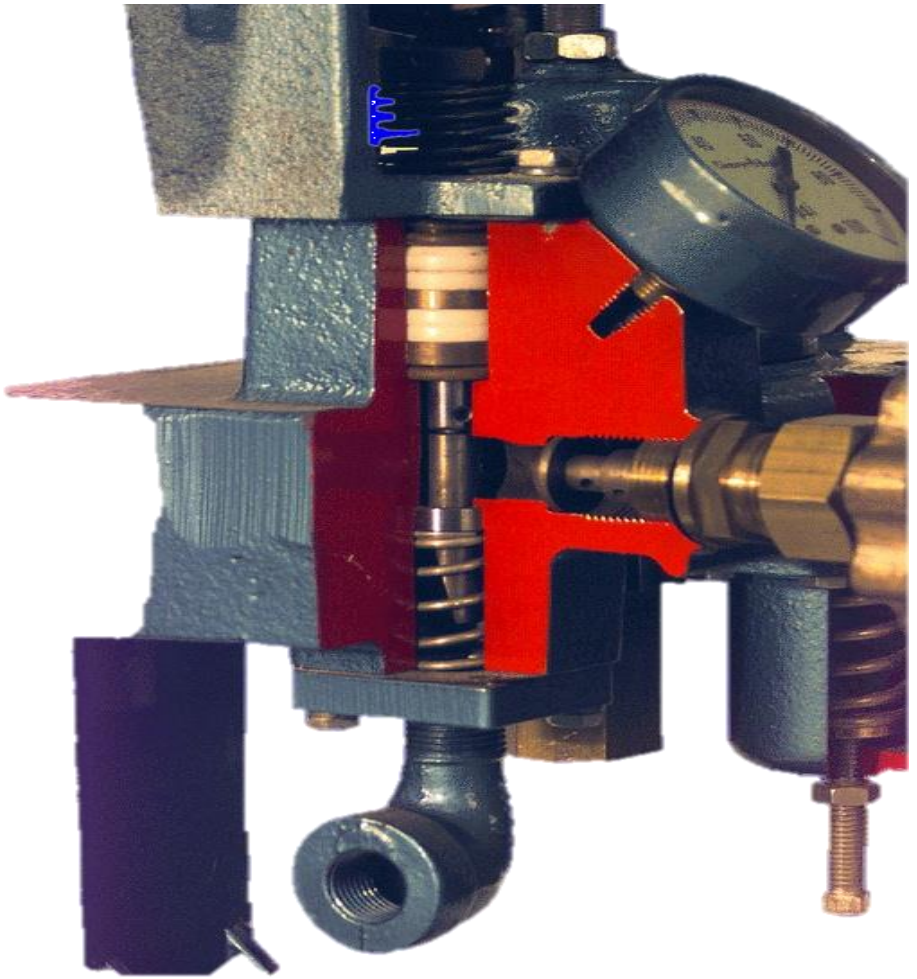
Weekly Maintenance

- Check flame scanner assembly
  - Remove and check flame failure response
  - Clean lens
  - Clean sight tube



Weekly Maintenance

- Check Packing glands.
  - Tighten metering stem packing gland.
    - Too tight will cause stem to bind.



Weekly Maintenance

- Check gauge glass
  - Tubular & Prismatic
  - Check for etching on waterside - thinning of glass

Weekly Maintenance

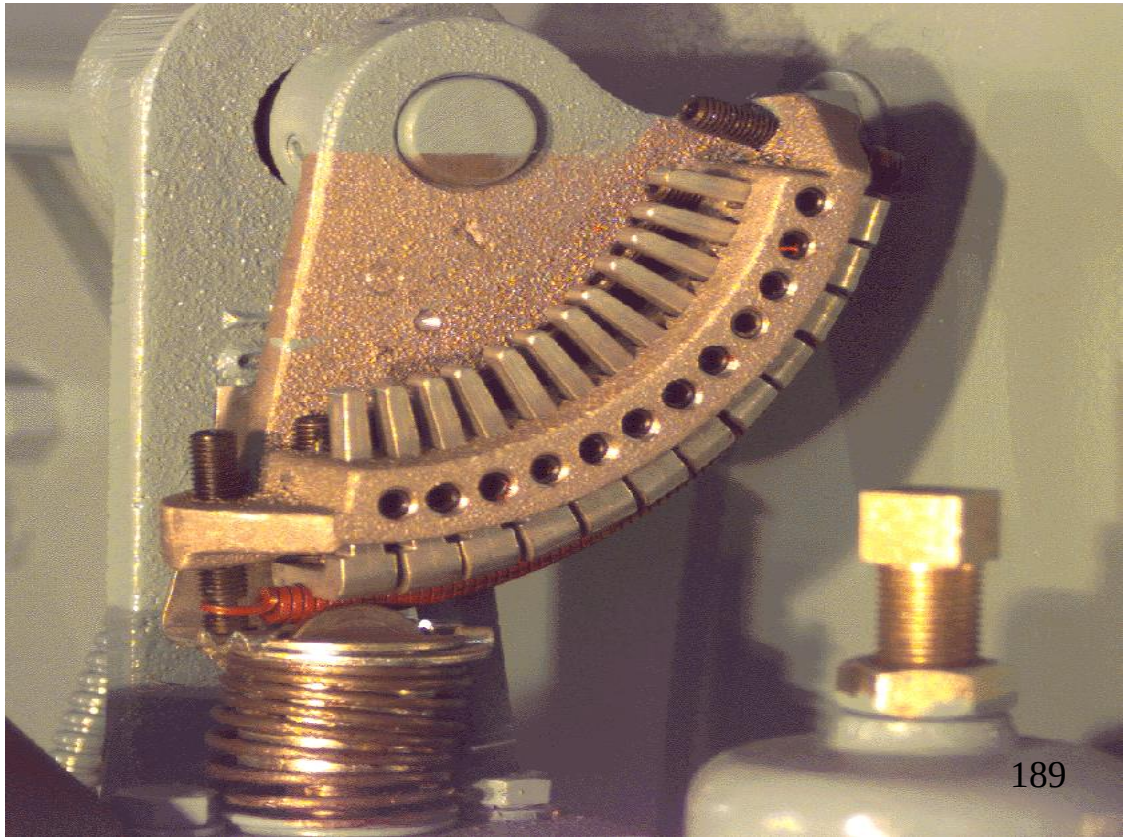
- Check indicating lights and alarms
- Check operation of all motors
- Check safety and interlock controls
- Check for leaks, noise, vibration, unusual conditions, etc.

