

**SECTION 23 52 39
FIRE TUBE BOILERS**

SPEC WRITER NOTES:

1. Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the Section and renumber the paragraphs.
2. References to pressure are gauge pressure unless otherwise noted.
3. This specification includes high pressure, factory assembled, packaged Scotch marine, horizontal, wetback, fire tube boilers with a minimum heating surface area of 5 square feet per boiler horsepower. Other types of high pressure, fire tube boilers are readily available, but are omitted from this specification.
4. Contract drawings must include (as applicable) the VA National CAD Standards listed below:
 - SD235239-01 Fire Tube Boiler
 - SD235239-02 Access Platform Arrangement for Fire Tube Boiler
 - SD235239-03 Natural Gas and Liquefied Petroleum Gas Burner and Igniter Fuel Standard Piping Diagram
 - SD235239-04 No. 2 Burner Fuel Oil Systems Standard Piping Diagram
 - SD232111-07 Boiler Feedwater Pumps Flow Diagram
 - SD232111-08 Boiler Flow Diagram

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies packaged fire tube boiler with trim (accessories), dual fuel (natural gas and No. 2 oil) burner, fuel valve and piping trains, //flue gas economizer, // and other accessories.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. //Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.//

- E. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
- F. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- G. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- H. //Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- I. //Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.//
- J. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- K. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- L. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- M. Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.
- N. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

1.3 APPLICABLE PUBLICATIONS

SPEC WRITER NOTE: Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project, unless the reference applies to all mechanical systems. Publications that apply to all mechanical systems may not be specifically referenced in the body of the specification, but, shall form a part of this specification.

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.
- B. ASTM International (ASTM):
 - A106/A106M-2015.....Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
 - A178/178M-2002 (R2012)..Standard Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes
 - A254-1997.....Standard Specification for Copper-Brazed Steel Tubing
 - C612-2014.....Standard Specification for Mineral Fiber Block and Board Thermal Insulation
 - D396-2015c.....Standard Specification for Fuel Oils
- C. American Society of Mechanical Engineers (ASME):
 - B31.1-2014.....Power Piping

ASME Boiler and Pressure Vessel Code:

BPVC Section I-2015.....Rules for Construction of Power Boilers

BPVC Section II-2015....Materials

BPVC Section VII-2015...Recommended Guidelines for the Care of Power
Boilers

BPVC Section VIII-2015..Rules for Construction of Pressure Vessels

BPVC Section IX-2015....Welding, Brazing, and Fusing Qualifications

Performance Test Code (PTC):

PTC 4-2013.....Fired Steam Generators

D. Environmental Protection Agency (EPA):

CFR 40, PART 60, Appendix A,

Method 9-2017.....Visual Determination of the Opacity of
Emissions from Stationary Sources

E. Department of Health and Human Services, Food and Drug Administration
(FDA):

CFR 21, 173.310-2016....Boiler Water Additives

F. National Fire Protection Association (NFPA):

85-2015.....Boiler and Combustion Systems Hazards Code

G. Department of Veterans Affairs (VA):

.....VHA Boiler Plant Safety Devices Testing Manual,
Third Edition

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 52 39, FIRE TUBE BOILERS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Boiler:
1. Complete catalog information and outline drawings of boiler, burner, and accessories with dimensions including tube removal space and access door opening space.
 2. Catalog cuts showing arrangement and construction of pressure parts, casing, internals, and support frame.

3. Piping connection sizes, locations, types (threaded or flanged).
 4. Technical data including temperature rating and arrangement of refractory and insulation.
 5. Steam nozzle construction, including the maximum forces and moments that are allowed to be imposed by connected piping.
 6. Amount of heating surface and combustion volume.
 7. Weight of boiler empty and flooded including burner and boiler and burner accessories, including corner weights and center of gravity dimensions for coordination with foundation design.
 8. Design pressures and temperatures.
 9. Recommended anchorage of boiler support frame to foundation.
 10. Furnace viewport construction, locations.
 11. Dimensioned location of normal water line, lowest and highest permissible water level, set points of water level alarms and cutoffs.
 12. Predicted external surface temperature of front, rear and sides of boiler.
 13. //Seismic design data on boiler and anchorage of boiler to foundation. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
- E. Boiler Trim: Includes bottom blowoff valves, water level alarm and cutoff devices, water level gauge, low water cutoffs, piping, all valves and fittings furnished by boiler manufacturer, feedwater control system, steam safety valves, steam pressure gauge, stack thermometer, draft gauge, and steam pressure switches.
1. Design, construction, arrangement on the boiler.
 2. Pressure and temperature limitations.
 3. ASTM numbers and schedule numbers of piping.
 4. Type and pressure ratings of pipe fittings.
 5. Flow and pressure drop data on feedwater regulating valves.
 6. Technical data on water level control system.
 7. Scale ranges of gauges, thermometers and pressure switches.
 8. Location of water level sensing and indicating device set points in relation to normal water line and lowest and highest permissible water levels of boiler.
 9. Set pressure and capacity of safety valves.

F. Burner and Fuel Valve and Piping Trains:

1. Catalog data and drawings showing burner assembly and fuel train arrangement.
2. Outline drawings of flue gas recirculation (FGR) ductwork (if applicable).
3. Outline drawings of sound attenuators on forced draft fan intake or discharge.
4. Drawings showing assembly of throat refractory into furnace.
5. Type and temperature rating of throat refractory.
6. Drawings and catalog data on all equipment in igniter (pilot) train, main fuel trains, and atomizing media train. Include data on pressure and temperature ratings, flow versus pressure drop, performance characteristics. Include complete data on air compressors (for oil atomizing) with sound attenuators and motors.
7. ASTM numbers and schedule numbers on all piping.
8. Type and pressure ratings of pipe fittings.
9. Burner flow and pressure data:
 - a. Main burner fuel and atomizing air pressures and flows at maximum required firing rate.
 - b. Igniter (pilot) fuel flow and burner pressure.
 - c. Natural gas main fuel pressure at inlet and outlet of main burner pressure regulator.
 - d. Igniter (pilot) fuel pressures (natural gas and LP gas) at inlet and outlet of burner-mounted pressure regulators.
 - e. Forced draft fan static pressure, power and air flow at maximum firing rate.
 - f. Oil pressure required at boiler fuel oil pump inlet (if applicable).
10. Full load efficiency and power factor of all motors.
11. Predicted sound level at maximum firing rate on each main fuel.
12. Weight of burner assembly.
13. Steps required to change from one fuel source to another.

G. Burner Management (Flame Safeguard Control) System: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

SPEC WRITER NOTE: Retain the following paragraphs only if flue gas economizer is required.

H. Flue Gas Economizer:

1. Drawings showing arrangement and dimensions of unit and all accessories.
2. Design and construction of unit and accessories including safety relief valve.
3. Weight of entire unit, empty and flooded.
4. Pressure and temperature limitations of unit and accessories.
5. Performance data on safety relief valve.
6. Manufacturer's support requirements.

I. //Seismic data. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

J. Boiler, Burner, Economizer Predicted Performance Data:

1. At Maximum Required Output: On each fuel at site altitude, with and without economizer (if applicable) in service, at 15 percent excess air. Data must include fuel and steam flow, boiler flue gas outlet temperature, economizer (if provided) flue gas outlet temperature, steam quality, boiler efficiency, furnace pressures, and predicted boiler radiation and unaccounted losses, feedwater and flue gas pressure losses in the economizer (if provided).
2. At low fire, 25 percent, 50 percent, and 75 percent of Maximum Required Output. Excess air, CO ppm, NOx ppm on each fuel.

