Furnish and install as shown on AERCO International plans and operation and maintenance manuals, with all applicable codes and authorities having local, state and federal jurisdiction, Benchmark Series Boiler Model BMK 1.5 LN. The boiler plant shall consist of ____ hydronic boiler(s) modules as manufactured by AERCO International, Inc. Each boiler shall be; UL Listed, CSD-1 approved, ASME coded and stamped, and incorporate a gas train designed in accordance with ___ FM or ___ IRI. Each boiler shall have an input of 1,500mbh with a gross output of 1,290 to 1,408 mbh (dependent upon return water temperature) when fired with natural gas. The boiler manufacturer *must* publish known part load value efficiencies; the thermal efficiency must increase as the firing rate decreases. Electrical service to each unit shall be 120V/1/60Hz 20 amp service. The boiler control panel shall be proprietary in design and incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display, on individual field replaceable circuit boards mounted within a single housing. Each boiler shall have a footprint of *no more than* 28" W, 44.5 and 79" H with a UL Listing for zero side wall clearance. The boiler installed weight shall *not exceed* 1533 lbs. dry. The boiler shall have an ASME approved relief valve setting of ____ psig.

**CONSTRUCTION**

Boiler modules shall be natural gas fired, condensing fire tube design with a modulating forced draft power burner and positive pressure vent discharge.

**Modulating Air/Fuel Valve and Burner**

The boiler burner shall be capable of a 20 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce <16ppm of NOx corrected to 3% excess oxygen. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 for boilers and water heaters < 3MBTUs and the Texas Commission on Environmental Quality (TCEQ) as compliant with Section 117.465 for boilers and water heaters ≤ 2MBTUs. The burner shall be metal fiber mesh covering a stainless steel body, with spark ignition 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. A modulating air/fuel valve shall meter the air and natural gas 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 variable frequency drive (VFD) controlled cast aluminum pre-mix blower shall be utilized to ensure the optimum mixing of air & fuel between the air/fuel valve and the burner.

**Pressure Vessel/Heat Exchanger**

The boiler shall be capable of handling return water temperatures down to 40 F without any failure due to thermal shock or fireside condensation. The heat exchangers shall be ASME stamped for a working pressure not less than 160 psig. The pressure vessel shall have a maximum water volume of 27 gallons. The boiler water pressure drop shall *not exceed* 4.9 psig at 130 gpm. The boiler water connections shall be 3" flanged 150 lb. ANSI rated. The pressure vessels are constructed of SA53 carbon steel, with a 0.25" thick wall and 0.25 in. thick upper head. Inspection openings in the pressure vessels 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. The heat exchangers shall be constructed of 316L 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 0.065" wall thickness.

The upper and lower stainless steel tubesheets shall be no less than 0.375" thick. The pressure vessel/heat exchangers shall be welded construction. The heat exchangers shall be ASME stamped for a working pressure not less than 160 psig. Access to the tubesheets and heat exchangers are available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8.3 in. diameter.

**Exhaust Manifold**
The exhaust manifold shall be of corrosion resistant stainless steel with a 6"diameter flue connection. The exhaust manifold shall have a gravity drain for the elimination of the condensation with collecting reservoir.

**BOILER CONTROLS:**
The boiler control system shall be segregated into three components: "C-More" Control Panel, Power Box, and Input/Output Connection Box. The entire system shall be Underwriters Laboratories Recognized.

The "C-More" control panel shall consist of 6 individual circuit boards utilizing state-of-the-art surface-mount technology, in a single enclosure. These circuit boards shall be defined as follows: display board incorporating LED display to read temperature, and a vacuum fluorescent display module for all message annunciation; CPU board which houses all control functions; electric low water cutoff board with test and manual reset functions; power supply board; ignition /stepper board incorporating flame safeguard control; and connector board. Each board shall be individually field replaceable. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor. The control panel hardware shall support both RS-232 and RS-485 remote communications. The controls shall annunciate boiler & sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of 8 separate status messages and 34 separate fault messages.

The "C-More" control panel shall incorporate three self-governing 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 are called: Setpoint High Limit, Setpoint Low Limit, and Failsafe Mode. Setpoint High Limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor.

It is a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to10 degree selectable band from the desired maximum boiler outlet temperature. Setpoint Low Limit allows for a selectable minimum operating temperature. Failsafe Mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode; hence the control can be set to shut off the unit upon loss of external signal if so desired.

The boiler control system shall incorporate the following additional features for enhanced external system interface: system start temperature feature; pump delay timer; auxiliary start delay timer; auxiliary temperature sensor; mA output feature which allows for simple monitoring of either temperature setpoint, outlet temperature, or fire rate; remote interlock circuit; delayed interlock circuit; and fault relay for simple remote fault alarm.

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

**Temperature Control Modes**
The Benchmark boiler(s) shall operate in the control modes listed below:
__ 1. Internal Setpoint
__ 2. Indoor/Outdoor Reset
__ 3. 4ma to 20ma Temperature Setpoint
__ 4. Network Temperature Setpoint
__ 5. 4ma to 20ma Direct Drive
__ 6. Network Direct Drive
__ 7. Boiler Management System II (BMS II)
__ 8. Boiler Management System (BMS) with Combination Control System (CCP)

The first six control modes refer to independent boiler settings, while the last two control modes refer to banks of boilers operated as a system by AERCO supplied BMS II or BMS and CCP in a combination system. The AERCO BMS II shall be programmed to operate the entire bank of boilers in either of the first four control modes. The following is a description of each control mode.

**Internal Setpoint:** Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. Control of discharge water temperature shall be set through an internal setpoint with an adjustment of 50ºF to 190ºF. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler and without header temperature swings.

