PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Section 23 00 10 - General Requirements

B. Section 23 00 20 - HVAC Scope of Work

C. Section 23 05 07 - Design Conditions

D. Section 23 05 13 - Motor Requirements for HVAC Equipment

E. Section 23 05 48 - Vibration Isolation

F. Section 23 05 93 - Testing, Balancing, and Adjusting

1.2 SUMMARY

A. Furnish and install factory built condensing boilers herein specified and as indicated on the Drawings including, at minimum, the following:
1. Boilers
2. Controls and boiler trim
3. Hot water and drain connections
4. Fuel connections
5. Electrical connections
6. Breeching connection
7. Fuel vent connections and piping to outside
8. Factory-authorized boiler start-up and inspection

1.3 REFERENCE STANDARDS

A. Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this section where cited below:
1. AGA – American Gas Association
2. ANSI – American National Standards Institute
3. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers
4. ASME – American Society of Mechanical Engineers
5. ASME CSD-1 – Controls and Safety Devices for Automatically Fired Boilers
6. NBS – National Bureau of Standards
7. NFPA – National Fire Protection Association
8. IBC – International Building Code
9. UL – Underwriters Laboratories Inc.
10. UMC – Uniform Mechanical Code
11. UPC – Uniform Plumbing Code
12. The State of California Codes
13. Local Codes
14. Local Air Quality Management District Regulations
15. Local utility company rules

1.4 QUALITY ASSURANCE

A. Provide factory-run tests to check construction, controls and operation of units.

B. Provide ASME boiler inspection prior to shipment and submit copy of inspection report to Architect.

C. Controls shall be per ASME CSD-1 requirements and California code.

D. Equipment performance scheduled on the Drawings is minimum capacity required.

E. Electrical capacity scheduled on the Drawings shall be considered as maximum available.

F. In addition to the warrantees and guarantees required by the General Conditions and Section 23 00 10: General Requirements, provide the following:
   1. Ten (10) year non-prorated pressure vessel/heat exchanger warranty against leakage due to defective materials or workmanship. Ten (10) year non-prorated warranty against failure due to thermal stress or condensate corrosion.
   2. Guaranteed minimum 86 percent overall fuel-to-water efficiency with inverse efficiency curve for 92 to 96 percent plus thermal efficiency at a full modulation turndown rate and condensing return water temperatures. The accuracy of these efficiencies must be reviewed and confirmed by a National Standards Rating Agency.
   3. Extended warranties
      a. The pressure vessel shall be guaranteed against thermal shock for ten (10) years when utilized in a closed loop hydronic heating system with a temperature differential of 170 degrees F or less. The boiler pressure vessel shall be similarly guaranteed, without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.
      b. All boiler components, including but not limited to forced draft fans, circulating pumps, diffusers, burner housings, etc., shall be unconditionally guaranteed for five (5) years from the date of equipment start-up.

1.5 SUBMITTALS

A. Submit the following for review:
   1. Manufacturer's installation instructions.
   2. Certified dimensioned shop drawings, materials of construction, thickness of tubes, shell, boilerplate and insulation, manufacturer's descriptive literature, operating instructions, and maintenance and repair data.
   3. Boiler factory inspection report and fire test report of all firing ranges.
   4. Boiler start-up report to verify performance.
   5. Warranty certificate.

B. Submittals shall include:
   1. Boiler-burner units:
      a. Unit equipment
      b. Safety devices
      c. Controls
      d. Wiring diagrams
   2. Performance:
      a. Fuel efficiency at 100 percent, 75 percent, 50 percent and 20 percent of rated capacity
      b. Blower motor electrical efficiencies
      c. Blower fan curve(s)
      d. Minimum and maximum gas pressure at burner
      e. Maximum stack backpressure boiler can overcome
      f. Percent of oxygen at 100 percent, 75 percent, 50 percent, and 20 percent of rated capacity
      g. Percent NOx at 100 percent, 75 percent, 50 percent, and 20 percent of rated capacity
   3. Test reports, as required and specified
   4. ASME Certification Stamp
   5. State of California certification that each boiler complies with standards of California Administrative Code Title 20, Chapter 2, Subchapter 4, Article 4, Appliance Efficiency Regulations.
   6. Certification from contractor, boiler manufacturer and stack/breeching manufacturer that the boiler(s) will perform as specified under all possible operating conditions with the flue/stack configuration as installed.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Aerco International, Inc. – Benchmark Series Model BMK 2.0 and 3.0

B. Buderus – Series Model SB-615 (with Weishaupt high turndown burner)

C. Patterson-Kelly Co. – Mach Series

2.2 GENERAL DESCRIPTION

A. Each unit shall be a condensing fire tube design type with a modulating forced draft power burner and positive pressure vent discharge complete with boiler fittings and automatic controls. The boiler assembly, with all piping and wiring, shall be completely factory-assembled as a self-contained unit. Each boiler shall be thoroughly tested and packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with maximum water working pressure not less than 150 psig. Boiler venting shall be AGA approved as a direct vent boiler, comply with ASME CSD-1, Code requirements and California Boiler & Fired Pressure Vessel Safety Orders.

