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The Description of the Project
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SPECIFICATION DIVISION 23

NUMBER SECTION DESCRIPTION

DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING (HVAC)
SECTION 235239- FIRE TUBE BOILERS (HOT WATER)

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DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING (HVAC)
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 1 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.

B. Related Section:

1. Section 220513 - Motors
2. Section 235150 Venting Systems For Specialty Gas Fired Appliances
3. Section 220523 Valves
4. Section 220519 Thermometers and Gauges
5. Section 033000 Cast-in-Place Concrete.
6. Section 230548.13 Vibration Controls

1.2 SUMMARY:

A. This section includes packaged, factory-fabricated and assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS:

A. Submit one complete all-electronic file of the boiler package and accessories shop drawings and performance data.

1. Submit product data, including rated capacity, weight, furnished specialties and accessories; with installation and start-up instructions.
2. Submit manufacturer's assembly type shop drawings indicating dimensions, weight loading, required clearances, methods of components assembly, and location and size of each field connection.
3. Submit manufacturer's wiring diagrams for interlock and control wiring, clearly identifying required field wiring.
4. Clearly identify control points, terminal block positions, relays, contacts that will generate the required status and alarm points that will be remotely monitored; as well as receipt of boiler group permissive signal to operate; and CSD-1 Emergency shutdown.

B. After equipment has been installed, and successfully started, submit one complete all-electronic file of the boiler package as part of Operation and Maintenance Manuals, including the following.

1. Complete shop drawing submittal specified in paragraph B.
2. Factory Testing Report.
3. UM Inspector approval forms.
4. Project commissioner final report.
5. Warranty documentation as specified in Article 1.4.

6. Complete job specific as-built wiring diagram indicating interlocks, etc. Standard factory wiring diagrams are not acceptable.

1.4 QUALITY ASSURANCE:

A. Codes and standards:

1. UL compliance: The control panel shall be UL labeled. The burner system shall be designed, built and tested to guidelines established by UL-795.
2. NFPA compliance: Install fire tube boilers in accordance with NFPA code 54 "national fuel gas code".
3. DOE Compliance: Minimum efficiency shall comply with 10 CFR Part 431, Subpart G, Appendix C, "Uniform Test Method for the Measurement of Thermal Efficiency and Standby Loss of Gas-Fired Instantaneous Hot Water Supply Boilers.
4. ASME compliance: Construct fire tube boilers in accordance with ASME boiler and pressure vessel code, section IV "heating boilers".
5. UL and NEMA compliance: provide fire tube boiler and ancillary electrical components which have been listed and labeled by UL and comply with NEMA standards.
6. FM compliance: Provide control devices and control sequences in accordance with requirements of Factory Mutual system (FM).
7. NEC compliance: Provide control panels and assembly and wiring of all devices in accordance with requirements of latest edition of NEC. All control panels shall have a label indicating listing by a nationally recognized testing agency such as UL, ETI or MET.
8. CSA Compliance: Test condensing boiler to comply with CSA Safety Certified to ANSI 221.13.Additionally, safeties for burner controls must comply with latest requirements of applicable township and state codes.
9. Gas train, including pilot gas train, must comply with current IRI requirements and township and state codes.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Provide a qualified service technician from the Manufacturer's staff to supervise installation and reconnection of unit sections and to perform start-up, testing and training as detailed in part 3.

1.6 COMMISSIONING:

A. Comply with commissioning as specified in Division 01. The boiler start up engineer and the installing contractor shall cooperate and coordinate their activities with the commissioning engineer.

1.7 INSURANCE COMPANY:

A. The owner's insurance company is Factory Mutual. The complete boiler and accessory installation shall meet all of the requirements of F.M. whether or not indicated in the plans and specifications, for each device and/or component.

1.8 SHIPPING, HANDLING AND DELIVERY

A. Manufacturer shall provide shipping protection to ensure that the interior and exterior of each unit is completely protected from dirt or weather. Duct and pipe openings shall be covered with sealed sheet metal, plastic or other durable means to ensure unit cleanliness is maintained.

