SECTION 23 52 25
LOW-PRESSURE WATER HEATING BOILERS

SPEC WRITER NOTES:
1. Delete between //----// if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraph. Deleted paragraphs should be labeled “omitted”.
2. References to pressure are gage pressure unless otherwise noted.

PART 1 – GENERAL

SPEC WRITER NOTES: Provide dual-fuel arrangement when natural gas is used as the prime fuel. The back-up fuel shall be either Propane Gas or No. 2 Oil, both stored at site.

1.1 DESCRIPTION:
This section specifies packaged hot water boilers with trim (accessories), //dual fuel// natural gas and //No. 2 oil//propane//burner, fuel valve and piping trains and other accessories.

1.2 RELATED WORK:
A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
B. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING.
C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
D. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
E. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
G. Section 23 10 00, FACILITY FUEL SYSTEMS.
H. Section 23 11 23, FACILITY NATURAL GAS PIPING
I. Section 23 21 13, HYDRONIC PIPING.
J. Section 23 21 23, HYDRONIC PUMPS.
K. Section 23 51 00, BREECHING, CHIMNEYS and STACKS.
L. Section 23 05 93, TESTING, ADJUSTING, and BALANCING.

1.3 QUALITY ASSURANCE:
A. Coordinate work of this section with all //existing //equipment and conditions. This includes, but is not limited to: boiler, boiler trim, burner, fuel valve and piping trains, gas pressure regulators and available gas pressure, //required fuel oil train pressures,//control systems,//combustion air piping,//and venting.
B. Provide a list of at least 5 installations, similar in size and scope as the proposed boilers. Include the name, address, and telephone number of a person familiar with each project as a reference source.

C. Boiler shall be pressure tested at the factory and bear the ASME stamp.

1.4 SUBMITTALS:

A. Before executing any work, submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Boiler:
   1. Complete catalog information and outline drawings of boiler, burner, and accessories with dimensions including required service clearances and access space.
   2. Catalog cuts showing arrangement and construction of pressure parts, casing, internals, and support frame.
   3. Piping connection sizes, locations, types (threaded or flanged).
   4. Technical data including temperature rating and arrangement of refractory and insulation.
   5. Design pressures and temperatures.
   //6. Seismic design data on boiler and anchorage of boiler to foundation. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. //

C. Boiler Trim: Includes water level alarm and cutoff devices, low water cutoffs, piping, all valves and fittings furnished by boiler manufacturer //and stack thermometer/.
   1. Design, construction, arrangement on the boiler.
   2. Pressure and temperature limitations.
   3. ASTM numbers and schedule numbers of piping.
   4. Type and pressure ratings of pipe fittings.
   5. Scale ranges of gages, thermometers and pressure switches.
   6. Set pressure and capacity of relief valves.

D. Burner and Fuel Valve and Piping Trains:
   1. Catalog data and drawings showing burner assembly and fuel train arrangement.
   2. Drawings and catalog data on all equipment in fuel trains.
   3. ASTM numbers and schedule numbers on all piping.
   4. Type and pressure ratings of pipe fittings.
   5. Burner flow and pressure data

E. Burner Management (Flame Safeguard) System:
   1. Catalog data and drawings showing burner management system assembly and arrangement
   2. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
F. Provide a ladder-type electrical diagram for boiler showing interlock requirements and clear division between the factory wiring and field wiring.

G. Submit water treatment test report to determine if selected boilers will be applicable to the facility.

1.5 DEFINITIONS:

A. High Efficiency Condensing Boiler: A boiler designed to recover energy normally discharged to the atmosphere through the vent. The vent gasses will condense in the boiler and vent during normal operation. The boiler shall be constructed to withstand the presence of condensation. The vent shall be constructed of corrosion resistant materials. The minimum efficiency shall be 94% on low-fire with a return water temperature of 38 degrees C (100 degrees F).

B. High Efficiency Non-Condensing Boiler: A boiler designed to recover a portion of the energy normally discharged to the atmosphere through the vent. The vent gasses may condense in the boiler and vent during normal operation. The boiler shall be constructed to withstand the transient presence of condensation. The vent shall be constructed of corrosion resistant materials. The minimum efficiency shall be 86% with a return water temperature of 49 degrees C (120 degrees F):

C. Standard Efficiency Non-Condensing Boiler: A conventional boiler with a standard vent. The vent gasses will not condense in the boiler or vent during normal operation. The minimum efficiency shall be 80% with a return water temperature of 60 degrees C (140 degrees F).

1.6 FUEL REQUIREMENTS

A. Fuels to be Fired: //Natural gas and //No. 2 fuel oil//Propane//.

B. Natural Gas: High heating value is reported as _____MJ per cubic meter (_____Btu per cubic foot) at gas company base pressure and temperature. Pressure provided to the inlet of the boiler-mounted regulators will be ___kPa (____ inches WC) gage as maintained by main regulator station.

//C. Fuel Oil: Fuel oil furnished directly to the Government by a local supplier. Provide burner-mounted pump and relief valve as required.//

//D. LP Gas: Propane furnished directly to the Government by a local supplier. Regulators at tank area will be set at 35 kPa (5 psi) gage.//
1.7 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

B. ASTM International (ASTM):
   A178/178M-02(2007) ..... Electric Resistance Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes
   A269-08 ............... Seamless and Austenitic Welded Stainless Steel Tubing for General Service
   C612-09 ............... Mineral Fiber Block and Board Thermal Insulation
   D396-09a .............. Fuel Oils

C. American Society of Mechanical Engineers (ASME):
   Section II ............. Material Specifications
   Section IV ............. Heating Boilers
   Section VI ............. Recommended Rules for Care of Heating Boilers
   Section IX ............. Welding and Brazing Qualifications
   Code for Pressure Piping:
   B31.1-2004 .............. Power Piping with addenda

D. National Fire Protection Association (NFPA):


F. Underwriters Laboratories (UL):
   50-2007 ............... Standard for Enclosures for Electrical Equipment, Non-Environmental Considerations

PART 2 - PRODUCTS

SPEC WRITER NOTES:
1. Hot water boilers specified in this section shall be used where steam (from the existing central boiler plant) is not available and the use of steam is not envisioned. Examples of such applications are: Standalone facilities such as community living centers and domiciliary, regional offices, and outpatient clinics (where the steam requirements are minimum and can be met by separate dedicated steam boilers).

