1. GENERAL
   1. SECTION INCLUDES
      1. Steam Boilers
      2. Low NOx Burners
      3. Steam Trim
      4. Fuel Burning System
      5. Emergency Shutdown System
      6. Plant Master Controller
   2. RELATED SECTIONS
      1. Section 01 11 00 – Summary of the Project
   3. REFERENCES
      1. A.N.S.I./A.G.A. Z223.1 – National Fuel Gas Code.
      2. A.N.S.I./A.S.M.E. Section 1 – Boiler and Pressure Vessels Code – Rules for Construction of High Pressure Power Boilers.
      3. A.N.S.I./A.S.M.E. Section 4 – Boiler and Pressure Vessels Code – Rules for Construction of Heating Boilers
      4. N.F.P.A. 70 – National Electrical Code.
      5. U.L. 795 – Commercial/Industrial Gas-Fired Boilers.
      6. CSD-1 - Control & Safety Devices for Automatically Fired Boilers
      7. FM
      8. NFPA 85 GE GAP.
   4. SUBMITTALS
      1. Section 01 33 00 – Submittal Procedures: Submittal requirements.
      2. Product Data: Submit data on general layout, dimensions, size, and location of connections, wiring diagram and piping detail.
      3. Submit manufacturer's installation instructions.
      4. Submit Installation and appropriate air permitting reports to appropriate local government agency. Include copy in operation and maintenance data under provisions of Section 01 70 00.
   5. CLOSEOUT SUBMITTALS
      1. Section 01 70 00 – Execution Requirements: Project record document procedures.
      2. Maintenance Data: Include manufacturer's descriptive literature; operating instructions, cleaning procedures, replacement parts list and maintenance and repair data.
   6. QUALITY ASSURANCE
      1. Standard Manufacturers: Firms regularly engaged in the manufacturing of the vertical steam boilers for a minimum of 70 years.
      2. Vendors: Boiler/burner unit shall be furnished as complete factory approved and integrated factory assembled unit.
      3. Substitute Equipment:
         1. Comply with requirements for substitutions specified in Division 1 and additionally as provided in this section.
         2. Other boilers may apply for approval as hereinbefore detailed no less than fifteen (15) days prior to bid. If the boilers are acceptable to the owner and engineer, an addendum will be issued advising bidders of same. Alternate manufacturers will not be accepted without the specified owner and engineer written approval and herein before specified addendum. The substitution request must be submitted by a qualified bidding contractor and not the equipment vendor. If an alternate manufacturer is utilized by the contractor, the contractor shall be solely responsible for all applicable Labor and Industry and Department of Environmental Protection permits along with the associated costs of same.
            1. Catalog cuts and drawings indicating the major design features and sufficient dimensional data to determine the suitability of the equipment. Alternate equipment must conform to the following design features:
         3. Boiler/burner must fit into the available space as detailed on the contract drawings.
         4. Boiler must be of vertical spiral ribbed tubeless design with a minimum of 0.375” (inch) steel in contact with the water. Water-tube, horizontal fire-tube, boilers containing any hard refractory, boilers containing turbulators, rifled or enhanced fire-tubes will not be accepted.
         5. Minimum thickness for any portion of boiler in contact with water or steam shall be no less than 0.375” (inch) thickness. No exceptions.
         6. All boiler, control and burner components must be a factory integrated and listed package to UL 795
         7. Steam quality shall be no less 99.5% at 12psig and higher operating pressure.
         8. Factory integrated burner and control system shall be capable of a minimum of up to 10:1 turndown.
         9. The minimum boiler efficiency shall be no less than 86% under the conditions described in BTS-2000/AHRI-1500. If the manufacturer’s published efficiency is less than 86%; external economizers must be supplied to meet this minimum specified efficiency requirement. If external economizers are utilized, the installing contractor shall be responsible for providing an ASME short form test to verify that the minimum specified 86% efficiency requirement has been satisfied. An efficiency chart must be provided at three different operating pressures and four different firing rates.
         10. For enhanced seasonal efficiency, all boilers must be furnished with linkage-less controls and constant oxygen level combustion monitoring and adjustment. The burner will automatically adjust combustion settings to hold steady oxygen combustion levels through oxygen compensation. No exceptions are allowed.
         11. For single-source unit responsibility, the boiler, burner, controls and all ancillary equipment must be furnished by a single-source manufacturer and local representative organization.
