



Document Level: Functional Series
Document Number: Criterion 403 R5
Approval Date: 09/29/10
Effective Date: 10/29/10
Supersedes: Criterion 403 R4

**CONDUCT OF MAINTENANCE (P950)
OPERATIONS AND MAINTENANCE MANUAL
OPERATIONS & MAINTENANCE CRITERION**

TITLE: BOILERS

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RECORD OF REVISIONS

Revision No.	Date	Description
0	0910/98	Initial Issue
1	03/01/00	This revision reflects the conversion from a WordPerfect document into a Microsoft Word document and additional clarification of how to develop criteria.
2	01/08/02	This revision includes <ul style="list-style-type: none"> • The addition of a Table of Contents. • The use of basis statements in Sections 6, 7, and 9. • Incorporation of ORPS and NRC “Lessons Learned” from 1/95 to 2/2/2000. • Incorporation of comment and rewording requested by the Maintenance Subcommittee.
3	09/23/05	This revision includes: <ul style="list-style-type: none"> • Added new definition of pigtail loop (not originally included in document). • Correct grammar and definition (e.g. “buckle up”) throughout document. • Updated boiler code information throughout document. • Updated Water and Air Quality Group information.
4	1/19/06	This revision includes: <ul style="list-style-type: none"> • Deleted note in Section 6.2.3.1. This will clarify preventive maintenance requirements. • Removed LIRs that have been rescinded or cancelled.
5	9/13/10	Revised document to reflect current LANL organizations, update references and aligned requirements to current expectations contained within ASME CSD-1-2007 <i>Boiler and Pressure Vessel Code</i> , and <i>Uniform Mechanical Code</i> , 2009.



TABLE OF CONTENTS

1.0	PURPOSE	4
2.0	SCOPE	4
3.0	ACRONYMS AND DEFINITIONS	4
3.1	Acronyms	4
3.2	Definitions	5
4.0	RESPONSIBILITIES	6
4.1	MSS-Division Leader (MSS-DL)	6
4.2	MSS- Maintenance Programs (MSS-MP)	6
4.3	Facility Operations Director (FOD)	6
4.4	Operations Manager (OM)	6
4.5	Maintenance Manager (MM)	6
4.6	Authority Having Jurisdiction (AHJ)	7
4.7	ENV-Resource Conservation and Recovery Act (ENV-RCRA)	7
4.8	Environmental Protection-Environmental Stewardship (ENV-ES)	7
5.0	PRECAUTIONS AND LIMITATIONS	7
5.1	Precautions	7
5.2	Limitations	7
6.0	REQUIREMENTS	8
6.1	Operations Requirements	8
6.2	Maintenance Requirements	9
7.0	RECOMMENDED AND GOOD PRACTICES	14
7.1	Operations Recommendations	14
7.2	Maintenance Recommendations	14
8.0	GUIDANCE	15
8.1	Operations Guidance	15
8.2	Maintenance Guidance	15
9.0	REQUIRED DOCUMENTATION	16
10.0	REFERENCES	17
11.0	APPENDICES	17



CRITERION 403 BOILERS

1.0 PURPOSE

The purpose of this Criterion is to establish the minimum requirements and best practices for operation and maintenance of all unmanned Boilers in service at Los Alamos National Laboratory.

This document addresses the requirements of P 315, *Conduct of Operations Manual*, and P 950, *Conduct of Maintenance*, by defining the minimum operations and maintenance criteria for structures, systems, and components that it covers. The Criterion lists requirements that are based on codes, standards, contract commitments, lessons learned, or business case. It also lists recommendations based on industry practices, operational experience, or business case. Guidance for implementation of the requirements and recommendations is also provided.

2.0 SCOPE

The scope of this Criterion includes the routine inspection, testing and preventive and predictive maintenance of unmanned boilers at all nuclear and non-nuclear LANL facilities. This Criterion does not address corrective maintenance actions required to repair or replace equipment.