2. Fuel selection shall be based on availability of resources at the
facility location. If natural gas is available, a secondary uninterruptable fuel source will be required. A life cycle cost analysis shall be performed to determine the most cost effective fuel selection or combination thereof. This method of selection will also apply to determining if high efficiency condensing boilers utilizing propane gas or high efficiency non-condensing boilers utilizing #2 fuel oil will be used.

3. High efficiency condensing boilers will use Natural gas/propane gas for dual fuel and Propane gas for single fuel arrangements.

2.1 HIGH EFFICIENCY CONDENSING BOILER:

A. Type: Factory-assembled packaged low pressure hot water boiler suitable for forced draft// natural gas and //Propane// firing //with natural gas-propane selector switch/>. Include fuel burning system, controls and boiler trim.

B. Service: Continuous long-term operation generating hot water at all loads from minimum to maximum output requirements in conformance to the specified performance requirements, shown in the schedules on drawings.

C. Performance:

1. Minimum Efficiency at Required Maximum Output: Refer to schedules on drawings.

D. Construction:

1. Codes: Comply with ASME Boiler and Pressure Vessel Code, Section IV.

SPEC WRITER NOTE: Coordinate the heat exchanger construction with the selected boiler.

2. Heat Exchanger:

a. Boiler heat exchanger design/ construction shall be one of the following:

1) Cast-iron sectional design
2) Cast aluminum sectional design
3) Fin-tube design, with vertically aligned straight copper tubes, integral extruded fins and cast iron headers.
4) Flex-tube design
5) Fire tube design, constructed of a SA53 carbon steel primary heat exchanger and a 316L stainless steel secondary heat exchanger. The fire tubes and tube sheets shall be configured in a one-pass combustion gas flow design. The pressure vessel/heat exchanger shall be welded construction.

b. The boiler shall be capable of handling return water temperature down to 10 °C (50°F) without any failure due to thermal shock or
fireside condensation. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases. The boiler operating limits shall be aligned with the expected operating temperatures for special lower temperature applications (i.e. snowmelting).

c. The heat exchanger shall be ASME stamped for a working pressure not less than //1000// kPa (//150// psig). The boiler water pressure drop shall not exceed //13// kPa (//2// psig) at the design flow rate.
d. There shall be removable access covers on the heat exchanger headers for the purposes of inspection, cleaning or repair. The heat exchanger shall have externally accessible boiler drains. An external viewing port shall be provided, permitting visual observation of burner operation.

3. Insulation: Boiler manufacturer's standard and experience proven design except insulation on the boiler shell shall be a minimum of 50 mm (two inches) thick. No part of the external casing shall exceed 33 degrees C (60 degrees F) above ambient, except for areas within 300 mm (one foot) of the casing penetrations.

4. Casing: Galvanized steel casing covering all areas of boiler shell. All openings in the casing shall be gasketed and sealed.

5. Skids/Bases: Boilers shall be factory-installed on the factory-fabricated skids/bases.

E. FINISH

1. Provide surface preparation, heat-resistant prime and finish coats using standard color of the boiler manufacturer.

F. BOILER TRIM (ACCESSORIES):

1. Conform to ASME Boiler and Pressure Vessel Code, Section IV

2. Relief Valves:
   a. Provide one (1) ASME rated relief valve per boiler. The valve shall be sized to relieve full boiler capacity. Type: Bronze bodies, side outlet, threaded inlet and outlet, lifting lever, stainless steel trim and o-ring EPDM seats.
   b. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Valves shall be set to relieve at the ASME working pressure.

3. Pressure Gage:
   a. Case: Turret-style, bottom connection, threaded ring, blowout disc in rear.
   b. Dial: 75 mm (3-1/4 inch) minimum diameter, non-corrosive, black markings on white background.
c. Measuring Element: Bourdon tube designed for hot water service.

d. Movement: Stainless steel, rotary.

e. Accuracy: One half percent of the full span.


4. Water Level Safety Controls:

a. Provide primary and auxiliary low water burner cutoffs. Primary and auxiliary low water burner cutoff devices shall be in two separate water columns, piped individually to the boiler water spaces. One device shall be float-type, the other device shall be conductivity probes. Primary and auxiliary cutoffs shall require manual reset. Auxiliary cutoff shall shut down power to the burner.

//5. Factory Switch Safety Control:

a. Provide flow switch to disable burner in event of loss of flow through the boiler.

b. Type: Brass body, paddle arm and pivot shaft.

c. Electric Switch: Cam acting type with adjustable flow sensitivity.

d. Ratings: 121 degrees C(250 degrees F), 1100kPA (160 psig) //

6. Condensate drain connection and manufacturer supplied kit must be supplied for all condensing boilers.

G. BURNER AND FUEL TRAINS:

SPEC WRITER NOTE: Include NOx requirements only where required by local air emissions authorities.

1. Burner Type: //Combination natural gas and//propane//, packaged, forced draft, modulating firing//, variable speed forced draft fan//. //Combination fuel burners shall be configured to allow automatic fuel changeover utilizing the fuel (natural gas-propane) selector switch//.

//a. Gas Burner: Ring type with multiple ports or spuds.//

2. Service:

a. Continuous operation at all firing rates on each fuel listed under Article, PROJECT CONDITIONS of Part 1. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures.

b. Main Fuels: //Natural gas// Propane//. //After boilers are accepted for operation, choice of fuels will be based on cost and availability.//

3. Performance:

a. Main flame shall ignite at lowest firing rate.
b. Main flame characteristics at all firing rates:
   1) Flame retained at the burner.
   2) Flame stable with no blow-off from the burner or flashback into the burner. No pulsations.
   3) No deposits of unburned fuel or carbon at any location.
   4) No carryover of flame beyond the end of the first pass (furnace tube).

c. Operation:
   1) Minimum turndown 5:1 for dual fuel or 3:1 for single fuel.
   2) Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures.
   3) Performance at any load point shall be repeatable after increasing or decreasing the firing rate.
   4) Noise and Vibration: Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan. Burners shall operate without pulsation.

   SPEC WRITER NOTE: Designer must review local emissions rules and revise the following paragraphs as necessary.

//d. Flue Gas Emissions Limits:
   1) Carbon Monoxide: Shall not exceed 400 PPM.
   2) Smoke: On natural gas and //No. 2 oil// propanewithout be visible and shall not exceed No. 1 on the Bacharach smoke scale.