The boiler will operate to maintain a constant header temperature outlet to $\pm$2ºF. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. Controls shall be fully field adjustable from 50ºF to 190ºF in operation. Main Header outlet temperature shall not be more than $\pm$2ºF from setpoint at any point of operation. The boiler shall have LCD display for monitoring of all sensors and interlocks.

**Indoor/Outdoor Reset:** Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler plant. The microprocessor-based controller shall have the ability to vary boiler input throughout its full range for bump-less transfer of header temperature, and to maximize the condensing capability of the boiler without header temperature swings.

The boiler will operate to vary header temperature setpoint on an inverse ratio in response to outdoor temperature to control discharge temperature ±2ºF. Unit 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 boiler shall have LCD display for monitoring of all sensors and interlocks.

**4ma to 20ma Temperature Setpoint:** Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler without header temperature swings.

The boiler will operate to vary header temperature setpoint linearly as an externally applied 4m to 20 mA signal is supplied. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. Main Header outlet temperature shall not be more than ±2ºF from setpoint at any point of operation. The boiler shall have LCD display for monitoring of all sensors and interlocks.

**Network Temperature Setpoint:** Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler without header temperature swings.

The boiler will operate to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-485 port. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. Main Header outlet temperature shall not be more than ±2ºF from setpoint at any point of operation. The boiler shall have LCD display for monitoring of all sensors and interlocks.

**4ma to 20ma Direct Drive:** Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler without header temperature swings.

The boiler will operate to vary the boiler firing rate linearly as an externally applied 4ma to 20 ma signal is supplied. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. The boiler shall have LCD display for monitoring of all sensors and interlocks.

**Network Direct Drive:** Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler without header temperature swings.

The boiler will operate to vary the boiler firing rate as an external communication utilizing the MODBUS protocol is supplied via the RS-485 port. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. The boiler shall have LCD display for monitoring of all sensors and interlocks.

**Boiler Management System II (BMS II):** The Boiler Manufacturer shall supply as part of the boiler package a completely integrated AERCO Boiler Management System II Model 5R5-384 Programmer to control all operation and energy input of the multiple boiler heating plant. The Boiler Management System II shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. The BMS II controller shall have the ability to operate up to 32 AERCO boilers per BMS II panel.

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 BMS II shall control the boiler outlet header temperature within $\pm$2ºF. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The BMS II controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

When set on Internal Setpoint Mode, temperature control setpoint on the BMS II shall be fully field adjustable from 50ºF to 190ºF in operation. When set on Indoor/Outdoor Reset Mode, the BMS II will operate on an adjustable inverse ratio 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 BMS II will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.

When set on MODBUS Temperature Control Mode, the BMS II will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port. The BMS II controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. 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 central BMS II system and individual boilers shall be twisted pair low voltage wiring, with the boilers ‘daisy-chained’ for ease of installation.

**Boiler Management System (BMS) with Combination Control System (CCP):** A combination system consisting of ___ boilers in BMS mode and ___ boilers in combination system (CCP) mode (maximum of four units) shall be supplied to accommodate the requirements for both space heating and domestic hot water.

The Boiler Manufacturer shall supply as part of the boiler package a completely integrated AERCO Boiler Management System Model 168 Programmer to control all operation and energy input of the multiple boiler heating plant (with all of the previously described features as the BMS II, except Ramp Up/Ramp Down control algorithm, and the BMS Model 168 shall have an LCD display) and a Combination Control Panel (CCP). The CCP shall work in conjunction with the BMS to control the firing of the combination boilers, associated accessories, the motorized control valve, and circulating pump for domestic water production. The BMS mode boilers shall be dedicated to space heating; the Combination mode boilers shall provide indirect domestic water production. The Combination boilers shall utilize pulse width modulation to supplement the BMS mode (space heating) boilers when the space heating load exceeds the total BMS mode boiler capacity.

**CONTROLS INTEROPERABILITY**
The "C-More" control panel and the AERCO BMS II shall utilize the MODBUS open protocol to interface with third party Building Automation Systems (BAS).

Controls interface with BACnet, Lonworks, and N2 shall utilize an ___optional AERCO Communications Gateway to act as a MODBUS interface/translator between the BAS and either the RS-485 port of the "C-More" boiler control panel or the RS-232 port of the AERCO BMS II. The AERCO Communications Gateway shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485. Non-volatile backup of all point mappings and programs shall be internally provided as standard. Connection between Gateway and individual boilers or to the AERCO BMS II shall be "daisy chain" with shielded, twisted-pair, low voltage wiring for ease of installation.

**INSTALLATION**
All aspects of installation of Boiler Plant shall be in strict accordance with manufacturer's instructions. The vent system *must conform to* all manufacturer's recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure. The vent must be sized in accordance with AERCO's recommendations. Boiler plant piping shall be field constructed of materials as specified. Each boiler shall have individually isolating shutoff valves for service and maintenance. Each boiler shall require a minimum gas pressure of ___ 4.0" W.C. (FM gas train) ___ 4.2" W.C. (IRI gas train) at 1,500 scfh (full load rated capacity).

**WARRANTY**

The pressure vessel/heat exchanger of the boiler shall carry a prorated 10-year warranty against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship. The six individual circuit boards of the "C-More" control panel assembly shall carry a 2 year warranty against failure due to defective materials or workmanship. A Warranty Certificate must be issued to the owner from the manufacturer and a copy of warranty must be submitted for engineer's approval.

**FIELD SERVICES**

Contractor shall provide the services of a local factory authorized representative to supervise all phases of equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the engineer with operation and maintenance instructions.