SECTION 235233 - WATER-TUBE BOILERS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
   * + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY

Retain one of two paragraphs below. Finned water-tube boilers are only available in gas-fired, heating water boilers. See the Evaluations for a comparison of finned water-tube, steel water-tube, and flexible water-tube boilers.

* + - * 1. Section includes packaged, factory-fabricated and -assembled, gas-fired, finned water-tube boilers for generating hot water.
        2. Section includes packaged, [**factory-**] [**or**] [**field-**] assembled, water-tube boilers for generating [**hot water**] [**steam**].
        3. Related Requirements:

List other Sections directly related to or affecting Work of this Section. Include Sections specifying information expected to be found in this Section as well as Sections required to describe complete system or assembly requirements.

Section 033000 - Cast-in-Place Concrete: Concrete housekeeping pads.

Section 221100 - Facility Water Distribution: Cold water piping connections to boilers.

Section 230513 - Common Motor Requirements for HVAC Equipment: Electric motors.

Section 230548 - Vibration and Seismic Controls for HVAC: Vibration isolators.

Section 230593 - Testing, Adjusting, and Balancing for HVAC: Adjusting and balancing hot water boiler flow rates.

Section 231113 - Facility Fuel-Oil Piping: Fuel oil piping connections to boilers.

Section 231123 - Facility Natural-Gas Piping: Natural gas piping connections to boilers.

Section 231126 - Facility Liquefied-Petroleum Gas Piping: LPG piping connections to boilers.

Section 232113 - Hydronic Piping: Hot water piping for connections to boilers.

Section 232213 - Steam and Condensate Heating Piping: Steam piping for connections to boilers.

Section 232500 - HVAC Water Treatment: Requirements for system cleaner, closed loop treatment, and steam treatment.

Section 235100 - Breechings, Chimneys, and Stacks: Breeching, chimney, and stack connections to boilers.

Section 260583 - Wiring Connections: Electric connections to boilers.

Section 230923 – Direct Digital Building Control System

Section 230993 – Sequence of Operations for HVAC

* + - 1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer's installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product, include the following:

Construction details, material descriptions, dimensions, and weights of individual components, profiles, and finishes for boilers.

Rated capacities, operating characteristics, and furnished specialties and accessories.

Predicted boiler efficiency while operating at design capacity and at varying part loads with basis indicated.

Predicted emissions levels while operating at design capacity and at varying part loads with basis indicated. Indicate operation that produces worst-case emissions.

Technical data for refractory and insulation, including temperature rating, thermal performance, attachment, and arrangement.

Calculations showing predicted surface temperature of boiler jacket with basis indicated.

Force and moment capacity of each piping and flue connection.

Dimensioned location of low, high, and normal water level, showing operating set point and each alarm set point.

Temperature and pressure rating, size, and materials of construction for boiler trim components, including piping, fittings, flanges, unions, and valves. Provide valve manufacturer's product data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.

Manufacturer's product data showing size, scale range, and accuracy of thermometers and pressure gages.

Pressure rating, size, and materials of construction for boiler fuel train components, including piping, fittings, flanges, unions, switches, and valves. Provide manufacturer's product data for each valve and switch furnished.

Detailed information of controls, including product data with technical performance, operating characteristics, and sequence of operation.

Product data for each motor, including performance, operating characteristics, and materials of construction.

* + - * 1. Shop Drawings: For boilers, boiler trim, and accessories.

Include plans, elevations, sections, and [**mounting**] [**attachment**] details.

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.

Include piping diagrams of factory-furnished piping that indicate size and each piping component.

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Plan and elevation views, drawn to <**Insert scale**> scale, indicating equipment manufacturers' service clearances, structure and base attachment, piping, power, controls, and flues. Each view shows a screened background with the following:

Column grids, beams, columns, and concrete housekeeping pads.

Room layout with walls, floors, and roofs, including each room name and number.

Equipment and products of other trades that are located in vicinity of boilers and are part of final installation, such as lighting, fire-suppression systems, and plumbing systems.

Retain "Seismic Qualification Certificates" paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Certificates: For boilers, accessories, and components, from manufacturer.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

* + - * 1. Installation instructions.
        2. Source quality-control reports.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
        2. Sample Warranty: For special warranty.
        3. Other Informational Submittals:

Retain "ASME 'A' Stamp Certification and Report" subparagraph below for steam boilers operating at more than 15 psig or hot-water boilers operating at more than 160 psig or 250 deg F.

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

Startup service reports.

* + - 1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.
         2. Spare Parts List: Recommended spare parts list with quantity for each.
         3. Touch-up Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.
         4. Instructional Videos: Including those that are prerecorded and those that are recorded during training.
      2. MAINTENANCE MATERIAL SUBMITTALS

Retain this article to require tool kit and touch-up paint.

* + - * 1. Tool kit to include the following:

A tool kit specially designed by boiler manufacturer for use in servicing boiler(s) furnished.

Special tools required to service boiler components not readily available to Director’s Representative service personnel in performing routine maintenance.

Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Boiler Tool Kit." Text size shall be at least 1 inch high.

A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 0.5 inch high.

* + - * 1. Touch-up Paint: [**32-oz.**] <**Insert volume**> container of paint used for finish coat. Label on outside of container shall have a detailed description of paint to allow for procurement of a matching paint in the future.
      1. DELIVERY, STORAGE, AND HANDLING
         1. Ship boilers from the factory free of water. Drain water and blow dry with compressed air if required to remove all water before shipping.
         2. Cover and protect flue, electrical controls, and piping connections before shipping. Protect and seal openings and connections with blinds, caps, plugs, and other materials during delivery, storage, and handling.
         3. Protect boiler components with removable temporary enclosures to prevent damage during shipping, storage, and installation.

Retain paragraph below for projects with special shipping requirements. Export shipping adds cost.

* + - * 1. Package boiler for export shipping in totally enclosed [**bagging**] [**crate**] [**crate with bagging**].
      1. WARRANTY

When warranties are required, verify with Director’s Representative 's counsel that warranties stated in this article are not less than remedies available to Director’s Representative under prevailing local laws. Coordinate with Section 016000 "Product Requirements." See discussion about warranties in "Characteristics Common to All Boilers" Article in the Evaluations.

Retain one of two "Special Warranty" paragraphs below. Retain first for finned water-tube boilers.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace heat exchangers damaged by thermal shock and vent dampers of boilers that fail in materials or workmanship within specified warranty period.

Verify available warranties and warranty periods for units and components with listed boiler manufacturers.

Warranty Period for Heat Exchangers: [**20**] <**Insert number**> years from date of Substantial Completion.

Warranty Period for Vent Dampers: [**Five**] <**Insert number**> years from date of Substantial Completion.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.

Verify available warranties and warranty periods for units and components with listed boiler manufacturers.

Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner: [**Five**] <**Insert number**> years from date of Substantial Completion, pro rata.

Warranty Period for Pressure Vessel: [**20**] <**Insert number**> years from date of Substantial Completion, for thermal shock.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. PERFORMANCE REQUIREMENTS

Retain this article to define performance requirements that are not indicated elsewhere.

* + - * 1. Fuel-to[**steam**] [**water**] efficiency indicated shall be based on the following:

Retain one of three "Efficiency Testing Method" subparagraphs below to establish test method used to determine efficiency indicated. Verify requirement with listed manufacturers.

Efficiency Testing Method: BTS-2000.

Efficiency Testing Method: ASME Performance Test Code (PTC) 4, [**Input-Output**] [**Heat Loss**] method.

