DIVISION 23

SECTION 23 52 39

FIRETUBE BOILERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Specifications, apply to this section.

1.02 SUMMARY:

A. This specification applies to packaged, factory-assembled and tested, natural gas fired, four-pass, wetback, scotch-marine, firetube type, low-pressure steam boiler-burners, trim, and accessories.

B. The work of this Section includes the provision of complete control systems and control wiring for the burners and the boiler-burner plant control system, as specified, except where control wiring is factory provided as integral to packaged equipment, where so specified.

C. The Contractor shall refer to, and coordinate with the specified requirements of Section 23 09 13, “Instrumentation And Control For HVAC”, for additional requirements regarding provision of interfaces with the NYCHA Computerized Heating Automation System (CHAS), and for requirements for provision of accommodations for future monitoring of the steam boiler plant via a future BMS to be provided under a future separate contract, by Others.

D. Related Sections:

1. Section 01 51 23 - Temporary Heating
2. Section 23 05 00 – Common Work Results For HVAC
3. Section 23 05 13 - Common Motor Requirements For HVAC Equipment
4. Section 23 05 23 - General Duty Valves For HVAC Piping
5. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
6. Section 23 05 53 - Identification for HVAC Piping and Equipment
7. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
8. Section 23 07 00 - HVAC Insulation
9. Section 23 09 13 - Instrumentation and Control for HVAC
10. Section 23 09 14 - Natural Gas and CO Gas Leak Detection Equipment
11. Section 23 09 23 - Control Dampers
12. Section 23 09 24 - Steam Flow Meters
13. Section 23 22 13 - Steam and Condensate Heating Piping
14. Section 23 25 19 - Water Treatment for Steam System Feedwater
15. Section 23 31 13 - Metal Ducts
16. Section 23 33 00 - Air Duct Accessories
17. Section 23 34 16 - Boiler Room Combustion Air Makeup And Ventilation System
18. Section 23 51 00 - Chimney Liner
19. Section 23 51 16 - Prefabricated Breechings and Accessories
20. Section 23 51 23 - Gas Vents

21. Section 23 52 39 - Firetube Boilers
22. Section 23 53 12 - Vacuum Condensate Pumps
23. Section 23 53 13 - Boiler Feedwater Pumps

1.03 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 and Burner:

a. Boiler And Burner General Arrangement Drawings, Detailed Drawings, Performance Data and Manufacturers Specifications, demonstrating conformance with specified requirements.
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 (low-water-cutoff-controls, gauge glass etc.), normal water line.
g. Detail calculation of steam space and disengaging area.
h. Boilers rigging plan.

2. Boiler and Burner Controls, Fuel Gas Train, Trim, and Instrumentation:

a. Complete Piping and Instrumentation & Control Diagrams, including all associated operating, lead/lag, steam pressure sensor/transmitter(s), control interfaces with NYCHA's remote central and local CHAS (Computerized Heating Automation System), and NYCBAR required instrumentation and control systems, as specified.
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 Drawings.
g. Ladder Diagram type wiring schematics and point-to-point type wiring diagrams. Wiring diagrams shall clearly delineate factory provided wiring from field-installed wiring.
h. Wiring schematic drawing index and symbols legend.
i. Burner gas train and pilot gas train details, schematic diagrams, instrumentation and component details, specifications, identification, wiring and installation instructions.
j. Electrical wiring diagrams for power, control, and power for control, including both point-to-point wiring diagrams and ladder schematic wiring diagrams and narrative control sequences of operation, clearly delineating factory provided wiring from field wiring, and identifying the junctions between factory provided wiring and field wiring, with numbered and color coded terminal identifications, wiring schematic drawing index and symbols legend. Wiring diagrams shall include both schematic and point-to-point wiring diagrams detailing new control wiring connections from the NYCHA CHAS control

system to the new boiler plant master control panel, from the new boiler plant master control panel to each of the new boiler-burner control panels, and new wiring connections from the new burner control panels to the boiler plant's new safety and emergency shutdown switches and to the natural gas leak detection monitoring and alarm control system.

k. Identification of the provision of the piping ports, thermal wells and auxiliary contact sets to accommodate the future provision of future BMS monitoring points for the steam boiler plant, as specified under Section 23 09 13, "Instrumentation and Control for HVAC". The Mechanical Contractor of this Section shall coordinate with the specified requirements of Section 23 09 13.

3. Boiler and Burner Accessories and Custom Components:

a. General arrangement or component drawings, including burner associated variable frequency drives, motor starters and control interlocking auxiliary devices and interfaces.
b. Component Data Sheets.
c. Detailed scale drawings and specifications of the free-standing floor-mounted burner control panels, their mounting, supports and attachments, and their cabinet construction.
d. Schematic ladder type and point-to-point type Wiring Diagrams. Wiring diagrams shall clearly delineate factory provided wiring from field-installed wiring.
e. Burner motor and control panel mounted variable frequency drive.
f. Burner factory test reports.
g. Manufacturer's warranty.

4. Miscellaneous Submittals:

a. Burner flue gas recirculation (FGR) breeching, to be submitted as specified under Section 235116, in coordination with the specified requirements of this Section.
b. Shop drawings of Boiler Room layout with all equipment drawn in AutoCAD program provided on CD and two sets of prints. Layout drawings shall be provided for each trade. Layout shall include the actual boiler supplied with tube pull spaces and other equipment supplied condensate receiver with feed water pumps, sparging tube, pull space, control panels, steam separator (if applicable), header, breeching, chemical feed units, etc. It also shall show all piping layout, concrete pads, wall openings, electrical and power, plumbing, etc.
c. Upon completion of the Contract Work, the Contractor shall provide As-built layout drawing in AutoCAD program on CD and two sets of prints. As-built drawings shall show the actual installation with all the details including Mechanical, Electrical, Plumbing, Structural, 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 and Burner General Arrangement Drawings, Detailed Drawings, Performance Data, and Manufacturers Specifications.
12. Piping, Instrumentation and Control Diagrams, including all associated operating lead/lag, steam pressure sensor/transmitter(s), control interfaces with NYCHA’s remote central and local CHAS (Computerized Heating Automation System), and NYCBAR required instrumentation and control systems, as specified.
13. Piping and Instrument symbols legend.
14. Control Sequences of Operation and Logic Diagrams.
15. Control panel layout drawings.
16. Instrumentation and Electrical component bill of material.
17. Burner Gas Train detailed schematic piping diagram.
17. Copy of ASME H-2.
18. Copy of ASME CSD-1 data sheet.
19. Recommended spare or replacement parts lists.

C. Factory Tests: Provide factory tests for steam quality and boiler efficiency as specified elsewhere under Part-3 of this Section of the specifications. Manufacturers previously approved shall include a statement in their submittal indicating prior acceptance and provide proof of same upon request. Boilers of any size or any manufacturer that have not previously passed a NYCHA factory acceptance test will require testing at the manufacturer’s expense, including travel and living arrangements for two (2) NYCHA representatives.

1.04 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. Codes and Standards:

1. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section IV, ANSI/ASME CSD-1A latest revision. Pressure vessels shall bear the appropriate ASME stamp.
2. National Fire Protection Agency (NFPA)
3. Local NYC DEP Regulations.
4. Local Natural Gas Utility.
5. Boiler testing and rating shall be in accordance with American Boiler Manufacturer's Association (ABMA) "Packaged Firetube Rating".
6. Minimum steady-state efficiency of boilers shall not be less than prescribed by ASHRAE 90A "Energy Conservation in New Building Design".
7. Electrical installations shall comply with National Fire Prevention Association (NFPA) Code-70 “The National Electrical Code” and in conformance with the New York City Electrical Code.
8. Gas Fired-boiler installations shall be in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".
9. Ancillary electrical components shall be Underwriters Laboratories (UL) listed and labeled.
10. The complete boiler package shall be designed and fabricated per UL guidelines.
11. Instrumentation and piping drawings and electrical drawings shall use symbology and protocol established and defined by the Instrument Society of America (ISA).
12. The installation shall be in accordance with ASME CSD-1.
13. The installation shall be in accordance with NFPA 8501.
14. The installation shall be in accordance with Factory Mutual (FM) requirements.
15. The installation shall be in accordance with IRI requirements.
16. The installation shall be in accordance with NYC Department of Environmental Protection (DEP) and in accordance with the requirements of the NYC Building Department. Compliance shall be proven prior to equipment acceptance.
17. All appliances regulated by the New York City Construction Codes shall be listed and labeled (reference MC 301.4, MC 301.6). Testing of material and equipment

shall be in accordance with 28-113 of the Administrative Code (reference MC 301.5). Whenever the NYC Construction Codes or the Rules of the Department of Buildings requires that material be listed or labeled and material proposed to be used is not so listed or labeled, the use of such material shall be subject to prior approval by the Commissioner (Office of Technical Certification and Research OTCR) and such material shall be used only to the extent set forth in such approval. Materials that were previously approved by the Board of Standards and Appeal (BSA) or by the Department (MEA) before the effective date of the NYC Construction Codes may continue to be used, but only to the extent set forth in such approval, and only if such approval is not specifically amended or repealed by the Commissioner.

C. System shall be arranged for lead/lag sequential operation as per Code requirements.

D. Fuel burning equipment shall be designed to operate satisfactorily and efficiently without objectionable smoke, odor, or noise.

E. Special Inspections shall be performed on installations of fuel burners, gas piping, boilers, and all other items and accessories, in accordance with the requirements of New York City Construction Codes.

F. At the completion of the Work, the Contractor shall file all necessary final applications and relevant papers, Drawings, Amendments, and all other items and accessories and secure for NYCHA, a Certificate of Operation or Registration (as applicable) from the NYC Bureau of Air Resources and the NYS Department of Environmental Conservation (DEC) for the burning system and all the approvals from the Building Department and the Bureau of Electrical Control. Submit with the request for final payment proof of filing for an inspection certificate from the Bureau of Electrical Control and a certificate of satisfaction from the Building Department. Acceptable evidence of filing with the Bureau of Electrical Control will be the job posting card issued by the Bureau.

G. Contractor is responsible for payment of any and all fees assessed by the NYC Bureau of Air Resources for inspection and/or cancellation if the initial BAR inspection fails to result in the issuance of the Certificate of Operation (as applicable) for the installation.

H. Certificates of approval issued by the Building Department (CID), Department of Health, Department of Water Resources, Bureau of Electrical Control, Fire Department, Department of Air Resources, and all other departments having jurisdiction in connection with this Work shall be submitted before final payment is made.

I. Contractor shall register, file applications and obtain all related permits, certifications and approvals required by all agencies including but not limited to:

1. Plumbing Inspection - sign off (DOB/CID).
2. Certificate of approval for Fuel Gas Burner Installation - (DOB/CID)
3. Bureau of Electrical Controls. (DOB/BEC).
4. Environmental Protection Agency (Federal).
5. STATIONARY COMBUSTION INSTALLATION - Application/ Permit New York State Department of Environmental Conservation (D.E.C.).

6. APPLICATION FOR CERTIFICATE OF OPERATION (as applicable) OF FUEL BURNING EQUIPMENT, Air Resources (B.A.R.) Tests, Inspection and Certificate of Operation (as applicable) - NYC Department of Environmental Protection (DEP).
7. Coordination, inspection and approval by the Natural Gas Utility Company.
8. Certificate of Compliance.

J. Before submitting any equipment shop drawings for approval, the HVAC Contractor, Automatic Temperature Controls Contractor and the Equipment Vendor and Manufacturer shall coordinate the controls required for the system.

K. Per NYC Fuel Gas Code 403.9.3, joints and connections shall be approved and of a type approved for natural gas piping systems. All threaded joints and connections shall be made tight with suitable lubricant or pipe compound. Pipe joint compounds and thread seal tape that utilize Teflon (PTFE) shall be approved for usage on natural gas lines.

1.05 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.

1.06 WARRANTY:

A. The specified Contract requirements of Section 017836 “Warranties” shall apply, along with the additional Warranty requirements specified herein as follows.

B. Complete boiler-burner package shall have a limited warranty on all materials and components supplied for 3 years from date of initial commissioning including material and labor. Manufacturer shall submit detailed provisions of warranties as part of submittal packages.

