

Operation & Maintenance Manual

MFC II

3-Pass Multi-Fuel Condensing Boiler



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IMPORTANT!

This manual provides general installation, operation, and maintenance guidance. Site-specific conditions vary. The installer and operator remain responsible for compliance with all applicable codes, regulations, and project-specific engineering requirements.

Read this Manual BEFORE using this equipment. Failure to read and follow all safety and use information can result in death, serious personal injury, property damage, or damage to the equipment.

Keep this Manual for future reference. This manual is an integral part of the product. It must be maintained in a safe place in legible condition and given to the user by the installer for future reference.

⚠ WARNING!

- Do NOT under any circumstances use matches, candles, flames, or other sources of ignition to check for gas leaks. Failure to heed this warning may result in death or serious injury.
- Fluids under pressure may cause injury to personnel or damage to equipment when released. Be sure to shut off all incoming and outgoing water shutoff valves. Always carefully decrease all trapped pressures to zero before performing maintenance.
- Always shut off all gas and electrical inputs to unit before performing any maintenance.
- The exhaust vent pipe of the unit operates under a positive pressure and therefore must be completely sealed to prevent leakage of combustion products into living spaces.

⚡ ELECTRICAL HAZARD WARNING ⚡

- This equipment operates on high-voltage and is subject to special hazardous operation guidelines. The safety equipment outlined below is not supplied with this boiler and is the responsibility of the high voltage electrical safety department at the site of use.
- Contact with energized components may cause electric shock, severe burns, serious injury, or death.
- Installation, wiring, startup, and service must be performed by qualified personnel in accordance with all applicable codes and the manufacturer's instructions.

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1. INTRODUCTION

AERCO MFC II boilers are 3-pass condensing boilers. The first pass is a furnace made of mild steel. The second boiler pass is made of mild steel tubes. The final condensing pass of tubes is all stainless steel. All material in contact with flue gases at condensing temperature are made of stainless steel including tubes, tubesheets, and smokeboxes.

MFC II boilers are capable of reaching 94.5% efficiency at high fire and 97% at low fire when firing natural gas with 80°F return water. Conventional (non-condensing) boilers can reach natural gas efficiencies up to 87% with a low flue gas outlet temperature. In a condensing boiler, additional efficiency is gained by condensing the water vapor in the flue gas.

MFC II boilers have a full-sized furnace capable of firing natural gas, propane, or light fuel oil. The large furnace allows for complete combustion with low NOx performance.

MFC II boilers have no limit on the return water temperature. However, the boilers reach the highest performance when used with heating systems where the return temperature is lower than 135°F. At higher temperatures condensation does not occur. MFC II boilers can operate with conventional heating loops (160 - 180°F) but will only produce efficiencies of 85-88%.

READ AND SAVE THESE INSTRUCTIONS FOR FUTURE REFERENCE. This manual and associated documents should be kept with the boiler and in legible condition for the life of the unit.

This manual will refer to the burner's manual when appropriate. A double asterisk (**) is used to indicate that your burner manual should also be checked for information on the topic being covered. In addition to the boiler and burner working together, there are controls, switches, valves, and other components on your boiler assembled specific to each end user. A list of exact components and information about them is appended to this manual. All devices work together to safely operate your boiler.

1.1 Acronyms, Definitions, Standards, & Sources

ASME: American Society of Mechanical Engineers

ASME CSD-1: Controls and Safety Devices for Automatically Fired Boilers

BPVC: ASME boiler and pressure vessel code.

Section IV: Portion of BPVC that applies to water boilers not exceeding 160 PSIG or 250°F and Steam boilers not exceeding 15 PSIG

Heating boiler: hot water boiler

Water boiler: Boiler that supplies hot water

LWCO: Low-water cutoff, or Low-water fuel cutoffs

Aux LWCO: Auxiliary Low water cutoff

LWCO mark: Vertical position on boiler where the primary LWCO operates

ANSI: American National Standards Institute

150# class: ANSI standard of flanged piping connections

NPS: Nominal pipe size

NPT: National pipe thread (tapered)

MAWP: Maximum allowable working pressure

Set point: A specific value of temperature used in a control where it will switch on or off.

Aquastat: Water temperature control device

PSI: Pounds per square inch PSIG: PSI gauge reading.

In. WC: Inches of water column. Units of pressure where one (1) PSI = 28 In. WC (28" WC)

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UL: Underwriters Laboratories Inc.

UL Mark: Signage on the boiler designating UL approval

UL 795: Commercial-Industrial Gas Heating Equipment

UL 353: Limit Controls

cUL: Verification to Canadian Requirements by Underwriters Laboratories Inc.

CSA: Canadian Standards Association

CSA B140.0-03: Oil-Burning Equipment: General requirements

CSA 3. 1-77-CAN1: Industrial and Commercial Gas-Fire Package Boilers (Reaffirmed 2011)

CSA 22.1: Canadian Electrical Code Part 1

CSA B149: Natural Gas & Propane Code

NFPA: National Fire Protection Agency

NFPA 31: Installation of Oil Burning Equipment

NFPA 54: National Fuel Gas Code

NFPA 70: National Electric Code, AKA: NEC

IFGC: International Fuel Gas Code

R&D drawing: Ratings and Dimensions drawings. AKA: General Arrangement.

1.2 Introduction To Safety

Refer to this manual and the manual supplied with the burner. For assistance or additional information consult a qualified installer, service agency, or fuel supplier as appropriate.

DO NOT STORE OR USE GASOLINE OR ANY OTHER FLAMMABLE LIQUIDS IN THE VICINITY OF THIS OR ANY OTHER APPLIANCE.

DO NOT USE GASOLINE, CRANKCASE DRAININGS, OR ANY OIL CONTAINING GASOLINE. NEVER BURN GARBAGE OR PAPER IN THE UNIT, AND NEVER LEAVE COMBUSTABLE MATERIAL AROUND IT.

All personnel involved with the startup, maintenance, or adjustment of this boiler must read and understand the entire contents of this manual prior to any startup or adjustment being made to the boiler and related components. Installation and service must be performed by a qualified installer, service agency, or the fuel supplier.

Safe and reliable operation is dependent to a large extent upon the skill and attentiveness of the operator and of the maintenance personnel. Operating skill implies the following:

- Knowledge of fundamentals
- Familiarity with equipment
- Suitable background of training and experience

Full and effective use should be made of manufacturer's instruction books on operation and maintenance. Of special importance are written procedures prepared expressly for each installation by the manufacturers' service engineers and qualified personnel from the operating organization before and during the commissioning period. These procedures are based on actual experience and often include invaluable information on what the equipment is expected to do. Limitations critical to safe and reliable operations are also given. Control systems vary in complexity from computer control to manual operation. Regardless of the type of system used, the operators should be thoroughly trained so that they can maintain safe and continuous operation during changeover from automatic to manual control as well as to continue operation by manual control if the automatic systems are out of service. The operator should have instrumentation visible at the point of manual operation to permit them to be aware of operating conditions. Regularly scheduled auto-manual changeover, manual operation, and emergency drills to prevent loss of these skills are recommended.

What to do if you smell gas:

- Do not try to light any appliance
- Do not touch any electrical switch
- Do not use any phone in your building
- Immediately call your gas supplier from a neighbor's phone
- Follow the gas supplier's instructions
- If you cannot reach your gas supplier, call the fire department.

THE INSTALLATION OF THIS BOILER SHALL BE IN ACCORDANCE WITH THE REGULATIONS OF AUTHORITIES HAVING JURISDICTION.

BOILERS SHALL BE OPERATED BY QUALIFIED PERSONNEL. BOILERS SHALL BE INSTALLED AND SERVICED BY QUALIFIED PERSONNEL ONLY.

Boilers intended for Canadian markets, refer to the following regulations as applicable:

The equipment shall be installed in accordance with the current Installation Code for Gas Burning Appliances and Equipment, CSA B149, and applicable Provincial Regulations for the class; which should be carefully followed in all cases. Authorities having jurisdiction should be consulted before installations are made.

Wiring shall be in accordance with the CSA 22.1 Canadian Electrical Cod, Part I.

The installation of the unit shall be in accordance with the regulations of the authorities having jurisdiction

Boilers intended for American markets, refer to the following regulations as applicable:

- NFPA54: National Fuel Gas Code
- NFPA70: National Electrical Code
- IFGC: International Fuel Gas Code

All drawings, wiring diagrams, schematic arrangements, manufacturers' descriptive literature, spare parts lists, and written operating instruction should be kept permanently in the boiler room or other suitable location so it will be available to those who operate and maintain the boiler. Where space permits, drawing and diagrams should be framed or sealed in plastic and hung adjacent to the related equipment. Other materials should be assembled and enclosed in a suitable binder. When changes or additions are made, the data and drawings should be revised accordingly.

READ AND SAVE THESE INSTRUCTIONS FOR REFERENCE.

Some states and municipalities require licensing or certification of personnel who operate or maintain heating equipment. Also, some authorities require posting of inspection certificates in the boiler room. The supervisor in charge of a given installation should make sure such requirements are met.

1.3 Massachusetts Installations

Boiler installations within the Commonwealth of Massachusetts must conform to the following requirements:

- Boiler must be installed by a plumber or gas fitter licensed in the Commonwealth of Massachusetts.
- Prior to operation, the gas train and all connections must be leak tested using a non-corrosive soap.
- The vent termination must be located a minimum of 4 feet above grade level. If side-wall venting is used, the installation must conform to the following requirements from 248 CMR 5.08 (2):
 - (a) For all side wall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:
 - INSTALLATION OF CARBON MONOXIDE DETECTORS. At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.
 - a. In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.
 - b. In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.
- 1. APPROVED CARBON MONOXIDE DETECTORS. *Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.*
- 2. SIGNAGE. A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, "GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS".

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3. INSPECTION. The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.
- (b) EXEMPTIONS: The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:
1. The equipment listed in Chapter 10 entitled "Equipment Not Required To Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and
 2. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.
- (c) MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM PROVIDED. When the manufacturer of Product Approved side wall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:
1. Detailed instructions for the installation of the venting system design or the venting system components; and
 2. A complete parts list for the venting system design or venting system.
- (d) MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED. When the manufacturer of a Product Approved side wall horizontally vented gas fueled equipment does not provide the parts for venting the flue gases, but identifies "special venting systems", the following requirements shall be satisfied by the manufacturer:
1. The referenced "special venting system" instructions shall be included with the appliance or equipment installation instructions; and
 2. The "special venting systems" shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.
- (e) A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.
-

1.4 General Warnings

Each generator is provided with a data plate that can be found in the envelope with the boiler documents. The plate lists:

- Serial number or identification code;
- Rated thermal output;
- Furnace thermal output;
- Types of fuel that can be used;
- Maximum operating pressure.

A manufacturer's certificate is also provided which certifies the hydraulic test pressure.

The installation must be performed in compliance with the regulations in force by professionally qualified personnel. The term “professionally qualified personnel” means persons with specific technical skills in the sector of heating system components.

Incorrect installation may cause personal injury or damage to property for which the manufacturer cannot be held responsible.

At the first start up, all regulation and control devices positioned on the control panel should be checked for efficiency. The guarantee shall be valid only upon compliance with the instruction given in this manual.

Should overheating occur or the gas supply fails to shut off, do not turn off or disconnect the electrical supply to the water pump. Instead shut off the gas supply at a location external to the appliance.

IMPORTANT: This boiler has been designed to heat hot water to a temperature lower than the boiling point of water at atmospheric pressure and must be connected to a heating plant and/or a domestic hot water plant within the limits of the boiler performance and output.

⚠ WARNING!

The boiler may only be installed in a room that complies with the appropriate ventilation requirements. Read the installation and user instruction before installing and lighting the boiler.

2. BOILER COMPONENT IDENTIFICATION

2.1 Specifications and Dimensions

MFC II MODEL	DIM	4000	5000	6000	8000	10000	12000
Overall Length	A	134	134	134	150	153	170
Burner Extension ^a	B	33	33	33	37	37	37
To Supply Nozzle	C	25 3/4	25 3/4	25 3/4	25 3/4	25 3/4	25 3/4
To Return Nozzle	D	123	123	123	137	145	157
Between Supports	E	62	62	62	69	78	90
Overall Widths	F	45	51	51	55	57	57
Support Width	G	42	46	46	48	50	50
CL to Return	H	17 1/2	18 1/4	18 1/4	19	22 1/2	21 3/4
Overall Heights	J	86 1/2	94 1/2	94 1/2	100 1/2	106 1/2	108 1/2
Outlet Nozzle	K	85 1/2	93 1/2	93 1/2	99 1/2	105 1/2	107 1/2
Return Nozzle	L	32	33 1/2	33 1/2	34 3/4	39	43
Flue Outlet	M	16	15 3/8	15 3/8	17 1/2	17 1/2	17 1/2
Drain	N	4	4	4	4	4	4
Furnace CL	P	61	66	66	70	75	77

CONNECTIONS

Supply Nozzle, 150 psi Flg.	Q	6	6	6	6	8	8
Return Nozzle, 150 psi Flg.	R ^b	6	6	6	6	8	8
Flue Outlet	S	12	12	12	16	16	16
System Drain	T	2	2	2	2	2	2
Condensate Drain	U	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
Safety Valve	V	3/4 x 1	1 x 1 1/4	1 x 1 1/4	1 1/2 x 2	1 1/2 x 2	1 1/2 x 2

MINIMUM CLEARANCES^c

To Combustibles Front	48	48	48	48	48	48
To Combustibles Side	4	4	4	4	4	4
To Combustibles Top	20	20	20	20	20	20
To Combustibles Rear	20	20	20	20	20	20
Door Swing Side	54/57	54/60	54/60	60/67	60/68	60/68
Door Swing Rear	45/40	48/40	48/40	51/45	52/45	52/45

^a Length based on standard burner firing natural gas/#2 fuel oil

^b Right Side standard, Left Side optional

^c Check local, state and federal codes.