Test Operating Conditions:

Ambient Temperature: <**Insert temperature**>.

Ambient Relative Humidity: <**Insert relative humidity**>.

Percent Excess Air in Exhaust Flue Gas: [**15**] <**Insert number**>.

Fuel Heating Value: <**Insert value**>.

Retain paragraphs below to require emissions restrictions. Retain "Gas-Fired Boiler Emissions" Paragraph for gas-fired boilers; retain "Oil-Fired Boiler Emissions" Paragraph below for oil-fired boilers.

* + - * 1. Gas-Fired Boiler Emissions: Not to exceed allowable ambient-air quality standards in governing jurisdiction and indicated values.

Carbon monoxide:

[**50**] <**Insert number**> parts per million at any point from 100 percent to [**50**] <**Insert number**> percent fire.

[**150**] <**Insert number**> parts per million at any point below [**50**] <**Insert number**>percent fire.

Nitrogen compounds: [**30**] [**20**] [**10**] <**Insert number**> parts per million (dry volume basis and corrected to [**3**] <**Insert number**> percent oxygen) at any point from 100 percent to low fire.

Sulfur compounds: [**One**] <**Insert number**> part per million (dry volume basis and corrected to [**3**] <**Insert number**> percent oxygen) at any point from 100 percent to low fire.

Hydrocarbon and Volatile Organic Compounds: [**10**] <**Insert number**> parts per million (dry volume basis and corrected to [**3**] <**Insert number**> percent oxygen) at any point from 100 percent to low fire.

Particulate Matter: [**0.01 lb/MMBtu**] <**Insert value**>.

Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.

* + - * 1. Oil-Fired Boiler Emissions: Not to exceed allowable ambient-air quality standards in governing jurisdiction and indicated values.

Carbon monoxide:

[**50**] <**Insert number**> parts per million at any point from 100 percent to [**50**] <**Insert number**> percent fire.

[**150**] <**Insert number**> parts per million at any point below [**50**] <**Insert number**> percent fire.

Nitrogen compounds: [**30**] [**20**] [**10**] <**Insert number**> parts per million (dry volume basis and corrected to [**3**] <**Insert number**> percent oxygen) at any point from 100 percent to low fire.

Sulfur compounds: [**One**] <**Insert number**> part per million (dry volume basis and corrected to [**3**] <**Insert number**> percent oxygen) at any point from 100 percent to low fire.

Hydrocarbon and Volatile Organic Compounds: [**10**] <**Insert number**> parts per million (dry volume basis and corrected to [**3**] <**Insert number**> percent oxygen) at any point from 100 percent to low fire.

Particulate Matter: [**0.01 lb/MMBtu**] <**Insert value**>.

Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.

* + - * 1. Multiple Boiler Operation: Equip individual boilers in multiple boiler applications with integral controls to provide multiple boiler operation for optimum system performance, energy efficiency, and the following:

Equalize runtime of boilers in service.

Operate multiple boilers hot to minimize disruption of service in the event of single boiler failure.

Configure controls so any boiler can be taken out of service with power disconnected and not impact multiple boiler operation.

<**Insert requirement**>.

Retain "Seismic Performance" Paragraph below with "Seismic Qualification Certificates" Paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Boiler shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the boiler will remain in place without separation of any parts when subjected to the seismic forces specified[**and the boiler will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor: [**1.5**] [**1.0**].

See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table for requirements to be inserted in subparagraph below.

<**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

Reference to ABMA publication in "Sound" Paragraph below may limit the number of qualified manufacturers capable of complying with this Specification.

* + - * 1. Sound: Boiler sound level, measured according to parameters defined in ABMA publication "Boiler 304 Measurement of Sound from Steam Generators" shall not exceed <**Insert number**> dBA.

Retain "Steam Quality" Paragraph below for steam boilers with special requirements.

* + - * 1. Steam Quality: [**99**] [**99.5**] <**Insert number**> percent dry[**and saturated**].

Retain "Operation Following Loss of Normal Power" Paragraph below if interrupted boiler operation is required.

* + - * 1. Operation Following Loss of Normal Power:

Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to back-up power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a back-up power source or through normal power if restored before back-up power is brought online.

Refer to Drawings for equipment served by back-up power systems.

Provide means and methods required to satisfy requirement even if not explicitly indicated.

Retain "Outdoor Installations" Paragraph below for boilers installed outdoors.

* + - * 1. Outdoor Installations:

Boiler shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [**25**] <**Insert number**> -year period, with minimal degradation due to exposure to outdoor ambient conditions.

Boilers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [**30**] <**Insert number**> -year period. Provide as part of boiler package, products, such as combustion-air pre-heaters and other means and methods required.

* + - * 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
        2. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

"ASHRAE/IES 90.1 Compliance" Paragraph below may be required to comply with Project requirements or authorities having jurisdiction and is required for sustainable design systems.

* + - * 1. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

Retain "DOE Compliance" Paragraph below for boilers with rating of 300,000 Btu/h and less.

* + - * 1. DOE Compliance: Minimum efficiency for boilers with capacity of 300,000 Btu/h shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

Retain first option in "UL Compliance" Paragraph below for oil burners. Retain second option for combination gas and oil burners and third option for gas burners.

* + - * 1. UL Compliance: Test boilers for compliance with [**UL 726**] [**UL 726 and UL 795**] [**UL 795**]. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
      1. FINNED WATER-TUBE BOILERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11465) Subject to compliance with requirements, provide products by one of the following:

[A. O. Smith Corporation](http://www.specagent.com/Lookup?uid=123457138875).

[Laars Heating Systems Company; a subsidiary of Bradford White Corporation](http://www.specagent.com/Lookup?uid=123457138869).

[Precision Boilers](http://www.specagent.com/Lookup?uid=123457138871).

[Raypak; a Rheem brand](http://www.specagent.com/Lookup?uid=123457138872).

Approved equivalent.

* + - * 1. Description: Factory-fabricated, -assembled, and -tested boiler, with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air-intake connections, water supply and return connections, and controls.
        2. Heat Exchanger:

Finned [**copper**] [**steel**] [**or**] [**copper-nickel**] tubing with stainless-steel baffles.

[**Bronze**] [**Cast-iron**] [**or**] [**Steel**] headers.

[**Single**] [**Two**]-pass, [**horizontal**] [**vertical**] [**or**] [**coil**] configuration.

Tubes shall be sealed in header [**with silicone O-ring gaskets**] [**by welding**] [**or**] [**by mechanically rolling tubes in header**].

* + - * 1. Combustion Chamber Internal Insulation: Interlocking panels of refractory insulation, high-temperature cements, mineral fiber, and ceramic refractory tile for service temperatures of up to 2000 deg F.
        2. Casing:

Jacket: [**Sheet metal**] [**or**] [**Stainless steel**], with snap-in or interlocking closures.

Control Compartment Enclosure: NEMA 250, Type 1A.

Stainless-steel enclosures are typically not painted. If retaining stainless-steel option in "Jacket" Subparagraph above, delete "Finish" Subparagraph below.

Finish: [**Baked enamel over primer**] [**Baked enamel over galvanizing**] [**Powder coated**].

Insulation: Minimum [**1-inch-**] [**2-inch-**] <**Insert value**> thick, mineral-fiber insulation surrounding the heat exchanger.

Delete "Draft Hood" Subparagraph below if a direct vent burner is specified.

Draft Hood: [**Integral**] [**External**].

Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.

Mounting base to secure boiler[**with accessory for mounting on combustible surface**].

