2.1.1 Steam Drum

The steam drum contains water inside the boiler and liberates the steam generated within the boiler. The Boiler Steam Drum, shown in Figure 20, is located at the top of the Boiler. It is a cylinder with hemispherical ends to contain pressure inside. Elliptical manways are installed at each end of the Boiler Steam Drum. The lower half of the Boiler Steam Drum is perforated with holes for the boiler tubes.

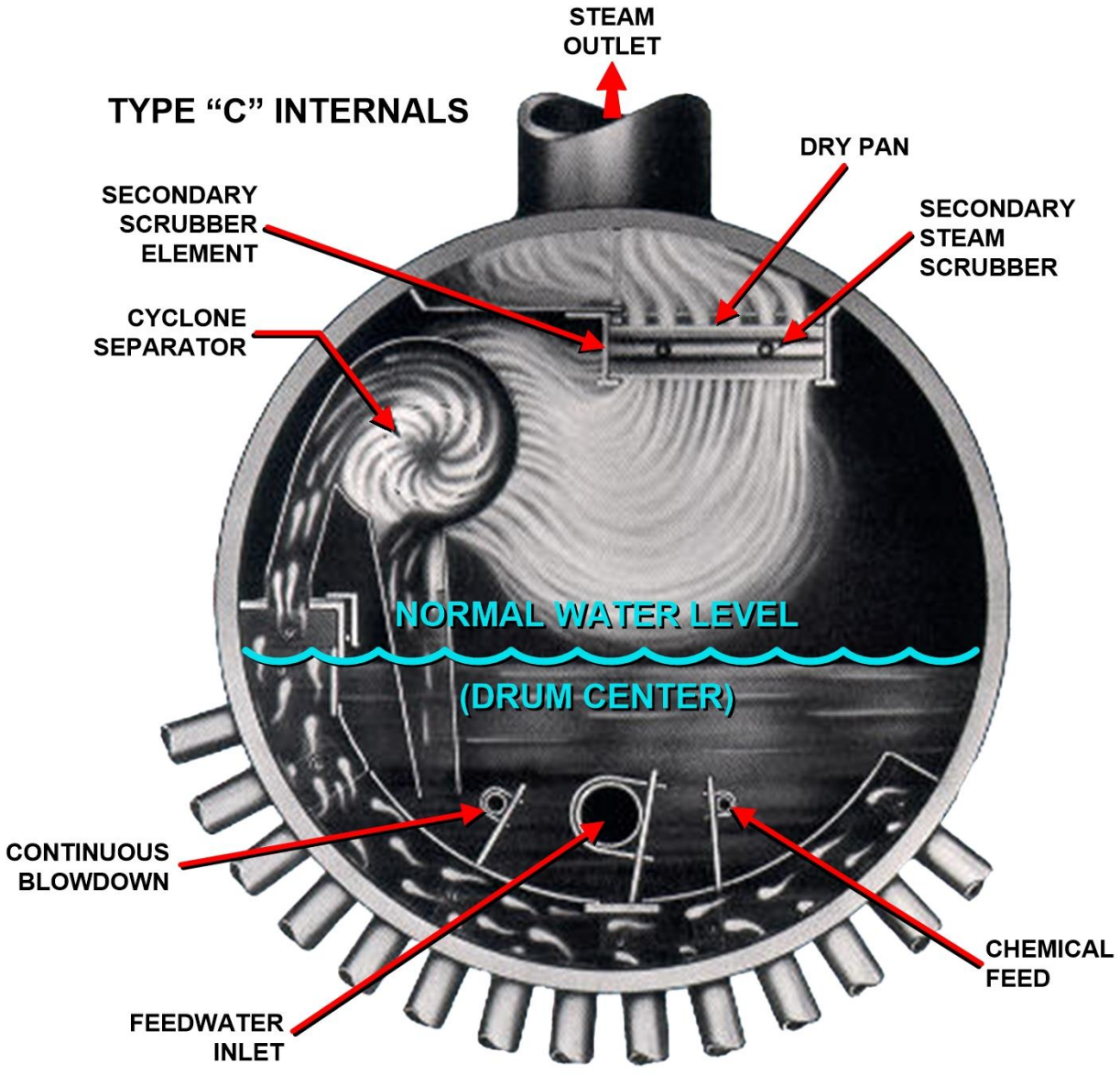

Figure 20 – Typical Steam Drum

The function of the steam drum is to provide primary separation of water and steam. The steam drum also serves as a reservoir for water to be supplied to the boiler tubes. The steam drum is 54 inches in diameter (nominal ID), constructed of 3.75” thick SA516-70 (carbon steel), and approximately 33 feet long.

The steam drum has the following accessories/connections:

- Feedwater Supply
- Solid and Perforated Plates
- Steam Separating Equipment
- Safety Valves
- Chemical Feed Line
- Boiler Continuous Blow-down System (Used to control Boiler Water NexGuard Concentration)
- Steam Drum Vent
- Level & Pressure Transmitters

Normal water level is at the centerline (or slightly below) of the steam drum. The lower portion of the drum is equipped with tube penetrations to receive the terminating ends of the downcomers and risers.