B. Support or restrain equipment components independently during transport to prevent to prevent damage during shipping.

C. Shipment: Shipment to be F.O.B. jobsite destination with freight prepaid and delivered to job site, or any other location designated by the installation contractor. All truck services will be arranged by manufacturer with a minimum notice of 5 working days to the installation contractor in advance of delivery. Delivery typically to be between the hours of 8:00 A.M. and 2:00 P.M. on a normal work weekday. The equipment manufacturer's representative shall be present when the equipment is delivered to inspect for any damage during both initial custody transfer receipt, and after setting boilers in Mechanical Room.

D. Handling: The equipment will be received by the installing contractor for installation. The Contractor will provide the crane and/or other rigging, and unload, inspect and accept the equipment. The installing contractor will do the rigging and move the equipment to the final locations, preceding the required piping and wiring. Crane lift details shall be fully outlined in the project-specific Safety Plan.

E. Delivery: Delivery of units is required to allow sufficient time for installation, startup and commissioning of the HHW system upgrades on or before the Substantial Completion date. The equipment shall be stored at the manufacturer's site if necessary and shipped on notification from the installation contractor. The exact delivery date is to be reflected in the contractor’s construction schedule.

F. Achieving Substantial Completion includes obtaining State of Michigan Boiler Code Inspector Certificate to Operate, UM inspector Installation Approvals, project Commissioner final report.

1.9 WARRANTY:

A. Pressure vessel warranty:

1. The pressure vessel shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 15 years.
2. Pressure vessel shall be warranted against thermal shock for the lifetime of the boiler.

B. Heat exchanger warranty

1. The heat exchanger shall carry a 15-year from shipment, prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects, or workmanship.

C. Condensate collection box warranty

1. The condensate collection box shall be guaranteed for 15 years.

D. Complete package warranty:

1. The complete package shall be warranted for a period of 2 years from the date of acceptance of the installation by the University. Warranty shall include all labor, materials and associated costs.

1.10 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with the requirements, provide fire tube boilers by one of the following manufacturer(s):

1. AERCO International, Lochinvar, Cleaver Brooks, Viessmann, Fulton, Raypack.

PART 2 - PRODUCTS

2.1 FIRE TUBE CONDENSING BOILER - GENERAL REQUIREMENTS:

A. Factory-fabricated, assembled, and tested, fire-tube, forced-draft, fully condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent and combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Each boiler shall be natural gas fired, fully condensing and fire-tube design. Power burner shall have full modulation and discharge into a positive pressure vent. Boiler efficiency shall increase with decreasing load (output) and/or HHWR temperature, while maintaining HHWS temperature setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connection, HHW supply & return, and condensate drain connections, unit maintenance drain, gas supply, pressure relief, and controls.

C. Manufacturer's proposed package shall include all options, accessories, instruments and control devices as part of the boiler package, or clearly identified as furnished by the installation contractor, to allow the package to fully function as specified and provide all of the required functions, features, alarms and remote communications as described in the Sequence of Operation and drawings.

D. Expected items included, but are not limited to the following:

1. Boiler Lead Lag controls via the boiler mounted control panel, with a Master/Slave arrangement.
2. Outdoor air Reset
3. Boiler Group Efficiency Optimization
4. Off-line individual boiler flow isolation

E. Each unit shall be a complete package ready for connection of electrical, water, blowdown, fuel and venting.

F. Each hot water boiler unit shall be AGA-certified, UL-labeled and constructed and tested in accordance with ASME pressure vessel code, section IV, for maximum working pressure of 30 psig. Each boiler assembly shall be hydrostatically pressure tested for 60 psig ASME working pressure. Each boiler must bear ASME stamp and be inspected under the national board rules.

G. Each hot water boiler shall be provided with an ASME listed safety relief valve and have a discharge capacity equal to or greater than the listed gross output of the boiler.