* + - * 1. Burner:

Consider impact of site altitude on fan and motor.

Burner Tubes and Orifices: Stainless steel, for [**natural**] [**propane**] gas.[**Mount burner tubes in a slide-out burner drawer for ease of inspection.**]

Retain applicable subparagraph(s) below for specified boiler. "Sealed Combustion" Subparagraph is for sealed combustion boilers. "Direct Vent" Subparagraph is typically for boilers vented through sidewalls. If conventional venting is specified, delete both subparagraphs.

Sealed Combustion: Factory-mounted centrifugal fan to draw outside air into boiler and discharge into burner compartment.

Direct Vent: Factory-mounted centrifugal fan to draw flue gas out of boiler and discharge into boiler vent.

Vertical Burner:

[**High-temperature stainless steel**] [**Ceramic**] to fire in a 360-degree pattern.

Filter option in first subparagraph below is required only for ceramic burner element.

Burner shall have a viewing port for observation of burner operation and a factory-mounted centrifugal fan to supply [**room**] [**outdoor**] air[**through a replaceable 99 percent efficient (1-micrometer particles) filter**] to boiler burner.

Fan shall be controlled to prepurge and postpurge the combustion chamber before firing.

Retain one of two "Gas Train" subparagraphs below. First subparagraph applies to commercial boilers; retain any of four control sequences with any of five safety requirements. Second paragraph applies to residential boilers.

Gas Train: Control devices and [**full-modulation**] [**on/off**] [**low/high/low**] [**proportional**] control sequence shall comply with [**AGA**] [**ASME CSD-1**] [**FM Global**] [**Industrial Risk Insurers (IRI)**] [**and**] [**or**] [**UL**] requirements. In addition to these requirements, include shutoff cock, pressure regulator, and control valve.

Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

Pilot: [**Standing**] [**Intermittent-electric-spark**] [**Hot-surface**] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

Flue-Gas Recirculation System: Centrifugal fans on burner assembly to recirculate flue gas to decrease emissions to requirements indicated. Complete package integrating burner, fan, damper, fuel train, and controls. Provide interconnecting external ducting if required by manufacturer's design.

Motors: Comply with requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

* + - * 1. Hot-Water Boiler Trim:

Retain option in "Hot-Water Temperature Controllers" Subparagraph below if using modulating or low-high-low firing sequence.

Hot-Water Temperature Controllers: Operating[**, firing rate,**] and high limit.

Safety Relief Valve: ASME rated.

Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

Boiler Air Vent: [**Automatic**] [**Manual**].

Drain Valve: Minimum NPS 3/4 hose-end valve.

Retain "Circulation Pump" Subparagraph below if pump is a component of boiler.

Circulation Pump: Non-overloading, in-line pump with [**split-capacitor**] motor having thermal-overload protection and lubricated bearings; designed to operate at boiler flow rate, pressures, and temperatures.

* + - * 1. Controls:

Boiler operating controls shall include the following devices and features:

Control transformer.

Retain "Motorized Vent Damper" Subparagraph below for residential boilers only.

Motorized Vent Damper: Interlocked with burner to open before burner starts. If damper fails to open, stop burner operation.

Set-Point Adjust: Set points shall be adjustable.

Retain one of two "Sequence of Operation" subparagraphs below for operating control sequences.

Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.

Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outdoor-air temperature. At [**0 deg F**] <**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**200 deg F**] <**Insert temperature**>; at [**60 deg F**] <**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**140 deg F**] <**Insert temperature**>.

Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

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

High Cutoff: [**Manual**] [**Automatic**] reset stops burner if operating conditions rise above maximum boiler design temperature.

Water Flow Switch: Automatic-reset paddle-switch shall prevent burner operation on low water flow.

"Blocked Vent Safety Switch" and "Rollout Safety Switch" subparagraphs below apply to atmospheric burners. Some boilers may be equipped with only one of two switches. Verify availability with listed boiler manufacturers.

Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.

Rollout Safety Switch: Factory mounted on boiler combustion chamber.

Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

Retain first subparagraph below if boiler controls interface with building automation or DDC system.

[**Building Automation**] [**DDC**] System Interface: Factory install hardware and software to enable system to monitor, control, and display boiler status and alarms.

Retain "Hardwired I/O Points" Subparagraph below if interface is through hardwired points and minimal interface is required. If extensive interface is required, delete subparagraph and retain "Communication Interface" Subparagraph below, or retain both subparagraphs if requiring both hardwired and communication interface. Contact listed boiler manufacturers to verify interface requirements are available.

Hardwired I/O Points:

Monitoring: On/off status, [**common trouble alarm**] [**low-water-level alarm**] <**Insert monitoring point**>.

Control: On/off operation, [**hot-water-supply temperature set-point adjustment**] <**Insert control point**>.

Retain "Communication Interface" Subparagraph below if extensive interface is required and is beyond that than can be provided by hardwired points. Coordinate communication protocol option retained with control system requirements. Contact listed boiler manufacturers to verify interface requirements are available.

Communication Interface: [**ASHRAE 135 (BACnet)**] [**(LonTalk)**] [**Modbus**] [**Industry-accepted, open-protocol**] <**Insert type of interface**> communication interface shall enable control system operator to remotely control on/off operation and capacity of boiler and monitor the boiler operation from an operator workstation. The control features and monitoring points at the boiler-control panel shall be available to the control system through an interface.

* + - 1. STEEL OR FLEXIBLE WATER-TUBE BOILERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11466) Subject to compliance with requirements, provide products by one of the following:

Cleaver-Brooks Fire Tube Boilers

[Ajax Boiler Inc](http://www.specagent.com/Lookup?uid=123457138878).

[Raypak; a Rheem brand](http://www.specagent.com/Lookup?uid=123457196877).

[York-Shipley Global; Division of Power Mechanical, Inc](http://www.specagent.com/Lookup?uid=123457138881).

Approved equivalent.

* + - * 1. Description: Factory-fabricated and [**field**]-assembled water-tube boiler, with heat exchanger sealed pressure tight, and built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls.

Retain one of two "Heat-Exchanger Design" paragraphs below for heat-exchanger design. Retain first paragraph for straight-tube design. Retain second paragraph for bent-tube design.

* + - * 1. Heat-Exchanger Design: Straight steel tubes rolled into steel headers.

Accessible head plates at both ends.

Handholes[**or couplings**] in headers for waterside inspections.

Accessible drain and blowdown tappings, both high and low, for surface and mud removal.

Lifting lugs on top of boiler.

Retain "Built-in air separator" Subparagraph below for hot-water boilers only.

Built-in air separator.

* + - * 1. Heat-Exchanger Design: Bent steel tubes [**swaged**] [**welded**] into steel headers[**with membrane waterwall design**].

Retain first subparagraph below to limit tube configurations.

Limit tube configurations to [**two**] [**four**] <**Insert number**>.

Accessible drain and blowdown tappings, both high and low, for surface and mud removal.

Accessible inspection ports in drum, mud legs, and tube manifolds.

Lifting lugs on top of boiler.

Retain "Built-in air separator" Subparagraph below for hot-water boilers only.

Built-in air separator.

The need for refractory insulation around the combustion chamber is reduced by a membrane waterwall (tube-wall) construction design offered by some manufacturers.

