

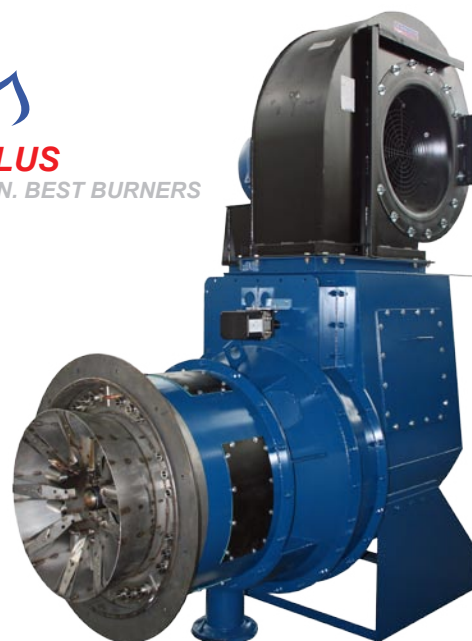
COMBUSTION SYSTEMS

XPlus Low Emissions Burner

The **XPlus Combustion System** is a new standard for boiler equipment upgrades. It delivers extremely low excess air operation throughout the firing rate to significantly reduce fuel consumption. Variable Speed Drives (VSDs) on the combustion air fan reduce electrical consumption. The XPlus Combustion System fully integrates the burner with state-of-the-art monitoring and controls. Throughout the entire development process, the burner design has included the requirement for repeatable, balanced and optimum fuel and air flow control. The result is a high quality burner that achieves and maintains overall fired equipment energy efficiency and low emissions. Most importantly, boiler owners are offered a single source for engineering, manufacturing, and field commissioning responsibilities unrivaled in the industry.

Firing Equipment

- **Low Emissions Design** - Gas tube injectors and atomizer sprayer plate produce stable, staged, low temperature fuel and air combustion.
- **Stable Combustion** - Center-fired gas, or very fine fuel oil droplets are ignited in the Stabilizing Combustion Zone. This feature produces outstanding flame stability during load changes and at very high excess air levels.
- **Energy Efficient** - Low electrical consumption is obtained by variable speed fan control with a Variable Speed Drive (VSD). When required, "pinpoint" injection of Flue Gas Recirculation (FGR), via the FGR Injection Plenum achieves the required NOx emissions with reduced FGR flow. Variable speed FGR Fan control is used for additional energy reduction.
- **Exceptional Turndown** - The combustion air plenum with "in-line" characterized damper are dynamically modeled to assure exceptional turndown and balanced cross-sectional air flow. Higher turndown reduces boiler cycling during low load periods, reducing fuel consumption and thermal stress to the boiler.
- **No Refractory Maintenance** - The burner throat is a high temperature metal. Custom refractory brick installation or maintenance are not required.
- **"Locked" Design** - No moving parts or adjustments necessary.
- **Recessed Plenum** - Minimizes atomizer length and withdrawal clearance requirements.
- **Atomizer Coupling Block With Disengagement Safeties** Protects operating personnel from hot oil or steam discharges.



XPlus Burner

Controls

- **Integrated Primary Flow Elements** - Integral combustion air, fuel gas and FGR measurements are used as the basis for combustion control. The integral FGR injection plenum allows independent measurement of Combustion Air and FGR flows.
- **Minimized "Hysteresis" Induced Control Errors** A direct-coupled damper/actuator is used. Damper linkage is not required.
- **Optimum Combustion Air Flow** VSD control of the FD Fan allows "trimming" of fan speed to exactly meet field conditions, thereby eliminating the need for fan oversizing, damper "short-stroking" or linkage adjustments.

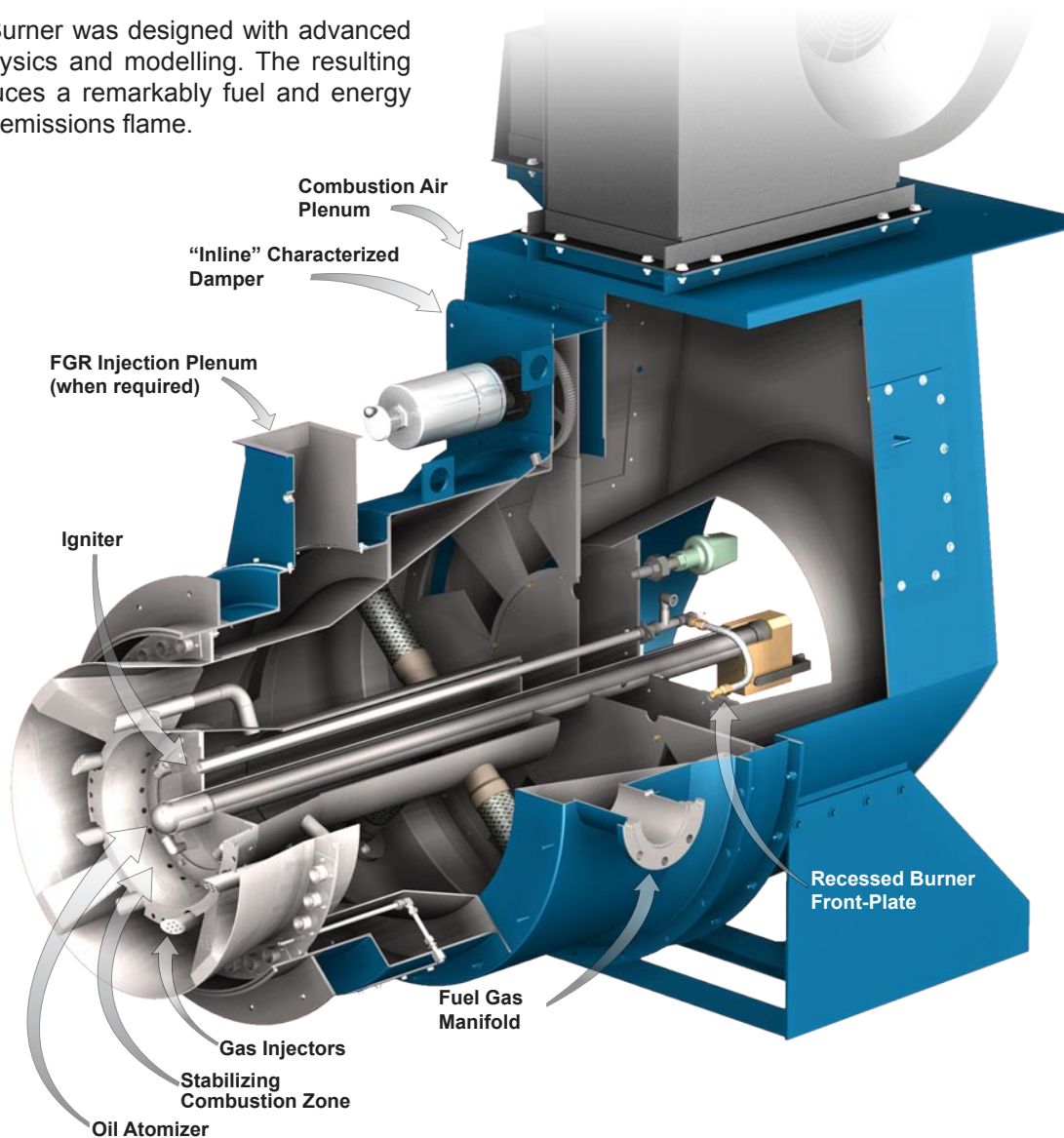
Fuel-Efficient Design

- **BurnerMate Universal Combustion Control** - Fully metered combustion control strategy with Oxygen trim and variable speed fan-based combustion air flow control is used. Any deviation from the required Oxygen set point resulting from changes in fuel stoichiometry, atmospheric conditions or boiler resistance, is automatically acknowledged and corrected, maintaining the highest fuel economy possible.
- **"Low-fire" Fuel Changeover** - Permits fuel transfer without requiring a burner shutdown and purge.
- **Enhanced Boiler Safety** - Flue gas Oxygen and temperature monitoring protects against excessive flue gas temperature and incomplete combustion.

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XPlus Low Emissions Burner

The **XPlus** Burner was designed with advanced computer physics and modelling. The resulting design produces a remarkably fuel and energy efficient, low emissions flame.



