SECTION 235217: 4-12 MMBTU MFC II SERIES CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections.

1.2 SUMMARY

A. This Section includes factory-fabricated and field-assembled, dual fuel, natural gas/propane-fired, #2 fuel oil (as backup), fire-tube condensing boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.

1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.

B. Pressure Drop Curve. Submit pressure drop curve for the following flow ranges:

1.

MFC II4000: 0-500 GPM
MFC II 5000: 0-630 GPM
MFC II 6000: 0-760 GPM
MFC II 8000: 0-1010 GPM
MFC II 10000: 0-1260 GPM
MFC II 12000: 0-1520 GPM

2. If submitted material is different from that of the design basis, boiler manufacture shall incur all costs associated with pump substitution.

C. Shop Drawings: For boilers, boiler trim and accessories include:

1. Plans, elevations, sections, details and attachments to other work
2. Wiring Diagrams for power, signal and control wiring

D. Source Quality Control Test Reports: Reports shall be included in submittals.

E. Field Quality Control Test Reports: Reports shall be included in submittals.

F. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.

G. Warranty: MFC II Series Limited Warranty document shall be included in submittals.

H. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit “H" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Condensing boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers.”

B. When operating on natural gas and installed and operated in accordance with manufacturer’s instructions, all boilers shall have CO emissions less than 50 ppm and the following NOx emissions referenced below:

- MFC II 4000-12000: <30 ppm corrected to 3% oxygen at all firing rates without the need of Flue Gas Recirculation (FGR). **Burners requiring FGR for reduced NOx emissions will not be accepted.**

Optional Ultra Low NOx burner shall be available to meet local requirements.

When operating on #2 fuel oil, all boiler models shall have CO emissions less than 50 ppm and NOx levels <90 ppm corrected to 3% oxygen at all firing rates. Smoke number shall be a maximum of trace at all firing rates when firing oil.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

1.6 WARRANTY

A. Standard Warranty: See complete MFC II Series Limited Warranty terms for details.

- 10-year pressure vessel/heat exchanger warranty
- 18-month burner warranty
- 18 months warranty for all other components, with the exception of the igniter and flame detector

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design is the MFC II Series Condensing Boilers as supplied by AERCO International Inc. Equivalent units and manufacturers must meet all performance criteria, and will be considered upon prior approval.

2.2 CONSTRUCTION

A. Description: Boiler shall be a multi-fuel natural gas, propane, or #2 oil fired (backup fuel), fully condensing when firing on gaseous fuels, 3-pass fire tube design. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be fabricated fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, and shall include insulated jacket, flue-gas vent connections, combustion-air intake connections, water supply, return and condensate drain connections, and controls.

B. Heat Exchanger: The heat exchanger shall be a 3-pass combustion flow firetube design. The heat exchanger shall be ASME stamped for a working pressure of 160 psig and maximum working temperature of 210°F.

1. The first boiler pass is a large mild steel furnace located in the center of the upper vessel.

2. All boilers shall have a furnace volume of not less than referenced below:

   - MFC II 4000: 23.8 cubic feet
   - MFC II 5000/6000: 37.1 cubic feet
   - MFC II 8000: 55.0 cubic feet
   - MFC II 10000: 64.7 cubic feet
   - MFC II 12000: 72.9 cubic feet

3. The second boiler pass is made of mild steel rifled tubes in the upper vessel. All tubes are to be a 3” OD with a nominal wall thickness of .109”. These tubes are to be attached to the tube sheets by full penetration welds to withstand thermal stresses caused by cold return water and up to 100° Delta T.

4. The tube sheets in the upper vessel are to be SA516-70 steel with a minimum thickness of 3/8”.

5. The third pass is made of grade 316L stainless steel tubes in the lower vessel. All tubes are to be 2" OD with a nominal wall thickness of .109". These tubes are to be attached to the tube sheets by full penetration welds. Tubes will include stainless steel turbulators for increased heat transfer.

