Drum Level Instrumentation
and
The ASME Boiler Code Requirements

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Presented by: Jim Kolbus
Topics

- ASME Code Section 1 Requirements for Drum Level Instrumentation
- Water Columns and Water Gage Isolation Valves
- Prohibition of Structural Webs in Water Gage Glasses
- End to End Reflex Type Water Gages
- Magnetic Level Gages
- Code Design Requirements for Isolation Valves
- New Level Switch requirements for HRSG applications
- Low Water Cutouts
- Common Code Violations
- Recommendations for Level Instrumentation Piping
ASME Code General Terms

Direct Reading Gage

Indirect Reading Gage

Glass Gage

Remote Level Indicator
Direct Reading Gages

- Tubular Glass to 250 PSI
- Prismatic (Reflex) to 350 PSI
- Flat Glass (Transparent) to 2000 PSI
- Bi-Color to 3000 PSI
Remote (Indirect) Level Indicators

Conductivity Probe Type
Level Indication System

PLUS OTHER TECHNOLOGIES
- Differential Pressure Transmitters
- Guided Wave Radar

Magnetic Level Gage
(equipped w/ 4-20 transmitter)
ASME Boiler Code

Water Gage Requirements:

Operating up to 400 PSIG
One Direct Reading Gage Required
(which must be kept continuous service)

Operating over 400 PSIG
Two Direct Reading Gages in service
OR
Two Remote (Indirect) Level Indicators
On Continuous Display for the
Operator and One Direct Reading Gage
(Which may be isolated but kept in serviceable condition)
Code Requirements for Gage Glass Placement

Level “A” = Lowest Permissible Water Level, at which there will be no danger of overheating the vessel.
Water Gage Glass Placement Explained

1. Lowest Permissible Water Level- At which level there will be no danger of overheating (Level A).
2. Water Connection for Water Column- Must be 1” below low visibility point of gage glass and at least 1” NPT. The line must be level or slope downward from column to drum.
3. Steam Connection for Water Column-Same as 2 above. Except slope downward from drum to column.
4. Steam Connection may come out of top of vessel- Centerline of steam connection would be at point marked “B”.
5. The lowest visible part of water gage glass-Must be at least 2” above the lowest permissible water level (Level A).
6. The highest visible part of water gage glass-Must be at least 1” below center of steam connection.
7. Gage cock connections- Must not be less than 1/2” pipe size and located within gage visibility range “V”. (Gage cocks are no longer required by ASME)
**Water Columns (PG - 60.2)**

- 1” min. connection size for water column to boiler (PG-60.3.4)
- 3/4” min. drain connection size (PG60.2.3)

Stainless Steel is prohibited for the construction of water columns (PG12.3)

**Water Level Indicators (PG-60.1)**

* Water Gage Glass Requirements ( PG-60.1.1)
* Gage Glass & Connections ( PG-60.3)
* 3/4” min. connection size for Remote (Indirect) level indicators (PG-60.3.4)
* Highest visible permissible water level (PG - 60.3.2)
* Lowest visible permissible water level ( PG.60.3.3)
* Stainless Steel for Gage Glass Body (PG-12)
* Magnetic Level Gage Chambers permitted up to 900 PSI (PG-12), as of 2007
* 1” Gage overlap requirement for Transparent Gages (PG-60.1), since 1996
* Transverse or Cross Web Structural Webs are prohibited from use in the construction of Transparent type Water Gage Glasses, which may obstruct the view of the level (PG60.1), as of 2009

**Ball Checks in Water Gages Valves** considered to be a user option, if specified, must meet the Code requirements (Automatic Shut Off Valves – Appendix A-18)
Gage Cocks (Trycocks) are not required (PG-60.4), since 1991 Many Operators continue to rely on Gage Cocks

Magnetic Water Level Gage: permissible for applications up to 900 PSI External switches are not permitted for control Purposes, such as Low Water Cutouts (PG.12 and PG.60)
Code Limitations for Materials Used for Pressure Parts

- Cast Iron to 250 PSI
- Ductile Iron to 350 PSI
- SB-61 Bronze to 450 PSI
- SA106 Carbon Steel Pipe or SA105 Forgings to 3000 PSI
Water Columns

- Cast Iron Water Columns are permissible up to 250 PSI
- Fabricated Steel Water Columns are used for applications up to 3000 PSI
- Three types of Water Column Functions
  - No Alarm for the sole purpose of supporting one or two water gage glasses
  - Float Alarm Type
  - Electrode (conductivity Probe) Type for Alarms and Cut Outs (Trips)
Water Columns and Tie Tubes

• Water Columns are not required on Power Boilers by ASME Boiler Code, but when specified, must be designed and manufactured to comply with Code.