The steam drum receives a mixture of water and steam that has passed upward through the boiler tubes. The steam and water arrive under apron plates which divert the water back to the lower drum while allowing the steam to pass upward through a series of cyclone separators. This steam fills the upper half of the steam drum and leaves through a secondary scrubber element which removes the moisture. The steam then passes on to the superheater.

Feedwater Supply

A feedwater pipe extends into the drum (west end) to admit feedwater so that complete mixing of feedwater and existing boiler water is accomplished before the water reaches the downcomer tubes. Feedwater supply to the boiler steam drum is discussed in detail in Section 2.2 . The location where feedwater enters the steam drum west end is shown in Figure 21.

Figure 21 – Feedwater Supply to Steam Drum (West End)

Solid and Perforated Plates

A floor plate in the bottom of the steam drum collects all of the steam generated in the boiler. The floor plate directs the steam up to a horizontal cyclone steam separator. The cyclone steam separator induces a spinning flow of the steam and water mixture. Centrifugal force from the spinning forces the water to the outside of the separator, which then drains to below the water level in the steam drum. The steam exits the center of the separator, entering the steam area of the steam drum where it exits the steam drum through a scrubber.

Steam Separating Equipment

Steam separating equipment is provided in the boiler steam drum to obtain separation of steam and water. “Clean” (containing low solids), “dry” (containing little moisture) steam is produced if the correct water level is maintained, boiler water solids and alkalinity do not exceed the maximum limits, boiler load does not exceed design rating, and the equipment is installed and maintained properly.

Separation of the steam-water mixture rising from the generating tubes is achieved in the gas boilers by use of internal baffling in the form of cyclone separators, scrubbers, and dry pans, shown in Figure 22.

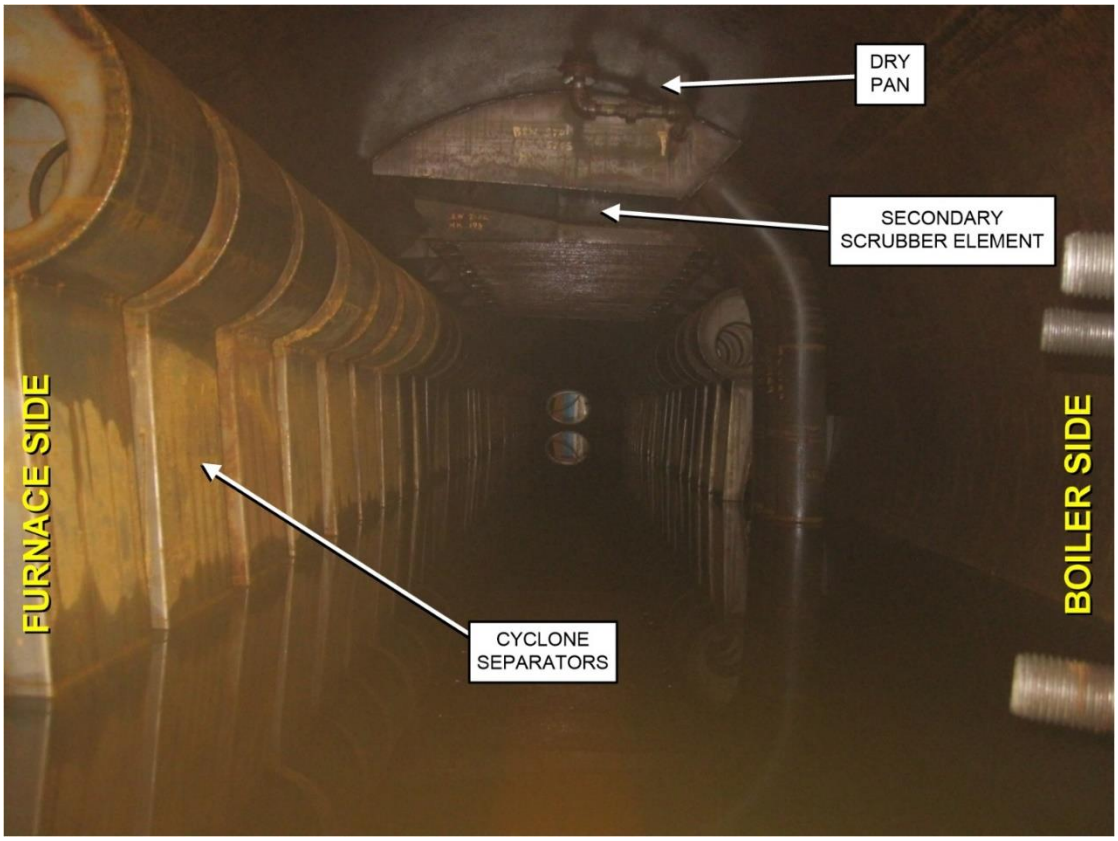

Figure 22 – Steam Drum Internals

The purpose of the cyclone steam separators (Figure 23) is to remove moisture droplets in the saturated steam before sending it to the superheater. These types of steam separators are typically only used on boilers with superheaters, such as the gas boilers at Abbott. The cyclones are located inside the boiler steam drum.