MFC II MODEL	4000	5000	6000	8000	10000	12000
RATED INPUT, MBH	4000	5000	6000	8000	10000	12000
GROSS OUTPUT, MBH	3800	4750	5700	7600	9500	11400
INPUT GAS (1000 BTU) CFH	4000	5000	6000	8000	10000	12000
OIL (140,000 BTU), GPH	28.6	35.7	42.9	57.1	71.4	85.7
HEATING SURFACE, SQ.FT.	454	567	566	730	878	1044
FURNACE VOLUME, CU.FT.	23.77	37.79	37.15	55.03	64.76	72.93
WATER VOLUME, GAL.	423	480	480	608	759	876
WATER WEIGHT, LBS.	3516	3994	3994	5053	6312	7289
SHIPPING WEIGHT, LBS.	7330	8600	8870	10985	12559	14082

Shipping weights based on standard units firing dual fuel at <2000 FASL.

Weights could be higher for high elevation, Low NOx or other conditions.

STANDARD FEATURES:

1. Units designed and fabricated to ASME Boiler and Pressure Vessel Code requirements, Section IV: 125 psig water @ 210°F.
2. 2" - 5.7# density mineral wool insulation with fabric backing.
3. Removable painted steel jacket casing.
4. 2 lifting eyes per vessel
5. Large furnace capable of firing #2 fuel oil
6. Hinged rear lid allowing easy furnace access
7. Gas train to either left or right side

STANDARD TRIM

1. ASME safety valve(s)
2. Low water cutoff - probe type
3. Operating (On/Off) temperature control
4. High Limit temperature control (Manual Reset)
5. Firing Rate (Modulating) temperature control
6. Temperature gauge - remote mounted
7. Pressure Gauge - remote mounted

2.2 Cross Sections

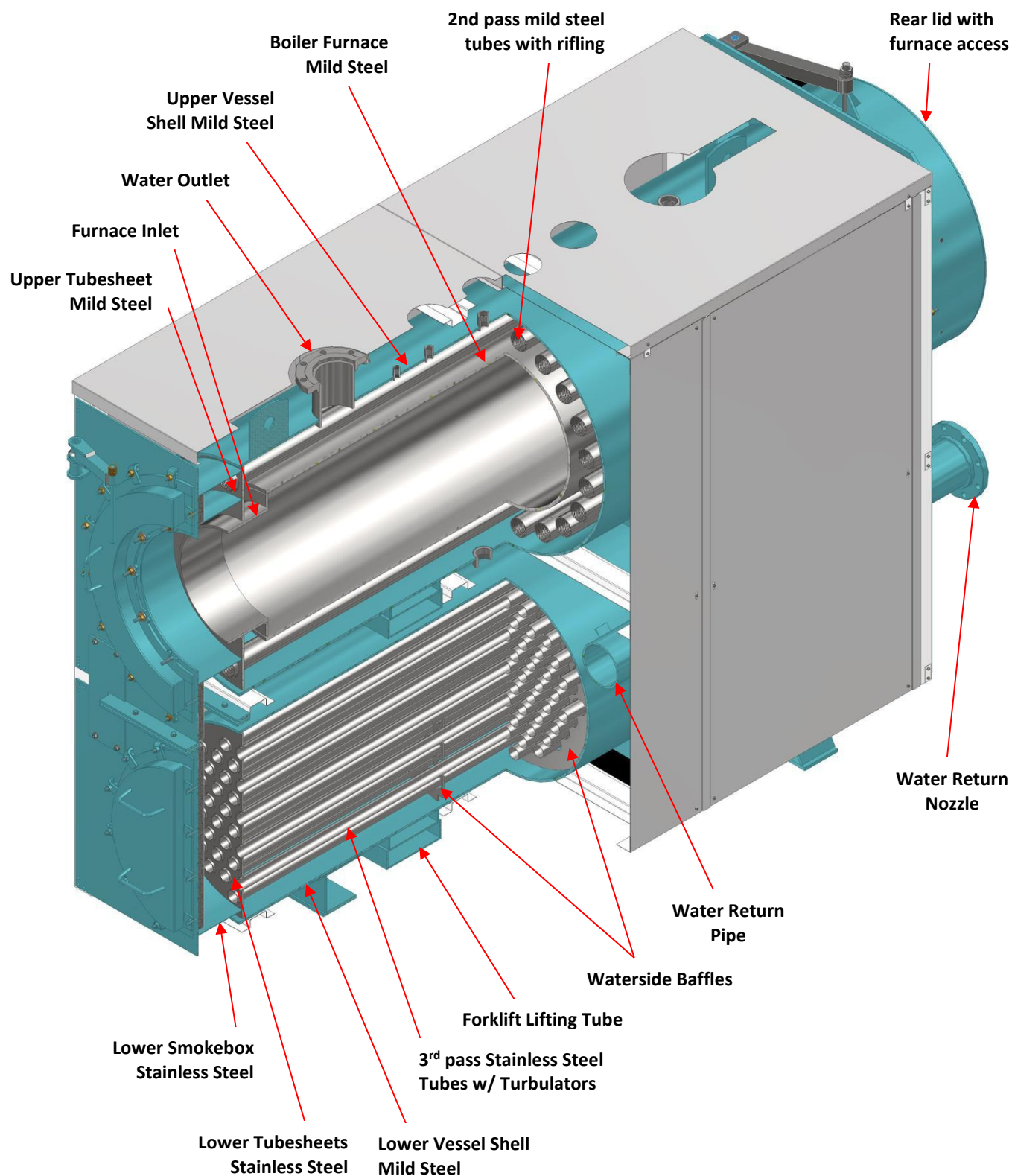
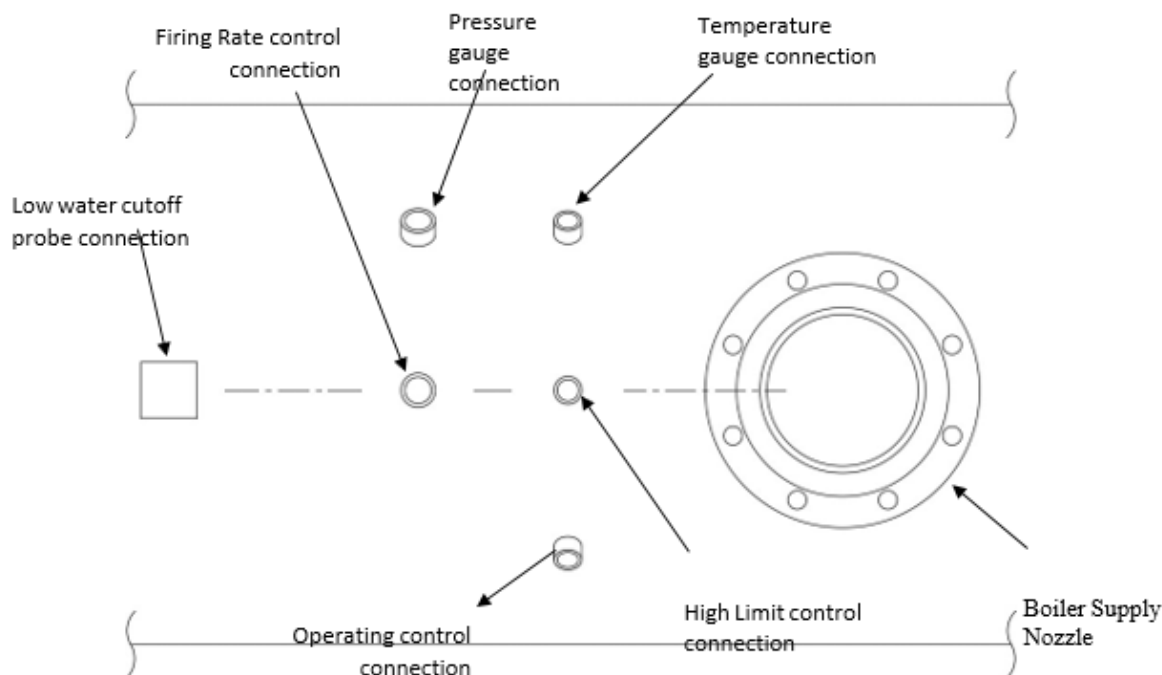


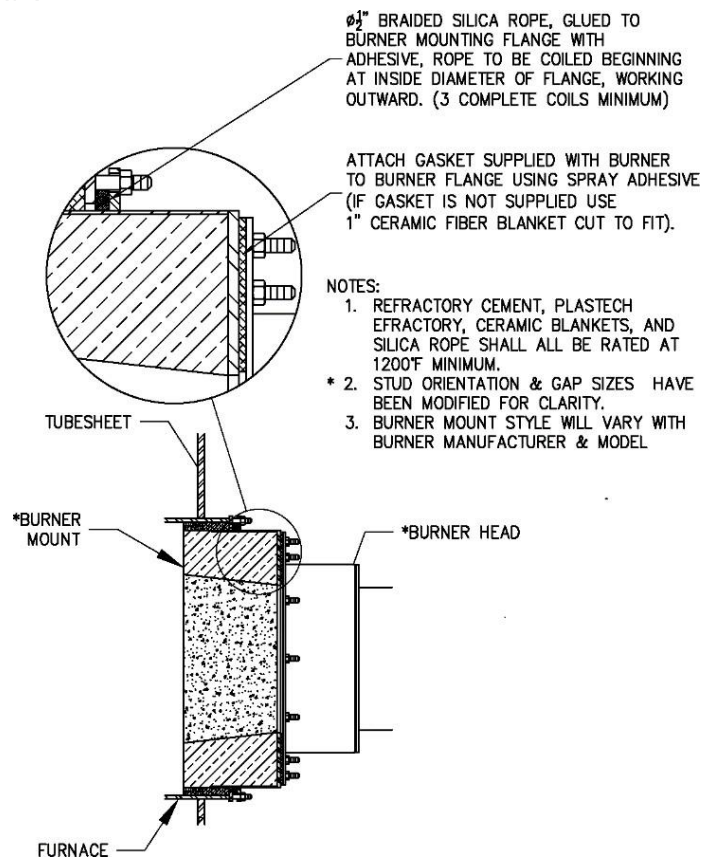
Figure 2-1: Cross Section Diagram of MFC II Boiler

2.3 Typical Instrumentation Cluster



2.4 Burner Mounting

The MFC II Boiler is shipped with a Weishaupt burner installed. This diagram illustrates the burner mounting details.



2.5 Gas Train

The gas train for Weishaupt burners acquired from AERCO is shipped loose and must be installed at the site. Refer to the gas train diagram supplied with the burner for instructions. Use unions (field provided) as necessary to allow access to the boiler for service.

Note that both the gas line and the pilot line require two unions near the front of the unit. All four unions (field provided) are required as shown below to allow the front door to swing open. Pilot line is only used for gas operation of MFC II 6000-12000.

An external lock-up type regulator must be installed at each MFC II boiler, as shown below.

The recommended distance between the gas pressure regulator and the nearest pipe fitting, elbow or valve is 5 to 10 pipe diameters.

A wiring schematic is provided with the gas train. Follow electrical connections for gas train components as shown in the schematic.

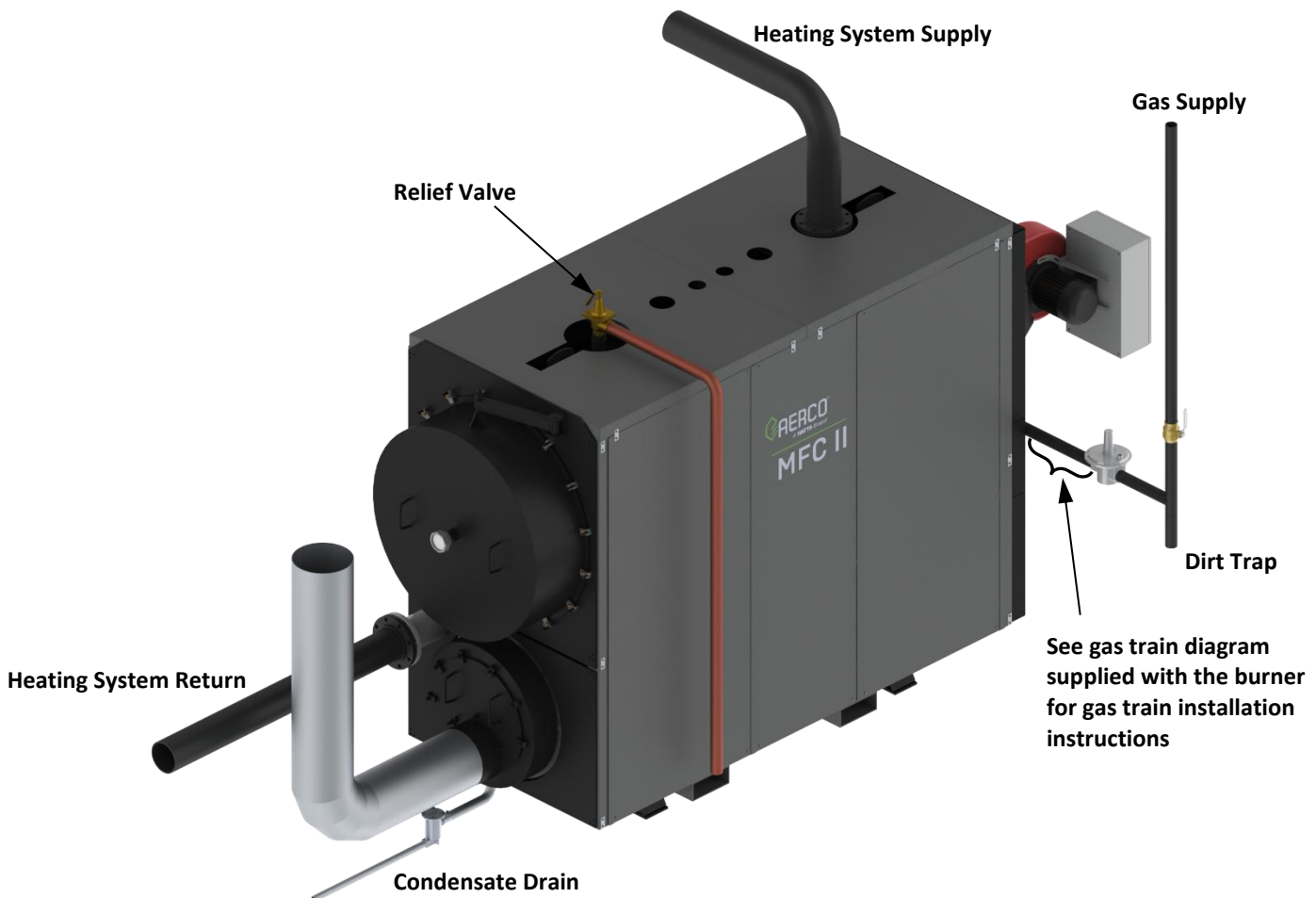


Figure 2-2: Single Boiler Gas Pipe Connections

3. SPECIFICATIONS

MFC II boilers are condensing water boilers with a horizontal furnace section, a second pass of tubes, and a condensing section. Sizing specifications are available in Section 2.1. The boiler is mounted on a structural steel base with a forced draft burner and burner controls.