         12. Boilers with the following items will not be accepted: Water-tubes, poured refractory, head plates, ferruled tubes, rolled and or belled tubes, turbulators, rifled or enhanced fire-tubes.
         13. Any deficiencies in the boiler output or efficiency will not be accepted.
      4. The boiler manufacturer shall have the capability to construct an engineered system, in their own facilities, skid mounted, including but not limited to mounting any number of boilers in a common system with common piping, electrical power, fuel supply, condensate return and vents. Electrical panel boxes for the system must be available along with all wiring requirements. Other available components shall include feed-water tanks and pumps, chemical feed systems, water softeners, carbon filters, and various relevant valves and other accessories. The system manufacturer shall have the engineering capabilities for all aspects of the mechanical and electrical design aspects of the skid mounted system.
      5. Efficiency curve of the proposed equipment detailing the unit efficiency throughout four firing rates shall be provided.
      6. A complete paragraph-by-paragraph review of the specification. Each paragraph shall be marked with one of the following: Comply with no exceptions, comply with deviations, exception–do not comply. For each and every deviation or exception, provide a numbered footnote with the reason for the proposed deviation or exception and an explanation of how the intent of the specification will be satisfied. Unless a deviation or exception is specifically noted in the compliance review, the contractor shall be held in complete compliance with the specifications without deviation or exception.
      7. Boilers must fit into the boiler room space provided. Custom or “special” boiler configurations will not be accepted.
      8. Failure to comply with the above requirements will mean automatic disapproval of the alternate equipment.
   7. REGULATORY REQUIREMENTS
      1. Conform to applicable N.F.P.A. 70 code for internal wiring of factory wired equipment.
      2. Conform to A.N.S.I./A.S.M.E. Section 1, CSD-1, U.L. 795 for boiler construction. Provide boiler registered with National Board of Boilers and Pressure Vessel Inspectors and with the appropriate state agency.
      3. Packaged Units certified to U.L. 795
   8. DELIVERY, STORAGE, AND HANDLING
      1. Section 01 60 00 – Product Requirements: Product delivery, storage, protection and handling requirements.
      2. Protect units before, during and after installation from damage to casing by leaving factory-shipping packaging in place until immediately prior to final acceptance.
      3. Manufacturer’s local representative shall be on site during the boiler rigging and installation to ensure proper handling.
   9. FIELD MEASUREMENTS
      1. Verify field measurements prior to fabrication.
   10. WARRANTY
       1. Section 01 70 00 – Execution Requirements: Product warranties and product bonds.
       2. Provide owner with manufacturer’s warranty for the entire system, including hardware, software and components for a period of one (1) year from startup or 18 months from shipment, whichever comes first, and acceptance by owner, in accord with conditions contract.
       3. Ten (10) Year Material and Workmanship Warranty: The boiler pressure vessel shall be covered against defective material or workmanship for a period of ten (10) years from the date of shipment from the factory. Boiler manufacturer shall repair or replace F.O.B. factory any part of the equipment, as defined above, provided the equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by boiler manufacturer. The commissioning agency must also successfully complete and return the equipment installation and operation checklists to Boiler Manufacturer’s Quality Assurance department.
       4. Warranty shall be a standard offering of the boiler manufacturer and shall not be on an individual project or boiler basis. In the event the manufacturer does not offer a standard ten (10) year minimum pressure vessel warranty, the manufacturer shall provide a bond in the amount of the boiler sell price for labor and material to repair or replace any pressure vessel component that fails for the life of the boiler.
       5. Burner firing head shall be warranted for five (5) years against failure. Provided the equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by boiler manufacturer. The commissioning agency must also successfully complete and return the equipment installation and operation checklists to Boiler Manufacturer’s Quality Assurance department.
   11. MAINTENANCE SERVICE
       1. Section 01 70 00 – Execution Requirements: Maintenance service.
       2. Furnish service and maintenance of boilers for one (1) year from date of substantial completion.
       3. Provide emergency call back service at all hours for this maintenance period.
       4. Perform maintenance work using qualified personnel under supervision of boiler manufacturer’s representative.
   12. MAINTENANCE MATERIALS
       1. Section 01 70 00 – Execution Requirements: Spare parts and maintenance products.
2. PRODUCTS
   1. MANUFACTURERS
      1. Basis of design Fulton Model VSRT as distributed and serviced by insert rep organization name.
      2. Competitor 1
      3. Competitor 2
      4. Other manufacturers will not be accepted.
   2. BOILER TYPE
      1. Provide a vertical tubeless fully wetted, boiler arranged for automatic firing with natural gas and/or propane. Boiler shall be complete with low NOx, natural gas/propane burner, controls, boiler trim, fittings and appurtenances necessary for connection and operation.