C. Boiler tube sheets, and rear submerged combustion chamber shall carry a fifteen (15) year parts and labor warranty.

D. Front and rear flue doors shall carry a fifteen (15) year parts and labor warranty.

E. The burner shall carry a limited warranty of five (5) years for parts only.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Boiler Manufacturers: Approved packaged firetube boiler manufacturers must be subject to and in compliance with this specification and other applicable contract requirements. Approved manufacturers shall be as listed hereinbelow, or approved equal:

1. Burnham Corp. (Basis-Of-Design)
2. Johnston Boiler Co.
3. EASCO Corp., model FPS

2.02 PACKAGED FIRETUBE BOILERS

A. Steam Boiler: The boiler shall be a natural gas-fired, four-pass, wetback, scotch marine packaged firetube type low-pressure steam boiler, of capacities and characteristics as scheduled on the Contract Drawings and as specified herein. 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.

B. 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 scheduled on the Contract Drawings and as specified herein.
2. The boilers shall have a maximum rated output capacity as scheduled on the Contract Drawings.
3. Boiler shall have a rated design pressure of 15 psig.
4. Boiler and controls shall be designed for an operating pressure as scheduled on the Contract Drawings.
5. Steam shall be at least 98.0% dry and saturated.
6. Boilers shall provide a minimum fuel to steam efficiency of at least 85.6% when firing natural gas. (Efficiency shall be calculated as prescribed under “Heat Loss Efficiency” of the ASME Power Test Code PTC4.1).
8. Burner shall be rated for 30 PPM-low-NO_X emissions, factory provided with integral flue gas recirculation (FGR) control valve, shall be factory provided with a variable frequency drive motor and shall have a turndown ratio of at least 10:1 when firing natural gas.
9. Boilers shall have a minimum steam space and disengaging surface area as follows:

Boiler Size BoHP	Min. Steam Space Cu. Ft.	Disengaging Surface Area Sq. Ft.
300	57.25	71.40

The size of steam space and disengaging surface area shall be determined from the normal operating water level.

C. 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" design.
4. The boiler shall have a minimum of five (5) square feet of heat transfer surface per rated boiler horsepower (BoHP), measured on the fireside (ASME method calculation).
5. The boiler package shall be complete with integral natural gas-fired, forced-draft, 30 PPM-low-NO_X burner with flue gas recirculation (FGR) control valve and variable frequency drive motor, manufactured for that boiler, and complete with burner refractory.
6. The boiler shall be provided with tubes of 2-½-inches diameter, with #10-gauge wall thickness.
7. The boiler shall be designed with front and rear observation ports.

2.03 BOILER SPECIFICATIONS

A. Boiler (pressure vessel): The boilers shall be a four-pass water-back Scotch Marine type listed and rated by the American Boiler Manufacturers Association, Fire-tube Section. The boiler shall be designed and built to comply with the latest ASME Code Rules for 15 lbs per square inch working pressure and be inspected and stamped by an authorized boiler inspector. 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. The combustion chamber tube sheet and rear tube sheet shall have only one inside and outside surface temperature to eliminate stresses and prevent ligament cracks.
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. Boiler shall have 2-½" dia. tubes with #10-gauge tube wall thickness. In addition, boiler shall have ½" thick combustion chamber and shell plate, and 5/8" tube sheets, front and rear heads and wrapper.
11. Boiler plate shall be made of carbon steel ASTM A-36 and have thickness of 5/8".

B. Front and Rear Flue Doors:

1. The boiler's front and rear flue doors shall be:
   a. Hinged or davited steel plate 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.

C. Smoke Box With Exhaust Gas Vent: Boilers shall have a flanged flue exhaust vent collar at the top front of the boiler. The vent shall include a 5" diameter stack thermometer and shall be designed for convenient connection to flue gas breeching or stack exhaust equipment, including a draft regulating damper. The smoke box, of minimum ¼-inch thick steel plate, shall be welded to the boiler with a continuous seam.

D. Insulation and Jacket: The boiler shall be factory insulated around its full circumference with 3-inches 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 galvanealed sheet metal jacket not less than #18 gauge thick. The jacket shall 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.

E. Flue Gas Recirculation: Boilers shall have flue gas recirculation piping and a servo-controlled FGR damper/valve to achieve $\leq$ 30 PPM NO_X when firing natural gas.

F. Boiler Trim: The boiler shall include the following control and accessory equipment (trim):

1. McDonnell & Miller Corp. #157, or approved equal, combination water column, complete with chain operated gauge glass set, red line gauge glass, and water column blowdown valve, and parallel slow opening motorized blowdown valve for burner controller daily low water float switch test.
2. Feedwater Valve Control shall be an integral part of the water column. The control shall be selected to automatically modulate the motorized feedwater valve as shown on the Contract Drawings.
3. 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.
4. McDonnell & Miller Corp. #63M, or approved equal, auxiliary Low Water Cutoff shall be provided to activate below the primary low water cut-off. Control shall be of the manual reset type.
5. A continuous surface water blow-off connection and automatic surface blowdown control with solenoid valve, probe, and controller shall be provided.
6. Steam Pressure Gauge: Steam pressure gauge, range zero-to-30 psig, shall be located on the front end of the boiler. The gauge installation shall include syphon, shut-off cock and test connection.
7. Steam Safety Relief Valves shall be provided in types, sizes and quantities to comply with ASME Code requirements, and as shown on Contract Drawings. A

chain and pulley attachment to operate the lifting level of the safety relief valves and a "gag" or "gag bar" shall be provided.

8. Steam Pressure Controls shall be provided to regulate the burner operation and boiler output and safety. The following controls shall be mounted near the water column:

    a. Honeywell operating pressure control Honeywell Corp. model L404F-1060, or approved equal, with pressure to electrical transducer shall provide process control for modulation of burner firing rate. Modulating pressure control 135Ω, 4-20ma or 1-10vdc.
    b. One primary operating pressure switch to sense boiler high steam pressure. The switch shall be wired into the burner management system to turn the boiler-burner off in the event steam pressure reaches the operating setpoint pressure of 8 psig (adj.). The switch shall be part of the boiler auto recycling limit circuit. The cut-in pressure setpoint shall be 1.0 psig (adj.) lower than the steam header (lead/lag) control cut-in pressure.
    c. One high-limit pressure switch, with set point above the primary operating pressure set point and below the boiler design pressure, shall be provided. Activation of the switch shall turn boiler off in the event pressure reaches the high-limit setpoint pressure of 12 psig (adj.). The switch shall be manual reset type, Honeywell Corp. model L4079B-1033, or approved equal.
    d. Provide a low-fire hold aquastat, Honeywell Corp. model L6006A-1145, or approved equal.

9. Data Reports: The Manufacturer shall supply two copies of data reports, ASME form H-2.

G. Boiler Flue Gas Outlet Nozzle:

1. Pressure at the outlet of the boiler after the draft damper shall not exceed 0.5” W.C. at high fire. When multiple boilers are connected to the same stack, the pressure shall not exceed 0.5-inch WC at any boiler outlet when all boilers are operating at 100% capacity.
2. Coordinate with the specified requirements of Section 235116, and refer to the breeching systems design requirements as shown on the Contract Drawings.

H. Housekeeping Pad Mounting: The boiler shall be mounted on and anchored to a 12-inches high reinforced concrete housekeeping pad, to be provided as specified and shown under the Structural Division.

2.04 NATURAL GAS-FIRED BURNER SPECIFICATIONS:

A. Factory provide each boiler with a UL (Underwriters Laboratories) listed and labeled 30 PPM Low-NO_X emissions rated natural gas-fired burner. The burner design, construction, components and installation shall meet all applicable Code requirements. The burner shall burn the specified quantity of fuel without objectionable vibration, noise or pulsation with not more than 20% excess air and no CO in the products of combustion.

B. The burner shall be as manufactured by Webster, Inc., or approved equal as

manufactured by Power flame Corp., S.T. Johnston Corp., or Weishaupt Corp. (The Contractor's special attention is alerted that, in the event that the use of a Burnham/Weishaupt Corp. burner is approved by the E.O.R. for use on this Project, an FGR valve and an FGR breeching system would then not be required in order to maintain specified 30 PPM max. NO_x concentration level in the products of combustion. Additionally, the Contractor shall then be responsible for any modifications of the electrical power system design, as may be necessary to accommodate the increased motor nameplate horsepower of the Weishaupt Corp. burner motor)

1. Each burner shall be a low NOx forced draft flame retention type burner, of Model No., motor nameplate HP, input and output capacities and characteristics as scheduled on the Contract Drawings, as manufactured by Webster Corp., or approved equal. Each burner shall be capable of burning the scheduled maximum input firing rate of Natural Gas having a specific gravity of 0.6 and a BTU content of 1000 BTU/cubic foot. NO_X emissions shall not exceed 30 PPM throughout the full firing range.
2. Each burner shall be capable of 10:1 turndown on natural gas firing.
3. Each burner shall be provided with Underwriters Laboratories listed components and each component shall bear the appropriate U. L. label in addition to the U. L. requirements, all equipment and installation procedures shall meet the requirements of UL 795, FM, IRI, ASME CSD-1 NFPA-8501, and shall conform with the requirements of the NY City Building Codes. Each burner shall be designed and constructed as an integrated combustion system package and shall be factory fire tested.
4. Each burner shall be of welded steel construction and have a baked on powder coat finish. The combustion head shall incorporate a multi-blade, stainless steel, flame retention diffuser. The gas firing head shall be of multiport type and constructed so as to place annular gas distribution opening between two parallel air flow streams to achieve maximum fuel/air mixing. Burners with cast alloy blower housings will not be acceptable. The burner combustion head shall carry a full five (5) year replacement warranty for "parts" only.
5. The burner combustion head components shall be easily accessible through an access door located on the side of the burner blast tube. The burner combustion head components shall be capable of being easily adjusted or replaced without having to disconnect fuel supply piping or electrical connections to the burner assembly.
6. All air required for combustion shall be supplied by a blower mounted integral to the burner. The blower wheel shall be of the centrifugal design and shall be directly driven by a three-phase high-efficiency motor of nameplate horsepower and voltage ratings as scheduled on the Contract Drawings. A multiple blade damper assembly located on the inlet side of the blower wheel and variable frequency drive (VFD) shall meter the combustion air flow. Design shall permit the disconnecting and locking of the damper if firing rates are near minimum burner input ratings. A permanent observation port shall be provided in the burner to allow observation of both the pilot flame and the main flame.
7. The VFD Drive shall have a display for setup, programming and monitoring. The variable frequency drive shall be manufactured by Siemens Corp., model Micromaster MM440, or approved equal. Provide variable frequency controllers suitable for operating variable or constant torque loads. Variable frequency

controllers shall meet or exceed the ratings specified herein below:

a. Rated input voltage: 208 volts plus or minus 10 percent, three-phase. Rated frequency: 60 hertz plus or minus 2 percent. VFD power range shall be for a 5 HP VFD human interface.
b. Motor nameplate voltage: 208 volts, three phase 60 hertz (as specified)
c. Displacement power factor: between 1.0 and 0.95, lagging, over entire range of operating speed and load.
d. Operating ambient: 32 to 122 degrees F or 0 to 50 degrees C up to 100HP, maximum ambient 104F (or 40 degree C) 125HP and higher.
e. Minimum efficiency at full load: 96 - 97 percent.
f. Variable frequency drive shall have modular construction to allow for maximum configuration flexibility.
g. Inputs and outputs for the VFD shall include six fully programmable isolated digital inputs with the option for a 7th and 8th, with scalable analog inputs also capable of being used as the 7th and 8th digital input, and with two (2) fully programmable analog outputs and three (3) fully programmable relay outputs.
h. With integral provision of complete inverter and motor protection.
i. Product shall provide simple commissioning macro to program the VFD for the application, motor data and control information. In addition, the drive shall provide automatic calibration routine to optimize motor electrical characteristics within the VFD.

8. The VFD Drive inverter shall include the following features, as a minimum:

a. Latest IGBT technology and Digital microprocessor control.
b. High performance control system shall be capable of configuration as an open or a closed loop vector control. Auto tuning for vector control optimization shall be provided. Closed loop control shall be capable of accepting either a TTL or HTL encoder feedback signal. In addition, flux current control, programmable multi-point V/Hz curve, Linear V/Hz control, Quadratic V/Hz control shall be provided.
c. Torque control shall be capable of being configured in the VFD and activated by command input.
d. Provision of Binary Connector (BiCo) technology for customizing signals as required by the application.
e. PID control loop for process control shall be provided with automatic tuning routine.
f. Fast, repeatable digital input response time with NPN/PNP Source-Sink control adaptability. As a minimum, the drive shall provide at least six programmable digital inputs for control of the following typical inverter functions:

1. On Fwd
2. Fault reset
3. External trip
4. External MOP set point frequency control.
5. Fixed frequency presets up to (15) different settings.
6. Analog reference switch
7. Activation of Drive or Control Data Sets.