* + - * 1. Combustion Chamber: Equipped with minimum [**2-1/2-inch**] [**3-inch**] [**4-inch**], 2700 deg F poured refractory on floor and minimum [**2-inch**] [**3-1/2-inch**] <**Insert value**> lap-jointed cast refractory with fiber-blanket joint seals on side walls. Combustion chamber shall have flame observation ports in front [**and**] [**or**] back.
        2. Casing:

Insulation: Minimum[**2-inch thick, lightweight refractory; 1-inch thick insulating board; galvanized-steel membrane; and**] 2-inch thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber.

Top Flue Connection: Constructed of [**aluminized**] [**or**] [**stainless**] steel.

Retain one of two "Jacket" subparagraphs below.

Jacket: Mirror-finish stainless steel, with screw-fastened closures.

Jacket: [**Galvanized**]sheet metal, with screw-fastened closures and [**baked-enamel**] [**powder-coated**] protective finish.

Mounting Base: Secures boiler to concrete base.

Retain first option in first paragraph below for atmospheric burner. Retain second option for forced-draft burner.

* + - * 1. [**Draft Diverter**] [**Barometric Damper**]: Galvanized-steel assembly with flue-gas thermometer.

Retain "Atmospheric Gas Burner," "Forced-Draft Gas Burner," "Forced-Draft Oil Burner," or "Forced-Draft Combination Gas and Oil Burner" Paragraph below.

* + - * 1. Atmospheric Gas Burner:

Burner and Orifices: [**Stainless steel**] [**Cast iron**], for [**natural**] [**propane**] gas.

Retain one of two "Gas Train" subparagraphs below. First subparagraph applies to commercial boilers; retain any of three control sequences with any of five safety requirements. Second subparagraph applies to residential boilers. Availability of three control sequences listed depends on boiler capacity. Consult listed boiler manufacturers.

Gas Train: Control devices and [**full-modulation**] [**on/off**] [**low/high/low**] control sequence shall comply with [**ASME CSD-1**] [**FM Global**] [**NFPA 85**] [**Industrial Risk Insurers (IRI)**] [**and**] [**or**] [**UL**] requirements.

Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

Pilot: [**Standing**] [**Intermittent-electric-spark**] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

* + - * 1. Forced-Draft Gas Burner:

Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for [**natural**] [**propane**] gas.[**Mount burner on hinged access door to permit access to combustion chamber.**]

Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

In "Gas Train" Subparagraph below, retain any of three control sequences with any of five safety requirements. Availability of three control sequences listed depends on boiler capacity. Consult listed boiler manufacturers.

Gas Train: Control devices and [**modulating**] [**on/off**] [**low/high/low**] control sequence shall comply with [**ASME CSD-1**] [**FM Global**] [**NFPA 85**] [**Industrial Risk Insurers (IRI)**] [**and**] [**or**] [**UL**] requirements.

Pilot: [**Intermittent**] [**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

* + - * 1. Forced-Draft Oil Burner:

Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil.[**Mount burner on hinged access door to permit access to combustion chamber.**]

Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

In "Oil Supply" Subparagraph below, retain any of three control sequences with any of five safety requirements. Availability of three control sequences listed depends on boiler capacity. Consult listed boiler manufacturers.

Oil Supply: Control devices and [**modulating**] [**on/off**] [**low/high/low**] control sequence shall comply with [**ASME CSD-1**] [**FM Global**] [**NFPA 85**] [**Industrial Risk Insurers (IRI)**] [**and**] [**or**] [**UL**] requirements.

Oil pump may be remotely mounted and shipped separately. Revise performance parameters in "Oil Pump" Subparagraph below to suit Project.

Oil Pump: Two-stage, gear-type oil pump[**integral to and directly driven by blower**] shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.

Oil Piping Specialties:

Suction-line, manual, gate valve.

Removable-mesh oil strainer.

0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.

0- to 300-psig oil-nozzle pressure gage.

Nozzle-line, solenoid-safety-shutoff oil valve.

Pilot: [**Intermittent**] [**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety-shutoff solenoid using [**cadmium sulfide**] [**UV scanner**] flame-safety control.

* + - * 1. Forced-Draft Combination Gas and Oil Burner:

Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil and [**natural**] [**propane**] gas.[**Mount burner on hinged access door to permit access to combustion chamber.**]

Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

In "Oil Supply" Subparagraph below, retain any of three control sequences with any of five safety requirements. Availability of three control sequences listed depends on boiler capacity. Consult listed boiler manufacturers.

Oil Supply: Control devices and [**modulating**] [**on/off**] [**low/high/low**] control sequence shall comply with [**ASME CSD-1**] [**FM Global**] [**NFPA 85**] [**Industrial Risk Insurers (IRI)**] [**and**] [**or**] [**UL**] requirements.

Oil pump may be remotely mounted and shipped separately. Revise performance parameters in "Oil Pump" Subparagraph below to suit Project.

Oil Pump: Two-stage, gear-type oil pump[**integral to and directly driven by blower**] shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.

Oil Piping Specialties:

Suction-line, manual, gate valve.

Removable-mesh oil strainer.

0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.

0- to 300-psig oil-nozzle pressure gage.

Nozzle-line, solenoid-safety-shutoff oil valve.

In "Gas Train" Subparagraph below, retain any of three control sequences with any of five safety requirements.

Gas Train: Control devices and [**modulating**] [**on/off**] [**low/high/low**] control sequence shall comply with [**ASME CSD-1**] [**FM Global**] [**NFPA 85**] [**Industrial Risk Insurers (IRI)**] [**and**] [**UL**] requirements.

Gas Pilot: [**Intermittent**] [**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

Oil Pilot: [**Intermittent**] [**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety-shutoff solenoid with [**cadmium sulfide**] [**UV scanner**] flame-safety control.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

* + - * 1. Motors: Comply with requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment" unless more stringent requirements are indicated below:

Efficiency: [**Premium efficient**] <**Insert requirement**>.

Enclosure: [**Open dripproof**] [**Totally enclosed**] [**or**] [**Totally enclosed, fan cooled**].

Insulation Class: [**F**] [**H**] <**Insert requirement**>.

Service Factor: [**1.15**] <**Insert value**>.

Motors operated through variable-frequency controllers shall be inverter duty rated according to NEMA MG-1.

Motor Sizes: Minimum size as indicated and large enough so driven load does not require motor to operate in service factor.

* + - * 1. Flue-Gas Recirculation System:

Equip boiler with packaged flue-gas recirculation system if required to satisfy emission requirements.

Complete package integrating burner, combustion-air blower and damper, fuel train, and controls. Provide interconnecting external ducting if required by manufacturer's design.

Retain "Hot-Water Boiler Trim" Paragraph below for hot-water boilers.

* + - * 1. Hot-Water Boiler Trim:

In first subparagraph below, retain first option if boiler operating pressure exceeds 160 psig or boiler temperature exceeds 250 deg F.

Include devices sized to comply with [**ASME B31.1**] [**ASME B31.9**].

Retain option in "Hot-Water Temperature Controllers" Subparagraph below if using modulating or low-high-low firing sequence.

Hot-Water Temperature Controllers: Operating[**, firing rate,**] and high limit.

Safety Relief Valve: ASME rated.

Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

Boiler Air Vent: [**Automatic**] [**Manual**].

Drain Valve: Minimum NPS 3/4 hose-end valve.

Coordinate "Tankless Heater" Subparagraph below with other plumbing Sections for domestic water heaters.

Tankless Heater: [**Carbon-steel**] [**Bronze**] header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.

Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

Retain "Steam Boiler Trim" Paragraph below for steam boilers.

* + - * 1. Steam Boiler Trim:

In first subparagraph below, retain first option if boiler operating pressure exceeds 15 psig.