• Water Columns are considered to be a Standard Pressure Part or Standard Welded Part as defined in Section 1: PG-11 of the ASME Boiler Code. Therefore, a code stamp for manufacturing is not required. The use Code recognized materials and applicable welding procedures are a must.
Always Install Chain Operators for Operator and Plant Safety

PG.60.1.7 requires an accessible operating mechanism from the isolation valves to the operating floor or platform.
Structural Webs are Prohibited From Flat Glass Gages Designs

- These Webs may mask the actual location of the water level
- The risk of Masking the level is enhanced on elevated gage glass installations
End-to-End Reflex Gage Glasses Are Permitted

- PG.60.1 Clarifies the use of multi-section gages without overlap, due to the light refraction principle.
Globe type valves are now permitted if the lowest edge of the seat is at least 25% of the port diameter.

In-line flow prevents sediment or condensate traps, which can lead to false level indication.
Magnetic Water Level Gages

Magnetic Level Gage
(equipped w/ 4-20 transmitter)

For Process

For Power Boilers
Code Issues and Concerns for the Use of Magnetic Level Gages on Boiler Drums

- Acceptable as an acceptable Indirect Reading for applications Gage up to 900 PSI (Ref: PG12.2)

- The Indication Scale must follow ASME guidelines (Ref: PG-60.3.2 & PG60.3.3)

- May not be used to support a water Gage glass, due to prohibition of stainless steel construction for water columns. Ref: PG-12.3

- No accessories are permitted to be attached for control purposes (No Trip Switches). This device must be used for indication only. Ref: PG-60.1.1.4

NOTE: The use of a Magnetic Level Gage does not replace the Code requirement for a Direct Reading Water Gage Glass on any Power Boiler Drum designed to meet the ASME Section 1 Boiler Code.
Concerns for the Application of Magnetic Water Gages on Boiler Drums

- The float design is based on the operating conditions (customer specified), not the boiler design conditions. Therefore, if the boiler is operated at a pressure lower than the planned operating pressure, the Magnetic Gage reading will be higher than the actual drum level.
- If the user has poor water quality, the potential exists for iron particles to attach onto the float. This will result in a heavier float, with an inaccurate level reading.
Low Water Cutouts

• Two devices are required (Ref: CSD-1: Controls and Safety Devices – ASME)

• These devices are typically activated by floats or conductivity probes

• The two devices must be in separate chambers or one of them may be inserted directly into the boiler
Low Water Cutouts

• The minimum connection pipe size is 1” and separately piped devices must have a vertical drain of no less than ¾ NPS

• One control must be set to activate ahead of the other one

• A Manual Reset function may be applied to the lower of the 2 controls, with a maximum delay of 3 minutes, after the fuel has been cut off
Low Water Cutouts

Time Delays:

- The cutout circuit may incorporate a time delay not to exceed 90 seconds or the manufacturer’s recommendation (whichever is less)
New Requirements for Level Switches on HRSG’s

- The Code now requires Drain Pots to be installed in the Boiler Proper or Boiler External Piping either upstream or downstream of the Desuperheater to ensure malfunctions of the devices will not allow water to enter hot boiler components. These drain pots shall include automatic detection of water and automatic operation of the drain pot valves. Drain pots with single element level control with delay to close are an acceptable method of detecting and removing spray water. Consult Code Section PHRSG-4 for more details.

Example Drain Pot Installation
Recommendations for Level Instrument Piping

- All piping from the drum to the water level instruments are to be insulated, for the following reasons:
  1. Provide safety for plant personnel
  2. Increases level accuracy
  3. Reduce excess condensate formation

- Any slope in the piping should be downhill on the steam line & uphill on the water line from the drum.
- Piping from Drum to Level Instruments should be kept to a minimum < 6 Ft
Common Code Violations and Concerns

- Isolated Inoperable Water Gages
- Missing Water Gage Glasses
- Missing Illumination from Ported type gages
- Inadequate display of remote Level Indicators in the control room combined with isolated gages
Common Code Violations and Concerns Continued

- Contaminated Water Gage Glasses that prevent viewing the actual level (meniscus line)
- Multiple Section Flat Glasses without the Code required overlap
- Poor Maintenance Practices
Annual Violation Report

- The data illustrates Boiler Controls as the primary source of violations.
Drum Level Instrumentation

Note: Photos are helpful for discussion
Photo of Serious Installation Error

Code Violation and Operation Risk to Boiler
Top Questions for Users

• Are you having any operational issues with Water Gage Glasses on Boiler Drum applications?
• What instruments are installed for the display Drum Level Indication in the Control Room?
• Are the water level limit controls on your boiler applications working properly and tested regularly?
• Does the existing Drum Level Instrumentation meet the Code for the Design and Operating Pressures of your Boiler Drum?
Summary Recommendations for Drum Level Instrumentation Installations for Users

- Specify or Install Code Compliant Designs
- Examine Piping and isolation Valves
- Consult with the Insurance Underwriter or Plant Safety Department for plant requirements, which may exceed Code Minimum
- Always follow the OEM maintenance instructions for the most accurate and reliable information
Summary

Your time and attention to this information is appreciated, along with your contributions to Operator and Plant Safety of Power Boilers

Questions