9. As a minimum, the VFD Drive shall provide three digital outputs for signal indication of any one of the functions specified herein below:

    a. Inverter running
    b. Inverter frequency 0.0 hertz.
    c. Motor direction in reverse
    d. Fault indication
    e. Warning active
    f. Output current greater than or equal to programmable set point.
    g. Output frequency greater than or equal to programmable set point.

10. The VFD Drive shall include provision of an RS-485 Serial Port. In addition, an optional RS232 cable adapter kit with STARTER or DRIVE MONITOR Software Commissioning Tool shall be provided.

11. The VFD Drive shall provide programmable acceleration/ deceleration, 0 sec. to 650 sec. with Multi-curve, adjustable ramp smoothing.

12. The VFD Drive shall be capable of providing Flying Restart.

13. The VFD Drive shall be capable of providing automatic restart following power failure or fault.

14. The VFD Drive shall be capable of providing fast current limit (FCL) for trip free operation.

15. The VFD Drive shall be capable of providing fine speed adjustment using a high-resolution 10-bit analog input.

16. The VFD Drive shall include provision of a dynamic braking electronic control unit built into the control unit. Injection and Compound braking shall also be provided for rapid controlled braking.

17. The VFD Drive shall be capable of providing four (3) skip frequencies.

18. The manufacturer of the VFD shall provide a digital keypad/display capable of controlling the drive and setting the drive parameters. The digital display shall have a 4-line by 16-character LCD panel that is backlit for easy readability. The LCD device for the VFD shall be capable of bus master operation with multiple AC drives of the same family. Broadcast messages shall be possible. The operator panel shall have the capability to store up to 3 different parameter sets. A minimum of 5 languages shall be available in the device. The panel shall be capable of normally displaying:

    a. Frequency in hertz.
    b. Drive status
    c. Output voltage.
    d. Output current.

19. The VFD's digital keypad shall allow operators to enter exact numerical settings in English engineering units. These parameters shall be adjustable for specific project application requirements on site. All setup operations and adjustments shall be digital, stored in non-volatile (EEPROM) memory. No analog or potentiometer adjustments will be allowed. As a standard feature, these variables

shall be protected from unauthorized tampering, revision, or adjustment by password code. The digital keyboard shall have six keys to provide easy programming of the drive. These keys shall include:

a. Up and down arrow keys to increase or decrease output frequency or data values.
b. Run and stop keys for starting and stopping in the manual mode.
c. Program key to enter the program mode and adjust parameters.

20. The VFD Drive shall be provided with the following short circuit and input protective features:

a. Solid-state instantaneous over current trip set at 275 percent.
b. Under voltage protection.
c. Transient surge protection.
d. Transistor over temperature and over current protection.
e. Current limit circuit to automatically phase back output current and frequency to prevent excessive currents from damaging motor insulation (frequency output rollback).
f. Microprocessor fault/memory chip error.
g. DC bus over voltage trip.

21. The VFD Drive shall be provided with the following output protective features:

a. Inverse time motor overload protection, UL approved for motor protection, (I squared T trip).
b. Thermal sensor detection, thermistor or thermostat for motor over temperature.
c. Protection against opening or shorting of motor leads.
d. Critical frequency avoidance circuit. Four (4) set points selective from 0 to maximum frequency. Bandwidth of set points to be adjustable.

22. The VFD Drive's RS485 communications interface shall provide monitoring and setting of all operating and fault parameters within the VFD. In addition, the RS485 interface shall be capable of monitoring digital input status of the VFD while providing direct access to the relay outputs and the analog outputs of the drive. Additional communication protocols such as Profibus (up to 12 MB) shall be provided.

23. The following conditions shall cause an orderly VFD drive shutdown and lockout:

a. Over current at start-up
b. Instantaneous over-current
c. Over-temperature of VFD or external fault
d. Motor over-temperature
e. Ground fault in motor output circuit
f. Over voltage during shut down
g. Motor I-squared T-trip

24. The VFD drive shall record and display the last four (4) faults that occurred in the drive. The VFD drive shall also display the last warning message experienced by

the inverter.

25. The VFD drive shall provide two 0 to 20-milliamp analog output signals proportional to the output frequency, output current, frequency set point, motor RPM, bus voltage, or inverter heat sink temperature (via BiCo connection).

26. The VFD drive shall have the capability to perform an automatic motor calibration test and adjust its internal settings automatically without any special tools or instruments.

27. The VFD drive shall have the capability to be reset to factory conditions via parameter change.

28. Ignition System: The burner ignition system shall utilize a spark ignited gas pilot as the fuel source. The system components shall include dual solenoid valves for the pilot line, regulator, pilot pressure gauge with dampening orifice and shutoff cock. The flame proving system shall incorporate a Ultra-Violet flame detector, which shall monitor both the pilot and main flames. The pilot assembly shall fit within the confines of the blast tube, avoiding requirement for provision of any special burner front plate pilot cut outs.

29. Siemens, or approved equal, Fuel/Air Control System:

    a. Main on-off natural gas supply shall be controlled by a motorized gas valve.
    b. A modulating servo motor shall control the positioning of the air inlet dampers. The position of the motor shall be controlled by a 4-20 milli-amp modulating type pressure controller. When the operating control is satisfied the burner shall shut off and return to the low fire start position. The modulating motor shall provide an electrical interlock to ensure a guaranteed low-fire start position prior to the pilot trial for ignition sequence.
    c. Interlocks: The modulating motor shall be sequenced to allow for four (4) complete air changes of the combustion chamber and breaching, and through an integral end switch, shall be electrically interlocked with the control burner circuit to ensure the air linkage is in the low fire start position before the burner ignition sequence can begin.
    d. Flame Safeguard Control: The flame safeguard control shall include lead sulfide sensor for flame detection and provide fully automatic sequencing of pre-purge and post-purge, blower motor, interrupted ignition system, and fuel/air flow components. Burner shall purge with full open air louver at not less than 60% of high fire air flow rate for a minimum of four (4) air changes and not less than 60 seconds. Flame safeguard shall provide safety shutdown with manual reset on air flow failure. The flame safeguard control shall be Siemens model LMV52, or approved equal, with O_2 trim.
    e. The model LMV52, or approved equal, flame safeguard control shall provide an electronic linkageless, microprocessor-based unit for the control and supervision of a single forced draft burner with modulating gas flow rate, providing a burner management system that delivers the required control, performance and diagnostics. The LMV52 burner management system shall accomplish burner control, utilizing an integrated configurable gas valve proving system, electronic fuel/air ratio control (FARC) with up to

four actuators, adjusting, air, gas, and flue gas recirculation (FGR), and shall be provided with PID temperature control function (load controller). The burner management system's major components, including the base unit model LMV52, the display and operating unit model AZL, or approved equal, and the actuators model SQM4, or approved equal, shall communicate over a reliable safety bus. The model LMV52 shall include two microprocessors that offer a very high level of safety and reliability for monitoring the software, the program, and the control sequences. The model SQM4 actuators shall include provision of the following features:

1. Characteristics and settings defined by the model LMV52 flame safeguard control.
2. Shall be controlled by digital signals on a safety bus from the model LMV52 flame safeguard control.
3. Shall be driven by stepper motors.
4. Shall have a resolution of 1/10 of a degree, or 900 repeatable positions, within 90 deg of rotation.
5. Shall be equipped with two factory calibrated feedback potentiometers.
6. Shall be capable of clock-wise or counter clock-wise rotation.
7. Shall be available in at least 3 torque ranges including, 30, 180, and 300 in/lbs. (3, 20, 35 newton-meters).
8. Shall not require any field adjustment.
9. Shall not require any switch wiring.
10. Shall not require any switch setting.

f. All safety-related digital outputs of the model LMV52 flame safeguard control shall be permanently monitored via a contact feedback network. The model LMV52 flame safeguard control shall provide burner-flame safeguard control approved for continuous duty applications, using optical solid state IR flame sensor technology, including the following features:

1. Provisions for flame supervision using flickering infrared flame detectors (QRI)
2. Provisions for flame supervision using ionization probes
3. The flame detector or probe shall also house the flame amplifier, eliminating reliability issues associated with remote amplifier flame sensor wiring.
4. Shall provide immunity to glowing refractory and 50-60 HZ lighting.
5. The model QRI IR flame sensor shall incorporate self-checking features and be specified for continuous duty.

g. The burner manufacturer shall be able to select from a total of seven fuel valve configurations. A large number of individual parameterization choices (program times, configuration of inputs / outputs, etc.) shall allow optimum adaptations to the specific fuel train configurations. A burner switch shall be provided for a standard low fire shutdown. An emergency stop switch shall be provided, for an immediate shutdown, which is wired directly in the fuel valve circuit. The model LMV52 flame safeguard control shall be capable of being replaced, and then being re-

commissioned by downloading the commissioning parameters from a backup in the model AZL programming and display unit, or via a PC, and shall not require re-programming. The model LMV52 flame safeguard control shall provide electronic fuel / air ratio control (FARC) with 15 points that can be added, deleted, or adjusted while running or in standby. The separate display and operating unit, model AZL, shall be provided with an LCD display and four buttons. The model AZL display and operating unit shall be provided with the following features:

1. Designed for front panel mounting
2. Display shall have a 4 line by 16 character LCD display with menu driven English text.
3. Shall provide straightforward operation, and continuously show the process variable, current setpoint, load and flame signal.
4. Shall have a real time clock

h. The model AZL display and operating unit shall afford a convenient readout of:

1. Burner settings
2. Operating state
3. Parameters of the burner control

i. The model AZL display and operating unit shall interface through three ports:

1. Safety bus (terminal X70) Modbus connection to the model LMV52 burner control base unit.
2. COM1 (terminal X70) connection to a PC with ACS450 software.
3. COM2 (terminal X72) connection to a BMS using and external e-bus interface.

j. The parameter setting levels for the burner-boiler manufacturer and heating engineer shall be password-protected to prevent unauthorized access. The plant operator shall be able to adjust user level settings, such as setpoint on site, shall not demand a password. When performing diagnostics, the model AZL display and operating unit shall show at least 21 faults, and the last 9 lockouts, with the following information:

1. Fault code number
2. English word message (or other language).
3. Operating state.
4. Point in time the fault occurred.

k. The model AZL display and operating unit shall be connected to the safety network, using a 9-pin sub-D type port, providing the following capabilities:

1. Selection of a language for the model AZL display and operating unit.
2. Commissioning of the model LMV52 burner control.

3. Convenient programming of burner settings.
4. Process visualization.
5. Selection of which additional COM port to use.
6. Provision of power to the model AZL display and operating unit.

l. The model AZL display and operating unit shall permit one additional port, COM1 or COM2 to be used, at the same time. COM1 is a sub-D 9-pin RS-232 serial port, designed to communicate with PC commissioning software ACS450. The following operating functions shall be provided:

1. Readout of settings, operating states, error types, and point in time the errors occur (from the model LMV52).
2. Graphical presentation of diagnostic data
3. Parameterization of the model LMV52.
4. Trend/data recording.
5. Printout functions for documenting the plant settings.
6. Program update of the model AZL.

m. COM2 shall be an RJ45 socket, ModBus port, on the model AZL, and shall be capable of being used as a digital interface, for building management systems (BMS) or touch screen displays. The external ModBus interface shall provide electrical isolation and include a power supply, and shall be designed to provide the following functions:

1. Hours of operation.
2. Operating display.
3. Current fuel type.
4. Current operating phase.
5. Input states (if available).
6. Output states including alarms (if available).
7. Actual value of the temperature or pressure.
8. Temperature or pressure setpoint.
9. Contents of lockout and error storages.
10. Select the type of fuel.
11. Set the date and the time of day.
12. Only non-safety-related data may be changed via the BMS.

n. The burner control shall be able of accepting an analog setpoint from a BMS, and settings shall be password protected to prevent unauthorized access.

30. Burner Modulation: The main On-Off gas supply shall be controlled by a motorized gas valve. A servo motor shall control the modulated positioning of the air inlet dampers and a modulating type gas valve to best meet varying system load conditions. The positioning of the servo motor shall be controlled by a 4-20 milliamp, modulating type pressure controller. When the operating control is satisfied the burner shall shutoff and return to the low fire start position. The servo motor and control system shall provide an electrical interlock to insure a guaranteed low fire start position prior to the pilot trial for ignition sequence.