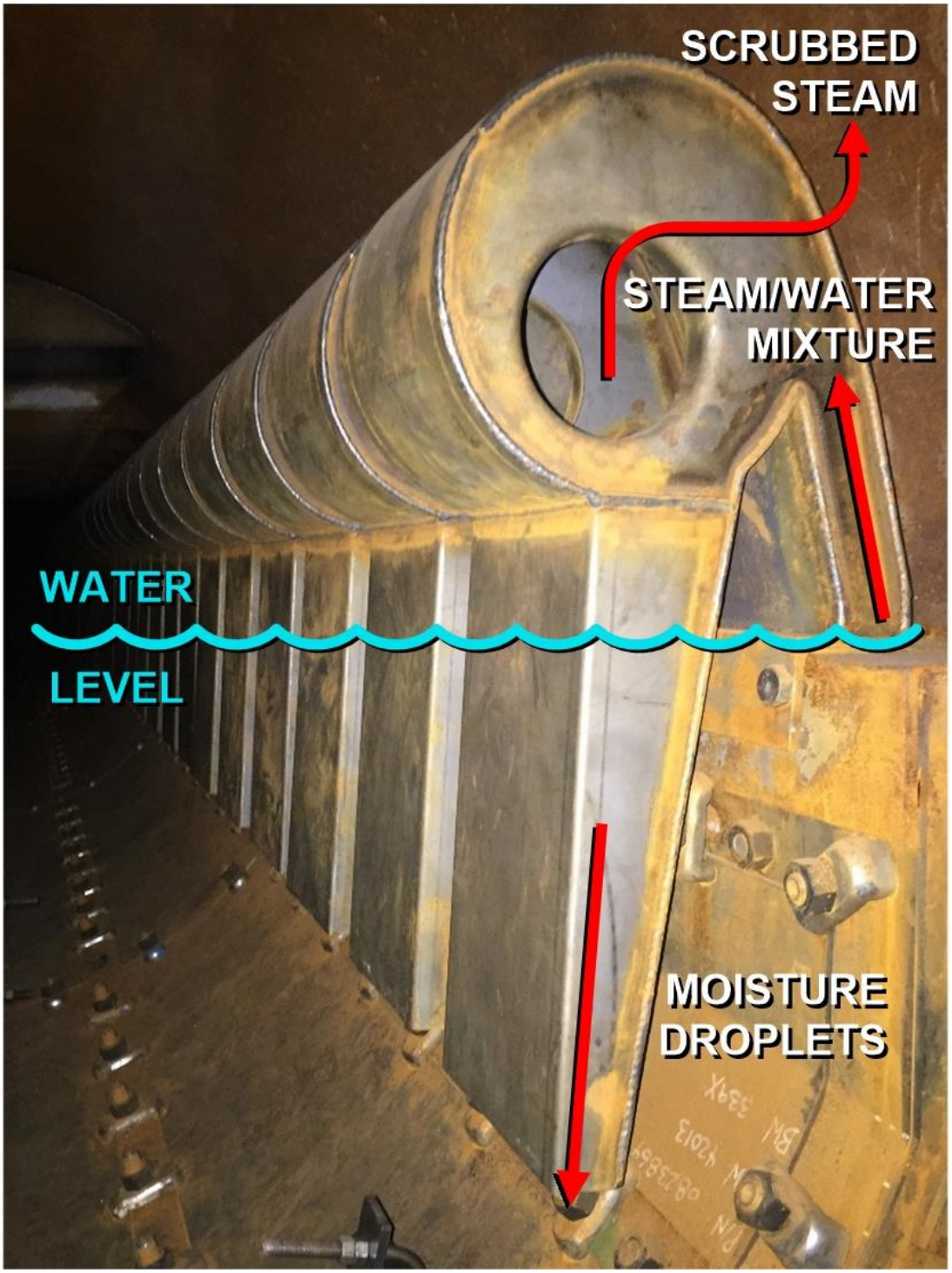

Figure 23 – Cyclone Steam Separator

Steam Drum Safety Valves

Safety valves are mounted on the steam drum to prevent over pressurization of the boiler. These valves open when their set pressure is exceeded and close when the drum pressure is sufficiently reduced. The steam drum safeties are described in detail in Section 2.1.5 .

Chemical Feed Line

A chemical feed pipe discharges chemicals between the boiler feed discharge and downcomers so that complete mixing of chemicals and boiler water is accomplished before reaching the downcomers. The chemical feed line, where it enters the steam drum, is shown in Figure 24.

Supplemental internal boiler water treatment is accomplished by injecting chemicals through the chemical feed line which discharges into a turbulent flow zone, ensuring thorough mixing with boiler water before the mixture enters the downcomers. The continuous blowdown and chemical feed lines are separated so that injected chemical cannot flow directly to the blowdown.

It should be noted that the chemical feed line is equipped with heat tracing. NexGuard, the chemical supplied to the boiler for water treatment, will start to solidify at approximately 40°F. The heat tracing ensures the NexGuard maintains its liquid state on the way from the chemical feed skid to the boiler steam drum.