Monthly Maintenance

- Review boiler room log sheets
- Inspect burner operation
- Inspect for flue gas leaks

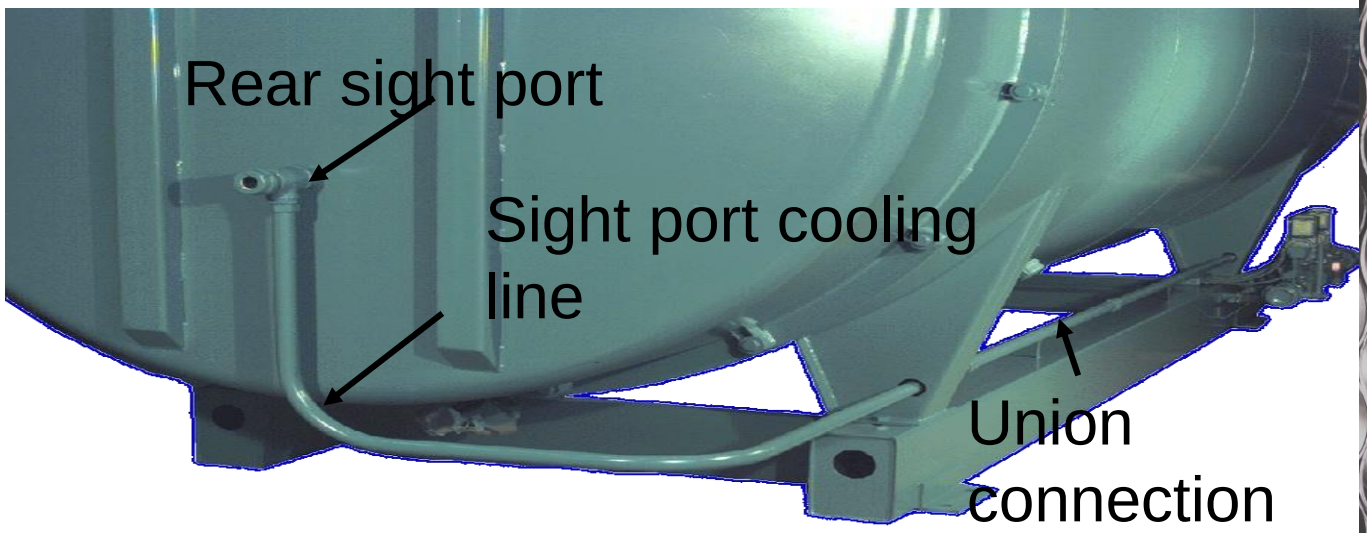
Monthly Maintenance

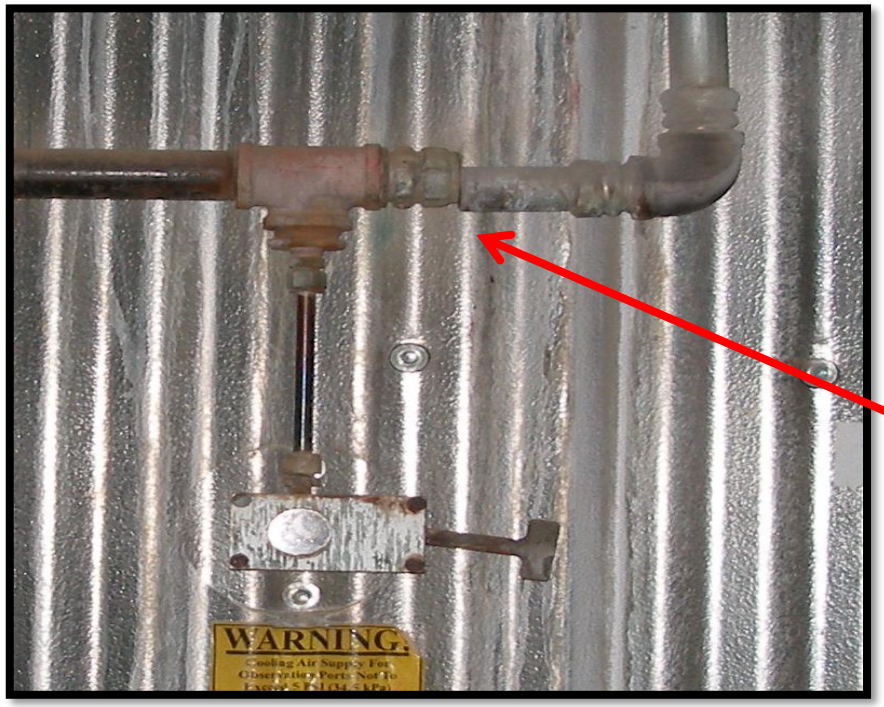
- Check cams
  - Ensure tightness of set screws
  - Excessive wear on cam spring?
  - Spray with light lubricant



Monthly Maintenance

- Check for hot spots
  - Flange area
  - Sight port area
  - Baffle area





Make sure cooling line stays connected
Cooling air supplied by blower motor
Sight glass will melt

Monthly Maintenance

- Check combustion air supply
- Check filter elements
- Check fuel system
- Check belt drives
- Check lubrication requirements

Quarterly Maintenance

- Perform flue gas analysis
  - Each seasonal change
  - When needed due to changes or part failures

Sample

COMBUSTION TEST RESULTS — **PBBS Equipment Corporation**

DATE _____ CUSTOMER _____

MODEL # _____ SERIAL # _____ STATE# _____

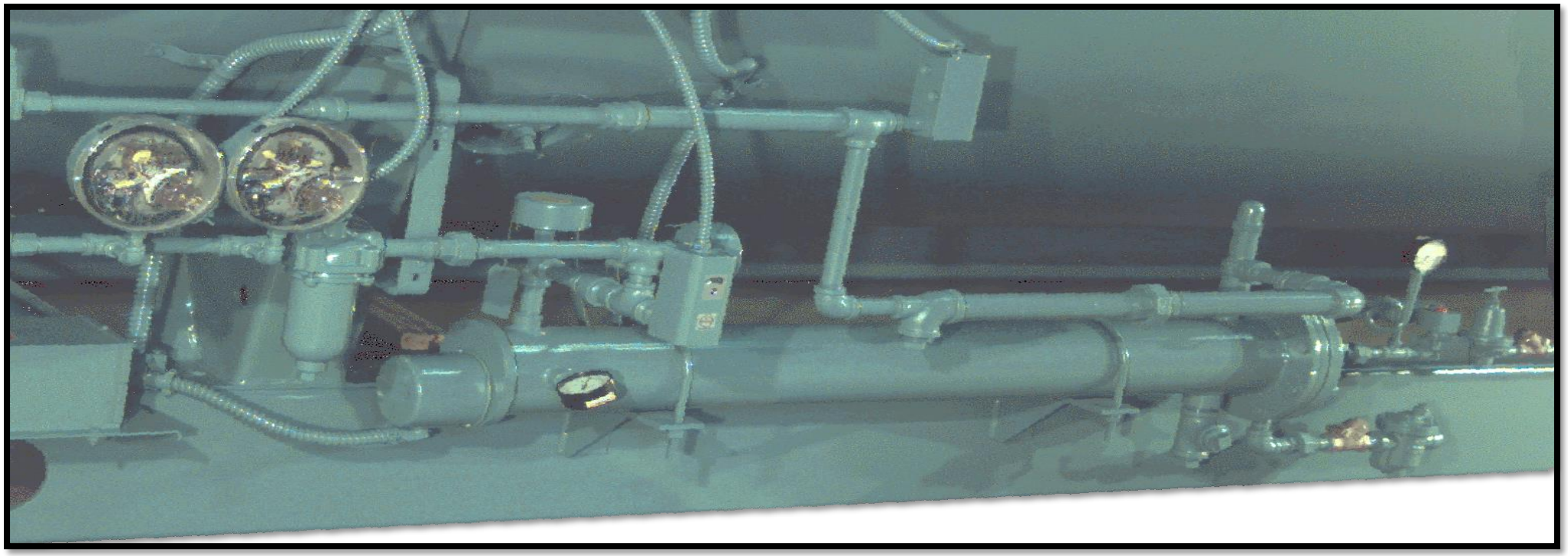
	Circle Fuel: GAS OIL PROPANE	1	2	3	4	5	6	7	8	9	10	1
	Firing Rate : %	10	20	30	40	50	60	70	80	90	100	
*	O2 (Before) : %	7.5	7.2	6.6	6	5.4	4.8	4.2	3.6	3.5	3.5	
*	CO (Before) : ppm	80	60	60	40	40	40	30	20	0	0	
*	O2 (After) : %	6.2	5.5	5	4.5	4	3.6	3.2	3	3	3	
*	CO (After) : ppm	40	40	30	20	0	0	0	0	0	0	
	Stack Temp. Net : deg.F	300	310	320	330	340	350	360	370	380	390	
*	Stack Temp. Gauge (Before) : deg.F	280	285	310	321	336	351	352	360	370	385	
*	Stack Temp. Gauge (After) : deg. F	300	310	320	330	340	350	360	370	380	390	
*	Efficiency (Before) : %	83.5	83.4	83.3	83.2	83.1	83	82.9	82.8	82.7	82.6	
*	Efficiency (After) : %	84.5	84.4	84.3	84.2	84.1	84	83.9	83.8	83.7	83.6	
	NOx : ppm	75	60	55	55	56	56	56	56	56	56	
	NOx (Corrected to 3%) : ppm	77	62	60	59	58	58	57	57	57	57	
*	Stack Pressure/Draft (+ or –) : "wc	0	0	0	0	0	0	0	0	0	0	
	Gas Press. Before Reg. : psig / "wc	27'	27'	26"	26"	26"	26"	26"	25"	25"	25"	
*	Gas Press. to Train : psig / "wc	10"	10"	10"	10"	10"	10"	10"	10"	9"	9"	
*	Gas Housing/Man. Press. : psig / "wc	0"	0"	1"	3"	4"	5"	6"	6"	7"	7"	
*	Oil Pressure @ Burner : psig											
*	Oil Supply Pressure : psig											
*	Atomizing Pressure : psig											