31. U.L., FM, IRI, ASME CSD-1, NFPA Compliant Siemens, or approved equal, High

Flow Ventless Gas Control Train: The gas valve train shall be a factory pre-piped and pre-wired Siemens Corp., or approved equal, Ventless gas train, including the components as detailed on the Contract Drawings and as specified herein, as follows:

a. Manual Shutoff cock.
b. Main gas pressure regulator "tight shutoff type" integral to motorized main valve.
c. Automatically operated main motorized gas valve with proof of closure interlock switch FM Labeled.
d. Automatically operated auxiliary motorized gas valve with proof of closure interlock valve FM Labeled.
e. Ventless Manual reset Low and High Gas Pressure Switch.
f. Manual leak test cock.
g. Burner manifold gas pressure gauge and gauge cock.
h. Gas strainer pilot and main.
i. Gas pressure gauges (4) pilot and Main train.
j. Valve proving system integrated to not require venting of the train.
k. Gas pressure switch for valve proving system.
l. The gas train piping shall include a ¼" NPT pressure tapping with ¼" pipe plug upstream and downstream of each valve and regulator in the gas train.

32. The ventless gas train shall be factory pre-piped and pre-wired to a junction box with terminals that match connecting terminals in the burner control panel. Terminals shall be numbered to match and wires color coded to match field connection to minimize field connections. The gas train shall be painted with high-visibility yellow paint.

33. Burner Operating Controls:

a. The On-Off operation of the burner shall be controlled by a pressure control.
b. A safety manual reset type limit control shall be provided to shut the burner down in the event of excessive pressure.
c. Modulation. The position of the modulating servomotor and other fuel/air components shall be controlled by a Honeywell Corp., or approved equal, model P7810C 4-20 milliamp, control in addition to the On-Off operating control.

34. Burner Control Panel:

a. Each burner shall be complete with a remote free-standing burner control panel, mounted on a 12-inches high reinforced concrete housekeeping pad, which shall house all required operating electrical components. The control panel shall be NEMA 3R rated and shall bear the UL Label. The main entrance buss, single drop and fuses shall be available for all 3-phase motors. The control circuit shall be 120 volts, 60 hertz, single phase. All flame safeguard wiring within the combustion control system shall be factory pre-wired utilizing a UL listed components and have U. L. Flame Safeguard panel approval label. All optional controls shall be wired

to a din rail mounted terminal strip within the control panel. A junction box pre-wired to the burner components shall be mounted on the burner. It shall have a din rail mounted terminal strip, which shall match the terminal strip in the remote control panel. Field wiring shall be provided between the burner mounted junction box and the remote control panel. All wring shall be numbered and color coded to facilitate field wiring connections. All devices on the face of the control panel shall have engraved laminated name plates. All relays, control devices and items mounted inside the panel shall be identified with engraved laminated name plates. Blower motor shall be controlled via variable speed drive with display. The VFD shall be mounted inside the control panel.

b. Appropriate electrical knockouts shall be provided on both sides and bottom of the panel to allow for necessary power and limit control wiring. The control panel shall be constructed of 16-gauge steel and shall be complete with a top mounted switch and control section which shall be hinged to allow for full access to all panel mounted components. The control panel shall have a powder coat painted finish identical to that of the burner being provided.

c. The control panel shall include a din rail mounted control circuit transformer with integral fuses on both the primary and secondary windings. Flame safeguard shall be Siemens model LMV52 as specified hereinabove. Din rail mounted motor starters, VFD's, relays, terminal blocks and other electrical devices as required including circuit breakers for all motor starters or VFD's, manual firing rate potentiometer and switch, limiting potentiometer and relay, control circuit transformer, outside air interlock, break glass interlock, BMS interlock, canopy light, SyncMatic Lead-Lag control, P7810C-1000, enforced low fire shutdown circuit. Provide indicator lights for Power on, oil on, call for heat, and flame failure. All lockout conditions shall sound an alarm, panel mount an auto-rest alarm silencing switch and alarm buzzer. Provide panel mounted fused disconnect for single point field electrical connection. Provide terminals for remote emergency stop field connections.

d. Optional lights and alarms indications: Additional auxiliary light shall be mounted in the top indication section of the panel and include an engraved label indicating the function of each light. Provide a relay coil in parallel with the alarm horn which will close a set of dry contacts when the alarm horn annunciates. Provide an alarm silence pushbutton on the face of the panel. Dry contacts shall be wired to low voltage field wiring strip terminals by the OEM. The following indication lights shall be provided along with necessary isolation circuits as required:

1. "High Flue Gas Temperature" (Red) With Alarm;
2. "Pilot Failure" (Red) With Alarm;
3. "Ignition On" (Amber);
4. "Air Flow Failure" (Blue) With Alarm;
5. "High Limit" (Red);
6. "Power On" (Green;
7. "Call For Heat" (Amber);
8. "Main Flame Failure" (Red) With Alarm;
9. "Low Water Cut-Off" (Red) With Alarm;
10. "Auxiliary Low Water Alarm" (Red) With Alarm;

11. “Main Gas Valves ON” (Amber);
12. “Pre-Purge” (Amber);
13. “Post-Purge” (Amber);
14. “Lockout” (Red) With Alarm;

35. Webster Corp., or approved equal, Sequence Over-Fire Draft Control:

a. The contractor shall furnish and install a UL approved Webster Corp., or approved equal, Sequence Over-fire Draft Control System. The controller shall be installed in the burner panel and shall have a two line liquid crystal display (LCD) for all tuning and scaling operations and for display of variables such as draft pressure. The operator interface shall have at least four pushbuttons on the front panel for all operator functions such as selection of displays and control functions. The display shall include set points and tuning parameters and operational values such as draft pressure and alarms.

b. The controller shall sense the draft pressure by direct connection to the furnace tap. The standard controller shall have a pressure transducer that is capable of measuring compound pressures within the range of minus 3-inches to +3-inches W.C. This transducer shall be temperature compensated and shall produce a signal that is directly proportional to the differential pressure between atmospheric and the furnace pressure.

c. The controller shall be field configurable for selecting the sequence mode from non-sequencing to sequencing with post purge and pre-purge capability and for positive or negative set point control applications. Post purge and pre-purge capability shall have adjustable time delays selectable from the front panel, or signaled directly from the combustion controller. The controller shall have Modbus (selectable as 9600 or 19200 baud rate) communications as standard.

d. The controller shall have an electronic draft indicator. The draft pressure shall be indicated on the two line liquid crystal display for the range.

e. The controller shall include an open/closed/auto selector switch and all necessary relays for full programming and control actions. The closed position shall bypass all automatic functions and closes the damper. The open position shall open the damper and the boiler shall be capable of being operated in the case of controller malfunction or boiler maintenance. In the automatic position, the controller shall maintain the desired setting to within one-hundredth (0.01) inch water column by varying the position of the draft damper. The controller shall include proportioning band adjustment and a dampening adjustment that shall filter out the furnace pulsation without loss of sensitivity.

f. The controller circuit shall interconnect with the combustion safeguard and limit control circuits governing burner operation, to provide fixed damper opening for pre-purge and stable ignition, full modulation of damper during firing, and close damper after boiler shut down. However, burner shall shut down when switch is moved from auto or open. The controller shall have a UL approved draft cutoff switch that shall shut down the system in the event of an unsafe draft condition in the furnace extending over 8 seconds duration. The switch shall be mounted inside the controller cabinet. After safe draft is reestablished, the combustion system shall recycle from the original starting position. The cutoff point of

the minimum draft switch shall be adjustable within two-hundredths (0.02) inch of the operating draft. The controller shall also indicate alarms on the display.

g. The controller output shall drive a Supply a 300 inch-pound torque rotary actuator with heavy-duty linkage. Unit shall be equipped with an adjustable “start position” switch. A purge position signal switch shall be an integral part of the operator. The operator shall be equipped with a mechanism permitting selection of any partially open setting of the damper for the purge position (minimum 20 percent). This feature shall allow the full range of the damper opening to be utilized during the firing cycle, and also permit adjustment of the purge position to provide maximum opening of the damper without adverse effect on pilot operation.

h. All necessary linkages, including adjustable clevises, pipe adapters, and damper lever arms shall be designed for the particular use of the equipment to be installed, to provide free, smooth and rigid operation, but eliminate unnecessary play and lost motion (backlash).

36. Flue Gas Temperature Indicator and Alarm:

a. The controller shall have a flue gas temperature indicator/ limit control. A Type J Thermocouple and 50-feet of extension wire shall be provided. Mounting shall be provided by the Contractor.

b. The controller shall accept the input from the thermocouple directly and shall display the temperature on the front panel light emitting diode (LED) display. The controller shall have the capability of setting the alarm temperature; provide a display of temperature alarms an alarm contact to shut-down the burner. The controller shall have local manual reset capability. The temperature controller must have the capability of temperature display in degrees Fahrenheit via front panel operation. Thermocouple failure shall result in a fail-safe response.

37. 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.

i. The Oxygen analyzer shall include a digital controller that performs continuous self-diagnostics with diagnostic codes for at least 10 common faults.

j. 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.

k. The detector shall be field replaceable without removing the probe from the stack and shall not require special tools.

l. The analyzer shall automatically perform periodic detector cell impedance tests to be used by the operator as an indication of calibration shift.

m. Analyzer calibration shall be pushbutton semi-automatic (no trim pots) with English language prompts and diagnostic messages.

n. Analyzer output shall be field selectable as 0-10% or 0-21% without field recalibration.

38. Digital gas meter: Provide a thermal dispersion Mass Flow-meter with an integral transmitter that will directly measure, indicate, totalize and transmit a linear 4-20 mA signal and a pulse output corresponding to the mass flow of the natural gas. The thermal mass flow-meter shall have the following features:

    a. Operating Principle: Constant temperature thermal anemometer circuit using two industrial grade Platinum.
    b. 200 millisecond response time.
    c. Programmable pulse output for remote totalization.
    d. Optional Modbus Communications.
    e. Smart electronics to permit filed adjustment of critical flow meter settings.
    f. Field validation of flow meter calibration.
    g. NEMA 4x HOUSING.
    h. Product and Manufacturer: The Insertion Mass Flow Transmitter shall be Model 620S BT as manufactured by Sierra Instruments.

39. Control Interlocks:

    a. Associated Boiler Room outdoor combustion air intake façade louver mounted motorized dampers with motor operator integral end-switches. Electrically hardwired interlock shall be provided in the burner operating circuit which shall ensure that the associated outdoor combustion air intake dampers are fully open before the burner can operate and to prevent the opening of the main fuel valves unless the outdoor combustion air intake damper is proven fully open. The burner control shall cause the motorized outdoor combustion air intake damper to automatically fully open whenever the burner forced draft fan is operating, and to close whenever the burner forced draft fan is not operating. The damper motor shall be spring return type, designed to operate with a transformer on 120-volt/1-Ph/60Hz electrical service. The transformer shall be provided with thermal overload protection. Boiler room freeze protection circuit shall be provided to close the associated outdoor combustion air intake dampers in the event of a flame failure, via hardwired interlock.
    b. The over-fire draft system circuitry shall be interlocked with the burner circuitry to insure correct sequencing of all combustion system components.

40. Burner Control System PC Computer Terminal Interface Capability: The burner control system controller shall be able to communicate via cable to a PC computer terminal loaded with a control edit software program to set and adjust control parameters.

41. Product Liability Insurance: The burner manufacturer shall provide an Insurance Certificate documenting his current coverage of Product Liability Insurance.

42. Burner Start Up Information and Test Data: On completion of the burner system

start up, the installing Contractor shall complete the "Burner Start Up Information and Test Data" form and "Control Settings" form, and shall submit it for review by the Engineer.

2.05 BOILER PLANT MASTER CONTROL AND INSTRUMENTATION PANEL:

A. Provide a fully integrated boiler control system to coordinate the operation of five (5) fully modulating steam boilers in order to maintain Steam Header Pressure at set point. The control system shall be microprocessor-based and mounted and wired in the boiler master control panel.

B. The control system shall provide a PID based 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. Normally the lag boilers shall be base loaded at an operator adjustable firing rate for peak efficiency. 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 0-135 ohm and shall be electrically isolated channel-channel and channel-ground.

