

Boiler Inspection
Water Tube Boilers
Greater Than 15 PSI

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Boiler Inspections of Water Tube Boilers

PREFACE

This presentation was designed to help ASOPE Licensed Engineers to understand what a Water Tube Boiler Inspection could consist of. The information in this presentation is designed to increase your knowledge and improve your abilities as they relate to Water Tube Boiler Inspections. Within this presentation you will find information pertaining to Water Tube Boiler Inspection and what could be inspected at the request of the Boiler Inspector.

Remember the Boiler
Inspectors are
Professionals. Their
inspection is for **Safety**.

When they ask a
question answer it
truthfully to best of
your knowledge, if they
need help, aid them.

General Description

- Water Tube Boilers of this type are used to produce high pressure steam commonly in large quantities. They range in size and pressure from the extremely large (several stories, or 400 feet high) to much smaller package units.



These Water Tube Boilers may be fired by any of the following types of fuels:

Wood	Oil #2,#4 #6
Bark	Black Liquor
Coal: Anthracite, Bituminous, Lignite, Culm	Waste: Garbage, Sewer, Pulp and Paper
Stoker Coal	Natural Gas, Biogas, Coal Gas
Calcined petroleum coke	Wheat shaft, Rice Hulls, Nut Hulls

These boilers may be further categorized as to type of construction namely:

Low-Head Bent Tube	Sterling
Springfield High-Capacity Cross Drum	Non-Sectional
Vertical Water Tube Boiler	Double Tube
Longitudinal Drum Box Header	Submerged Tube
3 Drum Bent Tube	A Type (3 Drum)
R.P Bent Tube	D Type
Straight Cross Drum	O Type
Sinuus (Sectional) Header	Two Drum Vertical with Water Wall Furnace
3 Drum Divided Flow	Once Thru (Radiant)
Utility Two Stage Furnace	Integral Furnace
Straight Cross Drum	Universal Pressure
Sinuus (Sectional) Header	Ribbed Tube
Fluidize Bed	HRSG
Recovery Boiler	Supercritical

- Primary service use of these boilers may be classified as:
 - Low-Head Bent Tube Turbo-electric Utilities
 - Petrol-Chemical Process
 - Industrial Process Heating
 - Power (Pumps, or Turbines)
 - Laundry Equipment
 - Absorption Refrigeration Systems
 - Sterilization
 - Oil Field Recovery
 - Co-generation
 - Food Processing

WHAT AFFECTS TO THE BOILER ARE THE BOILER INSPECTORS LOOKING FOR:

- On Both external and internal surfaces of the boiler there are many locations where moisture and oxygen can combine. Since this is the primary cause of corrosion, it can have a major detrimental effect upon the boiler.
- Water Tube boilers is more prone to erosion due to the high velocity flow of abrasive combustion gases.
- Their size and type of construction leave them exposed to mechanical cyclic stresses, or thermal cyclic stress reversals.

- The Inspector Starts With An External Inspection:
 - General inspection of the boiler room prior to starting on the boiler proper.
 - Checking these items;
 - Lighting
 - Ventilation
 - Personnel Safety
 - Housekeeping
 - Operating Logs and Records

The reasons for checking these items are given starting on the next slides.

General Inspection Boiler Room

Lighting

- The boiler room must be well lit for the operators to see what is happening, and for them to perform proper maintenance and operating procedures. It also helps the inspector to do a better job. Large units need provisions for emergency lighting source in case of a power failure.

Ventilation

- Openings for air supply must be adequate to support complete combustion of all fuel burning equipment located in the boiler room. This is necessary to insure against operator exposure to carbon monoxide poisoning due to incomplete combustion. A quick check may reveal that the total cross-sectional area of free air entering the boiler room is at least equal to the cross-sectional area of all burning equipment discharge pipes. Any doubt as to the adequacy of free air available in the boiler room must be reconciled resulting in a closer examination of openings, flue gas discharge pipes, and boiler breechings.

Personal Safety

- In addition to the requirements for ventilation, checks for access routes to the area you are about to enter. The Boiler Inspector will enquire who will be accompanying he or she at all times. Safety should not be taken for granted.

Housekeeping

- A clean, neat boiler room generally tells the Boiler Inspector that the boiler itself receives an equal level of care. The boiler room should be kept free of material and equipment not necessary to the operation of the boiler. This is particularly true of material which may be flammable or hazardous. The boiler room is not a warehouse or storage facility. Better maintenance can be achieved by having a clean boiler room.

Records & Licenses

- If the boiler is an existing unit, check the current license or operating permit for correctness and expiration date.
- Look at the logbook. It may indicate where you should concentrate your inspection activity.
- Check the maintenance schedule and records. This is an excellent source of information for items which need to be scrutinized. The information acquired could also indicate areas of least concern to inspect.
- Discuss past operational experience of the boiler operators.
- Ask if there have been any repairs since last inspection.