Semi-Annual Maintenance

- Clean low water cutoff (s)
  - Clean cross connecting piping
  - Should not be heavy accumulation
    - Check water treatment

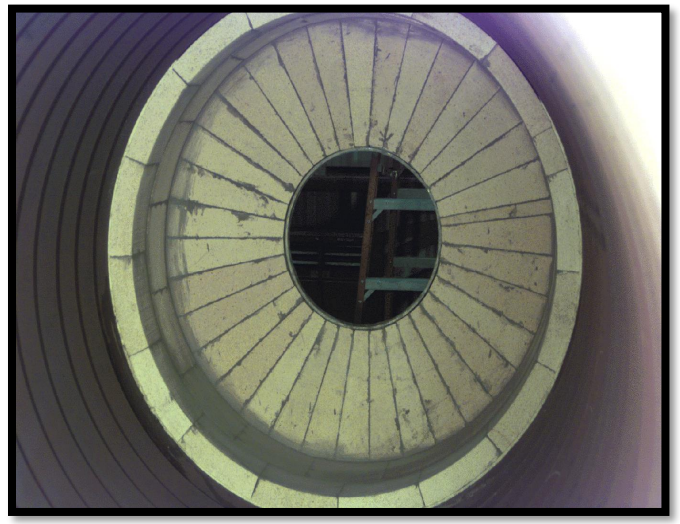
Semi-Annual Maintenance

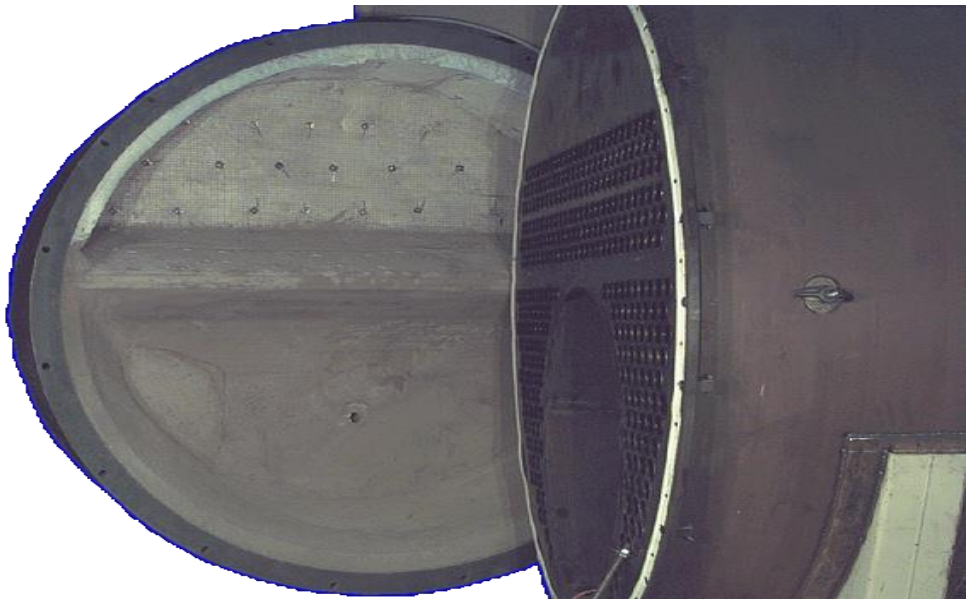
- Check oil preheaters
- Clean oil pump strainer and filter



Semi-Annual Maintenance

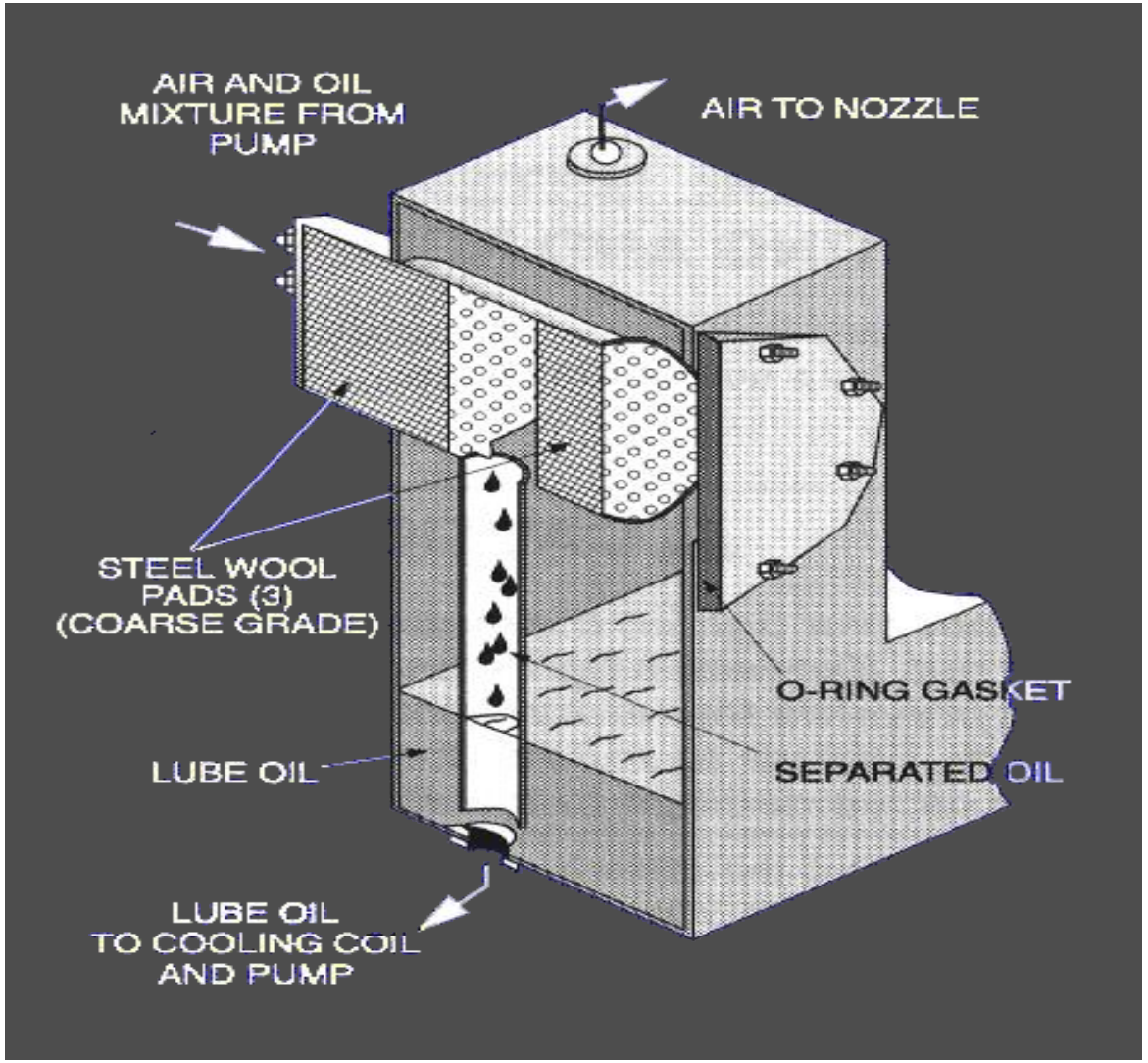
- Repair refractory
  - Throat & Liner
    - No loose bricks
    - Seal between housing and throat
  - Rear door
    - No loose sections
    - Baffle to lower half joint
  - Wash-coat lightly, if any