6. The tube sheets in the lower vessel are to be grade 316L stainless steel with a minimum thickness of 3/8".

7. The boiler shall be mounted on a structural steel saddle.

8. The bolt holes in the rear saddle are to be slotted to allow for expansion.

9. All heating surfaces must be fully accessible for inspection and cleaning without disturbing the burner equipment or removing jacketing.

10. The upper rear door is hinged for support. All rear door hinges are to be extra heavy duty and capable of supporting the door when it is being opened or shut. The hinge is to be positioned so that the rear door will open to the (right) (left) when viewed from the burner end.

11. The upper front doors are to be stainless steel capable of operation without insulation. These doors are to be the davited design.

12. The lower front doors are to be stainless steel capable of operation without insulation.

13. Front smokebox shall be covered by 16GA with adhesive backed insulation.

14. The lower rear smokebox and doors are to be constructed of stainless steel to resist erosion from the acidic condensate. Vent connections are specified in Part 2.5. The rear smokebox shall have a collecting reservoir and a gravity drain for the elimination of condensation.

15. All doors are to be held in place by lugs that are secured by replaceable brass nuts. The doors are to be sealed with a gas tight, non-proprietary ceramic fiber rope with a minimum density of 20 lbs. per cubic foot and a continuous use limit of 1800ºF.

16. All necessary inspection and access openings shall be provided in accordance with the A.S.M.E. Code.

17. The front and rear tube sheets must be fully accessible for inspections or cleaning when the doors are open. Opening of the doors is not to be impeded by electrical connections.

18. The boiler is capable of safely operating with a zero-flow condition.

19. The boiler is to be equipped with two lifting eyes on each vessel.

20. The boiler shell is to be insulated with 5.7# density rock wool insulation. This insulation is to have a water repellant fiber backing.

21. The boiler casing is made of powder coated steel panels. These panels can be easily removed to allow for waterside inspection.

Boilers with heat exchangers using carbon steel *only* or cast iron design will be deemed unacceptable. Non-condensing boilers will likewise be deemed unacceptable. Boilers with aluminum inserts will be deemed unacceptable due to their risk for fouling and erosion when firing #2 fuel oil.

C. The boiler pressure drop shall not exceed the following per model size:

- MFC II 4000 – 3.1 Ft Hd @ 400 gpm
- MFC II 5000 – 4.8 Ft Hd @ 500 gpm
- MFC II 6000 – 6.9 Ft Hd @ 600 gpm
- MFC II 8000 – 12.4 Ft Hd @ 800 gpm
- MFC II 10000 – 9.8 Ft Hd @ 1000 gpm
- MFC II 12000 – 14.1 Ft Hd @ 1200 gpm

Due to their inherent high waterside pressure drop, water tube designs will be deemed unacceptable.

The boiler shall be able to operate in low-to-near zero flow conditions without any harm to the heat exchanger or pressure vessel. The boiler shall be able to be installed in a primary-variable application. Boilers that require primary/secondary piping arrangements will be deemed unacceptable.

Optional dual return connections are available for low and high return temperature zones for added flexibility and optimization for thermal efficiency.

Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

D. BURNER

1. Performance:
   - The turndown ratio shall range from 4:1 to 7:1 for gas firing and 3:1 to 5:1 for oil firing.
   - The burner shall produce NOx emissions referenced in section 1.4 E
2. The burner shall be a forced draft automatic burner.
3. Burner Housing:
   - Cast aluminum burner housing.
   - The burner shall be capable of hinging open to the left or to the right.
   - Burner housing shall incorporate a flange safety interlock switch to prevent the burner from starting when in the open position.
   - Burner housing shall incorporate a self-checking differential air pressure switch.
   - The housing shall incorporate a large sight glass for flame viewing and a removable cover to allow free access to all serviceable components. The burner oil supply and return connections shall include stainless steel braided connection hoses.
4. Blower wheel shall be statically and dynamically balanced for all possible firing rates of the particular burner model and size.
5. The motor shall be three phase TEFC premium efficiency blower motor.
6. Air Intake:
   - Air intake shall consist of multiple aluminum air intake vanes on the suction side for combustion air regulation.
   - Air louvers shall be controlled by a dedicated servo drive.
   - Air louvers shall be driven to the fully closed position during the “off” cycle to minimize draft losses.
   - Air intake shall include sound attenuating material and a screen to reduce the likelihood of foreign material entering the blower.
7. Combustion Head:
   - Stainless steel alloy flame tube
   - Stainless steel alloy diffuser assembly
   - Flame tube and diffuser assembly shall have a temperature rating of > 1470°F

- Diffuser, ignition electrodes, mixing assembly and all serviceable components shall be accessible without need for burner removal.
- Combustion head shall be adjustable such that the pressure drop across the diffuser can be optimized to match the maximum firing rate of the burner.
- The gas butterfly valve shall be integral to the burner allowing the gas train to be connected to the left or the right of the burner.
- Gas butterfly valve shall be controlled by a dedicated servo drive having 900 settable increments from 90 angular degrees (open) to 0 angular degrees (closed).

8. Dual Fuel Capability. The boiler shall include provisions for dual fuel capability (natural gas/propane as main fuel, #2 fuel oil as backup). Oil Features include:
   - For fully modulating oil burners: in addition to the standard oil safety shut off valves the burner shall incorporate an integral nozzle shut off device to provide positive closure of the nozzle orifice to prevent dripping or evaporation of any fuel oil during off cycles and an additional solenoid shut off device located in the oil nozzle return line to prevent reverse oil flow during off cycles.
   - For 3-stage oil burners: the burner shall incorporate an internal shut off device to prevent oil drip and seal the nozzle assembly to prevent evaporation and carbonization of the nozzle internals or nozzle tip when operating on gas.
   - Oil atomization shall be by mechanical means.
   - The mixing case assembly shall incorporate flexible stainless braided oil hoses to allow removal of the entire mixing case for service without the need to disconnect supply or return oil lines.
   - The burner shall be capable of firing on oil with NO alternate form of gas supply or gas pilot.
   - The burner oil supply and return connections shall include stainless steel braided connection hoses.
   - A compressed air supply shall not be required to fire on #2 fuel oil. The oil pump shall be mounted integral to the burner.
   - For fully modulating oil burners: an integral regulator to adjust the flow of oil to the burner nozzles must be included with the oil pump.
9. Fuel Changeover (dual fuel models):
   - Fuel changeover shall be by simple switching. This switching mechanism shall be such that it shall not be possible to flow both fuels simultaneously.
   - The unit shall be calibrated to run on both fuel sources at start-up. When switching fuels, there shall be no requirement for readjustment of any kind.
   - The oil pump shall be engaged / disengaged automatically when fuels are changed via an electromagnetic clutch assembly to eliminate pump wear when firing gas.
   - All fuel piping connections must be factory supplied.
10. The burner shall have independently programmable Ignition and Low Fire Positions as follows:
    - Ignition position gas
    - Low fire position gas
    - Ignition position oil (dual fuel models)

- Low fire position oil (dual fuel models)

11. Fuel Trains:
    - The gas train shall comply with the requirements of UL, CSD-1. It should consist of one (1) motorized safety shut-off valve, one (1) motorized operation valve with proof of closure switch and integrated regulator, low and high gas pressure switches and two manual shut-off valves. The valve body must be double-valve type and aluminum.
    - The oil train must comply with the requirements of UL, CSD-1. Oil train shall be burner mounted, additional components such as air/gas separator or oil filter (if applicable) are supplied loose.
    - Cast aluminum burner housing.
    - The burner shall be capable of hinging open to the left or to the right.
    - Burner housing shall incorporate a flange safety interlock switch to prevent the burner from starting when in the open position.
    - Burner housing shall incorporate a self-checking differential air pressure switch.
    - The housing shall incorporate a large sight glass for flame viewing and a removable cover to allow free access to all serviceable components. The burner oil supply and return connections shall include stainless steel braided connection hoses.