The boiler is designed, constructed, and tested in accordance with the latest edition and addenda of the ASME boiler and pressure vessel code. The boiler is registered with the National Board of Boiler and Pressure Vessel Inspectors. The boiler is completely pre-assembled and tested at the factory to check construction, controls, and combustion characteristics of the unit. All MFC II boilers are constructed to meet CSD-1.

MFC II boilers are equipped with two lifting lugs on the top capable of supporting the boiler during lift operations. There are two lugs on the lower vessel section as well. These should be used to lift the lower section only. They should not be used to lift the combined vessel.

The furnace is located in the center of the upper section. It is surrounded by the second pass of XID tubes. The lower section contains the third condensing pass. This third pass consists of stainless steel tubes with turbulators.

All tubesheets are fully accessible for inspection or cleaning when the door is opened. Opening of the doors must not be impeded by fuel lines, door plates, baffles, linkages, or electrical connections. All doors are held in place by lugs that are secured by replaceable brass nuts.

A flue gas connection is located at the back of the boiler. It is centered horizontally and near the bottom vertically. Standard flue gas connection is slip on. This can be a flanged connection upon customer request. The flue gas connection is not designed to support the load of the stack, and additional support should be constructed in the field.

Safety relief valves (SRV) are selected and sized to the ASME boiler and pressure vessel code. Connections for SRV(s) are provided along the top centerline of the boiler.

Locations and sizes of many components are specified in the dimensional data and drawings.

An instrumentation cluster is provided near the boiler outlet as detailed in section 2.3. These connections are typically used for high limit, operating, and firing rate control. Temperature gauge and pressure gauge are also mounted in these connections. These controls are typically remote mounted with only the probe in the instrumentation cluster. The low water cutoff is mounted in a nearby connection along the boiler centerline.

The high limit, operating, and firing rate controls are installed as individual components in the boiler instrumentation cluster. Stop valves should not be installed between the boiler and any of these controls. These controls occupy three of the connections of the instrumentation cluster with aquastats. The firing rate controller can be replaced with a temperature sensor that is incorporated into the burners controls. The operator and firing rate controls can be incorporated into the same device.

The water supply nozzles are ANSI class 150# flanges. MFC II boilers come with a water return nozzle located at the rear of the boiler as shown in section 2.2. Recirculation piping should never be used in MFC II boilers. Recirculation will not help the boiler lifespan and will cause a major drop in efficiency. The boiler drain is at the rear of the boiler.

4. BOILER INSTALLATION

4.1 Receiving the Boiler

Over one hundred (100) separate inspections of the MFC II boiler are made during its construction. These inspections begin with the unit's engineering drawings and end with signing of the bill of lading by the freight carrier. Before signing the freight carrier's delivery receipt it is recommended that you examine your boiler in detail to be sure the unit has not been damaged in transit. If damage is evident, make a notation of the damage on the freight bill and file a claim against the carrier for the cost of replacement or repair. In the event your unit has concealed damage (not outwardly evident), you have up to fifteen (15) days after receipt to file a claim for repair or replacement of the damage. Most of our units are shipped with certain fragile and easily damaged parts packaged in a separate box. The freight bill will describe the number of pieces shipped. Be sure all pieces noted on the freight bill are received.

Boilers are typically shipped with the main boiler burner package assembled with mounted switches. The oil train is mounted and the gas train is field installed. Electrical components are wrapped in plastic and the boiler internals closed off from the elements. The shipped condition is only intended to protect the boiler from weather during transport, not additional long term storage. Some parts are shipped loose with the boiler.

4.2 Unloading the Boiler-Burner Unit

Your new unit is equipped with two lifting lugs, located on the top of the boiler, to be used for unloading. A crane is the best means of unloading and setting the new unit in place. A forklift can also be used to unload and set the boiler. When a forklift is used, be certain that it is only lifted from the designated points. *DO NOT USE A LIFTING CABLE AROUND THE UNIT.*

4.3 Boiler Unloading Instructions

1. Be sure to employ a firm experienced in moving equipment of the MFC II's size and weight.
2. Confirm that the crane being used to unload the boiler is of sufficient capacity. The boiler's dimensions and weights are found on the R&D drawing supplied with your submittal.
3. Upon arrival, inspect the boiler and all parts shipped with it. If any damage is found, notify AERCO and note damage on the bill of lading and any other receiving papers.
4. The boiler is designed to be lifted by the lifting lugs only. The use of tow motors, etc., is not recommended and can damage the boiler.
5. Before lifting the boiler, check that all transport tie downs have been removed and will not interfere with the lifting of the boiler.
6. Check lifting cables to ensure they are positioned properly and will not damage boiler.
7. Check all electrical enclosure doors and attached piping to ensure that they are secured.
8. Carefully lift the boiler off the trailer, lower it, and transport it to its installation location.
9. Lower the boiler onto its foundation and disconnect the lifting cables.
10. Clearances from combustible materials must be provided. Once the boiler is in position, verify that required clearances are satisfied. The required clearances are shown on the boiler nameplate. This should be checked while the boiler can still be easily moved.
11. The boiler should now be in position for the attachment of all piping and electrical wiring.
12. If the boiler cannot be moved into position by the crane, a forklift of sufficient size may be used. The forks must only be under the marked locations as shown below.

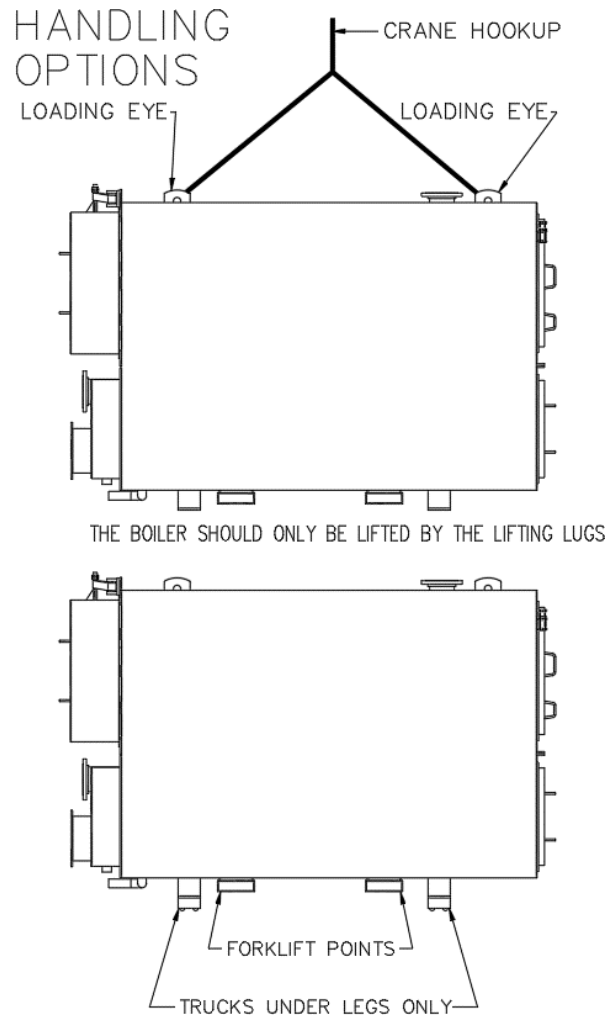


Figure 4-1: Forklift Handling Requirements

4.4 The Boiler Room

Local building codes and insurance requirements usually dictate the type of construction and material to be used in the boiler room. The floor should be non-combustible and of adequate strength to support the boiler full of water. The floor should include a drain (see Section 5.1.4). It is advisable to provide wall and floor surfaces that permit the use of water hoses. Adequate space should be provided for water treatment equipment and to permit cleaning and inspection of all piping. After the boiler has been set in place, ensure it is level.

4.4.1 Fresh & Ventilation Air

The boiler room must have an adequate air supply for combustion and to minimize soot formation. An unobstructed air opening should be provided sized on the basis of 1 sq in. free area per 1000 Btu/hr. maximum fuel input of the combined burners in the boiler room, or as specified in NFPA 54 or IFGC as applicable. The boiler room air supply openings must be kept clear at all times. Also review the ventilation requirements for your burner.

4.4.2 Lighting

The boiler room should be well lit, and have adequate emergency lighting for use in case of power failure. If a flashlight is used for this purpose, it should be maintained in usable condition and it should be protected against removal from the boiler room.

4.5 Extended Pre-Installation Storage

If a newly delivered boiler is to be placed outdoors for more than two weeks:

- Place the boiler on a flat surface on crossties under the legs;
- Make certain that any moisture from weather has been removed;
- Remove the washout plugs and place desiccant inside;
- The electrical enclosures and panels will also require desiccant to protect against condensation. A handful's worth of desiccant in a cardboard lid will do.
- Close the unit up tight to exclude all moisture and air.
- When desiccant has changed color, it is used up. Check weekly and replace as required.
- The boiler should be covered with a tarp, with emphasis on protecting the gas train, air compressor, low water cutoff, junction boxes, and burner and boiler control panels.

For the water side of a boiler, AERCO recommends a desiccant product called **Boiler Lizard**, a specialized, water-soluble protective device made by Cortec Corporation. These tubes of desiccant can be opened and placed in the water side of a boiler. The boiler lizard can remain in the water side of the boiler to be dissolved by water. The desiccant and tubular bags are water soluble; dissolving the first time water is added to the boiler. Desiccant placed in other locations should be removed prior to placing the boiler in service. This procedure is recommended even if the extended storage is indoors.

4.6 Jacketing Installation

MFC II boilers typically ship with all jacketing panels installed. These will only need to be removed for a waterside inspection, boiler repair, or moving the boiler sections through a small opening. If panels need to be removed follow the sequence below. All connections are bolted.

1. Bolt the 4 vertical C-channel supports to boiler smokeboxes
2. Connect the angle iron supports running the length of the boiler
3. Connect the support pieces along the width of the boiler
4. Install the center side panel. The boiler is still fully accessible for inspection at this point. When performing waterside inspections, only the steps below are required to be removed.
5. Install the front and rear side panels
6. Install the top panels
7. Cover all slots with the cover plates

When removing jacketing for maintenance or inspection, reverse this sequence.