C. The operator shall be capable of manually setting the Steam Header Pressure Set point 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 as a function of run time, every 1-to-168 hours (adj.), or shall be manually selected by the operator via a lead/lag sequencing selector dial mounted on the face of the control cabinet. Provide a warm standby boiler shell low-fire-hold aquastat input for each boiler. Each off-line boiler shall be started and held at low fire when the temperature drops, and shall be prevented from modulating towards high fire until boiler shell water temperature reaches 180^{o}F, minimum (adj.). When called to run, the boiler shall hold at low fire until the temperature rises above the warm 180^{o}F 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. The Control System shall include a minimum 100x150 pixel historical trending display or a paperless chart recorder or other videographic hardware 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.

F. Include hard wired backup stations to permit manual operation of the plant should the control system require service. Manual operation shall be possible when the microprocessor is not functioning. Hard wired “Hand-Off-Auto” control switches shall be wired directly into every boiler Start/Stop circuit. Each 0-135 ohm modulating control output must include a hard wired manual backup station with Auto/Manual switch, output control knob and output level indicator (bargraph, analog meter or digital display).

G. The Control System shall include simultaneous communication to a Data Acquisition System (DAS), Building Automation System (BAS) or Building Management System (BMS) via RS485 Modbus 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 set point, plant firing rate, boiler quantity called to start, boiler selected as lead and all setup parameters shall be readable and writable.

H. Provide a self-contained automatic sequence draft controller for each boiler. The controller shall be microprocessor-based and panel mounted. Provide a field mountable 4-20 mAdc pressure draft transmitter for measuring boiler outlet draft. Provide a high flue gas pressure (low draft) switch with 5 second delay for use in the Flame Safeguard Limit Circuit. The Controller shall continuously indicate boiler draft, draft set point and alarm set point on a highly visible backlit LCD display. The control shall provide both automatic and manual damper control. Provide an integral or separate 4-inches, 0.50% resolution (minimum) bargraph display in engineering units with visual alarm indication. Provide a “High Boiler Pressure” alarm, “Alarm Silence” pushbutton and one 10 ampere alarm relay output. The housing shall be panel mountable, fully gasketed with NEMA 4 front face. All adjustments shall be made from the front panel display in engineering units. The controller shall include setup menus for easy operation, tuning and troubleshooting from the Controller faceplate. No external configuration tools shall be required. The controller shall include an automatic draft sequence as follows: During burner “off” periods the draft control damper shall remain closed to hold residual heat within the boiler. On a call for burner operation the outlet damper shall be driven open for pre-purge. To prevent pressurizing the boiler, the burner fan shall start after a field adjustable time delay after starting to open the draft damper. The damper shall remain open for burner light-off. When the fuel valve opens, the draft control damper shall be released from the open position and modulate as required by the draft set point. During normal burner shut-down the damper shall be driven open during the post-purge period and then closed when the fan stops. Abnormal burner shut-down (safety lock-out of flame safeguard control) shall cause the damper to drive open where it shall remain until the flame safeguard system is reset. The controller shall interconnect with the flame safeguard system directly using 120Vac signals. The controller shall be capable of establishing an adjustable position for burner light-off. Each fuel shall have an independent light-off position. The

controller shall not close the light-off contact output unless the damper is above the proper position and the pressure is below the starting draft set point.

I. Provide a draft range transmitter and high pressure (low draft) switch with time delay relay. Both shall be supplied with field mountable, dust-tight, splash-proof enclosures. A single draft connection shall be piped to minus 1-inch WC to +1-inch WC 4-20 mA DC transmitter and an independent low draft switch. The low draft switch set point shall be field adjustable from +0.15-inch WC to +4.0-inch WC. 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 shall help avoid nuisance burner shutdowns due to momentary draft fluctuations.

J. Provide manufacturer’s standard draft regulating damper and an electric modulating draft damper actuator for each boiler. The actuator shall have adequate power to automatically position the damper and shall be suitable for control by the draft controller. 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 backlash and rotate 90º in 30-seconds.

1. Sequence of Operation for Breeching Draft Sequencing Damper:

    a. During the period when there is no call for burner operation by the boiler pressure operating control, the breeching draft sequencing damper shall be maintained in the safe closed position. Safe closed position shall be understood to mean that the damper blade shafts have been rotated approximately 70° from the fully open position.

        1. When the boiler pressure operating control calls for burner operation, the following sequence of operation shall take effect:
        2. On call for heat: the associated interlocked outdoor air intake damper, combustion air damper at burner and the draft sequencing damper shall prove open, prior to pre-purge.
        3. Draft sequencing damper shall be driven to full open position during pre-purge.
        4. For ignition, the sequence draft damper shall move to safe starting position. When the fuel valve opens, the draft sequencing damper control shall be placed under automatic draft control.
        5. During normal burner shutdown, the draft sequencing damper shall be driven open for post purge and shall be closed at the end of purging. Safety burner shutdown shall cause the draft sequencing damper to remain where it was at the moment of shutdown, until flame safeguard is reset.

    b. Breeching draft sequencing damper shall move to safe starting position, which shall be adjustable in the field. On call for heat Operation, the draft

sequencing damper cycle shall be initiated; on proving open, damper purge cycle shall start. After pre-purge, safe starting draft shall be proven in combustion chamber before light off can take place.

c. Burner forced draft fan shall be controlled through auxiliary fan relay in burner control panel.

d. As soon as safe starting draft is established, the flame failure control shall go through normal sequence of pilot ignition, pilot proving, main flame ignition and proving. When main flame is proven, draft controller shall modulate to maintain constant combustion chamber draft, within 0.01-inch WC of adjustable setting, regardless of firing rate or atmospheric conditions.

    1. When boiler pressure operating control is satisfied, flame failure control shall de-energize the fuel solenoid valve, shutting off main flame. Forced draft fan shall continue to run for 15-second (minimum) post purge period. During this period, breeching draft sequencing damper shall remain open to permit venting of gases. After completion of post purge period, breeching draft sequencing damper shall move to safe closed position.
    2. At any time during an operating cycle, if the draft in the combustion chamber should fail for any reason, an alarm signal light in the draft controller shall so indicate and if draft is not re-established within 5-to-7 seconds, the burner shall be shut-down.
    3. In case of flame or power failure or any emergency, burner shall shut down and breeching damper shall open fully and remain open. Burner and fan motors shall shut-down with burner lockout. Draft sequence controller shall recycle after manual reset of flame failure control.

K. Provide a stack temperature alarm and shutdown circuit for each boiler. Stack temperature shall be digitally displayed and setpoints shall be provided for "inefficient" and "dangerous" alarm conditions. Inefficient alarm setpoints will sound a local alarm requiring acknowledgement to silence. Dangerous stack temperature conditions shall shut the boiler down and shall require a manual reset.

L. Provide Smoke opacity monitors (one for each boiler). The smoke monitor shall consist of a NYCBAR approved light source, solid-state optical detector, microprocessor-based alarm and indicating instrument, and remote smoke alarm. The instrument shall provide a smoke opacity percent display in engineering units, warning indication, burner Safety Shutdown indication and relay contacts. The instrument shall continuous indicate smoke density on a highly visible backlit LCD display. Provide an integral or separate 4", 0.5% resolution (minimum) bar graph display in engineering units with visual alarm set point indication. Provide an “Alarm Silence” and “Manual Reset” pushbutton and two 10 ampere relays. The housing shall be panel mountable, fully gasketed with NEMA 4 front face. All adjustments shall be made from the front panel display in engineering units. The “Standard” Operating Sequence shall be as follows: When smoke density exceeds set point, the bar graph shall flash, and an “Alarm” message shall appear. After a 20 second “smoke-puff” delay the “Alarm” relay contact shall close the circuit for the remote alarm device. Pressing the “Alarm Silence” pushbutton shall reset the alarm relay to silence the alarm device. If the smoke density

reduces below the set point within 120 seconds (adjustable), the bar graph shall stop flashing and the “Alarm” message shall disappear. If the smoke density exceeds the set point for 120 seconds or more, the “Shutdown” message shall appear, the “Alarm” relay shall re-close and manually reset “Shutdown” relay contact open, to shut down the violating burner. Pressing the “Alarm Silence” pushbutton shall reset the alarm relay to silence the alarm device. When the smoke density then falls to below the set point, the “Shutdown” message shall remain on and the “Shutdown” relay shall remain in the manual reset mode. With smoke opacity cleared, pressing the “Reset” pushbutton shall reset the system, the “Shutdown” message shall disappear, and the “Shutdown” relay shall reset to permit normal burner operation. In order to avoid nuisance burner trips due to dust build-up on the light source and sensor, the instrument shall include an automatic, unattended re-calibration cycle whenever the burner fan stops running (ensuring a clear stack condition). The optical sensing unit lenses shall be designed to accommodate regular cleaning without dismantling the installed assembly. Light Source and Detector shall sight 100% of the effluent path length. Light Source shall utilize a pre-focused sealed beam lamp with a maximum 5 degree projection angle. Photo Detector shall include a photopically filtered, solid state photo cell and alignment verification bulls eye. The Instrument shall include a RS485 Modbus network interface and a 4-20 mAdc retransmit output to communicate to a future Data Acquisition System (DAS) or Building Automation System (BAS). The Instrument shall be manufactured and labeled in accordance with UL508A requirements (CSA C22.2 #14 for use in Canada). Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL). The draft control system shall be a Preferred Instruments, Danbury, CT, Model JC-30D. Smoke opacity monitors shall be equipped and wired so as to actuate an audible and visual alarm in both the boiler room (central panel) and in the Operating Engineers Office (remote panel).

M. Wiring from the water level, flue gas temperature sensing, smoke opacity monitoring, pressure controls and draft sequencing damper motors shall be rated for high temperature service from the components to the first termination or junction.

N. Microprocessor Lead-lag Master Controller:

1. The controller shall be pre-engineered and programmed exclusively for operation of multiple full modulating steam boilers.
2. The controller shall be UL Listed, tested per Standard 873 and CSA listed, tested per Standard C22.2 number 24-1987. It shall be approved for use in NYC by City of New York, Department of Buildings, Bureau of Electrical Control and Department of Air Resources.
3. The controller shall be installed in accordance with the manufacturer’s instructions and all applicable codes and regulations.
4. The controller shall be of modular construction to facilitate field modification, upgrading or repair.
5. The manufacturer shall set up installation supervision and full training program for building personnel.
6. The controller shall be compatible with the heating control system.

7. The contractor shall provide all required equipment, electrical and control wiring and conduits for the installation of the new Lead/Lag controller.

8. The control shall operate on 120 VAC, with a maximum power of 40 watts. The control shall operate between 20 and 130ºF with an operating humidity of 20 to 80% RH (non-condensing) with a storage temperature of no less than –4ºF and no more than 180ºF.