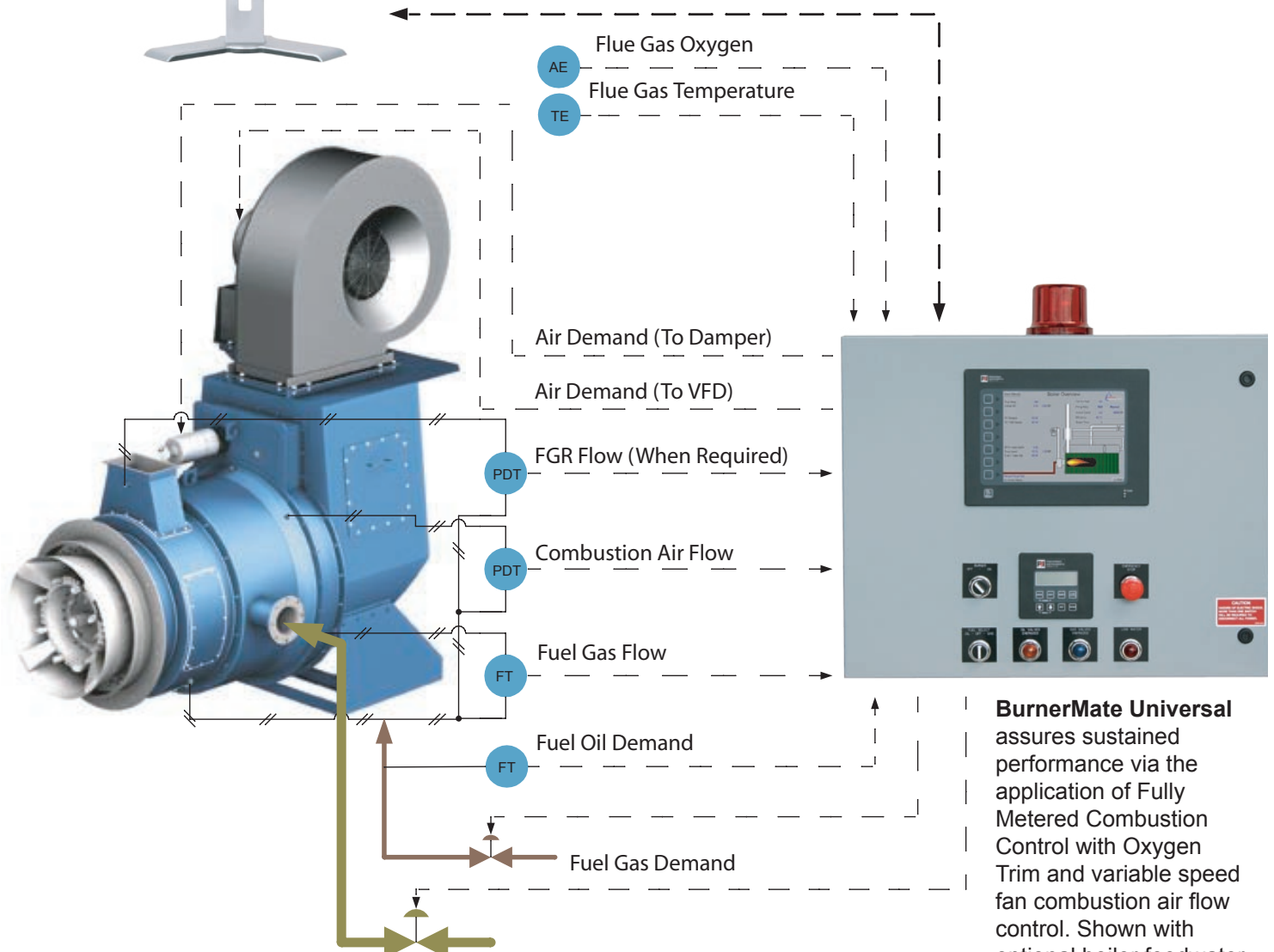
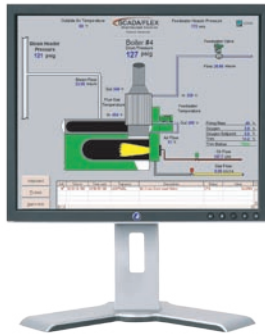
The Xplus custom Piping Train includes limit devices and all necessary fittings. These trains are NFPA 85 compliant.

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XPlus Low Emissions Burner

SCADA/Flex Remote Monitoring and Control System continuously monitors the **XPlus Combustion System** performance:

- Combustion Monitoring and Troubleshooting
- Historical Trending Of Flame Signal Strength, Fuel Flow, Air Flow, FGR Flow, Burner Cycles And Operating Hours.
- Maintenance "Reminder" Messages
- Boiler Efficiency Trends And Alarms



BurnerMate Universal assures sustained performance via the application of Fully Metered Combustion Control with Oxygen Trim and variable speed fan combustion air flow control. Shown with optional boiler feedwater controller.

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Specifications

Application

Single burner: Firetube/Watertube Boilers or HTHW Generators.
Fuel: No. 2 through No. 6 and/or Natural Gas (consult factory for special or waste fuels)

Heat Input Ranges 15 to 100 mmBTU/hr

NOx Emissions

Natural Gas: as low as 30 ppmc without FGR
No. 2 Fuel Oil: 100 ppmc (maximum 0.01% FBN) or less without FGR
No. 6 Fuel Oil: 300 ppmc (maximum 0.30% FBN) or less without FGR

Note: NOx performance is furnace geometry and heat release rate dependant. Lower NOx emissions are attainable with the application of FGR. CO emissions are less than 100 ppmc at all firing rates (exclusive of "short-circuiting").

Burner Efficiency

Any Fuel: **1.5 - 2.5% Excess O₂**
50 - 100% Firing Rate (exclusive of "tramp" air)
Electrical: **80% kW Reduction**
@ 40% Firing Rate

Operation

Turndown: 12:1 on gas firing
10:1 on oil firing
Ramp Rate: 200% per minute
Back-up Fuel: Oil or gas may serve as either the backup or supplemental fuel on simultaneous fuel firing applications

Supply Pressure

Natural Gas: 2-5 PSIG (at Gas Manifold Inlet)
Fuel Oils: 75-110 PSIG (No. 2 through No. 6 at Atomizer Coupling Block inlet)
Atomizing Media: Nominally 20 PSI higher than fuel oil pressure.

Note: consult factory for available pressures outside of the ranges given.

Burner Control & Monitoring

Firing Rate: **BurnerMate Universal** Fully Metered Combustion Control with Oxygen Trim and Variable Speed Fan Combustion Air Flow Control
Oxygen Sensor: **Model "ZP" In-Situ Sensor**, reliable zirconia oxide detector
Monitoring: **SCADA/Flex** Remote Monitoring and Control System
Controller: **PCC-III** Multiple Loop Controller
Instruments: Standard and optional equipment available

Options

- Dual Scanners - for added security and availability
- Simultaneous Fuel Firing
- Automatic Atomizer Post Purge - to prevent post combustion discharge of fuel oil into the furnace
- FGR Fan VSD control for energy savings, noise reduction and flow control

Ordering Information

Consult Factory

COMBUSTION SYSTEMS

Suggested Specifications

1. Scope

Supply a fully integrated Combustion System including Burner, Piping Trains, Combustion Control, Burner Management, and Auxiliary Boiler Control systems as well as the applicable transmitters, flow sensing devices, control valves and control actuators. The proposed Combustion System must include a "state-of-the-art" Fully Metered Combustion Control System with O2 Trim and Low Fire Fuel Changeover, Automatic Atomizer Post Purge and Redundant Scanning features. The Combustion System must deliver high Boiler efficiency while maintaining low emissions and operating costs. The Burner design shall include the requirements for repeatable and optimum fuel and air flow control. The Combustion System shall be designed to fire Natural gas or Fuel Oil and provide sufficient heat input for the maximum Boiler steaming (or hot water heating) capacity at the indicated steam (hot water) conditions.

The basis of the Combustion System design is the W.N. Best Equipment Company, a Division of Preferred Utilities Manufacturing Corporation in Danbury, Ct.

Low Emissions Design

The burner shall also be designed to minimize NOx and CO emissions such that the NOx and CO stated in the Guarantee Section will not be exceeded. If Flue Gas Recirculation (FGR) is required to meet the specified performance, the vendor shall specify the type of FGR system (forced or induced) to be provided and the quantity of FGR to be used (percentage referenced to Combustion Air flow).

Energy Efficient Design

Particular attention should be paid to both fuel and electrical energy operating costs. Systems with low boiler efficiency and/or high electrical energy cost or those that require steam injection for emission control will not be accepted. Proposals will be evaluated based on both capital cost and calculated operating cost over three (3) years. Operating costs shall include electrical energy and fuel consumption figures. A table presenting guaranteed excess air levels, FGR flow percentages (when required) and FD Fan and FGR Fan amperage draw at minimum, 25%, 50, 75 and 100% firing rate must be provided.