      2. Boiler shall be of the spiral rib tube design providing for a fully wetted pressure vessel with all flue gases contained within water backed surfaces.
      3. The boiler shall have no poured refractory. The burner shall be entirely surrounded by a water backed combustion chamber. The burner shall be uniquely matched to the boiler.
      4. Boiler capable of efficiencies up to 86.0%.
      5. The boiler shall be insulated with high density fiber insulation limiting insulation losses to less than 0.5% of the boiler nameplate rating.
   3. PERFORMANCE
      1. Provide boilers with gross output of \_ MBH or \_ PPH steam when fired with \_ MBH of natural gas/propane. Any deficiencies in the boiler output or increased input will not be accepted.
      2. Provide gross flue gas temperature chart over full range of boiler performance.
      3. Provide thermal efficiency chart of a full range of boiler operating performance.
      4. Provide documentation of <20ppm NOx at factory test fire over full turndown range.
      5. Provide documentation of <10ppm CO at factory test fire over full turndown range.
   4. BOILER DESCRIPTION
      1. The pressure vessel design and construction shall be in accordance with Section I/IV of the ASME Code for steam boilers. The boiler shall comply with CSD-1 code requirements and be packaged to UL 795.
      2. The boiler shall be a 4-pass vertical spiral rib tubeless design. The burner location and firing method shall be such that combustion takes place within the water-backed furnace of the boiler. The boiler must be completely refractory free, water backed design, with tubeless heat exchangers.
      3. It shall be acceptable to either direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors or by drawing air from the mechanical space itself.
         1. Sealed Combustion: Schedule 40 PVC pipe or smooth-walled galvanized steel, vent termination with 1/2” x 1/2” mesh bird screen, provided with air duct end switch interlock.
         2. The boiler shall be capable of operating with a maximum air intake pressure drop of 0.25” w.c.
         3. Mechanical Space: Adequate combustion air and ventilation shall be supplied to the boiler room in accordance with local codes, the boiler will be provided with damper end switch interlock.
      4. The flue gas exhaust stack shall be listed and labeled for use with Category I or Category III appliances, guaranteed appropriate for the application by the manufacturer and supplier of the venting.
         1. The boiler shall be capable of operating with a maximum stack draft of +1.50” w.c. and a minimum stack draft of -0.25” w.c.
         2. The boiler shall be capable of common exhaust and intake venting if common vented. The draft system shall be designed to prevent the backflow of exhaust gases through idle boilers.
      5. The entire boiler heat exchanger shall be water backed.
      6. The boiler heat exchanger design shall be entirely free of tubes.
      7. The surface temperature of the boiler jacket will not exceed 140°F.
      8. The manufacturer shall be able to provide an efficiency curve for the boiler showing efficiencies at three different operating pressures at four different firing rates.
      9. The manufacturer shall be able to provide flue gas temperatures at four different firing rates at three different operating pressures.
      10. With the complete water backed design, there shall be no combustion flue gas below the bottom blow down connection.
      11. The flue outlet connection of the boiler shall be configurable to be either top outlet or front outlet.
      12. The pressure vessel shell, furnace, and heads shall be SA-53B/106B ERW pipe or SA-516 Grade 70 plate. The shell thickness shall be no less than 0.50 inches, the heads shall be no less than 0.625 inches, and the furnace shall be no less than 0.50 inches.
      13. The steam space shall be large enough to insure steam quality of 99.5% or greater at operating pressures of 12 psig and higher.
      14. Boiler vessel design shall insure that there are minimal thermal stresses. The manufacturer shall provide a FEA to prove low thermal stresses on the pressure vessel.
      15. A minimum of four (4) hand-holes shall be provided for access to the water side of the boiler. Hand-hole openings shall be provided at the lower part of the boiler so that the entire bottom of the boiler may be cleaned.
      16. The burner must be integral with the boiler, provided by the same manufacturer. The burner should not have any refractory. The burner should be premix type.