H. The boiler water pressure drop shall not exceed 3 psig at maximum flow conditions.

I. The boiler water connections shall be minimum, boiler pipe size connection.

J. The boiler support frame shall have a maximum width of X'-Y" to allow setting on existing housekeeping pad, or on new house keeping pad as shown in the plans.

2.2 CONDENSING BOILER CONSTRUCTION:

A. Heat Exchanger: The heat exchanger shall be constructed of corrosion-resistant Type 316 stainless steel fire tubes and tube sheets, with a one-pass combustion gas flow design. The fire tubes shall be 5/8" OD, with no less than 0.04" wall thickness. The upper and lower stainless steel tube sheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tube sheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter.

B. Pressure Vessel: Pressure vessel shall be constructed of SA53 carbon steel with welded heads and tube connections, with minimum 0.25-inch thick wall and 0.50-inch thick upper head. 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 and/or HHWR temperature decreases. The pressure vessel shall have a minimum water volume as scheduled.

C. Burner - Natural gas, forced draft: Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of a **5 to 1** (boilers less than 2500 MBH and **10 to 1** (2500 MBH to 6000 MBH boilers) turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall meet Michigan Air Quality Regulations, Chapter 1, Part 8 Rules: "Oxides of Nitrogen (NOx). The burner shall be metal-fiber mesh covering a stainless steel body with pilot ignition system and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. Burner air-fuel regulation shall be accomplished by either: a linkage-less, self-regulating, air-fuel ratio gas valve-venturi system or by use of modulating air/fuel valve to meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A cast aluminum pre-mix centrifugal blower with a variable frequency drive (VFD), or variable speed ECM motor with integrated drive electronics, shall be controlled to ensure the optimum mixing of air and fuel between the air/fuel regulator and the burner. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

D. Minimum boiler efficiencies shall be as follows at a 20 degree F HHWS&R temperature differential:

	EWT	100% Fire	50% Fire	7% Fire
2.	160° F	86.5%	87%	87%
3.	140° F	87%	87.5%	87.5%
4.	120° F	88%	89%	90%
5.	100° F	93%	94.5%	95%
6.	80° F	95.5%	96.8%	98%

E. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel flue connection. The exhaust manifold shall have a fully welded 316L stainless steel collecting reservoir and a gravity drain for the elimination of condensation.

F. Ignition: Ignition shall be via spark ignition or proven pilot with 100 percent main-valve shutoff and electronic flame supervision.

G. The boiler's manufacturer recommended annual replacement parts, necessary to complete State of Michigan CSD-1 re-certification shall be non-proprietary.

H. The boiler shall be designed such that the combustion air is pre-heated inside of the boiler enclosure to increase efficiency.

I. Enclosure: The sheet metal enclosure shall be fully removable, allowing for easy access during servicing.

J. Condensate Trap: The boiler manufacturer shall furnish a condensate drain trap and neutralization unit for installation in the field, with quench water connection provision, to create the necessary pressure seal and collect the exhaust flue condensate, per boiler manufacturer's recommended installation requirements.

K. Individual condensate trap and neutralizing tank complete with neutralization media shall be furnished for each boiler.

L. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp and shall be manufactured within an ISO 9001 Certified facility to ensure high quality standards.

M. Boiler design and warranty shall be based on operation with closed loop HHW pH range held at 8.0 - 9.5.

2.3 BOILER TRIM:

A. Boiler trim shall include the following items mounted and piped on boiler:

B. Safety Relief Valve: ASME rated.

C. Pressure and Temperature Gauge: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gauge. Gauges will be mounted on water inlet and outlet. Gauges shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

D. High and low gas-pressure switches.

E. Audio alarm with silence switch.

F. Boiler Air Vent: Automatic.

G. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

H. Boiler Primary Pump: Non-overloading, [**in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings**] [**in-line pump with a variable frequency drive (VFD)**] [**variable speed ECM motor with integrated drive electronics**], designed to operate at specified boiler pressures and temperatures. Pump and motor shall meet all requirements of Section 220513 - Motors and Section 232123 - Plumbing and Hydronic Pumps.