9. The new microprocessor Lead/Lag controller shall be Multi-Mod by Heat Timer or Chief Dispatcher by Preferred Instruments and shall have the following features:

    a. Display: The control shall have a four line by twenty character VFD display capable of displaying both numbers and characters. The display shall be visible with no ambient light. All control operation information shall be available for display.
    b. During times of inactivity, or 15 minutes after last user entry, the display shall enter a lower power mode. In this mode, the display shall reduce visible light output. The control shall exit this mode whenever button or digital encoder activity is sensed.
    c. The control shall use five push buttons and one rotary digital encoder for user parameter entry. User parameter entry shall be accomplished using a menu system.
    d. The controller shall be provided with remote communication capability and shall be capable of being field upgraded for use of future BACnet.
    e. The control shall be Johnson Metasys, or approved equal, compatible. This communication shall be via RS485. The control shall have dual RS485 output capability to communicate with any two of the following: TGC, Notifact, or Metasys.
    f. The control shall have the capability of operating in a temperature or pressure mode. Temperature sensors shall be of the thermistor type. Standard operating range shall be –30 to 250ºF. Pressure sensors shall be of the 4-20ma type. Standard operating range shall be selectable for 0-15, 0-30, 0-100, o-200 and 0-300 PSIG.
    g. The control shall accept a dry contact input to shut all boiler stages down. The control shall keep any boilers being shut down in low fire for 45 seconds before opening the limit circuit relay.
    h. Boiler Lockout Inputs: The control shall be capable of accepting four dry closure type boiler lockout inputs.
    i. Outputs: The control shall have four normally open contacts that can be used to start/stop the burner. These outputs shall have a minimum current carrying capability of 5 amps. The relays controlling these outputs shall be field replaceable. The control shall have four modulating outputs. These outputs shall be modules with two outputs per module. The control shall have the capability to operate modules having 0-5 volts, 1-5 volts, 0-10 volts, 2-10 volts, 135 ohm, and 4-20 ma outputs. The control shall be capable of operating two different output groups. The control shall be capable of identifying the output module types and adjusting control methods accordingly. Where practical, the output modules shall be protected from accidental incorrect connection. Should damage occur, where practical, damage shall be confined to the output module.

j. Additional Outputs: The control must be able to accept an extension module to increase the capacity by an additional 8 stages. All of the functions of the extension module shall be displayed on the Multi Mod.

k. System Prove: The control shall be capable of accepting a dry closure type system prove input. This shall prevent any stages from activating until the contact is closed.

l. System Output: The control shall have a set of normally open contacts that shall close when the Multi-MOD requires output. These contacts shall remain closed for an adjustable period of time after the last stage is turned off.

m. User Parameters: The control shall have the following user adjustable parameters:

n. Sensor Setpoint: The control shall provide an integral sensor set point adjustment. The set point shall be adjustable in 1ºF or 1 PSIG increments.

o. Ignition Start Point: Adjustable from 1 to 50%. This setting shall determine the position of the firing rate (fully modulating) motor at the time the burner is energized or de-energized. There shall be an independent adjustment of this setting for each burner.

p. Modulation Start Point: Adjustable from 0 to 100%. This setting shall determine the percent modulation a stage must achieve before the next stage is activated. There shall be an independent adjustment of this setting for each burner.

q. Purge Timer: Adjustable from 0-10.0 minutes. This setting shall determine the delay time between a stage being energized and the beginning of modulation.

r. Lag Stage Relay: Adjustable from 0 to 60 minutes. The next stage in the rotation shall not be fired until the previous stage has remained in high fire for the period of time set by the Lag Stage Delay.

s. Setback: Setback shall be adjustable from 0 to 75ºF, or 0 to 7.5 PSIG on 0-15 or 0-30 PSIG units, 0 to 75 PSIG on 0-100 PSIG units, 0 to 150 PSIG on 0-200 PSIG units, or 0 to 200 PSIG on 0-300 PSIG units. This setting shall determine the ºF/PSIG drop from the primary set point whenever the setback mode is activated. The setback mode shall be activated by an external switch closure.

t. Standby Timer: Adjustable from 1 to 60 minutes. This setting shall determine the delay period that must elapse before any designated standby stages are activated.

u. System Delay: Adjustable from 0 to 60 minutes. This timer shall start after the last stage has turned off. The System contacts will remain energized until the time period has ended.

v. Rotation Mode: The control shall be capable of the following rotations:

    1. Manual rotation;
    2. Automatic rotation adjustable in one-hour increments from 1 hour to 7 days;
    3. First on/First off;

w. Heat/Cool Mode: The control shall be capable of running either in a heating mode or a cooling mode.

x. Parallel Modulation Mode: The control shall be capable of operating stages such that all active stages modulate at the same rate.

y. Process Mode: The control shall be capable of accepting a throttling range around the set point.

z. Battery: A lithium “coin” type battery shall be included to maintain all system parameters in the event of a power failure. Storage capacity shall be 100 days.

O. The control panel shall be manufactured and labeled in accordance with UL508. Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL). The control system shall be by Preferred Instruments, Danbury, CT, as represented by Analytical & Combustion Systems, Inc. or approved equal.

2.06 AUXILIARY CONTROLS:

A. Thermal Cut-off: Furnish and install a Factory Mutual approved (hand wheel type) thermal cut-off set at 165° F on each boiler front, 24 inches above the burner. Mount another thermal cut-off 12 to 24 inches above the top-front edge of each boiler. Submit shop drawings for approval. All thermal cut-off switches shall be installed with the spindle in the horizontal position.

B. Emergency Breakglass Switches: Furnish and install two (2) emergency breakglass switches, one (1) at each boiler room 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. Thermal cut-offs, breakglass switches, shall be wired in series to shut down the boilers and domestic hot water heaters.

C. Aquastat: Provide an aquastat to maintain minimum 180°F temperature in each boilers. Aquastat shall be Honeywell Model No. L4006A, or approved equal.

D. Contractor shall provide a local boiler room alarm system and connect to NYCHA Intranet for the remote monitoring of power failure alarm and low steam pressure alarm. Contractor shall enlist the services of a CHAS system specialist (Intech21 Corp.) for the installation of the alarm system.

1. Alarm’s Communication Panel:

a. Provide, install and program a new RE2104 alarm panel with new enclosure, as manufactured by Intech21 Corp.

b. Provide a dedicated 110VAC/15A circuit for the RE2104 alarm panel.

c. Provide testing and certification of communication wiring to ensure reliable communications to NYCHA’s existing Computerized Heating Automation System (CHAS) application.

d. Provide and connect CHAS alarm pressure sensor (pressuretrol) and electrical supply monitoring sensor relay. Alarm sensor points shall be wired to new communication panel for remote alarm point monitoring.

e. Provide wiring and cables as required to complete the CHAS system interfaces.

2.07 MISCELLANEOUS BOILER PLANT CONTROL INSTRUMENTATION:

A. Refer to the specified requirements of Section 230924 for provision of steam supply meters in the boiler plant steam supply mains.

B. Plant Steam Pressure Recorder

1. Furnish on control panel a 10-inch electronic type circular chart recorder for recording steam pressure in the boiler header. Gauge shall be mounted in an iron or cast aluminum case with enamel finish, provided with a range from zero-to-30 pounds per square inch gauge pressure. Clock shall be electronic type and shall be completely prewired in control panel. Supply with gauge 100 twenty-four (24) hour charts, bottle of recording ink, ink filler, and lock and key for recorder. Transmitter shall be connected to point in top of main header.

2. Plant steam pressure recorder shall be Honeywell Model DR-4200EVI-30 or equal.

C. Run Time Indicator (One for each boiler): Provide in the control panel of each boiler a run time totalizing meter to record the total number of hours of boiler operation. The meter shall have a six digit readout from 0 to 999,999 hours.

D. Digital Natural Gas Meter: The Thermal Convection Mass Flowmeter shall include a Single-Point Mass Flow Element with Integral/Remote Transmitter and shall directly measure, indicate, totalize and transmit linear 4-20 mA signals corresponding to the mass flow and temperature of the air (gas) in the pipeline.

1. Insertion Mass Flow Transmitter Required Features:

a) Operating Principle: Constant temperature thermal anemometer circuit using two industrial grade Platinum RTD's, having two-wire, loop-powered sensor electronics, including automatic sensor lead wire resistance compensation, low-self-heat temperature sensor circuitry and five-wire RTD construction with surface mount electronics technology, and with CE Compliance for EMI, RFI and surges.
b) Velocity Range: 0 - 18,000 SFPM (300 SFPS), air at standard conditions of 25°C and 760 mmHg, specific range digitally selected.
c) Velocity Measurement Accuracy/Interchangeability: ±[(1% + .025%/°C) Reading + (20 SFPM + .25 SFPM/°C)] above or below 25°C.
d) Repeatability: 0.25%.
e) Process Temperature Rating: -40°C to +200°C.
f) Process Pressure Rating: 300 PSIG.
g) Time Response (T/C): Velocity changes: 1 second; Temperature changes: 1-3 seconds.
h) Sensitivity to Velocity Angle of Incidence: Less than 2% for yaw or pitch angles of up to ±20°.
i) Pressure Drop: Less than 0.1" W.C.
j) Sensor Material: Alloy C-276, all-welded construction.
k) Sensor Support: 316L Stainless Steel, all-welded construction; 1/2", 3/4", or 1" diameter.
l) Insertion Length: Per manufacturer's recommendations (See DCN 364002).

m) Process Line Sizes: 2 1/2" pipe and larger.
n) Sensor Electronics Enclosure: NEMA 4/7 painted aluminum dual chamber, Class 1, Div. 1, Groups B, C, D.
o) Sensor Enclosure Temperature Rating: -40°C to +60°C.
p) Process Connection: 1/2", 3/4", or 1" 316 Stainless Steel Compression fitting to fit FNPT fitting on pipe (by customer), with flange mounting.
q) Field Wiring: Two pair of twisted and shielded 20-22 gauge wire for signal and one pair 14-18 gauge wire for power.
r) Safety Approvals: Explosion-Proof (XP), Flame-Proof (FP), and Non-Incendive (NI).
s) EMI Approval: CE compliance: light industrial: (EN 50081-2) for emissions, heavy industrial (EN 50082-2) for immunity and (EN 61000-4-5) for surges.

2. Electronics Specifications:

a) Display : Microprocessor Based with two-line sixteen character LCD display and 20 key user interface keypad mounted in the electronics enclosure for display of flow rate, temperature, flow area, time, date, flow totalization, alarms, and elapsed time. Easy read back-lit display with adjustable orientation.
b) Features: User changeable STP reference conditions, multi-point calibration correction factors, with Help Screens. Digital input of all data including 12 character I.D., two access codes, built-in input/output calibration, two optically isolated 4-20 mA outputs, four sealed alarm relays, user entry of flow area, velocity or mass flow range, meter I.D., variable velocity flow correction factors, built-in RS-232C “Echo” terminal port for IBM laptop upload/download/recording. Velocity/Temperature/Mapping for wide ranging velocity and temperature processes. Remote Electronics enclosure, Flash EEPROM program memory, 12 bit analog outputs, 18 bit input signal, resolution, auto-zero/span input calibration, and Modbus network communications.
c) Field Service. The vendor shall provide start-up assistance, check-out, training, perform the in-situ, flow calibration and input of flow calibration correction factors into the Mass Flow Computer. The flow calibration may be accomplished using an EPA type Pitot tube traverse for applications in which the upstream unobstructed L/D is greater than 8:1; or a Trace Gas Calibration for applications having less than an 8:1 L/D ratio. The Trace Gas Method is preferred for small pipes because of the difficulty of making accurate measurements.
d) Product and Manufacturer: The Natural Gas Insertion Mass Flow Transmitter shall be Model 454-08, 454-12, or 454-16 as manufactured by Kurz Instruments, Inc., 2411 Garden Road, Monterey, CA.

3. Provisions For Future Instrumentation and Monitoring Interfaces With Future BMS: Under a future separate contract scope of work, to be provided by Others, the Building No. 5 central steam boiler plant is to be provided with a BACnet protocol supervisory building controller (Tridium JACE 8000, or equivalent), to collect data from the boiler master controller and other boiler plant equipment and monitoring points. The supervisory building controller will interface with existing Niagara N4 front end software and utilize NYCHA standard graphics templates and naming standards. A BMS Points List for monitoring and control in

the Central Steam Boiler Plant, and the gas-fired domestic water heating systems of each of the Satellite Bld'gs. and for the gas-fired domestic hot water heaters in the Central Boiler Plant, is specified under Section 23 09 13. The Instrumentation And Controls Contractor of Section 23 09 13 shall provide the necessary piping pressure, temperature and flow-rate wells, ports, taps, instrumentation, meters, associated control wiring, control transformers and power for control, to facilitate the future connections of the monitoring and controls instrumentation of the new Central Steam Boiler Plant and of each of the new domestic water heating systems, as specified under the BMS Points List of Section 23 09 13, to the future BMS.

a) The new steam boiler plant controls, as specified to be provided under other Sections of Div. 23, are to utilize open BACnet and/or Modbus protocols.

b) The new domestic water heaters, as specified under the Plumbing Sections of the Work, are to be provided with an integral BACnet card, and instrumentation ports and taps are to be provided as shown under the Plumbing Contract Drawings, as necessary in each Building's domestic water heaters system, for future connections of future monitoring instrumentation to be provided by others, to the future BMS.

c) Plant steam flow meters, makeup water meters and potable cold water supply meters to new domestic water heaters, as specified under other Sections of Div. 22 and Div. 23, are to be furnished and installed to facilitate future remote monitoring via the future BMS.

d) The natural gas utility meter is to be provided with capability to facilitate real-time digital monitoring via the future BMS.