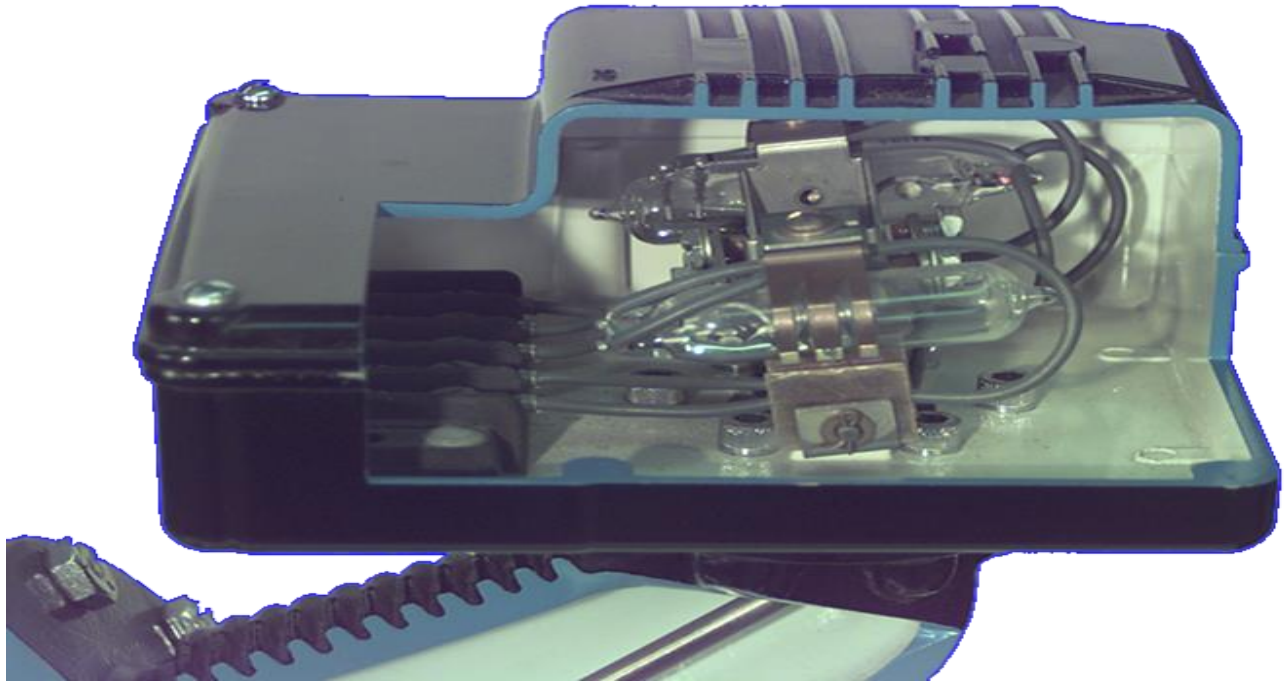
Semi-Annual Maintenance

- Clean air cleaner and air/oil tank
  - Steel wool pads
  - Sludge in bottom



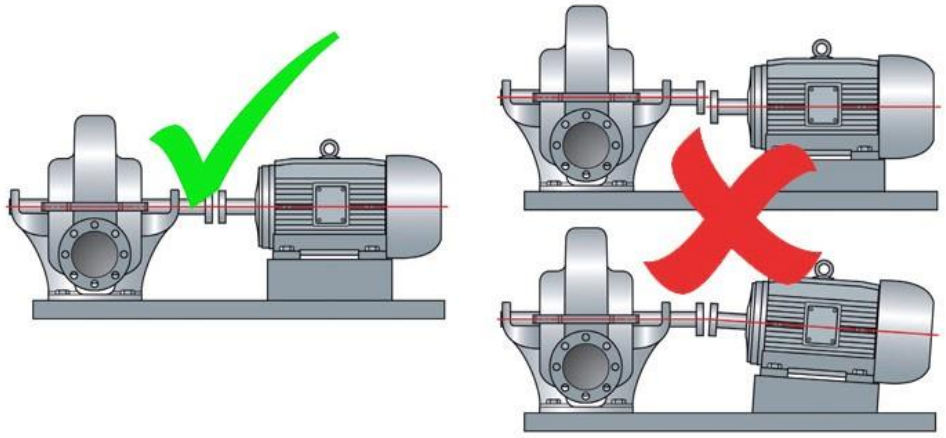
Semi-Annual Maintenance

- Inspect mercury switches
  - Mercury should be shiny
    - Dull surface indicates contamination
- Check wires going to switches



Semi-Annual Maintenance

- Check pump coupling alignment
- Reset combustion

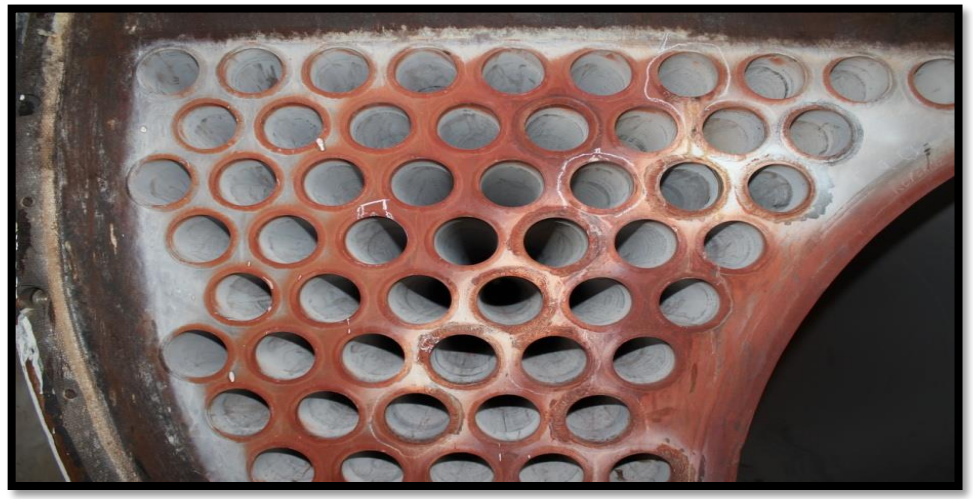


Annual Maintenance

- Coordinate with Inspector – Annual PTO
- Establish procedures based on operations
- Review all log sheets & file for future reference
- SAFETY - SAFETY - SAFETY

Annual Maintenance

- Clean fireside surfaces
  - Brush & vacuum tubes
  - Amount of soot indicates how well burner is performing
- Inspect Brickwork.



