

**SECTION 23 52 39
FIRE-TUBE BOILERS**

PART 1 – GENERAL

1.01 REFERENCE STANDARDS

- A. ASME BPVC - Boiler and Pressure Vessel Code; 2023.
- B. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers; 2024.
- C. NFPA 54 - National Fuel Gas Code; 2024.
- D. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.
- E. UL 795 - Commercial-Industrial Gas Heating Equipment; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS:

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Specifications, apply to this section.
- B. Section includes horizontal, packaged, factory-assembled and tested fire-tube boilers, controls, trim, and accessories for generating steam.
 - 1. Related Sections:
 - a. Section 23 09 01: Natural Gas and Carbon-Monoxide Detection
 - b. Section 23 09 93: Sequences of Operations
 - c. Section 23 51 16: Fabricated Breechings and Accessories
 - d. Section 23 53 13: Surge Receiver Tank and Boiler Feed-water Pumps
 - e. Section 23 25 19: Water Treatment for Steam System Feed Water
 - f. Section 23 90 00 BAS General Requirements
- C. Drawings

1.03 SCOPE:

- A. This section covers the primary elements of the Boiler Plant that includes:
 - 1. Four (4) – 300 BHP Scotch Marine, Natural Gas Fired Low Pressure Steam Packaged Boilers with all ancillary elements as described in this section.
 - 2. A Packaged Boiler Plant Controls System
 - 3. Ancillary Components (Receiver/Surge Tank and Feedwater System, Blow-down Tank, valves, controls, etc. Covered under Section 235313).
- B. The contractor is to provide a fully integrated installation, such that, all of the Boiler Plant Systems elements (Boilers, Feed-Water Tank and Pumps, Combustion Air Fans and Intake FSD Dampers, Motor Actuated Flue Dampers, Boiler Isolation Valves, Level controls, Safety Devices, Controls and Instrumentation conduits and wiring, etc. shall operate as a single system.
- C. The Scope of supply elements cited herein shall take precedence in terms of the components to be installed and coordinated with the Piping and Instrumentation and Layout drawings.

1.04 SUBMITTALS:

- A. Product Data - Manufacturer's technical data shall be presented prior to start of fabrication in an organized and bound submittal and shall include the following:
 - 1. Boiler:
 - a. Product General Arrangement Drawing.
 - b. Rated capacities of selected models.
 - c. Product dimensions including required clearances.

- d. Unit weights (shipping and operating).
 - e. Customer Order Data Sheet confirming job site conditions and requirements.
 - f. Drawings showing the locations of all controls (LWCO, gauge glass etc.), normal water line.
 - g. Detail calculation of steam space and disengaging area.
 - h. Boilers rigging plan.
2. Boiler Controls, Trim, & Instrumentation:
 - a. Piping & Instrument Diagrams.
 - b. Instrument & Electrical symbols legends.
 - c. Drawing Index.
 - d. Bills of Materials listing manufacturer, models, and quantity of supplied components.
 - e. Control Panel Layout Drawings.
 - f. Panel Controls and Indicators Layout Drawing.
 - g. Ladder Diagram type wiring schematics.
 - h. Wiring schematic drawing index and symbols legend.
 - i. Complete list of Scope of Supply of all components.
 3. Accessories and Custom Components:
 - a. General arrangement or component drawing.
 - b. Component Data Sheet.
 - c. Panel layout drawing.
 - d. Power and Control Conduit and Wiring Diagram(s).
 4. Others (Items to be provided by Contractor):
 - a. Shop drawings of Boiler Room layout with all equipment drawn in AutoCAD program, provided on CD, in PDF format and two sets of prints at 1/4"=1'-0" Scale, Layout drawings shall be provided for each trade. Layout shall include the actual boiler supplied with tube pull spaces and other equipment supplied like Vacuum Condensate pump, condensate receiver, Feed water tank with feed water pumps, pull space, control panels, steam separator, header, breeching, chemical feed units, etc. It also shall show all piping layout, concrete pads, wall openings, electrical and power, plumbing, etc.
 - b. Upon completion of the contract work provide Composite As-built layout drawing in AutoCAD program on CD, and two sets of prints at 1/4"=1'-0" scale. As-built drawings shall show the actual installation with all the details including Mechanical, Electrical, Plumbing, Structural, Architectural, etc.
- B. Operating & Maintenance Instructions - O & M manuals shall be compiled in an organized and bound volume and submitted prior to commissioning of the equipment. The manuals shall include the following:
1. Pre-commissioning installation, checks, and adjustment instructions.
 2. Step by step commissioning instructions.
 3. Step by step unit normal start-up instructions.
 4. Step by step normal operating instructions.
 5. Step by step normal shutdown instructions.
 6. Step by step emergency shutdown instructions.
 7. Trouble shooting guide and instructions.
 8. Maintenance data for components and system.
 9. Preventative maintenance schedules or recommendations.
 10. Vendor data or "cut sheets" on major components.
 11. Boiler General Arrangement Drawing.
 12. Piping & Instrument Diagrams.
 13. Piping and Instrument symbols legend.
 14. Control panel layout drawing.
 15. Instrument & Electrical component bill of material.

16. Copy of ASME H-2.
17. Copy of CSD-1 data sheet.
18. Recommended spare or replacement parts lists.

C. Factory Test:

Submit a factory test fire report covering testing of the boiler with gas firing that will be used in the field. Test report is to include the following:

1. Data on fuel fired at minimum of 10%, 25%, 50%, 75%, and 100% of rated capacity:
 - a. Flue oxygen levels or percent excess air.
 - b. Flue carbon monoxide content expressed in PPMVD.
 - c. Flue Nox expressed in PPMVD corrected to 3% flue O₂ content.
 - d. Boiler steam pressure.
 - e. Flue outlet gas temperature (stack).
 - f. Fuel supply pressure.
 - g. Fuel regulated pressure.
 - h. Fuel manifold pressure.
 - i. Flame monitor signal strength on pilot.
 - j. Flame monitor signal strength on primary fuel(s).
 - k. Furnace pressure measured at the distal end of the furnace tube.
 - l. Combustion air static pressure profile.
 - m. Name, signature, and date of each tester certifying the accuracy of the results.
2. Testing shall comply with all NYC-DEP requirements including performance data, documentation submissions and sign-offs, etc.

1.05 QUALITY ASSURANCE:

A. Manufacturer's Qualifications:

1. Firms must be regularly engaged in the manufacture of Scotch Marine boilers of types and capacities required. The firm's products must have been in satisfactory use in similar service for not less than 10 years.
2. The firm must have a written Quality Control manual and program which is currently maintained and includes the following information:
 - a. Authority and Responsibility for content and implementation of the QC program.
 - b. Company organization and individual authority and responsibility for each phase of the QC program's operation.
 - c. Sales order entry requirements, documentation, and control.
 - d. Design criterion requirements, documentation, and control.
 - e. Drawing requirements, documentation, and control.
 - f. Calculation requirements, documentation, and control.
 - g. Fabrication specifications, requirements, documentation, and control.
 - h. Material procurement requirements, documentation, and control.
 - i. Material handling and storage requirements, documentation, and control.
 - j. In-process inspection and examination program.
 - k. Non-conformity identification and correction program.
 - l. Welding process and qualification control.
 - m. Non-destructive examination program.
 - n. Heat treatment requirements, documentation, and control.
 - o. Calibration program for test, measurement, and production equipment.
 - p. Record requirements and retention.
 - q. Third party inspection program.
3. The firm must establish individual qualifications for each person engaged in welding and establish and maintain the following:
 - a. Weld standards and procedures for each identified manufacturing process.