2. Quality Assurance

Acceptable Suppliers

The combustion system including...Burner, Combustion Control System (CCS), Burner Management System (BMS), Transmitters, Control Valves, and Control Actuators...shall be furnished by a single manufacturer who is regularly engaged in boiler control projects. The same manufacturer shall design the system and provide start-up and training services.

The Combustion System manufacturer must accept sole source responsibility for design, manufacture and start-up. The fired equipment CCS and BMS shall be manufactured and supported in the United States and shall be UL Recognized and NFPA 85 compliant.

Manufacturer qualifications

- Manufacturer must be an established burner supplier with similar burner projects as evidenced by an installation list (to be submitted)
- Manufacturer must be an established control systems supplier with similar controls projects as evidenced by an installation list

(to be submitted)

- Manufacturer shall have a minimum of (5) combustion control engineers
- Manufacturer must have a minimum of (5) service engineers trained in Burners, Boilers and Controls.
- Manufacturer shall have fully operational CAD capability, including the ability to create drawings in AutoCAD 2009 format if required.

Control System Supplier Certification

The control cabinet(s) and all the instrumentation shall be supplied by one Original Equipment Manufacturer. The only control equipment that will be acceptable shall be provided by an Original Equipment Manufacturer that has employees who manufacture, design, start up and service control systems of this nature throughout the United States. Proof of manufacturing and commissioning of systems of this magnitude and nature within the last five years must be supplied. The Boiler Control and Burner Management systems shall be manufactured in accordance with UL508A (CSA C22.2 #14 for use in Canada). Further the CCS and BMS must be UL Recognized (hardware per UL 372; software per UL 1998). The assembled control cabinet as a whole must be inspected for proper wiring methods, fusing, etc., and must be labeled as conforming to UL508A. Inspection and labeling shall be supervised by UL, FM, ETL or other OSHA approved Nationally Recognized Test Lab (NRTL). These systems shall be given a full factory functional test prior to shipment. The manufacturer shall notify the engineer when testing is to take place in order that he/she and/or a representative of the owner may exercise their option to witness the testing. The system shall be designed to ensure the safe start-up, on-line operation and shutdown of fuel firing equipment. The system shall comply with NFPA 85. Per NFPA 85 "1.9.3.2.3 Requirement for Independence, separation requirements, flame safeguard functions shall be performed in a separate processor from that performing the combustion control and other boiler control functions".

Combustion System Supplier

The complete system shall be supplied by the W.N. Best Equipment Company, a division of Preferred Utilities Manufacturing Corporation of Danbury, CT.

Substitutions

Where items of equipment and/or materials are specifically identified herein by a manufacturer's name or model number, only such specified items may be used in the base bid. The successful contractor will be held responsible to furnish specified items under their base bid. If the contractor wishes to bid on equipment other than that specifically named in either the base bid or alternate, they must submit a request in writing, together with the full description and technical data on the equipment proposed, 7 days before opening of the bids. If such equipment is accepted as an alternate, all bidders shall be notified to allow them to include an add or deduct from the base on the accepted equipment. It is further understood that this alternate will include any and all modifications or extra cost(s), regardless of the trade(s) involved, for any changes necessary due to the alternate equipment. Submittal or shop drawings, if other than the base named equipment, must show detailed changes

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required by all other trades involved. The contractor shall be responsible for all additional costs involved. Under no circumstances shall the Architect or Engineer be responsible for the installation, operation, or performance of substitute materials or equipment, even though accepted; this shall be the sole responsibility of the contractor. The calculations for capacities, quantities, dimensions, and all other attributes are based on the pertinent data of the Base Named Manufacturers. If submitted alternate manufacturer is accepted as an alternate, it shall be the contractor's responsibility to investigate in detail the products of these other manufacturers. The contractor shall be solely responsible for all changes in design, location, dimension, function, and installation involved in selection of other than the Base Named Manufacturer. The contractor shall be responsible for, and bear all costs for, any and all changes including any required work of any and all other trades, or the owner and including all of the Architects and Engineer's redesign or evaluation of submittal costs caused directly or indirectly by the use of equipment other than that listed on the drawings or called for in the specifications.

Submittals

The following shall be provided:

- Burner Arrangement Diagrams
- Combustion System P&IDs
- CCS and Auxiliary Boiler Control Configurations
- BMS Functional Chart Diagrams
- OIT Setup Instructions
- Cabinet Outline Diagrams
- Cabinet Internal Wiring Diagrams
- Bills of Materials

Factory Testing

Prior to shipment, the manufacturer shall perform the following tests:

After fabrication, the Cabinet(s) shall be fully tested, and a copy of the test procedures shall be sent to the consulting engineer and owner. The owners and/or consulting engineer, at their discretion, shall observe this and all other tests. Electrical components shall be functionally tested with all instruments and controls. Settings of all instruments and controls shall be verified for conformance to these specifications. A certificate of factory testing, together with a copy of the wiring diagram shall be placed in the control cabinet prior to shipment. The UL 508 label shall be affixed to the inside of the cabinet.

The manufacturer shall notify the engineer when testing is to take place in order that he/she and/or a representative of the owner may exercise their option to witness the testing.

3. Guarantees

Requirements

The burner manufacturer shall guarantee, as a minimum, the performance parameters as outlined below, while the unit is being fired with either of the primary fuels at the specified operating conditions. If the vendor fails to meet any of the performance guarantees, the vendor, at his own expense, shall modify, adjust or replace all related components, until all guarantees are met.

Steam (Hot Water) generating capacity:

The NO_x emissions shall not exceed ___ PPM ("Dry" and corrected to 3% O₂) when firing Natural gas and shall not exceed ___ PPM when firing () Fuel Oil (with less than ___ % by weight Fuel Bound

Nitrogen content). If Flue Gas Recirculation (FGR) is required to meet the specified performance, the vendor shall specify the type of FGR system (forced or induced) to be provided and the quantity of FGR to be used (percentage referenced to Combustion Air flow). The CO emissions shall not exceed 100PPM ("Dry" and corrected to 3% O₂) when firing either fuel.

The burner excess Oxygen level from 50% to 100% firing rate shall not exceed 1.5 - 2.5% when firing either primary fuel.

The combustion air fan motor electrical consumption, at 40% firing rate, shall be reduced by at least 70% when operating in the Variable Speed Fan Mode.

The Burner turndown capability shall not be less than 10 to 1 when firing Natural Gas and not be less than 8 to 1 when firing ___ Fuel Oil. The NO_x and CO emissions shall not exceed their guaranteed values from minimum fire to 100% MCR operation.

The burner shall fire over the entire range with no flame impingement on side or rear heating surfaces.

Testing

Performance and efficiency tests shall be conducted immediately after completion of startup. The manufacturer must have a representative in attendance at the time the test is conducted. At a minimum, combustion test reports shall detail combustion performance at 10 points from and including the minimum and maximum firing rate. These reports shall be performed for each fuel burned. They shall include the following:

- Flue Gas ("Dry") Oxygen Reading
- Flue Gas Temperature
- Fuel Flow(s)
- Efficiency (ASME "By Losses" Method)
- NO_x (PPM & lb/MMBTU "Dry"/corrected to 3% O₂)
- CO (PPM & lb/ MMBTU "Dry"/corrected to 3% O₂)
- FD Fan Motor Hertz and amps.

All equipment is to be guaranteed against defective design, workmanship, or material for one year from date of initial operation, but not to exceed 18 months from date of shipment.

Site Conditions

Equipment Location (City, State):

Site Elevation above Sea Level:

Design Ambient Temperature, deg. F.

Electrical Supply (Voltage/Phase/Hertz)

Motors:

Controls:

Boiler (HTHW) Data

Boiler Capacity, PPG

Operating Pressure, PSIG

Final Steam Temperature, deg. F.

Feedwater Temperature, deg. F.

Boiler Efficiency ___ Fuel Oil ___ Natural Gas

HTHW Generator Heat Input, mMBTUH

Combustion Air Temperature, deg. F. Furnace Pressure, in. W.C.