Annual Maintenance

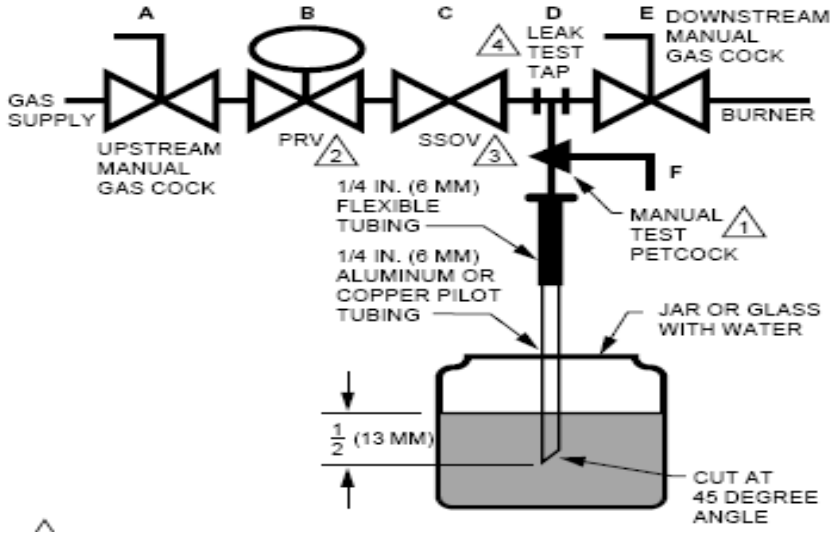
- Repair refractory
  - Cracks 1/8” and under will close up when heated.
  - Look for loose sections.
- Support door
  - Check tightness of davit pin nut.
  - Be careful of baffle hitting shell.
  - Replace gasket when needed.

Annual Maintenance

- Check hydraulic valves
  - Bubble test for valve seat tightness check.
  - Follow valve manufacture procedure
  - Actuators open & close properly

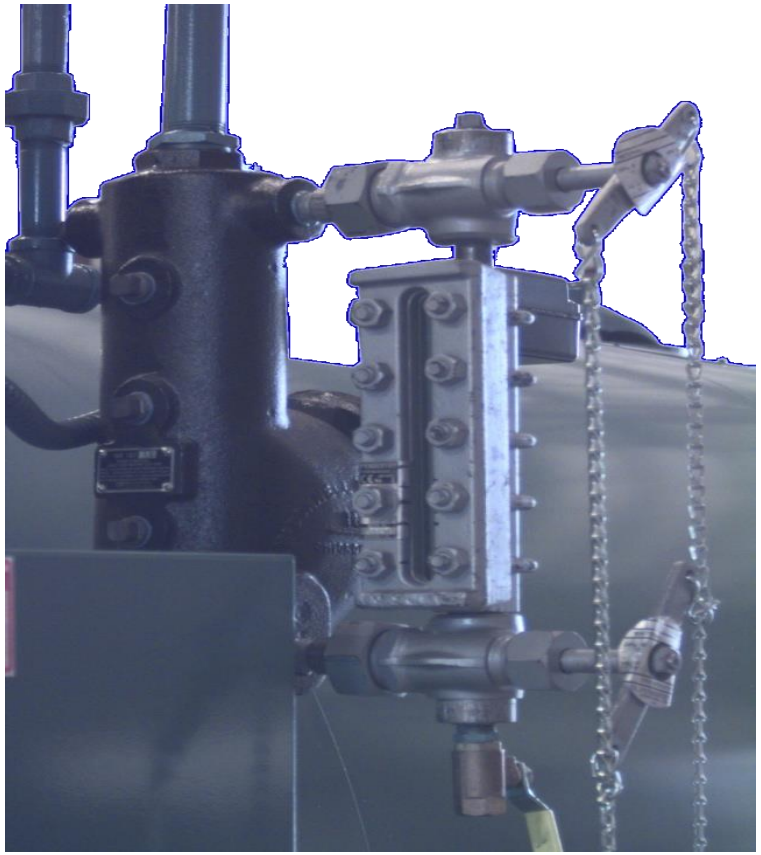
Valve Leak Test (Fig. 7)

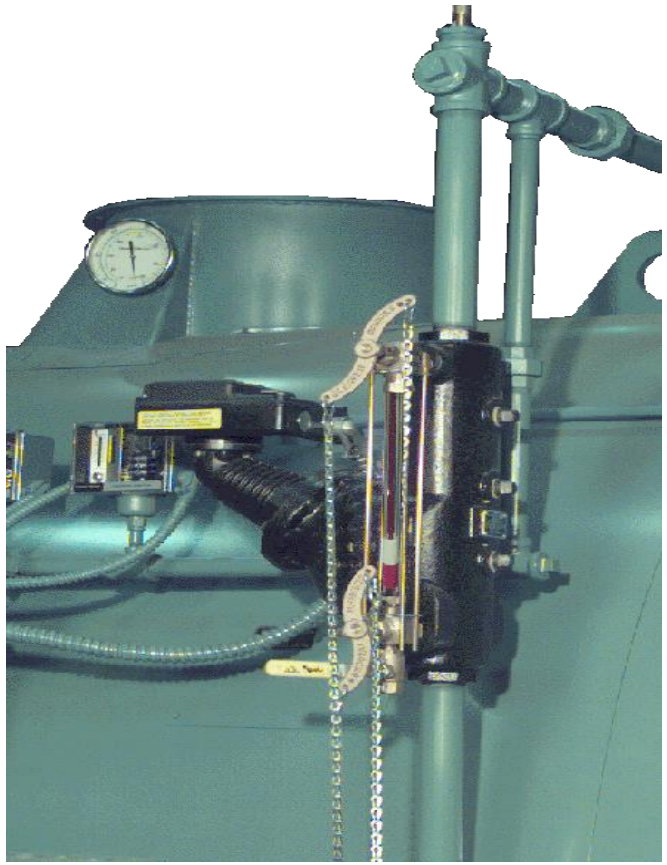
This is a test for checking the closure tightness of a gas safety shutoff valve. It should be performed by qualified personnel during the initial startup of a burner system, or whenever the valve or valve bonnet is replaced (see Service Information section). It is recommended that this test also be included in the scheduled inspection and maintenance procedures. For a periodic inspection test, follow steps 1, 3, 4, 5, 8, 9, 10, 12, 13, 16, and 17.