- b. Tests to qualify each individual for any weld process employed in their job responsibilities.
 - c. Accredited on-site welding instruction and testing facility to train and certify welding personnel.
- B. Certifications:
 - 1. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - a. The products and systems furnished are in strict compliance with the specifications.
 - b. The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
 - c. ASME certification.
 - d. UL and CSD-1 certification.
 - e. The equipment furnished has been installed in accordance with the manufacturer's installation instructions.
 - f. The specified factory tests have been satisfactorily performed.
 - g. The specified field tests have been satisfactorily performed.
 - 2. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
 - 3. Test Reports: Factory and field test reports as described above and as specified hereinafter, shall be submitted prior to final acceptance by the engineer.
 - 4. Contractor's Certification: Upon final installation of the boiler/burner assembly, the contractor shall certify the following:
 - a. The products and systems installed are in strict compliance with the specifications.
 - b. The specified field tests have been satisfactorily performed
- C. Codes and Standards:
 - 1. Boiler testing and rating will be in accordance with American Boiler Manufacturer's Association (ABMA) "Packaged Fire-tube Rating".
 - 2. Minimum steady-state efficiency of boilers will not be less than prescribed by ASHRAE 90A "Energy Conservation In New Building Design".
 - 3. Low pressure boiler construction will be in accordance with American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. Pressure vessels shall bear the appropriate ASME stamp.
 - 4. Electrical installations shall comply with National Fire Prevention Association (NFPA) Code- 70 "The National Electrical Code".
 - 5. Gas Fired-boiler installations shall be in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".
 - 6. Ancillary electrical components shall be Underwriters Laboratories (UL) listed and labeled.
 - 7. The complete boiler package is to be designed and fabricated per UL guidelines.
 - 8. Instrument and piping drawings and electrical drawings are to use symbology and protocol established and defined by the Instrument Society of America (ISA).
 - 9. The installation shall be in accordance with ASME CSD-1.
 - 10. The installation shall be in accordance with Factory Mutual (FM) requirements.
 - 11. The installation shall be in accordance with NYC Department of Environmental Protection and NYC Building Department.
- D. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with NYCHA and the Commissioning Agent (CxA). Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 017700 Closeout Procedures, for closeout details. Refer to Section 019113 Project Commissioning Requirements, for detailed commissioning requirements.

E.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Packaged boiler critical envelope dimensions shall be provided to allow review for clearances prior to transport or insertion into restricted spaces.
- B. Exposed electrical components that may be subject to transportation damage due to ambient exposure shall be wrapped and isolated with appropriate elastomer or weatherproofing material at the factory.
- C. Exposed physical utility connections (flanges, pipe ends, etc.) shall be isolated for transport from ambient influences with appropriate blinds, caps, or weatherproofing materials.
- D. Manufacturer shall provide lifting lugs at points of crane or lift attachment. Lifting load (weight) shall be provided by the manufacturer.
- E. Water shall be drained from all water storage areas, piping systems, valves, and components prior to shipment.

1.07 WARRANTY:

- A. The Boiler plant equipment and controls as specified in this section will be provided with a three (3) year warranty and materials and labor from time of formal acceptance by the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Available Manufacturers: Approved packaged firetube boiler manufacturers must be subject to and in compliance with this specification and other applicable contract requirements. Approved manufacturers are:
 - 1. Johnston Boiler Co.
 - 2. Burnham Boilers.
 - 3. Cleaver Brooks.
 - 4. Easco Boilers
- B. PACKAGED FIRETUBE BOILER
- C. Steam Boiler: The selected unit shall be a Scotch Marine factory packaged fire-tube steam boiler. The boiler pressure vessel, burner, fuel and combustion air delivery systems, burner management systems, electrical control, and feedwater systems shall be specifically engineered as a compatible packaged system. The boilers and accessories shall be factory mounted on a heavy steel base frame. Solid supports or saddles should be used to attach and provide placement of the pressure vessel with the frame and package. The boilers shall be factory assembled and tested. The packaged units shall be designed to be transported and installed with a minimum of field assembly required. The delivery of the boilers to the site shall be coordinated by the Contractor with the manufacturer.
- D. General Boiler Specifications: The boiler shall be designed to provide reliable and consistent performance to the following operating parameters:
 - 1. The boilers shall have a nominal rated capacity as per drawings.
 - 2. The boilers shall have a maximum output as per drawings at 212 degrees Fahrenheit.
 - 3. Boiler shall have a design pressure of 15 psig.
 - 4. Boiler and controls shall function at an operating pressure of 11 psig.
 - 5. Steam supply shall be at least 99.0% dry/saturated steam.
 - 6. Boilers shall have a rated input flow capacity of natural gas of 12,186 scf/hr each (maximum) and provide a minimum fuel to steam efficiency of 84.0 % when firing natural gas. (Efficiency shall be calculated as prescribed under "Heat Loss Efficiency" of the ASME Power Test Code PTC4.1).
 - 7. Pressure Vessel shall be constructed to ASME BPVC Section 4 "Heating Boilers" criteria.

8. Burner shall have a turndown ratio of 10:1 firing natural gas with 30 ppm max NOx emissions.
- E. General Boiler Design: The packaged fire tube boiler shall be designed with the following features to provide optimized efficiency and unit life:
1. Four pass heated gas contact configuration.
 2. Horizontal fire-tube orientation.
 3. The boiler shall be of the "water back" (wet back) or "dry back" design.
 4. The boiler shall have a minimum of five (5) square feet of heat transfer surface per rated boiler horsepower, measured on the fireside (ASME method calculation).
 5. The boiler package shall be complete with integral forced draft burner (with flue gas recirculation) manufactured in a manner highly compatible with the boiler.
 6. The boiler shall utilize the Prosser technique for mechanical tube to tube sheet connections.
 7. The boiler shall be designed with front and rear observation ports.

2.02 BOILER SPECIFICATIONS

- A. Boiler (pressure vessel): The boilers shall be a four pass water (wet) back Scotch Marine type listed and rated by the American Boiler Manufacturers Association, Fire tube Section. The boiler will be designed and built to comply with the latest ASME Code Rules for 15 lbs per square inch steam working pressure and be inspected and stamped by an authorized boiler inspector. Units shall carry packaged label of Under- writer's laboratory (UL) and be in accordance with ASME CSD-1.