Note: The Steam Plant boilers that are continuously manned are not subject to the requirements of this document. Autoclaves and steam generators used for programmatic processes are also exempt from this Criterion.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

AHJ	Authority Having Jurisdiction
ASME	American Society of Mechanical Engineers
BAS	Building Automation System
CFR	Code of Federal Regulations
CSB	Chemical Safety Board
CSE	Cognizant System Engineer
DL	Division Leader
DOE	Department of Energy
DSA	Documented Safety Analysis
ENV-ES	Environmental Protection-Environmental Stewardship
ENV-RCRA	Environmental Protection-Resource Conservation and Recovery Act
ESS	Equipment Surveillance System

FOD	Facility Operations Director
LANL	Los Alamos National Laboratory
LEL	Lower Explosive Limit
MC	Maintenance Coordinator
ML	Management Level
MM	Maintenance Manager
MP	Maintenance Programs
MSDS	Material Safety Data Sheet
MSS	Maintenance and Site Services
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OM	Operations Manager
PM	Preventive Maintenance
PMI	Preventive Maintenance Instruction
RCRA	Resource Conservation and Recovery Act
SSC	Systems, Structures, and Components
TSR	Technical Safety Requirements

3.2 Definitions

ASME Code- The Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers establishes recommended rules for the care and operation of heating boilers and also establishes the rules of safety governing the design, fabrication and inspection of boilers and pressure vessels.

Boiler- A closed vessel used for heating water or for generating steam for process and space heating, by direct application of heat from combustible fuels or electricity.

Boiler System- A system comprised of the boiler(s), its controls, safety devices, interconnecting piping, vessels, valves, fittings and pumps.

Condensate- The liquid water formed by the cooling and condensing of steam due to the loss of its heat. Condensate is returned and stored in a condensate storage tank before it is delivered back to the steam boiler by the feedwater pump.

Conductivity- The measurement of ionizable solids, in solution, expressed in micromhos per centimeter. Conductivity measurements are used to measure the total dissolved solids in the steam boiler water.

Expansion Tank- Expansion tanks are used on hot water systems to allow for the expansion of the water when it is heated. An air cushion in the tank is compressed by the expanding water thus maintaining a constant system pressure.

Gauge Glass- The transparent part of a water gauge assembly connected directly or through a water column to the boiler, below and above the waterline, to indicate the water level in a steam boiler.



Limit Control- A device, with a manual reset, which shuts down the burner when operating limits are surpassed.

Management Level (ML1, ML2, ML3, ML4) - ML designation is used to grade the structures, systems, equipment, and components and associated activities based on their importance to the protection of the public, environment, and workers, security, and the Laboratory mission. See AP-341-502, *Management Level Determination* for definitions of each ML level.

Operating Control- A device which automatically controls the operation of a fuel burner to maintain the desired temperature or pressure.

Safety Relief Valve- An automatic pressure-relieving device (required by code to be used on hot water heating boilers) that is actuated by the pressure generated within the boiler. Valves of this type are spring loaded without full-opening action and have a factory set non-adjustable pressure setting. A safety relief valve set pressure must be equal to or less than boiler maximum allowable working pressure and its relieving capacity must be equal to or greater than boiler output.

4.0 RESPONSIBILITIES

4.1 MSS-Division Leader (MSS-DL)

Receives and approves or rejects, in conjunction with the AHJ, requests for variances from this Criterion. Maintains the record of decision for all variance requests.

4.2 MSS- Maintenance Programs (MSS-MP)

Responsible for the technical content, monitoring the applicability and the implementation status of this Criterion. MSS-MP will assist organizations that are not applying or meeting implementation expectations or will elevate concerns to the appropriate level of LANL management.

4.3 Facility Operations Director (FOD)

Responsible for implementation of this O&M Criterion for identified systems/equipment within their facility boundaries.

4.4 Operations Manager (OM)

Responsible to the FOD for implementing operation portions of this Criterion and for coordinating transfer of systems/equipment to the Maintenance Manager for maintenance activities. The OM with concurrence of the FOD will prioritize implementation within budget allocations.

4.5 Maintenance Manager (MM)

Responsible to the FOD and the MSS-Division Leader for implementing the maintenance portions of this Criterion and for coordinating the transfer of systems/equipment to the



Operations Manager at the conclusion of maintenance activities. The MM with concurrence of the FOD will prioritize implementation within budget allocations.