Furnace Inside Dimensions (Length, Width & Height)

Furnace Volume, ft³

Furnace Heating Surface, ft²

Insurance Requirements (NFPA, IRI...):

Fuel Data:

Oil Fuel:

Fuel Oil Grade

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Fuel Oil HHV, BTU/gallon

Regulated Fuel Oil Pressure Available:

Fuel Oil Viscosity:

Fuel Oil FBN (% by weight):

Atomizing Media (Steam or Air)

Natural Gas Fuel:

Higher Heating Value, BTU/ft³

Specific Gravity (typically 0.5543):

Regulated Gas Pressure Available:

4. Low NOx Burner Assembly Burner

The Burner assembly shall be of a design developed specifically for low NOx emissions. The burner geometry shall be essentially fixed and contain no moving parts. The use of energy wasting "steam injecting" schemes will not be accepted. Combustion air flow control shall be accomplished by a combination of a characterized type flow control damper and variable speed fan control. The Burner front plate shall be of sufficient size to accommodate openings for the Oil Atomizer Assembly, Igniter Assembly, two peepholes each with sight glass and two scanner mounts complete with cooling air provisions and scanner assembly. Burner performance shall be repeatable with optimum fuel/air ratio control over the Boiler's operating range. A UL Recognized, fully metered Combustion Control system with Oxygen trim and variable speed fan air flow control shall be used. Integral to the burner assembly shall be combustion air, fuel gas and flue gas recirculation (when required) flow measurement connections. Redundant Flame Scanning, Automatic Atomizer Post Purge and Low fire Fuel Changeover features at a minimum shall also be included.

Combustion Air Damper Assembly

The Combustion Air Damper Assembly shall serve as the primary air flow-throttling device and provide air flow balancing. The cross-sectional flow area of the damper shall be "characterized" to provide improved air flow turndown capabilities. Parallel blade type dampers shall not be acceptable. The damper actuator shall be direct connected to the damper. The use of linkage shall not be acceptable.

Forced Draft Fan Assembly

The Forced Draft Air Fan Assembly shall be sized to deliver the correct flow of combustion air at a static pressure sufficient to overcome all of the system pressure drops when operating at the boiler's rated capacity with a minimum safety factor of 10% on volume and 21% on static pressure above design requirements at an ambient temperature of 105° F. The Forced Draft Fan Assembly shall be complete with motor, Variable Speed Drive (VSD) with drive integrated full feature bypass if a VSD failure should occur, and inlet screen. The motor shall be 460 V - 3 PH - 60 Hz premium efficiency type and designed for inverter duty with a 10:1 turn down ratio. The VSD shall vary the motor's rotational speed to allow fine-tuning to the specific requirements of the application while coincidentally minimizing electrical power consumption at every operating load point.

Fuel Gas Assembly

The Gas Injection assembly shall be a low NOx can or tube injector design suitably drilled for the quantity and pressure of gas required. The gas manifold will be complete with flanged inlet connection.

Oil Atomizer Assembly

The Oil Atomizer Assembly shall be a low NOx, steam (or compressed air) atomized type, complete with all flexible hoses, manual valves, check valves and fittings to permit easy access, purge and removal for maintenance. All tools necessary to permit oil tip cleaning and replacement shall be supplied. One (1) spare sprayer plate assembly shall be provided. The Oil Atomizer Assembly shall include an oil atomizer, atomizer head and coupling block. The coupling block shall have three (3) inlet connections for fuel oil, atomizing media and purging media. All three channels shall be provided with anti-blowback assemblies to protect operating personnel from hot oil or steam discharges upon removal of the atomizer. In conjunction with the combustion safeguard system all hardware and logic must be provided for "Automatic Atomizer Post Purge" (with igniter energized). This feature is required to prevent the post combustion of fuel oil that has drained from the atomizer into the furnace.

Igniters

The igniter shall be of the gas-electric type and be capable of providing sufficient ignition heat input using either natural gas or propane. It shall be furnished complete with flexible steel, braided gas hose, and braided flexible electrical harness assembly connecting the igniter spark plug to the ignition transformer. The igniter shall use combustion air from the burner forced draft fan and not require an independent source of cooling or combustion air.

Flue Gas Recirculation (FGR) System (If Required)

If flue gas recirculation (FGR) is required to meet the specified performance, the vendor shall specify the amount and type of FGR (forced or induced) in their offering. The FGR system shall be integrated into the burner management and combustion control system to assure a safe and reliable system. When a forced FGR system is used, it shall include a variable speed FGR Fan, VSD, and FGR Safety Shutoff Valve with actuator and proof of closure limit switch.

5. Burner Piping Trains

General

The oil, atomizing media, ignition and main gas piping trains shall be factory assembled, painted, wired and tested, and shipped as a complete assembly. These trains shall include piping train mounted limit devices, and all necessary fittings. These trains must fully comply with NFPA 85 and shall be designed for de-energize to trip operation. All piping shall be Schedule 40 seamless steel pipe with 300 lb. malleable iron screwed fittings for oil and steam lines and with 150 lb. standard butt weld and flanged fittings for gas lines 2½" and over and 150 lb. malleable iron screwed fittings for gas or air lines 2" and smaller.

Igniter Gas Piping Train

One (1) Igniter Gas piping train shall be provided consisting of the below listed major components. Igniter gas system shall be designed for a maximum gas supply pressure of ___ PSIG at the piping train inlet. Equipment shall include, but not be limited to, the following:

- One (1) "Y" type strainer
- One (1) Pilot gas pressure regulator
- Two (2) Automatic Solenoid Safety Shut-Off Valves
- One (1) Automatic Solenoid Vent Valve

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- One (1) Pilot gas pressure gauge & shut-off valve
- Two (2) Manual shut-off valves
- One (1) Flexible hose

Fuel Gas Piping Train

One (1) Fuel Gas Piping Train consisting of the below listed major components. Fuel gas piping system shall be designed for a regulated pressure of ___ PSIG at the piping train inlet. (Note: besides the listed components a Natural Gas Flow Meter will ship loose for installation in the Burner supply header):

- Two (2) burner pressure gauges with shut-off valves
- One (1) Lot Leak test cocks (as required)
- One (1) Low fuel gas pressure switch
- One (1) High fuel gas pressure switch
- Two (2) Automatic Safety Shut-Off Valves w/POCS
- One (1) Automatic Solenoid Vent Valve
- Two (2) Manual shut-off valves
- One (1) Fuel Gas Control Valve with Actuator and Low-fire position switch (Note: if the specified CCS/BMS system is supplied this switch is unnecessary)
- One (1) Flexible hose

Fuel Oil Piping Train

One (1) Fuel Oil piping train consisting of the below listed major components. Fuel oil piping system shall be designed for use with oil supplied at a regulated pressure of ___ PSIG at the piping train inlet.

- One (1) "Y" type strainer
- Two (2) pressure gauges with shut-off valves
- One (1) Low oil pressure switch
- One (1) High Oil Pressure Switch
- One (1) Automatic Fuel Oil recirculation valve
- Two (2) Automatic Safety Shut-Off w/POCS
- One (1) Low Oil Temperature Switch
- One (1) High Oil Temperature Switch
- One (1) Oil Temperature gauge
- One (1) Fuel Oil Control Valve with Actuator and Low-fire position switch (Note: if the specified CCS/BMS system is supplied this switch is unnecessary)
- One (1) Fuel Oil Flow Meter w/Pulse Converter
- Two (2) Manual shut-off valves
- One (1) Flexible hose

Atomizing Media Piping Train

One (1) Atomizing Steam Piping Train consisting of the below listed major components. The Atomizing Steam piping system shall be designed for use with steam at a maximum ___ PSIG (saturated) pressure at the piping train inlet.

- One (1) "Y" type strainer
- Two (2) pressure gauges with shut-off valves
- One (1) Combination Atomizing Steam Safety Shut-Off/Pressure Control Valve (Note: Pressure Control is afforded by the specified CCS/BMS Control System)
- One (1) Low Atomizing Steam Pressure Switch
- One (1) Low Atomizing Steam Flow Switch
- One (1) Atomizing Steam at Burner Pressure Transmitter with calibration manifold and siphon
- Two (2) Manual shut-off valves
- One (2) Steam Trap assembly

- One (1) Flexible hose

6. Combustion Control, Burner Management & Auxiliary Boiler Control System

A UL Recognized NFPA 85 compliant CCS and BMS Control System must be provided. The CCS strategy must be Fully Metered Combustion with Oxygen Trim and VSD Combustion Air flow control. Atomizing Steam Pressure (or Differential Pressure) control must be possible as well as either Forced or Induced FGR Flow control (if FGR required to meet emissions guarantees). The BMS must be designed for either Natural Gas or #6 Fuel Oil firing with Low-fire Fuel Changeover, Automatic Atomizer Post Purge and Redundant Scanning capabilities at a minimum. The system shall be designed to provide continuous operation within design limits with a high level of safety and the lowest cost of fuel. As required the system shall provide continuous process control of Steam pressure and Boiler Drum level. The system BMS and CCS shall be fully integrated to assure fully automatic, safe and reliable startup and shutdown.

