

## Chapter 12

### Boiler and Pressure Vessels



#### Purpose:

This chapter gives guidance to the construction, installation, operation, testing and maintenance of boilers and pressure vessels at Hanford.



#### Scope:

ASME, NFPA, and ANSI Codes provide the pertinent codes and some of the more important code requirements are repeated herein. This manual imposes a few additional requirements as well as contained in the following topics.

- ❖ Application
- ❖ Construction and Installation
- ❖ Operation
- ❖ Inspection and Maintenance
- ❖ References
- ❖ Related Chapters
- ❖ Attachments



#### Application:

Vessels and components for and in nuclear service shall comply in all respects with the applicable provisions of Sections III and XI of the ASME Code.

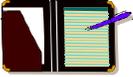


#### Construction and Installation:

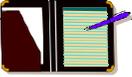
1. All pressure vessels shall be designed according to the ASME Code for the service intended, and when purchased shall bear the appropriate ASME stamp of an authorized inspector.

(Exception – Cylinders for compressed gases, certain air receivers on vehicles, and vessels below specified dimensions are excluded from this section)

2. All pressure vessels shall be installed according to the provisions of the ASME Code.
3. Safety combustion controls and interlock controls for gas and oil fired equipment are required to meet those features specified by the “Improved Risk” insurance companies. This would be Factory Mutual, Industrial Risk Insurers, and Kempers. The following is a summary of items which are required as minimum criteria, but not necessary limited thereto: (NOTE: units under 400,000 BTU are



- generally considered too small to require controls in addition to those specified in NFPA 85 and 86 A).
- a) Two low water cut-out switches. One main and one backup. These shall be interlocked to immediately shut down the combustion equipment when a low water condition exists. Existing boilers with “full time attendance” may be operated with a single low water cut-out switch provided the boiler is equipped with a low water alarm.
  - b) Excess-pressure cut-out switches on steam boilers. This control is in addition to operating pressure controls.
  - c) Excess-temperature cut-out switches for hot water boilers. This is in addition to operating temperature controls.
  - d) Approved flame failure controls to supervise the pilot as well as the main burner.
  - e) Pre-ignition purging of at least four air changes. Eight air changes are required with water tube boilers.
  - f) Time trial for ignition as short as practical but will vary depending on the type of fuel. Gas as 10 seconds, #1 through #4 oil at 10 seconds, and #5 and #6 oil at 15 seconds.
  - g) Fuel pressure supervision. For oil – low oil pressure and temperature. For gas – high and low pressure. (Temperature not needed for unheated oils.)
  - h) Forced or induced fans supervised to insure proper airflow. Need both air flow switches and motor starter interlocks.
  - i) Modulating control and interlocks to provide low fire start with air dampers on maximum open for start-up and purge.
  - j) Fuel oil strainers, heaters, filters, and water separators as needed.
  - k) Approved shut-off valves interlocked with the safety circuit. These shall be in addition to the operating control valves. For oil these can be single valves. For gas these shall be arranged as two valves and vent (double block and bleed).
  - l) If atomizing air or steam is provided, a low-pressure supervisory switch shall be provided. This would be for oil fired burners.
  - m) For fuel oil boilers with a rotating cup, electrical interlock shall be provided to shut down the boiler upon loss of motor power.
  - n) A circulating by-pass shall be provided on the oil heated systems to prevent overheating. These systems also need low and excess temperature cutouts.
  - o) Safety valves or safety relief as specified in the ASME code.
  - p) Emergency manual fuel shut-off valves shall be provided, preferably outside the boiler area.
4. Safety valves, safety relief valves, and pressure-temperature relief valves shall be installed as required by the Code. Particular attention shall be paid to size. Any shut-off device between the



source of pressure and the valve, or any restriction of the outlet side of the valve, shall require advance approval.

5. Water heaters, including those of domestic sizes, shall be equipped with temperature pressure relief valves as a minimum requirement.