2.4 ADDITIONAL EQUIPMENT & ACCESSORIES:

A. Gas Regulator: Provide a dedicated gas regulator at each boiler. Incoming gas pressure to building is currently regulated to 14" w.c. maximum, with available pressure in boiler room expected to range from 7 - 14" w.c.

B. Digital Remote Alarm Contacts: 1) Provide in each boiler one set of discrete auxiliary alarm contacts to close when the boiler control panel goes in to a Boiler Fault alarm mode; 2) Provide a set of discrete auxiliary alarm contacts to close when unit is not achieving set point temperature, after an appropriate timed delay. These contacts will be wired to the University DDC system for remote alarm annunciation.

C. Digital Remote Status Contacts: 1) Provide in each boiler one set of discrete auxiliary alarm contacts to close when the boiler is in operation or burner is firing. This contact will be wired to the University DDC system for remote status annunciation.

D. 120 VAC CSD-1 Emergency Shutdown Contacts: Provide for each boiler, a relay or set of contacts to receive the CSD-1 Emergency Shutdown signal, to stop all boiler group operations.

2.5 BOILER CONTROLS

A. Refer to Division 23 Section 230900 Controls specification."

B. The boiler control system, panel and components shall be Underwriters Laboratories recognized.

C. The control panel shall consist of circuit boards using state-of-the-art surface-mount technology in a single enclosure, including:

1. A display board incorporating LED display to indicate temperature and all message annunciation
2. Individual replaceable circuit boards including CPU for all control functions, electric low-water cutoff with test and manual reset functions, power supply, ignition /stepper board incorporating flame safeguard control, and connector.

D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.

E. The control panel hardware shall support both RS-232 and RS-485 remote communications.

F. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate separate status and fault messages.

G. The control panel shall incorporate features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:

1. Setpoint High Limit, with selectable maximum boiler outlet temperature, acting as a temperature limiting governor, based on a PID function to limit firing rate to maintain outlet temperature within a 0 to 10 degree selectable band.
2. Setpoint Low Limit, with selectable minimum operating temperature.
3. Failsafe Mode, allowing the boiler to switch to an internal setpoint if its external control signal is lost, rather than shut off.

H. The boiler control system shall include the following additional features for enhanced external system interface:

1. System start temperature feature (separate from external DDC system permissive)
2. Pump delay timer
3. Auxiliary start delay timer
4. Auxiliary temperature sensor
5. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate
6. Remote interlock circuit
7. Delayed interlock circuit
8. Fault relay for remote fault alarm

I. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.

J. Each boiler shall have an oxygen monitoring system that will measure the oxygen content of the exhaust gasses in real-time. Output of O2 information shall be accessible via the boiler control panel.

K. The Boiler Manufacturer shall supply as part of the boiler package the specified Boiler Master Control (whether built in to each unit, or as a separate, additional BMCP panel) a completely integrated control system to control all operation and energy input of the multiple boiler group. The control system shall include a microprocessor, utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port.

L. The controller shall have the ability to vary the firing rate and 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 BMCP shall control the boiler outlet header temperature within +2°F. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with precise variable load response.

M. The BMCP shall have the following anti-cycling features:

1. Manual designation of lead boiler and last boiler.
2. Lead boiler rotation at user-specified time interval.

3. Delay firing/shutting down of boilers when header temperature is within a predefined dead band.

N. Control Modes:

1. When set on Internal Setpoint Mode, temperature control setpoint shall be fully field adjustable from 50°F to 190°F in operation. When set on Indoor/Outdoor Reset Mode, an adjustable inverse ratio is used in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the BMCP will operate the boiler group to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.
2. When set on MODBUS Temperature Control Mode, the BMCP will vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port. The ACS controller shall have local panel display screens for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between individual boilers (and with the separate BMCP if required) shall be twisted pair low voltage wiring, with the boilers 'daisy-chained' for ease of installation.
3. Communication interface: Provide the necessary hardware and software for future BACNET MS/TP monitoring of the boiler plant remotely. All equipment shall be BTL certified. UM BAS/DDC system for remote monitoring and interface utilizes the Siemens Apogee system.

O. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: All set points shall be adjustable.
3. Electric, factory-fabricated and installed panel to control burner-firing rate, to reset supply-water temperature inversely with outside-air temperature. Refer to Hot Water Heating Outdoor Air Reset Schedule on plans.
   a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

P. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch factory or field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

Q. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:
   a. Monitoring: On/off status and common fault alarm.
   b. Control: On/off operation.

2.6 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are shown on Drawings and specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**].
5. Provide branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].
6. Provide each motor with overcurrent protection.

2.7 CONDENSATE-NEUTRALIZATION TANKS

A. Description: Provide minimum 4.8 gallon polypropylene condensate-neutralizing tank and lid with two 1” FNPT threaded or flanged inlet and outlet pipe connections. Plastic/PVC canister type device is not permitted. Device functions to prevent acidic condensate from damaging drain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.

B. Tank features:

1. All polypropylene material.
2. Suitable for use on all natural gas and propane boilers.
3. Includes initial charge of neutralizing agent.
4. Neutralizing agent to be easily replaceable when exhausted.
5. Inlet and outlet pipe connections.

C. Tank Configuration:

1. Utilized where boiler is elevated or where tank is installed in a pit with tank top flush with floor.
2. Top easily removed for neutralizing agent replacement.
3. Internal baffles to channel flow for complete neutralization.
4. Integral bypass to prevent condensate backflow into appliance.
5. Multiple units may be used for larger capacity.

D. Tank Manufacturer:

1. Axiom NT25 Condensate Neutralization Tank or equal

2.8 VALVES, MOTORS AND OTHER ITEMS SPECIFIED ELSEWHERE:

A. All motors shall meet requirements of Section 220513.

B. All valves shall meet requirements of Section 220523.

C. Thermometers and gauges shall meet requirements of Section 220519.

D. Positive Pressure Vent For Condensing Gas Fired Appliances shall meet requirements of Section 235150

2.9 SOURCE QUALITY CONTROL

A. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

B. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

C. CSA Compliance: Test boilers for compliance with ANSI Z21.13-2017/CSA 4.9.

D. Performance Testing: Test and label boilers for efficiency to comply with AHRI 1500.

E. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

F. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

G. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 DEMOLITION AND PREPARATION:

A. Demolish existing boilers and associated piping and controls as indicated on drawings.

B. Each existing boiler is expected to be removed off site as a complete unit. Contractor may choose to disassemble or cut up each boiler, HOWEVER contractor shall maintain complete responsibility for any exposed hazardous material (asbestos) handling issues created by such an approach.

C. Modify existing housekeeping pad as indicated on drawings for installation of new boilers.

3.2 EXAMINATION

A. The plans shown are intended to be schematic and may not be correct in all details (such as the location of all outlets and inlets) to the unit, manufacturer and model, being provided by awarded contractor. The Contractor shall review the shop drawing available from the vendor and allow sufficient funds in his base bid for any additional work required to suit the unit being supplied. All equipment shipped loose shall be installed and piped as directed by the manufacturer and/or owner, by this contractor.

B. 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 performance of the Work.

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

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

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

3.3 BOILER INSTALLATION:

A. Install the boilers in strict compliance with manufacturer's written instructions, and as shown on drawings. Position boilers, install ducts, pipe to allow necessary access to components for service/maintenance.

B. Elevate boiler 6" (or as required) above the housekeeping pad, via prime and finish painted structural steel support frame, to allow for condensate drainage to slope to drain. Coordinate minimum requirements with boiler manufacturer.