The boiler design shall include the following:

1. The combustion chamber shall be fully submerged within the boiler water.
 2. The boilers shall have two separate rear tube sheets.
 3. The boilers shall have tubes attached by prossering, roller expanding, and beading.
 4. Connections for bottom blow-offs shall be supplied on both ends of the boiler shell.
 5. Openings for trimmings and external connections shall be flanged and/or threaded.
 6. A minimum of six (6) hand holes and one manhole for thorough inspection and cleaning shall be provided.
 7. The boiler shall be equipped with a steam baffle to ensure steam quality and prevent water carry over.
 8. Gas tight inspection doors shall be provided.
 9. Boilers must bear ASME Stamp and be inspected under National Board Rules.
 10. Basis of Design is a Four-Pass Wet-back boiler configuration.
- A. Front and Rear Flue Doors:
1. The boiler's front and rear flue doors shall be:
 - a. Hinged or davited for easy access and interference clearance.
 - b. Sealed with heat resistant gaskets.
 - c. Fastened with lugs or threaded studs with nuts and washers.
 - d. Designed so that front and rear tube sheets and all flues are accessible for inspection and cleaning when doors are open.
 - e. The doors shall be thermally insulated with ceramic fiber blanket insulation.
 2. Front and rear flue doors shall carry a full fifteen (15) year parts and labor warranty.
 3. Exhaust Gas Vent: Boilers shall have a flanged flue exhaust vent at the top front of the boiler. The vent is to include a 5" diameter stack thermometer and will be designed for convenient connection to flue or stack exhaust equipment.
 4. Insulation and Jacket: The boiler shall be factory insulated around its full circumference with 2" thick fibrous, non-asbestos containing insulation. The insulation shall be held in place by spacer pins welded to the shell and covered by a corrosion resistant galvan-neale sheet metal jacket not less than 18 gauge thick. The jacket will be assembled with

lock seam joints. Insulation shall also be provided on the boiler rear head. The jacket shall be designed and arranged to provide adequate support for personnel along the top centerline of the boiler to facilitate installation and inspection work.

5. Flue Gas Recirculation: Boilers shall have flue gas recirculation flue/piping (insulated) and a servo-controlled FGR damper to achieve 30 PPM NO_x when firing natural gas, corrected to 3% O₂.
6. Boiler Trim: The boiler shall include the following control and accessory equipment (trim):
 - a. Water Column complete with chain operated gauge glass set, red line gauge glass, and water column blowdown valve (with guard). Each boiler to be provided with a boiler feed-water (electric motor actuated) valve. This valve will be provided with inlet strainer, unions and isolation valves.
 - b. The Feedwater/ water column control will signal the boiler feed-water control valve to maintain proper water level.
 - c. Low Water Cutoff (LWCO) shall be an integral part of the water column. The LWCO shall be factory installed and wired into burner control circuits to prevent burner operation if water level falls below safe operating limits.
 - d. Auxiliary Low Water Cutoff will be a second float type, installed to activate below the primary low water cut-off. Control shall be either a manual reset type or wired into non-recycle limits of the flame safeguard control.
 - e. A low-low level switch shall disengage the feedwater pumps if energized.
 - f. Steam Pressure Gauge: Steam pressure gauge shall be located on the front end of the boiler. The gauge installation shall include siphon, shut-off cock and test connection. Gauge range shall suit the specified design pressure.
 - g. Steam Safety Valves shall be provided in types, sizes and quantities to comply with ASME Code requirements, and as shown on contract drawings.
 - h. Steam Pressure Controls will be provided to regulate the burner operation and boiler output and safety. The following controls will be mounted near the water column:
 - 1) One pressure to electrical transducer to provide process control for modulation of burner firing rate.
 - 2) One primary operating pressure switch to sense boiler high steam pressure. The switch will be wired into the burner management system to turn the boiler off in the event steam pressure reaches the set pressure. The switch will be part of the boiler au- to recycling limit circuit.
 - 3) One high limit pressure switch, with set point above the primary operating pressure set point and below the boiler design pressure, will be provided. Activation of the switch shall turn boiler off in the event pressure reaches the set pressure. The switch may be manual reset type or wired into the burner safeguard non-recycle circuit.
 - 4) A Steam Pressure Indicating Sensor will be mounted on the Boiler Steam Header to assist in Sequencing the Boilers.
 - 5) Data Reports: The Manufacturer shall supply two copies of data reports, ASME form H-2.

2.03 GAS BURNER

A. Manufacturers:

- a. Johnston Boiler
2. S.T. Johnston
3. Cleaver Brooks
4. Power Flame

B. Burner:

1. The burner shall be an industrial quality burner that includes Flue Gas Recirculation for 30 ppm No_x while firing natural gas and the burner shall have a 10 to 1 turn-down capacity capability.

- a. The burner shall be mounted on front of the boiler and shall be of the flame retention ring type complete with integrally mounted combustion air blower and designed for operation with natural gas.
2. Standards and Certifications:
 - a. The burner system shall be designed, built, and tested to guidelines established by UL 795 (gas).
 - b. The burner shall meet the requirements of FM insurance codes.
 - c. The burner shall meet the requirements of ASME CSD-1
3. Construction:
 - a. The burner shall be supplied with an integral packaged combustion air blower.
 - b. Burner housing will be rigid and robustly designed with wall thickness of not less than 1/4".
 - c. Burner shall be self-supporting for transportation and operation.
 - d. Burner internals shall be readily accessible for adjustment or replacement by utilization of a hinged assembly.
 - e. A burner mounted observation port with optical lens shall be provided.
 - f. Burner components shall include stainless steel alloy diffuser assemblies.
 - g. External adjustment of burner primary and secondary air will be provided to optimize performance.
 - h. Air flow dampers shall be driven via servo motor to a closed position with minimal leakage to ensure minimum heat loss through the boiler during boiler shutdown periods.
 - i. Accessories and Components: The gas burner shall include the following accessories and component:
 - j. Gas Train shall have a single point connection between the pilot and burner gas train(s) shall (each) have a pilot-type gas pressure regulator.
 - k. Differential air pressure switch for proof of air flow.
 - l. Gas Pilot of the fuel/air premix type with automatic electric ignition. The unit will be complete with an electronic detector to monitor pilot so that the primary fuel valve cannot open until the pilot flame has been established.
 - m. Pilot train is to include (pre-piped and factory installed/wired):
 - 1) Two (2) gas safety shutoff solenoid valves.
 - 2) Pilot gas pressure regulator.
 - 3) Pilot gas manual shut off valve.
 - 4) Normally open solenoid operated vent valve
 - 5) Pilot gas pressure gauge.
4. Burner Gas Piping: The gas delivery system shall be delivered completely assembled and installed/wired with the packaged boiler. The gas train will be a "vent-less" type as manufactured by Siemens or equal. The gas piping system shall be designed to deliver the required fuel flow rates and pressures to the burner with the supply gas composition and characteristics defined in the packaged boiler schedule. The gas pipe train shall include as a minimum the following:
 - a. Burner main gas manual shut off valve.
 - b. Servo operated gas flow control valve.
 - c. Gas safety shutoff valves. The dual valve body shall be Siemens VGD series, size as indicated on the boiler schedule. First shutoff valve shall be operated by a Siemens SKP15 actuator with proof of closure switch. Second shutoff valve shall be operated by a Siemens SKP25 actuator with integral regulator and proof of closure switch.
 - d. One manual dual lubricated plug cock valve.
 - e. Plugged leakage test cocks
 - f. High and low gas pressure switches
 - g. Valve leak test gas pressure switches
 - h. Incoming gas pressure gauge
 - i. Manifold gas pressure gauge

- j. Gas pressure transmitter.
- k. Digital gas flow meter.