Include devices sized to comply with [**ASME B31.1**] [**ASME B31.9**].

Retain option in "Pressure Controllers" Subparagraph below if using modulating or low-high-low firing sequence.

Pressure Controllers: Operating[**, firing rate,**] and high limit.

Safety Relief Valve:

Size and Capacity: As required for equipment according to 2010 ASME Boiler and Pressure Vessel Code.

Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

Retain "Exhaust Head" Subparagraph for boilers installed outdoors.

Exhaust Head: Install exhaust head on vent pipe connected to safety relief valve.

Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure of about 50 percent of full range.

Water Column: Minimum 12-inch glass gage with gage rods to protect glass, ball check and shutoff cocks, water column blowdown valves, and vacuum breaker. Midpoint of gauge shall be at normal operating water level.

In "Bottom Blowdown Valves" Subparagraph below, retain option if boiler operating pressure exceeds 100 psig (690 kPa).

Bottom Blowdown Valves: Factory-installed, duty-rated, slow-acting blowdown valves and interconnecting piping same size as boiler nozzle.[**Blowdown valves shall be combination of slow and quick acting as required by ASME B31.1.**]

In "Surface Blowdown Valves" Subparagraph below, retain option for boilers with integral automated control of surface blowdown.

Surface Blowdown Valves: Factory-installed, duty-rated isolation valves and interconnecting piping.[**In addition, provide electrically operated control valve, duty rated, to control total dissolved solids (TDS) through boiler controls.**]

Stop Valves: Boiler outlets, except safety relief valves, shall be equipped with stop valve in an accessible location as near as is practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.

Retain "Stop-Check Valves" Subparagraph below for boilers that operate at more than 15 psig and supply steam to a common steam header with other boilers.

Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

Retain one of two "Feedwater Valves" subparagraphs below. Retain second subparagraph for boilers with integral automated control of water level. Coordinate requirements with boiler feedwater equipment specified in other Sections.

Feedwater Valves: Factory-installed, duty-rated stop and check valves and interconnecting piping. Stop valves larger than NPS 2 shall have rising stem.

Feedwater Valves: Factory-installed, three-valve bypass arrangement with modulating control valve positioned between duty-rated stop valves, bypass piping with throttling valve, check valve, and interconnecting piping. Stop and throttling valves larger than NPS 2 shall have rising stem. Modulating control valve shall have the following features and characteristics:

Duty rated with electric operator to control water level through boiler controls.

Equal percentage flow characteristic.

Valve Flow: [**Indicated on Drawings**] [**1.25 times boiler output**] <**Insert requirement**>.

Valve Pressure and Temperature Rating: Equal to boiler.

Shut-off Leakage: [**0.0001**] <**Insert number**> percent of valve coefficient.

Chemical Injection Assembly: Factory-installed, duty-rated injection quill with ball check valve and isolation valve compatible with dispensed chemical.

Sample Cooler: Factory [**installed**] [**or**] [**furnished for field installation**], with [**needle**] valve for each connection.[**Constructed of 316 stainless steel.**]

Coordinate "Tankless Heater" Subparagraph below with plumbing Sections for domestic water heaters.

Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper manifold and sealed with fiber gasket.

Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

* + - * 1. Controls:

Boiler operating controls shall include the following devices and features:

Control transformer(s) with fuse protection, as required by manufacturer, to implement requirements indicated. Provide transformer with 25 percent spare capacity.

Set-Point Adjust: Operating and alarm set points shall be field adjustable.

Retain "Pressure Control for Steam Boilers" Subparagraph below for steam boilers.

Pressure Control for Steam Boilers:

Operating-Pressure Control: Factory wired and mounted to control boiler to maintain boiler at constant pressure within [**2**] <**Insert number**> percent of set point.

High-Pressure Cutoff with Automatic Reset: Control stops burner if operating conditions rise above normal operating-pressure set point. Set point shall be adjustable.

High-Pressure Cutoff with Manual Reset: Control stops burner operation upon reaching adjustable high limit set point that is below safety valve setting.

Retain "Water-Level Control for Steam Boilers" Subparagraph below for steam boilers.

Water-Level Control for Steam Boilers:

Operating Water-Level Control: [**Cycle feedwater pump(s)**] [**Operate feedwater pump(s) continuously and modulate boiler feedwater valve**] for water-level control.

Low-Water Cutoff Switch: [**Electronic**] [**Float and electronic**] probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**] [**automatic**]-reset type.

Auxiliary Low-Water Cutoff Switch: [**Electronic**] [**Float and electronic**] probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.

Retain first four subparagraphs below for microprocessor control with better accuracy and additional features.

Microprocessor-based control.

Accuracy within [**0.01 inch**] <**Insert value**>.

Visual indication of level, alarms, and errors through alphanumeric display.

Features:

Revise first 12 subparagraphs below to provide required features.

Continuous water-level indication.

Low-water cutoff and alarm.

High-water alarm.

Low- and high-water warning.

Control of feedwater pump.

Control of modulating feedwater control valve.

Continuous monitoring of float operation.

Column blowdown detection and reminder.

Auxiliary low-water cutoff check.

Auto and manual reset.

Alarm annunciation.

<**Insert feature**>.

Retain "Operating Controls for Hot-Water Boilers" Subparagraph below for hot-water boilers.

Operating Controls for Hot-Water Boilers:

Retain one of three "Sequence of Operation" subparagraphs below.

Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outdoor-air temperature. At [**0 deg F**] <**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**200 deg F**] <**Insert temperature**>; at [**60 deg F**] <**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**140 deg F**] <**Insert temperature**>.

Sequence of Operation: Indicated on Drawings.

Sequence of Operation: <**Insert requirements**>.

Retain "Multiple Boiler Operation" Subparagraph below for control of multiple boilers.

Multiple Boiler Operation: Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

Retain "Boiler Emergency Shutdown" Subparagraph below if emergency shutdown is provided with boiler.

Boiler Emergency Shutdown: Interlock with field-installed boiler emergency shutdown switch to shut down boiler when activated. Manufacturer to furnish break-glass-type switch with permanent nameplate titled "Boiler Emergency Shutdown" for field installation.

Retain "Chemical Feed System Interface" Subparagraph below for steam boilers.

Chemical Feed System Interface: Dry contacts to interface control and operation of chemical feed pump.

Retain "Burner Safety Controls for Steam Boilers" Subparagraph below for steam boilers.

Burner Safety Controls for Steam Boilers: To maintain safe operating conditions, burner safety controls limit burner operation.

High Cutoff: [**Automatic**] [**and**] [**Manual**] reset stops burner if operating conditions rise above maximum boiler operating pressure.

Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.

Auxiliary Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.

Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

Retain "Burner Safety Controls for Hot-Water Boilers" Subparagraph below for hot-water boilers.

Burner Safety Controls for Hot-Water Boilers: To maintain safe operating conditions, burner safety controls limit burner operation.

High Cutoff: [**Automatic**] [**and**] [**Manual**] reset stops burner if operating conditions rise above boiler design temperature.

Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**] [**automatic**]-reset type.

Auxiliary Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.

Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

Burner Flame Safeguard Controls:

Factory equipped with flame safeguard control and infrared flame scanner.

Microprocessor-based, solid-state control having sequence and flame-on visual indication and fault code indications of flame safeguard trip functions.

Control shall include dynamic self-check logic.

Control shall have a fixed operating sequence incapable of being manually altered that includes start, prepurge, pilot and main fuel ignition run, and postpurge cycles.

Control shall be nonrecycle type for maximum safety that shall shut down the burner and indicate, as a minimum, the following trip functions:

Pilot and main flame failure.