The chemical feed system for the gas boilers is described in Section 2.7 .

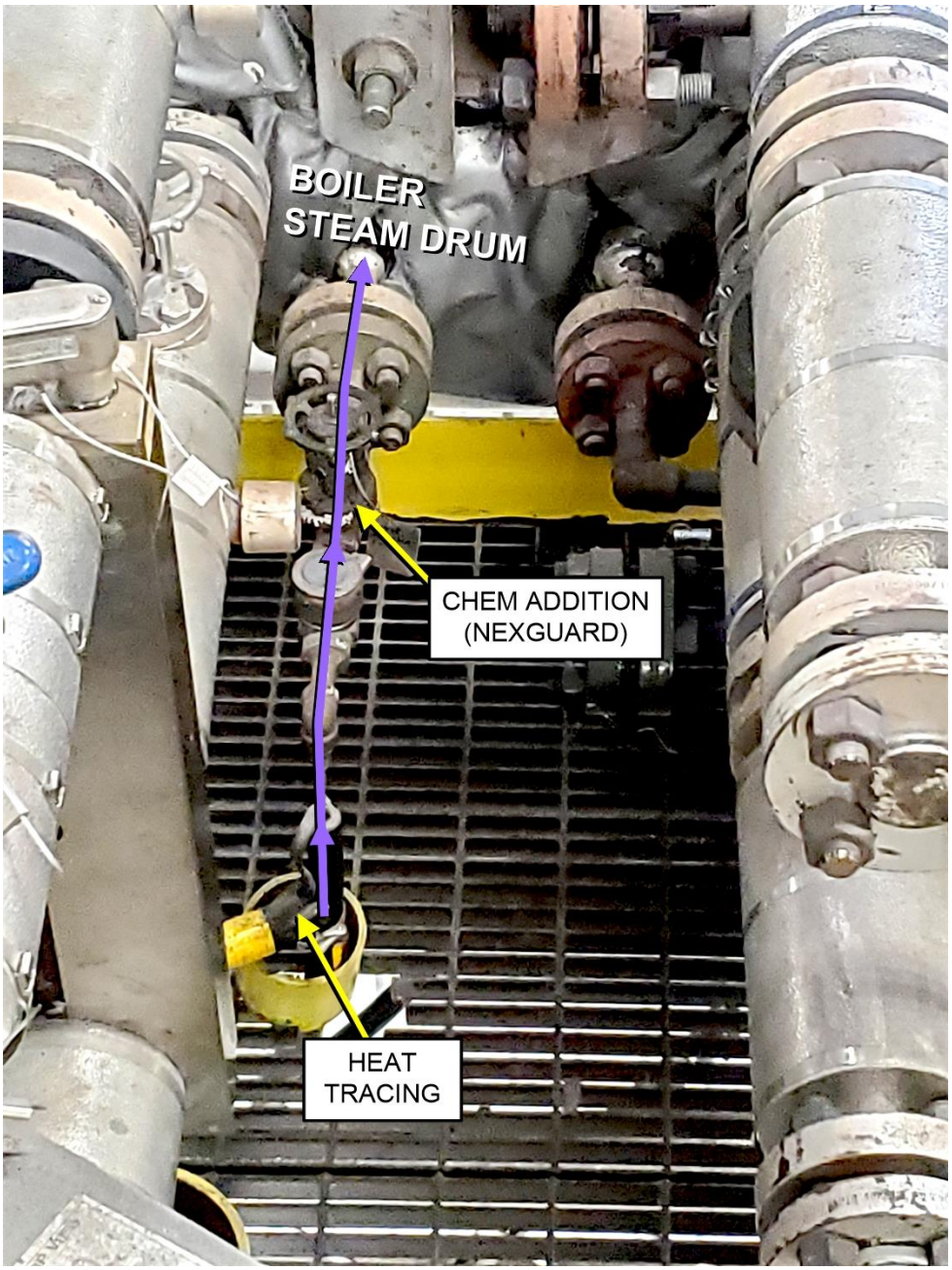

Figure 24 – Boiler Chemical Feed Line

Continuous Blow-down Line

An open ended continuous blowdown pipe is installed in the steam drum to control boiler water solids and NexGuard Concentration. The continuous blowdown system for the gas boilers is described in detail in Section 2.6.1 .

Steam Drum Vent

A pair of manually-operated vent valves in series are mounted on the top of the steam drum. This vent valve is closed during normal operation. It is opened at startup to vent air from the boiler during initial firing until the drum pressure increases to about 15 psig. The vent valve is opened when the boiler is shut down to cold condition to prevent the creation of a vacuum in the steam drum. The steam drum vent valves for boilers 1&2 are on the west end of the steam drum as shown in Figure 25, while the drum vent valves for the boiler 3 steam drum are on the east end.

