

SECTION 23 52 25
LOW-PRESSURE WATER HEATING 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.

PART 1 - GENERAL

SPEC WRITER NOTES:

1. This specification is intended to include water heating boilers with design pressures of no more than 1034 kPa (150 psig).
2. The VA does not want any boilers specified that are not NFPA 85 compliant. This will be enforced for added safety and to extend boiler life expectancy. The designer must obtain VHA OCAMES and VA CFM CSS approvals at the beginning of design phase for the use of any types of boilers that do not comply with NFPA 85. This will limit the types of hot water boilers that can be used in VA facilities.
3. Refer to Design Alert 135, which also affects the editing of this section.
4. Refer to the VA's Physical Security Design Manual for special design requirements applicable to mission critical facilities (e.g., providing dual fuel boilers). In these cases when natural gas is used as the prime fuel, the back-up fuel shall be No. 2 oil or propane, with the back-up fuel stored on site as required by the Steam, Heating Hot Water, and Outside Distribution Systems Design Manual. Edit section carefully to include appropriate optional content associated with the back-up fuel.

1.1 DESCRIPTION

- A. This section specifies non-condensing packaged hot water boilers with trim (accessories), natural gas //and No. 2 oil// //and propane// burner, fuel trains, 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// //Section 23 05 11, COMMON WORK RESULTS FOR HVAC//.

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 11, COMMON WORK RESULTS FOR HVAC.//
- H. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- I. //Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- J. //Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.//
- K. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- L. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- M. Section 23 21 13, HYDRONIC PIPING.
- N. Section 23 51 00, BREECHING, CHIMEYS AND STACKS.

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. American Boiler Manufacturers Association (ABMA):
304-1995.....Measurement of Sound from Steam Generators
- C. American Society of Mechanical Engineers (ASME):
ASME Boiler and Pressure Vessel Code:
BPVC Section II-2015....Materials
BPVC Section IV-2015....Rules for Construction of Heating Boilers
BPVC Section VII-2015...Recommended Guidelines for the Care of Power Boilers

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

Performance Test Code (PTC):

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

D. //ASTM International (ASTM):

D396-09a.....Fuel Oils//

E. Environmental Protection Agency (EPA):

CFR 40, PART 60, Appendix A, Method 9, Visual Determination of the
Opacity of Emissions from Stationary Sources

F. National Fire Protection Association (NFPA):

54-2015.....National Fuel Gas Code

SPEC WRITER NOTE: The VA desires to specify boilers with fuel and safety systems in compliance with NFPA 85, even though NFPA 85 is intended to apply to boilers greater than the sizes of boilers specified in this specification section. Contact manufacturers to verify that NFPA 85 compliance is possible for the boilers included in this specification for each project.

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

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 25, LOW-PRESSURE WATER HEATING 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 required service and operational clearances and access 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. Design pressures and temperatures.
 6. //Seismic design data on boiler and anchorage of boiler to foundation. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
 7. Procedures for all testing, including sequence of steps to be taken and a definition of the outcome resulting in a successful test.
- E. Boiler Trim: Includes low water level alarms and cutoff devices, high water temperature alarm and cutoff devices, water flow switch, piping, all valves and fittings furnished by boiler manufacturer //and stack thermometer//.
1. Catalog data and drawings showing design, construction, arrangement on the boiler, and schematic of instrumentation.
 2. Pressure and temperature limitations.
 3. ASTM numbers and schedule numbers of piping.
 4. Type and pressure ratings of pipe fittings.
 5. Scale ranges of gauges, thermometers, and temperature, flow, level, and pressure switches.
 6. Set pressure and capacity of relief valves.
 7. Location of sensing and indicating devices.
- F. Burner and Fuel Valve and Piping Trains:
1. Catalog data and drawings showing burner assembly and fuel train arrangement.
 2. Drawings and catalog data on all equipment in fuel trains.
 3. ASTM numbers and schedule numbers on all piping.
 4. Type and pressure ratings of pipe fittings.
 5. Scale ranges of gauges, thermometers, and safety switches.
 6. Burner flow and pressure data.
- G. Burner Management and Flame Monitor and Safeguard Systems:
1. Catalog data and drawings showing flame monitor and safeguard system assembly and arrangement.
 2. Catalog data and drawings showing independent burner management system assembly and arrangement.
 3. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- H. Complete instrument index and instrument specification sheets for all instruments provided with the boiler.
- I. Provide a control wiring diagram for boiler showing interlock requirements and clear division between the factory wiring and field wiring.

SPEC WRITER NOTE: The designer must consider on-site water quality and utilize water treatment systems to provide treated hot water that does not damage or degrade the boiler or hot water system over time. The designer should sample water quality, or otherwise obtain water chemistry reports, and provide the results of the testing as part of the contract documents. If a water treatment system is existing and re-used, or is otherwise not provided as part of the same construction project that installs the boiler, the contract documents shall include a water test report and the following paragraph shall be retained.

- J. //Submit certification that a water treatment test report has been reviewed, and the hot water chemistry is suitable for long term use with the selected boiler.//
- K. 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. Equipment data sheets for all equipment with design performance and details of operation.
 - 4. Complete flow sheet with all instruments and devices.
 - 5. Complete instrument index and instrument specification sheets.
 - 6. Site specific safety device test manual with all make, model and set point data added to provide complete safety device testing procedures.
 - 7. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- L. //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.//
- M. Provide proof of instrument calibration.
- N. //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 work of this section with all //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,// //control systems,// //combustion air piping,// and venting.
- B. The model and size of the proposed burner shall have been applied to at least five boilers which are similar in type, size, proportion, number of passes and furnace dimensions to the proposed boiler. Provide a list of at least five installations, similar in size and scope as the proposed boilers. Include the name, address, and telephone number of a person familiar with each project as a reference source.
- C. Boiler shall be pressure tested at the factory and bear the ASME stamp. The boiler shall be retested after installation is complete to ensure boiler is still at factory tolerances.

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 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.

- 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 isolation devices for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. to facilitate the development of lockout/tagout procedures. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 20 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 set point. 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 FUEL REQUIREMENTS

SPEC WRITER NOTES:

1. Choose fuels specific to each project's applications.
2. Back up fuel storage must be onsite at all locations where these boilers are located and as required by VHA policies for number of winter days of fuel that shall be stored. All physical security requirements must be maintained.

- A. Fuels to be Fired: Natural gas //and No. 2 fuel oil// //propane//.
- B. 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 (// // inches WG) gauge as maintained by main regulator station.
- C. //No. 2 Fuel Oil: Fuel oil furnished directly to the Government by a local supplier.//
- D. //Propane: Fuel furnished directly to the Government by a local supplier. Regulators at tank area will be set at 34 kPa (5 psig) gauge.//

PART 2 - PRODUCTS

SPEC WRITER NOTES:

1. Hot water boilers specified in this section shall only be used where steam (from the existing central boiler plant) is not available and the use of steam from a central boiler system is not envisioned. Examples of such applications are: Standalone facilities such as community living centers and domiciliary, regional offices, and outpatient clinics (where the steam requirements are minimum and can be met by separate dedicated steam boilers).
2. Fuel selection shall be based on availability of resources at the facility location. If natural gas is available, a secondary uninterruptable fuel source will be required. A life cycle cost analysis shall be performed to determine the most cost-effective fuel selection or combination thereof.

2.1 NON-CONDENSING BOILER CONSTRUCTION

- A. Type: Factory-assembled packaged horizontal fire tube hot water boiler. Three or four-pass wet or dry back design with internal furnace located below center of boiler shell. Designed for natural gas //and No. 2 fuel oil// //and propane// firing.
- B. Service: Continuous long-term generation of 1034 kPa (150 psig) hot water throughout the burner firing range in conformance to the specified performance requirements.
- C. Performance:
 - 1. Minimum Efficiency at Required Maximum Output:
 - a. Natural Gas Fuel (37.3 MJ/cubic meter) (1000 Btu/cubic foot): 80 percent at 15 percent excess air.
 - b. //Fuel Oil (ASTM D396, Grade 2): 80 percent at 15 percent excess air.//
 - c. //Propane (92.4 MJ/cubic meter) (2480 Btu/cubic foot): 80 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 1034 kPa (150 psig).
- F. Features:
 - 1. Codes:
 - a. Comply with ASME BPVC Section II, ASME BPVC Section IV, ASME BPVC Section VII, and ASME BPVC Section IX.
 - b. Comply with NFPA 85.
 - c. The complete packaged boiler shall be listed as a unit by Underwriters Laboratories and shall bear the Underwriters label.
 - 2. Arrangement:
 - a. The furnace is to be located in the bottom third of the boiler to provide for maximum heat transfer while being in contact with the coolest boiler water. The hot water return and outlet connections shall be located on the top center line of the boiler. The boiler shall be designated to rapidly mix the return water with the boiler water.
 - b. A dip tube shall be included as an integral part of the water outlet.

- c. Two lifting eyes shall be located on top of the boiler.
- d. Front and rear doors on the boiler shall be hinged. Doors are to be sealed with fiberglass gaskets and fastened tightly using heavy capscrews that thread into replaceable brass nuts.
- e. Rear refractory and insulation shall be contained in the formed door, which must swing open for inspection of brick work.
- f. Front and rear tube sheets and all flues must be fully accessible for inspection and cleaning when the doors are swung open. The shell must be furnished with adequate handholes to facilitate boiler inspection and cleaning.
- g. The exhaust gas vent shall be located near the top center line and shall contain a stack thermometer and oxygen sensor.
- h. Excess Air in Flue Gases with Oxygen Trim at Null Position:
- | Boiler 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 |
- i. 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.
- j. Provide observation ports for the inspection of flame conditions at each end of the boiler.
- G. Boiler insulation: Shall consist of a 50 mm (2 inch) blanket under a sectional preformed sheet metal lagging. This insulation must be readily removable and capable of being reinstalled.
- H. The entire boiler based frame and other components shall be factory painted before shipment using a hard finish enamel coating.
- I. Boiler External Piping: Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- J. Hydronic Piping: Refer to Section 23 21 13, HYDRONIC PIPING.
- K. Boiler Vent: Refer to Section 23 51 00, BREECHING, CHIMEYS AND STACKS. Vent boilers independently.

- L. Controls and Safety Devices: In accordance with VHA Boiler Plant Safety Device Testing Manual, VHA Steam Design Manual, and NFPA 85.

2.2 BOILER TRIM

- A. Burner Management and Flame Monitor and Safeguard Control Systems: Provide flame monitor and safeguard system and independent burner management system in accordance with NFPA 85.
- B. Low Water Level Cutoff: A low water level cutoff control (manual reset) shall be mounted on the top centerline of the boiler wired into the burner control circuit to prevent burner operation if boiler water falls below a safe level.
- C. Pressure and Temperature Gauges: Pressure and temperature gauges shall be mounted on the boiler with temperature sensing element located adjacent to the hot water outlet.
- D. Relief Valves: Provide at least two water relief valves of a type and size required to comply with ASME Code requirements shipped loose.
- E. Temperature Controls: Temperature controls to regulate burner operation shall be mounted on the unit with temperature sensing elements located adjacent to the hot water outlet. Controls shall be high limit (manual reset) and operating limit (auto reset).
- F. Water Flow Proving Controls: Provide flow switch to detect water flow and cutoff (auto reset) boiler operation when water is not flowing through boiler.

2.3 BURNER AND FUEL TRAINS

- A. Burner Type: Integral combination natural gas //and fuel oil// //and propane//, packaged, forced draft. The burner, integral with the front head of the boiler, shall be a high radiant multiport-type for natural gas and back-up fuel. The burner shall be approved for operation with natural gas //and fuel oil// //and propane//.
- B. Burner Operation: Burner operation shall be fully modulating. The burner shall always return to low fire position for ignition. Change of fuels will not require any disassembly and reassembly of the fuel train on burner fuel nozzles.
- C. Service: Continuous operation at all firing rates on each fuel listed. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures.
- D. Burner Turndown: Turndown range of the burner shall be 4:1, minimum.

- E. Noise and Vibration: Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan. Burners shall operate without pulsation.
- F. Igniter fuel train pipe and fittings: ASME B31.1 requirements do not apply. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- G. Gas Burner Piping: Gas burner piping on all units shall include automated double block and vent valves, manual isolation valves, pressure regulator, and pressure gauge. Automated gas shutoff valves shall be motor operated with proof of closure switch and plugged leakage test connection. The automated gas shutoff valves shall be wired to close automatically in the event of power failure, flame failure, low water, or any safety shutdown condition. A lubricating plug cock, ball, or butterfly manual isolation valve shall be provided as a means for a tightness check of the primary shut off valve and at entrance to gas train.
- H. Gas Pilot: The gas pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include automated double block and vent valves, manual isolation valves, pressure regulator, and pressure gauge.
- SPEC WRITER NOTE:
1. Retain the following four paragraphs if the back-up fuel is fuel oil.
 2. Remember that the piping required for the remote fuel oil pump and atomizing air compressor are intended to be specified in other sections, such as Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- I. //Oil Burner: Provide low pressure air atomizing type.
- J. Oil Burner Piping: Fuel oil piping on the unit shall include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer, all integrally mounted on the unit.
- K. Oil Pump: Base mounted, motor driven pump suitable for modulating firing rate and with a capacity of approximately twice the maximum burning rate shipped separate from boiler for field installation. Provide oil pressure gauge and low-pressure switch.
- L. Low pressure air atomizing: Base mounted, motor driven air compressor suitable for modulating firing rate, with lubricating oil tank, oil

level indicator, inlet air filter, air pressure gauge and low atomizing air pressure switch shipped separate from boiler for field installation.//

SPEC WRITER NOTE: Retain the following two paragraphs if the back-up fuel is propane.

M. //Propane Burner: High radiant multiport-type suitable for modulating firing rate.

N. Propane Burner Piping: Gas burner piping on all units shall include automated double block and vent valves, manual isolation valves, pressure regulator, and pressure gauge. Automated gas shutoff valves shall be motor operated with proof of closure switch and plugged leakage test connection. The automated gas shutoff valves shall be wired to close automatically in the event of power failure, flame failure, low water, manual emergency stop, or any safety shutdown condition. A lubricating plug cock, ball, or butterfly manual isolation valve shall be provided as a means for a tightness check of the primary shut off valve and at entrance to gas train.//

SPEC WRITER NOTE: Retain the following paragraph only if the back-up fuel is propane and a propane pilot is desired in addition to the natural gas pilot. Verify the availability of this option for each project's application with boiler manufacturers.

O. //Propane Pilot: The propane pilot shall be premix type with automatic electric ignition. An electronic detector shall monitor the pilot so that the primary fuel valve cannot open until flame has been established. The pilot train shall include automated double block and vent valves, manual isolation valves, pressure regulator, and pressure gauge.//

2.4 BLOWER

A. Combustion Air: Shall be supplied by a forced draft blower mounted in the front boiler door, above the burner, to eliminate vibration and reduce noise level.

B. Maximum sound level: Boiler/burner package shall not exceed // // db(A) when measured in accordance with ABMA 304.

C. Impeller: Shall be coated steel or cast aluminum, radial blade, carefully balanced, and directly connected to the blower motor shaft.

- D. Combustion Air Control: Provide fully modulating firing, by providing a blower motor variable frequency drive or by providing a combustion air damper and cam operated fuel metering valves operated by a single damper control motor that regulates the fire according to load demand. Potentiometer type position controls shall be provided to regulate operation of the damper control motor independent of all flame safety controls.

2.5 BURNER MANAGEMENT AND FLAME SAFEGUARD CONTROLS

- A. Provide independent systems in accordance with NFPA 85.
- B. Factory Testing: Install controls on boiler and burner at factory and test operation of all devices.
- C. Controller: Each boiler shall be factory equipped with burner management and flame safeguard controllers. Controller shall be computerized solid state having sequence and flame-on lights and digital "first out" fault code indications of flame safeguard trip functions. It shall include dynamic self-check logic. The controller shall have a fixed operating sequence incapable of being manually altered. The sequence shall include start, pre-purge, pilot and main fuel ignition run and post-purge cycles. Controller shall be the non-recycle type for maximum safety that shall shutdown the burner and indicate as a minimum the following trip functions: pilot and main flame failure, high and low fire proving switch faults, running interlocks open, false flame signal and fuel valve open, and proof of fuel valve closure. The controller shall have a run/test switch. It shall allow interruptions to sequence just after pre-purge, during pilot ignition trial and run cycles for adjustments to firing rate motor, damper linkages and pilot flame for minimum turndown tests.
- D. Control Panel: The control panel shall be mounted on the front door of the boiler in a location convenient to the operator. The hinged metal cabinet will have NEMA 4 rating that includes a neoprene dust seal and a cabinet key type lock. The panel shall contain the boiler flame safeguard controller, blower motor starter, indicating lights and selector switches. The panel shall have a removable sub-base for mounting the flame safeguard controller, blower motor starter, and terminal blocks. For combination gas-oil fired boilers the panel will contain the fuel selector switch.
- E. Operator Interface: Provide a touchscreen interface to allow boiler operator control and monitoring of the boiler's operating status, load,

and faults/alarms. Provide additional indicating lights for critical faults/alarms, such as flame failure, high water temperature, loss of water flow, etc.

F. Wiring and Accessories:

1. Oil, heat and moisture resistant wire shall be used and identified with circuit numbers corresponding to the electrical wiring diagram.
2. All electrical equipment and wiring shall be in conformance with Underwriters Laboratories requirements.
3. Boiler to be supplied with a control circuit transformer and fuse protection for the control circuit.

2.6 PERFORMANCE

- A. Provide boiler with capacity as scheduled on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation does not comply with the requirements of the contract documents, as judged by 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. Vent piping shall be installed and combustion air shall be provided in accordance with VHA standards, applicable national codes, NFPA standards and per the boiler manufacturers' recommendations.

SPEC WRITER NOTE: The designer shall determine a safe relief valve vent discharge location, design vent piping to that location, and indicate the vent piping and destination on the contract documents.

- D. Relief Valves: Install as required by the manufacturer and the contract documents. The discharge from each relief valve shall be piped independently to the discharge location indicated.

3.2 CLEANING AND PROTECTION FROM CORROSION

- A. Refer to //Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION// //Section 23 05 11, COMMON WORK RESULTS FOR HVAC//.

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, burners, controls, instruments, safety devices, and accessories comply with requirements. When test results are not acceptable, make corrections and repeat tests at no additional cost or time to the Government. Pretests do not require the presence of the COR.
- B. Condition of Boiler After Delivery, Rigging, Placement: After setting the boiler and prior to making any connections to the boiler, 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.
- C. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator.
- D. A written project and site-specific test procedure in accordance with the VHA Boiler Plant Safety Device Testing Manual shall be provided for field testing all safety devices installed on the boiler(s).
- E. Hydrostatic Tests:
 - 1. Boiler: Contractor shall provide inspector certified by National Board of Boiler and Pressure Vessel Inspectors 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 of four (4) hours. 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.
 - 2. 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.
- F. Boiler Relief Valves:
 - 1. Test each valve set pressure with boiler operating pressure.
 - 2. Valve Popping Tolerance: Plus or minus three percent of set pressure for set pressures over 480 kPa (70 psig) gauge, and plus or minus five percent of set pressure for set pressures of 480 kPa (70 psig) gauge or less.

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.
- G. Burner Control (via Flame Monitor and Safeguard and Burner Management) Systems:
1. Demonstrate operation of all control, interlock and indicating functions.
 2. Prior to scheduling final test submit certification that all control, indicating, and interlock functions have been pretested.
 3. Conduct final test immediately prior to boiler-burner tests.
 4. Experienced personnel representing the manufacturer of the system shall conduct the tests.
- H. Performance Testing of Boiler, Burner, Combustion Control, Boiler Plant Instrumentation:
1. Perform tests on each boiler on all main burner fuels.
 2. If required by local emissions authorities, provide services of testing firm to determine NO_x and carbon monoxide. Test firm shall be acceptable to emissions authorities.
 3. Test No. P-1:
 - a. Operate boiler on each fuel in service and record data for at least four evenly spaced loads from low fire start to 100 percent of full output, and in the same sequence back to low fire.
 - b. Demonstrate proper operation of combustion controls and instrumentation systems.
 4. Test Methods:
 - a. Utilize permanent instrumentation systems for data. All systems shall be operable and in calibration. Provide proof of instrument 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. Utilize dry bulb and wet bulb thermometers furnished and retained by Contractor for checking combustion air.
- f. Smoke testing shall be by visual observation of the stack and by smoke density monitor. 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).

SPEC WRITER NOTE: If NOx emissions limits are applicable, list the method of testing and allowable limits required by local authorities.

- g. //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.//
- h. 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.

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 //8//
// // 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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