      17. The boiler shall be mounted on a base made of heavy gauge steel. The boiler shall be a completely water backed design and should not contain any poured refractory.
      18. The boiler must be supplied with an air filter that will capture airborne particles equivalent to a MERV 8 specification.
      19. The boiler shall be capable of operating with <20ppm NOx and <10ppm CO throughout the entire turndown range of operation as standard. The use of external FGR lines is unacceptable.
      20. The boiler shall be fully assembled and thoroughly tested at the factory at all firing rates. The boiler shall be test fired, test firing shall include filling with water, adjusting operating and safety control settings, and setting combustion points. A minimum of ten (10) combustion points are to be factory configured and tested under live firing conditions. Manufacturer shall supply copies of the test fire report, including fuel air settings and combustion test results. Factory representatives, specifying engineers, installing contractors and/or end users/customers shall all be welcome to witness the boiler being built and/or test fired at the manufacturer’s factory.
      21. Boiler inspection shall include a hydrostatic test in the presence of an inspector having a National Board Commission. They shall certify a Data Report, which shall be delivered with the boiler as evidence of ASME code compliance. In addition to the ASME symbol, the boiler shall bear a National Board Registration Number.
      22. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping.
   5. STEAM TRIM
      1. A water column shall be provided and piped to the boiler at the factory. A gauge glass and drain valve shall be supplied. The water column shall also include the primary low water cutoff probe to automatically shutoff burner operation when water falls below a predetermined level. An auxiliary low water cutoff probe shall be mounted in the boiler shell. The boiler feedwater control shall be controlled by level probes / float type controller.
      2. Feedwater stop and check valve shall be supplied at factory in line to an internally baffled feed connection in boiler shell to prevent thermal shock.
      3. Probe type auxiliary low water cutout. Control unit shall have manual reset feature and be factory mounted in vicinity of blowdown valves.
      4. The boiler shall be supplied with an ASME Section I/IV safety relief valve. The safety relief valve size shall be in accordance with ASME code requirements and set at \_\_\_psig.
      5. Steam pressure gauge with range of 1.5 times to 2 times safety valve setting.
      6. Additional standard trim shall include quick and slow type bottom blow down valves and water column blow down valve.
      7. A surface blowdown connection shall be provided, and provided with a manual valve.
      8. A steam stop valve shall be provided as standard, to be installed on the internally baffled steam connection in the boiler shell.
      9. All required piping and valves to satisfy ASME Boiler External Piping code (ASME B31.1) shall be provided in base quotation by boiler manufacturer. This includes any and all steam piping and valves. Any other proposals will not be accepted.
      10. All external boiler piping shall conform to the A.S.M.E. code and be listed on the boiler’s Data Report, the piping shall be hydrostatically tested at the factory. This pertains to the water feed; blow-off and steam trim piping through the required valves.
   6. FUEL BURNING SYSTEM
      1. Basic Burner System:
         1. The boiler burner system shall be an integrated certified package to UL-795
         2. The boiler and burner manufacturers shall be the same company. Burners that are manufactured by third party vendors to the boiler manufacturer or not part of the integrated boiler burner package will not be accepted.
         3. The UL packaged boiler shall be factory fire tested with documented emissions at all firing rates.
         4. The burner combustion air fan shall be constructed to ACMA standard 99-0401-86 Class B.
         5. Burner be premixed and shall incorporate a stainless steel alloy flame tube. The flame shall be radially distributed around the flame tube providing even heat transfer to the boiler furnace.
         6. The burner head shall be provided with a 5 year warranty. Less than a 5 year warranty will not be accepted.
         7. Control butterfly valves shall be integral to the burner boiler assembly allowing the gas and air valves to each be controlled by a dedicated servo drive repeatable to 0.1 of an angular degree.
         8. The entire fuel air ratio control system shall be free of linkages with each control component being individually controlled by dedicated servo drives and fan speed programmable via the flame safeguard keypad.
         9. Burner fuel air ratio shall be controlled by individual servomotors controlling suction side air and gas flow control valve. A common mod motor and linkages for the combustion air, gas valve and fuel valve will not be accepted.
         10. Air flow shall also be controlled via a Variable Frequency Drive with closed loop fan speed control. Single speed combustion air fan motor assembles will not be accepted.
         11. Burner fuel air ratio shall be infinitely adjustable throughout the entire firing range with a programmable curve via the Siemens flame safeguard programming pad.