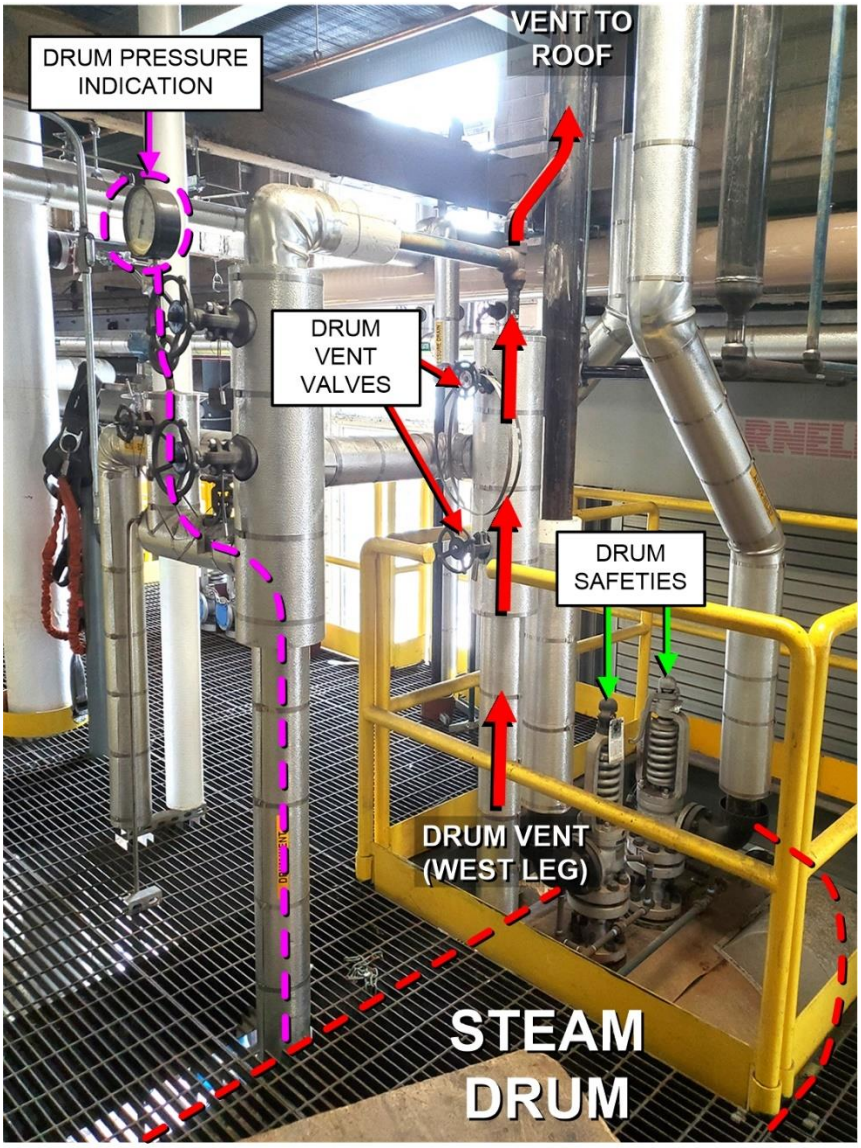

Figure 25 – Steam Drum Vent Valves

With the boiler cold, the steam drum vent valves should be in the full OPEN position. Start the burner and warm the boiler (per temperature guidelines). Once the steam drum pressure increases to 15 psig, CLOSE the steam drum vent. The Steam Drum vent should remain in the CLOSED position during normal operation of the boiler.

With the boiler operating, the steam drum vent valve should be in the fully CLOSED position. During a boiler shutdown and cooldown, once the steam drum pressure decreases to 25 psig, crack OPEN the steam drum vent.

Level & Pressure Transmitters

There are numerous drum level instruments on the east end of the steam drum, shown in Figure 26. These instruments provide signals to the boiler control system and provide operators both local and remote indications of level and pressure in the boiler.