4. The existing steam boiler plant NYCHA Computerized Heating Automation System (CHAS) panels, as identified on the Contract Drawings, (ie., existing Intec21 ZVLC and RE control panels, and existing Dunham Corp. control panels), shall remain in-place, fully intact, operational and functional, and the Contractor shall provide complete temporary protection for the existing control panels, fully protecting them from any potential damages due to impact, dust and/or moisture, throughout the duration of construction. The existing steam boiler plant NYCHA CHAS panels shall remain in-place, fully intact and operational throughout the complete duration of this Contract Scope of Work, and until the future BMS system controls work begins. Any new control wiring interfaces to be provided from new instrumentation or sequencers to the existing CHAS panels that are to remain, shall be provided in such a manner so as to easily allow for later control panel replacement to a nearby location.

2.08 ELECTRICAL PROVISIONS OF BOILER PLANT CONTROLS WORK:

A. Control power, including systems furnished as part of factory fabricated equipment, shall be maximum 10 VDC, 24 or 120 VAC, single phase, 60 hertz, unless otherwise noted. Provide power supplies and wiring to all control panels, and electronic transmitters specified herein, in accordance with the requirements of this Section and as specified under Section 230913.

B. Control wiring is defined to include wire, conduit and miscellaneous materials for mounting and connecting control devices. Control power wiring is defined to include

wire, conduit and miscellaneous materials for powering thermostats, DDC controllers, remote temperature control panels, valves and damper motor operators, and associated control devices. Control wiring and control power wiring shall be provided under this Section for the work specified herein. Provide control wiring, without splices between terminal points, color-coded, in neat workmanlike manner, securely fastened in galvanized steel threaded conduit. For low voltage AC: Minimum 600 volt insulated copper, No. 18 AWG or larger, Type MTW, THHN or TFFN. For low voltage DC and electronic circuits carrying less than 0.5 amps: Cables of two or more conductors not smaller than No. 18 AWG solid copper, or No. 18 AWG solid copper if not shielded in lieu of individual wires. Cables carrying analog signals shall be shielded.

C. Install and connect control components, furnished as part of package equipment, but not installed at the factory.

D. Provide separate control power transformers for supplementary control of system components in control panels where feasible; otherwise mounted in field in separate NEMA rated enclosures.

E. Provide DC power supplies for each electronic transmitter, controller or device requiring direct current for its 4 to 20 miliamp operations. DC power supplies shall be the product of the respective transmitter manufacturer and shall be suitable for 120 volt or less, single phase, 60 Hz power input. Mount power supplies in NEMA 3R enclosures.

F. Number-code and color-code conductors and conduit appropriately for future identification and servicing of control system.

G. Provide the following electrical work in conformance with the specified requirements of Division 26.

1. Low voltage power supplies (120 volt or less) from local power panels provided under Division 26 to control system power supplies for controls, including but not limited to each burner controller, annunciators, 120/24 volt or other control transformers, DC power supplies for local control panels. Coordinate circuits required with Division 16, Electrical.
2. All control wiring between equipment and controllers provided under this Section, controls provided under this Section, factory furnished, field-installed controls, and indicating devices provided as specified under other Division 23 Sections. Provide all necessary 120V power supplies, transformers, and DC power supplies.
3. All control wiring between the CHAS console terminal, controllers and control panels provided under this Section and the equipment specified under other Sections of Division 23, as may be applicable.
4. Control power connections from motor starter and/or VFD control transformers to associated system control devices and instrumentation.
5. All control wiring between instrumentation and controls provided under this Section and the local factory furnished controllers of equipment specified under Division 23 Sections, as may be applicable.
6. All status function conduit and control wiring for all equipment provided under this Section and under other Division 23 Sections.
7. Conduit and control wiring between the burner control panels and boiler-burner control instrumentation and sensing elements, including low voltage control wiring in conduit.

8. Conduit and control wiring between equipment motor starters, VFD's, and control relay contacts and remote relays in existing and/or new control panels, and between equipment motor starters and VFD's as required for interlocking operation of equipment, as specified.
9. Conduit and wiring between the burner control panels, metering instrumentation, indicating and alarm devices, remotely operated contactors and existing boiler plant control panels as shown on the Contract Drawings and as specified herein.

H. Install complete control wiring system for control systems. Conceal wiring, except in areas where other conduit and piping are exposed. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly. Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with the specified requirements of Division 26, the National Electrical Code and the 2014 Building Code of the City of New York.

1. Install circuits under 25-volt with color-coded No. 18 wire with 0.031" high temperature 105°F (41°C) plastic insulation on each conductor and plastic sheath over all.
2. Install electronic circuits with color-coded No.22 wire with 0.023" polyethylene insulation on each conductor with plastic-jacketed copper shield over all.
3. Install all wiring in minimum 0.75" diameter galvanized steel rigid electrical conduit. All specials, such as junction boxes and connectors shall be of type designed for use with rigid galvanized steel conduit.

2.09 FIRE EXTINGUISHERS

A. Fire Extinguishers

1. Provide in location at each boiler-burner, one 5 pound capacity BC dry chemical charge fire extinguisher. Extinguisher shall be approved by NYC Board of Standards and Appeals and shall be so labeled.

PART 3 - EXECUTION

3.01 BOILERS FACTORY TESTING

A. Boilers Hydrostatic Pressure and Fire Tests:

1. Factory hydrostatic pressure and fire tests (for packaged boilers)

a. Boilers shall be pressure tested at the factory in accordance with ASME requirements. All factory pressure and safety tests shall be certified by an Inspector of the National Board of Boilers and Pressure Vessel Inspectors. This certification shall be submitted to the Authority's Construction Project Manager prior to shipment from the factory. After installation, the contractor shall perform a field pressure test at 60 PSI for a period of not less than 4 hours and with a pressure loss of not more than 1.0 PSI. This test shall be

subject to approval by the Authority's Construction Project Manager. Should any boiler(s) fail a test, the contractor shall perform necessary repairs and additional testing to the satisfaction of the Authority. Contractor shall submit a report of the factory test to the Authority's Construction Project Manager.

b. Boilers shall be fire tested and set for proper combustion at the factory prior to shipment to ensure that controls and safety devices are functioning properly. Contractor shall submit a report of the factory test to the Authority's Construction Project Manager.

B. Steam Quality and Performance Tests:

1. Factory steam quality and performance tests (for packaged boilers)

a. The boilers provided to NYCHA shall be tested **in the factory** for steam quality, fuel-to-steam (overall) efficiency and gross output. The testing requirement shall apply to Scotch Marine boilers. The test shall be performed in the presence of NYCHA representatives and in accordance with NYCHA's Standard Procedure for Steam Quality and Fuel-to-Steam Efficiency Testing specified herein after. The tested boiler shall produce a minimum of 98% steam quality and a minimum of 80% fuel-to-steam efficiency when fired with natural gas at the rated output of the boiler. A certified test report shall be prepared by the boiler manufacturer and submitted for approval to NYCHA prior to shipment of the boilers. A boiler of particular model and size that has previously been tested in the factory and approved by the NYCHA need not be tested again. Any boilers that have been modified with respect to the tube arrangement, water level control, settings, dry pan, steam space, disengaging area, burner model or any other change that might affect its performance and steam quality, since it was approved, shall be retested in the factory and approved by NYCHA prior to shipment. The Contractor shall include in his Base Bid the cost of the factory test as well as travel expenses for two (2) NYCHA representatives to witness the test. The boiler being tested in the factory shall not be fitted with a steam separator at the time of the test.

b. Samples shall be collected continuously for a period of two hours with the boiler firing at its rated capacity (full fire). Sample readings shall be taken at 15-minute intervals and recorded. A minimum of eight samples shall be collected. The steam pressure at the boiler outlet shall be kept as constant as possible at 10 psig. The variables that must be measured every 15 minutes during the two hours test are listed as follows.

1. Combustion air temperature (°F)
2. Fuel inlet temperature (°F)
3. Fuel input flow rate (Gallons/Hour – GPH)
4. Feed water input flow rate (Gallons/Minute - GPM)
5. Atmospheric pressure (psia)
6. Steam output pressure (psig)
7. Throttling calorimeter temperature (°F)
8. Weight of water collected from separating calorimeter (lbs)
9. Flue gas analyzer variables:

- CO (ppm)
- CO_2 (%)
- O_2 (%)
- NO (ppm)
- NO_x (ppm)
- SO_2 (ppm)
- % Excess Air

C. Computation Of Steam Quality:

Steam flow through the orifice plate shall be computed using Napier's formula as follows:

$$Q = \frac{P \times A \times 3600}{70}$$

where: Q = steam flow in pounds per hour
P = absolute pressure of steam at inlet of throttling orifice in pounds per square inch
A = cross-area of orifice in square inches.

The formula to compute moisture in the throttling calorimeter shall be:

$$Y_1 = \frac{H-1150.4-0.48(T-212)}{L}$$

The formula to compute the percentage of steam quality in the throttling calorimeter shall be as follows:

$$X_1 = 100 (1 - Y_1)$$

Where: Y_1 = moisture content in sample after throttling, in percent
X_1 = percentage of steam quality in sample after throttling, in percent
H = heat content (enthalpy) of saturated steam in line, in Btu/lb
1150.4 = heat content (enthalpy) of saturated steam at atmospheric conditions, in Btu/lb
0.48 = specific heat of steam in line, in Btu/lb-°F
T = temperature of superheated steam in calorimeter, in °F
212 = temperature of steam in calorimeter after throttling, in °F
L = latent heat of vaporization of steam in steam line, in Btu/lb

H and L can be found from the saturated steam table. T is measured at the throttling calorimeter.

The formula to compute the percentage of steam quality from the separating calorimeter shall be as follows:

$$X_2 = 100 \times \frac{(M+R)}{(W+M)}$$

Where: M = Q

X_2 = steam quality from separating calorimeter, in percent
M = weight of steam passing through throttling calorimeter, in lbs/hr.
W = weight of water collected, in lbs/hr.
R = weight of water corresponding to heat loss by radiation, in lbs/hr. Assume to be zero if calorimeters are insulated.

The overall steam quality shall be determined as follows:

$$X = 100 \times \frac{(X1)}{(100)} \times \frac{(X2)}{(100)}$$

Where X is the overall percentage of quality of steam in steam line, in percent.

The overall percentage of moisture shall be determined as follows:

$$Y = 100 - X$$

Where: Y = overall percentage of moisture content of steam in steam line

ISOKINETIC FLOW ANALYSIS

$$m_{ni} = (nA_p/A_l)\ (EVR)$$

$$m_{na} = Q + W$$

$$D = [\ (m_{ni} - m_{na})/m_{ni}\ ] \times 100$$

Where:

m_{ni} = Isokenetic flow in sampling nozzle in lbs/hr.

n = Number of ports on the sampling nozzle

A_p = Cross Sectional Area of steam lead pipe in square inches

A_l = Cross Sectional Area of port in square inches

EVR = Actual evaporation rate in lbs/hr

m_{na} = Actual flow in the sampling nozzle in lbs/hr.

D = Deviation from isokenetic flow.

Note: The test is conclusive if D is not more than10%.

D. Computation Of Fuel-To-Steam Efficiency By Heat Loss Method:

The computation of efficiency by HEAT LOSS METHOD shall be performed on ASME Abbreviated Efficiency Test Forms PTC 4.1a and PTC 4.1b. Use ABMA Standard Radiation Loss Chart to compute the losses due to radiation and convection. The unmeasured losses shall be neglected.

E. Computation Of Fuel-To-Steam Efficiency:

The INPUT/OUTPUT efficiency shall be calculated as follows:

EVR (lbs/hr) = (density of feed water in lbs/cu-ft) X (feed water rate in gal/min) X 8.021

where: EVR = actual evaporation rate of steam in lbs/hr

HEAT ABSORBED PER POUND OF STEAM (Btu/lb) = $h_s - h_w$

where:
h_s = enthalpy of steam at (P,X) in Btu/lb
h_w = enthalpy of feed water at the feed water temperature in Btu/lb

$$\text{GROSS OUTPUT (hp)} = \frac{\text{EVR X HEAT ABSORBED PER POUND OF STEAM}}{33472}$$

$$\text{INPUT(hp)} = \frac{\text{(measured fuel input in gal/hr) X (fuel heat content in Btu/gal)}}{33472}$$

$$\text{EFFICIENCY (\%)} = \frac{\text{GROSS OUTPUT}}{\text{INPUT}} \times 100$$

F. TEST REPORT FOR STEAM

Contractor shall submit reports on the test results no later than two weeks after completion of the testing. Individual reports shall be submitted for each model and size of the boiler. Test report shall be submitted to Office of Design, New York City Housing Authority, 24-02 49th Ave., LIC, NY 11101. The report shall include the following information:

1. Objective and scope of the test
2. Water and gas meters calibration certificates
3. List of equipment used for the test
4. List of persons witness the test
5. Field data
6. Steam quality calculations
7. ASME PTC 4.1a and 4.1b - 1964 Abbreviated Efficiency Test Forms
8. Boiler efficiency calculations by INPUT/OUTPUT method
9. Boiler efficiency calculation by HEAT LOSS method
10. Error analysis to reconcile results from two methods
11. Summary of results
12. Conclusions
13. Other relevant information

3.02 INSTALLATION:

A. Boiler and Burner Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping. Provide space that permits full opening of all boiler and burner doors, panels and other access openings. Provide space for pulling full length of all boiler tubes directly from their installed location.