To assure system integrity, a pre-wired and factory-tested, microprocessor-based, multiple control loop combustion system shall be provided to implement boiler control functions. If packaged in an enclosure, the system shall be manufactured and tested according to UL 508 requirements. The system must meet NFPA 85 paragraph 1.9.3.2.3 separation requirements..."flame safeguard functions shall be performed in a separate processor from that performing the combustion control and other boiler control functions".

Controller equipment requirements:

- Controller shall be designed for sub-plate mounting inside a control enclosure. Wiring connections are to be made by plug-in terminal blocks for ease of wiring.
- Optional Modbus/Ethernet/web-based remote monitoring shall be available.
- Parameter Selectable configuration with a minimum of 33 basic setup parameters
- A minimum of six Actuator outputs shall be available
- A minimum number of six F(x) curves shall be provided
- The minimum number of points per F(x) curve shall be 15
- Controller shall be commissioned by parameter set-up. No ladder logic, function block or block-ware programming shall be required.
- To regulate access to the system parameters, the controller shall maintain separate password levels for operators, technicians, and engineers. To prevent unsafe operation, system parameters that affect boiler operation shall only be permitted to be changed when the Flame Safeguard is in Shutdown or Lockout mode.
- In the event of AC power loss, the controller shall allow the user to select whether the boiler restarts or goes into lockout when power is restored.
- Standard LCD Display: four Lines, 20 Characters per line, flush-mount
- Provide separate direct-acting digital Actuator for the Fuel Gas and Fuel Oil Flow Control Valve(s) and Combustion Air Damper(s) and if required the Draft Damper, FGR Damper, and/or Boiler Feedwater Control Valves. The Actuators shall be totally enclosed in a dust-tight, splash-proof housing. Actuators shall include a direct shaft connected, electrically isolated feedback

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potentiometer with 0.1° position resolution, integral brake, and 90° rotation in 25 seconds. The Actuators shall be capable of being stopped, started, or instantly reversed without loss of power or overloading. For repeatable fuel air ratio control, Actuator positioning accuracy shall be 0.1 degrees. To ensure all Actuators are functioning correctly, Actuator full stroke Safe Start Check features shall be provided and conducted on each start of the Burner. No Actuator feedback adjustments shall be required with pushbutton zero setup. Electrical connections to all Actuators shall be with one single daisy chained conduit. Rewiring the Actuator shall not be required to change direction of travel. For high torque Valve and Damper applications Actuators up to 700 ft-lbs of torque and 0.4° position resolution must be provided. Actuators shall be Preferred Instruments, Model BMU-SM series.

- Flame scanners shall be Preferred Instruments Model BMU-IR, BMU-UV, or BMU UVSC for infrared, ultraviolet, or self-checking ultraviolet, respectively.
- Touch Screen Operator Interface Terminal / Control
- Touch screen requirements must conform to the following specification and shall be provided:
- Provide a ten (10) inch Operator Interface Terminal (OIT) designed to provide local operation, graphic display of information, alarm message display, historical and real time trending, remote controller tuning, x/y plots of fuel-air curve data for intuitive commissioning, Ethernet connectivity, and standard internet browser remote communication. The OIT shall be networked to the fired equipment control and flame safeguard systems.
- The system shall be an industrially hardened OIT. Development software shall be standard IBM PC compatible to simplify future expansion, replacement and service requirements. The terminal shall be web-enabled and allow remote monitoring via a standard internet browser and must support Modbus TCP/IP Master, TCP/IP Slave, RS-485 Modbus Master, Allen Bradley DF1 Master and OPC communications.

OIT Hardware features:

- The OIT display shall measure 10.4-inch and utilize Thin Film Transistor (TFT) with 256 Colors and 640 x 480 pixel LCD resolution.
- The OIT shall be suitable for panel sub-plate mounting. The OIT operating front face plate shall be rated NEMA 4X/IP66, (for indoor use only) and shall have an aluminum construction. Plastic type cases shall not be acceptable.
- The OIT should have a minimum of seven (7) pushbuttons for moving to different pages with a Menu button to allow display of pushbutton function.

Ethernet communication

10 BASE-T /100 BASE-TX, RJ45 jack connection with Protocols; web enabled, Modbus TCP/IP Master, TCP/IP Slave, Encapsulated Modbus Master, Allen Bradley DF1 Master, OPC

RS422 / 485 communication

(2) ports with up to 115,200 baud, RJ45 jack connection, Protocols; Modbus Universal Master, ASCII Slave, RTU Monitor, RTU Slave, Danfoss VLT 6000, Allen Bradley DF1 Master, DH485 Master, Siemens S7 via MPI Adapter, S7 via PPI, Simovert via USS, TI-500 Series

RS232 communication

(2) ports with up to up to 115,200 baud. RJ12 jack connection, Protocols; Modbus Universal Master, ASCII Slave, RTU Monitor, RTU Slave, Danfoss VLT 6000.

USB Port for Programming, Type B connection

Field replaceable backlight, real-time clock, battery-backed clock time stamps critical data, 8 MB on-board flash application memory, 512 MB memory card, application expanded memory card for historical, alarm & event storage, resistive analog touch screen with free formable to fit target shape

OIT Software features:

- Operator interaction shall be touch screen-based to allow for easy selection of screens, manual / automatic status changes, start/stop functions, setpoint changes, output changes and PID tuning parameters without any special programming skills. Screen selection shall also be available through tactile feedback function keys.
- The OIT shall provide facsimiles of the local controllers and clearly labeled English language and engineering unit display of the control parameters.
- The OIT must have x/y plotting capability. When the OIT is used in conjunction with fired equipment fuel/air ratio control, provide automated fuel/air ratio curve and oxygen trim setpoint curve adjustment for rapid, error-free burner setup. Curve data shall be graphically displayed for easy review. Only a single operator action shall be required to store commissioning data into multiple characterizer curves for a particular load point.
- Touch screen program must include a minimum of 75 total graphic pages. Information shall be displayed on the HMI as part of an easy to understand pictorial representation of the process. At a minimum, an individual boiler overview and individual control loop overview shall be provided. As an example, a typical steam generator would display (when available): steam drum pressure, steam flow for each boiler, steam temperature, drum water levels for each boiler, flame failure, combustion air temperature, flue gas temperature, flue gas recirculation damper position, outlet damper position, controller faceplate grouping for each boiler, trend screens for each group of controlled process variables as they pertain to each controller in the system. Each pen shall be user selectable as to "on/off" and scaling. All values shall be displayed in engineering units adjacent to the pictorial point of measurement.
- Each controller in the system shall be capable of remote tuning of gain, reset, rate and other important parameters via the OIT. When each controller is placed in the remote tuning mode, a real time trend chart of controller inputs shall be displayed on the OIT to aid the technician in setting the proper parameter values. This function shall be password protected for security.
- Where applicable, alarm status shall be displayed on the OIT generated process pictorials. In addition, all alarms shall be logged in an alarm and event log. The alarm log shall indicate the time at which the alarm occurred, the time at which the alarm was acknowledged and the time at which the value returned to normal status. In addition to alarm conditions, this log shall also document status changes such as a transfer from automatic to manual, a setpoint change, etc. so that the resultant collection of alarms and events is a true and complete log of plant operating conditions.

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- The OIT shall include historical and real-time trend displays. This display shall include up to sixteen (16) traces per chart. Arrow keys shall be provided to change the chart span from 30 seconds, 1 minute, 2 minutes, 3 minutes, 4 minutes, etc, on up to 1 hour. Provide a chart cursor to allow the user to display the value of each trace at a selected point on the trend. The OIT shall display the trace values at the point the cursor intersects the traces. The cursor shall be positioned backward or forward in time using arrow keys. Real time data shall be displayed when a trend is first displayed.
- The OIT shall automatically create a historical data file each hour. Each file shall be accessible over an Ethernet connection using a standard internet browser. The files shall be Microsoft Excel® compatible. As an example, for a steam generator application a data file could include (when available); steam pressure, steam flow, and feedwater flow.
- The OIT shall have dedicated communications between the OIT and the Burner Management System so as to allow all alarms to be graphically represented and summarized. The OIT must be capable of displaying and recording the following statistics: burner limits, individual lockouts, burner operational hours, total burner cycles, burner status, last six lockouts, total lockouts, and flame signal strength.
- The OIT shall provide graphic pages allowing step-by-step commissioning of the controller parameters using English language prompts and selections.
- The OIT shall be manufactured in accordance with UL50, IEC 1010-1 and EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1. The Operator Interface Terminal shall be a Preferred Instruments, Danbury, CT, Model OIT 10 with part number 90283 expanded memory card and 90284 additional communication card.