High- and low-fire proving switch faults.

Running interlocks open.

False flame signal and fuel valve open.

Control shall include a run/test switch to allow interruptions to sequence just after prepurge and during pilot ignition trial, and run cycles for adjustments to firing rate motor, damper linkages, and pilot flame for minimum turndown tests.

Combustion-Air Controls: Factory equipped with motor-operated combustion-air damper and blower control to regulate burner fire according to load demand.

Retain "Oxygen Trim Control" Subparagraph below for automatic control of burner and combustion air in response to oxygen set point.

Oxygen Trim Control:

Provide oxygen trim system to continuously monitor and display oxygen concentrations in boiler flue gas and adjust fuel and airflow to maintain an adjustable oxygen-level set point.

System shall compensate for changes in ambient temperature, barometric pressure, humidity, and variations in fuel characteristics.

Retain "Surface Blowdown Control" Subparagraph below for steam boilers with automated control of surface blowdown.

Surface Blowdown Control: Provide a conductivity sensor and control circuitry to operate an automatic control valve in surface blowdown piping to maintain total dissolved solids (TDS) within boiler manufacturer's prescribed level.

Retain first subparagraph below if boiler controls interface with building automation or DDC system.

[**Building Automation**] [**DDC**]System Interface: Factory install hardware and software to enable system to monitor, control, and display boiler status and alarms.

Retain "Hardwired I/O Points" Subparagraph below if interface with control system is through hardwired points and minimal interface is required. If extensive interface is required, delete subparagraph below and retain "Communication Interface" Subparagraph below, or retain both subparagraphs if requiring both hardwired and communication interface. Contact listed boiler manufacturers to verify interface requirements are available.

Hardwired I/O Points:

Monitoring: On/off status, [**common trouble alarm**] [**low-water-level alarm**] <**Insert monitoring points**>.

Control: On/off operation, [**hot-water-supply temperature set-point adjustment**] [**steam pressure adjustment**] <**Insert control points**>.

Retain "Communication Interface" Subparagraph below if extensive interface is required and is beyond that than can be provided by hardwired points. Coordinate communication protocol option selected with control system requirements. Contact listed boiler manufacturers to verify interface requirements are available.

Communication Interface: [**ASHRAE 135 (BACnet)**] [**(LonTalk)**] [**Modbus**] [**Industry-accepted, open-protocol**] <**Insert type of interface**> communication interface shall enable control system operator to remotely control on/off and capacity of boiler and monitor the boiler operation from an operator workstation. Control features are available, and monitoring points are displayed locally at boiler control panel through the interface.

Retain "Integrated Boiler Control System" Subparagraph below for an advanced level of boiler controls. Verify availability with listed boiler manufacturers.

Integrated Boiler Control System:

Integral control of burner management for flame safety, boiler modulation, and operator interface functions with features and functions indicated.

Factory preconfigured.

Utilizing solid-state controls and sensors to provide various control functions, including the following:

Automatic sequencing of the boiler through standby, prepurge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout, and postpurge.

Full modulating control of air and fuel through Proportional-Integral-Derivative (PID) algorithm.

Thermal shock protection.

High and low limit alarms and shutdowns.

Local operator interface through nominal [**10-inch**] <**Insert size**> color touch screen graphical display for setup, monitoring, and data acquisition.

Manual control of the boiler firing rate using control screens to increment or decrement firing rate.

Indication of burner management controller status and diagnostics.

Display of system alarms and faults.

Display of history of alarms and faults.

Display of recommendations for troubleshooting of fault conditions.

Display of water-level indication and alarm(s).

Stack flue-gas, combustion-air, and shell water-temperature indication.

Boiler efficiency calculation and display.

Low-fire hold with minimum temperature control.

Assured low-fire cutoff (ALFCO).

High stack temperature annunciation with auto cutoff.

Audible alarm and silencing through touch screen intervention.

Fully integrated control of the following:

Revise first six subparagraphs below to provide required features.

Blower operation and combustion-air damper for varying operating conditions.

Oxygen trim and monitoring to compensate for combustion-air variations.

Parallel positioning for independent fuel and air control for enhanced fuel efficiency.

Multiple boiler lead/lag control with hot standby.

Draft control for maintaining proper and consistent draft for enhanced fuel efficiency.

<**Insert additional features**>.

E-mail and paging feature to multiple contacts via Internet and phone line independent of control system interface.

LAN/WAN interface with remote monitoring software to allow remote monitoring independent of control system interface.

Control Enclosures:

NEMA 250, Type [**1**] <**Insert type**>.

Provide enclosure with integral vents, fans, heater, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.

Wiring shall be numbered and color-coded to match wiring diagram.[**Provide a laminated wiring diagram located inside enclosure.**]

Mounted on boiler assembly at a location convenient to operator.

Provide hinged full-size door with key lock. Provide common key for all locks.

Enclosure shall consist of multiple sections divided by a partition with a separate hinged door for each section. One section shall house low-voltage controls and other section shall house line voltage controls.

Enclosure shall house the following:

Control transformers with fuses.

Labeled terminal strips.

Controller(s) to provide control and alarm functions indicated.

Audible indication of safety alarms.

Face of enclosure shall provide the following:

Visual indication of operating components and alarms.

Auto/local capability to allow operator to manually operate boiler locally.

Audible alarm-silence capability.

Labels for switches, lights, and displays to provide clear indication of service.

Control Instrument Enclosures: Control instruments and devices that are mounted on the boiler assembly and cannot be installed inside the control enclosure shall have same or higher level of protection indicated for control enclosures.

Control Cable and Wire:

Control cable and wiring shall be numbered and color-coded to match wiring diagram.

Install cable and wiring located outside of enclosure(s) in a[**metal**] raceway. Use flexible conduit to make final terminations. Provide watertight installation for applications exposed to moisture.

* + - 1. ELECTRICAL POWER
         1. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

Enclosure: NEMA 250, Type [**1**] <**Insert type**>.

Enclosure shall have integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.

Mounted on boiler assembly at a location convenient to operator.

Enclosure shall have hinged full-size door with key lock with common key for all locks.

Wiring shall be numbered and color-coded to match wiring diagram.[**Provide a laminated wiring diagram located inside enclosure.**]

Install factory wiring outside of an enclosure in a [**metal**]raceway. Make final connections to motors using flexible conduit. Provide watertight installation for applications exposed to moisture.

Field power interface shall be to [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**]. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.

Provide branch power circuit to each motor and to controls[**with disconnect switch or circuit breaker**].

Provide each motor with NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

Retain subparagraph below for boiler-mounted receptacle. Verify availability with listed boiler manufacturers.

Provide transformer with fuses and power wiring to power a 20-A 120-V duplex receptacle mounted in each boiler control panel for use in connecting analytical and testing equipment.

* + - 1. VENTING KITS

Retain this article for finned water-tube boilers and if venting kit is a component of boiler. Coordinate with Section 235113.11 "Draft Control Fans," Section 235113.16 "Vent Dampers," Section 235116 "Fabricated Breechings and Accessories," Section 235123 "Gas Vents," and Section 235133 "Insulated Sectional Chimneys."

* + - * 1. Vent Damper: Motorized; UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless-steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.

Accessories in "Kit" and "Combustion-Air Intake" paragraphs below can be included with boiler or specified in Section 235116 "Fabricated Breechings and Accessories," Section 235123 "Gas Vents," and Section 235133 "Insulated Sectional Chimneys." Retain option in first paragraph if boiler efficiency exceeds 83 percent.