K. Schematic wiring diagram of boiler control system showing all components, all interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring and separation of the burner control system from the Burner Management (Flame Safeguard Control) system.

L. ASME "P" Forms, Manufacturer's Data Report, on boiler and economizer construction - submit after boiler and economizer are fabricated.

M. Pretest Data - Boiler, Burner, Controls: As required by Part 3.

N. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:

1. Include complete list indicating all components of the systems.
2. Include complete diagrams of the internal wiring for each item of equipment.
3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

- O. //Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- P. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

1.5 QUALITY ASSURANCE

- A. Coordinate all new and existing equipment and conditions. This includes, but is not limited to: boiler, boiler trim, burner, fuel valve and piping trains, gas pressure regulators and available gas pressure, required fuel oil train pressures and fuel oil header back pressure regulator on house oil pump set, compressed air system for oil atomization, control systems, economizer (if provided), breeching and stacks.
- B. The model and size of the proposed burner shall have been applied to at least three fire tube boilers which are similar in size, proportion, number of passes and furnace dimensions to the proposed boiler. In each of the three installations, burner performance shall have conformed to requirements specified in the paragraph, BURNER AND FUEL TRAINS, subparagraph, PERFORMANCE of this Section. Provide list of these installations, and name, address, and telephone number of person familiar with each project who will serve as a reference source.

SPEC WRITER NOTE: Retain the next paragraph for all boiler sizes even though NFPA 85 states that it only applies to boilers of sizes exceeding 3.6 MW (12,500,000 Btu/h).

- C. Regardless of fuel input rating, the equipment, installation and operation shall conform to NFPA 85. Where conflicts exist between NFPA 85 and this specification, this specification will govern.

1.6 AS-BUILT DOCUMENTATION

SPEC WRITER NOTE: Coordinate O&M Manual requirements with Section 01 00 00, GENERAL REQUIREMENTS. O&M manuals shall be submitted for content review as part of the close-out documents.

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be //in electronic version on CD or DVD// inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

SPEC WRITER NOTE: Select and edit one of the bracketed options after the paragraph below to indicate the format in which the contractor must provide record drawing files. Select the hand-marked option only when the designer has been separately contracted to provide the record drawings from the contractor's mark-ups. Select the BIM option only when a BIM model will be generated, which is typically only performed by the designer on some Design-Bid-Build projects or by the contractor on some Design-Build projects.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
1. //Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.//
 2. //As-built drawings are to be provided, with a copy of them on AutoCAD version // // provided on CD or DVD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.//

3. //As-built drawings are to be provided, with a copy of them in three-dimensional Building Information Modeling (BIM) software version // // provided on CD or DVD.//
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

1.7 PROJECT CONDITIONS

- A. Fuels to be Fired, Main Burner: //Natural gas// //No. 2 fuel oil//.
- B. Igniter (Pilot) Fuels: Natural Gas and LP gas (propane).
- C. Natural Gas: High heating value is reported as // // MJ/cubic meter (// // Btu/cubic foot) at gas company base pressure and temperature. Pressure provided to the inlet of the boiler-mounted regulators will be // // kPa (// // psig) gauge as maintained by main regulator station.
- D. Fuel Oil: Will be furnished under Government contract. House pumping system is designed to provide // // kPa (// // psig) gauge nominal to the fuel train entrance on each burner. Pressure will vary in accordance with characteristics of backpressure regulator on oil pump set (Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT. Oil grade (No. 2) refers to ASTM D396. No burner-mounted pump or relief valve is required.

- E. Oil Atomizing Media: Low-pressure air atomizing burners are required and each boiler must include a dedicated air compressor system furnished by burner manufacturer.
- F. LP Gas: Propane furnished directly to the Government for igniter (pilot) fuel by a local supplier. Regulators at tank area will be set at 34 kPa (5 psig) gauge. Serves as igniter fuel when there is an interruption to the natural gas supply.

PART 2 - PRODUCTS

SPEC WRITER NOTE: Make material requirements agree with applicable requirements specified in the referenced Applicable Publications. Update and specify only that which applies to the project.

2.1 BOILER

SPEC WRITER NOTES:

1. Wetback boilers are specified because they do not have the large rear doors filled with refractory that requires periodic maintenance and replacement. Also, wetback boilers theoretically have less stress on the rear tube sheets than dry back boilers. Most major manufacturers produce wetback boilers.
 2. The furnace location below the centerline of the boiler provides an increased safety factor if low water occurs.
- A. Type: Factory-assembled packaged Scotch marine horizontal fire tube high pressure industrial steam boiler. Three or four pass wetback design with internal furnace located below center of boiler shell. Designed for natural gas and No. 2 fuel oil firing.
 - B. Service: Continuous long-term generation of steam throughout the burner firing range in conformance to the specified performance requirements with feedwater supply at 100 degrees C (212 degrees F).
 - C. Performance:
 1. Steam Output Quantity and Pressure: Refer to schedules on drawings.
 2. Steam Output Quality: 99 percent minimum at all steam flow rates. Based on water quality in boiler of 2200 ppm maximum total solids, 15 ppm maximum suspended solids, 440 ppm maximum alkalinity.

SPEC WRITER NOTE: Review efficiency ratings from boiler manufacturers for the required boiler capacity and steam

pressure and revise the efficiencies listed below upward if possible.

3. Minimum Efficiency at Required Maximum Output:
 - a. Natural Gas Fuel (37.3 MJ/cubic meter) (1000 Btu/cubic foot): 82 percent at 15 percent excess air.
 - b. Fuel Oil (ASTM D396, Grade 2): 85 percent at 15 percent excess air.
- D. Heating Surface: Heating surface is defined as the fireside area of the furnace and combustion chamber plus inside (gas side) circumferential area of all convection tubes. Minimum surface shall be 470 square centimeters per kW (5 square feet per boiler horsepower).
- E. Design Pressure: Shall equal the ASME-stamped maximum allowable working pressure of 1380 kPa (200 psig). Purpose of high design pressure is to provide additional corrosion allowance and additional safety margin to perform safety device testing.
- F. Construction:
 1. Codes: Comply with ASME BPVC Section I, ASME BPVC Section II, ASME BPVC Section VII, and ASME BPVC Section IX.