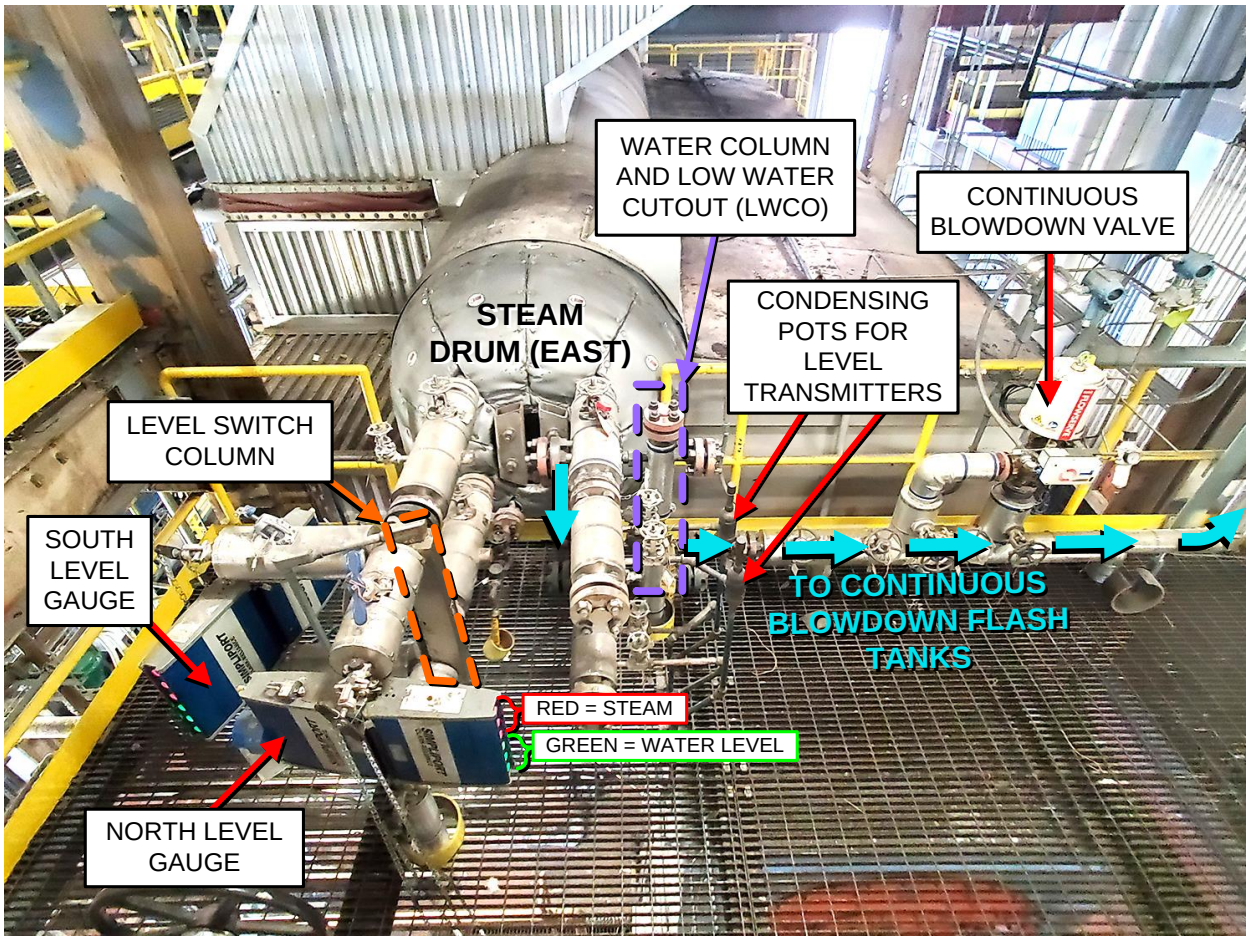

Figure 26 – Steam Drum (East End)

The steam drum contains both level and pressure controls for the boiler. Drum pressure is monitored by a pressure transmitter and measured locally by a pressure gauge. The steam drum water level is measured by the following devices:

- Locally via two Simpliport Bi-Color level gauges (Figure 27).
- Remotely in the Control Room via level transmitters (Figure 28).
- Level column with level switches, a float, and alarms: high level, low level, low-low level cutout, and auxiliary cutout.
    - High level switch, low level switch, low-low level switch cutout, and auxiliary low-low cutout switch.
    - The low-low and auxiliary low level switches cause a Master Fuel Trip (MFT) if the specified level is reached.

Chain operated valves are used for putting the gage glass in and out of service. In the event of a gage glass failure, these chain operated valves must be used to shut-off the gage glass.