   SPEC WRITER NOTE: Delete NOx requirements except where required by local air emissions authorities. Insert local NOx emissions limits if applicable. If local emissions rules express the requirement in a different way, revise the subparagraph to conform.

   //3) NOx: _____ ppm maximum, corrected to 3 percent oxygen, dry basis on natural gas //or propane// and low nitrogen No. 2 fuel oil//.//

4. Construction:
   a. Burner Access (Main Burner//and Igniter//): Arrange fuel valve and piping trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
   b. Arrangement of Fuel Valve and Piping Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. Do not attach any piping or devices to boiler casings.
   c. Coatings: Provide surface preparation, heat resistant prime and finish coats using standard color of boiler manufacturer.
SPEC WRITER NOTE: Delete any fuel valve and piping trains not required. Determine if the natural gas supplier has any special requirements that must be incorporated in the main or igniter fuel trains.

5. Natural Gas Main Fuel Train:
   a. Arrangement: Comply with ANSI/IRI/FM requirements.
   b. Pressure Regulator:
      1) Single seated, diaphragm-operated, designed for natural gas service. Controlled pressure shall be sensed downstream of main valve. Valve may be self-operated or pilot-operated as necessary to comply with performance requirements.

6. Automatic Safety Shut-Off Valves:
   a. Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
   b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators.
   c. Approval: IRI/FM approved, UL listed for burner service.

7. Automatic Vent Valve:
   a. Type: Motorized or solenoid closing, spring opening, full port, controlled by burner control system.

8. Pressure Switches: Switch settings must be within 20% of the controlled pressure.

9. Fuel Flow Control Valve:
   a. Type: Throttling, controlled by combustion control system.
   b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner.

H. BOILER CONTROL, BURNER MANAGEMENT (FLAME SAFEGUARD) SYSTEM AND ACCESSORIES:

1. The boiler control system shall be provided by the boiler manufacturer to control the burner incorporating all required safeties. The entire system shall be UL listed and FM approved.

2. Provide a complete automatic safety control and monitoring system for burner ignition sequencing, operating cycle, and shut-down sequencing. System shall include microprocessor programmer, self-checking flame scanner, burner cycle display, diagnostic annunciation display, burner safety shut down interlocks, communication with monitoring systems, and accessories.

3. Control Panel:
a. Controls shall be mounted in NEMA 4 enclosure on side of boiler or on burner. There shall be no power wiring in this enclosure.
b. Electrical: Provide circuit breakers, transformers, all devices for complete control system. All control electronics and relays shall be in waterproof UL 50 compliant NEMA 4X panels.
c. The control panel shall include individual circuit boards in a single enclosure which houses all control functions. Each board shall be individually field replaceable. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor.
d. 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.

4. 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.

5. Each boiler shall utilize an electric single seated safety shutoff valve 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.

6. Temperature Control Modes – Boiler shall include integral factory wired operating controls to completely control and operate the boiler. The boiler(s) shall operate in the control modes listed below:
   a. Internal Setpoint
   b. Indoor/Outdoor Reset
   c. 4mA to 20mA Temperature Setpoint
   d. Network Temperature Setpoint
   //e. Boiler Management System//
   The //first// four control modes refer to independent boiler settings//, while the last control mode refer to banks of boilers operated as a system by manufacturer supplied Boiler Management System. The Boiler Management System shall be programmed to operate the entire bank of boilers in either of the first four control modes//.
7. Boiler Management System:
   a. The Boiler Manufacturer shall supply as part of the boiler package a completely integrated Boiler Management System to control all operation and energy input of the multiple boiler heating plant. The Boiler Management System shall be comprised of a microprocessor based control utilizing the open protocol to communicate with the Boilers via the RS-485 port.
   b. The controller shall have the ability to control each individual boiler throughout its full modulating range. The Boiler Management System shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

8. Controls Interoperability:
   a. The boiler control panel shall utilize open protocol to interface with third party Building Automation Systems (BAS).
   b. The BACnet controls interface shall utilize an interface/translator as required between the BAS and either the RS-485 port of the boiler control panel or the RS-232 port of the Boiler Management System.


10. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

1. Boiler Vent/Combustion Air Piping:
   1. The boiler vent shall be provided in accordance with applicable national codes (ANSI Z223.1), NFPA standards (NFPA 54) and per the boiler manufacturers’ recommendations.
   2. The boiler vent shall be an approved AL29-4C stainless steel venting system and components for cold-start condensate/positive pressure Category IV stack and breeching of the double wall construction with a 25mm (1 inch) annular insulating air space, outer wall constructed of 304 stainless steel and inner wall constructed of type AL29-4C stainless steel. Vent components exposed to the atmosphere shall be type 304 stainless steel.
   3. The combustion air conduit shall be PVC or CPVC pipe utilizing a vacuum relief damper sized equal in diameter to the intake pipe.
   4. All supports, vent caps, adapters, flashing and drain fittings shall be included by and as recommended by the manufacturer.

   SPEC WRITER NOTE: High efficiency non-condensing boilers shall make use of natural gas and propane gas for dual fuel
and #2 fuel oil or Propane Gas for single fuel arrangements.

2.2 HIGH EFFICIENCY NON-CONDENSING BOILER:

A. Type: Factory-assembled packaged low pressure hot water boiler suitable for forced draft/ induced draft/ natural gas and No. 2 fuel oil/Propane/ firing with natural gas/oil/propane/ selector switch/. Include fuel burning system, refractory, controls and boiler trim.

B. Service: Continuous long-term operation generating hot water at all loads from minimum to maximum output requirements in conformance to the specified performance requirements.

C. Performance:
1. Minimum Efficiency at Required Maximum Output: Refer to schedules on drawings.

D. Construction:
1. Codes: Comply with ASME Boiler and Pressure Vessel Code Section IV.

   SPEC WRITER NOTE: Coordinate the heat exchanger construction with the selected boiler.