SPEC WRITER NOTES:

1. Tube thickness specified exceeds the boiler manufacturer's typical standard in order to reduce the possibility of tube sagging.
 2. In limited special cases, the VA may consider the use of rifled tubes to improve heat transfer. If rifled tubing is to be specified, contact VA CFM and VHA OCAMES to obtain written approval prior to editing this specification to include this tubing.
2. Tubes: ASTM A178/178M, Grade A, smooth wall inside and outside. Minimum thickness 2.7 mm (0.106 inches). Flue gas spinners or turbulators are prohibited.
 3. Manway: Cover and yokes shall be forged steel. Manway shall seal tight with no leakage. Provide non-asbestos gaskets.
 4. Handholes: Covers and yokes shall be forged steel or cast iron. Handholes shall seal tight with no leakage. Provide non-asbestos gaskets.
 5. Access to Tubes and Furnace: Provide hinged and davited doors and access panels to permit access to all tubes, burner head, and furnace for cleaning, repairs and replacement. Doors wider than the

- radius of the boiler shell shall be davited and shall be operable by one person. Hinges or davits are not required for access panels less than 600 mm (2 feet) in width and height. All doors and panels shall have non-asbestos gaskets and shall be sealed tight with capscrews threaded into brass nuts. Panels shall have handles.
6. Shell Piping Connections: Flanged, except threaded is permitted for pipe sizes less than 65 mm (2-1/2 inches). Connections shall include, but not be limited to:
- SPEC WRITER NOTE: Steam nozzle forces and moments imposed by thermal expansion and seismic movement (in seismic areas) of connecting piping must be scheduled on the drawings.
- a. Steam nozzle shall be 2070 kPa (300 psig) ASME flanged. Design nozzle and shell assembly to withstand forces and moments imposed by connected piping. Studding nozzle is prohibited.
 - b. Locate manual steam vent on top of boiler shell to permit access to vent gate valve from platform located above boiler.
 - c. Locate safety valve outlets to permit straight run of vents through roof and to permit valve handle access from platform located above boiler.
 - d. Connections for water level control, alarm and indication devices.
 - e. Connections for boiler feed water, chemical admission, combined continuous blowdown and water sampling. Locate below normal water level and as shown.
 - f. Bottom blowoffs. Locate to permit complete collection of sediment and complete drainage.
 - g. Pressure gauge and pressure switch connections. (May be connected to water level controller steam piping.)
7. Support System: Provide proper support of all elements of the boiler, burner, and accessories during shipment, rigging, and in final installation. Arrange supports to permit thermal expansion// and to resist seismic shocks (in seismic areas)//. No element of the boiler or accessories shall be overstressed, displaced, have cracks, broken welds, or excessive deflection. All vertical elements of the boiler and accessories shall be plumb, and all horizontal elements shall be level.

- a. Base Frame: Design for mounting on flat concrete base. All elements shall be level. Provide attachments for anchorage to the concrete foundation.
 - b. Rigging and Jacking: Provide lifting lugs and provisions for jacking. Painted stencils shall identify jacking locations.

SPEC WRITER NOTE: Include the following if a boiler-supported valve access platform is required.
 - c. Platform Support Brackets: Provide brackets attached to boiler shell to support field-installed valve and manway access catwalk alongside top of boiler.
 - 8. Refractory and Insulation: Boiler manufacturer's standard and experience proven design except insulation on the boiler shell shall be a minimum of 50 mm (2 inches) thick. No part of the external casing shall exceed 16 degrees C (60 degrees F) above ambient, except for areas within 300 mm (1 foot) of the casing penetrations.
 - 9. Casing: Sheet steel covering all areas of boiler shell. Flash or seal all openings at top of boiler at piping and flue connections to prevent leakage of water into insulation. Provide a 300 mm (1 foot) minimum width section of heavy gauge reinforced casing or heavy density insulation minimum 96 kg per cubic meter (6 pounds per cubic foot) along the top centerline of the entire length of the boiler to permit walking on top of the boiler without denting the casing.
 - 10. Observation Port: Provide single port at rear of furnace located to permit flame observation. Furnish with one clear and one tinted interchangeable heat resisting glass, gas-tight operable metal closure between furnace and glass, forced air cooling to reduce moisture condensation on glass.
 - G. Factory Inspection and Certification: Inspect the completed boiler assembly in accordance with the requirements of the ASME BPVC Section I. The boiler inspection shall be certified. Submit four copies of ASME Form P-2 for each boiler.
 - H. Finish: Provide surface preparation, heat-resistant prime and two finish coats using standard color of the boiler manufacturer.
 - I. Controls and Safety Devices: In accordance with NFPA 85.
- 2.2 BOILER TRIM (ACCESSORIES)**
- A. Conform to ASME BPVC Section I.

B. Steam Safety Valves:

1. Capacities certified by National Board of Boiler and Pressure Vessel Inspectors (NBBI).
2. Type: Bronze or cast-iron bodies, side outlet, flanged or threaded inlet and outlet, lifting lever, dual control rings, stainless steel trim, O-ring EPDM seats on bronze valves.
3. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Set pressures as shown. Set pressure of lowest pressure valve shall not exceed normal boiler plant operating pressure by more than 207 kPa (30 psig). Provide 34 kPa (5 psig) difference in setting between each of the valves.

C. Steam Pressure Gauge:

1. Case: Turret-style, bottom connection, threaded ring, blowout disc in rear.
2. Dial: 200 mm (8 inch) minimum diameter, non-corrosive, black markings on white background.
3. Measuring Element: Bourdon tube designed for steam service.
4. Movement: Stainless steel, rotary.
5. Pointer: Micrometer adjustable, black color.
6. Window: Laminated safety glass, or plastic.
7. Accuracy: One half percent of the full span.
8. Range: //0 - 2070 kPa// //0 - 300 psig// gauge.
9. Installation: Stop valve, steel piping, valved blowdown, siphon, union at gauge, and valved connection for inspector's gauge. Refer to Detail, FIRE TUBE BOILER.

D. Water Level Safety and Operating Controls and Indicators:

1. Provide high and low water warning alarms, primary and auxiliary low water burner cutoffs, automatic electronic modulating feedwater level control system, gauge glass.
 - a. High and low water warning alarms shall operate bell and separate high and low water level indicating lights on boiler control panel and shall not shut down the burner.
 - b. Primary and auxiliary low water burner cutoff devices shall be in two separate water columns, piped individually to the boiler water spaces. One device shall be float-type, the other device shall be conductivity probes. Primary and auxiliary cutoffs shall require separate manual reset. Non-latching shunt switches shall allow blowdown of water columns without shutting down the burner.

- c. Water level set points for all devices shall be as recommended by boiler manufacturer.
 - d. Water level control system shall maintain the water level within limits established by boiler manufacturer for normal water level with no tripping of high and low-level alarms with instantaneous load swings of 25 percent of boiler capacity. Feedwater pump will operate continuously.
 - e. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT for detailed operation of all indication, monitoring, alarm and control devices.
2. Water Column Unit with Water Level Controller, Gauge Glass, Water Level Sensor for Primary Low Water Cutoff:
- a. Float-type electric or electronic modulating water level control device and primary low water cutoff. As an option to the float type device, electronic self-checking magnetostrictive or capacitance devices may be provided.
 - b. Height of water column and gauge glass shall be sufficient to show water level in the gauge glass at least 15 mm (1/2 inches) above high water alarm set point and at least 15 mm (1/2 inches) below auxiliary low water cutoff set point.
 - c. Control system shall automatically modulate an electric feedwater flow control valve. Feedwater pump will operate continuously.
 - d. Gauge Glass and Gauge Valves: Single vertical tubular gauge glass, tempered borosilicate, red line, rated for 315 degrees C (600 degrees F). Provide automatic off-set gauge valves with ball checks to prevent fluid flow if gauge breaks. Provide gauge rods to protect glass.
3. Auxiliary Water Column with Water Level Sensors for High and Low-Level Alarms and Auxiliary Low Water Cutoff:
- a. Conductivity probe type high and low-level alarm sensors and auxiliary low water cutoff sensor.
 - b. UL listed, factory-built probe and chamber unit mounted externally from the boiler.
 - c. Stainless steel conductivity probes and grounding probe. Virgin Teflon insulation.
4. Water columns shall be rated for 1380 kPa (200 psig) minimum saturated steam and have boiler and drain connections.