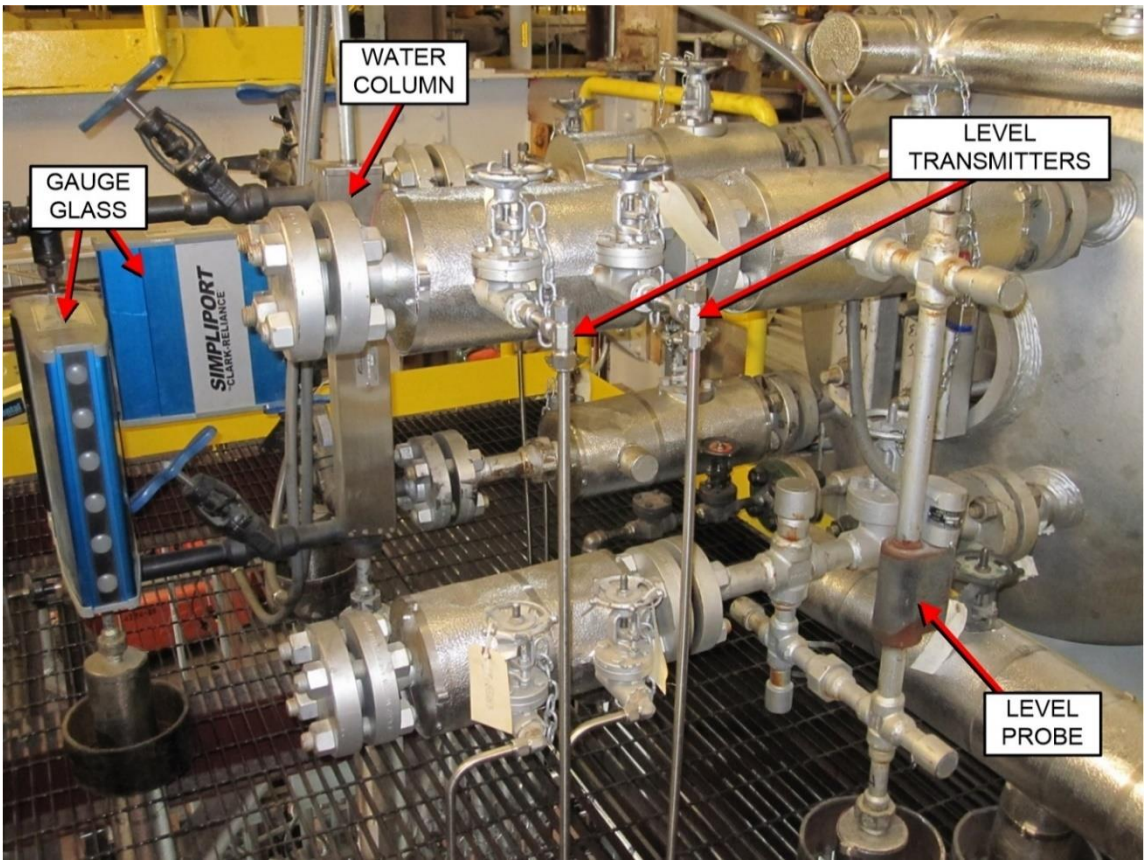

Figure 27 – Drum Level Instruments

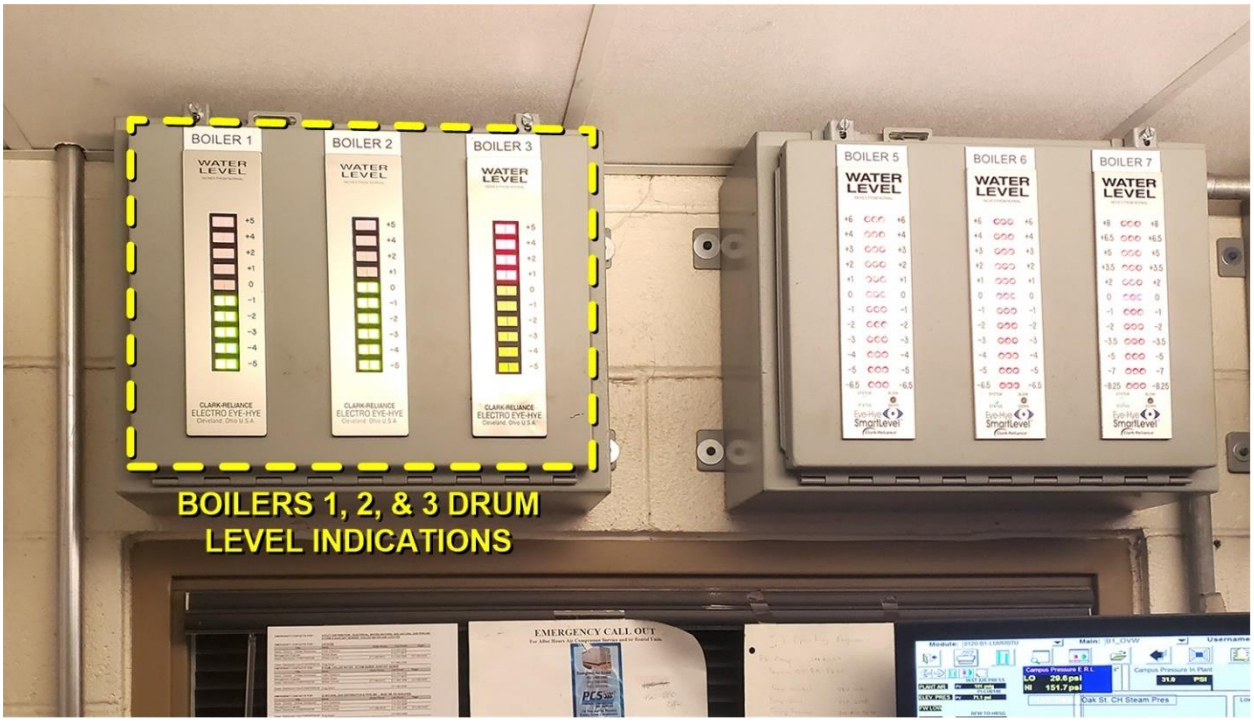

Figure 28 – Control Room Drum Level Monitoring

It should be noted that there are two Simpliport Bi-color level gauges for monitoring the boiler steam drum level locally at the steam drum. A photograph of these level gauges is shown in Figure 29 and an illustration of how these level gauges function is shown in Figure 30. Normally, only one of these level gauges is in operation and the other is isolated. The gauges are swapped weekly to equalize runtime.

On the Simpliport Bi-color level gauges, red indicates steam and green indicates water. The point at which red and green meet is the current steam drum water level. As illustrated in Figure 30, a red and green LEDs are aimed through the gauge glasses. When steam is present, the red LED strikes the gauge glass to indicate steam is present at that level. When water is present, the green LED strikes the gauge glass to indicate that water is present at that level.