7. Controller Functions

Burner Management System (BMS)

Integral with the combustion system controller shall be a Burner Management System (BMS)/Flame Safeguard System (FSG). The system shall be designed to ensure the safe start-up, on-line operation and shutdown of fuel firing equipment. Burner management system components shall be located in the combustion control cabinet and shall be fully integrated for automatic sequencing of light-off and shutdown.

- An industrial duty microprocessor-based BMS shall monitor safety interlocks, Actuator position, and flame status. The controller shall sequence the Burner through purge, light-off, run, shutdown, and post-purge. The BMS shall be capable of firing up to three fuels. Fuel selection must be determined by hard-wired contact or Modbus link according to user configuration. Additional BMS functions shall include as a minimum:
- All recycle and shutdown interlocks will be wired to separate, parallel 120 VAC inputs. Analog sensors for gas or oil pressure shall not be required.
- The controller shall supply both 120 VAC and 24 VDC power for flame scanner(s). To prevent nuisance trips, dual flame scanners

shall be wired into separate digital inputs. Analog (flame signal quality) inputs shall be used for flame strength indication only.

- To minimize thermal stress to fired equipment “assured low fire cutout” shall be provided to drive the burner firing rate to low fire before shutting down the burner.
- Because dry boiler operation is a leading cause of boiler explosions and meltdown, flue gas temperature shall be input to the controller and monitored to alarm or trip the burner in the event the boiler is dry-fired and the low water cutouts malfunction.
- Adjustable time delays (up to four seconds) shall be provided for the low fuel pressure, low atomizing flow, and low draft cutout interlocks to reduce nuisance shutdowns due to transient conditions.
- The controller shall accommodate automatic gas valve leak detection when required by the user.
- To prevent unsafe purging of oil guns, oil gun purge logic shall be provided to enable either the safe purging of any resident oil in the atomizer into the furnace (with pilot energized), or the activation of a scavenging pump to draw the unused oil out of the oil gun.
- A minimum of five user-configurable auxiliary relays shall be provided for alarm, or to start auxiliary fans, oil pumps, oil heaters, gas booster pumps, etc.
- When the optional in-situ oxygen analyzer is provided, the controller will alarm and/or shut down the burner when a user-configurable low stack oxygen set point is reached.
- To allow easy controller trouble-shooting, individual annunciation shall be provided for up to nine recycle limits and thirty-three non-recycle (shutdown) limits.
- The controller shall provide time/date stamp of individual servo positions, status of each digital input, and the status of all controlled functions for up to the last ten boiler shutdowns.
- BMS shall include Modbus RS-485 communications. A common dry alarm contact output shall be supplied for the Building Management System for any fault or alarm condition related to the Flame Safeguard System.
- To ensure a safe and reliable system, flame safeguard logic and associated software shall be recognized by Underwriters Laboratories (UL 372 hardware and UL 1998 software.)

Combustion Control System (CCS)

The combustion control system shall position up to eight independent Actuators for Fuel, Atomizing Media or Feedwater Valves, and Combustion Air, FGR and/or Draft Dampers, as required by the application. In addition up to five separate 4-20 mA analog outputs shall be provided for Stack Damper, Feedwater Valve, or VSD operation (FD, ID or FGR Fan).

- PID combustion controls shall be designed to safely maintain the Steam Header Pressure at the operator-selected value. A Fully Metered Combustion Control strategy with Oxygen Trim and FD VFD control shall be used. Demand from the Boiler Master shall serve as a demand for both Fuel and Air control devices with Fuel-Air Ratio (including O₂) Trim. To ensure a safe and reliable system, software regulating fuel-air ratio shall be recognized by Underwriters Laboratories.

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- One Actuator shall be applied to each Fuel Flow Control Valve(s) while a separate Actuator(s) shall position the Air Control Damper(s). Each Actuator shall be equipped with an integral position retransmitter. Fuel-air ratio shall be established and adjusted by use of a “soft” function curve of Fuel Valve position vs. Air Damper Position.
 - The Atomizing Steam Control Valve shall be positioned based on Atomizing Steam (at Burner) Pressure or Differential Pressure Control as a function of Firing Rate. If Differential Pressure Control is implemented, the controller should allow for possible Fuel Oil/Atomizing Steam Pressure “crossover.”
 - The Boiler Master shall utilize a steam flow feed-forward index to the drum pressure feedback for improved response. Fuel Valve and Air Damper shall be modulated in response to an external Plant Master demand signal or the Boiler Master output signal. A minimum of 11 points must be entered for each “setup” curve. The controller shall interpolate between curve points to ensure smooth operation during load changes.
 - The controller shall automatically detect a failed or malfunctioning Actuator. During Purge, all of the Actuators shall be driven to their minimum and maximum positions. If the feedback signal from any Actuator is out of range, the Burner will go into Lockout to prevent firing under dangerous conditions. Because of this test, which is conducted each time the Burner is started, Damper and Valve Position Proving Switches are not required.
 - An in-situ oxygen analyzer shall measure the oxygen concentration in the flue gas and trim the air/fuel ratio to follow the oxygen vs. load curve input during unit commissioning. Oxygen trim can be turned off when the firing rate drops below a user-defined firing rate. In addition, the controller shall provide a user-defined lag time during which the oxygen trim function is nullified for a set amount of time after light-off to allow the burner to warm-up and stabilize.
 - Provide microprocessor-based flue gas recirculation (FGR) control (if required to meet emissions guarantees). FGR flow rate shall be controlled in response to boiler load for both Forced and Induced type FGR systems. The controller shall have a characterizable setpoint curve for Damper or Variable Speed Fan output signal.
 - If a non-specified burner is offered that requires the use of FGR and the Burner is unstable until the flue gas recirculation heats up to steady state temperature, cold FGR low fire cutback shall be provided. This ensures that the FGR is heated to steady-state temperature before the burner is released for automatic operation.
 - To ensure Burner operation is witnessed to be safe and within manufacturer’s limits at all firing rates, the controller shall require the Burner to be run at each load point to verify and confirm combustion at that point is stable before the controller can be put in the automatic mode. This requirement shall apply whenever the adjustments are made to a curve point as well.
 - The controller shall include software-enabled high and low firing rate limits in the event the technician needs to limit the upper or lower end of the firing rate in automatic operation.
 - The fuel controller shall be configured to provide for control of the gas and/or oil control valve, depending on the fuel selected.
 - The control system shall allow changeover from Natural Gas to #6 Fuel Oil (at Low-fire position) and vice versa when initiated by hard-wired input or Modbus connection.
 - To ensure the burner can continue to be run safely even with a failed FD fan VSD, the CCS shall contain independent variable and full speed fan setup curves for each fuel. In the event of a VSD failure, the burner shall trip, the operator shall be able to transfer the VSD bypass transfer switch and restart the equipment.
 - “Off-curve” points shall be provided to allow the technician to determine the servo positions during standby, ignition, and purge modes.
 - All external or auxiliary power supplies necessary for electronic transmitters (or Valve or Damper final control elements) shall be included.
- Enhanced Boiler Control Functions**
- Feedwater Control.**
The controller shall include user-selectable one, two or three-element PID drum level control. Drum level shall be controlled by modulating the feedwater control valve in response to drum level in single element mode, a combination of drum level and steam flow in two-element mode and the combination of drum level, steam flow and feedwater flow in the three-element mode. The transfer between one, two or three-element control shall be automatic as operating conditions warrant. The controller shall position a feedwater control valve or VSD feedwater pump, as required. Adjustable time-delay alarms shall be provided for high and low water level.
- Draft Control.**
Using an analog input from a Draft transmitter, the PID draft control loop shall position the boiler outlet damper (or ID fan VSD) to maintain consistent draft pressure at all boiler loads. An internal firing rate signal from the combustion control loop shall be used as a feed-forward to the draft control loop to better control draft during boiler load swings. In the event a VSD drive is used on the ID fan in lieu of a boiler outlet damper, the controller shall provide a 4-20 mA output to control the ID fan VSD drive. A low draft (high stack pressure) alarm with adjustable time delay shall be provided to alert the operator of unexpected draft conditions. Abnormal burner shutdown (safety lock-out of flame safeguard control) shall cause the outlet damper to drive open where it shall remain until the flame safeguard system is reset.
- Efficiency.**
A “Combustion Efficiency by Losses” computation based on Flue Gas Oxygen and Flue Gas Temperature can be displayed on the LCD. This is available for Oil and Gas only and not for Fuel 3 due to unknown fuel chemistry. It must be possible via parameter selection of to select either #2 Fuel Oil or #6 Fuel Oil for the efficiency calculation.
- Warm Standby.**
To respond rapidly to a call for heat, the controller shall cycle the burner in response to an external Shell Temperature, Drum Temperature, or Steam Pressure signal. Start and stop set points shall be user-defined. Controller shall include low fire hold, and cold start warm up ramping capabilities.
- Low Fire Hold.**
To prevent thermal shock to the boiler, the controller shall be

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capable of holding the burner at Low Fire after a cold boiler start. The boiler shall be released to modulate after a user-defined time delay, or when the Boiler warm-up signal (Shell Temperature, Drum Temperature, or Steam Pressure) set point is reached.