F. Blower: The boiler shall include a VFD controlled or constant speed fan to operate during the burner firing sequence and pre-purge the combustion chamber.

1. Motors: Blower motors shall comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Ignition: Ignition shall be via spark ignition (either direct or proven pilot) with 100 percent main-valve shutoff and electronic flame supervision.

H. The boiler shall be designed such that the combustion air may be drawn from the mechanical room itself or ducted combustion air from outside.

2.3 CONTROLS

A. Refer to Division 23, Section “Instrumentation and Control of HVAC.”

B. The boiler control system shall be Underwriters Laboratories recognized.

C. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities.

D. Burner Management System:

2. The burner management system shall be Weishaupt W-FM Series (Siemens LMV Series) and shall integrate fuel/air ratio control, flame safeguard functions and Modbus RS-232 or RS-485 remote communications into one control system.

3. The fuel/air ratio control system shall be free of linkages which connect fuel control and air control functions into a common servomotor or actuator. Burners requiring linkage will not be accepted.
4. Fuel and air control components shall be individually controlled by dedicated stepper motors programmable via the ABE (AZL) keypad.
5. The burner shall have an ignition position independently configurable for best light-off.
6. All functions including burner history, commissioned values and operating parameters shall be accessible / adjustable without the need for laptop computer or other special tools.
7. Burner management system shall have four levels of password protection.
8. Both the ABE programming pad and the W-FM* main control module shall hold the programmed data with capability of uploading / downloading from one to the other.
9. The fuel air ratio shall be infinitely adjustable throughout the firing range.
10. Flame safeguard system shall be integrated into the W-FM* control system and shall include ionization electrode for gas-only models and QRA UV flame scanner for dual fuel models.
11. Control system shall have selectable operating modes to allow for either direct modulation via the building automation system using either a 4-20 mA, 0-10V or floating point operating signal from a PID-type load controller.
12. Control system shall incorporate a 4-line, 64 character LCD display (ABE).
13. ABE display shall be capable of being mounted either on the burner or in a remote control panel up to 10M from the W-FM main control module.
14. ABE shall be easy to remove from its mounting while remaining connected to the wiring harness enabling a technician to have “hand held” adjustment capability.

E. The controller shall incorporate the following features:

1. Burner switch input (to enable/disable the boiler)
2. Alarm terminal (for remote fault alarm)
3. External load control, utilizing an analog input signal, that will directly control the burner load.
4. External load control, via Modbus communication, that will directly control the burner load.
5. Retransmission of the burner load as an analog output signal or via Modbus.
6. The Modbus interface allows monitoring and adjustment of all non-password, non-safety related, user-adjustable parameters such as:
    - Burner status
    - Hours run on a specific fuel, and the number of starts for each fuel
    - Load
    - Actuator position
    - Flame signal
    - Alarm status
    - Fault history

F. Control panel shall come in a NEMA1 enclosure with following features:

1. Gasketed gland plate

2. Door with foamed in place gasket and cam-lock latches
3. Fused control circuit transformer
4. DIN rail with terminal strip and alpha-numeric coded wiring laid in covered ducts
5. Switch for Burner On/Off
6. LED-type lights for Power On, Burner On, Gas On, Oil On, Pilot On (if pilot is included) and Fault

G. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.

A. For boiler plants with 2 or more units, the Boiler Manufacturer shall supply as part of the boiler package a Master Lead/Lag panel to control all operation and energy input of the multiple boiler heating plant. The sequencing control system shall be comprised of a microprocessor-based control than can modulate up to 8 boilers.