4.6 Authority Having Jurisdiction (AHJ)

The AHJ is the Point of Contact for the Mechanical Chapter of the LANL Engineering Manual. The AHJ is responsible for providing decisions on specific technical questions regarding the systems or equipment relevant to this Criterion.

4.7 Environmental Protection-Resource Conservation and Recovery Act (ENV-RCRA)

Responsible for monitoring waste streams (outfalls) and overseeing the NPDES permit program.

4.8 Environmental Protection-Environmental Stewardship (ENV-ES)

Responsible for air quality compliance and ambient air monitoring. For gas boiler replacements or upgrades, the State of New Mexico stipulates air quality requirements for activities that increase air emissions. Therefore, it is necessary to contact ENV-ES to ensure compliance with state regulations and LANL P408, *Air Quality Reviews*, if a gas boiler upgrade or replacement is planned.

5.0 PRECAUTIONS AND LIMITATIONS

5.1 Precautions

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. However, all applicable precautions should be contained in the implementing procedure(s) or work control authorization documents. The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards and precautions that may not be immediately obvious.

5.2 Limitations

The intent of this Criterion is to identify the minimum requirements and recommendations for structures, systems, and components (SSCs) operation and maintenance across the Laboratory. Each Criterion user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, manufacturer O&M requirements and guidance, etc.)

Nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion. Nuclear facilities should implement the requirements of DOE Order 433.1A, *Maintenance Management Program for DOE Nuclear Facilities* as the minimum programmatic requirements for a maintenance program. Additional requirements and

recommendations for SSC operation and maintenance may be necessary to fully comply with the current DOE Order or the Code of Federal Regulations (CFR) as applicable.

Nuclear facilities, certain high hazard facilities and explosives facilities may have additional facility specific requirements beyond those presented in this Criterion which are contained in the Documented Safety Analysis (DSA), Technical Safety Requirements (TSRs), or facility safety plans, as applicable.

6.0 REQUIREMENTS

Minimum requirements for all users are specified in this section. Requested variances to these requirements shall be prepared and submitted to MSS-MP for review and approval. The MSS Division Leader approves or denies variances. The Criterion users are responsible for analysis of operational performance and SSC replacement or refurbishment based on this analysis. Laws, codes, contractual requirements, engineering judgment, safety matters, and operations and maintenance experience drive the requirements contained in this section.

Note: Discovery of SSC with a degraded or non-conforming condition is a triggering input to the Operability Determination and Functional Assessment process defined in AP-341-516, *Operability Determination and Functionality Assessment*. Degraded or non-conforming conditions include, but are not limited to, failed equipment or components, unsatisfactory readings, code or standard violations and fire protection impairments. Personnel performing tests or inspections under this O&M Criterion are not responsible nor authorized to perform the Operability Determination. Any degraded or non-conforming condition discovered under this O&M Criterion shall be communicated to the FOD Representative for input to the AP-341-516 process. While that process may not apply in Low Hazard Non-Nuclear and Office facilities, the same concept applies. The FOD organization is responsible to determine the response (taking equipment out of service, establishing fire watches, limiting operations, etc.) to SSC degraded and non-conforming conditions.

6.1 Operations Requirements

6.1.1 *Third Party Inspection*

It is required that a National Board-accredited third party inspector externally inspect all steam and hot water boilers annually.

Basis: LANL boiler maintenance experience and O&M Criterion 419, *Inspections and Testing of Pressure Vessels and Pressure Relief Valves*

6.1.2 *Inspection Checklist*

It is required that a checklist/inspection log be provided in each boiler room to record maintenance work, inspections, certain tests and other pertinent data.

Basis: ASME VI Boiler & Pressure Vessel Code, 2007, Section 6.09B

6.2 Maintenance Requirements

6.2.1 Fuel Gas Purging

Because of a number of tragic deaths caused by natural gas explosions due to purging indoors, LANL is implementing a number of administrative controls and awareness training. See the gas line purging requirements in LANL Master Specification 23 1123R3, Section 3.1.K. Only trained personnel may perform fuel gas purging. Personnel must be trained on odor fade/fatigue, and attend course #53548, *Fuel Gas Purging Inside Structures*.