5. Water Column Piping to Boiler and to Drains: ASTM A106/A106M, Grade B, seamless or ERW piping, Schedule 80 threaded. Fittings shall be 300 lb. malleable iron or forged steel. All changes in direction shall be with crosses, no ells. Provide valved drain piping connected to the lowest part of each of the water columns.
6. Electrical: Provide circuit breakers, transformers, all devices for complete control system. All control electronics and relays shall be in waterproof NEMA 4 panels.
7. Modulating Feedwater Control Valve:
 - a. Characterized rotary or sliding gate valve. Operated by electric drive unit actuator with top mount integrated digital positioner. Equal-percent valve flow characteristics. Modified linear valve flow characteristics shall be utilized when digital positioner is furnished.
 - b. Performance: Refer to schedules on the drawings for pressure, temperature and flow requirements. If not shown on the drawings, the valve shall be designed for maximum flow rate of 125 percent of the maximum boiler steam output with 69 kPa (10 psig) pressure drop, maximum inlet pressure of 2070 kPa (300 psig), maximum temperature of 138 degrees C (280 degrees F). Shut-off seat leakage less than 0.0001 percent of valve CV.
 - c. Rotary Valve: Three-piece carbon steel body, 316 stainless steel ball and stem, Polyfil seat, TFE coated stainless steel seal, 2070 kPa (300 psig) 138 degrees C (280 degrees F) minimum ratings. Flanged ends or wafer type for pipe sizes over 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and less.
 - d. Sliding Gate Valve: Stainless steel body, head section, actuator springs valve stem and fixed disc. Tribaloy (STN2) self-aligning sliding disc. Carbon filled PTFE packing. Minimum ratings 2070 kPa (300 psig), 138 degrees C (280 degrees F).
 - e. Sound Levels: Conform to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
 - f. Electric Drive Unit for Rotary Valve: Shall have sufficient power to operate valve under all operating conditions. All parts of linkage between drive unit and valve shall be free-working, securely attached, and shall not distort under all operating conditions.

8. Shunt Switches for Primary Low Water Cutoff and Auxiliary Low Water Cutoff: Provide separate non-latching shunt switches for each of the low water cutouts to allow manual blowdown of water column without tripping burner. Locate each switch adjacent to the drain valve for the low water cutout that is affected by the switch.
 9. Low Water Cutout Operation: Manual reset of primary low water cutoff shall be combined with the burner management manual reset. The burner management system annunciator and associated alarm horn shall indicate the primary and auxiliary low water cutoff operation. The manual resets for primary and auxiliary low water cutoffs shall be separate, such that an operator would be alerted to a failure of the primary cutoff.
- E. Stack Thermometer:
1. Dial-type, bi-metal element, stainless steel case and stem, adjustable angle, one percent of full scale accuracy, dual scale, 100 to 550 °C and 200 to 1000 °F, minimum diameter 125 mm (5 inches).
 2. Electronic temperature sensor with stainless steel sheath, for indication at the BAS.
- F. High Steam Pressure Burner Cutouts:
1. Provide two UL listed, FM approved units with different set points. Unit with lowest set point shall be automatic reset; unit with highest set point shall be manual reset.
 2. Bellows or bourdon tube actuated sealed snap-acting switch with adjustable set point and adjustable differential pressure (automatic reset unit); switch position indicator.
 3. Rated for 1380 kPa (200 psig) minimum emergency pressure.
 4. Set pressure range: To 150 percent of required set pressure.
 5. Provide indicators with graduated scales for set point and differential pressure.
 6. Mounting: Connect to water column piping. There shall be no valves between cutoff and boiler shell. Provide siphons at each switch to protect bellows from high temperature.
 7. Set Points:
 - a. Automatic Reset Unit: Refer to boiler schedule shown on the drawings. If not shown, set at 34 kPa (5 psig) below the set pressure of the manual reset unit.

- b. Manual Reset Unit: 34 kPa (5 psig) below lowest safety valve set pressure. Subtractive differential not to exceed 69 kPa (10 psig).
- 8. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT for the operation of the cutouts.

2.3 BURNER AND FUEL TRAINS

SPEC WRITER NOTE: Delete low NOx requirements unless required by air emissions authorities.

- A. Burner Type: Integral combination natural gas and fuel oil, packaged, forced draft, modulating firing//, and variable speed forced draft fan//. //Design for low NOx emissions.// Burner shall be manufactured and tested by the boiler manufacturer on the boiler specified herein.
 - 1. Gas Burner: Ring type with multiple ports or spuds.
 - 2. Oil Burner: Gun type, inside mix, low pressure air atomizing.
 - 3. Igniter (Pilot): Interrupted, electrically ignited, natural gas and propane.
 - 4. Change of fuels will not require any disassembly and reassembly of the fuel train on burner fuel nozzles.
- B. Service:
 - 1. Continuous operation at all firing rates on each fuel listed under paragraph, PROJECT CONDITIONS of this Section. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures.
 - 2. Igniter (Pilot) Fuels: Normal fuel will be natural gas. Propane will be used if there is an interruption in natural gas service.
 - 3. Main Fuels: After boilers are accepted for operation, choice of fuels will be based on cost and availability.
- C. Performance:
 - 1. Igniter (pilot) flame on natural gas and propane shall form close to the point of ignition and shall be stable. Ignite both the gas and oil burner with single igniter.
 - 2. Main flame on gas and oil fuels shall ignite at lowest firing rate.
 - 3. Main flame characteristics at all firing rates:
 - a. Flame retained at the burner.
 - b. Flame stable with no blowoff from the burner or flashback into the burner. Pulsations, rumble, or vibrations are prohibited at any firing rate.

- c. No deposits of unburned fuel or carbon at any location.
 - d. No carryover of flame beyond the end of the first pass (furnace tube).
 - e. Steady constant direct contact or impingement of the flame on any surface is prohibited.
4. Main Burner Operation:

SPEC WRITER NOTE: Turndown varies with boiler size and for controlled emissions versus uncontrolled emissions. Turndown may be 10:1 on gas with uncontrolled emissions, but may be as low as 5:1 on gas with controlled emissions.

- a. Minimum turndown //10:1// //8:1// //5:1//.
- b. Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures, atomizing media trains or pressures.
- c. Excess Air in Flue Gases with Oxygen Trim at Null Position:

Boiler Steam Output, Percent of Maximum Required Capacity	Percent Excess Air Allowable Range
Below 25	15 minimum
25 to 39	15 to 35
40 to 100	15 to 25

- d. Performance at any load point shall be repeatable after increasing or decreasing the firing rate. Repeatability plus or minus five percent excess air, at 25 percent and higher boiler loading except excess air must remain within ranges specified above.

SPEC WRITER NOTE: Oxygen trim control should be specified on boilers that have parallel positioning combustion controls.

- e. //Oxygen trim control set at maximum position shall not blow out the fire at any load point. At minimum position, the combustion shall not go below stoichiometric.//
- f. Noise and Vibration: Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan and oil atomization system. Burners shall operate without pulsation.

SPEC WRITER NOTE: Engineer must review local emissions rules and revise the following paragraphs as necessary.

5. Flue Gas Emissions Limits:

- a. Carbon Monoxide: Shall not exceed 200 ppm.
- b. Smoke: On natural gas and No. 2 oil shall not be visible and shall not exceed No. 1 on the Bacharach smoke scale.

SPEC WRITER NOTE: Delete NOx requirements except where required by local air emissions authorities. Insert local NOx emissions limits if applicable. If local emissions rules express the requirement in a different way, revise the subparagraph to conform. The VA prefers to avoid any requirements for low NOx limits (30 ppm or lower), unless local air emission regulations require such, because of typically adverse effects on turndown, capacity, and efficiency.