The lead/lag panel communicates with the boiler panel via RS485 communications to provide firing rate control and vary the energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The lead/lag panel shall be a PID type controller and uses parallel or sequential modulation for accurate temperature control with excellent variable load response. The lead/lag panel shall provide contact switching for auxiliary equipment such as boiler pumps, isolation valves, and combustion air inlet dampers based upon outdoor air temperature. When utilized, optional isolation valves must be of the spring return, normally open / fail open type.

The Master lead/lag panel shall have the following anti-cycling features:

- Manual designation of lead boiler and last boiler.
- Lead boiler rotation based on run time equalization.
- Adjustable firing delay, modulation delay, and boiler stage delay.

When in Setpoint operation mode, the lead/lag target temperature shall be fully field adjustable up to 190ºF. When set on Outdoor Temperature Reset, the controller uses a characterized heating curve to determine the rate at which the water temperature is changed as a function of outdoor temperature. The characterized heating curve shall be adjustable to suit the type of terminal units used in the system.

The controller shall be capable of receiving a setpoint via Modbus or external DC signal from a Building Automation System. To provide greater energy savings, the controller shall have programmable daily or weekly schedules, and customizable for occupied and unoccupied periods.

2.4 ELECTRICAL POWER

A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in product O&M manual and electrical guide.

B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices shall provide a single-point field power connection to the boiler. 120V/1PH/60Hz shall be for the control system while the main blower/burner shall utilize the voltage options listed under Electrical Characteristics:

C. Electrical Characteristics:

Voltage	**208 V**	**240 V**	**460 V**	**575 V**
Phase	Three	Three	Three	Three
Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Full-Load Current	24-73 FLA	21-65 FLA	11-36 FLA	9-28 FLA

Note: Actual Full Load Current dependent on configured burner model

2.5 VENTING

A. The exhaust vent must be UL Listed for use with Category II and IV appliances condensing flue gas service. UL-listed vents Al 29-4C stainless steel must be used with boilers.

B. The vent connection size for each boiler is 12-inch (MFC II 4000-6000) and 16-inch diameter (MFC II 8000-12000). The minimum exhaust vent duct size for each boiler is 12-inch (MFC II 4000-5000), 14-inch (MFC II 6000) and 16-inch diameter (MFC II 8000-12000).

C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.

D. The minimum ducted combustion air duct size for each boiler is 12-inch (MFC II 4000-6000) and 16-inch diameter (MFC II 8000-12000).

E. Common vent and common combustion air must be an available option for boiler installation. Consult manufacturer for common vent and combustion air sizing.

F. Follow guidelines specified in manufacturer’s venting guide.

2.6 SOURCE QUALITY CONTROL

A. Hydrostatic Test: Perform hydrostatic testing.

B. Inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. The electrical test shall be a test for the boiler safety controls. All components wired into the boiler safety control circuit are to be tested by simulating a failure condition. A copy of this report is to be included in the manual.

1. If burner is field sourced and installed, the local vendor is responsible for all field assembly and testing.

D. Allow Owner access to source quality-control testing of boilers. Notify Architect fourteen days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations and piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Install gas-fired boilers according to NFPA 54.

C. Install oil-fired boilers according to NFPA 31.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to boiler to permit service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Install condensate piping from the drain on the smokebox to the factory supplied condensate trap and optional condensate neutralizer and then pipe to a floor drain. The piping should be either PVC or Polypropylene; copper should not be used.

E. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection as close as possible.

G. Install piping from safety relief valves to nearest floor drain. Piping must remain at a minimum the same size of the relief valve outlet.

H. Boiler Venting

1. Install flue venting kit and combustion-air intake.

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
3. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:

The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least two separate curves at 25% and 100% BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Repeat tests until results comply with requirements indicated.
4. Provide analysis equipment required to determine performance.
5. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
6. Notify Architect in advance of test dates.
7. Document test results in a report and submit to Architect.

END OF SECTION 235217