Annual Maintenance

- Check gauge glass
  - Leaks
  - Thinning of glass
  - Alignment of valves
  - Tubular
    - Replace - with new grommets



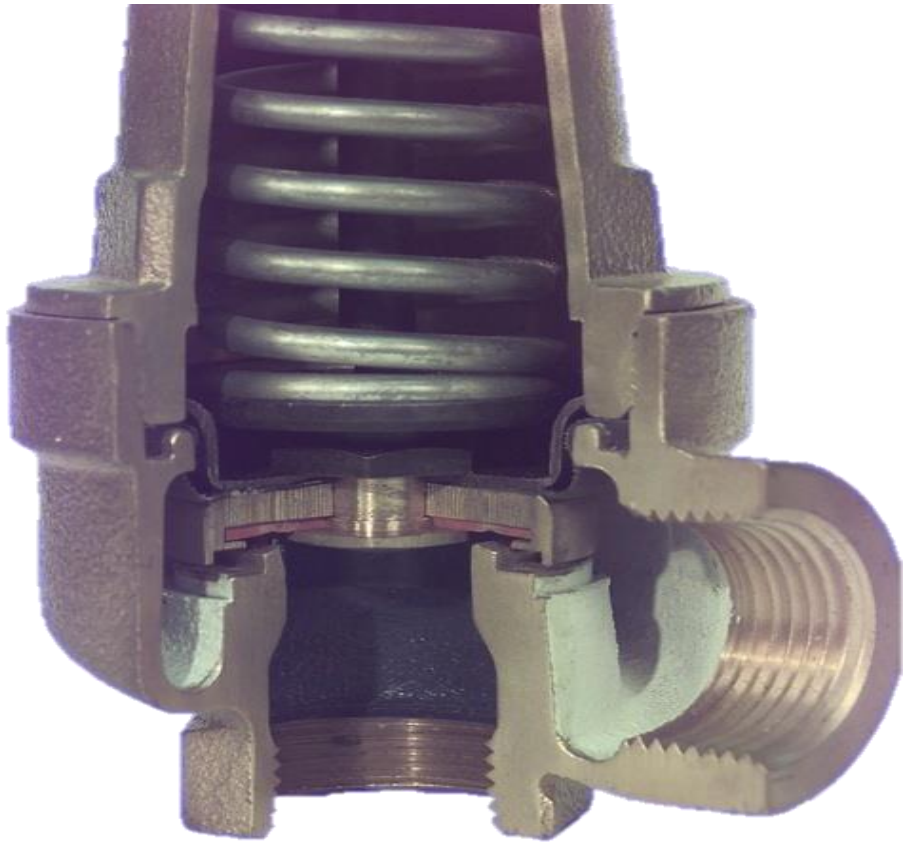


Annual Maintenance

- Clean & flush all waterside surfaces
- Check water column piping & float controls
- Check blowdown piping & valves
- Flush & clean pressure control piping
- Complete visual inspection

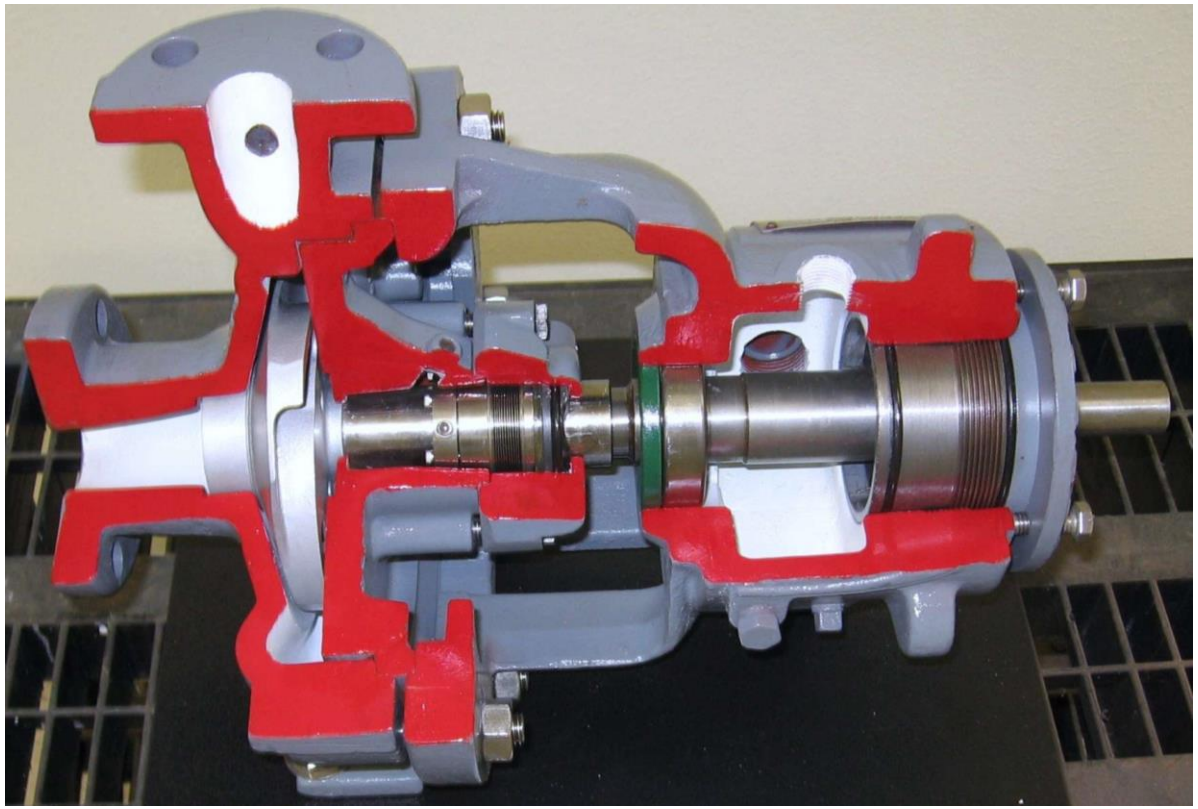
Annual Maintenance

- Remove and Recondition safety valves (if required)
  - Inspect piping for loose hangers putting weight on valves
  - Check for any signs of leakage



Annual Maintenance

- Check boiler feed pumps
  - Wear rings
  - Seals
  - Packing
  - Bearings
  - Recondition shaft and/or impellers