- c. NOx: // // ppm maximum, corrected to 3 percent oxygen, dry basis on natural gas //and // // // ppm, maximum low nitrogen No. 2 fuel oil//.

D. Construction:

- 1. Burner Access (Main Burner and Igniter): Arrange fuel valve and piping trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
- 2. Arrangement of Fuel Valve and Piping Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. Do not attach any piping or devices to boiler casings.
- 3. Coatings: Provide surface preparation, heat resistant prime and two finish coats using standard color of boiler manufacturer.
- 4. Combustion Air System and Flue Gas Recirculation (FGR) System (if provided):
 - a. Air flow rates controlled by forced draft fan inlet or outlet dampers// and variable speed drive//.
 - b. Symmetrical, balanced distribution of combustion air into the burner.
 - c. Provide induced type FGR system if FGR is necessary to achieve specified NOx limits. All FGR ductwork shall comply with Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.
 - d. Forced Draft Fan: Airfoil or backwardly inclined wheel, electric motor driven. Design for required excess air and for static

pressure that is based on losses from fan inlet to stack or chimney outlet, including economizer (if provided), at jobsite altitude. Fan shall have no resonant frequencies at all operating speeds.

- e. Motor: TEFC or open drip proof, non-overloading under all fan operating conditions, design for 40 degrees C (104 degrees F) ambient, premium efficiency type. Motors for variable speed service shall be rated inverter-ready. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
 - f. Damper: Design to provide accurate control of excess air with minimum hysteresis. //On variable speed systems, the damper shall operate across all firing rates.//
 - g. Motor Starter Panel: Provide motor starter //and variable speed drive// mounted in NEMA 4 enclosure, readily accessible. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT, for burner management system motor power interlocks.
 - h. Sound Attenuators: Provide attenuators on forced draft air intakes to reduce sound levels to allowable limits. Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
5. Provide front and rear viewports, with one clear and one tinted replaceable interchangeable glass. Locate to permit view of main and igniter flames.
 6. Burner Throat: Refractory tile, shaped to promote proper combustion, arranged with provisions for expansion and contraction and rated by the refractory manufacturer for the maximum service conditions.
 7. Electrical Conduit: Provide liquid-tight flexible metal conduit with sealing fittings for all power and control services to fuel trains and burners. Flexible metal conduit must be limited to 900 mm (3 feet) in length, unless additional length is required for door or burner swing. Refer to Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
 8. Factory Testing: Mount burner and controls on boiler at factory and fire-test to verify proper operation, including Flame Safeguard and safety interlock operation.

SPEC WRITER NOTE: Delete any fuel valve and piping trains not required. Determine if the natural gas supplier has any

special requirements that must be incorporated in the main or igniter fuel trains.

E. Natural Gas Main Fuel Train:

1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description. Starting at the entrance to the train, the devices are, in sequence: plug valve, filter, pressure gauge, pressure regulator, valved connection to pilot burner fuel train, flow meter (if required), pressure gauge, low pressure switch, two automatic safety shut off valves, valved leak test, high pressure switch, fuel flow control valve, plug valve, pressure gauge, burner. Provide tee connection for vent between the automatic safety shut off valves. Vent line shall include valved leak test connection, automatic vent valve, valved leak test connection, lockable plug valve, vent thru roof. High and low pressure switches shall be located to sense the constant pressure controlled by the burner pressure regulator and not the variable burner pressure.
2. Filter: Replaceable fiberglass or cellulose cartridge, 10 micron or smaller particle retention. Static pressure capability two times the maximum lock-up pressure of nearest upstream pressure regulator. Maximum pressure loss at high fire 1.3 kPa (5 inches WG). Provide vent with cock for relieving pressure in filter.
3. Pressure Regulator:
 - a. Single seated, diaphragm-operated, designed for natural gas service. Controlled pressure shall be sensed downstream of main valve. Valve may be self-operated or pilot-operated as necessary to comply with performance requirements.
 - b. Service: Provide precisely controlled downstream pressure in fuel train, as required by burner and fuel trains furnished, with upstream pressure as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lock-up pressure of the nearest upstream pressure regulator.
 - c. Performance: Maximum outlet pressure droop 5 percent of the set pressure over the burner firing range. Maximum lock-up pressure 1.5 times regulated pressure. Speed of response to opening of automatic safety shut off valves shall be sufficient to allow set

pressure of low pressure switch to be within 20 percent of the normal operating pressure with no nuisance burner trips.

- d. Construction, Main Valve: Cast iron body, replaceable plug and seat. Downstream pressure-sensing line.

4. Automatic Safety Shut-Off Valves:

- a. Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
- b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators.

SPEC WRITER NOTE: Valves with longer opening times often do not allow the main burner to ignite within the specified (and code required) 10 seconds trial for main flame.

- c. Performance: Timed opening of six seconds or less to safely and smoothly ignite main flame, and close within one second.
- d. Construction: Valves 65 mm (2-1/2 inches) and greater, flanged ends; valves 50 mm (2 inches) and less threaded ends; position indicator showing open and shut, visible from front or side of boiler. Aluminum seating surfaces are prohibited. Closed position interlock switch on each valve. Valved leak test fittings before and after each valve.
- e. Approval: FM approved, UL listed for burner service.

SPEC WRITER NOTE: VA safety device testing program has revealed problems with auto safety shut off valves other than Maxon. Problems included proof of closure switches, and pressure pulses upon closure that affect the high gas pressure switches.

- f. Proof of Closure Test: Provide non-latching push button controls in the proof of closure circuit to interrupt the circuit when the valves are closed.

5. Automatic Vent Valve:

- a. Type: Motorized or solenoid closing, spring opening, full port, controlled by burner control system.
- b. Service: Provide open-shut control of vent line that is connected between the two safety shut-off valves. Valves shall shut bubble-tight and be suitable for operation with upstream pressure of two

times the highest pressure at entrance to boiler-mounted regulators. Valve shall be open whenever safety shut-off valves are closed.

- c. Approval: UL listed for burner service.
- 6. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position. Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections between automatic vent valve and plug valve and ahead of the automatic vent valve.
- 7. Pressure Switches: Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES in Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. Switch settings must be within 20 percent of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.
- 8. Fuel Flow Control Valve:
 - a. Type: Throttling, controlled by combustion control system. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
 - b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner. Static pressure rating shall exceed the lockup pressure of the boiler-mounted regulator.
 - c. Valve Requirement for Single Point Positioning Jackshaft Control Systems: Valve shall have adjustable characterization cam shaped by at least twelve adjustment screws.
 - d. Gas turn down capability shall be a minimum of 4:1 for boilers up to 2 MW (200 hp) and 10:1 from 2.45 MW (250 hp) and above.
- 9. Pressure Gauges, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- F. Fuel Oil Train:
 - 1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description. Starting at the entrance to the train, the devices are, in order: manual shut off valve, filter, pressure gauge, pressure regulator (if required by burner furnished), low pressure switch, high pressure switch, flow meter

- (if specified), oil flow control valve, valved drain, automatic safety shut off valve, valved leak test, automatic safety shut off valve, valved leak test, manual shut off valve, pressure gauge, burner. Provide retractable nozzle with flexible hoses.
2. Filter: Permanent edge-type elements, cleanable by rotation of a handle without interruption of flow. Filter element spacing 0.1 mm (0.004 inch). Pressure rating shall exceed upstream safety relief valve set pressure plus accumulation. Maximum pressure loss 21 kPa (3 psig) at high fire. Provide plugged drain.
 3. Pressure Regulator: Do not provide unless required by the burner furnished. Pressure control is provided by a back pressure control valve on the house fuel oil pump set.
 4. Automatic Safety Shut-Off Valves:
 - a. Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
 - b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble-tight and be suitable for operation with upstream pressure exceeding upstream safety relief valve set pressure plus accumulation.