2. Heat Exchanger:
   a. Boiler heat exchanger shall be cast-iron sectional design/ cast aluminum sectional design/ fin-tube design, with vertically aligned straight copper tubes, integral extruded fins and cast iron headers/.
   b. The boiler shall be capable of handling return water temperature down to 49 °C (120°F) without any failure due to thermal shock or fireside condensation. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.
   c. The heat exchanger shall be ASME stamped for a working pressure not less than 333/667/1000 kPa (50/100/150 psig). The boiler water pressure drop shall not exceed 13 kPa (2 psig) at the design flow rate.
   d. There shall be removable access covers on the heat exchanger headers for the purposes of inspection, cleaning or repair. The heat exchanger shall have externally accessible boiler drains. An external viewing port shall be provided, permitting visual observation of burner operation/.

3. Refractory and Insulation: Boiler manufacturer's standard and experience proven design except insulation on the boiler shell shall be a minimum of 50 mm (two inches) thick. No part of the external
casing shall exceed 33 degrees C (60 degrees F) above ambient, except for areas within 300 mm (one foot) of the casing penetrations.

4. Casing: Galvanized steel casing covering all areas of boiler shell. Casing shall be galvanized on both sides. All openings in the casing shall be gasketed and sealed.

5. Skids/Bases: Boilers shall be factory-installed on the factory-fabricated skids/bases.

E. Finish: Provide surface preparation, heat-resistant prime and finish coats using standard color of the boiler manufacturer.

F. BOILER TRIM (ACCESSORIES):
1. Conform to ASME Boiler and Pressure Vessel Code, Section IV
2. Relief Valves:
   a. Provide one (1) ASME rated relief valves per boiler. Each valve shall be sized to relieve full boiler capacity.
   b. Type: Bronze bodies, side outlet, threaded inlet and outlet, lifting lever, stainless steel trim and o-ring EPDM seats.
   c. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Valves shall be set to relieve at the ASME working pressure.
3. Pressure Gage:
   a. Case: Turret-style, bottom connection, threaded ring, blowout disc in rear.
   b. Dial: 90 mm (3-1/2 inch) minimum diameter, non-corrosive, black markings on white background.
   c. Measuring Element: Bourdon tube designed for hot water service.
   d. Movement: Stainless steel, rotary.
   e. Accuracy: One half percent of the full span.
   f. Range: 0 - 667 kPa // 0 - 100 psi// gage.
4. Water Level Safety Controls:
   a. Provide primary and auxiliary low water burner cutoff. Primary and auxiliary low water burner cutoff devices shall be in two separate water columns, piped individually to the boiler water spaces. One device shall be float-type, the other device shall be conductivity probes. Primary and auxiliary cutoffs shall require manual reset. Auxiliary cutoff shall shut down power to the burner.
   b. Electrical: Provide circuit breakers, transformers, all devices for complete control system. All control electronics and relays shall be in waterproof NEMA 4X panels.

//5. Factory Switch Safety Control:
   a. Provide flow switch to disable burner in event of loss of flow through the boiler.
b. Type: Brass body, paddle arm and pivot shaft.
c. Electric Switch: Cam acting type with adjustable flow sensitivity. 
d. Ratings: 121 degrees C (250 degrees F), 1100kPA (160 psig) 

6. Stack Thermometer: Dial-type, bi-metal element, stainless steel case and stem, adjustable angle, one percent of full scale accuracy, dual scale, //100 - 550 °C and 200 - 1000 °F//, minimum diameter 76 mm (3 inches). Locate at flue gas outlet.

G. BURNER AND FUEL TRAINS:

SPEC WRITER NOTE: Delete low NOx requirements unless required by air emissions authorities.

1. Burner Type: Combination natural gas and//fuel oil//propane//, packaged, forced draft, modulating firing//, variable speed forced draft fan//.
   a. Gas Burner: Ring type with multiple ports or spuds.
   b. Oil Burner: Gun type, inside mix, low pressure air atomizing.
   c. Igniter (Pilot): Interrupted, electrically ignited, natural gas//.

2. Service:
   a. Continuous operation at all firing rates on each fuel listed under Article, PROJECT CONDITIONS of Part 1. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures.
   //b. Igniter (Pilot) Fuels: Natural gas.//
   c. Main Fuels: //Natural gas//Propane//After boilers are accepted for operation, choice of fuels will be based on cost and availability.

3. Performance:
   a. //Igniter (pilot) flame on natural gas shall form close to the point of ignition and shall be stable. Ignite both the gas and oil burner with single igniter. //
   b. Main flame on gas //and oil// fuels shall ignite at lowest firing rate.
   c. Main flame characteristics at all firing rates:
      1) Flame retained at the burner.
      2) Flame stable with no blow-off from the burner or flashback into the burner. No pulsations.
      3) No deposits of unburned fuel or carbon at any location.
      4) No carryover of flame beyond the end of the first pass (furnace tube).
   d. Operation:
      1) Minimum turndown 4:1. 

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2) Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures.

3) Performance at any load point shall be repeatable after increasing or decreasing the firing rate.

4) Noise and Vibration: Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan. Burners shall operate without pulsation.

SPEC WRITER NOTE: Engineer must review local emissions rules and revise the following paragraphs as necessary.

e. Flue Gas Emissions Limits:
   1) Carbon Monoxide: Shall not exceed 400 PPM.
   2) Smoke: On natural gas and //No. 2 oil//propane// shall not be visible and shall not exceed No. 1 on the Bacharach smoke scale.

SPEC WRITER NOTE: Delete NOx requirements except where required by local air emissions authorities. Insert local NOx emissions limits if applicable. If local emissions rules express the requirement in a different way, revise the subparagraph to conform.

//3. NOx: ______ ppm maximum, corrected to 3 percent oxygen, dry basis on natural gas //or propane//and low nitrogen No. 2 fuel oil.//

4. Construction:
   a. Burner Access (Main Burner//and Igniter//): Arrange fuel valve and piping trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
   b. Arrangement of Fuel Valve and Piping Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. Do not attach any piping or devices to boiler casings.
   c. Coatings: Provide surface preparation, heat resistant prime and finish coats using standard color of boiler manufacturer.

SPEC WRITER NOTE: Delete any fuel valve and piping trains not required. Determine if the natural gas supplier has any special requirements that must be incorporated in the main or igniter fuel trains.

5. Natural Gas Main Fuel Train:
   b. Pressure Regulator:
      1) Single seated, diaphragm-operated, designed for natural gas service. Controlled pressure shall be sensed downstream of main
valve. Valve may be self-operated or pilot-operated as necessary to comply with performance requirements.