Basis: LANL Master Specification 23 1123R3, and RN1001, US Chemical Safety Board Urgent Recommendations Relative to Fuel Gas Purging Activities, effective 4/22/10.

6.2.2 Starting a Boiler After Layup (Steam)

Note: Following summer lay-up, boiler start-ups should be completed by October 10th of each year. Once boilers have been checked out and put into service, reactivate boiler alarms by contacting the system administrator of the ESS, MiserTalk or BAS, via the MC or the CSE. Alarms should be verified operational.

1. Review manufacturer's recommendations for startup of burner and boiler.
2. Set control switch in "off" position.
3. Make sure fresh air to boiler room is unobstructed.
4. Check availability of fuel.
5. Check water level in gauge glass. Make sure gauge glass valves are open.
6. Use try cocks, if provided, to double-check water level.
7. Vent combustion chamber to remove unburned gasses.
8. Clean glass on fire scanner if provided.
9. Set main steam shutoff valve to the open position.
10. Open cold water supply valve to water feeder if provided. Open suction and discharge valves on vacuum or condensate pumps. Set electrical switches for desired operation. Vent boiler to remove air when necessary.
11. Check operating pressure setting of boiler.
12. Check manual reset, if provided, on low-water fuel cutoff and high-limit pressure control to determine that they are properly set.
13. Set manual fuel oil supply valve or manual gas valve in the open position.
14. Place circuit breaker or fused disconnect switch in "on" position.

15. Place all boiler emergency switches in “on” position.
16. Place boiler control starting switch in “on” or “start” position.
17. Bring pressure and temperature up slowly. Stand by boiler unit until it reaches the established cut-out point to make sure the operating control shuts off the burner.
18. During the pressure buildup period, walk around the boiler frequently to observe that all associated equipment and piping is functioning properly. Check for proper over-the-fire draft.
19. Immediately after burner shuts off, inspect water column and individually open each try-cock (if provided) to determine true water level.
20. Enter in log book:
 - a. Date and time of start up
 - b. Any irregularities observed and corrective action taken
 - c. Time when controls shut off burner at established pressure, tests performed, etc.
 - d. Signature of operator
21. Check safety valve for evidence of simmering. Perform try lever test.

6.2.3 Starting a Boiler After Layup (Hot Water)

1. Review manufacturer’s recommendations for startup burner and boiler.
2. Fill boiler and system with water. Vent air at high point in system.
3. Check altitude gauge and expansion tank to assure system is properly filled.
4. Set control switch to “off” position.
5. Make sure fresh air to boiler room is unobstructed and dampers are open.
6. Check availability of fuel.
7. Vent combustion chamber to remove unburned gases.
8. Clean glass on fire scanner, if provided.
9. Observe proper functioning of water pressure regulator and turn circulator pumps on electrically.
10. Check temperature control(s) for proper setting.
11. Check manual reset button on low-water fuel cutoff and high-limit temperature control.
12. Set manual fuel oil supply or manual gas valve in open position.

13. Place circuit breaker or fused disconnect in “on” position.
14. Place all boiler emergency switches in “on” position.
15. Place boiler control starting switch in “on” or “start” position. (Do not stand in front of boiler doors or breeching.)
16. Do not leave boiler until it reaches the established cutout point to make sure the controls shut off the burner.
17. During the temperature and pressure buildup period, walk around the boiler frequently to observe that all associated equipment and piping is functioning properly. Visually check burner for proper combustion.
18. Immediately after burner shuts off, inspect water pressure and open the highest vent to determine that system is completely full of water.
19. Enter in log book:
 - a. Date and time of startup
 - b. Any irregularities observed and corrective action taken
 - c. Time when the controls shut off the burner at the pre-established temperature
 - d. Signature of operator
20. Check safety relief valve for evidence of leaking. Perform try lever test.

6.2.4 Daily (Steam Boilers, in Service Only)

Observe operating pressures, water level, and general conditions. Determine cause of any unusual noises or conditions and correct.

6.2.5 Weekly (Steam Boilers, in Service Only)

1. Test low-water fuel cutoff and or water feed. Blow down boiler if substantial makeup water is used.
2. Perform sludge blowdown where required.
3. Test water column or gauge glass.
4. Observe condition of flame. Adjust burner if flame is smoky or if burner starts with a puff.
5. Check fuel supply (fuel oil only).
6. Observe operation of condensate or vacuum pump.