Cold Start Setpoint Ramp.

When enabled, the Boiler will be warmed up using a user-defined set point ramp. Step increments and duration shall be selectable by the boiler operator.

Automated Boiler Water Column Blowdown.

To ensure the Low Water Cutouts on the Boiler are working correctly, the controller shall sequence an automated water column blow-down test. The operator shall be able to select the time of day and duration of the Blowdown test. The controller shall monitor the low water cutouts and alarm or lockout the burner in response to a failed low water cutout test.

Gas Safety Shutoff Valve Leak Test

To ensure the Natural Gas Safety Shutoff Valve integrity it must be possible to enable this test procedure via Parameter selection. A test can be performed on systems that include or do not include an Automatic Vent Valve.

8. Field Devices

Burner Management Field Equipment

The following BMS field equipment shall be provided:

- One (1) High Steam Pressure Switch
- One (1) High High Steam Pressure Switch
- One (1) Minimum Air Flow Switch
- One (1) Purge Air Flow Switch
- Two (2) Flame Scanners. Each flame scanner shall be equipped with independent "Flame Established" contacts as well as a 4-20 mADC output of Flame Signal Strength
- One (1) High Furnace pressure switch is required to protect the furnace from high furnace pressure (low furnace draft) when there is a flue gas control damper or induced draft fan installed.

Note: Low Water Cutout and Auxiliary Low Water Cutout Switches are presumed to exist and to be in proper working order or supplied by others.

Flow Elements

- Fuel Oil Flow - Provide one (1) oval gear oil flow element. An oval gear type volumetric flow meter shall be used for fuel oil flow measurement because of its ease of installation, accuracy & repeatability features. Each oval gear rotation measures a swept volume of liquid, independent of viscosity or density and accurately records the volume. Accuracy shall be 1.00 % of reading. Meters for heavy fuel oil shall include construction rated for #6 Fuel Oil heated to 250 degrees F. Provide a pulse transmitter to send a 4 - 20 mA rate of flow signal to the combustion control system.
- Natural Gas Flow - Provide one (1) thermal mass insertion meter. The Thermal Mass Flow Meter consists of two sensing elements, a velocity sensor and a temperature sensor. The transducer electronics heats the velocity sensor to a constant temperature differential above the gas temperature and measures the cooling effect of the gas flow. The electrical power required to maintain a constant temperature differential is directly proportional to the gas mass flow rate. The thermal type mass flow meter provides a mass flow measurement independent of natural gas pressure or temperature changes.

- Combustion Air Flow - Provide one (1) combustion air flow element for each boiler. The primary element shall be a piezometer tube in the FD fan inlet or silencer. The Windbox to furnace differential pressure can be used as a basis for establishing air flow so long as the burner does not include devices in the air stream, which move as a function of firing rate or type of fuel being burned.
- Steam Flow - Provide one (1) Steam flow element for each boiler (If required for drum level control). The elements shall include a 316 SS orifice plate and a set of tapped flanges. Orifice plate beta ratio shall be within 0.25 to 0.75. The elements shall be sized for a 5 to 1 turn-down.
- Flue Gas Recirculation (FGR) Flow (when flue gas recirculation is included) - Provide one (1) flue gas recirculation element for each boiler. The primary element shall be a Venturi element in the flue gas recirculation duct. The flue gas recirculation duct to furnace differential pressure can be used as a basis for establishing FGR flow so long as the burner does not include devices in the gas stream, which move as a function of firing rate or type of fuel being burned.

Pressure Transmitters

The Steam Drum Pressure Transmitter shall be of the "Smart" or "Intelligent" type with one (1) valve manifold, process fluid isolating diaphragms, NEMA 4 housing, local LCD indicator and provide a 4-20 mADC output. It shall be provided with an isolating siphon.

Differential Pressure Transmitters

Each transmitter shall be of the "Smart" or "Intelligent" type with three (3) valve manifold, process fluid isolating diaphragms, NEMA 4 housing, local LCD indicator and provide a 4-20 mADC output. Steam and Boiler Drum Level service units shall be provided with Condensate Pots. Provide the following transmitters:

- Combustion Air Flow
- Flue Gas Recirculation (when required)
- Drum Level
- Steam Flow
- FGR Flow Transmitter (if FGR is required)
- Draft Range Transmitter Assembly (when draft control is required)

Provide a -1" W.C. to +1" W.C., 4-20 mADC boiler draft range transmitter and an independent high pressure cut-out with 5 second time delay. Instruments shall be provided with a dust-tight, splash-proof enclosure. The high pressure setpoint shall be field adjustable from +0.15" W.C. to +4.0" W.C. The high pressure switch shall be mounted and wired to a pilot light so as to illuminate when the switch activates and to a 5 second time delay relay so as to provide an isolated, 10 ampere contact for use in the Flame Safeguard Limit Circuit. The Draft Range Transmitter with time delayed high pressure cut-out shall be a Preferred Instruments, Danbury, CT Model JC-22XMTR.

9. Boiler Control Field Equipment

Actuators

Electric actuators shall be furnished. Actuators shall be all electric. A mix of electric and pneumatic actuators shall not be permitted

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because actuation speeds for pneumatic and electric actuators are not identical. Positioning accuracy shall be within 0.1 degrees for Actuators with 37 ft-lbs of torque or less and within 0.4 degrees for Actuators with higher than 37 ft-lbs of torque. Actuators shall provide the required torque, 90° rotation in 30 seconds, and shall "lock in the last position" when not driven, or when the control power fails. Provide a device for manually repositioning the output shaft in the event of a power or controller failure. All final control elements requiring levers and linkage shall be furnished with all necessary ball and socket joints, levers, arms, clevises, pins, etc. for both the drive and driven ends of the linkage. Electric actuators shall be supplied with either 4-20 mADC type input or TRIAC input and a position feedback potentiometer signal.

Provide actuators for the following dampers:

- Combustion Air Control Damper
- FGR Damper (if required)
- Draft Damper (if required)

Control Valves

Control valves shall have electric actuators. Electric actuators shall be supplied with either a 4-20mADC type input or TRIAC input and a position feedback potentiometer signal. Fuel Gas and Fuel Oil Control Valves shall be "Characterized Seat" Ball Valves and equipped with a Low-fire position switch (only if the specified BMS/CCS is not used). Atomizing Steam and Feedwater control valves shall be of a tight shutoff "Characterized Seat" Ball Valve design with a steel body suitable for at least 300 PSIG Steam. The Feedwater Control Valve shall be sized for 125% of maximum rated boiler flow while having a pressure drop of approximately 15 PSIG at design capacity.

Provide the following control valves:

- Natural Gas Flow Control Valve
- Fuel Oil Flow Control Valve
- Feedwater Flow Control valve (if required)
- Atomizing Steam Pressure Control Valve

Flue Gas Oxygen Analyzer

Provide a breeching mounted in-situ, zirconium oxide Oxygen Analyzer. Extractive or "Wet Cell" type Oxygen analyzers are not acceptable. The probe shall be of a suitable length to sense the Oxygen level in the middle third of the breeching. All wetted parts shall be stainless steel. The Oxygen analyzer shall include continuous self-diagnostics with diagnostic codes for at least 10 common faults. The system shall automatically send the trim control to the 'null' position and trigger the alarm dry contacts in the event of an Oxygen analyzer fault. The detector shall be field replaceable without removing the probe from the stack and shall not require special tools. The analyzer shall automatically perform periodic detector cell impedance tests to be used by the operator as an indication of calibration shift. Analyzer calibration shall be pushbutton semi-automatic (no trim pots) with English language prompts and diagnostic messages. Analyzer output shall be field selectable as 0-10% or 0-21% without field re-calibration.