* + - * 1. Kit: Complete system, [**ASTM A959, Type 29-4C**]stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, and sealant.
        2. Combustion-Air Intake: Stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.
      1. CAPACITIES AND CHARACTERISTICS

If Project has more than one type or configuration of boiler, delete this article and schedule boilers on Drawings.

* + - * 1. Heating Medium: [**Hot water**] [**Steam**].

Retain "Design Pressure and Temperature Rating" Paragraph below for finned water-tube boilers.

* + - * 1. Design Pressure and Temperature Rating: [**160 psig, 250 deg F**] <**Insert values**>.

Retain one of two "Design Pressure Rating" paragraphs below for steel or flexible water-tube boilers. Retain first for hot-water boilers and second for steam boilers.

* + - * 1. Design Pressure Rating: [**60 psig**] [**100 psig**] [**140 psig**] [**160 psig**] <**Insert value**>.
        2. Design Pressure Rating: [**15 psig**] [**150 psig**] [**250 psig**] <**Insert value**>.
        3. Safety Relief Valve Setting: <**Insert psig**>.

Retain "Entering-Water Temperature," "Leaving-Water Temperature," "Design Water-Flow Rate," and "Design Pressure Drop" paragraphs below for hot-water boilers.

* + - * 1. Entering-Water Temperature: <**Insert deg F**>.
        2. Leaving-Water Temperature: <**Insert deg F**>.
        3. Design Water-Flow Rate: <**Insert gpm**>.
        4. Design Pressure Drop: <**Insert psig**>.

Retain "Steam Operating Pressure" and "Steam-Flow Rate" paragraphs below for steel or flexible water-tube steam boilers.

* + - * 1. Steam Operating Pressure: <**Insert psig**>.
        2. Steam-Flow Rate: <**Insert lb/h**>.

Retain "Minimum Efficiency AFUE," "Minimum Thermal Efficiency," "Minimum Combustion Efficiency," or "Fuel-to-(Steam) (Water) Efficiency" Paragraph below. Specify standing or intermittent pilot with minimum AFUE. Sustainable design systems require compliance with ASHRAE/IES 90.1 and may require efficiency in excess of minimum efficiency required by ASHRAE/IES 90.1.

* + - * 1. Minimum Efficiency AFUE: <**Insert number**> percent.
        2. Minimum Thermal Efficiency: <**Insert number**> percent.
        3. Minimum Combustion Efficiency: <**Insert number**> percent.
        4. Fuel-to-[**Steam**] [**Water**] Efficiency: <**Insert number**> percent.
        5. Number of Passes: [**One**] [**Two**] <**Insert number**>.

Retain "Gas Input" or "Gas Input Flow" Paragraph below for method of gas input rating.

* + - * 1. Gas Input: <**Insert MBh**>.

Consider actual Btu content of fuel source if retaining "Gas Input Flow" Paragraph below. Contact fuel supplier and boiler manufacturers to determine impact. Add text indicating Btu content of fuel if applicable.

* + - * 1. Gas Input Flow: <**Insert cfh**>.
        2. Gas Pressure: <**Insert psig**>.

Retain "Oil Input" or "Oil Input Flow" Paragraph below for method of oil input rating.

* + - * 1. Oil Input: <**Insert MBh**>.

Retain "Oil Input Flow" Paragraph below for oil-fired steel or flexible water-tube boilers. Consider actual Btu content of fuel source if retaining paragraph below. Contact fuel supplier and boiler manufacturers to determine impact. Add text indicating Btu content of fuel if applicable.

* + - * 1. Oil Input Flow: <**Insert gph**>.
        2. Output Capacity: <**Insert MBh**>.

Retain "Tankless Water Heater" Paragraph below for steel or flexible water-tube boilers and to require boilers to be equipped with tankless water heaters.

* + - * 1. Tankless Water Heater:

Design Water Flow: <**Insert gpm**>.

Design Pressure Drop: <**Insert psig**>.

Entering-Water Temperature: <**Insert deg F**>.

Leaving-Water Temperature: <**Insert deg F**>.

Consider impact of site altitude on fan and motor.

* + - * 1. Burner Blower:

Motor Horsepower: <**Insert number**> hp.

* + - * 1. Electrical Characteristics:

Volts: [**115**] [**208**] [**230**] [**460**] <**Insert number**> V.

Phase: [**Single**] [**Three**].

Hertz: [**50**] [**60**] <**Insert number**> Hz.

Full-Load Amperes: <**Insert number**> A.

Minimum Circuit Ampacity: <**Insert number**> A.

Maximum Overcurrent Protection: <**Insert number**> A.

* + - * 1. Sound (decibels, A weighted): <**Insert number**> dB.
      1. SOURCE QUALITY CONTROL

Factory tests are an additional-cost item.

* + - * 1. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

Retain "Burner and Hydrostatic Test" Paragraph below for factory-assembled boilers.

* + - * 1. Burner and Hydrostatic Test:

Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve performance requirements indicated.

Perform hydrostatic test of pressure vessel, piping, and trim of assembled boiler.

Retain "Witness Testing" Paragraph below if Director’s Representative wants to witness source quality-control testing.

* + - * 1. Witness Testing:

Allow Director’s Representative access to witness source quality-control testing of boilers.

Notify [**Architect**] [Director’s Representative] [**15**] <**Insert number**> days in advance of testing.

1. EXECUTION
   * + 1. EXAMINATION
          1. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and flue; piping; controls; and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections.

* + - * 1. Examine areas where boilers will be installed for suitable conditions.
        2. Proceed with installation only after unsatisfactory conditions have been corrected.
      1. BOILER INSTALLATION
         1. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
         2. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Retain one of two subparagraphs below to require vibration isolation and seismic-control devices. Retain first subparagraph for projects in seismic areas; retain second subparagraph for projects not in seismic areas. Indicate vibration isolation and seismic-control device type and minimum deflection in supported equipment schedule on Drawings.

Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

Retain first paragraph below for gas-fired boilers.

* + - * 1. Install gas-fired boilers according to NFPA 54.

Retain first paragraph below for oil-fired boilers.

* + - * 1. Install oil-fired boilers according to NFPA 31.

Retain first paragraph below if boiler is not factory assembled.

* + - * 1. Assemble boiler tubes in sequence and seal each tube joint.
        2. Assemble and install boiler trim, components, and accessories that are not factory installed.
        3. Install control and electrical devices furnished with boiler that are not factory mounted.
        4. Install control and power wiring to field-mounted control and electrical devices furnished with boiler that are not factory installed.
        5. Perform boil-out and cleaning procedures according to manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests.[**Boiler manufacturer's Company Field Advisor per OGS Spec Section 014216 shall witness boil-out and cleaning procedures.**] Following boil-out and cleaning procedures, boiler shall be washed and flushed until water leaving boiler is clear.
        6. Protect boiler fireside and waterside from corrosion.

Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.

After boiler is filled with water, and left not fired for more than [**10**] <**Insert number**> days, protect by wet storage method recommended by boiler manufacturer.

Chemical Treatment: Quality of water in boilers shall be maintained by a professional water-treatment organization that shall provide on-site supervision to maintain the required water quality during periods of boiler storage as well as during operating, standby, and test conditions. Refer to <**Insert applicable Section number and title**> for additional requirements.

* + - 1. PIPING CONNECTIONS

Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
        2. Where installing piping adjacent to boiler(s), allow space for service and maintenance.

Retain first paragraph below for boilers that use gas as a fuel source.