2) Construction, Main Valve: Cast iron body, replaceable plug and seat. Downstream pressure-sensing line.

c. Automatic Safety Shut-Off Valves:
   1) Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
   2) Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators.
   3) Approval: //IRI//FM //approved, UL listed for burner service.

d. Automatic Vent Valve:
   1) Type: Motorized or solenoid closing, spring opening, full port, controlled by burner control system.

e. Pressure Switches: Switch settings must be within 20% of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.

f. Fuel Flow Control Valve:
   1) Type: Throttling, controlled by combustion control system.
   2) Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner.

6. Fuel Oil Train:
   b. Filter: Replaceable elements, five micron or smaller particle retention.
   c. Pressure Regulator: Do not provide unless required by the burner furnished. Pressure control is provided by a back pressure control valve on the house fuel oil pump set.
   d. Automatic Safety Shut-Off Valves:
      1) Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
      2) Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble-tight and be suitable for operation with upstream pressure exceeding upstream safety relief valve set pressure plus accumulation.

SPEC WRITER NOTE: Valves with longer opening times often do not allow ignition of the main flame within the specified and
code allowed 10 seconds trial for main flame.

3) Performance: Timed opening of six seconds or less to safely and smoothly ignite oil burner, one-second closure.

4) Construction: Threaded ends, valve position indicator visible from front or side of boiler. Closed position interlock switch on each valve.

5) Approval: FM approved, UL listed for burner service.

6) Provide valved leak test connections between the two safety shut-off valves and after the second safety shut-off valve.

7) Proof of Closure Test: Provide non-latching push button controls in the proof of closure circuit to complete the circuit when the valves are open and interrupt the circuit when the valves are closed.

e. Pressure Switches: Switch settings must be within 20% of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.

f. Fuel Flow Control Valve:
   1) Type: Throttling, controlled by combustion control system.
   2) Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner.

g. Boiler/Burner-Mounted Oil Pump and Relief Valve: Provided with burner by boiler manufacturer.

//7. Igniter (Pilot) Fuel Train, Burner and Ignition System:
   b. Filters: Replaceable elements, five micron or smaller particle retention.
   c. Pressure Regulators:
      1) Type: Single-seated, diaphragm-operated. Provide separate regulators for natural gas service and for LP gas service
      2) Service: Provide controlled pressure in igniter train as required by igniter, with upstream pressures as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lockup pressure of the nearest upstream pressure regulator. As an alternate to the outlet emergency pressure rating, provide internal relief valve vented to outside set at pressure that will avoid overpressure on regulator outlet that could damage the regulator.
3) Performance: Lockup pressure shall not exceed 1.5 times the regulated pressure.
4) Construction: Propane regulator must be designed for LP gas.
e. Automatic Safety Shut-Off and Vent Valves:
1) Type: Solenoid-type, two normally closed shut-off valves and one normally-open vent valve, arranged as shown, controlled by the burner control system. Provide threaded leak-test ports with threaded plugs on each shut-off valve body.
2) Service: Provide open-shut control of fuel flow to igniter and vent between shut-off valves. Design for 140 kPa (20 psi) differential at shut-off.
3) Approval: Safety shut-off valves UL listed, FM approved for burner service. Vent valves UL listed for burner service.
g. Igniter and Ignition System: Provide removable igniter, ignition electrodes, ignition transformer, high voltage cable. Provide shield at ignition area so that spark is not visible to flame scanner from any position on its mounting.
h. Igniter fuel train pipe and fittings: ASME B31.1 requirements do not apply. //

H. BOILER CONTROL, BURNER MANAGEMENT (FLAME SAFEGUARD) SYSTEM AND ACCESSORIES:
1. The boiler control system shall be provided by the boiler manufacturer to control the burner incorporating all required safeties. The entire system shall be UL listed and FM approved.
2. Provide a complete automatic safety control and monitoring system for burner ignition sequencing, operating cycle, and shut-down sequencing. System shall include microprocessor programmer, self-checking flame scanner, burner cycle display, diagnostic annunciation display, burner safety shut down interlocks, communication with monitoring systems, and accessories.
3. Control Panel:
a. Controls shall be mounted in NEMA 4 enclosure on side of boiler or on burner. There shall be no power wiring in this enclosure.
b. The control panel shall include individual circuit boards in a single enclosure which houses all control functions. Each board shall be individually field replaceable. The combustion
safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor.

c. 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.

4. 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.

5. Each boiler shall utilize an electric single seated safety shutoff valve 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.

6. Temperature Control Modes - Boiler shall include integral factory wired operating controls to completely control and operate the boiler. The boiler(s) shall operate in the control modes listed below:
   a. Internal Setpoint
   b. Indoor/Outdoor Reset
   c. 4mA to 20mA Temperature Setpoint
   d. Network Temperature Setpoint
   //e. Boiler Management System//

The //first// four control modes refer to independent boiler settings/, while the last control mode refer to banks of boilers operated as a system by manufacturer supplied Boiler Management System. The Boiler Management System shall be programmed to operate the entire bank of boilers in either of the first four control modes/.

//7. Boiler Management System:
   a. The Boiler Manufacturer shall supply as part of the boiler package a completely integrated Boiler Management System to control all operation and energy input of the multiple boiler heating plant. The Boiler Management System shall be comprised of a microprocessor based control utilizing the open protocol to communicate with the Boilers via the RS-485 port.
b. The controller shall have the ability to control each individual boiler throughout its full modulating range. The Boiler Management System shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature. //

8. Controls Interoperability:
   a. The boiler control panel shall utilize open protocol to interface with third party Building Automation Systems (BAS).
   b. The BACnet controls interface shall utilize an interface/translator as required between the BAS and either the RS-485 port of the boiler control panel// or the RS-232 port of the Boiler Management System. //


10. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

I. BOILER VENT/COMBUSTION AIR PIPING:
   1. The boiler vent shall be provided in accordance with applicable national codes (ANSI Z223.1), NFPA standards (NFPA 54) and per the boiler manufacturers’ recommendations.
   2. The boiler vent shall be //an approved AL29-4C stainless steel venting system and components for cold-start condensate//positive pressure Category IV stack and breeching of the double wall construction with a 25mm (1 inch) annular insulating air space, outer wall constructed of 304 stainless steel and inner wall constructed of type AL29-4C stainless steel. Vent components exposed to the atmosphere shall be type 304 stainless steel.
   3. The combustion air conduit shall be PVC or CPVC pipe// utilizing a vacuum relief damper sized equal in diameter to the intake pipe//.
   4. All supports, vent caps, adapters, flashing and drain fittings shall be included by and as recommended by the manufacturer.