SPEC WRITER NOTE: Valves with longer opening times often do not allow ignition of the main flame within the specified and code allowed 10 seconds trial for main flame.
 - c. Performance: Timed opening of six seconds or less to safely and smoothly ignite oil burner, one-second closure.
 - d. Construction: Threaded ends, valve position indicator visible from front or side of boiler. Closed position interlock switch on each valve.
 - e. Approval: FM approved, UL listed for burner service.
 - f. Provide valved leak test connections between the two safety shut-off valves and after the second safety shut-off valve.
 - g. Proof of Closure Test: Provide non-latching push button controls in the proof of closure circuit to interrupt the circuit when the valves are closed.
 5. Pressure Switches: Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES in Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. Switch settings must be within 20 percent of the controlled

- pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.
6. Fuel Flow Control Valve:
 - a. Type: Throttling, controlled by combustion control system. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
 - b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner. Static pressure rating shall exceed the lockup pressure of the boiler-mounted regulator.
 - c. Valve Requirement for Single Point Positioning Jackshaft Control Systems: Valve shall have adjustable characterization cam shaped by at least twelve adjustment screws.
 - d. Fuel oil turn down capability shall be a minimum of 4:1 for boilers up to 2 MW (200 hp) and 8:1 from 2.45 MW (250 hp) and above.
 7. Pressure Gauges, Thermometers, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

SPEC WRITER NOTE: Verify the existence and pressure/flow capability of the house oil pumps and relief valves.
 8. Boiler/Burner-Mounted Oil Pump and Relief Valve: Do not provide. House pumps are provided that include relief valves.
- G. Low Pressure Air Atomizing System:
1. Complete system for each burner, furnished by burner manufacturer, including compressor and drive, air filter, low pressure switch and all piping systems.
 2. Motor: Premium efficiency type. Refer to the Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
 3. Motor Controls: Provide motor starter in NEMA 4 enclosure. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT, for burner management control interlock providing power supply to motor.
 4. Sound Attenuators: Provide compressor enclosure, air intake silencer, or other means to reduce sound levels to those required.

Refer to the Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.

5. Pressure Gauges and Pressure Switches: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

H. Igniter (Pilot) Fuel Train, Burner and Ignition System:

1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description. Arrange the system to allow selection of either natural gas or propane for the ignition fuel. Provide separate piping with plug valve, pressure gauge, filter and pressure regulator for natural gas and for propane. Connect to the main burner natural gas service downstream of the main burner pressure regulator. Join the natural gas and propane services by means of a three-way plug valve. Continue with one pipe line including a low pressure switch, pressure gauge, automatic safety shut off valve, automatic vent, automatic safety shut off valve, igniter.
2. Filters: Replaceable elements, five micron or smaller particle retention. Static pressure capability two times the maximum lockup pressure of nearest upstream pressure regulator. Maximum pressure loss, at full flow, 1.3 kPa (5 inches WG). Provide unions for filter removal.
3. Pressure Regulators:
 - a. Type: Single-seated, diaphragm-operated. Provide separate regulators for natural gas service and for LP gas service.
 - b. Service: Provide controlled pressure in igniter train as required by igniter, with upstream pressures as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lockup pressure of the nearest upstream pressure regulator. As an alternate to the outlet emergency pressure rating, provide internal relief valve vented to outside set at pressure that will avoid overpressure on regulator outlet that could damage the regulator.
 - c. Performance: Lockup pressure shall not exceed 1.5 times the regulated pressure.
 - d. Construction: Propane regulator must be designed for LP gas.
4. Automatic Safety Shut-Off and Vent Valves:
 - a. Type: Solenoid-type, two normally closed shut-off valves and one normally-open vent valve, arranged as shown, controlled by the

burner control system. Provide threaded leak-test ports with threaded plugs on each shut-off valve body.

- b. Service: Provide open-shut control of fuel flow to igniter and vent between shut-off valves. Design for 138 kPa (20 psig) differential at shut-off.
 - c. Approval: Safety shut-off valves UL listed, FM approved for burner service. Vent valves UL listed for burner service.
5. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position. Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections between automatic vent valve and plug valve and ahead of the automatic vent valve.
 6. Igniter and Ignition System: Provide removable igniter, ignition electrodes, ignition transformer, high voltage cable. Provide shield at ignition area so that spark is not visible to flame scanner from any position on its mounting.
 7. Igniter fuel train pipe and fittings: ASME B31.1 requirements do not apply. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

SPEC WRITER NOTE: The low igniter pressure switch is not required by NFPA 85 but the VA inspection and testing program has validated its use. The pressure set point is selected to assure reliable and safe ignition.

8. Pressure Switch and Pressure Gauges: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

2.4 BURNER MANAGEMENT AND FLAME SAFEGUARD CONTROL SYSTEMS AND ACCESSORIES

- A. Provide in accordance with NFPA 85.
- B. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- C. Control Panel: Controls shall be mounted in NEMA 4 enclosure on side of boiler or on burner. There shall be no power wiring in this enclosure.
- D. Factory Testing: Install controls on boiler and burner at factory and test operation of all devices.

SPEC WRITER NOTE: Delete the following paragraph if economizer is not required in the project.

2.5 FLUE GAS ECONOMIZER

- A. Heat exchangers to transfer heat from boiler flue gases to boiler feedwater.

SPEC WRITER NOTE: Parallel flow is specified instead of the more common counter-flow. This is because on warm-ups counter flow units can be subject to trapped air and water hammer.

- B. Type: Rectangular configuration, replaceable finned tubes, up flow flue gas, parallel flow water, insulated casing with removable panels allowing access to all tubes for cleaning and replacement.
- C. Performance: Refer to schedules on drawings. Coordinate input flue gas temperatures with data from boiler manufacturer.
- D. Construction:
1. Comply with ASME BPVC Section VIII. Design unit to permit operation with no water in the tubes at the temperature listed below.
 2. Design Pressure:
 - a. Water Tubes, 2070 kPa (300 psig) minimum.
 - b. Inner Casings, 2.5 kPa (10 inches WG) minimum.
 3. Design Temperature, 371 degrees C (700 degrees F).
 4. Tubes and Headers: ASTM A254, Type 316 Stainless steel. Helically wound non-serrated stainless steel fins continuously welded to tubes. 2070 kPa (300 psig) flanged piping connections. Drainable by gravity. Return bend areas shall be exposed to the bulk temperature of the flue gas. Headers shall be external to the casing. Fin density shall not exceed 157 fins per meter (48 fins per foot). Maximum fin height, 15 mm (1/2 inches).
 5. Casing: Double wall, removable panels, with insulation between walls. 75 mm (3 inch) angle flanges on flue gas inlet and outlet for attachment of breeching and stack.
 - a. Inner Casing, stainless steel, all welded. Steel angles for breeching attachment to casing. Entire casing systems must be gas tight.
 - b. Insulation: Mineral fiber, ASTM C612, 50 mm (2 inches) thick.
 - c. Outer Casing: Galvanized or painted steel, 0.4 mm (0.016 inches) thick.
- E. Accessories:
1. Safety Relief Valve: Valve designed for steam and water service, ASME National Board certified, selected by economizer manufacturer

in accordance with ASME Code requirements. Set pressure 1896 kPa (275 psig) gauge.