         12. Automatic ignition of the main fuel shall be from a natural gas pilot which will cut off after main flame has been established. Pilot gas train shall include shutoff cock, pilot pressure regulator and pilot solenoid valves.
         13. The pilot assembly shall be removable from the boiler independently of the main burner.
         14. Gas train, supplied tested as part of certified packaged boiler shall include:
             1. Main gas shutoff valve with pilot line connection.
             2. Main gas pressure regulator.
             3. High gas pressure switch.
             4. Low gas pressure switch.
             5. Main gas shutoff valve with integral pressure regulator and automatic valve proving control.
             6. Leakage test cock.
             7. Factory mounted metering gas flow control valve.
             8. Gas train components sized for a supply pressure of 13”w.c. to 5psig.
             9. Where the specifications exceed the requirements of the code and insurance requirements, the specifications shall be followed without exception.
             10. Natural gas/Propane valve train shall be manufactured by Siemens. No substitutions will be accepted.
             11. Gas train components shall be factory assembled and tested by the manufacturer as part of the certified boiler package.
      2. Variable speed burner blower motor shall be incorporated. Fixed speed fan operation is not acceptable. 3-phase, 480/230/208 volt, 60 cycle alternating current shall be used. The three phase TEFC blower motor shall be fully compatible for use with variable frequency drive. Provide a VFD and break resistor. Motor starting shall be accomplished using a soft start device to minimize the current draw at start up.
      3. Variable speed modulating burners shall be arranged for a minimum of 10:1 turndown. Burner turndowns of less than 10:1 will not be accepted. A documented factory test fire sheet demonstrating turndown compliance shall be provided with each boiler.
      4. The burner shall be capable of <20ppm NOx operation at all firing rates. A documented factory test fire sheet demonstrating NOx compliance shall be provided with each boiler.
      5. <20ppm NOx emissions shall be achieved via premixed surface combustion. Use of external FGR piping loops and additional control valves is not acceptable.
      6. Fuel and air ratios shall be controlled via electronic parallel positioning and closed loop feedback of fan speed. Fuel air ratio control via mechanical linkage is not acceptable. Fixed speed fan operation is not acceptable. Fuel air ratio via pneumatic air pressure sensing is not acceptable.
      7. Burner control system shall provide solid-state flame safeguard protection, pre and post purge, low fire start and modulated firing rate, 2 to 4 second shutdown on flame failure, and 10 second safety lockout. The air inlet damper shall close after each firing cycle to minimize standby loss during the "OFF" periods. All controls shall be wired for 120 volt operation. The flame safeguard system shall be as manufactured by Siemens Inc. using a programming solid state control with keyboard display module and ultra-violet flame detector together with the appropriate auxiliary equipment. The burner control shall be capable of communication with a building automation system.
      8. The burner controls shall include Siemens flame safeguard control, control transformer, signal lights, manual firing rate control, and flame failure alarm circuit. Burner motor, burner motor starter, interlocks, ignition equipment, and flame detector shall be factory wired to the control cabinet terminal strip as a certified package. Burner control flame safeguards that are proprietary to the boiler or burner manufacturer are not acceptable.
      9. The boiler shall be furnished with a PURE controller for precise steam pressure control. No exceptions.
      10. To conform to A.S.M.E. CSD-1 Section CE-110 each panel shall include an integral disconnect switch. The disconnect switch shall be capable of being locked in the open position so that the boiler can be disconnected from all sources of potential. All required fuse blocks along with a control power transformer with primary and secondary fuses shall be integral to the panel. The control panel shall be arranged for a single point power connection.
      11. The electrical panel shall be constructed and wiring in a UL 508-A facility.
   7. CONTROLS
      1. The boiler electrical control panel shall include the following devices and features:
         1. 7” color touch screen control display factory mounted on the front cabinet panel door.
            1. The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, boiler status, configuration, history and diagnostics.
         2. Controls Transformers: 120VAC, 24 VDC, 12 VDC.
         3. Flame safeguard control with (10) ten combustion fuel/air load profile points.
         4. All standard controls shall be factory mounted and wired according to UL requirements.
      2. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:
         1. Operating Pressure Limit: An automatic reset mechanical UL353 pressure control device shall stop the burner if the pressure conditions rise above the controller set point. The burner shall shut down and automatically restart after the pressure has dropped.