2.04 BURNER CONTROLS

A. General Requirements:

1. The burner controls shall include two functions, the Flame Safeguard System (FSS), and the Combustion Control System (CCS). The CCS shall be a linkage-less parallel positioning combustion control system with oxygen trim and a variable speed drive (VSD) control. The system shall provide continuous process control of steam pressure, combustion air and fuel & flue gas flows. The system shall be fully integrated to the burner management system to provide fully automatic, safe and reliable startup and shutdown. To assure system integrity, a pre-wired and factory-tested, microprocessor- based, multiple control loop combustion system shall be provided to implement boiler control functions. The system shall be manufactured and tested according to UL 508 requirements. The flame safeguard system (FSS) shall be performed in a separate processor from that performing the combustion control and other boiler control functions.
2. Controller equipment requirements:
 - a. Controller shall be designed for sub-plate mounting inside a control enclosure. Wiring connections are to be made by plug-in terminal blocks for ease of wiring.
 - b. Modbus/Ethernet/web-based remote monitoring shall be available.
 - c. Minimum number of Servo Outputs: 8
 - d. Minimum number of F(x) Curves to be provided: 6
 - e. Minimum number of points per F(x) Curve to be provided: 15
 - f. Controller shall be commissioned by parameter set-up. No function block or block-ware programming shall be required.
 - g. Inputs. No special or proprietary sensors shall be required
3. Operator Interface: The optional OIT's display shall measure 10" and utilize Thin Film Transistor (TFT) with 256 Colors and 640 x 480 pixel LCD resolution. The OIT shall be suitable for panel mounting. The OIT operating front face plate shall be rated NEMA 4X/IP66, and shall have an aluminum construction. Plastic type cases shall not be acceptable.
4. Manufacturer: Provide Model BMU-1ZNO-Z1121 Burnermate Universal Controller manufactured by Preferred Instruments.

B. Flame Safeguard System (FSS)

1. Integral with the combustion system controller shall be a Burner Management System (Change)/ Flame Safeguard System (FSG). The system shall be designed to ensure the safe start-up, on-line operation and shutdown of fuel firing equipment. Burner management system components shall be located in the combustion control cabinet and shall be fully integrated for automatic sequencing of light off and shutdown. Numbered terminal strips shall also be provided to permit termination of all field wiring.
2. An industrial duty microprocessor-based FSG shall monitor safety interlocks, servo position, and flame status. The controller shall sequence the burner through purge, light-off, run, and shutdown, and post-purge. Additional FSG functions shall include as a minimum:
 - a. All recycle and shutdown interlocks will be wired to separate, parallel 120 VAC inputs.
 - b. The controller shall supply both 120 VAC and 24 VDC power for flame scanner(s). If dual flame scanners are used, they shall be wired into separate digital inputs for flame proving, and separate analog inputs for flame signal strength indication. By configuration, the user shall select whether the flame scanner inputs are monitored in "parallel" or "series".

- c. Assured low fire cutout shall be provided to drive the burner firing rate to low fire before shutting down the burner.
- d. Flue gas temperature shall be input to the controller and monitored to alarm or trip the burner in the event the boiler is dry-fired and the low water cutouts malfunction.
- e. Adjustable time delays shall be provided for the low fuel pressure, low atomizing flow, and low draft cutout interlocks to reduce nuisance shutdowns due to transient conditions.
- f. The controller shall accommodate automatic gas valve leak detection.
- g. A minimum of five user-configurable auxiliary relays shall be provided for alarm, or to start auxiliary fans, booster pumps, etc.
- h. The controller will alarm and/or shut down the burner when a user-configurable low stack oxygen set-point is reached.
- i. Individual annunciation shall be provided for up to six recycle limits and thirty- three non-recycle (shutdown) limits.
- j. The controller shall provide time/date stamp of individual servo positions, and the status of all controlled functions for up to the last eight boiler shutdowns.
- k. Flame safeguard system shall include Modbus RS-485 communications. A common dry alarm contact output shall be supplied for the building management system for any fault or alarm condition related to the flame safeguard system.
- l. The burners shall disengage if excessive CO or Gas is detected in the boiler room.

C. Combustion Control System (CCS)

- 1) The combustion control system shall position up to eight independent servo actuators for fuel valves, and combustion air, or FGR control, as required. In addition up to two separate 4-20 mA analog outputs shall be provided for VSD operation.
 - (a) PID combustion controls shall be designed to safely maintain the desired process variable (main steam header pressure, water or thermal fluid exit temperature) at the operator-selected value. A parallel positioning combustion control logic scheme with oxygen trim and VFD control shall be used. Demand from the boiler master shall serve as a demand for both fuel and air control devices with "position cross-limiting" features being implemented to insure that a safe fuel-air ratio is maintained.
 - (b) One servo actuator shall be applied to the gas control valve while separate actuator(s) shall position the air control damper(s). Each actuator shall be equipped with an integral position re-transmitter. Fuel-air ratio shall be established and adjusted by use of a "soft" function curve of fuel valve position vs. air damper position.
 - (c) The fuel flow controller shall be "position cross-limited" with the air flow controller so that fuel demand cannot be increased until an air damper position increase is proven by the air damper position feedback signal. Additionally, air demand cannot be decreased until a fuel flow valve position decrease is proven by the fuel flow position feedback signal.
 - (d) The controller shall automatically detect a failed or malfunctioning servo actuator. During purge, all servo actuators shall be driven to their minimum and maximum positions. If the feedback signal from any positioner is out of range, the burner will go into lockout to prevent firing under dangerous conditions.
 - (e) The in-situ oxygen analyzer shall measure the oxygen concentration in the flue gas and trim the air/fuel ratio to follow the oxygen vs. load curve input during unit commissioning. Oxygen trim can be turned off when the firing rate drops below a user-defined firing rate. In addition, the controller shall provide a user- defined lag time during which the oxygen trim function is

nullified for a set amount of time after light-off to allow the burner to warm-up and stabilize.

- (f) Provide microprocessor-based flue gas recirculation (FGR) control for each burner. FGR flow rate shall be controlled in response to boiler load for forced type FGR systems. The controller shall have a characterizable set-point curve for damper or variable speed fan output signal.
- (g) Cold FGR low fire cutback shall be provided when FGR control is required. This ensures the FGR is heated to steady-state temperature before the burner is re-leased for automatic operation.
- (h) Whenever a curve point is changed by the technician, the controller shall require the burner to be run at that load to verify combustion at that point before the controller can be put in automatic mode.
- (i) The controller shall include software-enabled high and low firing rate limits in the event the technician needs to limit the upper or lower end of the firing rate in automatic operation.
- (j) The fuel controller shall be configured to provide for control of the gas control valve, depending on the fuel selected.
- (k) The combustion controller shall contain independent variable and full speed fan setup curves for each fuel. In the event of a Variable Speed Drive (VSD) failure, the burner shall trip, the operator shall be able to transfer the VSD bypass transfer switch and restart the equipment. Separate servo actuator curves shall be supported for VSD bypass mode.
- (l) "Off-curve" points shall be provided to allow the technician to determine the servo positions during standby, ignition, and purge modes.
- (m) All external or auxiliary power supplies necessary for electronic transmitters (or final control element) shall be included.
- (n) The control shall include a field selectable draft control. The commissioning engineer shall be able to select simple Draft Control, or PID Draft Control with firing rate feed forward. The controller outputs shall be field selectable as Servo damper, 4-20 damper, VSD Draft Fan or combined damper and VSD Open Damper. The (10 ga. Carbon steel) dual opposed-bladed combustion air draft damper (with 24 v. electric rotary actuator) starting position shall be open or an adjustable starting position (via a 4-20 mA DC transmitter and shaft position sensor).