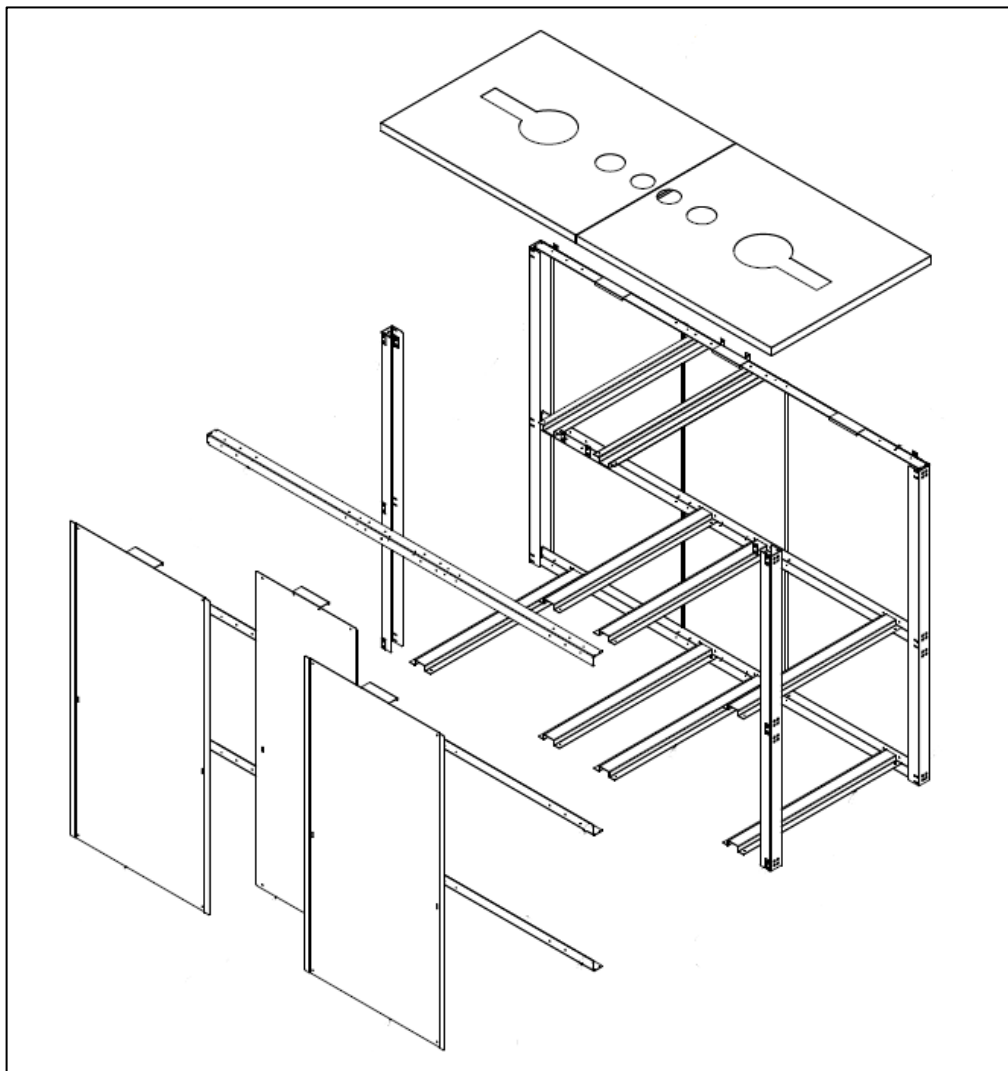


Figure 4-2: Sample Jacketing

4.7 Installation of Loose Shipped Items

When the boiler is set in place with all jacketing assembled, loose shipped items can be installed and the boiler connected to your systems. Accessories that typically ship loose are:

- Touch up paint
- Safety relief valve(s)
- Condensate Trap
- Condensate Neutralizer
- Motorized isolation valve

Please refer to the appropriate documentation of each accessory for installation.

At least one parts box will be supplied with your boiler for items like relief valve(s) and any other small loose items you ordered. Larger and heavier items are typically shipped on pallets.

The safety relief valve(s) shall be installed at connections provided on the top of the boiler. Often this takes place after the boil-out procedure. The safety relief valve(s) provided for your boilers are documented in the ASME data reports provided with this manual. See section 7.1.

4.8 Condensate Trap

The condensate trap must be installed at the condensate outlet at the back of the MFC II boiler (see diagram in section 2.5). Models MFC II 8000, MFC II 10000 and MFC II 12000 include **two condensate traps per boiler** - traps and must be piped in parallel to accommodate the condensate flow from these models.

4.9 Electrical Installation

⚠ WARNING!

Improper installation, adjustment, service, maintenance, or operation of this equipment can result in fire, explosion, series injury, or death.

⚡ ELECTRICAL HAZARD WARNING ⚡

Electrical installation shall be in accordance with the regulations of authorities having jurisdiction. The following codes shall be followed : CSA 22.1: Canadian electrical code part 1, NFPA 70: National Electric Code (NEC).

Electrical systems of thermal plants designed only for heating purposes must comply with local regulations which apply in general as well as specifically to each application or fuel type.

Each unit must be connected to a dedicated electrical circuit. NO OTHER DEVICES SHOULD BE ON THE SAME ELECTRICAL CIRCUIT AS THE BOILER.

A three-pole switch must be installed on the electrical supply line in an easily accessible location to quickly and safely disconnect electrical service. DO NOT attach the switch to sheet metal enclosures of the unit.

After placing the unit in service, the ignition safety shutoff device must be tested. If an external electrical power source is used, the installed boiler must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction. In the absence of such requirements, the installation shall conform to National Electrical Code (NEC), ANSI/NFPA 70 and/or the Canadian Electrical Code (CEC) Part I, CSA C22.1 Electrical Code.

A wiring diagram is inside the burner control panel. Before installing, modifying, or servicing system, the main electrical disconnect switch must be in the OFF position. There may be more than 1(one) disconnect switch. Lock out and tag switch with a suitable warning label.

The exact configurations of electrical panels vary. Additional small junction boxes are used when needed. If wiring is run to any probes for repair purposes, that wiring shall be sufficient for 150°F. Grounding of some components is conducted through the boiler and the mounting of burner to the boiler. Electrical power requirements are listed on placards for the respective components. Wiring from any boiler mounted controls and any fuel train controls is pulled into the burner control panel. Wiring for sensors are specific to the manufacture of the burner management system. If maintenance is performed on this wiring, ensure the appropriate wire is used. Wires are mounted on terminal strips for ease of maintenance.

4.9.1 Power for Electrically Operated Controls

All controls are powered with a potential of 150 V or lower with one side grounded. A separate equipment ground conductor should be brought to the control panel frame with ground continuity assured to the fuel valve. All operating coils of control devices should be connected to the neutral side of the control circuit, and all control limit switches or contacts should be in the ungrounded (hot) side of the control circuit. If an isolating transformer is used, it should be bonded to the control panel frame.

The equipment ground is not required when the isolating transformer is used. Do not fuse control transformers above their rated current value because these devices are current limiting and an oversize fuse may not blow under short circuit conditions.

4.9.2 Remote Emergency Shutdown Switches

A manually operated remote shutdown switch or circuit breaker shall be located just outside the boiler room door and marked for easy identification. Consideration should also be given to the type and location of the switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door. Where a boiler is located indoors in a facility and not in a boiler room, a remote emergency shutdown switch shall be located within 50 feet of the boiler along the primary egress route from the boiler area. The installer shall be responsible for installing the remote emergency shutdown switch(s) and for verifying that it is suitably marked.

4.10 Miscellaneous Installation Guidelines

Software & Safety: Programming controls provide proper sequencing of the above controls to ensure that all conditions necessary for proper burner operation are satisfied. Included in a programmed control are pre-purge and post-purge cycles to remove accumulated gases.

Flame Safeguard: When installation is complete, safety controls will stop fuel flow in case of ignition failure, main flame interruption, mechanical draft failure, or circuit failure. The controls are designed to prevent fuel flow when any of the boiler conditions are outside intended limits of pressure, temperature, and water level as is appropriate for your system.

Venting of Gas Controls: Venting should conform to recognized installation standards. It is best to check with the authorities having jurisdiction to determine your specific requirements.

Protect Controls from Water: The boiler must be installed so that the gas ignition system is protected from water. Do not use this boiler if any part has been under water. Immediately call a qualified service technician to inspect the boiler and to replace any part of the control system and any gas control which has been under water.

Minimum Clearances: The nameplate lists the clearance to combustibles. Check with any local jurisdictions and confirm the boiler clearance are not in conflict with local requirements. Finally, see the burner manual for any clearance needs for the burner itself.

4.11 Boiler Stack Connection

A flue gas connection is located at the bottom centerline at the back, above the condensate drain. The stack connection is slip-on. The flue gas connection is not designed for support. The breaching and chimney shall at minimum be the size of the stack connector. The exhaust must be pitched a minimum of ¼ inch per foot back to the boiler to allow drainage. MFC II vents must not be connected to other manufacturer's equipment.

INSTALLATION AND MAINTENANCE OF THE STACK SHALL BE IN COMPLIANCE WITH THE AUTHORITIES HAVING JURISDICTION.

Furnace pressure: The pressure drop between the burner and the stack connector at high fire.

Draft: The difference between the "stack effect" and the pressure drop of your stack.

Stack effect: Flue gasses are hotter & buoyant compared to ambient air.

Your new boiler-burner unit is supplied with a forced draft burner capable of supplying all the air for combustion when operating at reasonable amount of draft. The boiler shall be connected to a vent having sufficient draft at all times to ensure safe and proper operations of the unit. For details on the relationship between draft and burner operation, refer to your burner manual or consult a professional. The draft at the boiler stack connection should be between (-0.25"WC) and (+0.25" WC).

Stack installation and adjustment are the responsibility of the installer. The installation of your venting system should be conducted by a professional installer who can properly balance the draft of your system with the tuning of your burner. Draft can dramatically impact the adjustment of your burner on a seasonal basis. Draft values and draft control vary depending on the configuration of your stack, weather conditions, firing rate of your boiler, and many other variables. The stack draft must not impair the stability of the flame.

See MFC II Series Venting Guide, TAG-0115 for venting installation instructions and guidelines.

4.12 Vent Material Selection

AERCO recommends the use of category IV UL 1738 Stainless Steel listed ducting systems for positive pressure condensing boilers installed by a professional contractor. The ducts should be double wall construction with at least one inch between the liner (inside wall) and a shell (outside wall). Single wall construction can be used but heat losses must be considered in the overall venting design; consult local codes for guidance on use of single-wall vs. double-wall venting. A properly insulated ducting system minimizes heat loss due to changing weather and minimizes heat risks to personnel. See UL 1738 for more information.

⚠ WARNING!

The flue gas temperatures produced by MFC II boilers are considerably lower than in non-condensing boilers. For this reason the chimney must be completely watertight, able to withstand corrosion from acidic condensate, and adequately heat- insulated to guarantee sufficient draft.

5. PLUMBING YOUR BOILER

⚠ WARNING!

The improper installation, adjustment, service, maintenance, or operation of this equipment can result in fire, explosion, serious injury, or death.

THE INSTALLATION OF THE UNIT SHALL BE IN ACCORDANCE WITH THE REGULATION OF THE AUTHORITIES HAVING JURISDICTION. INSTALLATIONS SHALL BE IN ACCORDANCE WITH CSA B149, NFPA 54, AND IFGC AS APPROPRIATE

NOTE: Refer to the MFC II Series Boiler Application Guide, TAG-0118 for guidelines regarding installation of different water piping configurations and applications. The following are general guidelines only.

Refer to **Figure 5.1** for component identification in a sealed hot water heating system with an expansion tank. Ensure the hydraulic pressure measured after the reduction valve on the supply pipe does not exceed the operating pressure specified on the rating plate of the boiler.

- As system water pressure increases during operation, ensure its maximum value does not exceed the maximum hydraulic pressure specified on the component rating plate.
- Ensure that the safety valve outlets of the boiler and hot water tank, if any, are piped to within 12 inches (30.5 cm) of the floor to prevent injury in the event of a discharge.
- Ensure pipes system are not used as an earth connection for the electrical system as this can seriously and very rapidly damage the pipes, boiler, heater and radiators.
- Once the heating system is filled, close the supply cock and keep it closed so that any leaks will be identified by a drop in hydraulic pressure on the pressure gauge.

5.1.1 Boiler Connections, General

- The configuration of the supplied piping is documented in the submittal drawing.
- The piping on a boiler should be kept leak proof.
- Discharge from all drains, relief valves, and venting shall be plumbed to a safe point of discharge. Consult the authorities having jurisdiction to determine requirements.
- All plumbing installation shall be in accordance with the authorities having jurisdiction.
- Provisions shall be made for the expansion and contraction of hot water mains connected to boilers so there will be no undue strain transmitted to the boilers.

5.1.2 Water Connections

A proper and convenient water fill connection should be installed, and provisions should be made to prevent boiler water from back-feeding into the service water supply. Provision should also be made in every boiler room for a convenient water supply which can be used to flush out the boiler and to clean the boiler room floor.

5.1.3 Hot Water Boilers Supply & Return Connections

Makeup water shall only be introduced to the boiler through the water inlet. The makeup water pipe shall include either a check valve or a backflow preventer containing a check valve near the boiler. There shall also be a stop valve between the check valve and the boiler or between the check valve and the return piping system. Some jurisdictions may require installation of a backflow preventer in the feedwater connection.

Stop valves shall be placed in the supply and return pipe connections of a single hot water heating boiler installation to permit draining the boiler without emptying the system. When stop valves over two (2") inches are used, it shall be clear from a distance if the valve is closed or open. One such valve is the outside screw and yoke spindle type. The wheel may be carried either on the yoke or attached to the spindle. If the valve is of the plug cock type, it shall be fitted with a slow opening mechanism and an indicating device. The plug shall be held in place by a guard or gland. The design pressure of all valves used in water headers should equal or exceed the design pressure of the boilers.

5.1.4 Drains

Unobstructed floor drains, properly located in the boiler room, will facilitate proper cleaning of the boiler room. Floor drains that are used infrequently should have water poured into them periodically to prevent the entrance of sewer gasses and odors. If there is a possibility of freezing, an environmentally safe antifreeze mixture should be used in the drain traps.

5.1.5 Drain Connections

The discharge piping shall be full size to the point of discharge. The minimum pressure rating of valves and cocks used for drain purposes shall be at least equal to the pressure stamped on the boiler. The temperature rating of such valves and cocks shall not be less than 210°F.

5.1.6 Condensate Drain Connection

The condensate drain is located at the rear of the boiler below the flue connection. Slope the condensate tubing down and away from the boiler into a drain or condensate neutralizing filter. Do not expose the condensate line to freezing temperatures.

A condensate pump is required if boiler is below the drain. When installing a condensate pump, select one approved for use with condensing boilers and furnaces. The pump should have an overflow switch to prevent property damage from condensate spillage. The switch should be wired to the auxiliary device proving switch terminals on the low voltage connection board.

Condensate from MFC II boilers will be slightly acidic (typically with a pH from 3 to 5). As this will be corrosive hot water, the condensate line needs to be constructed of corrosion resistant material (i.e. stainless steel or CPVC). Install a neutralizing filter if required by local codes. If the boiler is not supplied with acid condensate neutralizer, a siphon loop must be fitted on the condensate drain to avoid flue gas leakage.