         2. High Limit: A manual reset mechanical UL353 pressure control device shall stop the burner if operating conditions rise above maximum boiler design pressure.
         3. Low-Water Cut Off: Electronic probe type / float type mounted in the pressure vessel shall prevent burner operation on a low water condition. This switch is an automatic reset switch unless local jurisdictions require a manual reset alarm.
         4. Auxiliary Low Water Cut Off: Electronic probe type / float type mounted in the pressure vessel shall be mounted below the Low Water Cut off and be a manual reset device that prevents burner operation and signals an alarm on the control panel.
         5. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.
      3. O2 Compensation: To maximize efficiency throughout seasonality, factory mounted and wired.
         1. A wide band Oxygen sensor shall be factory mounted and measure the Oxygen level present in combustion byproducts during run. The current Oxygen level shall be displayed to the user. The Oxygen sensor minimum requirements shall be:
            1. % O2 Range: 0 to 21%
         2. The O2 Compensation system shall utilize a combination open-loop and closed-loop control system to continuously tune the air/fuel ratio during operation, optimizing combustion reliability, flame stability, combustion efficiency.
         3. Boilers listed as an alternate to the Basis of Design that do not include a closed-loop O2 Compensation control system in compliance with this specification shall be required to provide and commission a Siemens LMV52 Burner Management System with the QGO20 Oxygen Sensor, PLL52.110A100 O2 Trim Module, and associated installation parts.
      4. The Boiler Operating Controls will include the following features:
         1. Steam Pressure Monitoring.
         2. Combustion Air Temperature Monitoring.
         3. Flue Gas Exhaust Temperature Monitoring: Sensor probe shall be stainless steel.
         4. Proportional Integral Derivative (PID) pressure load control capability for single or lead/lag operation.
         5. Operating pressure sensor for automatic start and stop.
         6. Time of day display.
         7. Customizable boiler name display.
         8. Alarm history for a minimum 100 most recent alarms including status at time of lockout.
            1. Alarm annunciation shall include full text descriptions including alarms from the flame programmer in full text descriptions.
         9. User access to upload custom control settings onto SD memory card for backup
         10. Hot standby option with user defined variable setting
         11. The following items will be available for data trending
             1. Boiler firing rate
             2. Steam pressure
             3. Steam pressure set point
             4. Steam header pressure
         12. The controller shall display up to date combustion efficiency value.
         13. The ability to share information across a local network including but not limited to::
             1. Boiler name
             2. Boiler status
             3. Boiler firing rate
             4. Lead/Lag status
             5. Boiler run hours
             6. Boiler cycle count
             7. Alarm status information
             8. Full list of online boilers
         14. The PLC will provide an option to host a webpage with information from the controller to provide boiler status and alarm history.
         15. The controller will be capable of sending email to notify of a boiler alarm.
         16. The ability to control automated bottom blowdown on a set 7-day schedule.
         17. The ability to control automated surface blowdown on a set 7-day schedule.
         18. To provide maintenance reminders for daily, monthly, and yearly maintenance tasks.
         19. Flue gas temperature monitoring with alarm option.
         20. High water alarm option
         21. Snapshot diagnostic capability to be able to be sent out for troubleshooting assistance
         22. Administrative password protection options.
      5. Lead/Lag Control of Modular (Multiple) Boiler Plants: Lead/Lag capabilities shall be integral to the boiler controller for up to 10 boilers installed in the same steam header and shall not require an external panel.
         1. The boiler manufacturer shall provide a steam header pressure sensor for field installation.
         2. Lead/lag operation shall not require a master boiler or external control panel. Field wired sensors or communication may be connected to any boiler in the lead/lag sequence.
         3. The boilers shall communicate with each other via a private Ethernet/IP addressed network.
            1. Field wiring between boilers shall be shielded Cat5e or Cat6 Ethernet cable.
            2. In the event a communication cable becomes damaged or interrupted, communication shall be lost with only one boiler and not the entire lead/lag operation. Daisy chain style wiring lacks this redundancy and shall not be accepted.
         4. Sequence of Operation:
            1. Upon loop pressure dropping below start point, the lead boiler shall be enabled at low fire and shall modulate according to the steam load demand.
            2. As steam demand increases, lag boilers will be enabled based on control variable set points for each boiler.
            3. The lead boiler will modulate up to a specified firing rate prior to the lag boiler energizing. This will continue until the steam load demand is satisfied.