D. Boiler Control Functions:

- 1. Provide boiler plant heating controls (e.g., boiler controllers, sequencers, meters) that utilize open BACnet and Modbus protocols. Plant energy flow meters, feed water meters, makeup water meters, and potable supply to domestic hot water heaters shall be installed to facilitate remote plant energy monitoring.
- 2. Under a separate project, the central plant shall be equipped with a BACnet supervisory building controller (Tridium JACE 8000 or equivalent) to collect data from boiler master controller and other boiler room equipment and measurement points. The supervisory building controller shall interface to existing Niagara N4 front end software and utilize NYCHA standard graphics templates and naming standards. A list of controls and measurement points will be provided upon contract award. Information as needed referencing these controls requirements will be added to the design drawings and associated notes.
- 3. Remote Boiler Operation. Call for heat (burner on signal) may be generated locally by an operating limit switch, or remotely by digital input or Ethernet communication. In addition, the controller shall allow either the boiler firing rate or steam pressure set-point to be determined remotely by either hard-wired inputs or Modbus communication. Boiler(s) shall be capable of being enabled, disabled and receive Alarm signals from the existing BAS. Boilers settings shall not be reset remotely.
- 4. Warm Standby. To respond rapidly to a call for heat, the controller shall cycle the burner in response to an external shell temperature, drum temperature, or steam pressure signal.

Start and stop set-points shall be user-defined. Controller shall include low fire hold, and cold start warm up ramping.

5. Low Fire Hold. To prevent thermal shock to the boiler, the controller shall be capable of holding the burner at low fire after a cold boiler start. The boiler shall be released to modulate after a user-defined time delay, or when the boiler warm-up signal (shell temperature, drum temperature, or steam pressure) set-point is reached.
 6. Cold Start Set-point Ramp. When enabled, the boiler will be warmed up using a user-defined set-point ramp. Step increments and duration shall be selectable by the boiler operator.
 7. Break glass Switches: Furnish and install two (2) break glass switches, one (1) at each boiler room entrance/exit. Cover and hammer shall be constructed of solid brass. A glass window in the cover shall maintain the switch in the closed position. The hammer shall be securely attached to the box with a chain. Switching mechanism shall be the single pole double throw type, connected so as to open when the glass is broken.
 8. Provide control wiring for the (room exterior) gas shutoff switch(es) and have them wired to cut out the burners per NYC Fuel Gas Code requirements.
 9. Each boiler is to have a dedicated control panel to control the functions of the boiler including water level control, engaging boiler-feedwater pumps, receive boiler trim monitoring points, etc.
- E. Burner control panel
1. Factory mounted and wired control panels shall be provided (unless otherwise shown on plans). Wires shall be oil, heat and moisture resistant. Motor starter circuits shall be protected with thermal-magnetic circuit breakers. Electrical connectors to control panels shall be made to terminal blocks. Neutral connections to control devices shall be made to a common unbroken neutral conductor. Control panel enclosure shall be NEMA 12. Control voltage shall be 120 volts from an integral control circuit transformer. The control panel shall include the following devices.
 - a. Burner Management/Combustion Controller as detailed above with 10" color touch screen and keypad/LCD display unit
 - b. Switches: On/off, Manual/Auto.
 - c. Pilots: Flame Fail, Power on, Low Water, Gas Valve Open
 - d. Motor Starters: Blower motor
 - e. Operator Interface for BMS System
 - f. Branch circuit protection with circuit breakers
 - g. Control Circuit Transformer (24V.)
- F. FD Fan Variable Speed Drive (VSD)
1. Provide a Pulse Width Modulation (PWM) type VFD suitable for microprocessor-based digital control.
 - a. The VSD shall be provided with a fused disconnect switch.
 - b. The VSD shall accomplish step-less speed control by adjusting both the output voltage and frequency to the motor.
 - c. The VSD shall utilize IGBT power semiconductor technology in the inverter section.
 - d. VSDs must be UL listed. Provide a NEMA 12 enclosure for the VSD to protect it from dust and splashed water. VSD shall be sized for 104° F continuous ambient air temperature conditions. The enclosure shall be completely self-ventilating with powered fans as required.
 - e. The VSD shall automatically limit the rate of fan speed increase to that which will prevent an over-current or over-voltage trip in the event of a "STEP" speed increase of 0 to 100 %.
 - f. The VSD shall include a line reactor or DC Link Choke to reduce rectifier peak currents, and reduce total harmonic distortion (THD).
 - g. In order to extend motor insulation life, the VSD shall limit peak voltages. The "dv/dt" shall be limited to 900V/microseconds on a [500] foot cable length between the VSD

and motor. VSD's that do not include internal dv/dt limiting shall be provided with external filters.

- h. The VSD shall control the speed of the forced draft fan. The VSD shall be Danfoss Model FC-102-ACS, ABB, Allen Bradley, Emerson or Schneider Electric.

G. Boiler Instrumentation

1. Provide a draft range transmitter and high pressure (low draft) switch with time delay relay.
 - a. Both shall be supplied with field mountable, dust-tight, splash-proof
 - b. A single draft connection shall be piped to -1"wc to +1"wc 4-20 mA dc transmitter and an independent low draft switch.
 - c. The low draft switch set point shall be field adjustable from +0.15"wc to +4.0"wc.
 - d. The low draft switch shall be mounted and wired to a pilot light so as to illuminate when the low draft switch activates and to a 5 second time delay relay so as to provide an isolated "Low Draft Cut-Out", 10 ampere contact for use in the Flame Safeguard Limit Circuit. The time delay feature helps avoid nuisance burner shutdowns due to momentary draft fluctuations.
2. Provide manufacturer's standard damper and a servo draft damper actuator for each boiler flue:
 - a. The actuator shall have adequate power to automatically position the damper and shall be suitable for control by the draft controller.
 - b. The actuator shall be totally enclosed in a dust-tight housing; have integral, snap-action, travel limit and open proving switches, be capable of being stopped, started, or instantly reversed without loss of power or overloading. A double ended output shaft shall have an integral brake for precise positioning without back-lash and rotate 90° in 30 seconds.
3. Provide a stack temperature alarm and shutdown circuit for each boiler.
 - a. Stack temperature shall be digitally displayed and setpoints shall be provided for "inefficient" and "dangerous" alarm conditions.
 - b. Inefficient alarm setpoints will sound a local alarm requiring acknowledgement to silence.
 - c. Dangerous stack temperature conditions will shut the boiler down and require a manual reset.
4. Provide a boiler breeching mounted in-situ, zirconium oxide Oxygen analyzer for each boiler.
 - a. Extractive or "Wet Cell" type Oxygen analyzers are not acceptable.
 - b. The probe shall be of a suitable length for sensing the Oxygen level in the middle of the breeching.
 - c. All wetted parts shall be stainless steel.
 - d. The Oxygen analyzer shall include a digital controller that performs continuous self-diagnostics with diagnostic codes for at least 10 common faults.
 - e. The system shall automatically send the trim actuator to the "null" position and trigger the alarm dry contacts in the event of an Oxygen analyzer fault.
 - f. The detector shall be field replaceable without removing the probe from the stack and shall not require special tools.
 - g. The analyzer shall automatically perform periodic detector cell impedance tests to be used by the operator as an indication of calibration shift.
 - h. Analyzer calibration shall be pushbutton semi-automatic (no trim pots) with English language prompts and diagnostic messages.
 - i. Analyzer output shall be field selectable as 0-10% or 0-21% without field re-calibration.
 - j. Analyzer shall be Preferred Instruments, Danbury, CT, Model ZP.