5.1.7 Safety Relief Valves (SRVs)

SRVs need to be installed so that no significant loads are placed on the outlet. Testing and occasional weeping can create condensate. Drip pan elbows are recommended to handle these issues during installation. Safety valves are shipped loose because they are vital to safe operation and can be damaged during transport.

SRVs are installed to prevent operation of the boiler above maximum allowable working pressure. It is good practice to manually open the safety relief valves on your boiler monthly. This is done by lifting and releasing the handle provided on the valve. Refer to the maintenance section for details on use of these valves.

5.1.8 SRV Discharge Piping

A discharge pipe shall be used. Its internal cross sectional area shall be not less than the full area of the valve outlet or of the total of the valve outlets discharged therein. It shall be as short and straight as possible and so arranged as to avoid undue stress on the valve or valves. A union may be installed in the discharge piping close to the valve outlet. When an elbow is placed on a safety or safety relief valve discharge pipe, it shall be located close to the valve outlet downstream of the union.

The discharge from safety relief valves shall be so arranged as to minimize the danger of scalding attendants. The safety or safety relief valve discharge shall be piped away from the boiler to a safe point of discharge and there shall be provisions made for properly draining the piping. The size and arrangement of discharge piping shall be independent of other discharge piping and such that any pressure that may exist or develop will not reduce the relieving capacity of the relieving devices below that required to protect the boiler.

The discharge piping should be supported so that loads (piping weights and dynamic forces during operation) transmitted to the relief valves are minimized. The weight supported by the valve should not exceed the weight of a short elbow and drip pan or comparable weight of a direct connected free hanging discharge pipe. Installations requiring long discharge piping runs should not have those discharge piping runs directly connected to the valve. The valve manufacturer should be consulted if the weight to be loaded on a valve outlet exceeds a short elbow with a drip pan.

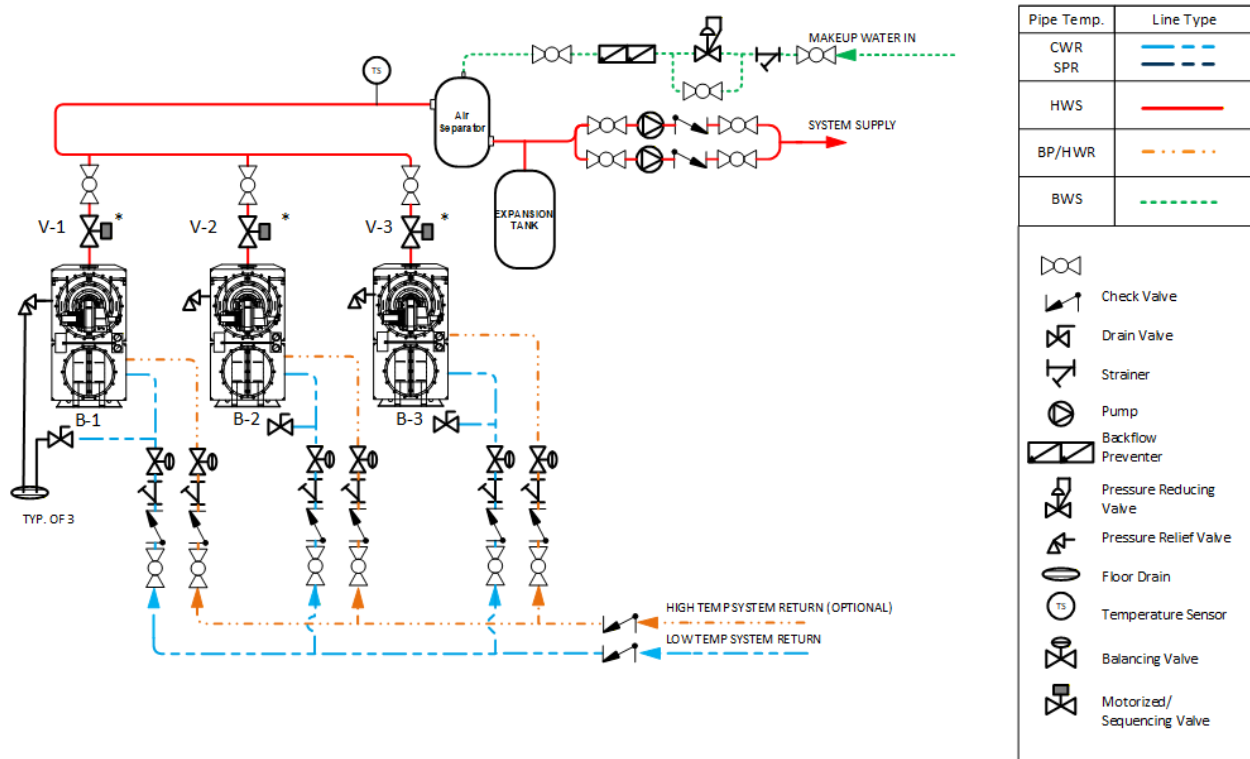


Figure 5-1: MFC II Boiler – Example of Water Piping Components

6. BOILER START-UP

The design, manufacture, and assembly of your new unit is the result of years of engineering work and field testing. It is a sophisticated piece of equipment to be serviced only by qualified people. If you don't already have a qualified operator, we recommend that you contact your AERCO representative for the name of experienced service personnel in your area.

Each burner can vary in detail, but the following should help outline the steps involved with first time startup. The following section and the manual supplied with the burner will provide many details for safe first time startup.

⚠ WARNING!

The improper installation, adjustment, service, maintenance, or operation of this equipment can result in fire, explosion, series injury, or death.

All Personnel involved with startup, maintenance, or adjustment of this boiler must read and understand the entire contents of this manual prior to startup or adjustment to this boiler.

6.1 Operating Data

Whenever a new boiler is placed in service, operating data should be recorded, compared to predicted performance, and saved for future reference. This information is extremely valuable for diagnosing problems if abnormal operation occurs. Record all operating parameters such as pressures, temperatures, flows, draft losses, motor amps, turbine speeds, damper positions, and interlock set points.

This data assists operators to spot trends and take corrective action. Maintenance plans can be made by comparing the routine logs to the base data. For operating data to be meaningful, the instruments and controls must be well maintained and properly calibrated.

A new or relocated power boiler should not be put into operation until it has been inspected by an Authorized Inspector for the authorities having jurisdiction or insurance company and the required certificates have been issued.

6.2 Start-Up Guidelines

Start-up and testing of a new unit is a SERIOUS matter. Take time to become familiar with the equipment you will be working with.

- Review the burner manual.
- Review the wiring diagrams, operating sequence, piping schematics, installation drawings, and any other pertinent information for the equipment.
- Before applying electrical power to the unit, check all electrical connections to ensure they are secure and properly connected
- Before applying fuel to the unit, check all piping to ensure it is arranged per the drawings and that all connections are tight

Before starting the boiler, check the following:

- DO NOT START BURNER UNLESS ALL SMOKEBOX DOORS ARE SECURED.
- The rating plate specifications and power supply network (electricity, water, gas or fuel oil) specifications correspond;
- The burner power range is compatible with the power of the boiler;
- There is a copy of the burner instructions in the boiler room;
- The flue gas exhaust pipe is correctly fitted;

- The air inlet supply is the correct size and free of any obstacles;
- The manhole, exhaust flue and burner plate are closed to provide a complete;
- The system is full of water and all air pockets have been eliminated;
- The anti-freeze protections are operative;
- The water circulation pumps are operating correctly;
- The expansion vessel and safety valve(s) are connected correctly and properly operating.
- Check the electrical parts and thermostat operation.

6.3 Tools & Gauges

Before you begin, check that the following tools & gauges are installed or available:

- Stack thermometer, 50-500°F
- Temperature gauge appropriate for your size of boiler
- Flue gas analyzer
- U-tube inclined type manometer to measure stack draft and furnace pressure
- U-tube or calibrated gauge for gas pressure
- Multi-meter
- Meter to measure flame signal
- A stack velocity meter if you need to verify stack flow

6.4 Fuel Guidelines

- Do not attempt to relight the pilot or start burner with the combustion chamber full of gas or with a very hot combustion chamber.
- Do not use gasoline, crankcase drainings, or any oil containing gasoline.
- NEVER BURN GARBAGE OR PAPER IN THE UNIT, AND NEVER LEAVE COMBUSTIBLE MATERIAL AROUND IT.
- Review all safety guidelines

6.5 Cleaning and Filling a New Boiler

Before putting water into a new boiler, make certain the firing equipment is in operating condition to the extent possible without actually lighting a fire in the boiler. This is necessary because raw water must be heated to at least 180°F promptly after it is introduced into the boiler in order to drive off the dissolved gases, which might otherwise corrode the boiler.

In a hot water heating system, the boiler and entire system (other than the expansion tank) must be full of water for satisfactory operation. The red, or fixed, hand on the combination altitude gage and thermometer is normally set to indicate the amount of pressure required to fill the system with cold water. Water should be added to the system until the black hand registers the same or more than the red hand. To ensure that the system is full, water should come out of all air vents when opened.

The water must enter the system as slowly as possible, and in proportion to the rate of air purge from the components involved. In the case of a system with a closed expansion tank, water is injected until the pressure gauge reaches the static pressure for the tank. Then proceed to heat the water to the maximum allowed plant temperature. During this operation, the air in the system purges from the automatic or manual air separators fitted to the system. On completion of the air purge, bring the pressure to the set value and close the manual and/or automatic water supply valve.

6.6 Water Level Controls

Water level controls are provided on every boiler. The most important function they provide is low-water fuel cutoff. Low-water fuel cutoffs are designed to provide protection against hazardous low-water conditions in boilers. History indicates that many boiler failures result from low-water conditions. Low- water fuel cutoffs may be generally divided into two types, float and probe. Only probe type controls will be used on the MFC II boilers See Figure 16.

6.6.1 Electric Probe Type Low-Water Fuel Cutoffs

The electric probe type low-water fuel cutoff is located in the instrumentation spool. It consist of one electrode (probe) that under normal conditions is immersed in the boiler water with a small current being conducted from the electrode to ground to energize a relay. If the water level drops sufficiently to uncover the probe, the current flow stops and the relay operates to shut off the burner.

6.6.2 Low-Water Fuel Cutoff Maintenance

Low-water fuel cutoffs dismantled annually, by qualified personnel, to the extent necessary to insure freedom from obstructions and proper functioning of the working parts. Examine all visible wiring for brittle or worn insulation and make sure electrical contacts are clean and that they function properly. Complete replacement mechanisms, including necessary gaskets and installation instructions are available from AERCO. After re-assembly test as required.

6.6.3 Low-Water Cutoff (LWCO)

MFC II boilers are equipped with a probe type LWCO with a manual reset located in the control panel. If this device is activated to shut off the burner, the operator must reset the device. This ensures the operator is aware that the LWCO is not operating as designed.

6.7 Water Level Operations

Operating without sufficient water to cool pressure parts is the most common way to destroy a boiler. Maintenance of water at a safe level in the boiler is of vital importance. It must not be allowed to go low enough to endanger the boiler through overheating.

If a complete shutdown occurred, let boiler cool and then add water. Do not put the boiler back into service until the condition responsible for the low water has been identified and corrected.

6.8 Water Treatment

The most common phenomena in heating systems are scaling and corrosion on the water side.

Scale reduces heat transfer between the combustion gases and the water, causing an abnormal increase in the temperature of the metal and therefore reducing the life of the boiler. Scale is found mostly at the points where the wall temperature is highest and the best remedy, at construction level, is to eliminate areas that overheat. Scale creates an insulating layer which reduces the thermal transfer of the boiler, affecting system efficiency. This means that the heat produced by burning the fuel is not fully exploited and is lost to the flue.

Water treatment starts with the boil-out procedure and the quality of your makeup water. Makeup water, regardless of the type of treatment program used, will still contain measurable concentrations of impurities. To maintain reliable boiler operation, the concentrations of each component of the boiler's water must be limited to certain maximums. Feedwater treatment and chemicals are the typical means used to maintain water quality inside your boiler.

Maximum trouble free boiler life is in most cases tied directly to proper boiler water treatment. The exact chemistry of water varies greatly from one area to another so there is no such thing

as one treatment being effective in all areas. Treatment must be provided to prevent scale formation, oxygen corrosion, excess acidity, control of total dissolved solids, prevent caustic embrittlement, and so forth. We, therefore, recommend that you contact a reputable boiler treatment company operating in your area for advice in this field.

If the boiler is to be installed in an existing system where there could be frequent losses from the system or if the hardness of the water is greater than 10 F, it will be necessary to use a filter and a softener for system water and control the pH above 8-9.

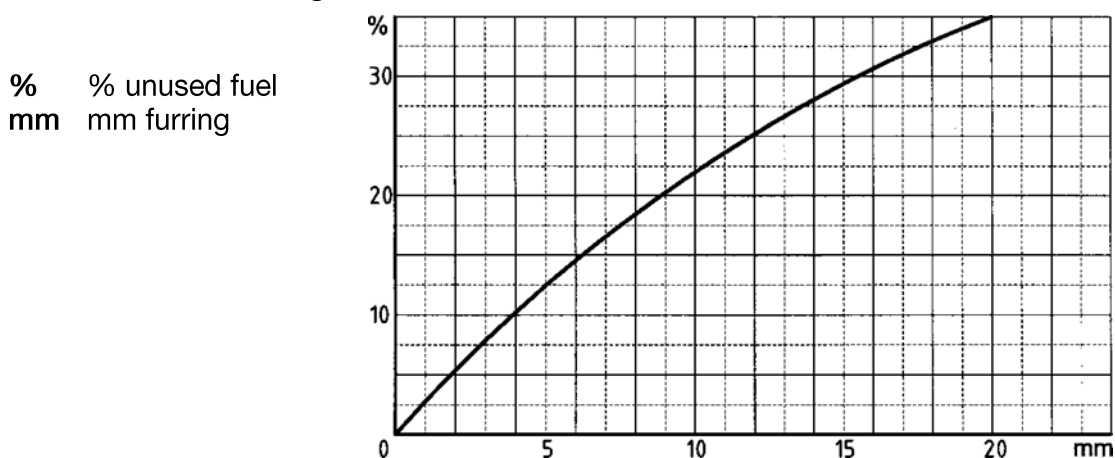
The most common phenomena in heating systems are:

6.8.1 Furring (Calcareous Deposits Of Calcium Carbonate)

Furring impedes heat exchange between the flue gases and the water, thereby increasing the temperature of parts exposed to the flame and reducing considerably the boiler life. Furring concentrates where the boiler wall temperature is higher, and the best defense against this phenomenon is a boiler design that eliminates high temperature spots.