DESIGNER NOTE: Standard Efficiency Non-Condensing Boilers shall be used for applications where higher water temperatures are required and/or justified by the lowest LCC. Acceptable fuels for dual fuel arrangement standard efficiency non-condensing boilers are natural gas/propane gas or natural gas/#2 fuel oil. For single fuel arrangements #2 fuel oil and propane gas are acceptable.
2.3 STANDARD EFFICIENCY NON-CONDENSING BOILER:

A. Type: Factory-assembled packaged low pressure hot water boiler suitable for forced draft//induced draft//atmospheric//natural gas and No. 2 fuel oil//Propane//firing with natural gas--oil//propane//selector switch/. Include fuel burning system, refractory, controls and boiler trim.

B. Service: Continuous long-term operation generating hot water at all loads from minimum to maximum output requirements in conformance to the specified performance requirements.

C. Performance:
1. Minimum Efficiency at Required Maximum Output: Refer to schedules on drawings.

D. Construction:
1. Codes: Comply with ASME Boiler and Pressure Vessel Code, Sections II, IV, VI, and IX.

SPEC WRITER NOTE: Coordinate the heat exchanger construction with the selected boiler.

2. Heat Exchanger:
   a. Boiler heat exchanger shall be cast-iron sectional design.
   b. The heat exchanger shall be ASME stamped for a working pressure not less than 333//667//1000// kPa (50//100//150// psig). The boiler water pressure drop shall not exceed 13// kPa (2// psig) at the design flow rate.
   c. There shall be removable access covers on the heat exchanger headers for the purposes of inspection, cleaning or repair. The heat exchanger shall have externally accessible boiler drains. An external viewing port shall be provided, permitting visual observation of burner operation.

3. Refractory and Insulation: Boiler manufacturer's standard and experience proven design except insulation on the boiler shell shall be a minimum of 50 mm (two inches) thick. No part of the external casing shall exceed 33 degrees C (91.4 degrees F) above ambient, except for areas within 300 mm (one foot) of the casing penetrations.

4. Casing: Galvanized steel casing covering all areas of boiler shell.
   All openings in the casing shall be gasketed and sealed.

5. Skids/Bases: Boilers shall be factory-installed on the factory-fabricated skids/bases.

E. Finish: Provide surface preparation, heat-resistant prime and finish coats using standard color of the boiler manufacturer.

F. BOILER TRIM (ACCESSORIES):
1. Conform to ASME Boiler and Pressure Vessel Code, Section IV

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2. Relief Valves:
   a. Provide one (1) ASME rated relief valves per boiler. Each valve shall be sized to relieve full boiler capacity.
   b. Type: Bronze bodies, side outlet, threaded inlet and outlet, lifting lever, stainless steel trim and o-ring EPDM seats.
   c. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Valves shall be set to relieve at the ASME working pressure.

3. Pressure Gage:
   a. Case: Turret-style, bottom connection, threaded ring, blowout disc in rear.
   b. Dial: 200 mm (8 inch) minimum diameter, non-corrosive, black markings on white background.
   c. Measuring Element: Bourdon tube designed for steam service.
   d. Movement: Stainless steel, rotary.
   e. Pointer: Micrometer adjustable, black color.
   f. Window: Laminated safety glass, or plastic.
   g. Accuracy: One half percent of the full span.
   h. Range: // 0 - 667 kPa // 0 - 100 psi// gage.

4. Water Level Safety Controls:
   a. Provide primary and auxiliary low water burner cutoffs.
      Primary and auxiliary low water burner cutoff devices shall be in two separate water columns, piped individually to the boiler water spaces. One device shall be float-type, the other device shall be conductivity probes. Primary and auxiliary cutoffs shall require manual reset. Auxiliary cutoff shall shut down power to the burner.
   b. Electrical: Provide circuit breakers, transformers, all devices for complete control system. All control electronics and relays shall be in waterproof NEMA 4X panels.

5. Factory Switch Safety Control:
   a. Provide flow switch to disable burner in event of loss of flow through the boiler.
   b. Type: Brass body, paddle arm and pivot shaft.
   c. Electric Switch: Cam acting type with adjustable flow sensitivity.
   d. Ratings: 121 degrees C(250 degrees F), 1100kPA (160 psig)//

6. Stack Thermometer: Dial-type, bi-metal element, stainless steel case and stem, adjustable angle, one percent of full scale accuracy, dual scale, //100 - 550 °C and 200 - 1000 °F//, minimum diameter 125 mm (5 inches). Locate at flue gas outlet.

G. BURNER AND FUEL TRAINS:
1. Burner Type: Combination natural gas and//fuel oil//propane//, packaged, forced draft, modulating firing//, variable speed forced draft fan//.
   a. Gas Burner: Ring type with multiple ports or spuds.
   b. Oil Burner: Gun type, inside mix, low pressure air atomizing.
   c. Igniter (Pilot): Interrupted, electrically ignited, natural gas//.

2. Service:
   a. Continuous operation at all firing rates on each fuel listed under Article, PROJECT CONDITIONS of Part 1. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures.
   b. Igniter (Pilot) Fuels: Natural gas//.
   c. Main Fuels: After boilers are accepted for operation, choice of fuels will be based on cost and availability.

3. Performance:
   a. Igniter (pilot) flame on natural gas shall form close to the point of ignition and shall be stable. Ignite both the gas and oil burner with single igniter. //
   b. Main flame on gas //and oil// fuels shall ignite at lowest firing rate.
   c. Main flame characteristics at all firing rates:
      1) Flame retained at the burner.
      2) Flame stable with no blowoff from the burner or flashback into the burner. No pulsations.
      3) No deposits of unburned fuel or carbon at any location.
      4) No carryover of flame beyond the end of the first pass (furnace tube).
   d. Operation:
      1) Minimum turndown 4:1.
      2) Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures.
      3) Performance at any load point shall be repeatable after increasing or decreasing the firing rate.
      4) Noise and Vibration: Refer to Section 23 05 5i, NOISE and VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan. Burners shall operate without pulsation.

SPEC WRITER NOTE: Delete low NOx requirements unless required by air emissions authorities.