2.05 WARRANTY:

- A. Complete burner - boiler plant and controls package as specified in this section to have a warranty on all materials and components supplied for five (5) years from date of initial commissioning including material and labor. Manufacturer will submit detailed provisions of warranties as part of submittal packages.
- B. Boiler tube sheets and rear submerged combustion chamber to carry a fifteen (15) year parts and labor warranty.
- C. Front and rear flue doors to carry a fifteen (15) year parts and labor warranty.

2.06 PACKAGED BOILER COMMISSIONING:

- A. The contractor will ensure that all utilities, connections, piping, electrical, and other associated equipment and tie-ins are completed, serviceable, and ready for boiler operation.
- B. The boiler manufacturer will make available the services of a factory authorized service engineer for the boiler start-up.
- C. A comprehensive start-up report shall be completed and provided to the job site and other parties.
- D. Factory authorized training for operators, maintenance, and others shall be performed at the time of commissioning.
- E. Reference Section 230996 for additional Central Boiler Plant Commissioning requirements.

2.07 BOILER MASTER SEQUENCING (CONTROL) PANEL (MSP) AND LEAD/LAG CONTROL

- A. Supply a fully integrated boiler control system to coordinate the operation of (six (6) boilers) fully modulating steam boilers in order to maintain Steam Header Pressure at setpoint. The control system shall be microprocessor-based and suitable for wall mounting. MSP shall be free – standing nearby the boilers in the space.
- B. The control system shall provide a PID based Boiler Modulation control scheme. Modulation shall be field selectable as either “Unison” (all at the same firing rate) or as “Series”. Series modulation shall include “Base Load Auto-Shift” logic in order to minimize boiler on/off cycling. When the lead boiler’s firing rate approaches high fire, the lag boiler(s) will automatically modulate up from the base load firing rate to “help” the lead boiler without starting another lag boiler. If the lead boiler approaches low fire, the lag boilers will modulate toward low fire to “help” the lead boiler and prevent a short cycle of a lag boiler. When the lead boiler leaves the high or low fire position the lag boiler(s) resume firing at the normal base load for peak efficiency. If the load increase or decrease is long term, a lag boiler shall be cycled on or off as required. Modulation signals shall be 4-20 mA dc and shall be electrically isolated channel-channel and channel-ground.
- C. The operator may set the Steam Header Pressure Setpoint via a front panel display.
- D. The control system shall utilize both Steam Header Pressure and Boiler Firing Rate percent to start and stop the boilers and minimize the total number of boilers in operation. The controller shall start and stop boilers when the Steam Header Pressure is outside an adjustable pressure limit band for longer than an adjustable short time delay. To anticipate and minimize header pressure deviations, the control system shall start or stop the next boiler if the “lead” boiler has been near high or low fire for longer than the adjustable time delay. The control system shall monitor each boiler’s lockout and limit circuits and shall rapidly and automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. The lead boiler shall either automatically rotate every seven (7) days or shall be manually selected by the operator. Provide a warm standby boiler shell aquastat input for each boiler. If recommended by the boiler manufacturer, each off-line boiler shall be started and held at low fire when the temperature drops. When called to run, the boiler shall hold at low fire until the temperature rises above the warm standby setting. Provide an aquastat release to modulate

over-ride timer to prevent a protracted low fire hold. The Control System shall reduce the firing rate to a minimum before stopping a boiler to prevent accumulation of fuel in the furnace.

- E. The control system shall include a 16 line x 40 character (or greater) LCD display for boiler sequence control and status, alarm and event summaries, and setup menus for easy operation, tuning and troubleshooting. Alarms, events and operator actions shall be logged with Time/Date stamp and English language description. The Control System shall include a minimum of 200 point memory.
- F. The Control System shall include a minimum 100x150 pixel historical trending display and paperless chart recorder to permit logging of at least 32 data points for at least 45 days. Provide a minimum of 4 "pens" per chart with 8 minute thru 24 hour chart "width" selections available.
- G. Include hard wired backup stations to permit manual operation of the plant should the control system require service. Manual operation must be possible when the microprocessor is not functioning. Hard wired "Hand-Off-Auto" control switches must be wired directly into every boiler Start/Stop circuit. Each 4-20 mA modulating control output must include a hard wired manual backup station with Auto/Manual switch, output control knob and output level indicator (bar graph, analog meter or digital display).
- H. The Control System shall include simultaneous communication to a Data Acquisition System (DAS), Building Automation System (BAS) via RS485 Modbus or Bacnet protocol and to a Personal Computer and an alphanumeric pager via standard telephone lines. The individual boiler limits, lockout, start/stop, warm standby, and firing rate status shall be readable. Header setpoint, plant firing rate, boiler quantity called to start, boiler selected as lead and all setup parameters shall be readable and writable.
- I. The control system shall be manufactured and labeled in accordance with UL 508 requirements. Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL). It shall be approved for use in NYC by Department of Building, Bureau of Electrical Control and Department of Air Resources. The control system shall be a Preferred Instruments, Danbury, CT, Model PWC-ACS- 1121 or equal.

2.08 BOILER ALARM SYSTEM

CONTRACTOR SHALL PROVIDE A LOCAL BOILER ROOM ALARM SYSTEM AND CONNECT TO NYCHA INTRA-NET FOR THE REMOTE MONITORING OF FLOOD ALARM, POWER FAILURE ALARM AND LOW STEAM PRESSURE ALARM. CONTRACTOR MUST ENGAGE A CHAS SYSTEM SPECIALIST FOR THE INSTALLATION OF THE ALARM SYSTEM.