* + - * 1. Connect gas piping to boiler gas-train inlet with dirt leg, shutoff valve, and union or flange. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

Retain first paragraph below for boilers that use oil as a fuel source.

* + - * 1. Connect oil piping to oil-train connection with dirt leg, shutoff valve, and union. Piping shall be at least full size of oil-train connection. Provide a reducer if required. Provide drain valve with threaded plug at piping low point.

Retain first paragraph below for hot-water boilers.

* + - * 1. Connect hot-water piping to supply- and return-boiler connections with shutoff valve and union or flange at each connection.

Retain first paragraph below for steam boilers.

* + - * 1. Connect steam and condensate piping to supply-, return-, and blowdown-boiler connections with union or flange at each connection. Provide each connection with shutoff valve if shutoff valves are not factory furnished with boiler trim.[**Provide check valves in blowdown piping of each boiler that connects multiple boilers.**]

Retain first paragraph below for hot-water boilers

* + - * 1. Install piping from safety relief valves to nearest floor drain.

Retain first paragraph below for steam boilers.

* + - * 1. Install piping from safety valves and drip-pan elbows. Extend piping from safety valves and terminate to vent outdoors. Extend piping from drip-pan elbow drain to nearest floor drain.
        2. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
        3. Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

Provide a temperature-controlled nonpotable domestic cold water source to cool hot equipment drains to deliver a discharge temperature of <**Insert temperature**>.

Retain paragraph below for steam boilers requiring a direct connection to chemical-treatment system.

* + - * 1. Connect chemical-treatment piping to each boiler chemical-treatment connection with check valve and isolation valve.
      1. FLUE CONNECTIONS

Retain "Boiler Flue Venting" Paragraph below for finned water-tube boilers provided with venting kits.

* + - * 1. Boiler Flue Venting:

Install venting kit and combustion-air intake.

Connect full size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."

* + - * 1. Connect breeching to full size of boiler outlet. Comply with requirements in [**Section 235116 "Fabricated Breechings and Accessories"**] [**and**] [**Section 235133 "Insulated Sectional Chimneys"**] for venting materials.
        2. Install flue-gas recirculation duct from vent to burner if not factory furnished and installed. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for recirculation duct materials.
        3. Install easily accessible test ports for field testing of flue gas from each boiler.
      1. ELECTRICAL POWER CONNECTIONS
         1. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
         2. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
      2. CONTROLS CONNECTIONS
         1. Install control and electrical power wiring to field-mounted control devices.
         2. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system.

Retain paragraph below to connect boilers to DDC control system for remote monitoring and control.

* + - * 1. Connect control wiring between boiler control interface and [**DDC control system**] <**Insert system description**> for remote monitoring and control of boilers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC"**] <**Insert Section number and title**>.
      1. NETWORK AND PHONE CONNECTIONS

Retain this article if retaining e-mail, paging, and LAN/WAN features described in "Integrated Boiler Control System" Subparagraph in "Steel or Flexible Water-Tube Boilers" Article.

* + - * 1. Connect LAN/WAN network cable to boiler controls to provide connectivity for remote monitoring through integrated boiler control system.
        2. Connect phone system cable to boiler controls to provide connectivity for remote monitoring and alarm notification through integrated boiler control system.
      1. FIELD QUALITY CONTROL

Retain "Testing Agency," "Manufacturer's Field Service," and "Perform the following tests and inspections" paragraphs below to identify who shall perform tests and inspections. If retaining second option in "Testing Agency" Paragraph or if retaining "Manufacturer's Field Service" or "Perform the following tests and inspections" Paragraph, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article.

* + - * 1. Department of Labor Inspection: Arrange with NYS Department of Labor for Inspection of Boiler upon completion of installation.

Do not operate boilers until NYS Department of Labor inspection is made and a Certificate of Inspection is received.

Pay application and inspection fees required by NYS Department of Labor.

Preparation of boiler for inspection: Prepare boiler for internal inspection or hydrostatic pressure test on the date specified by the Department of Labor inspector.

Remove manhole and handhole plates, and washout plugs in the water column connection.

Remove grates of internally fire boilers.

Remove as directed by the NYS Department of Labor inspector, brick work and insulation.

Remove steam gage for testing if required by NYS Department of labor inspector.

Stop leaks of steam of hot water into the boiler being inspected from the other components.

Provide to the NYS Department of Labor inspector a competent person to be placed under the inspector’s supervision to disassemble, reassemble, test adjust, operate or forcible handling any part of the boiler.

* + - * 1. Provide framed glass holder for NYS Department of Labor Certificate of Inspection, and post near the boiler prior to operation of the boiler.
        2. Fasten two inch high metal identification numbers corresponding to number assigned by NYS Department of Labor Commissioner to a metal mounting plate and securely attach to the front of the boiler or front of boiler settings.

Retain "Manufacturer's Field Service" Paragraph below to require a factory-authorized service representative to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a Company Field Advisor per OGS Spec Section 014216 to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform the following tests and inspections" Paragraph below to require Contractor to perform tests and inspections.

* + - * 1. Perform the following tests and inspections[**with the assistance of a Company Field Advisor per OGS Spec Section 014216**]:

Perform installation and startup checks according to manufacturer's written instructions.

Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.

Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

Retain "Burner Test" Subparagraph below for field-assembled boilers.

Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.

Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and [**water temperature**] [**steam pressure**].

Set field-adjustable switches and circuit-breaker trip ranges as indicated.

See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

* + - * 1. Boiler will be considered defective if it does not pass tests and inspections.
        2. Prepare test and inspection reports.
        3. Occupancy Adjustments: When requested within [**12 months of date of Substantial Completion**] <**Insert time period**>, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] <**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

Retain "Performance Tests" Paragraph below if performance tests are required. Performance verification based on field tests is not typically required because of the associated cost. Consult Director’s Representative.

* + - * 1. Performance Tests:

Manufacturer's Field Service: Engage a Company Field Advisor per OGS Spec Section 014216 to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

Boilers shall comply with performance requirements indicated, as determined by field-performance tests. Adjust, modify, or replace equipment in order to comply.

Perform field-performance tests to determine the capacity and efficiency of the boilers.

For dual-fuel boilers, perform tests for each fuel.

Test for full capacity.

Test for boiler efficiency at [**low fire, 10, 20, 30, 40, 50, 60, 70, 80, 90, and high fire (100)**] <**Insert range**> percent of full capacity. Determine and document efficiency at each test point.

Test each safety valve. Record pressure at valve blowdown and reset. Test valve(s) with boiler operating at full capacity to ensure valve has capacity to prevent further rise in pressure.

Retain first subparagraph below if retaining "Oxygen Trim Control" Subparagraph in Part 2 "Steel or Flexible Water-Tube Boilers" Article.

For boilers equipped with automatic oxygen trim control, conduct tests with automatic oxygen trim control on manual at zero trim and record performance. Repeat tests with automatic oxygen trim control under automatic control and record performance.

Repeat tests until results comply with requirements indicated.

Provide measurement and analysis equipment required to determine performance.

Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.

Notify [**Architect**] [Director’s Representative] [**20**] <**Insert number**> days in advance of test dates.

Document test results in a report and submit with informational submittals.

* + - 1. DEMONSTRATION
         1. [**Engage a Company Field Advisor per OGS Spec Section 014216 to train**] [**Train**] Director’s Representative 's maintenance personnel to adjust, operate, and maintain boilers.[**Video training sessions and provide electronic copy of video to** Director’s Representative**.**]

END OF SECTION 235233