Variable Speed Drive (VSD)

Provide a pulse width modulation (PWM) type VSD suitable for microprocessor-based digital control. The VSD shall accomplish stepless speed control by adjusting both the output voltage and frequency to the motor. The VSD shall utilize IGBT power

semiconductor technology in the inverter section. VSDs must be UL listed. Provide a NEMA 12 enclosure for the VSD to protect it from dust and splashed water. VSD shall be designed for 104° F continuous ambient air temperature. The enclosure shall be completely self-ventilating with powered fans as required. A NEMA type 1 rated enclosure will not be accepted. The VSD shall automatically limit the rate of fan speed increase to that which will prevent an over current or over voltage trip in the event of a "STEP" speed increase of 0 to 100%. The VSD shall include a line reactor or DC Link Choke to reduce rectifier peak currents, and reduce total harmonic distortion (THD). In order to extend motor insulation life, the VSD shall limit peak voltages. The "dv/dt" shall be limited to 900V/microseconds on a 500-foot cable length between the VSD and motor. VSDs that do not include internal dv/dt limiting shall be provided with external filters.

10. Supervisory Control & Data Acquisition

General

Provide a remote Supervisory Control And Data Acquisition (SCADA) system designed to provide remote operation, graphic display of information, alarm message display, report generation, historical trending and remote controller tuning. The SCADA system shall be networked to the boiler control and burner management systems.

Equipment Requirements

Communications between the data acquisition system and both the individual controllers and the flame safeguards shall be via an industry standard protocol such as Modbus.

Hardware features

The system shall use standard PC hardware to simplify future expansion, replacement and service requirements. Workstation hardware must include high speed serial ports, parallel port, 56K Internal Modem and Ethernet Network Card, Keyboard and Microsoft mouse, Tower Case for Computer, Alarm printer, tractor feed 24 pin Dot Matrix printer, Shift report and trend DeskJet printer and 650 VA UPS backup power system.

Software features

The software package shall operate in conjunction with the Microsoft operating system. Reports shall be prepared automatically utilizing standard Microsoft Excel® spreadsheets to allow for easy log sheet customizing. Software shall be mouse based to allow for easy selection of screens, manual/automatic status changes, start/stop functions, setpoint changes, and output changes without any special programming skills. The system shall be expandable in the future to a multi-workstation system via standard Ethernet LAN hardware. Any measured or calculated value shall be available to third party software via standard OLE for Process Control (OPC) Data Exchange. Provide all necessary software to allow field modification or expansion of the Data Acquisition system including graphics drawing programs, data base builders, report generators, etc. Controller discrete output valves. The HMI display shall provide a facsimile of the local controller and clearly labeled English language and engineering unit display of the control parameters. No special programming skills shall be required for any routine operating sequence.

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Human Machine Interface (HMI) Terminal Operation

The operator, when the local controllers are enabled, shall have remote control of the following functions from the data acquisition terminal: Manual/Auto mode of each controller, Controller setpoint values, Controller output when in the manual mode, PID tuning parameters, Controller analog output values,

Graphic Display

Information shall be displayed on the HMI as part of an easy to understand pictorial representation of the process. High and low alarms shall be displayed for each analog variable displayed. At a minimum, the following pictorial "screens" shall be available for observation: as an example, a typical steam generator would display (when available): Steam drum pressure, Steam Flow for each boiler, Steam Temperature, Drum Water Levels for each boiler, Flame Failure, Fuel flows, Combustion Air Temperature, Flue gas Temperature, Boiler Efficiency by ASME "By Losses" method, Air Flow %, Flue Gas Recirculation Damper Position, Outlet Damper Position, Controller Faceplate Grouping for each boiler, Trend Screens for each group of controlled and Process Variables as relates to each controller in the system. All values shall be displayed in engineering units adjacent to the pictorial point of measurement. flash until acknowledged.

Remote Tuning

Each controller in the system shall be capable of remote tuning of gain, reset, rate and the other important parameters via the SCADA System. Tuning the controllers shall be a "menu driven" operation and shall not require special programming skills. When each controller is placed in the remote tuning mode, a real time trend chart of controller inputs shall be displayed on the HMI to aid the technician in setting the proper parameter values. This function shall be password protected for security.

Alarm Generation

Where applicable, alarm status shall be displayed on the CRT generated process pictorials. In addition, all alarms shall be printed as they occur on the alarm printer, and displayed on the lower portion of each HMI display. The alarm log, as generated at the printer, shall indicate the time at which the alarm occurred, the time at which the alarm was acknowledged and the time at which the value returned to normal status. In addition to alarm conditions, this log shall also document status changes (such as a transfer from automatic to manual, setpoint change, etc.) so that the resultant printout is a true and complete log of plant operating conditions.

Report Generation

The log sheet printer shall print out: on demand, shift; daily and monthly plant operating reports for evaluation by the plant manager. As an example, a report for a steam generator application would list (when available):

- Total steam generated by the plant and each boiler
- Total fuel used by the plant and each boiler
- Average cost of steam
- Input-Output efficiency of the plant and each boiler (Shall also be reported on a "per degree day" basis)
- Combustion efficiency ASME "By Losses" Method for each boiler
- Make-up water flow in pounds and also as a percent of steam flow
- Hours of operation for each boiler

- Steam flow to each of the distribution headers

Historical Trending

The system shall be capable of storing the values from all transmitters as well as system-computed values (such as efficiency and compensated flow rates) to hard disk at selected intervals. Stored data can be regularly downloaded to an external USB drive for archival storage and future reloading into the system for analysis. All data stored in the system shall be available on HMI or paper plot displays as strip chart records with up to eight channels per display. The horizontal and vertical axes of the trend displays shall be variable to provide the degree of overview or fine resolution required for each specific analysis. The software package shall be pre-programmed to give the operator a "menu" of standard trend displays. If a custom display is required, the operator shall be able to generate the required display via help messages and a "fill-in-the-blanks menu." No special programming skills shall be required.

Flame Safeguard Interface

The SCADA system shall have dedicated communication between the computer and the Flame Safeguard systems so as to allow all alarms to be graphically represented on the monitor. The system must be capable of displaying and recording the following statistics: burner Limits, Individual Lockouts, Burner Operational Hours, Total Burner Cycles, Burner Status, Last Six Lockouts, Total Lockouts, Average Flame Signal Strength and Present Flame Signal Strength.

Data Acquisition System Compatibility

The SCADA System may be expanded to cover other plant utilities. It is therefore essential that the SCADA System supplied for this project be "open" and easily adaptable to other brands of controllers, sensors and I/O hardware. At a minimum, the system supplied under this contract must be able to communicate with 3 separate communication links simultaneously. The system must have available communication drivers for: Fireye and Honeywell flame safeguards and Preferred Instrument PCC-III and PWC Controllers. The system must not be proprietary or dedicated to a single brand of controller or I/O hardware.

Quality Assurance

All control functions shall be accomplished within the individual Boiler Control and Burner Management controllers and shall be monitored by the SCADA system so that the integrity of the control system shall not be dependent on the status of the SCADA system or the interconnecting network (In the event of a control network and/or a SCADA shutdown, continued plant operator monitoring and control must be available from the local controllers). The SCADA system shall be a Preferred Instruments, Danbury, CT, SCADA/Flex.

11. Combustion System Field Services

General

The manufacturer shall furnish, at no additional cost to the purchaser, the services of a competent service engineer to supervise and assist in effecting boiler boil out, boiler/burner startup, adjustments, testing, and instruction of operating personnel. Manufacturer's proposal shall state the period of time incorporated in the offering for field engineering services. If additional services are desired, the proposal shall also state the manufacturer's per Diem rate, travel, and living expense costs applicable.

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Requirement

Provide a minimum of five (5) days of factory service per boiler for the startup and adjustment of the Burner, Boiler Controls and Burner Management System. Provide a minimum of five (5) additional days (plant wide) of startup service for the Supervisory Control and Data Acquisition (SCADA) system. All unused field service time shall be credited to the facility for use during the first year of operation. Provide for three (3) training sessions of one (1) day each in the proper operation and maintenance of the equipment. Training sessions shall cover the operation, troubleshooting, maintenance and tuning of the loop controllers and associated equipment.

The facility shall reimburse the manufacturer for all travel time and expenses incurred during all field service engineer trips.

Field Service Qualifications

- Manufacturer's Service Department must be staffed with a minimum of (5) Service Engineers
- Manufacturer's Service Engineers must be trained in the commissioning, operation and safety of Boiler, Burner and Control systems
- Manufacturer must be regularly engaged in the commissioning of Boiler, Burner and/or Controls projects as well as the training of Service Engineers of other firms.

APPENDIX A: Fuel Analysis

To be supplied by the customer and attached here.

Minimum Fuel supply pressures available at the piping train inlets must be provided.

Please note:

No. 6 Fuel Oil "Fuel Bound Nitrogen" content (% by weight) and viscosity (SSF at 122° F) must be provided.