- A. ALARM COMMUNICATION PANEL
 1. Provide, install and program a new RE2104/w new enclosure, by Intech21.
 2. Provide a dedicated 110VAC/15A circuit for the RE2104 alarm panel.
 3. Provide testing and certification of communication wiring to ensure reliable communications to CHAS application.
 4. Provide and connect CHAS alarm sensor pressure sensor (pressurtrol) or aquastat electrical supply monitoring sensor relay and flood sensor. Alarm sensor points must be wired to new communication panel for remote alarm point monitoring.
 5. Remove all existing computer, RE2104 and wiring during removal of equipment. Reinstall and reconnect all existing wiring and cables as required to complete the CHAS system.
 6. Purchase/ install new server by Intech21
- B. Local Server Requirements for Hybrid Sites and Storm Damaged Sites
 1. Processor: Quad-core Core Intel Xeon E3, 3.10 GHz, 8 MB Cache 1.33 GHz FSB.
 2. Memory: 16 GB UDDR2 1333 MHz
 3. Operation System: Windows Server 2008 SP2
 4. Primary Hard Drive: 1TB 7.2K RPM SATA 3Gbps 3.5 Cable Hard Drive
 5. Secondary hard Drive: 1TB 7.2K RPM SATA 3Gbps 3.5 Cable Hard Drive

6. Network adapter: Intel Pro 1GbE Dual Port NIC
7. HD Controller: Onboard SATA, 1-4 Hard Drives connected to onboard SATA Controller- No RAID
8. Database: SQL Server 2008 R2 SP1 Express Edition
9. ASP.NET: .NET Framework version 4.5
10. Additional Software: Intech BMS CHAS Local Server Edition
11. Network adapter: 1GbE 2 port NIC
12. Input / Output: keyboard and Optical Mouse
13. Optical Media: DVD- Rom
14. Monitor: Two 17" LCD Monitors

PART 3 - EXECUTION

3.01 EXAMINATION

- A. 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.
 1. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections.
- B. Examine areas where boilers will be installed for suitable conditions.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER PLANT INSTALLATION

- A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Equipment Mounting: Install boilers on cast-in-place concrete equipment base(s).
- C. Install gas-fired boilers according to NFPA 54.
- D. Electrical/ Controls System Elements.
 1. It is the responsibility of this division to provide all low voltage control wiring and conduit for the entire boiler plant.
 2. The Mechanical Contractor shall obtain the services of an electrical contractor to furnish and install these elements per the Boiler Manufacturer's Certified Shop Drawings.
 3. This scope shall include all of the control wiring between the Receiver Tank/feedwater system, The Four (4) Boilers (Control panels sensors, devices, etc.), Master Sequencing Panel, actuated dampers and valves, etc.
- E. Assemble and install boiler trim, components, and accessories that are not factory in- stalled.
- F. Install control and electrical devices furnished with boiler that are not factory mounted.
- G. Install control and power wiring to field-mounted control and electrical devices furnished with boiler that are not factory installed.
- H. Perform boil-out and cleaning procedures according to manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests. Following boil-out and cleaning procedures, boiler shall be washed and flushed until water leaving boiler is clear. (see section 3.3)
- I. Protect boiler fireside and waterside from corrosion.
 1. Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.
 2. After boiler is filled with water, and left not fired for more than 10 days, protect by wet storage method recommended by boiler manufacturer.
 3. 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 re-

quired water quality during periods of boiler storage as well as during operating, standby, and test conditions. Refer to chemical treatment sections for additional requirements.

- J. Install the Manufacturer furnished Flue gas recirculation pipe/duct for each boiler and control dampers per the manufacturer's instructions.

3.03 BOILER STARTUP PROCEDURE

A. Factory Inspection:

- 1. During fabrication of the boilers at the factory, upon completion of the internals and the pressure vessel boundaries of the boilers, the insurance carrier's inspector must be notified to inspect the boilers in the factory. This inspection must be performed prior to performance testing of the boilers at the factory. A three-week advanced notice to NYCHA is required to inform the inspector.

B. Factory Performance Test:

- 1. The factory performance test will take place after the manufacturer has installed the burner, all safety and operating controllers and tested it on all required fuels to within acceptable levels, and submitted the factory test sheets for approval by NYCHA.
- 2. Water treatment: Acceptable treated water must be used for the pressure (hydro) and performance tests. The manufacturer shall provide their water treatment program and the latest water treatment analysis five days prior to the performance test for review and approval by NYCHA.
- 3. Hydrostatic test: The hydrostatic test shall be performed per manufacture testing procedure. The test report and certification shall be provided to the consultant and NYCHA for their record.
- 4. Performance test for Steam Boilers: The input/output method as per ASME PTC4.1 test procedure (simplified as approved by the engineer) is be performed to determine boiler fuel to steam efficiency and evaporation ratio. In addition to input/output performance test, a calibrated combustion analyzer must be utilized by the manufacture to measure the combustion efficiency at 25%, 50%, 75%, and 100% firing rate. All testing devices and components must be calibrated and the calibration report must be provided to NYCHA at the time of testing. In addition to efficiency test, the boiler steam quality must be measured as a part of performance testing of the boilers. Calibrated calorimeter must be used for the steam quality test. The minimum steam quality of 98% must be achieved during the performance test.
- 5. The contractor must notify NYCHA 4 weeks prior to the factory performance test. Representatives from NYCHA, The CM, the consultant, and the contractor must witness the combustion and the performance tests prior to accepting the boilers for shipment. A field acceptance test will not be required.

C. Shipment:

- 1. After the performance test and once the boilers are accepted for shipment by NYCHA the boilers are to be readied for shipping dry as described below. One additional set of Dry Layup product will be supplied for each boiler, to be used after the boil-out or setup if deemed necessary.
- 2. Dry Layup Procedure (Steam Boilers):
 - a. If possible, all horizontal and non-drainable boiler tubes are to be blown out with compressed air. Particular care must be taken to purge water from long horizontal tubes that may have bowed slightly.
 - b. Heat should be applied to dry the unit, and then the unit should be closed to reduce air circulation. Whenever necessary, to maintain the temperature of all surfaces above the dew point, heaters should be installed.
 - c. Immediately after surfaces are dried, one of the two following desiccants is to be spread on water-tight wood or corrosion-resistant trays:
 - 1) Silica Gel-used at a rate of 8 pounds per 100 cubic feet of volume
 - 2) Activated Alumina-used at a rate of 8 pounds per 100 cubic feet of volume

3. Locate on the top flues of the fire tube boiler. Allow 50 percent freeboard in trays in order to contain desiccant swelling. Tightly blank and close all manholes, handholes, vents and connections.
4. Once the boilers are delivered to the site or kept in rigger yard, the boilers should be opened every three or four months for inspection of the desiccant. Renew if necessary.
5. The contractor must submit a type written report to NYCHA and the engineer when boilers are opened for inspection of the desiccant.
6. Once all the required boiler attachments are made and the boilers are ready for startup, the boil-out can proceed by following steps:
 - a. The boiler is filled to the normal operating level.
 - b. Using the desired fuel, the burner should be test fired to verify that it will be capable to adequately meet the needs of the boil-out. This test fire should be performed by the manufacturer certified burner technician who can also use this time for initial burner adjustments, interlock, and cutout testing.
 - c. Prior to the boil-out, the safety valves must be removed or otherwise protected. This is a manufacturer requirement on both steam and hot water boilers, and is designed to protect the safety valves from any potential compromise that may be caused by any construction contaminants that may be present inside the boiler.
 - d. The boil-out is to proceed as per manufacturer procedures unless other- wise directed by NYCHA. As part of the normal boil-out process, the boiler should be periodically overflowed. This will allow for the removal of floating contaminants, which would otherwise coat the internal surfaces of the boiler upon draining.
 - e. After the boil-out and boil-out drain is completed, the boiler will be filled and drained, and then flushed through manholes/hand-holes using a hose.
 - f. All doors and openings that are exposed to boil-out chemical are to be opened and new gaskets are to be installed.
 - g. Once the boil-out is complete, arrangements can be made for the burner technician to finish setting up the boiler/burner. For this, it is desirable to achieve steady-state full load operation. For a steam boiler, it may be re- quired to install a steam vent.
 - h. Support systems will need to be operational for boiler/burner setup. This may include the following:
 - 1) Boiler feedwater source including makeup water, feedwater pumps, condensate pumps, etc.
 - 2) Water conditioning including pre-heat, chemical treatment pumps should be tested with water prior to any attempt with chemical.
7. The burner technician is to test and document all of the required interlocks and safety cutouts. The high pressure recycling cutout and high pressure lockout are to be tested under actual conditions and not with a 'bench-test' pump. Tempera- ture cutouts will also be tested under actual conditions.
8. Upon successful completion of the interlock and safety testing, the burner technician will finish tuning the boiler/burner. This is to be performed for each type of fuel. This will include but will not be limited to the following:
 - a. Emissions at minimum, 25%, 50%, 75%, 100%
 - b. Burner opacity
 - c. Flame shape, stability, and color
 - d. Proper turndown
 - e. Proper maximum fuel input
 - f. Proper boiler output – steam in lb/hr or water temperature control
 - g. Proper burner ramp rate
 - h. Efficiency
9. Under operating conditions, the boiler blowdown system(s) should be tested, including any quench system.
10. Upon successful completion of the above, the boilers can either be readied for use, or if decided, to be placed into a storage mode.