Water Tube Boiler External Inspection

External Inspections

Drums and Headers could be inspected for:

- Signs of leakage, corrosion, overheating, or erosion.
- Drum casing seals for signs of any leakage.
- Drum supports for general condition and checked for expansion clearances.
- Blow down connections at drums and headers for expansion and flexibility of their support.
- Drum and Header Seals and for gasket leakage.

External Inspections

Superheater could be inspected for:

- Any external connections for leakage and proper support.
- Seals at inspection openings.

External Inspections

Refractory, Casing, Setting could be inspected for:

- Condition of the supporting steelwork where visible.
- Any doors, lancing doors, or openings in the casing for tightness and condition of gaskets or seals.
- Casing for any holes or cracks that would permit leakage of combustion gases into the boiler room. Note: Leakage at the casing can also affect the combustion air ratio and draft differential.
- Any casing bulges or warps may be an indication of a furnace explosion, improper combustion or of a vacuum being applied to the boiler furnace by the I.D. fan.

External Inspections

Water Columns could be inspected for:

- Gage glasses for leaks, cleanliness and visibility.
- Remote illuminators, reflectors, and mirrors for cleanliness and adjustment.
- Operation and conditions of gage cocks, chains and pulleys.
- Connecting piping between boiler and water column for possible stress points, and it free to expand and contract with the boiler.
- High and low water alarms are in good condition and tested for operability.

External Inspections

Feedwater Regulator could be inspected for:

- Cleanliness and operability.
- Excessive leakage and corrosive deposits on external surfaces could cause problems.
- Connecting lines and mechanical linkage or parts.
- Operability of the feedwater makeup by observing how fast it can recover from any low water condition.

External Inspections

Soot Blowers could be inspected for:

- External mechanical gears, chains, pulleys, etc. for broken or worn parts.
- Seals, gaskets, glands, and openings in the boiler casing for signs of leakage.
- Supply piping to soot blowers for faulty supports, leakage, and expansion or contraction provisions. This includes any valves located in these lines.
- Drain lines must be and will be checked to see that they are clear and operable.

External Inspections

Valves could be inspected for:

- Packing gland leakage, stem or handle damage, body defects, and general corrosion damage.

External Inspections

Safety Valves could be inspected for:

- Condition of the spring or spring housing chamber.
- Hard corrosive deposits, or foreign matter of any kind between the spring coils.
- Valve body for cracks, corrosion, or external defects.
- Valve discharge piping is correct discharged.
- Adjustment lead seals are all in place.
- Most authorized safety valve repair firms have replacement seals to put on the valve following completion of their work and re-assembly of the valve.
- External bolts and nuts, body to yoke attachments for tightness.
- Only a manufacture or repair ASME VR code shop can make adjustments to a safety valve.

External Inspections

Other that could be inspected for:

- Manhole or handhole areas for leakage and/or corrosion.
- Support stays and hangers for drums, headers, tube assemblies, etc. for tightness and cracked or broken rods.
- Buck stays and tie rods for straightness.
- Boiler blow-off or drain piping between boiler proper and blow-off tank for leakage and proper supports.
- Inspect the steam pressure gage for accuracy and calibration.
- Check the proper operation of reducer stations.

External Inspections

Other could be inspected for:
(Continued)

- Temperature readings at the air pre-heater and economizer.
- Draft indicators.
- Remote water level indicators and recorders.
- Feedwater control system for operability. This includes transmitters and power actuated controllers.
- Blow-off connections where they are connected to the boiler for corrosion and weakness.

Before any internal inspection can be done the boiler must be prepared using the Boiler Inspection Procedure, Lockout and Tag Procedure, Confined Space Procedure and the Boiler Inspection requirements.

Water Tube Boiler Internal Inspection

Internal Inspection

Prior to the inspection the operator should open all doors in the furnace casing after firing has ceased. There will be very little noise in the fire room at this time. While pressure is still on the boiler, operators should listen for and detect leaks that would not be detected during normal firing due to the noise associated with operation. For operators this is a prerequisite and report any steam leak noises and then present it to the Boiler Inspector, prior to the start of your internal inspection. The operator should make note of the level and particular openings where they have heard these steam leak noises. This can be an extremely valuable tool for the Boiler Inspector.

Internal Inspection

What the Boiler Inspector will be looking for during an internal inspection.

This type of inspection requires that every part of the boiler, external and internal, be made available to the Boiler Inspector as far as possible. The surfaces to be inspected should be cleaned. The inspection can start at the top level and proceed down a level at a time or can start at the bottom level and proceed upward as each level inspection is completed.

Internal Inspection

Top Supports and Saddles

- The items that could be inspected are top support rods for drums, headers, economizers, super heaters, water wall assemblies, and boiler tube sections for tightness, and bowed or warped rods and nuts.
- The items that could be inspected on the bottom supported drum and saddle assembly for position, cracks, or wear.

