Combined Cycle Power Plant Visual Level Gauges for HRSG Applications

Combined cycle power plants generate electricity in two ways. First, natural gas or light oil is burned in a combustion turbine that directly operates a generator. Second, the exhaust gases from the turbine pass through a heat exchanger and produce steam. This steam powers a steam turbine connected to a generator. The heat exchanger used in this process is called a "Heat Recovery Steam Generator" (HRSG).

In order to obtain maximum efficiency from this process, the HRSG tube bundles are normally divided into more than one group, and produce steam at more than one pressure. Typically, three groups are used:

1. High Pressure (HP), 1800 to 2400 psi
2. Intermediate Pressure (IP), 500 to 800 psi
3. Low Pressure (LP), 100 to 200 psi

Each HRSG tube section requires a separate steam drum. The American Society of Mechanical Engineers (ASME) has established the requirements for steam drum level gauges. The ASME Boiler and Pressure Vessel Code require at least one visual level gauge for every steam drum. The visual level gauge is the only product considered to give "Direct" indication of steam drum water level. Section PG-60 of the ASME B and PV Code addresses these water level indicator requirements. From the 2001 code, some of the requirements within these paragraphs include the following:

"**PG-60.1** *All boilers having a fixed water level (steam and water interface) shall have at least one gage glass (a transparent device that permits visual determination of the water level).*

Gage glasses having multiple tubular sections shall have a minimum of 1" (25mm) overlap of the sections in which the water level may be visible.

Segmented gage glasses, such as ported or end-connected strip gages, shall be equipped to provide obvious visual discrimination between water and vapour in the individual sections.

PG-60.1.1 *Boilers having a maximum allowable working pressure exceeding 400 psi shall have two gage glasses. Instead of one of the two required gage glasses, two independent remote water level indicators (two discrete systems that continuously measure, transmit, and display water level) may be provided.*

PG-60.1.1.1 *When the water level in at least one gage glass is not readily visible to the operator in the area where control actions are initiated, either a fiber optic cable (with no electrical modification of the optical signal) or mirrors shall be provided to transfer the optical image of the water level to the control area. Alternatively, any combination of two of the following shall be provided: (a) an independent remote water level indicator; (b) an independent continuous transmission and display of an image of the water level in a gage glass.*

PG-60.1.1.2 *When two independent remote water level indicators are in reliable operation (continuously indicating water level), the one required gage glass may be shut off, but shall be maintained in the serviceable condition.*"

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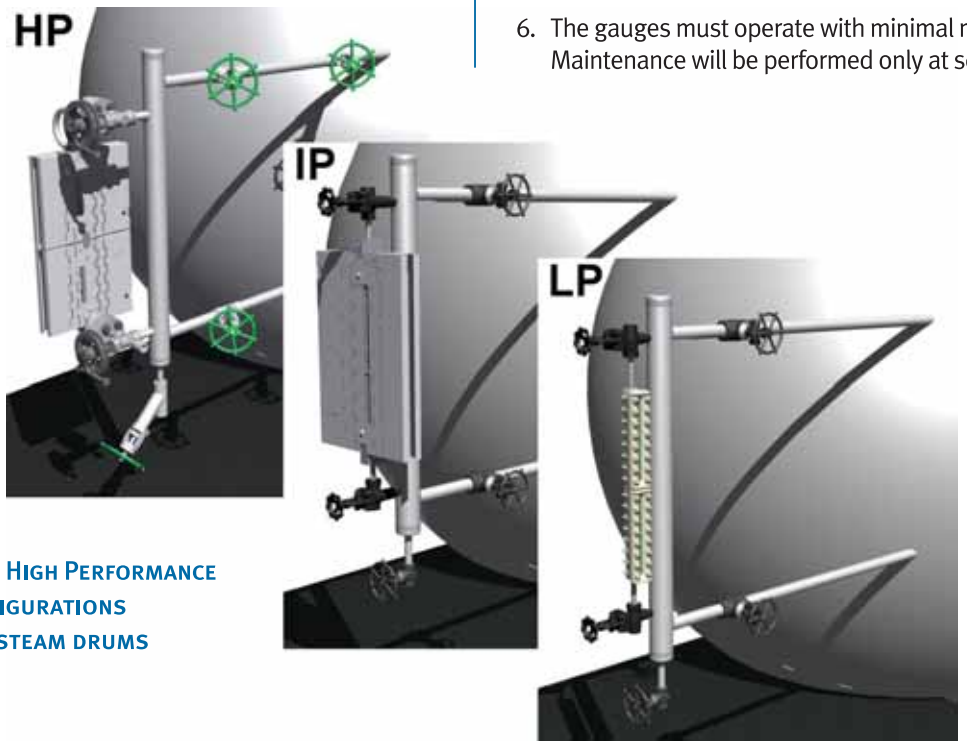
Visual Level Gauge Considerations

There are several factors that make these visual gauge applications unique from the typical coal and oil fired high pressure power boilers exclusively used in the past:

1. One boiler unit has three steam drums at three design pressures
2. The steam drums are typically much larger
3. The power plant is often located outdoors
4. The control room is a significant distance from the power plant
5. These plants are normally used for “peaking loads”, and can be started up and shut down quickly.
6. Since these designs are less complex, shift operating and maintenance personnel are fewer. In addition, the equipment can be reached only by stairs, making access more difficult.

These Factors Have Produced the following visual gauge design requirements:

1. Three cost effective designs for visual gauges, valves and piping are required
2. Visual gauges require large visibilities. The ASME code requirement for overlapping sections when using transparent gauges makes these designs impractical.
3. Gauges and accessories must be able to withstand the elements for the life of the plant. Equipment may require heat tracing.
4. The visual gauge image will not be transmitted to the control room. There will be a stronger reliance on “indirect” level measurements.
5. Equipment must be capable of frequent start up and shut down. These thermal cycles will cause steam leaks from inadequate designs.
6. The gauges must operate with minimal maintenance. Maintenance will be performed only at scheduled outages.



Diagrams showing High Performance Visual Gauge configurations for each of these steam drums

References

1. ASME Boiler and Pressure Vessel Code, 2001
2. Aquarian 3000V Visual Level Gauge Brochure, PN 9340-1106
3. Aquarian 3000V Gauge Illuminator Brochure, PN 9340-1116

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