3.04 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to boiler(s), allow space for service and maintenance.
 - 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.
 - 2. Connect boiler feed-water piping and blow-down tapplings with shutoff valve and flange at each connection.
- C. Connect steam piping with a flange (Class 150 RF – Typ) 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.
- D. Connect feedwater piping to inlet- with union or flange at each connection. Provide each connection with shutoff valve and other accessories indicated and recommended by manufacturer.
- E. Install piping from safety relief valves to nearest floor drain.
- F. 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.
- G. 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.
- H. 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.
 - 1. Provide a temperature-controlled nonpotable domestic cold water source to cool hot equipment drains to deliver a discharge temperature of 140 F (or less).
- I. Connect chemical-treatment piping to each boiler chemical-treatment connection with check valve and isolation valve.

3.05 FLUE CONNECTIONS

- A. Connect breeching to full size of boiler outlet (minimum). Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for venting materials.
- B. Install flue-gas recirculation duct from vent to burner if not factory furnished and in- stalled. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for recirculation duct materials.
- C. Install easily accessible test ports for field testing of flue gas from each boiler.

3.06 ELECTRICAL POWER CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. 208/3Ph Power Supply to Power Panel.

3.07 CONTROLS & INSTRUMENTATION CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system. The mechanical contractor shall be responsible

to include the costs to furnish and have installed all of the control conduits and control wiring (including all terminations and continuity testing) for the boiler plant including equipment mounted devices and piping/remote control devices.

- C. Connect control wiring between boiler control interface and DDC control system for remote monitoring and control of boilers.

3.08 NETWORK AND PHONE CONNECTIONS

- A. Connect LAN/WAN network cable to boiler controls to provide connectivity for remote monitoring through integrated boiler control system.

3.09 FIELD QUALITY CONTROL

- A. Reference Section 230996 for additional requirements related to commissioning of the Boiler Plant.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. 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.
 - b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and steam pressure.
 - c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- E. Boiler will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide one (1) day of on-site assistance in adjusting system to suit actual occupied conditions.
- H. Field Performance Tests:
 - 1. The field performance tests to be conducted shall be performed in accord with the NYC-DEP (RCNY Title 15) in order to obtain a permit (See Engineering Fee Schedule) from the NYC-DEP to operate. Engage a Licensed Professional Engineer for the permitting process. Applications and forms include, but are not limited to:
 - a. Work Permit Application for Boilers: At least one month prior to installation, apply for work permit using the NYC-DEP CATS System. Application must be submitted by a Professional Engineer licensed in New York. Include all required components of the application, including but not limited to: Work Permit Request Form (stationary), required specifications, two hard and one pdf copy of required drawings/plans (including but not limited to plot plan, boiler room plan, and boiler plan), equipment compliance certification form (if equipment is not on the DEP accepted equipment list), draft calculations on Stack Adequacy form or ASHRAE- Program generated calculation, head load calculations, workman's compensation insurance document, and Installer Form if installer is changed after application is submitted. Submit applicable fees (approximately \$500 per boiler, to be verified based on current CATS

- Fee Schedule) or DOF Filing if installation is tax exempt and no fees apply. Apply for work permit extension if installation is not completed prior to work permit expiration (typically 6 months, to be verified when permit is received). Permitting requirements and process should be verified with NYS-DEC.
- b. Performance Test Worksheet: One installation is complete, adjust burner at high fire (80 to 110% load) and also at low fire to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency. Confirm that combustion efficiency and Smoke Bacharach number pass the NYCDEP standards as listed on the NYCDEP "Performance Test Worksheet". Record all information requested on the Performance Test Worksheet. Maintain original strip charts (combustion analyzer print outs).
 - c. NYC-DEP Annual Boiler Tune-Up Form. Complete all information required on the form which verifies that equipment was tuned and calibrated as per manufacturer's specifications. Mark each check box verifying inspection was conducted as stated on form.
 - d. Submit an Inspection Request for Original Certificate to Operate (CO) through the NYC-DEP CATS system within 3 months of performance test. Attach Performance Test Worksheet and scan of strip charts (combustion analyzer printout). Submit inspection request fee (approximately \$500 per boiler if project is not tax exempt, to be verified based on current CATS Fee Schedule).
 - e. Arrange and have licensed engineer present at inspection conducted by City Engineer. Address any issues through the NYC-DEP "affidavit" process, including paying fees of 50% original filing fee.
 - f. Registration of Hot Water Heaters through NYC-DEP CATS system. Each hot water heater 350,000 btu/hr or greater in capacity must be registered through the NYC-DEP CATS system. Hot water heaters 2.8 MMbtu/hr in size or greater must be registered and installed by licensed professionals and require submittal of a boiler room plan, a Performance Test Worksheet and an Inspection Request Form, and inspection as specified under H.1.b. and H.1.d. and H.1.e. above. Hot water heaters 4.2 MMbtu/hr and above require a Work Permit and all submittals outlined in H.1.a-e. Registration requirements for the hot water heaters should be verified with NYS-DEC. Registrations fees should be verified and submitted based on the CATS Fee Schedule.
2. Manufacturer's Field Service: Engage a factory-authorized service representative 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.
 3. Perform field-performance tests to determine the capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire, 10, 25, 50, 75, 100 percent of full capacity. Determine and document efficiency at each test point.
 4. 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.
 5. 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.
 6. Repeat tests until results comply with requirements indicated.
 7. Provide measurement and analysis equipment required to determine performance.
 8. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
 9. Notify 10 days in advance of test dates.
 10. Document test results in a report and submit with informational submittals.

3.10 SYSTEM VERIFICATION TESTING

- A. System verification testing is part of the Commissioning Process. Verification testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Section 019113, Project Commissioning Requirements, for detailed commissioning requirements.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions and provide electronic copy of video to Owner. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 52 39 23 52 39