C. The HWH safety valve outlet shall be piped to the nearest floor drain, with an air gap. The safety valve discharge must not be piped to any area where freezing temperatures could occur. Connect safety valve piping with union to allow for ease of relief valve replacement.

D. Following installation, flush and clean piping in compliance with the associated specification section.

E. Fill the boiler with water, and pressure-test the boiler and system per schedule on the drawings, or alternatively up to the rating of the relief valve. Clean the system per associated spec section and manufacturer's instructions; flush the system to remove all trash and dirt; and refill the system with water. Reconnect the existing water treatment chemical feed system and engage Owner, who will dose the closed HWH piping loop to the proper pH level.

F. Compressed air blow clean the new gas piping, and perform pressure test. Bleed air from the gas line in a safe manner.

G. All equipment, piping, valves and other components shipped loose shall be installed per manufacturer's instruction, whether indicated or not, in these plans and specifications.

H. Complete power and control interconnecting wiring. Perform continuity checks and energize the boiler controls.

3.4 PIPING CONNECTIONS

A. Comply with requirements for hydronic piping specified in Section 232113 "Hydronic Piping."

B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.

E. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.

F. Install condensate piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.

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

H. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve, and union or flange at each connection.

I. Install piping from safety relief valves to nearest floor drain.

3.5 DUCT CONNECTIONS

A. Boiler Venting and Combustion Air Intake:

1. Install boiler venting system and combustion-air intake.
2. Boiler venting system shall meet requirements of Section 235150 "Venting Systems for Specialty Gas Fired Appliances", and comply with UL 1738.
3. Provide combustion air intake duct material, size, and configuration as indicated in boiler manufacturer's instructions and to comply with UL 1738.
4. Comply with all boiler manufacturer's installation instructions.
5. Connect boiler vent full size to boiler connections.

3.6 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260513 "Medium, Low and Control Voltage Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.7 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260513 "Medium, Low and Control Voltage Cables "

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

1. Nameplate shall be laminated plastic, as specified in Section 260533 "Electrical Materials and Methods."

3.8 FIELD QUALITY CONTROL

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

B. Perform tests and inspections with the assistance of a factory-authorized service representative:

C. Tests and Inspections:

1. Perform installation and startup checks in accordance with manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: 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.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 FIELD TEST:

A. Observe the ignition of the pilot and the main burner to make sure they are smooth and complete. Perform combustion efficiency test, provide a report on measured carbon monoxide, carbon dioxide and oxygen and measured efficiency. Check out the safety controls and verify that they are functioning properly. Set the operating controls for the proper pressure.

B. Submit a blank copy of the proposed start-up report form for review and approval by the project engineer at least two (2) weeks before start-up.

C. Start-up report shall include, but not necessarily be limited to the following:

1. Amperage and air flow on forced draft (combustion air) fan at low and high fire
2. Gas pressures prior to and after regulators
3. Gas pressure through gas train
4. Draft pressure at boiler outlet
5. Combustion efficiency test
6. Safety control check out
7. Operating control check out

D. Operate the boiler for no less than 2 hours. Provide a written report, through channels and on company letterhead, stating that ignition is proper, safety controls have been checked and operating controls are set and functioning properly. The system is not complete until this report has been received.

3.10 START UP SERVICE:

A. After the boiler installation is completed, a factory trained technician shall supervise starting, boil out and adjusting the initial fire, schooling for the operators in the care and handling of the equipment and 12 months warranty service after initial firing to cover warranty service. Start-up services shall include all labor, materials and associated costs. The boiler manufacturer shall provide a letter stating the technician is factory trained to start-up their boilers.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, maintenance and to obtain maximum efficiency in plant operation. Refer to Section 017900 "Demonstration and Training. Video record the training sessions and provide electronic copy to Owner.]

1. Provide not less than two hours of training.
2. Obtain Owner sign-off that training is complete.
3. Owner training shall be held at Project site.

END OF SECTION 235239