2.3 BOILER SIZE AND EFFICIENCY RATINGS

A. The capacity of each unit shall be as scheduled on the Drawings.

B. 86 percent overall fuel-to-water efficiency with inverse efficiency curve for 92 to 96 percent plus thermal efficiency.

2.4 BOILER DESIGN

A. Boiler modules shall be gas-fired, condensing fire tube design with a modulating forced draft power burner and positive pressure vent discharge. Each boiler module shall be capable of a full modulating turndown of firing rate without loss of combustion efficiency; the thermal efficiency shall increase as the firing rate decreases. Heat exchanger/combustion chamber shall incorporate a fire tube design that shall be self-supporting, baffle free, and warranted to withstand thermal shock. Heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Unit shall have an ASME approved relief valve with a setting of 150 psig (maximum). Exhaust manifold shall be of corrosion-resistant porcelain enameled cast iron with a round external flue connection. Exhaust manifold shall have a gravity drain for the elimination of condensation with collecting reservoir.

B. The boiler shall be configured and designed to accept return water as low as 50 degrees F.

C. The boiler shall be equipped for condensing operation with an integral secondary circulating pump wired for intermittent operation. Secondary circulators shall operate intermittently to prevent radiant heat loss due to water circulation through boiler modules in the off mode.

D. External convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5 percent of the rated input. The boiler shall not contain any refractory or refractory lined furnace or firebox.

E. The boiler shall be designed for operation in the condensing mode, in order to extract latent heat from the water in combustion products, with a minimum overall fuel-to-water efficiency of 86 percent at a return water temperature of 80 degrees F. This efficiency shall be obtained at full rated input capacity of the boiler. Efficiency shall increase, as the firing rate decreases, to a minimum 92 to 96 percent thermal efficiency.

F. The combustion chamber shall be constructed of stainless steel and sealed for combustion. The burner surface shall be constructed of high-temperature aluminum/chromium alloy woven mesh and fire in a vertical plane within the combustion chamber. The burner shall employ a perforated flame injection tube extending the entire length of the heat exchanger. The burner shall be capable of firing at both a complete blue flame with maximum gas and air input as well as firing infrared when gas and air are reduced. Burner shall be capable of firing at 100 percent of rate output when supplied with natural gas at 4 inches water column of inlet pressure. The burner shall fire in a 360-degree pattern resulting in uniform heat transfer across the entire heating surface. A viewing port shall be provided, permitting visual observation of burner operation.

G. The hot water boiler shall use a combustion air blower to precisely control the fuel/air mixture for maximum efficiency. The all-aluminum blower shall be mounted on the burner and draw gas and air from a premixing chamber. Utilization of a variable frequency drive shall enable the blower to infinitely vary its speed,

therefore adjusting the volume of gas and air supplied for combustion. The boiler shall operate between 25 percent and 100 percent of rated output. The combustion air blower shall operate for a pre-purge period before burner ignition and a post-purge period after burner operation to clear the combustion chamber.

H. The flame monitoring system shall incorporate a UL-recognized combustion safeguard system utilizing interrupted spark ignition and a rectification type flame sensor. An electro-hydraulic double seated safety shut-off valve shall be an inherent part of the gas train.

I. Each boiler module shall incorporate electric probe type low water cut-off and dual over-temperature protection including a manual reset in accordance with ASME Section IV and CSD-1. Remote fault alarm contacts, sensor failure detection, and auxiliary contacts shall be provided.

2.5 BOILER FLUE VENTING

A. The boiler shall be AGA Approved as a Direct Vent Boiler. Conventional chimney or stack shall not be required. Direct venting shall be accomplished with a stainless steel, double wall vent pipe installed in accordance with applicable national and local codes. Outer jacket shall be Type 430 stainless steel. The inner wall shall be type AL29-4C stainless steel alloy with a minimum 0.15-inch air space between the 2 metal walls. Refer to Section 23 31 00 – Ductwork and Sheet Metal. Each boiler module shall have its combustion air intake supply ducted with stainless steel pipe from the outside. Vent tee drain connections shall be provided on all boiler modules.

2.6 BOILER FITTINGS

A. Safety valve(s) shall be ASME Section IV approved side outlet type. Their size and number shall be in accordance with Code requirements and set to open at 150 psig.

B. Temperature and pressure gauge shall be mounted on top of each boiler module.

2.7 BOILER MANAGEMENT

A. Boiler manufacturer shall supply as part of boiler package a completely integrated Boiler Management System to control all operation and energy input of the multiple boiler plant. The system shall be comprised of an electronic control utilizing pulse width modulation to maintain header temperature. The controller shall have the ability to vary each external individual module input throughout its full range to maximize the condensing capability of the module and the entire plant without header temperature swings. The controller shall be PID type for accurate temperature control with excellent frequency response, and accept/relay contacts for automatic adjustable heat start circuit for plant activation. Auxiliary equipment such as pumps and combustion air dampers shall be interfaced using external control relay contacts.