6.2.6 Monthly (Steam Boilers in Service Only)

1. Perform try lever test on safety valve.
2. Test flame detection devices.

3. Test limit controls.
4. Test operating controls.
5. Perform sludge blowdown where required.
6. Check boiler room floor drains for proper functioning.
7. Inspect fuel supply systems in boiler room area.
8. Check condition of heating surfaces. For preheated oil installation, inspect more frequently, (twice a month.)
9. Ensure combustion air supply opening is not closed or blocked.

6.2.7 Annual (Steam Boilers, in Service Only)

1. Perform internal and external inspection after thorough cleaning.
2. Perform routine burner maintenance.
3. Perform routine maintenance of condensate or vacuum return equipment.
4. Perform routine maintenance of all combustion control equipment.
5. Perform combustion and draft tests.
6. Perform safety valve pop test.
7. Slow drain to test low-water cutoff.
8. Inspect gas piping for proper support and tightness.
9. Inspect boiler room ventilation intake louvers.

6.2.8 Daily (Hot Water Boilers, in Service Only)

Observe operating pressures and temperature and general conditions. Determine cause of any unusual noises or conditions

6.2.9 Weekly (Hot Water Boiler, in Service Only)

1. Observe condition of flame. Adjust burner if flame is smoky or if burner starts with a puff . For fuel oil burning boilers, observe daily.
2. Check fuel supply (fuel oil only).
3. Observe operation of circulating pump(s).

6.2.10 Monthly (Hot Water Boilers, in Service)

1. Perform try lever test of safety relief valve.
2. Test flame detection devices.
3. Test limit controls.
4. Test operating control.

5. Check boiler room floor drains for proper functioning.
6. Inspect fuel supply systems in boiler room area.
7. Check condition of heating surfaces. For preheated oil installation, inspect more frequently, (twice a month).
8. Perform combustion and draft tests (preheated oil only).
9. Test low-water fuel cutoff and /or water feeder, if piping arrangement allows test without draining excessive water from the boiler.

6.2.11 Annual (Hot Water Boiler, in Service Only)

1. Perform internal and external inspection after thorough cleaning.
2. Perform routine burner maintenance.
3. Perform routine maintenance of circulating pump and expansion tank equipment.
4. Perform routine maintenance of entire combustion control equipment.
5. Perform combustion and draft tests.
6. Perform safety relief valve(s) pop test.
7. Slow drain to test low-water cutoff.
8. Inspect gas piping for proper support and tightness.
9. Inspect boiler room ventilation louvers and intake.
10. Perform a try lever test on the safety valve/safety relief valve: Manually open the valve by lifting up on the handle while boiler is under pressure. Water or steam should flow when the handle is lifted, and should shut off completely when the handle is released. Some boilers have two of these devices.

6.2.12 Removal of Boiler from Service (Steam and Hot Water Boilers)

Note: Summer boiler lay-ups should not be started before May 10 of each year. Once idle boilers have been secured for the summer, deactivate alarms by contacting the system administrator of the ESS, MiserTalk or BAS, via the MC or the CSE. Alarms should be verified as deactivated. Note that some systems require that their boilers operate year round.

1. While maintaining boiler water temperature of between 180°F and 200°F (82°C to 93°C), drain off boiler water from bottom drain until it runs clear.
2. Refill to top of gauge glass, and add sufficient water treatment compound to bring the treatment up to strength.
3. When all the dissolved gases are released (approximately 1 hr), shut down the firing equipment by disconnecting the main switch.

Basis: The above maintenance requirements are based on ASME VI 2007, *Boiler And Pressure Vessel Code*, sections 7.02, 7.06, 7.07p, 8.02, 8.06, and 8.07p.

7.0 RECOMMENDED AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on the unique application and operating history of the subject systems/equipment.

7.1 Operations Recommendations

No operations recommendations.