Annual Maintenance

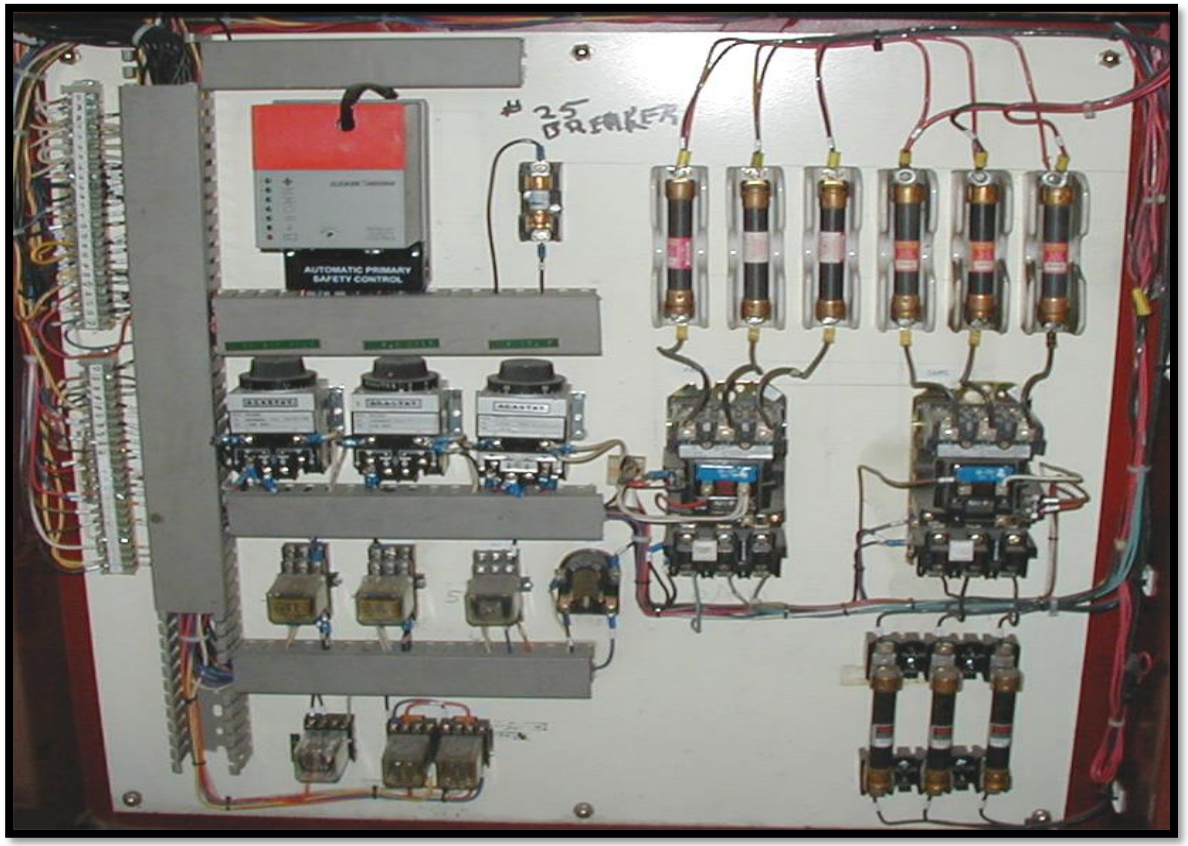
- Check condensate receivers
  - Flush out
  - Check any lining for failure
  - Clean pump strainers

Annual Maintenance

- Check chemical feed system
  - Clean out tank
  - Recondition pump
  - Inspect & clean out piping to injection points

Annual Maintenance

- Tighten electrical terminals
  - Power off!!
  - All panels, all controls & components

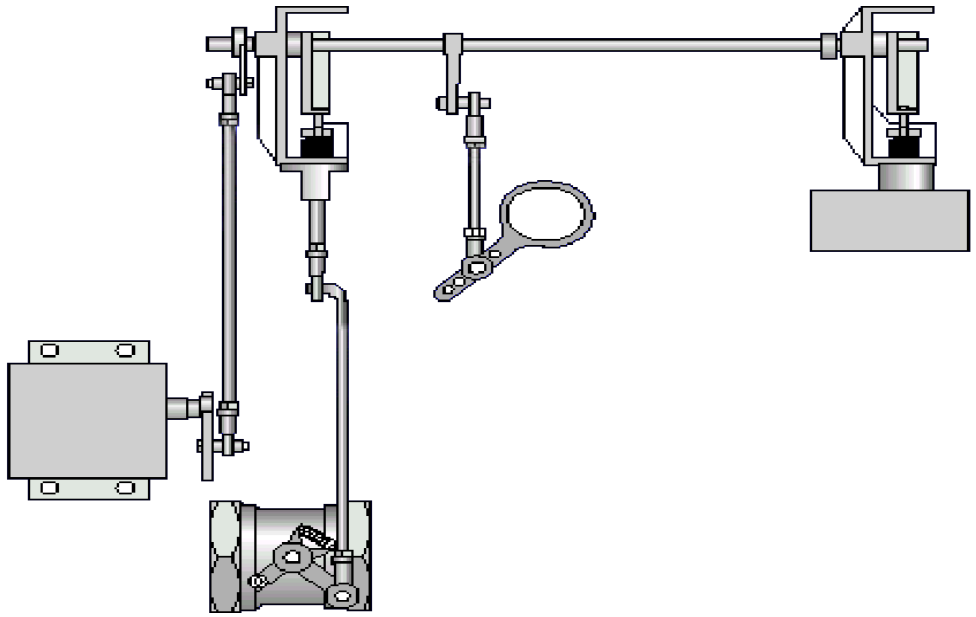


Annual Maintenance

- Check deaerator or boiler feed system
  - Water spray head
  - Collector cone assembly & steam atomizing valve of spray types
  - Check any possible lining
  - Clean out pump strainers

Annual Maintenance

- Check linkages
  - Lubricate
  - Tighten
  - Replace worn parts



Boiler Room Log

- Water level
- Steam pressure / water temperature
- Feed pump pressure
- Feed water temperature
- Condensate temperature
- Flue gas temperature
- Gas pressure
- Oil pressure
- Oil temperature
- Deaerator water level

Steam Cleaver-Brooks Boiler Room Log

Date						
Time						
Boiler #						
Operator						
Water visible in gauge glass						
Combustion check (visual)						
Steam pressure						
Feedwater pressure						
Feedwater temperature						
Flue gas temperature						
Burner						
Gas pressure						
Gas meter reading						
Oil pressure (regulated)						
Oil temperature						
Oil meter reading						
Atomizing air pressure						
Ambient air temperature						
Barometric pressure						
Blowdown water column						
Blowdown boiler						
Comments/Observations						

Note: Record water analysis and treatment on separate log.

PBBS EQUIPMENT CORPORATION

DAILY BOILER INSPECTION

BOILER NUMBER:	DAY	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	DATE							
	TIME							
RECORD GAS METER READING	CU FT/HR							
RECORD TOTALIZED GAS USAGE	CU FT							
RECORD GAS PRESSURE BEFORE GAS REGULATOR	PSI							
RECORD GAS PRESSURE TO GAS TRAIN	INCH'S							
RECORD BURNER MANIFOLD PRESSURE	INCH'S							
RECORD OUTDOOR TEMPERATURE	DEG F							
RECORD INDOOR TEMPERATURE	DEG F							
RECORD STEAM FLOW	LBS/HR							
RECORD TOTALIZED STEAM USAGE	LBS							
RECORD BOILER OPERATING PRESSURE	PSI							
RECORD BOILER WATER LEVEL	INCH'S							
RECORD FEEDWATER PRESSURE (PUMP RUNNING)	PSI							
RECORD FEED TANK TEMPERATURE	DEG F							
RECORD MAKEUP WATER FLOW	GPM							
RECORD TOTALIZED MAKEUP WATER USAGE	GAL							
RECORD MAKEUP WATER TEMPERATURE	DEG F							
RECORD FLUE GAS TEMPERATURE	DEG F							
RECORD FLAME SIGNAL	MIN 10							
CHECK THAT GAGE GLASS IS CLEAN								
CHECK IF GAGE GLASS IS CRACKED/BROKEN								
CHECK OPERATING CONTROLS								
CHECK WATER LEVEL CONTROLS								
CHECK COMBUSTION VISUALLY								
CHECK GENERAL BURNER OPERATION								
CHECK GENERAL BOILER OPERATION								
BLOWDOWN BOILER								
BLOWDOWN WATER COLUMN								
TREAT WATER ACCORDING TO PROGRAM								
COMMENTS								

THIS LIST CONSISTS OF RECOMMENDED INSPECTION / MAINTENANCE - IT MAY NOT INCLUDE ALL POINTS OF INSPECTION / MAINTENANCE FOR THE SPECIFIC BOILER ROOM.
IT MAY BE BENEFICIAL TO EXPAND UPON THIS LIST FOR RECORD KEEPING AND MAINTENANCE PURPOSES. THIS LIST DOES NOT GUARANTEE UNFORESEEABLE BOILER FAILURES, BUT WILL CONTRIBUTE TO IMPROVED BOILER MAINTENANCE.