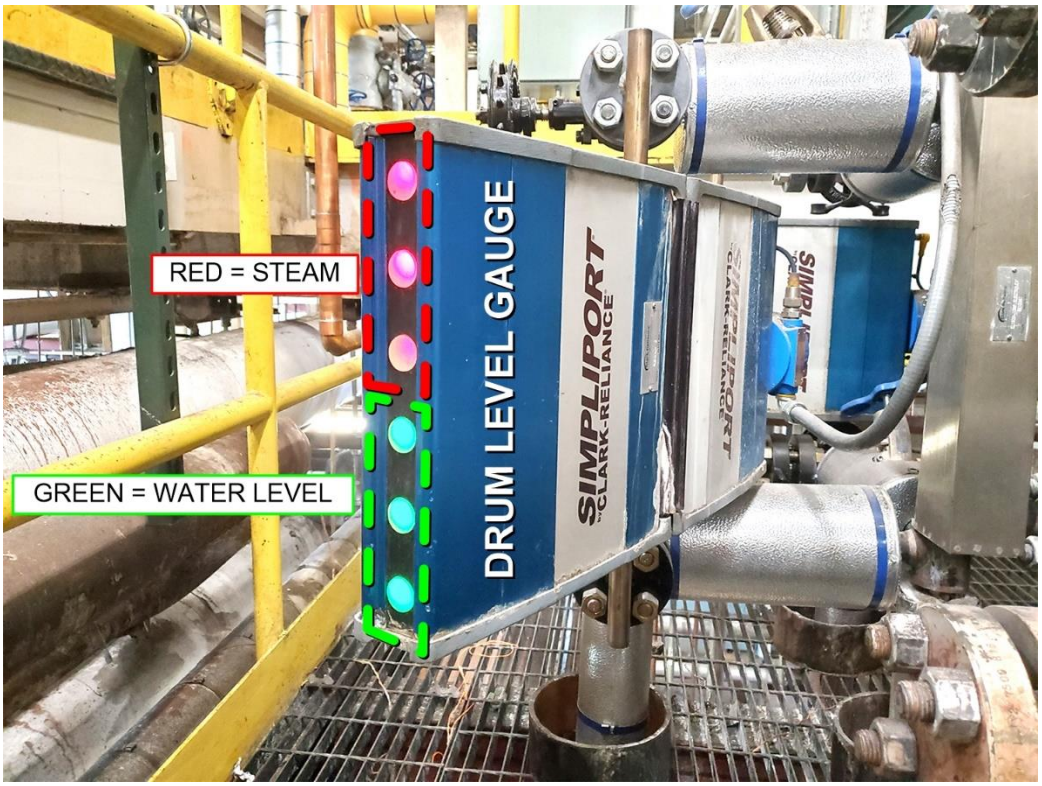

Figure 29 – Simpliport Bi-Color Steam Drum Level Gauge

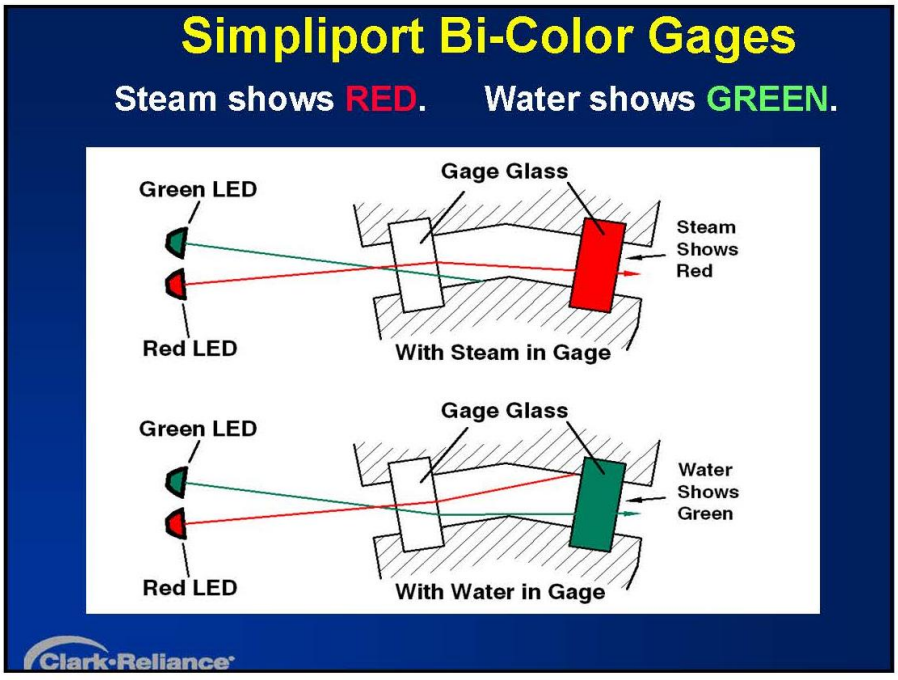

Figure 30 – Gauge Glasses