Internal Inspection

Drums, Headers, and Tubes (Water Side)

- The items that could be inspected for corrosion, scale, pitting, oil or other contaminants on water/ steam surfaces and any sign of metal loss or deterioration.
- The items that could be inspected are metal surfaces around all gasket seating surfaces for metal loss.
- The items that could be inspected are the steam scrubbers, dryers, dry pipes, and baffles.
- The items that could be inspected are drum internals for cracks, metal defects, pitting, soundness, and tightness of all supports and bolting.
- The items that could be inspected are the chemical feed line to see that it is open and free of obstruction and secured tightly to prevent vibration or wear.

Internal Inspection

Drums, Headers, and Tubes (Water Side Continued)

- The items that could be inspected are the feedwater line to see that it is free of scale or obstructions that would interfere with adding make up water to the boiler. Is it properly secured to the drum and oriented properly.
- The items that could be inspected are openings to the safety valves or dry pipes to assure they are free of any obstruction.
- The items that could be inspected are all water side surfaces for scale build-up or blockage and for grooving and erosion.
- The items that could be inspected are internal damages due to parts being broken off or loosened during service or tools or material being left in the boiler following maintenance.

Internal Inspection

Drums, Headers, and Tubes (Water Side Continued,)

- They will inspect nozzle connection inside the drums or headers for erosion, cracking, or other metallurgical problems. They will inspect circumferential and longitudinal weld areas for cracks or other defects.
- They will inspect the bottom water wall headers in the furnace area grate stoker areas or pulverized coal for erosion due to the abrasive action of coal and ash sliding along side the header.
- Float LWCO will be inspected for float condition and free movement.

Internal Inspection

Drums, Headers, and Tubes (Fire Side)

- The items that could be inspected are exterior surfaces of drums for signs of tube leakage and for fire side erosion, corrosion, or metal wastage.
- The items that could be inspected are metal surfaces exhibiting signs of flame impingement or over heating.
- The items that could be inspected are drum supports for clearance and freedom of movement.
- The items that could be inspected are water wall tubes for freedom of soot, slag, and fly ash deposits.
- The items that could be inspected are exterior surfaces of all tubes accessible for inspection for leakage and erosion due to channeling or including water wall tubes for cracks, corrosion, erosion, blisters, sagging, and distortion.

Internal Inspection

Superheater

- The items that could be inspected are the superheater headers internally and externally for scale, corrosion, cracks, overheating, and metallurgical defects.
- The items that could be inspected for steam impingement, soot blower washing, and channeling of superheater tubes or headers. inspect the freedom of headers for expansion and contraction.
- The items that could be inspected are all superheater vents and drains for cleanliness and freedom of obstructions

Internal Inspection

Economizer

- The items that could be inspected are interior parts for scale, oxygen pitting, and corrosion.
- The items that could be inspected are surfaces for excessive fly ash build-up, corrosion, erosion, leakage, and impingement at each level.
- The items that could be inspected are all drains and vents to determine if they are free and clear of obstructions.

Internal Inspection

Refractory, Casing, and Setting

- The items that could be inspected are supporting steel work both inside and outside the casing for cracks, loose bolts, and missing bolts. If riveted, check condition of rivets.
- The items that could be inspected are furnace tile, brick, and all other refractory for being loose, missing, cracked, spalled, or other damage.
- The items that could be inspected are casing and casing seals on interior and exterior surfaces for holes, cracks, thinning, or deterioration. Check for bowed, burned or warped plates.
- The items that could be inspected are burner refractory and tile for spalling and flame impingement.
- The items that could be inspected are the refractory in all fire side baffles for holes, cracks, or damage. Check caulking and seals at all baffles.
- The items that could be inspected are baffle supports and structural attachments on tubes and signs of metal fatigue.

Internal Inspection

Water Column

- The items that could be inspected are all water gage glasses for cleanliness and visibility and illuminators, reflectors, mirrors, and any other water level indicating device.
- The items that could be inspected are all lines between water column and drum to verify they are free and clear of any obstruction.
- The items that could be inspected are workability of gage cocks and any chain or pulley attached.
- The items that could be inspected are the high and low water level alarm internal connection.
- Inspect all probes.

Internal Inspection

Soot Blowers

- The items that could be inspected are the alignment of soot blower. If retractable, move element into the blowing position.
- The items that could be inspected are soot blowers for distortion of the element, worn hangers, bearings, tubes rubbing against the nozzle holes, distortion, worn or cracked nozzle elements and any soot blowers that are wasting or eroding the tubes.
- The items that could be inspected are the condition of drain piping and vents to make certain they are free and clear and alignment of soot blower. If retractable, move element into the blowing position.

Internal Inspection

Valves

- The items that could be inspected are all feedwater, blowdown, drain, bottom blow-off drain valves, and stop valve for packing gland leakage, operability, tightness, handle or stem damage, body defects and general corrosion damage.

External or Internal Items

- The items that could be inspected are all manhole and handhole plates and their seating areas for cracks, corrosion, and erosion.
- The items that could be inspected are the boiler blowdown piping and supports between boiler drum or header and the blowdown tank or separator for cracks, leakage, distortion, loose hangers, or distorted blowdown lines.
- The items that could be inspected are all boiler insulation to see that none is missing and that the casing is tight.

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