2. Inlet and Outlet Transitions: Designed and furnished by economizer manufacturer.

SPEC WRITER NOTE: Consult with economizer manufacturers on need for feedwater preheat system to provide protection from "cold-end" corrosion in the economizer and stack. Generally, on natural gas and No. 2 oil firing, with 108 degrees C (226 degrees F) feedwater, a preheat system will not be necessary. If a preheat system is required, provide a specification.

- F. Factory Test and Inspections: Inspect the completed economizer assembly in accordance with the ASME BPVC Section I. Certify the inspection and submit four copies of completed ASME Form P-3 for each economizer.

2.6 TOOLS

- A. Oil Burner Vise and Wrenches: Deliver to COR for mounting by VA personnel. Furnish only if burners require vise and wrenches not stocked by local tool suppliers.
- B. Boiler Tube Brushes: Furnish hand brushes of sizes, and with handle lengths, to clean full length of all tubes in boiler. Provide handle and extension sections 1800 mm (6 feet) long or less to permit storage. Coupled lengths shall be suitable for use from front of boiler.

2.7 SPARE PARTS

- A. Fuel Trains:
 1. One of each type and size of main and pilot fuel motorized and solenoid automatic safety shut-off valves and automatic vent valves.
 2. Complete set of filter elements and gaskets for each gas filter for each boiler.
 3. Complete set of all gaskets for each edge-type oil filter for each boiler.
- B. Boiler, Burner, Trim, Feedwater Control System:
 1. One assembly of electrodes, transformer, and high voltage lead with end connectors for igniters.
 2. Two complete sets of gaskets, for each boiler, to fit all doors, handholes, manholes.
 3. One clear lens and one tinted lens for each furnace and burner observation port on each boiler.

4. Sufficient tubular glass inserts and gaskets to re-equip water level gauge glasses on each boiler.
5. One set of drive belts for each belt-driven apparatus for each boiler.
6. One gallon oil for atomizing air compressor.
7. Complete set of air compressor intake filter elements for each compressor, for each boiler, if disposable filters are provided.
8. One complete feedwater control valve and actuator.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Boiler and Burner Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping. Provide space that permits full opening of all boiler and burner doors, panels and other access openings. Provide space for pulling full length of all boiler tubes directly from their installed location.
- C. Drainage Facilities for Boiler Water Column, Gauge Glass, Low Water Cutoffs, Water Level Alarms:
 1. Refer to Detail, FIRE TUBE BOILER.
 2. Locate and orient sight flow indicators so that one person can view the fluid flow while simultaneously operating drain valves and low water cutoff shunt switches.
- D. Boiler Flue Gas Outlet Location: Drawings show a location based on an assumption on the number of passes of the boilers. If the boilers submitted have a different flue gas outlet location, redesign and relocate the stack and breeching systems, at no additional cost or time to the Government.
- E. Boiler Casing Flashing: Flash or seal all openings in the casing at the top of the boiler at the piping and the flue penetrations to prevent leakage of water into the boiler insulation.

3.2 CLEANING AND PROTECTION FROM CORROSION

- A. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- B. Boiler Cleaning:
 1. Upon completion of installation, the initial firing of the burner shall be performed to boil out, under supervision of boiler

- manufacturer, all internal surfaces with chemical solution recommended by boiler manufacturer, to remove all mill scale, corrosion products and other foreign material. Following boil out, boiler shall be washed and flushed until water leaving the boiler is clear. Drain boiler, inspect internal surfaces for cleanliness, then refill boiler with softened and treated water.
2. Refer to the paragraph, INSPECTIONS AND TESTS for requirements for cleaning boiler after operational tests are completed.
- C. Protection from Corrosion:
1. Protect the boilers from fire-side and water-side corrosion at all times.
 2. Dry Storage: When the boilers are not filled with water, protect the water-sides and fire-sides with a dry storage method recommended by either the boiler manufacturer or the ASME BPVC Section VII.
 3. Wet Storage: If, after water is placed in the boilers, they are not fired for equipment adjustment or testing for more than two weeks, the boilers shall be protected with a wet storage method recommended either by the boiler manufacturer or the ASME BPVC Section VII.
 4. Chemical Treatment: The quality of the water in the boilers shall be maintained by a professional water treatment organization. This organization shall provide onsite supervision to maintain the required water quality during periods of boiler storage, operating, standby and test conditions. Furnish monthly reports by the water treatment organization, to the COR. The Contractor shall provide all chemicals, labor and professional services until the boilers have been accepted by the Government for operation. All chemicals utilized must conform to FDA Regulation CFR 21, 173.310, guidelines applicable for steam used in food preparation.

3.3 INSPECTIONS AND TESTS

- A. The following tests and demonstrations must be witnessed by the COR or his/her representative, and must prove that boilers, economizers, burners, controls, instruments, and accessories comply with requirements. Refer to Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT for general requirements. When test results are not acceptable, make corrections and repeat tests at no additional cost or time to the Government. All safety devices shall be tested in accordance with the VHA Boiler Plant Safety Devices Testing Manual and all construction documents. The VA will not take beneficial use of

equipment until all safety devices pass the required tests. Pretests do not require the presence of the COR. Evidence of the tests shall include completed sign-in sheet and test checklists from the VHA Boiler Plant Safety Devices Testing Manual, which shall be filled out completely for all equipment that has been provided by, or directly or indirectly affected by, the project.

- B. Manufacturer Certification at Start-Up: The boiler manufacturer shall certify that the equipment furnished has been installed, connected, and tested in accordance with the manufacturer's installation and operating instructions.
- C. Condition of Boiler and Economizer (if provided) After Delivery, Rigging, Placement: After setting boiler on foundation and placing economizer on supports, and prior to making any connections to boiler and economizer, the Contractor and COR shall jointly inspect interior and exterior for damage. Correct all damage by repair or replacement to achieve a like new condition.
- D. Hydrostatic Tests:
 - 1. Boiler, Economizer (if provided): Contractor shall provide inspector certified by National Board of Boiler and Pressure Vessel Inspectors (NBBI) to conduct tests after equipment is installed and connected for operation and prior to initial firing. Test pressure shall be 1-1/2 times the design pressure of the boiler for a period required by the inspector. Provide written certification of the satisfactory test, signed by the inspector. Correct any deficiencies discovered during the testing, and retest equipment until satisfactory results are achieved and are accepted by the inspector. The COR or his/her representative shall be present for inspections and tests.
 - 2. Boiler External Piping (as defined by ASME B31.1):
 - a. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
 - b. Test may be conducted concurrently with boiler and economizer testing.
 - 3. Identify and remove any connecting equipment which is not rated for the test pressure. Cap the openings left by the disconnected equipment. Reinstall the equipment after tests are completed.
- E. Boiler Steam Safety Valves:
 - 1. Test each valve set pressure and blowdown pressure with boiler steam pressure. Perform accumulation test by operating burner at high fire to verify that safety valve flow capacity is sufficient to handle

the maximum boiler steaming rate. Tests shall be performed with boiler isolated from the main steam header and all generated steam exhausting through the safety valves.

2. Valve Popping Tolerance: Plus or minus three percent of set pressure for set pressures over 480 kPa (70 psig) gauge.
3. Valve Blowdown Tolerance: Reset at not less than 6 percent below set pressure of valve with the lowest set pressure. Minimum blowdown two percent of the set pressure.
4. Accumulation Test: With burner at high fire, the boiler pressure shall not rise more than six percent above the set pressure of the safety valve with highest pressure setting and shall remain below the maximum allowable working pressure of the boiler.

F. Burner Management (Flame Safeguard Control) System:

1. Demonstrate operation of all control, interlock and indicating functions. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
2. Prior to scheduling final test submit certification that all control, indicating, and interlock functions have been pretested.
3. Conduct final test immediately prior to boiler-burner tests.
4. Experienced personnel representing the manufacturer of the system shall conduct the tests.

G. Performance Testing of Boiler, Burner, Economizer (if provided), Combustion Control, Boiler Plant Instrumentation:

1. Perform tests on each boiler on all main burner fuels.
2. If required by local emissions authorities, provide services of testing firm to determine NOx and carbon monoxide. Test firm shall be acceptable to emissions authorities.
3. Test No. P-1:

SPEC WRITER NOTE: Increase number of load points if burner turndown greater than 6 to 1 is specified.

- a. Operate boiler on each fuel, with economizer (if provided) in service and record data for at least six evenly spaced steam loads from low fire start to 100 percent of full steam output, and in the same sequence back to low fire. Demonstrate performance and efficiency required by paragraphs, BOILER, BURNER AND FUEL TRAINS, and FLUE GAS ECONOMIZER and by boiler and economizer equipment lists on drawings.

- b. Demonstrate proper operation of combustion controls, draft control (if provided), feedwater level controls, and instrumentation systems. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
 - c. When flue gas oxygen trim is provided, conduct tests with trim control on manual at the zero trim (null) position. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. After completion of tests with trim control on manual control, repeat the tests on one fuel with the trim control on automatic control.
4. Test No. P-2:
- a. Demonstrate sound level of fans and burner systems and atomizing air compressor.
 - b. Test point shall be at 100 percent of maximum boiler load.
 - c. Refer to sound level requirements in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
5. Test No. P-3:
- a. Check current draw of forced draft fan motor at prepurge and at 100 percent of maximum boiler load.
 - b. Current draw shall not exceed full load current stamped on motor nameplate.
 - c. This test may be combined with Test No. P-1.
6. Test Methods:
- a. Utilize permanent instrumentation systems for data. All systems shall be operable and in calibration.
 - b. Utilize portable thermocouple pyrometer furnished and retained by Contractor to measure stack temperature as a verification of permanent stack temperature recorder.
 - c. Use portable electronic flue gas analyzer to determine constituents of flue gas. Analyzer shall be capable of measuring oxygen in per cent with accuracy of plus or minus 0.5 percent oxygen and carbon monoxide in ppm with accuracy of plus or minus 5 percent of reading (Range 0 to 1000 ppm). Obtain oxygen and carbon monoxide readings at each test point. Calibrate instrument with certified test gases within three months prior to use and immediately after analyzer cell replacement.

- d. In Test No. P-1 retain boiler at each load point for a time period sufficient to permit stabilization of flue gas temperature and other parameters.
 - e. Steam loads for tests may be furnished by the hospital systems, by operation of the steam silencer vent system, or by a combination of the above. If variable hospital loads interfere with testing, conduct tests at night or on weekends when loads are more stable.
 - f. Utilize dry bulb and wet bulb thermometers furnished and retained by Contractor for checking combustion air.
 - g. Smoke testing shall be by visual observation of the stack and by smoke density monitor (permanent instrument - if provided). If smoke density monitor is not provided, utilize Bacharach Model 21-7006 Smoke Test Kit. If there is disagreement with the results of these tests, provide qualified observation person and tests in compliance with EPA Reference Method 9 (CFR 40, Part 60, Appendix A).
 - h. Sound level instruments will be Government furnished.

SPEC WRITER NOTE: If NOx emissions limits are applicable, list the method of testing that is required by local authorities if it differs from the method listed.
 - i. NOx emissions shall be tested with electronic analyzer reading in ppm. Analyzer shall be calibrated with certified test gas within three months prior to use. Analyzer shall be accurate to plus or minus 5 percent of reading.
 - j. An additional efficiency test will be required, conforming to ASME PTC 4, if the boiler efficiency determined in the Test P-1 above, does not comply with requirements. Utilize ASME Test Forms and the abbreviated input-output and heat balance methods.
7. Pretesting:
- a. Perform pretest at the final stage of the burner fine-tuning process.
 - b. Prior to scheduling final test, submit evidence of pretest. Evidence shall consist of start-up data sheets signed and dated by personnel representing burner manufacturer, combustion controls manufacturer, burner controls manufacturer. Evidence of the tests shall also include completed sign-in sheet and test

checklists from the VHA Boiler Plant Safety Devices Testing Manual, which shall be filled out completely for all equipment that has been provided by, or directly or indirectly affected by, the project.

c. Pretest data sheets shall list the following data for each fuel and at each fuel valve controller position, starting at minimum position, proceeding to the maximum position and returning to the minimum position.

- 1) Fuel flow and air flow controller position.
- 2) Fuel pressures: At burner and also upstream of fuel flow control valve.
- 3) Fuel flow rate.
- 4) Boiler feed pressure, upstream of feedwater regulator (at minimum, 50 percent, maximum firing positions only).
- 5) Boiler feed temperature (at minimum, 50 percent, maximum firing positions only).
- 6) Stack temperature: Boiler outlet, economizer (if provided) outlet.
- 7) Flue gas oxygen and carbon monoxide (utilize flue gas analyzer which has been calibrated with certified test gases).
- 8) Steam flow rate (at minimum, 50 percent, maximum firing position only).
- 9) Steam pressure - Boiler, Header (at minimum, 50 percent, maximum positions only).
- 10) Opacity of flue gas.
- 11) Flue gas NOx (if limit specified).
- 12) Combustion air temperature - dry bulb and wet bulb.
- 13) Barometric pressure (one reading).

d. Calibrate all pressure gauges prior to pretest.

H. Internal Inspection of Pressure Parts and Furnace:

1. After all operational tests are satisfactorily completed, a Government retained, licensed boiler inspector will determine if the boiler is free from corrosion, deposits, and any other type of damage or defect.
2. In preparation for the inspection, open all manways, handholes, and access doors or panels at the ends of the boiler. Drain and clean the interior of all pressure parts and clean all soot and debris from furnace and fire tubes.

- 3. Any corrosion, damage or defect shall be corrected to a like new condition in the judgment of the boiler inspector.
- 4. After the boiler inspector has approved the boiler, all manways, handholes, and the access doors shall be closed with new gaskets.
- I. If burner operation results in deposits of carbonaceous materials in the furnace or tubes clean the furnace and tubes, modify the burners as necessary, and retest the burner performance and safety devices, as the safety device settings can be affected by burner adjustments.
- J. Any retests required as a result of failed tests shall be performed at no additional cost to the Government. Costs incurred by the Government as a result of witnessing failed tests shall become the responsibility of the contractor, and the Government may choose to withhold contract payment equal to the value of such costs.

3.4 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. //The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.5 //COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.//

3.6 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for //4//
// // hour//s// to instruct each VA personnel responsible in the operation and maintenance of the system.
- B. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

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