Furring represents an insulation layer that decreases heat exchange, penalizing boiler efficiency. This means that a large part of the combustion heat is not transferred to the water but leaves the system via the chimney.

Calcium Carbonate Diagram:



6.8.2 Water-Side Corrosion

Corrosion of metallic boiler surfaces, waterside, is due to iron dissolving to form ions (Fe^{+}). In this process, the presence of any dissolved gas plays a major role, in particular oxygen and carbon dioxide. Often there are corrosion phenomena with softened and demineralized water, which are by their nature aggressive to iron (acid water with $\text{pH} < 7$): in these cases though clearly there will be no furring, corrosion remains a risk and it will be necessary to condition the feedwater with corrosion inhibitors.

6.8.3 Heating Boilers

Water treatment in a heating boiler is usually not a problem because the same water is used over and over. Treatment's primary purpose is to eliminate corrosion and pitting caused by alkalinity and oxygen. It is usually necessary to treat the water in a heating boiler once a year at the beginning of the heating season. AERCO recommends you consult a competent water consultant to determine your water treatment. The appearance of scale, corrosion, or pitting is definite evidence that water treatment is needed.

6.8.4 Water Treatment Guidelines

Get professional help: Detailed instructions, prepared by a competent feedwater chemist, for feedwater treatment should be followed. It is inadvisable to experiment with "homemade" treating methods or compounds. Representative samples of feedwater and boiler water need to be analyzed frequently to ensure they are within specifications.

Oil & water don't mix: Every effort should be made to prevent oil from getting into the water side of boilers. Oil causes foaming or combines with suspended matter to form a sludge that, in turn, can cause overheating of pressure parts through its insulating effect. If oil does get into a boiler, the boiler should be taken out of service immediately and thoroughly cleaned.

Heating boilers should not breathe: Use every practical means for excluding oxygen from boiler water. One source of oxygen is makeup water; therefore, hold makeup to a minimum. If a water boiler in a closed loop system loses more than 3 in. of water per month, this indicates there probably is a leak in some part of the system. The leak should be found and corrected.

6.9 Firing a New Boiler

Commissioning and firing a new boiler is to be conducted by your installer. This process is beyond the scope of this manual. This is to be conducted by qualified personnel only. Refer to the burner manual for more information about starting up the burner.

NOTE: When tuning the flame, it should not be allowed to impinge upon the back of the furnace. If this occurs, the warranty is void. See the boil out and start up instructions below.

6.10 Boil-Out Procedure

IMPORTANT: All new boilers must be boiled out or AERCO will void the warranty! Check local environmental regulations before introducing boil-out chemicals to drain system.

It is necessary to clean the inside of your new boiler of oil and grease, to provide clean heat transfer surfaces. Failure to remove these materials will result in your unit foaming, priming, and pulling over. Before boil-out procedures may begin, the burner must be ready for firing and the operator must be familiar with the procedure outlined under burner operation. Consult a boiler water treatment specialist for appropriate boil-out chemical to use. Follow the technical data sheet dosage and precautions detailed in their Safety Data Sheet (SDS).

1. Close off supply and return water valves and remove safety relief valves.
2. An overflow pipe should be attached to vent or safety valve connection at the top of the boiler and routed to a safe discharge, in compliance with local environmental regulations. Use care in removing and reinstalling these valves. All other openings shall be closed off.
3. All valves in the piping leading to and from the boiler must be closed to prevent cleaning solution from getting into the system.
4. Fill pressure vessel with soft water to normal water line. Add boil-out chemical, following manufacturer's dosage recommendations.
5. The boiler should then be fired intermittently at a low rate sufficient to hold the solution just at the boiling point. Maintain this temperature for a minimum of twelve (12) to twenty-four (24) hours to allow sufficient time for the removal of all dirt, oil, and grease from the internal boiler surfaces. Do not produce steam pressure.
6. Add a fresh water to boiler to create a slight overflow to carry off surface impurities.
7. Maintain temperature and overflow until impurities clear. Do not produce steam pressure.
8. Shut down the burner and permit the boiler to cool to 120° F then drain boiler. Use caution that the hot water is discharged with safety.

9. Remove washout plugs and wash the waterside surfaces thoroughly.
10. Inspect internal surfaces and repeat steps four (4) through nine (9) if necessary.
11. All washout plugs and any other openings shall be closed except a vent line. Fill the boiler immediately to prevent flash corrosion. Fire boiler until water is heated to at least 180°F to drive off any dissolved gases that may corrode the metal.
12. Proper water treatment must be maintained at all times to prevent scale and corrosion. See your water treatment professional for the program that best fits your needs.
13. Connect a vent pipe to the safety relief valve port on the boiler and run this vent to a drain.
14. Fire the boiler at a low rate for three (3) to four (4) hours allowing the steam to discharge through the vent pipe (installed in place of the safety relief valve if necessary).
15. Drain the boiler while still warm. Remove washout plugs. Wash interior of boiler with tap water at full pressure through a nozzle. Wash until all evidence of dirt, mud, and impurities are removed through the washout plug opening. Clean any shell mounted probe holders.
16. When the boiler is so equipped, remove water level prove holder(s), and check for contamination that may have been caused by the boil-out chemicals. Clean the water side surfaces of the probe holder and the probe(s) to remove any contamination. Reinstall using appropriate pipe thread sealant to ensure a leak proof seal.
17. The boil-out procedure is complete after replacing safety valve and opening outlet valve.
18. The above cleaning operation also serves to safely remove any moisture in the insulating refractory in your boiler.

6.11 Start-Up of Hot Water Boilers

If you know that the system is working safely, start-up can be simplified to the following:

1. Review the burner manual for startup recommendations.
2. Fill boiler and system; vent air at high point in system
3. Check altitude gage and expansion tank to assure system is properly filled.
4. Set control switch in “OFF” position.
5. Make sure fresh air to boiler room is unobstructed and manual dampers are open.
6. Check availability of fuel.
7. Vent combustion chamber to remove unburned gases (Burner prepurge: integral to burner operation).
8. Clean glass on both the burner’s view port, and the boiler’s sight glass.
9. Observe proper functioning of water pressure regulator and turn circulator pumps on electrically.
10. Check temperature controls for proper settings.
11. Check manual reset button on low-water fuel cutoff and high-limit temperature control.
12. Set manual fuel supply valves in open position.
13. Place circuit breaker or fused disconnect switch in “ON” position.
14. Place all boiler emergency switches in “ON” position.
15. Place boiler control start switch in “ON” or “Start” position. Do not stand in front of boiler access doors. This is a precautionary measure should a combustion explosion occur.

NOTE: Once main flame has been established, visually check the flame and note its appearance. The flame should be relatively small to achieve a slow warm-up. The main use is stable combustion and slow even heating of the boiler to minimize structural stresses.

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. Note: Remain fully aware of water temperature and flow rate while operating the boiler at higher capacities.
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 into log book: Time and date of startup, any irregularities observed/actions taken, time control shut off burner at established pressure/temperature, tests performed, etc.
20. Check safety relief valve(s) for evidence of leaking. Perform try lever test.

6.12 Good Practice Recommendations for Hot Water Boilers

Use of this hot water boiler for temporary heating of an unfinished building is not recommended and will render the warranty void against leakage. Use of the boiler prior to closing the building and balancing the heating system may lead to thermal shock and leakage.

1. Do not put into service for any purpose without properly balancing the heating system and properly adjusting the burner.
2. The burner must be adjusted to avoid short term cycling. This will help eliminate the problems connected with rapid expansion and contraction associated with short cycling when the burner is not modulating continuously.
3. The firing rate of the unit must not be exceeded.
4. A circulation flow switch (when a circulation pump is provided) must not permit the burner to fire unless water from the heating system is circulating through the boiler.
5. Prior to initial start-up, the entire heating system must be cleaned of all foreign matter such as rust, oil, etc.
6. Proper water treatment must be used.
7. Operating personnel should be properly trained in maintenance procedures.

6.13 Guidelines For Hot Water Boiler Heating System.

Condition: Boiler Warm – System Warm

- Start the burner on low fire only.
- Open supply and return headers and start system pump.
- After boiler and system temperature are equal, release burner to automatic.

Shut down of hot water boiler heating system

- Put manual low fire hold switch in low fire hold position.
- After burner is at low fire, open burner control switch and let burner cycle to off position.
- Shut pump system off.
- Close supply and return header valves.

7. OPERATION

7.1 Safety Relief Valves

A safety relief valve is an automatic pressure relieving device actuated by the pressure generated within the boiler. It is used primarily on water boilers. Valves of this type are spring loaded without full-opening pop action and have a factory set nonadjustable pressure setting.

Safety relief valves relieve excess pressure generated within a boiler. The safety relief valve (or valves) is the final line of protection against overpressure in the boiler. They discharge a volume of hot water when relieving. This is the most important single safety device on any boiler.

Safety relief valves should be tested every 30 days of use and after any period of inactivity.

- All testing personnel should be briefed on location of all shutdown controls.
- Care should be taken to protect those present from hot water.
- All safety relief valve tests are to be documented in your logbook.

7.1.1 Try Lever Test:

- a. Check that safety relief valve discharge piping is properly installed and supported.
- b. Check and log the system operating pressure and temperature.
- c. Fully open the try lever on the safety relief valve until clean water is discharged.
- d. Release the try lever and allow the spring to snap to the closed position. If the valve leaks, operate the try lever two or three times to clear the seat of any foreign matter that is preventing proper seating. As safety relief valves are normally piped to the floor or near a floor drain, it may take some time to determine if the valve has shut completely.
- e. If the safety relief valve continues to leak, it must be replaced before operation.
- f. Check that system operating pressure and temperature have returned to normal.
- g. Check again to ensure the safety relief valve has closed completely and is not leaking.

7.1.2 Safety Relief Valve Test:

- a. Check that safety relief valve discharge piping is properly installed and supported.
- b. With circulating equipment in operation, turn the fuel burning equipment off and allow boiler water to reach approximately 80-85% of normal operating temperature.
- c. Turn off water circulating equipment. On some boilers, it may be necessary to jumper out the circulating pump flow switch to allow the burner to come on during the test.
- d. Turn off system supply and return valves, then isolate expansion tank from boiler.
- e. Install a calibrated test gauge.
- f. After all personnel are clear of discharge piping, turn on the fuel burning equipment.
- g. If the temperature at the start of the test is below normal operating temperature, as recommended in (b), it will *not* be necessary to change or jumper out operating or high limit temp controls. If water is at normal operating temperature, it may be necessary to readjust limits upward to reach the opening pressure of the safety relief valve.
- h. The safety relief valve should open¹ within an acceptable range above or below the set point. This range is ± 3 psi for valves set to open at or below 60 psig.
- i. There will be a point when the valve opens and provides water flow with no significant rise in pressure. At this point log the pressure and turn off the fuel burning equipment.

¹ In the absence of flow metering equipment, opening of the valve can be considered to have been achieved when a steady fast drip or stream of approximately 40 cc/min is observed at the discharge opening of the valve.

- j. If the safety relief valve does not open at the set pressure plus the allowable tolerance, shut off the fuel burning equipment and do not operate the boiler until the safety relief valve has been replaced.
- k. If the safety relief valve opens at a pressure below the allowable tolerance, this is not necessarily a dangerous condition. However, it can indicate a deteriorating condition or improper spring setting. The valve should be replaced.
- l. After the safety relief valve has closed, open the valve to the expansion tank, system return line, and supply line to allow the boiler to return to normal operating pressure.
- m. If applicable, remove the flow switch jumper and return the operating and high limit temperature controls to normal.
- n. Start the water circulating equipment.
- o. Start the fuel burning equipment. Observe pressure and temperature until system returns to normal and the operating control cycles the burner on and off at least once.
- p. Check again to assure that the safety relief valve is not leaking

7.2 Gauges

A proper pressure gauge was shipped loose with your boiler and must be field-mounted in the connection detailed in section 2.3. If your gauge needs to be replaced, the following information is helpful to specify its replacement. Gauges can be damaged by overpressure or corrosion.

7.2.1 Pressure Gauge Range

The gauge range should be selected so that the gauge will normally operate in the middle of the scale. For hot water boilers, the gauge should have a range of not than 1 ½ times nor more than 3 ½ times the safety relief valve setting.

7.2.2 Pressure Gauge Accuracy

The gauge accuracy is expressed in percent of full scale reading. For example, if a 100 psi gauge is 2% accurate, then it will be within ±2 psi of the actual pressure. A gauge is usually more accurate at mid- scale and should be calibrated at that point. Most gauges used on boilers have an accuracy of 1 % to 1 ½ %. An inspector gauge is usually ½ % accurate and a laboratory gauge may have an accuracy of ¼ %.

7.2.3 Pressure Gauge Calibration:

The gauge should be calibrated at least once per year. This can be accomplished by comparing it to an inspector gauge or using a deadweight tester. If an inspector gauge is used, the accuracy of that gauge should be verified with a deadweight tester at least once every 2 years.