            4. The last lead boiler energized will act as a trim boiler to maintain proper load demands.
            5. As steam demand decreases, the sequence shall operate in reverse
            6. Optional sequencing mode to be parallel boiler load modulation:

As lag boiler stages are enabled according to steam load demand, burners shall return to low fire. Boilers shall modulate in parallel as a cohesive unit according to steam load demand.

When all boilers are active they shall be released to modulate in parallel up to full fire according to the steam load demand.

As steam demand decreases, the sequence shall operate in reverse.

* + - * 1. Rotation of the lead and subsequent lag boilers shall be automatic.

User to have option to configure boiler rotation based on run hours or boiler cycles.

* + - 1. The controller shall also include a (7) seven day setback schedule option for night and day settings.
    1. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.
       1. Hardwired Contacts:
          1. Monitoring: Boiler Status, Burner Demand, General Alarm.
          2. Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Enable, Emergency Stop (E-Stop).
          3. Remote Setpoint Signal: 4-20 mA
       2. Communication Protocol: A Modbus communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.
          1. **[Optional Device:]** A BACnet MSTP and IP protocol communication gateway shall be provided. The BACnet gateway is field installed on a boiler. Additional boilers in the lead/lag system shall not require a dedicated BACnet gateway for the BAS to monitor status. A communication point mapping list shall be
  1. BOILER CLEANING
     1. Contractor shall do a boil-out of the new boiler and deaerator using any commercially available product for this purpose. The boil-out shall include “OVER-THE-TOP” wasting of water. A temporary 2” pipe shall be run from the relief valve tapping to a floor drain to assure that grease and oils are floated to the top and out of the unit. Minimum time for the procedure shall be eight (8) hours of constant water discharge alternating between bottom and top blowdown. At least two (2) complete bottom blowdown and complete refills shall be done.
  2. EMERGENCY SHUTDOWN SYSTEM
     1. Provide at each internal and external door exit from the boiler room, a break glass push-button station equal to Allen-Bradley Bulletin 800T-NX114. Station shall have bright red finish, hammer with attaching chain and nameplate reading “Break Glass to Stop Boilers”.
     2. Break glass stations shall be series wired to a new multi-pole relay in NEMA 1 enclosure. Relay contacts shall be wired into the burner limit circuit of each new and existing boiler.

1. EXECUTION
   1. INSTALLATION
      1. Install in accord with manufacturer's instructions. The first day of the boiler erection must be supervised by the boiler manufacturer’s local representative.
      2. Provide for connection to electrical service.
      3. Provide connection of gas service in accord with A.N.S.I./A.G.A. Z223.1.
      4. Pipe relief valves as indicated.
      5. Equipment shall be installed complete in all respects with accessories and auxiliary equipment and in accord with the requirements of the local codes.
   2. FIELD SERVICES
      1. Prepare and start system under provisions of Section 01 75 00.
      2. Boiler/burner vendor, through the contractor, shall furnish a start-up engineer to provide complete and detailed instruction for the operating personnel in the proper operation, care, and maintenance of equipment. Required service and maintenance of the first year shall be provided by this contractor.
      3. After each new burner and combustion control system has been placed in operation, equipment shall be adjusted for maximum combustion efficiency. In the process of effecting these adjustments, a combustion efficiency test shall be conducted with the use of an electronic type analyzer with printouts capable of measuring carbon dioxide, oxygen and carbon monoxide. This test shall continue for the length of time necessary to adjust the burner for maximum efficiency at 100%, 75%, 50%, and 25% of rating. Stack temperature, over fire draft, carbon dioxide and oxygen shall be recorded. A written report of the combustion test and verification that all operating and safety controls are functioning properly shall be submitted in duplicate for each boiler.
      4. If requested, the boiler/burner manufacturer’s representative shall provide proof of his ability to render competent service for the maintenance and repair of equipment on a 24-hour basis. He shall further attest that a complete inventory of parts, controls, etc., is maintained locally and that an effective service organization with these qualifications has been maintained for five (5) years or more and presently employs a staff of at least ten (10) factory trained service technicians.
      5. All start-up, warranty, instruction and supervision labor shall be paid at the herein before specified prevailing rate.
      6. Submit written report after start-up including control settings and performance chart of control system.

END OF SECTION