SPEC WRITER NOTE: Engineer must review local emissions rules and revise the following paragraphs as necessary.
e. Flue Gas Emissions Limits:
   1) Carbon Monoxide: Shall not exceed 400 PPM.
   2) Smoke: On natural gas and //No. 2 oil////propane// shall not be visible and shall not exceed No. 1 on the Bacharach smoke scale.

   SPEC WRITER NOTE: Delete NOx requirements except where required by local air emissions authorities. Insert local NOx emissions limits if applicable. If local emissions rules express the requirement in a different way, revise the subparagraph to conform.

   //3) NOx: _____ ppm maximum, corrected to 3 percent oxygen, dry basis on natural gas //or propane//and low nitrogen No. 2 fuel oil//.//

4. Construction:
   a. Burner Access (Main Burner//and Igniter//): Arrange fuel valve and piping trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
   b. Arrangement of Fuel Valve and Piping Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. Do not attach any piping or devices to boiler casings.
   c. Coatings: Provide surface preparation, heat resistant prime and finish coats using standard color of boiler manufacturer.

   SPEC WRITER NOTE: Delete any fuel valve and piping trains not required. Determine if the natural gas supplier has any special requirements that must be incorporated in the main or igniter fuel trains.

5. Natural Gas Main Fuel Train:
   b. Pressure Regulator:
      1) Single seated, diaphragm-operated, designed for natural gas service. Controlled pressure shall be sensed downstream of main valve. Valve may be self-operated or pilot-operated as necessary to comply with performance requirements.
      2) Service: Provide precisely controlled downstream pressure in fuel train, as required by burner and fuel trains furnished, with upstream pressure as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lock-up pressure of the nearest upstream pressure regulator.
3) Performance: Maximum outlet pressure droop 5 percent of the set pressure over the burner firing range. Maximum lock-up pressure 1.5 times regulated pressure. Speed of response to opening of automatic safety shut off valves shall be sufficient to allow set pressure of low pressure switch to be within 20% of the normal operating pressure with no nuisance burner trips.

4) Construction, Main Valve: Cast iron body, replaceable plug and seat. Downstream pressure-sensing line.

c. Automatic Safety Shut-Off Valves:
   1) Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
   2) Service: Provide open-shut control of fuel flow to burner.
      Valves shall shut bubble tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators.
      SPEC WRITER NOTE: Valves with longer opening times often do not allow the main burner to ignite within the specified (and code required) 10 seconds trial for main flame.
   3) Performance: Timed opening of six seconds or less to safely and smoothly ignite main flame, and close within one second.
   4) Construction: Valves 65 mm (2-1/2 inches) and larger, flanged ends; valves 50 mm (2 inches) and below threaded ends; position indicator showing open and shut, visible from front or side of boiler. Aluminum seating surfaces not permitted. Closed position interlock switch on each valve. Valved leak test fittings before and after each valve.
   5) Approval: //IRI//FM //approved, UL listed for burner service.

d. Automatic Vent Valve:
   1) Type: Motorized-opening, spring closing, full port, controlled by burner control system.

e. Pressure Switches: Switch settings must be within 20% of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.

f. Fuel Flow Control Valve:
   1) Type: Throttling, controlled by combustion control system.
   2) Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner.

6. Fuel Oil Train:
a. Arrangement: Comply with ANSI, IRI, FM, or other requirements.
b. Filter: Replaceable elements, five micron or smaller particle retention.
c. Pressure Regulator: Do not provide unless required by the burner furnished. Pressure control is provided by a back pressure control valve on the house fuel oil pump set.
d. Automatic Safety Shut-Off Valves:
   1) Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
   2) Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble-tight and be suitable for operation with upstream pressure exceeding upstream safety relief valve set pressure plus accumulation.

   SPEC WRITER NOTE: Valves with longer opening times often do not allow ignition of the main flame within the specified and code allowed 10 seconds trial for main flame.

   3) Performance: Timed opening of six seconds or less to safely and smoothly ignite oil burner, one-second closure.
   4) Construction: Threaded ends, valve position indicator visible from front or side of boiler. Closed position interlock switch on each valve.
   5) Approval: FM approved, UL listed for burner service.
   6) Provide valved leak test connections between the two safety shut-off valves and after the second safety shut-off valve.
   7) Proof of Closure Test: Provide non-latching push button controls in the proof of closure circuit to complete the circuit when the valves are open and interrupt the circuit when the valves are closed.
e. Pressure Switches: Switch settings must be within 20% of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.
f. Fuel Flow Control Valve:
   1) Type: Throttling, controlled by combustion control system.
   2) Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner.

g. Boiler/Burner-Mounted Oil Pump and Relief Valve: Provided with burner by boiler manufacturer.

//7. Igniter (Pilot) Fuel Train, Burner and Ignition System:
a. Arrangement: Comply with ANSI / IRI / FM requirements.
b. Filters: Replaceable elements, five micron or smaller particle retention.
c. Pressure Regulators:
   1) Type: Single-seated, diaphragm-operated. Provide separate regulators for natural gas service and for LP gas service
   2) Service: Provide controlled pressure in igniter train as required by igniter, with upstream pressures as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lockup pressure of the nearest upstream pressure regulator. As an alternate to the outlet emergency pressure rating, provide internal relief valve vented to outside set at pressure that will avoid overpressure on regulator outlet that could damage the regulator.
   3) Performance: Lockup pressure shall not exceed 1.5 times the regulated pressure.
   4) Construction: Propane regulator must be designed for LP gas.
d. Automatic Safety Shut-Off and Vent Valves:
   1) Type: Solenoid-type, two normally closed shut-off valves and one normally-open vent valve, arranged as shown, controlled by the burner control system. Provide threaded leak-test ports with threaded plugs on each shut-off valve body.
   2) Service: Provide open-shut control of fuel flow to igniter and vent between shut-off valves. Design for 140 kPa (20 psi) differential at shut-off.
   3) Approval: Safety shut-off valves UL listed, FM approved for burner service. Vent valves UL listed for burner service.
f. Igniter and Ignition System: Provide removable igniter, ignition electrodes, ignition transformer, high voltage cable. Provide shield at ignition area so that spark is not visible to flame scanner from any position on its mounting.
g. Igniter fuel train pipe and fittings: ASME B31.1 requirements do not apply. /\n
H. BURNER MANAGEMENT (FLAME SAFEGUARD) SYSTEM AND ACCESSORIES:
   1. Complete automatic safety control and monitoring system for burner ignition sequencing, operating cycle, and shut-down sequencing.
System shall include microprocessor programmer, self-checking flame scanner, burner cycle display, diagnostic annunciation display, burner safety shut down interlocks, communication with monitoring systems, and accessories.