B. The Boiler Management System shall operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature outlet to plus or minus 2 degrees F. Units shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. Reset ratio shall be fully field-adjustable from 0.3 to 3.0 in operation. The controller shall have LCD display for monitoring all sensors and interlocks. Non-volatile back-up of all control setpoints shall be internally provided. Control shall automatically balance operating time on each module by a first on-first off mode and provide for setback and remote alarm contacts. Connection between central BMS system and individual modules shall be twisted pair low voltage wiring to internal terminal strips for easy installation.

C. The boiler shall be capable of two-way communication on a Modbus or Lon Works® building management network. The boiler shall be provided with a terminal strip for easy communication wiring. (Remote diagnostic and operation information utilizing a personal computer shall be provided via the Lon Works® network connection. Temperatures, unit operation status, outdoor air reset programming, operational sensor location, total run time, sequencing operation, and firing rate shall be visible using the remote connection, adjustment of changeable points is required. Monitoring only is acceptable.)

D. Efficiency optimization shall energize boilers and control firing rate to maximize the efficiency of the entire boiler plant. The sequencing control shall determine building heat load, then calculate the optimum

available firing rate based on the number of boilers available for operation. The control shall energize the selected number of boilers and fix their firing rate to match system demand while maximizing efficiency.

2.8 BOILER CONTROLS

A. All controls shall be panel-mounted and located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water, fuel or heat of combustion gases. All controls shall be mounted and wired according to UL requirements. A dedicated protected electrical service shall be provided for each boiler.

B. Boiler control panel shall include a combustion safeguard/flame monitoring system as specified. Control panel hardware shall support both RS-232 and RS-485 remote communications. Controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of 8 separate status messages and 34 separate fault messages. Control shall incorporate setpoint high limit, setpoint low limit and failsafe mode self-governing features to eliminate nuisance faults when operating in modes where it receives an external control signal

C. The boiler control system shall include the following for external system interface:
1. system start temperature;
2. pump delay timer;
3. auxiliary start delay timer;
4. auxiliary temperature sensor, 4-20mA output feature which allows for simple monitoring of either temperature setpoint or outlet temperature;
5. remote interlock circuit;
6. delayed interlock circuit; and
7. common fault alarm.

D. Each boiler shall utilize an electric single seated safety shut-off valve with proof of closure switch in its gas train and incorporate dual over temperature protection with manual reset and dual low water protection with manual reset.

2.9 EMISSIONS

A. The boiler(s) shall operate with CO emissions less than 50 parts per million corrected to 3 percent O2 and shall operate with NOx emissions less than 30 parts per million corrected to 3 percent O2 over the entire burner turn-down range.

PART 3 EXECUTION

3.1 INSTALLATION

A. Complete structural, mechanical, piping and electrical connections in accordance with manufacturer's installation instructions.

B. Install boilers as specified and as indicated on the Drawings.
1. Provide code-required electrical services clearance for all electrical components.
2. Provide sufficient maintenance and service clearance for replacing boiler tubes, cleaning, and servicing of components.
3. Provide steel channel base of suitable rigidity and strength for attachment of vibration isolators, seismic restraints and anchor bolts.

C. Boiler Trim:
1. Provide drain valves for:
   a. Water level controls
   b. Water columns
   c. Low water cutoffs
2. Pipe drain valves to nearest floor drain.
3. Pipe safety relief valves discharge full size to nearest floor drain.
4. Extend gas valves and control relief vents to outside air in a location acceptable to the Architect.

3.2 TESTS AND START-UP

A. All testing and start-up required shall be executed using each fuel type specified.

B. After installation is completed:
1. Test boilers hydrostatically to specified working pressure in accordance with ASME recommendations.
2. Test operating and safety controls by firing boiler and raising water temperature and lowering water level.

C. Provide services of factory representative of boiler and burner manufacturers to:
1. Supervise installation of boilers, burners and controls.
2. Start up and adjust burners and controls for single and multiple boiler operation.
3. Test individual burner controls for proper operation.
4. Test safety controls for proper operation.
5. Set burner firing rates for specified conditions including all possible combinations of multiple boiler operation and lead-lag operation.
6. Adjust burners for optimum fuel-air ratio over entire operating range.
7. Test boiler safety (or relief) valves.
8. Test combustion efficiency over full operating range by means of carbon dioxide analysis and exit gas temperature.
9. Test for NOx emissions.

D. Submit written report by boiler-burner manufacturer confirming that safety and operating controls and burners have been properly installed, calibrated and adjusted and certify that air pollution control standards are being met and NOx is less than 30 parts per million.

E. Instruct Owner's designated personnel in operation of equipment for a minimum period of two eight-hour days.

END OF SECTION