7.2.4 Temperature Gauges

Water boilers are supplied with a proper temperature gauge installed at a location indicated in the installation section of this manual. The temperature gauge is located so that it shall indicate the temperature of the water in the boiler at or near the outlet. The temperature gauge's range shall always be capable of reading the water temperature of your water boiler.

7.2.5 Stack Thermometers

All boilers are supplied with a proper stack thermometer good for at least 300°F to be installed near the stack outlet.

7.3 Temperature Controls

7.3.1 High Limit

Water boilers have a high temperature limit control that cuts off fuel supply to prevent water outlet temperature from exceeding its maximum fixed set point. This control is constructed to prevent a temperature setting above the maximum design temperature. Operation of the high limit will cause a safety shutdown requiring a manual reset. The manual reset button is on the controller itself to make the user aware of what has happened.

7.3.2 Operator

Hot water boilers have a control that will cut off the fuel supply when system water temperature reaches a preset operating limit, which shall be less than the maximum water temperature.

7.3.3 Firing Rate Control

Hot water boiler have a control that will modulate the burner between the firing rate set point and its differential. Both the operator and firing rate control typically have a single temperature setting and a fixed subtractive differential determined at the factory during manufacture.

7.4 Maintenance of Temperature Limiting Controls

Maintenance of temperature limiting controls is generally limited to visual inspection for wear, corrosion, etc. If the control is defective, replace it. Do not attempt to make field repairs. Also see the maintenance section for operational check of temperature limiting devices.

7.5 Oil Firing on MFC II Boilers

MFC II boilers are capable of firing #2 oil in addition to natural gas and propane. When firing on backup #2 fuel oil, boiler return temperatures must be maintained above 140°F (60°C) to prevent flue gas condensation and prevent damaging the heat exchanger due to excessively acidic (<2 pH) condensate and particulates. Heat Exchanger damage due to condensing while firing on #2 fuel will void heat exchanger warranty. However, if the fuel oil utilized is certified to be ultra-low sulfur (<15 ppm sulfur content), the boiler return temperature may be no less than 100°F (38°C), thus allowing the boiler to condense when firing #2 fuel oil as backup. In addition, the boiler must be inspected and cleaned if necessary, every 5 days and when the boiler is switched back to gas. The only time an inspection is not needed is if boiler is fired on oil for a monthly safety check. The following outlines the inspection and cleaning procedure:

1. Open the doors to the lower vessel.
2. Inspect the tubes for any deposits or soot in the tubes.
3. Follow the cleaning steps below if needed. If no deposits are found close the doors, reinstall insulation panels, and return the burner to service
 - a. Remove turbulators from all tubes
 - b. Using a **stainless-steel** tube brush, clean the tubes. NOTE: Use of a mild steel tube brush will void the warranty against corrosion.
 - c. Rinse tubes with soft water. An alkaline cleaning product can be added if needed.
 - d. Reinstall turbulators. The tube(s) in the lowest pass will not have a turbulator.
 - e. Close smokebox doors, reinstall insulation panels, and return boiler to service.
 - f. **NOTE:** The condensate neutralizer should be inspected during these weekly inspections. If soot has formed, it could block the filter at the neutralizer inlet.

Operating the boiler firing oil in condensing mode will produce blockages in the heat exchanger. If these are not immediately washed out, they will dry and be impossible to remove. If this happens, it is necessary to replace the entire heat exchanger. Failing to follow the cleaning information or requirements for oil will void the warranty for the heat exchanger.

7.6 Combustion Calibration Guidelines

Follow the combustion calibration guidelines below for both Natural Gas and #2 Fuel Oil.

Natural Gas:

- Maintain minimum Oxygen (O₂) level of 3% (for <30 ppm NO_x burner, use 3.5%) for firing rates greater than 50%.
- Maintain minimum Oxygen (O₂) level of 4% (for <30 ppm NO_x burner, use 4.5%) for firing rates less than 50%.
- Maintain maximum Carbon Di-Oxide (CO₂) level of 10.2% for firing rates greater than 50%.
- Maintain maximum Carbon Di-Oxide (CO₂) level of 9.5% for firing rates less than 50%.

#2 Fuel Oil:

- Maintain minimum Oxygen (O₂) level of 3% (for <30 ppm NO_x burner, use 3.5%) for firing rates greater than 50% with a smoke level less than 1.
- Maintain minimum Oxygen (O₂) level of 4% (for <30 ppm NO_x burner, use 4.5%) for firing rates less than 50% with a smoke level less than 1.
- Maintain maximum Carbon Di-Oxide (CO₂) level of 13.5% for firing rates greater than 50% with a smoke level less than 1.
- Maintain maximum Carbon Di-Oxide (CO₂) level of 12.8% for firing rates less than 50% with a smoke level less than 1.

8. MAINTENANCE

With proper operation and maintenance, you can expect years of trouble-free service from your new boiler. The next few pages give guidelines for typical boiler maintenance. Cover plates, enclosures, and guards shall be maintained in place except during maintenance.

Periodically, the waterside surfaces of the boiler should be visually checked for scale formation, pitting, and corrosion. Scale collection should not be thicker than an eggshell as scale is a good insulator and can considerably lower your boiler's overall efficiency. When lowering the water level or draining the boiler for inspection, caution must be used. **DO NOT DRAIN A HOT BOILER QUICKLY.** Good practice dictates draining the boiler only after it has been out of service at least twenty-four (24) hours.

IN NO CASE EVER FILL A WARM BOILER WITH COLD WATER. THIS WILL CAUSE LEAKAGE.

If you want to reduce the time it takes to cool off the boiler, the burners fan can run cool air through the boiler. This is not a recommended practice, however in some cases the downtime cannot be afforded to allow the boiler to cool down slowly.

8.1 Spare Parts.

Spare parts for controls, including electronic components which require time for procurement, should be maintained in stock supply. Spare parts should be kept in the boiler room or close by in a cool, dry place. In case you need to open your boiler unexpectedly, it is a good idea to keep spare gaskets on hand. Many locations require that boilers are inspected once a year. Typically the yearly maintenance is conducted at the same time as this inspection. A full set of gaskets will be needed to reseal all access openings.

Documenting the start-up is required to activate your warranty. Keeping records of all boiler activities can be helpful in troubleshooting if you have a problem with operations.

8.2 Maintenance Schedule

The suggested maintenance schedule has been broken down into daily, weekly, monthly, semi-annual, and annual procedures. While the exact frequency of your inspections may vary, the schedule presented here is a good place to start. Over time you can determine exactly how often each item needs to be checked. Examples of maintenance logs are provided at the end of the manual. However the end user is responsible for creating log sheets that match your system requirements.

A permanent log book should be provided in each boiler room to record maintenance work, inspection, certain tests, and other pertinent data. Brief details of repairs or other work done on a boiler plant (including time started, time completed, and signature of person in charge) should be recorded.

Performance and results of test, inspections, or other routines required by codes or laws, insurance company inspection reports, and initial acceptance test data should be recorded.

A double asterisk (**) is used to indicate that your burner manual should also be checked for information on the topic being covered.

CAUTION: Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

8.2.1 Daily Procedure (Also Reference Burner Manual Procedures)

1. All gauges, monitors, and indicators should be checked for proper operation.
2. Observe burner starting sequence and flame characteristics to verify normal behavior. Check furnace for debris and sooting.
3. If an operating log is kept, enter readings; otherwise, conduct visual check of all pressure and temperature gauge readings.
4. Check safety relief valves and connections for signs of leakage.
5. If the burner is firing oil, check level in oil storage tank. If the burner has an atomizing air compressor, check its lubricating oil level.
6. Check stack temperature. If temperature is higher than normal, check burner operation for over-firing or improper combustion.
7. Check the condensate line for proper operation

8.2.2 Weekly Procedure (Also Reference Burner Manual Procedures)

1. Test LWCO for proper operation.
2. Check the temperature limit shutdown. During this check, observe the operation of the primary safety to make sure that the operation is as described in the sequence of operation section of the burner manual.
3. Wipe entire unit, particularly the operating parts, so that oil and dust do not accumulate.
4. Check combustion control operation as outlined in check list section of burner manual. Investigate and correct any failure at once. **
 - Check flame safety control's response to lack of flame with main gas off. **
 - Intermittent Pilot – Start burner with pilot gas off, verify lockout.
 - Interrupted Pilot – Start burner with pilot gas on, verify lockout.
 - Determine that alarms are reacting to lockout.
 - Details about lockout system timing should be in burner manual. **
 - During and after flame failure test, observe ignition spark and pilot flame for abnormalities. **
 - Record pilot and main flame signals if proper meter is available. **
 - Verify that main fuel valves are closing within specified timings; check valve position indicators. **
5. If boiler is equipped with modulating burner, verify that adequate differential exists between operating and modulating controls to prevent short cycling. **

8.2.3 Monthly Procedure (Also Reference Procedures in Burner Manual)

1. Clean combustion air fan and air inlet assembly.
2. Clean air intake filter on atomizing air if compressor is present. Replace filter oil.
3. Clean scanner lens.
4. Test low draft, combustion fan air flow switches mechanically and electrically. Disconnect wire, start burner, verify pilot does not light. Reconnect wire when finished.
5. Check “open damper proving switch circuit” mechanically and electrically. Terminal must not be powered until motor reaches high fire position. If wire is disconnected, verify that motor remains at high position. Reconnect wire when finished.

**Refer to Burner Manual for Additional Information

6. Test main gas valves for leakage. Close checking cock, connect hoses to open leak test valves, submerge hose ends in water, and watch for bubbling.
7. Test fuel pressure interlock switches. With burner in normal operation (preferably at high fire), raise low gas pressure switch set point above available fuel pressure. Burner must shut off when visual indicator trips. Test high gas pressure switch by reducing set point below existing manifold pressure. Again, burner must shut off when indicator trips. After returning to normal set point, burner must not restart until switches have been manually reset.
8. Test oil atomizing medium interlock by interrupting flow of compressed air to burner. Oil valves must close, with subsequent flame safeguard lockout
9. Manually lift safety valve with test lever momentarily while boiler is at normal operating pressure. You should see flow out of this valve. If the valve does not flow when opened, or properly close afterwards, refer to the safety relieve valve's manual for further details.
10. Check the flue gas connector, vent connector (breaching), and stack for leaking and or corrosion. All vent system components and draft controls shall be checked per their manuals or instructions provided by the installer.
11. Test high and low oil pressure and oil temperature interlocks. Refer to burner manual for details.

8.2.4 Semi-Annual Procedure (Also Reference Procedures in Burner Manual)

1. Cool boiler slowly to room temperature. NOTE: Failure to cool boiler slowly can cause plates to leaks. This is very important! If required to assist cool down, use the Test/Run or Check/Run switch located on the programmer to run the blower.
2. Remove lugs from rear door and swing it open on the hinges.
3. Clean the combustion chamber.
4. Clean the sight port glass, replace if required.
5. Inspect and clean the condensate trap(s) to ensure the float is free to move and condensate flows normally.
6. Inspect the condensate neutralizer, and, if necessary, replace the media.
7. Rinse the condensate drain pipe with soft water.
8. Flush air compressor (if used) as directed in its manual or in the burner manual **
9. Clean & adjust pilot assembly. This will be covered in the burner manual. **
10. Re-calibrate all indicating and recording devices
11. Check flame failure detection system components. Refer to the burner manual for additional instructions. **
12. Check firing rate control. **
13. Check piping and wiring of all interlocks and shut off valves. **
14. Inspect burner components; refer to the burner manual for additional instructions. **
15. Check wire insulation for brittleness, cracking, or missing patches.
16. Disassemble and clean all safety control related piping
17. Check boiler pressure gauge against calibrated master gauge or with dead weight tester. New gauges are built to one percent (1%) accuracy.

**Refer to Burner Manual for Additional Information

8.2.5 Annual Procedure (Also Reference Procedures in Burner Manual)

1. Follow steps 1 through 6 listed under Semi-Annual Procedure.
2. If the condition of the water in the boiler indicates there is considerable foreign matter in it, the boiler needs the waterside cleaned. If this is needed, take the following steps:
 - Cool and drain the boiler.
 - Wash down the inside (water side) of the boiler with a hose, making sure to get all sludge and scale out of bottom of boiler.
 - Remove the washout plugs.
 - Inspect the shell surfaces for signs of corrosion or scale formation. If scale is forming (to any degree) on internal surfaces, chemical treatment is not correct. Consult your water treatment professional.
 - Disconnect the return and supply piping to inspect for scale build up. Check stop and check valves for proper operation and replace if necessary.
 - Fill the boiler and reset the low water cutoff.
3. At the time of this yearly inspection and cleaning, it is recommended that the local state or insurance inspector, in addition to a certified AERCO technician, be called in to check the condition of the equipment. A water treatment professional should also be present.
4. Jumper operating control and run boiler under manual control at reduced load to determine if high limit control functions correctly. Remove jumper wire when finished.
5. Bypass both operating and high limit controls under manually controlled low load condition. Gradually bring boiler pressure up to safety relief valve set point. Valves rated 15 to 69 psi are permitted two percent (2%) tolerance and 70 to 300 psi valves may vary by three percent (3%).
6. Remove gas line strainer basket and clean.
7. Flame failure detection system, pilot turn down test. **
8. Check dual fuel change over control. **
9. Replace scanners or flame rods in accordance with manufacturer's instructions. **
10. Conduct a combustion test. **
11. Check all coils and diaphragms; test other operating part of all safety shutoff and control valves. **
12. Test fuel valve interlock switch in accordance with manufacturer's instructions. **
13. Perform leakage test on pilot and main gas valves. **
14. Test purge air switch in accordance with manufacturer's instructions. **
15. Test low fire start interlock in accordance with manufacturer's instructions. **
16. As required. **
 - Recondition or replace lower water fuel cutoff device
 - For oil-fired burners, clean atomizers and oil strainers.
 - For gas-fired burners, check drip leg and gas strainers.
 - Flame failure detection system, pilot turn down test.
 - Test safety relief valves in accordance with SRV tests.