PBBS EQUIPMENT CORPORATION

RECOMMENDED INSPECTION / MAINTENANCE BOILER ROOM LOG

WEEKLY BOILER INSPECTION

DATE							
BOILER NUMBER: **TIME**							
CHECK FOR TIGHT CLOSING OF FUEL VALVES							
RECORD SHUT DOWN TIMING WHEN GAS VALVE CLOSES							
CHECK FUEL LINKAGE							
CHECK AIR LINKAGE							
CHECK INDICATING LIGHTS AND ALARMS							
CHECK OPERATING CONTROLS							
CHECK WATER LEVEL CONTROLS							
CHECK LIMIT CONTROLS AND LIMIT SWITCHES							
CHECK SAFETY CONTROLS							
CHECK INTERLOCK CONTROLS							
CHECK LOW WATER CUTOFF OPERATION							
CHECK FOR:							
LEAKS							
NOISE							
VIBRATION							
UNUSUAL CONDITIONS							
CHECK OPERATION OF ALL MOTORS							
CHECK GENERAL BURNER OPERATION							
CHECK GENERAL BOILER OPERATION							
CHECK LUBRICATING OIL LEVELS							
CHECK FLAME SCANNER ASSEMBLY							
CHECK IGNITION SYSTEM							
CHECK FLAME SIGNAL							
CHECK PACKING GLANDS							

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RECOMMENDED INSPECTION / MAINTENANCE BOILER ROOM LOG

MONTHLY BOILER INSPECTION

DATE							
BOILER NUMBER: TIME							
INSPECT BURNER							
INSPECT HEATING SURFACES							
INSPECT FOR HOT SPOTS							
INSPECT FOR FLUE GAS LEAKS							
INSPECT FLUE/STACK DAMPERS FOR PROPER OPERATION							
ANALYZE COMBUSTION							
CHECK COMBUSTION AIR SUPPLY							
CHECK ALL FILTER ELEMENTS							
CHECK FUEL SYSTEM							
CHECK HIGH AND LOW GAS PRESSURE SWITCHES							
CHECK CAMS							
CHECK BELT DRIVES							
CHECK LUBRICATION REQUIREMENTS							
REVIEW BOILER BLOWDOWN PROCEDURES							

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RECOMMENDED INSPECTION / MAINTENANCE BOILER ROOM LOG

SEMI-ANNUAL INSPECTION

DATE							
BOILER NUMBER: TIME							
INSPECT BURNER COMPONENTS							
INSPECT REFRACTORY							
INSPECT MERCURY SWITCHES							
CLEAN LOW WATER CUTOFFS							
CLEAN AIR DAMPER							
CHECK FLAME FAILURE RESPONSE							
CHECK FLAME SAFEGUARD COMPONENTS							
CHECK PIPING							
CHECK PIPING OF ALL SHUT OFF VALVES							
CHECK WIRING OF ALL INTERLOCKS OF SHUT OFF VALVES							
CHECK HAND-HOLE GASKETS							
CHECK COMBUSTION AND ADJUST IF NECESSARY							

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PBBS EQUIPMENT CORPORATION

RECOMMENDED INSPECTION / MAINTENANCE BOILER ROOM LOG

ANNUAL INSPECTION

DATE							
BOILER NUMBER: TIME							
INSPECT FIRESIDE SURFACES							
INSPECT WATERSIDE SURFACES							
INSPECT BREECHING							
CLEAN FIRESIDE SURFACES							
CLEAN WATERSIDE SURFACES							
CLEAN BREECHING							
TEST SAFETY VALVES							
CHECK OPERATING PRESSURE CONTROLLER							
CHECK HIGH PRESSURE CONTROLLER							
CHECK OTHER BOILER SAFETY CONTROLS							
CHECK BOILER FEED PUMPS							
CHECK CONDENSATE RECEIVERS							
CHECK CHEMICAL FEED SYSTEMS							
CHECK DRIP LEG / STRAINER							
CHECK AUTOMATIC CHANGE OVER CONTROL							
CHECK FLUID LEVELS ON HYDRAULIC VALVES							
TIGHTEN ALL ELECTRICAL TERMINALS							
GAS PILOTS - CONDUCT PILOT TURNDOWN TEST							
REPLACE IGNITION AND FLAME RODS							
PERFORM GAS LEAKAGE TEST							
CHECK COMBUSTION AND ADJUST IF NECESSARY							

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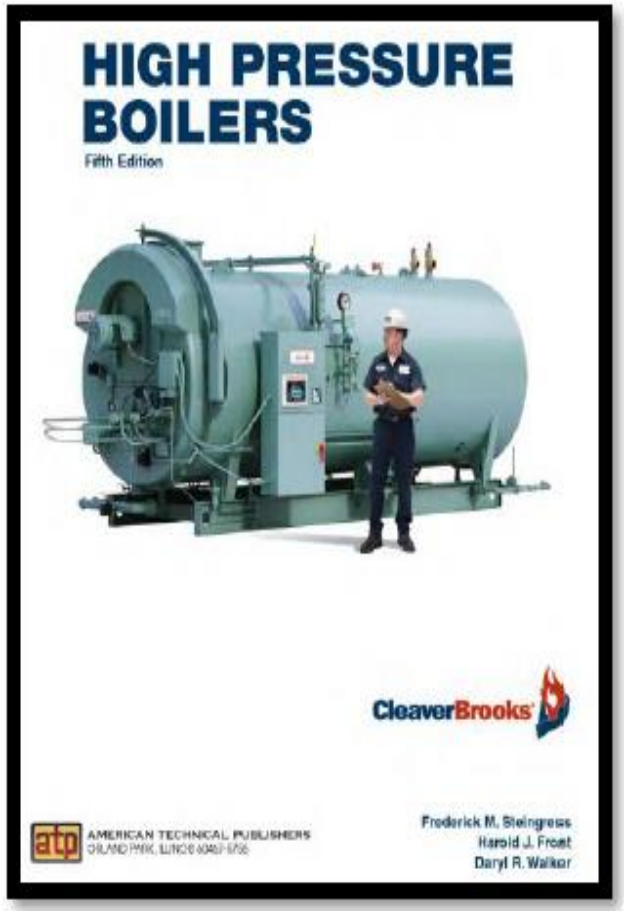
Boiler Room Essentials is an online, self-paced learning course designed to educate individuals that are looking for a career in the steam boiler operations field or just gain an understanding of the high-pressure steam boiler industry.

Includes a textbook and CD

If interested contact PBBS for further information.

Information is included on the USB.

Price if purchased thru PBBS is 395.00



Thank You!

For any questions or further information please contact me at:

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