7.2 Maintenance Recommendations

7.2.1 *Maintenance Personnel Certification*

It is recommended that maintenance personnel engaged in the operation and maintenance of boilers hold a “Certificate of Competence” issued by the State of New Mexico Construction Industries Division, Regulation and Licensing Department.

Basis: State of New Mexico, Construction Industries Division, *Rules and Regulations for Boilers*, 2009.

7.2.2 *Nuisance Trouble Calls*

Boiler trouble calls, especially from “nuisance” boilers that are being reset on a regular basis, should be referred to qualified maintenance personnel after the second reset.

Basis: LANL boiler maintenance experience

7.2.3 *Housekeeping*

Generally, a neat boiler room indicates a well-run plant. The boiler room should be kept free of all material and equipment not necessary to the operation of the heating system. Good housekeeping should be encouraged and procedures should include routine inspections to maintain the desired level of cleanliness.

Basis: ASME VI 2007, *Boiler and Pressure Vessel Code*, Section 6.07.

7.2.4 *Annual Chemical Testing*

It is recommended that water in hot water heating boilers be tested annually for proper chemical levels. This includes boilers that have been taken out of service for an extended period.

Exception: The water in a boiler that heats potable domestic water is not treated.

7.2.5 *Major Emergency Repairs*

If needed, obtain the services of an outside ASME certified boiler service company for major emergency repairs, such as re-tubing a boiler, tubesheet repairs, etc.

8.0 GUIDANCE

8.1 Operations Guidance

None.

8.2 Maintenance Guidance

Provided it has been reviewed and approved by MSS-MP, an acceptable program for boiler inspection may be found in preventative maintenance instruction PMI 40-40-003, *Boiler Preventative Maintenance & Repair*. Additionally, a boiler chemical treatment program should be instituted to ensure proper operation and longevity of the boilers. The boiler chemical treatment program should address chemical treatment, boiler blow down and boiler lay-up.



9.0 REQUIRED DOCUMENTATION

Maintenance history shall be maintained for boiler systems to include, as a minimum, the parameters listed in the Table 9-1 below:

Table 9-1: Maintenance History Documentation Parameters				
Parameter	ML 1	ML 2	ML 3	ML 4
Maintenance Activities				
Manufacturer's Name Plate Data	Required	Required	Required	Required
Repair / Adjustments	Required	Required	Required	Required
PM Activities	Required	Required	Required	Required
Replacement (includes dates)	Required	Required	Required	Required
Equipment Problems				
Failure Dates	Required	Required	Required	-
Failure Root Cause	Required	Required	Required	-
Inspection Results				
Inspection Date	Required	Required	Required	Required
SSC Condition	Required	Required	Required	-
Test the two float-operated low water cut-offs (6.2.1)	Required	Required	Required	-
Test water conductivity (6.2.1)	Required	Required	Required	-
Test boiler water for proper chemical levels (6.2.1)	Required	Required	Required	-
Test condensate pH (6.2.1)	Required	Required	Required	-
Test float-operated low water cut-offs (6.2.2)	Required	Required	Required	-
Test safety/safety relief valves (6.2.2)	Required	Required	Required	-
Test limit control (6.2.2)	Required	Required	Required	-
Test flame detection devices (6.2.2)	Required	Required	Required	-
-' indicates documentation is not required.				

Basis: Documentation of the parameters listed in Table 9-1 above satisfies the requirements of P 950, Section 3.5.15 which states, "A maintenance history



and trending program is maintained to document data, provide historical information for maintenance planning, and support maintenance and performance trending of facility systems and components”

10.0 REFERENCES

The following references, and associated revisions, were used in the development of this document.

- 10.1 AP-341-502, *Management Level Determination*
- 10.2 AP-341-516, *Operability Determination and Functionality Assessment*
- 10.3 ASME CSD-1, *Controls and Safety Devices for Automatically Fired Boilers*, 2009
- 10.4 ASME VI *Boiler and Pressure Vessel Code*, 2007
- 10.5 DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*
- 10.6 P 315, *Conduct of Operations Manual*
- 10.7 P 950, *Conduct of Maintenance*
- 10.8 State of New Mexico, Construction Industries Division, Rules and Regulations for Boilers, 2009
- 10.9 Uniform Mechanical Code, 1997

11.0 APPENDICES

None.