**Refer to Burner Manual for Additional Information

8.3 Detailed Empty Inspection

Before commissioning, and as required the boiler can be drained and inspected in detail. The following checklist is what most inspectors will be looking for.

8.3.1 Safety Checklist For Inspection

1. Notify person in charge at the site when beginning and finishing the inspection.
2. Inspect with another person so if assistance is required help will be close at hand.
3. Always be aware of the nearest escape routes.

8.3.2 Water Side Checklist

1. The water side should be free of dirt, tools, rags, wood, or trash.
2. All internal fittings should be in serviceable condition and securely in correct position.
3. Look for evidence of corrosion on pressure parts.
4. Look for erosion at mating surfaces of washout plugs and flanges
5. Note location and type of deposits in boilers that have previously been in operation and collect samples for analysis.

8.3.3 Fire Side Checklist

1. All combustion air and flue gas passages such as the furnace, ductwork, and fans should be free of extraneous material.
2. It is especially important to remove all combustible material that might ignite, burn, and trigger the explosion of unburned fuel if ignition is lost or interrupted at the burners.
3. Dampers and burner registers should be operated to confirm that they are free to travel from fully closed to wide open. (Vent damper may have a stop preventing full closure)
4. Check to verify that the refractory is correctly located and properly installed. Burner orifices, over fire air nozzles, observation ports, and instrument taps must not be covered or plugged. Repairs should be made if refractory is missing or significantly damaged. Slag should not be removed from the surface of the refractory unless it interferes with normal operation. It is very likely that chunks of refractory will be removed with the slag.
5. Look for daylight shining through holes that indicate air or flue gas leaks.
6. Always carry a note pad and pencil and make notes of conditions to avoid reliance on memory. Sometimes a photo or sketch is valuable as a reference for future inspections.

8.3.4 Look For Corrosion Of Pressure Parts:

- under deposits;
- at joints;
- where the flue gas may have been below its dew point;
- under refractory or insulation if it has been water soaked for a period of time.

8.3.5 Look For Erosion:

- of draft fan housings and wheels handling dirty gas
- at sharp turns or points where dirty gas flow may concentrate
- in areas near where any water leaks have occurred

8.3.6 External Checklist:

1. Free access should be provided to burner front, observation ports, and operating valves.
2. All instrumentation and controls should be complete, operational, and checked for proper calibration and action.
3. External indicators permanently marked or installed on damper shafts and registers are necessary for positive determination of position while the boiler is in service.
4. Personnel protection from hot surfaces should be provided by restricting access or by covering the hot surfaces with insulation.
5. Find potential air or flue gas leaks in the furnace of out of service boilers operated with positive furnace pressure by operating the forced draft fan at high flow rates. Leaks that can be felt or heard should be repaired before returning the boiler to service.
6. Safety relief valve outlets should be piped so they cannot discharge on people or any property that may be damaged. The discharge piping should be supported so that loads (piping weights and dynamic forces during operation) transmitted to the relief valves are minimized. The weight supported by the valve should not exceed the weight of a short elbow and drip pan or comparable weight of a direct connected free hanging discharge pipe. Installations requiring long discharge piping runs should not have those discharge piping runs directly connected to the valve. The valve manufacturer should be consulted if the weight to be loaded on a valve outlet exceeds a short elbow with a drip pan.

8.4 Limit Control Tests

All limit controls should be tested periodically. Refer to the maintenance schedule as a starting point and discuss the details with your installer. A test gauge should be used to check the operation of all pressure controls. In general, the tests are to be performed as follows. Some tests may not apply to your specific installation.

8.4.1 High & Low Gas Pressure Switch Limit Test & Adjustment

The max and min pressure range of the gas train is on the rating plates on the front of the boiler. If any readings are above this range, or if adjustments can't be consistently made within this range, then other issues like pressure regulators or line pressure need to be addressed first.

The boiler and its individual shutoff valve must be disconnected from the gas supply pressure during any pressure testing of that system at test pressures in excess of ½ psi (3.5 kPa). The boiler must be isolated by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressure equal to or less than ½ psi (3.5kPa).

For setting and testing the gas pressure switches:

Close the main manual gas shutoff valve and install a manometer or calibrated gauge in a test port that will see the same pressure as the switch. Reopen the main manual gas shutoff valve. When finished, close the main manual shutoff valve, remove calibrated gage or manometer, and restore the test plug. Restore the main manual gas valve to full open.

Setting and testing the low gas pressure switch:

Cycle the burner to high fire and a gas pressure reading. Using the main manual gas shutoff valve, throttle down the gas flow to a point there the reading is approximately 10% below the full open reading. Then adjust the low gas pressure switch until it breaks and shuts down the burner. Restore main manual gas shutoff valve to full open.

Set the burner to high fire and use the main manual gas shutoff valve to throttle the gas flow. The low gas pressure switch should immediately break and shut down the burner at about 10% reduced pressure.

For setting and testing of the high gas pressure switch:

If the high gas pressure switch (HGPS) is located downstream of the metering valve, adjustment and testing of the HGPS is performed at high fire. If the HGPS is located upstream of the metering valve, then adjustment and testing is performed at low fire.

Cycle the burner to maximum firing rate and take gas pressure reading. Slowly adjust the switch until it breaks and shuts down the burner, then reverse the adjustment so that setting is approximately 10% greater than the reading at which the switch broke.

8.4.2 Electrical Limit Controls.

All electrical current limiting or overload devices, including fuses and thermal overload elements, should be inspected to determine that they are properly sized and in good condition. Switches, starters, and relays should be checked for proper operation.

8.4.3 Oil Pressure Supervisory Switch (If Used - On Installation With Separate Pump Set.)

Manually turn down burner cock to burner until oil pressure drops below minimum recommended by the burner manufacturer. Burner should shut off. If test passes, reset firing cock, restart burner, and check operation.

9. TROUBLESHOOTING

If burner does not start, check the controller fault code in the burner manual.

1. Check all electric fuses.
2. Check water level in boiler.
3. Check limit controls to make sure they are making circuit.
4. Push motor or starter reset button.
5. Push reset button on the programming control.
6. Push reset on high and low gas pressure switches.
7. Push reset button(s) on LWCO and temperature devices.
8. If burner then fails to start, call a qualified service technician.

Refer to burner manual, look for sections about start up, flame sensors, flame safeguard, etc...

9.1.1 To Stop Burner

1. Switch off burner control switch or push emergency door switch.
2. Do not kill the pump until boiler is cooled

9.1.2 Burner Adjustments

The burner manual should be used for reference on burner adjustment.

1. The flame should not be impinging on the walls of the furnace.
2. If you are having problems adjusting the flame using the burner controls, draft controls may need to be adjusted, or added if not present.

9.1.3 Switch Problems

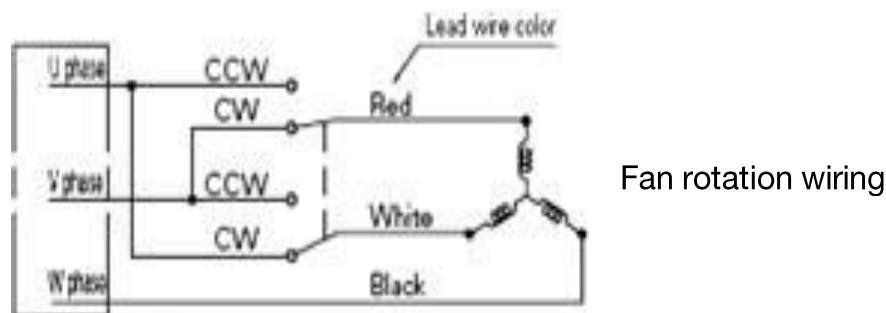
Probe style switches can give a false closed switch signal because of contamination. Clean water side of probe holder.

9.1.4 Leaking

If water starts coming out of the smoke box door, this is common during initial cold start up. If this does happen during start up but stops after the boiler has warmed up, this is acceptable. If this happens during normal operation when the boiler is warm, then you may have a leak. This could also just be the result of condensation buildup if the condensate drain lines are plugged. If you believe you have a leak, call your local boiler service technician.

9.1.5 Fan Rotation

Even when factory tested, the fan motor can be wired backwards in the field. Observe the fan rotation indicator marked on the fan. The diagram below shows how the three phase wiring can control a fan going clockwise (cw) vs. counterclockwise (ccw). In general, incorrect fan rotation is corrected by switching the position of two wires.



10. OUT OF SERVICE OPERATIONS

10.1 Shutdown

When shutting down a boiler, switch burner to manual, set burner to low fire for a few moments, and then turn burner off. After burner cycles to off position, shut off any dedicated pumps. If all boilers are being shut down, shut off system pump. Close supply and return header valves.

10.2 Boiler Taken Out of Service

When a boiler is taken out of service, it should be laid-up using either the wet or dry procedure. **NOTE:** AERCO does not warranty boilers out of operation that are not properly laid up for extended periods of time. If the boiler could be subject to freezing temperatures when out of service, the boiler must be laid up dry. If draining the boiler is not practical, the laid up wet procedure may be used. Wet boiler layups are not recommended for periods longer than 30 days. AERCO does not Warranty boilers laid up wet for more than 30 days.

ALWAYS KEEP THE FUEL SUPPLY VALVE(S) SHUT OFF IF THE BURNER IS SHUT DOWN FOR AN EXTENDED PERIOD OF TIME.

10.3 Boiler Laid Up Dry

1. Allow the boiler to cool and shut off the water supply.
2. Drain, clean, and dry the boiler thoroughly (both fire and water sides)
3. Fuel and electricity to the unit shall be shut off. Use proper tag and lock out procedures.
4. An oil coating of fire side metal surfaces is beneficial when boiler is not used for extended periods of time to prevent oxidization. Avoid putting oil on firebox thermal blankets.
5. Place desiccant inside the boiler, primary junction box, and burner control panel
6. Close all opening to the boiler preventing leakage of humid air into the boiler.
7. Fuel lines taken out of service should be drained, flushed, and refilled with distillate fuel.
8. When the lay-up time is finished, see the re-commissioning section

10.4 Boiler Laid Up Wet Procedure

1. Fill boiler to overflowing with the highest quality water available. Steam condensate, soft water, or filtered fresh water all generally acceptable. Raw city water should not be used.
2. While maintaining boiler water temperature at 120°F minimum to remove oxygen, drain off boiler water from boiler drain until it runs clear.
3. Add enough caustic soda to the hot water to maintain approximately three hundred fifty (350) parts per million of alkalinity and also add enough sodium sulfite to produce a residue of sixty (60) parts per million of this chemical.
4. Wait until all dissolved gases are released and chemicals mixed into water (~1 hr)
5. Completely close the water side of the boiler so that open air does not contact the water.
6. Dry the flue gas side of the boiler.
7. Fuel and electricity to the unit shall be shut off. Use proper tag and lock out procedures.
8. The fire side should then be cleaned. An oil coating of fire side metal surfaces is beneficial when the boiler is not used for extended periods of time. This will prevent oxidization of the metal. Care should be taken to avoid putting oil on the firebox thermal blankets.
9. Place desiccant on wooden or plastic trays in fireside of boiler. Do not fill trays more than half full. Also place small amount of desiccant in junction box and burner control panel.

10. Close all opening to the boiler preventing leakage of humid air into the boiler.
11. Fuel oil lines taken out of service should be drained and flushed then refilled with distillate.
12. When the lay-up time if finished, see the re-commissioning section.
13. When the boiler is done with a laid-up wet period of time, make sure blowdown is conducted during start up.

10.5 Re-Commissioning

1. When approaching the end of your lay-up time, review the operator logs for any items that may need to be replaced. Some items can take time to procure.
2. Check that you have gaskets/seals to replace any that have been opened. This likely includes gaskets for: smoke box doors, washout plugs, and sight glass. Your spare parts list will be helpful in determining exactly what is needed. Your AERCO representative can supply you with spare parts.
3. Remove all desiccants placed within the boiler except boiler lizards placed in the water side of the boiler can be left inside.
4. If the boiler was laid up dry, rinse out the water side of the boiler
5. Remove your tag and lock outs
6. See the start-up section of this manual. Boil-out procedures do not need to be repeated unless inspection finds oil buildup inside the water side.

MAINTENANCE, TESTING, AND INSPECTION LOG

DAILY

Building: _____ Month: _____ Year: _____

Address: _____

Boiler No. _____ Emergency contact: _____

Log maintained by: Operator: _____

Operator: _____

10.5.1 DAILY BOILER READINGS:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Water level														
Pressure														
Gas Temp														

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Water level														
Pressure														
Gas Temp														

	29	30	31
Water level			
Pressure			
Gas Temp			

Notes:

MAINTENANCE, TESTING, AND INSPECTION LOG WEEKLY & MONTHLY

Building: _____ Month: _____ Year: _____

Address: _____

Boiler No. _____ Emergency contact: _____

Log maintained by: Operator: _____

Operator: _____

WEEKLY BOILER READINGS:

	Week 1	Week 2	Week 3	Week 4
Test LWCO				
Observe Flame Conditions				

MONTHLY BOILER READINGS:

Linkages:

Flame sensor:

Fuel Piping:

Combustion air adequate/unobstructed:

Limit controls:

Operating controls:

Safety relief valve:

Draft controls:

Check & Non-return valves:

Water quality:

Floor drain:



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