B. Drainage Facilities for Boiler Water Column, Gage Glass, Low Water Cutoffs, Water Level Alarms:

1. Refer to the details on the Contract Drawings.
2. Locate and orient sight flow indicators so that one person can view the fluid flow while simultaneously operating drain valves and low water cutoff shunt switches.

C. Boiler Flue Gas Outlet Location: Drawings show a location based on an assumption on the number of passes of the boilers. If the boilers submitted have a different flue gas outlet location, redesign and relocate the stack and breeching systems, at no additional cost to the Government.

D. Boiler Casing Flashing: Flash or seal all openings in the casing at the top of the boiler at the piping and the flue penetrations to prevent leakage of water into the boiler insulation.

E. Gas Piping: Provide gas piping as specified under section 231123, and in accordance with the burner manufacturer’s published instructions.

F. Perform Testing, Adjusting and Balancing in accordance with the specified requirements of Section 230593.

G. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable.

H. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

3.03 CLEANING AND PROTECTION FROM CORROSION:

A. Boiler Cleaning:

1. Upon completion of installation, the initial firing of the burner shall be performed to boil out, under supervision of boiler manufacturer, all internal surfaces with chemical solution recommended by boiler manufacturer, to remove all mill scale, corrosion products and other foreign material. Following boil out, boiler shall be washed and flushed until water leaving the boiler is clear. Drain boiler, inspect internal surfaces for cleanliness, then refill boiler with softened and treated water.

2. Refer to the Subparagraph Inspections And Tests, below, for requirements for cleaning boiler after operational tests are completed.

B. Protection from Corrosion:

1. Protect the boilers from fire-side and water-side corrosion at all times.
2. Dry Storage: When the boilers are not filled with water, protect the water-sides and fire-sides with a dry storage method recommended by either the boiler manufacturer or the ASME Code, Section VII.
3. Wet Storage: If, after water is placed in the boilers, they are not fired for equiment adjustment or testing for more than two weeks, the boilers shall be protected with a wet storage method recommended either by the boiler manufacturer or the ASME Code, Section VII.
4. Chemical Treatment: The quality of the water in the boilers shall be maintained by a professional water treatment organization furnished by NYCHA.

3.04 INSPECTIONS AND TESTS:

A. The following tests and demonstrations must be witnessed by the owner or his/her representative, and must prove that boilers, economizers, burners, controls, instruments, and accessories comply with requirements.

B. Condition of Boiler and Economizer (if provided) After Delivery, Rigging, Placement: After setting boiler on foundation and placing economizer on supports, and prior to making any connections to boiler and economizer, the Contractor and owner's representative shall jointly inspect interior and exterior for damage. Correct all damage by repair or replacement to achieve a like new condition.

C. Hydrostatic Tests:

1. Boiler: Contractor shall hydrostatic test after equipment is installed and connected for operation and prior to initial firing. Test pressure shall be 1-1/2 times the design pressure of the boiler for a period of two (2) hours duration. Provide written certification of the satisfactory test, signed by NYCHA's representative. Correct any deficiencies discovered during the testing, and retest equipment until satisfactory results are achieved and are accepted by the owner.
2. Boiler External Piping (as defined by ASME B31.1, Power Piping):
   a. Test may be conducted concurrently with boiler testing.
3. Identify and remove any connecting equipment which is not rated for the test pressure. Cap the openings left by the disconnected equipment. Reinstall the equipment after tests are completed.

D. Boiler Steam Safety Valves:

1. Test each valve set pressure and blowdown pressure with boiler steam pressure. Perform accumulation test by operating burner at high fire to verify that safety valve flow capacity is sufficient to handle the maximum boiler steaming rate. Tests shall be performed with boiler isolated from the main steam header and all generated steam exhausting through the safety valves.
2. Valve Popping Tolerance: Plus or minus three percent of set pressure for set pressures over 480 kPa (70 psi) gauge.
3. Valve Blowdown Tolerance: Reset at not less than 6 percent below set pressure of valve with the lowest set pressure. Minimum blowdown two percent of the set pressure.

4. Accumulation Test: With burner at high fire, the boiler pressure shall not rise more than six percent above the set pressure of the safety valve with highest pressure setting and shall remain below the maximum allowable working pressure of the boiler.

E. Burner Control (Flame Safeguard-Burner Management) System:

1. Demonstrate operation of all control, interlock and indicating functions.
2. Prior to scheduling final test submit certification that all control, indicating, and interlock functions have been pretested.
3. Conduct final test immediately prior to boiler-burner tests.
4. Experienced personnel representing the manufacturer of the system shall conduct the tests.

F. Performance Testing of Boiler, Burner, Combustion Control, Boiler Plant Instrumentation:

1. Perform tests on each boiler on all main burner fuels.
2. If required by local emissions authorities, provide services of testing firm to determine NOx and carbon monoxide. Test firm shall be acceptable to emissions authorities.
3. Boiler Performance Test

    a. Operate boiler on each fuel, with economizer (if provided) in service and record data for at least six evenly spaced steam loads from low fire start to 100% of full steam output, and in the same sequence back to low fire. Demonstrate performance and efficiency required by paragraphs under Articles, BOILER, BURNER AND GAS TRAIN, and by boiler and equipment lists on drawings.
    b. Demonstrate proper operation of combustion controls, draft control, feedwater level controls, and instrumentation systems.
    c. When flue gas oxygen trim is provided, conduct tests with trim control on manual at the zero trim (null) position. After completion of tests with trim control on manual control, repeat the tests on one fuel with the trim control on automatic control.

4. Sound Level Test

    a. Demonstrate sound level of fans and burner systems and atomizing air compressor.
    b. Test point shall be at 100 percent of maximum boiler load.

5. Current Draw Text

    a. Check current draw of forced draft fan motor at pre-purge and at 100 percent of maximum boiler load.
    b. Current draw shall not exceed full load current stamped on motor nameplate.
    c. This test may be combined with performance testing.

6. Test Methods:

a. Utilize permanent instrumentation systems for data. All systems shall be operable and in calibration.
b. Use portable electronic flue gas analyzer to determine constituents of flue gas. Analyzer shall be capable of measuring oxygen in per cent with accuracy of plus or minus 0.5 percent oxygen and carbon monoxide in parts per million (ppm) with accuracy of plus or minus 5 percent of reading (Range 0-l000 ppm). Obtain oxygen and carbon monoxide readings at each test point. Calibrate instrument with certified test gases within three months prior to use and immediately after analyzer cell replacement.
c. During performance test, retain boiler at each load point for a time period sufficient to permit stabilization of flue gas temperature and other parameters.
d. Steam loads for tests may be furnished by operation of the steam silencer vent system.
e. NOx emissions shall be tested with electronic analyzer reading in parts per million. Analyzer shall be calibrated with certified test gas within three months prior to use. Analyzer shall be accurate to plus or minus 5% of reading.
f. An additional efficiency test will be required, conforming to ASME Performance Test Code PTC 4, if the boiler efficiency determined in the Test P-1 above, does not comply with requirements. Utilize ASME Test Forms PTC 4.1.a, 4.1.b, or the abbreviated input-output and heat balance methods.

3.05 STARTUP AND TESTING:

A. The Commissioning Agent shall observe startup and contractor testing of the boiler plant. Coordinate the startup and contractor testing schedules with NYCHA's representative.

B. Start-up packaged boiler-burners in accordance with manufacturer's start-up instructions and in the presence of the boiler-burner manufacturer's authorized representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment. The Contractor shall submit a written and signed affidavit attesting that the equipment is operating as designed and manufactured, and in strict accordance with the requirements specified under this Section.

C. Supervisory Personnel: Provide field service personnel in the employ of the Boiler and Fuel Burning Equipment and Control System Manufacturer for such time as required to put installed equipment into operation. Supervisory services shall include the following:

1. Inspect fuel burner and control installations prior to start-up.
2. Supervise initial firing of boiler-burners.
3. Boiler-Burner testing.
4. Training of Personnel.
5. Service.

D. Boiler-Burner Pre-Start Up and Start-Up Interdisciplinary Tests:

1. Upon completion of boiler-burner and controls installations, a burner manufacturer's authorized representative shall visit the site; inspect the installations and notify NYCHA's Representative of any Work which must be done or modified prior to firing boilers.

2. Upon completion of required Work, or modifications to installed Work and all testing, the manufacturer's representative, with the NYCHA Representative, shall supervise the boiler-burner start-up. Start-up burner units in accordance with the burner manufacturer's start-up instructions and in the presence of Manufacturer's Authorized Representative.

3. Fire the boilers and conduct a preliminary test, for the purpose of checking general operation of the boilers, proving mechanical and electrical controls and making necessary adjustments, all in the presence of the NYCHA's Authorized Representative. The Contractor shall submit a signed start-up affidavit signed by the factory authorized service representative indicating that all of the manufacturer's pre-start up and start up interdisciplinary test procedures have been successfully completed.

4. Provide pre-startup check list, start-up list and operating instructions for each boiler, framed under rigid plastic and place where directed in the Boiler Room.

E. Boiler-Burner Tests: Manufacturer's representatives shall be present for all specified burner tests.

F. Training of Personnel: Approved Boiler-Burner and Control System manufacturer's representatives shall instruct duly authorized personnel in the operation and maintenance of the boiler-burners and control systems. Provide a period of two (2) days, covering three (3) work shifts, not to include travel time, for on-site instruction of personnel. This time shall be exclusive of all pre-start-up, start-up and service call time. Provide supervisors capable of instruction, in all phases of fuel burner and control construction, operation and accessories. If more than one instructor is required to adequately cover the overall subject (boiler-burners, controls and accessories), the instruction time shall be consecutive not concurrent.

G. Service: Provide the services of a competent field service representative to furnish fuel burner service to the facility. Service must be available within 48 hours from the time of notification.

3.06 PACKAGED BOILER COMMISSIONING:

A. The contractor shall 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 shall 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. Refer to the Phasing, Staging and Sequencing requirements indicated on the Contract Drawings for requirements for performance of the commissioning of each of the boilers in a staged, sequentially phased plan.

3.07 BOILER PLANT COMMISSIONING:

A. Provide commissioning for all inspection, start up, and Contractor testing required as specified.

B. Components provided under this Section of the specification shall be tested as part of a larger system.

C. The contractor shall ensure that all utilities, connections, piping, electrical, and other associated equipment and tie-ins are completed, serviceable, and ready for boiler operation.

D. The boiler manufacturer shall make available the services of a factory authorized service engineer for the boiler start-up.

E. A comprehensive start-up report shall be completed and provided to the job site and other parties.

F. Factory authorized training for operators, maintenance, and others shall be performed at the time of commissioning. Provide a minimum of 20 Hours per shift of Factory Authorized Training for the designated NYCHA Maintenance and Operations Personnel.

G. Refer to the Phasing, Staging and Sequencing requirements indicated on the Contract Drawings for requirements for performance of the commissioning of each of the boilers in a staged, sequentially phased plan.

3.08 DEMONSTRATION AND TRAINING:

A. Provide services of manufacturer’s technical representative to instruct all personnel responsible in the operation and maintenance of units.

B. Provide services of manufacturer's authorized technical representative for two days, covering three work shifts, to instruct the designated NYCHA Maintenance and Operations Representatives in the operation and maintenance of the burners.

C. Schedule training with NYCHA. Provide at least 2-days’ notice of training date to the NYCHA Chief Maintenance Representatives.

D. All training shall be videotaped. Submit videotapes to the NYCHA Chief Maintenance Representatives within 48 hours of the completion of training. Obtain receipt that the tapes have been delivered and furnish receipt to NYCHA.

END OF SECTION