2. Control Panel: Controls shall be mounted in NEMA 4 enclosure on side of boiler or on burner. There shall be no power wiring in this enclosure.

//3. Controls Interoperability:
   a. The boiler control panel shall utilize open protocol to interface with third party Building Automation Systems (BAS).

4. Factory Testing: Install controls on boiler and burner at factory and test operation of all devices.

5. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

I. BOILER VENT
   1. Refer to Section 23 51 00, BREECHING, CHIMEYS and STACKS.
   2. The boiler vent shall be provided in accordance with applicable national codes, NFPA standards and per the boiler manufacturers’ recommendations.
   3. All supports, //ventilated thimble, barometric dampers,// vent caps, adapters, flashing, drain fittings and expansion joints shall be included by and as recommended by the manufacturer.

2.4 PERFORMANCE
   Provide boiler with capacity as scheduled.

PART 3 - EXECUTION

3.1 INSTALLATION:
   A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
   B. Boiler and Burner Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping. Provide space that permits full opening of all boiler and burner doors, panels and other access openings. Provide space for pulling full length of all boiler tubes directly from their installed location.
   //C. Vent //and combustion air// piping shall be installed in accordance with applicable national codes, NFPA standards and per the boiler manufacturers’ recommendations.//
3.2 CLEANING AND PROTECTION FROM CORROSION:
   A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

3.3 INSPECTIONS AND TESTS:
   A. The following tests and demonstrations must be witnessed by the Contracting Officer’s Technical Representative (COTR)/ Resident Engineer (RE) or his/her representative, and must prove that boilers, burners, controls, instruments, and accessories comply with requirements. When test results are not acceptable, make corrections and repeat tests at no additional cost to the Government. Pretests do not require the presence of the COTR/RE.

   B. Condition of Boiler After Delivery, Rigging, Placement: After setting the boiler and prior to making any connections to the boiler, the Contractor and COTR/RE shall jointly inspect interior and exterior for damage. Correct all damage by repair or replacement to achieve a like new condition.

   C. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator.

   D. A written test procedure shall be provided by the factory for field testing all safety devices installed on the boiler(s).

   E. Hydrostatic Tests:
      1. Boiler: Contractor shall provide inspector certified by National Board of Boiler and Pressure Vessel Inspectors to conduct tests after equipment is installed and connected for operation and prior to initial firing. Test pressure shall be 1-1/2 times the design pressure of the boiler for a period of four (4) hours. Provide written certification of the satisfactory test, signed by the inspector. Correct any deficiencies discovered during the testing, and retest equipment until satisfactory results are achieved and are accepted by the inspector.

      2. Identify and remove any connecting equipment which is not rated for the test pressure. Cap the openings left by the disconnected equipment. Reinstall the equipment after tests are completed.

   F. Boiler Relief Valves:
      1. Test each valve set pressure with boiler operating pressure.

      2. Valve Popping Tolerance: Plus or minus three percent of set pressure for set pressures over 480 kPa (70 psi) gage.

      3. Valve Blowdown Tolerance: Reset at not less than 6 percent below set pressure of valve with the lowest set pressure. Minimum blowdown two percent of the set pressure.
G. Burner Control (Flame Safeguard-Burner Management) System:
1. Demonstrate operation of all control, interlock and indicating functions.
2. Prior to scheduling final test submit certification that all control, indicating, and interlock functions have been pretested.
3. Conduct final test immediately prior to boiler-burner tests.
4. Experienced personnel representing the manufacturer of the system shall conduct the tests.

H. Performance Testing of Boiler, Burner, Combustion Control, Boiler Plant Instrumentation:
1. Perform tests on each boiler on all main burner fuels.
2. If required by local emissions authorities, provide services of testing firm to determine NOx and carbon monoxide. Test firm shall be acceptable to emissions authorities.
3. Test No. P-1:
   a. Operate boiler on each fuel in service and record data for at least four evenly spaced loads from low fire start to 100% of full output, and in the same sequence back to low fire.
   b. Demonstrate proper operation of combustion controls and instrumentation systems.
4. Test Methods:
   a. Utilize permanent instrumentation systems for data. All systems shall be operable and in calibration.
   b. Utilize portable thermocouple pyrometer furnished and retained by Contractor to measure stack temperature as a verification of permanent stack temperature recorder.
   c. Use portable electronic flue gas analyzer to determine constituents of flue gas. Analyzer shall be capable of measuring oxygen in per cent with accuracy of plus or minus 0.5 percent oxygen and carbon monoxide in parts per million (ppm) with accuracy of plus or minus 5 percent of reading (Range 0-1000 ppm). Obtain oxygen and carbon monoxide readings at each test point. Calibrate instrument with certified test gases within three months prior to use and immediately after analyzer cell replacement.
   d. In Test No. P-1 retain boiler at each load point for a time period sufficient to permit stabilization of flue gas temperature and other parameters.
   e. Utilize dry bulb and wet bulb thermometers furnished and retained by Contractor for checking combustion air.
   f. Smoke testing shall be by visual observation of the stack and by smoke density monitor (permanent instrument - if provided). If
smoke density monitor is not provided, utilize Bacharach Model 21-7006 Smoke Test Kit. If there is disagreement with the results of these tests, provide qualified observation person and tests in compliance with EPA Reference Method 9 (CFR 40, Part 60, Appendix A).

SPEC WRITER NOTE: If NOx emissions limits are applicable, list the method of testing that is required by local authorities if it differs from the method listed.

//g. NOx emissions shall be tested with electronic analyzer reading in parts per million. Analyzer shall be calibrated with certified test gas within three months prior to use. Analyzer shall be accurate to plus or minus 5% of reading.//

h. An additional efficiency test will be required, conforming to ASME Performance Test Code PTC 4, if the boiler efficiency determined in the Test P-1 above, does not comply with requirements. Utilize ASME Test Forms PTC 4.1.a, 4.1.b, and the abbreviated input-output and heat balance methods.