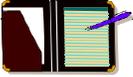
#### **Operation:**

##### 1. Definitions:

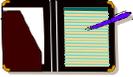
- a) Full-time Attendance – The operator never leaves the boiler room for more than twenty minutes.
- b) Part-time Attendance - The operator leaves the boiler room for more than twenty minutes, usually to perform other duties, and the boiler operates unattended but is checked at intervals of not less than once every two hours.
- c) Unattended – The boiler is fully automatic and operates for more than two hours without an operator checking the conditions but is checked by an operator at least once every twenty-four hours, and preferably more frequently, depending upon the operating conditions. The boiler should be visually checked once each eight hour shift by an individual with enough training or knowledge to identify flame failure or other routine operating problems.
- d) Automatic – Refers to all controls necessary for a boiler to operate safely without attendance. Such controls may include , but shall not be limited to: pre-start purge, igniter cycle, temperature controls, high pressure cut-off, flame failure shut down , and low water cut-off. The NFPA 85 Series, Factory’s Manual’s “Loss Prevention Data,” and Industrial Risk Insurer’s “Recommended Good Practice” shall be consulted for the controls necessary for safe automatic operation of a particular installation.

##### 2. Attendance:

- a) Low Pressure Boilers – Automatically operated low-pressure steam (15 psig or less) and hot water heating boilers (160 psig or less), oil, gas or stoker-fired or electrically heated, may be operated unattended provided they are equipped with approved controls and safety devices as recommended in applicable NFPA Codes, the ASME Boiler and Pressure Vessel Code, “Improved Risk” standards and the jurisdictional authority.



- b) High-Pressure Boilers – Automatically operated high-pressure (over 15 psig) steam boilers or high-pressure (over 160 psig) hot water boilers shall be operated with at least part-time operator attendance. Where radical load fluctuations or high make-up feed rates (over 15 %) are involved or when an unusual condensate contamination hazards exists, full-time operator attendance is required.
  - c) For boiler plants having a total output capacity in excess of 50,000 pounds steam per hour or 50,000 Btu/hour (water), full-time operator attendance shall be provided.
3. Training and Certification:
- a) Boiler and high-pressure hot water boiler operators, whether on continuous operation duty or making periodic checks on automated equipment, shall be trained and certified in the operation of the specific equipment for which they are responsible. See Attachment 1.
    - (1) Training shall include all aspects of normal operation, emergency operation, shutdown, startup, testing and safety requirements.
    - (2) Training shall be the responsibility of line supervision but may be conducted by another whose competence is recognized by management. A detailed manual shall be available and used for instruction.
    - (3) Certification shall be in writing and signed by the recognized instructor and the immediate supervisor. Re-certification by the instructor and the supervisor shall be required at intervals not to exceed three years.
  - b) Personnel responsible for the care and operation of unfired pressure vessels shall be knowledgeable of the safety and periodic inspection requirements for such vessels.
    - (1) Operating Rules for each fired pressure vessel, of any kind, shall be legibly and conveniently posted near that vessel. Those rules shall be in a step-by-step form; checklists shall be used routinely. For each high pressure system, the detailed manual for that system shall be readily available to the operator.
    - (2) Emergency Rules, i.e., instructions to be followed under serious abnormal conditions, shall also be legibly and conveniently posted.



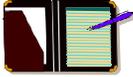
### Inspection and Maintenance:

1. Routine Inspection and Testing:

- a) Fired pressure vessels with “full-time” duty operators shall be externally inspected for visible deficiencies during the duty period of each operator. The operator shall inspect and test controls and safety devices as required by the Inspection and Testing Schedule.
- b) Fired pressure vessels attended only “part-time” or “unattended” shall be externally inspected by the operator each time he visits the equipment. The Operator shall inspect and test controls and safety devices as required by the applicable operating rules. (As an example, on a boiler checked by an operator once every 24 hours [unattended operation], the “hourly” and “8-hour” tests required would be conducted only once every 24 hours at the time the operator checks the boiler).

c) Minimal Inspection and Testing Schedule:

Hourly	check water column check flame condition
Every 8 hours	Blow down low water control Blow down water column
Daily	Test Flame - Supervisory Control
Weekly	Test for CO <sub>2</sub> or O <sub>2</sub> (if not continuously monitored) Check gas pressure switches Check oil pressure switches Test oil temperature switches Test atomizing-steam/air switch Test forced draft air switch Test induced draft air switch Test gas safety shut-off valves Test gas vent valves Test oil safety shut-off valves Check purge timing Check damper-limit controls Check modulator controls.
Monthly	Test safety relief valves Test excess steam pressure switches



Check fuel and air linkage

Semi-Annual Clean out low water control

Annual Test and recalibrate boiler gauges  
Clean out stack.

d) A log of the tests and inspections performed and the results shall be kept in the vicinity of each boiler. See Attachment 2.

e) Unfired pressure vessels require frequent inspection in accordance with approved operating standards.

2. Special Inspections:

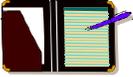
a) Fired pressure vessels, including all combustion safeguards which are new or which have been removed, overhauled, or subjected to major repair, shall be completely inspected by a qualified inspector before being placed in or returned to service. They shall be so inspected at least annually thereafter. The current certificate of inspection, with satisfactory results, shall be prominently posted near the vessel. Both “Pressure Side” and “Fire Side” inspections will be conducted.

(1) Safety valves shall be tested by means of the vessel pressure as part of the preparation for internal inspection.

(2) In order to facilitate complete inspection, it is suggested that where more than one boiler is installed, an internal inspection of the boiler(s) out of service and the controls of boiler(s) in service be tested on the same visit of the inspector.

b) Unfired pressure vessels shall be inspected by a qualified inspector on a frequency agreed upon between the inspector and the responsible supervisor. The period between inspections shall not exceed three years. The extent of the inspection shall be as determined by the inspector.

c) All periodic “pressure side” inspections shall be performed by an inspector certified or commissioned by the National Board of Boiler and Pressure Vessel Inspectors or by an inspector whose qualifications via training and experience have been shown to be at least equal to Board requirements. A certificate of the most recent inspection shall be permanently posted in the boiler room. An internal inspection and an external inspection will be conducted annually. Reports of boiler inspections shall be provided to the appropriate management having control of such boiler operations.



- (1) All pressure vessels shall be maintained in Code condition. Defects noted during inspections shall be corrected promptly. Causes of failures of any kind shall be determined and corrected without delay. Housekeeping and cleanliness standards shall be high.
- (2) The Safety Department of the contractors shall conduct an annual audit of boiler installations under their operational control to assure all inspections have been completed, reports are available, corrective action was taken when required, and the installations meet current code requirements.



#### References:

- ❖ American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Sections I through XI. In particular:
  1. Section I, "Power Boilers"
  2. Section III, "Nuclear Power Plant Components"
  3. Section IV, "Heating Boilers"
  4. Section VI, "Recommended Rules for Care and Operation of Heating Boilers"
  5. Section VII, "Recommended Rules for Care and Operation of Power Boilers"
  6. Section VIII, "Pressure Vessels"
  7. Section XI, "Rules for In-service Inspection of Nuclear Power Plant Components"
- ❖ NFPA 85 Series on Boilers – Furnaces
- ❖ ANSI Z96.3, "Safety Standards for Oil-Fired Boiler Assemblies"



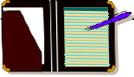
#### Related Chapters:

- ❖ Chapter 10, "Gas Cylinders."



#### Attachments:

- ❖ Attachment 1: *Operator Training and Qualification Records*
- ❖ Attachment 2: *Test and Inspection Records*

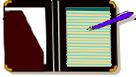


**Attachment 1:**  
*Operator Training and Qualification Records*



Please insert a copy of applicable records following this page or indicate the location of these records on the form below.

Facility Name:		
Records Location:	Initial:	Date:



**Attachment 2:**  
*Test and Inspection Records*



Please insert a copy of applicable records following this page or indicate the location of these records on the form below.

Facility Name:		
Records Location:	Initial:	Date: