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USACE / NAVFAC / AFCEC / NASA | UFGS-23 52 49.00 20 (November 2008)
Change 2 - 08/18

Preparing Activity: NAVFAC | Superseding
UFGS-23 52 49.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 49.00 20

STEAM BOILERS AND EQUIPMENT (500,000 - 18,000,000 BTU/HR)

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SECTION 23 52 49.00 20

STEAM BOILERS AND EQUIPMENT (500,000 - 18,000,000 BTU/HR)
11/08, CHG 2: 08/18

****
NOTE: This guide specification covers the requirements for steam boilers and related equipment for capacities from 150 to 5275 kW 500,000 to 18,000,000 Btu/Hr.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: This guide specification supersedes the requirements for these boilers and equipment contained in specification 52Y. Some paragraphs may need to be supplemented to meet the project requirements. The boilers are equipped for oil-, gas-, or oil-and-gas combination firing, as specified.
****

****
NOTE: The following information shall be shown on the project drawings:

1. Dimensions of construction

2. Relationship of materials

3. Quantities, location and capacity of equipment.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 4	(2013) Fired Steam Generators

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2018) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D888	(2012; E 2013) Dissolved Oxygen in Water

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-27	(1991) National Board Rules and Recommendations for the Design and Construction of Boiler Blowoff Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-B-18897	(Rev F; CANC Notice 1) Boilers, Steam and Hot Water, Watertube (Straight Bare and Finned Tube), Cast Iron and Firebox, Packaged Type (40,000 to 35,000,000 BTU/HR Thermal Output Capacity)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50504	(Basic) Analyzers, Flue-Gas, Orsat-Type, Portable
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-50566	(Basic) Monitoring Devices, Emission, Stack Related
CID A-A-50573	(Basic, Notice 1) Water Softener Unit, Lime-Soda Type
CID A-A-59249	(Basic; Notice 1; Notice 2) Filters, Fluid, Pressure, Feedwater
FS F-B-2903	(Basic; Notice 2) Boilers, Steam and or Water, Firetube, Scotch Packaged Type (320,001 to 35,000,000 BTU/HR Thermal Output Capacity)
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-F-2901	(Basic; Notice 1) Feeders, Boiler Water Treatment, By-Pass and Compound Receiver Types
FS F-P-2908	(Basic; Notice 1) Pumping Units, Condensate, Return; and Boiler Feed Package
FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)

NAVFAC MO 225	(1990) Industrial Water Treatment

WATER QUALITY ASSOCIATION (WQA)

WQA S-100	(2000) Household, Commercial, and Portable Exchange Cation Exchange Water Softeners

1.2 SYSTEM DESCRIPTION

Describe the performance or design requirements and tolerances of the boiler system.

1.2.1 Heating Surface and Volume Measurements

Submit heating surface and volume measurements, including heat release calculations and performance data at minimum, 25 percent, 50 percent, 75 percent, and 100 percent load sufficient to establish compliance of boilers with heat release requirements. Base calculations on the specified efficiency and capacity.

1.3 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies, with the additions and modifications stated herein.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed

item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steam Boiler System

SD-05 Design Data

Heating Surface and Volume Measurements

Heat Release Calculations

Performance Data at Minimum, 25 Percent, 50 Percent, 75 Percent, and 100 Percent Load

SD-06 Test Reports

Boiler System Start-Up Tests

Submit test reports in accordance with section FIELD QUALITY CONTROL. Submit a detailed written record of the start-up performance, including burner setting data over the entire load range, before the Contractor's and sub-contractor's test personnel leave the site.

SD-07 Certificates

Report of Prior Installations

Qualifications of Engineer

Start-Up Plan

Start-Up Certification

Boilers

Submit evidence that boilers meet requirements of standards specified. Include with the certificate of compliance acceptable evidence that standards are met. Acceptable evidence will be the official UL listing mark prescribed in the UL gas and oil equipment list for oil-fired, gas-fired, or gas and oil-fired boiler assemblies, as applicable plus the appropriate official ASME symbol stamp. In lieu of the above certification, acceptable evidence will be a test report from an independent testing laboratory, indicating that the boilers and accessories have been inspected and tested and meet requirements of the applicable standards specified.

SD-10 Operation and Maintenance Data

Boilers, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

1.5.1 Report of Prior Installations

Boilers shall be shipped to the site of installation as [a] [an] [completely assembled packaged boiler-burner unit] [unassembled package. A competent installation engineer or technician as stated in paragraph QUALIFICATIONS OF ENGINEER shall assemble an unassembled boiler-burner package in strict accordance with the manufacturer's instructions.] Boilers and feedwater equipment installed shall be of proven design which has been tested, successfully installed, and operated in commercial or industrial installations. Submit a certified written report from the boiler and feedwater equipment manufacturer indicating date of installation, type, model, capacity, and address location of installed boilers along with maintenance records and operating conditions including operating load and load swings. Show that substantially identical equipment of comparable capacity, within 20 percent, has been successfully installed and operated in not less than three installations under similar operating conditions for a period of not less than 2 years.

1.5.2 Start-Up and Installation Engineer

Provide the services of a qualified engineer or technician for start-up and tests and installation of equipment as specified below. More than one engineer or technician may be employed based on the types of specific equipment. One engineer or technician appointed by the Contractor shall supervise and be responsible for the overall installation, start-up, test, and checkout of systems.

1.5.3 Qualifications of Engineer

Submit a printed certified qualification resume of the engineer or technician. The engineer's or technician's resume shall list applicable experience related to installation, start-up, and testing of equipment and applicable factory training and education. Qualifications require the engineer to have supervised two installations of similar size and type which are operating satisfactorily. If more than one engineer or technician is employed, provide a certified resume for each one indicating their specific specialty and item of work.

1.5.4 Installation

****
NOTE: Delete this paragraph for boilers under 2930 kW 10,000,000 Btu/hr capacity.
****

Provide an installation engineer or technician to install and supervise the installation of steam boiler system including instrumentation and boiler controls. Provide the technician or engineer until the installation of equipment is coordinated and checkout completed.

1.5.5 Start-Up Plan

Submit a written schedule with dates of start-up tests, installation, and checkout of equipment.

1.5.6 Start-Up and Test

Start-up and test engineer or technician shall be approved by the manufacturer of the specific piece of equipment including boiler, boiler controls, boiler instrumentation, and feedwater equipment. The start-up and test engineer or technician shall remain on the job until the unit has been in successful operation for [_____] days, and has been accepted by the Contracting Officer.

1.5.7 Start-Up Certification

After installation of equipment, the engineer or technician shall submit a signed certificate or certified written statement that the equipment is installed in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 BOILERS

****
NOTE: Only allow option of MIL-B-18897 for low pressure boilers of capacities less than 2930 kW 10,000,000 Btu/h. On/off combustion controls may be used for up to 880 kW 3,000,000 Btu/h, hi-low-off type may be used for 585 to 1465 kW 2,000,000 to 5,000,000 Btu/h, and modulating positioning type may be used for over 880 kW 3,000,000 Btu/h.
****

****
NOTE: Research local, state, and federal emission standards and place any new or unusual requirements in this specification section.
****

[Firetube, packaged type of standard duty conforming to FS F-B-2903] [or] [Firetube type (horizontal return tubular and horizontal fire box)] [Water tube type] [Cast iron, sectional type conforming to MIL-B-18897] [except that treatment and painting shall be in accordance with manufacturer's standard practice,] Boilers shall have gross output capacity of at least [_____] kW Btu per hour when operating at a steam pressure of [_____] kPa (gage) pounds per square inch gage (psig) at the site under design conditions when the burner is firing [[No. [_____] oil conforming to [ASTM D396] having a higher heating value of [_____] MJ/kg Btu per gallon] [or] [[natural] [manufactured] [mixed] [liquified petroleum] gas having a higher heating value of [_____] MJ/kg Btu per cubic foot and a pressure of [_____] kPa (gage) psig at the fuel train connection].] [Gas fired boilers shall have a steady state combustion efficiency of at least 80 percent when fired at the maximum and minimum rated capacities which are provided and allowed by the controls.] [Oil fired boilers shall have a steady state combustion efficiency of at least 81 percent when fired at the maximum and minimum rated capacities which are provided and allowed by the controls.] Boilers shall comply with local, state, and federal emission regulations for the fuel being used. Smoke emission shall not

exceed Ringlemann No. 1, except during start-up, cleaning, or soot blowing. Boiler furnaces shall be equipped with combustion control safety devices conforming to [ASME CSD-1, for boilers of less than 3660 kW 12,500,000 BTU/HR thermal heating capacity.] [NFPA 85, for boilers with thermal heating capacity of 3660 kW 12,500,000 BTU/HR or larger.] [Burners and controls for boilers conforming to MIL-B-18897 shall conform to FS F-B-2910.] Burners of the rotary type are not acceptable. Programming controls shall be of the automatic [recycling] [non recycling] type and shall incorporate means for automatic self-checking of the circuit at the beginning of each start-up cycle. Include a repetitive self-checking circuit to check components at intervals not to exceed the specified flame failure response time in [FS F-B-2910] [or] [FS F-B-2903] [as applicable] during the entire period of burner operation. Combustion controls, shall be of the [on-off], [hi-low-off] [modulating-positioning] type. [Provide connections for remote starting or stopping of the boilers.] [Explosion relief doors are required.] [Provide steam operated feedwater injectors.] [Cast iron boilers shall be of the sectional type and shall conform to the requirements above and as specified. Boilers shall be [automatic] [semi-automatic,] [or] [manual] start.] [For each boiler, provide a steam operated soot blower made of materials that shall withstand expected temperatures.]

2.1.1 Boiler Connections

Requirements for interconnecting piping, insulation, fuel supply, [vibration isolation,] [_____], and other related work necessary to provide a complete and operable steam system, whether or not specifically mentioned above, shall conform to applicable requirements of other UFGS sections.

2.1.2 Boiler Instrumentation

In addition to the instruments required by the boiler specifications referenced above, provide the following instruments and locate where shown and where recommended by instrument manufacturer:

a. A flue gas temperature gage.

b. A draft gage, [single point] [two point], conforming to ASME B40.100.

****
NOTE: Select the applicable paragraph(s) from the following:
****

****
NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h.
****

[c. A carbon dioxide recorder to measure, record, and indicate the percentage by volume of carbon dioxide detected in the flue gas. Flush mount the recording unit and furnish with locking device and master key. The carbon dioxide recorder shall in other respects conform to CID A-A-50566.]

****
NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h.

****

[c. A complete oxygen analyzer system to measure oxygen content of flue gases generated by combustion of [gas] [or] [oil] as specified in paragraph BOILERS shall be provided for each boiler. The output of the analyzer shall range from zero to [_____] [25] percent oxygen:

(1) Provide a complete aspirating system with proper connection to stack, necessary steam or water aspirating facilities, and piping of proper specification to analyzer. Provide piping in accordance with the oxygen analyzer manufacturer's recommendations and install tight. Install equipment in accordance with the manufacturer's instructions.

(2) Provide a paramagnetic analyzer. Analyzer shall provide oxygen analysis in the zero and 25 percent oxygen range, and have means of calibration. Provide zero range and span adjustments as required.

(3) Analyzer output and recorder input shall be compatible. Provide, connect, and place in proper operation necessary transducers. Follow special instructions relating to electrical transmission between analyzer and recorder as to the application of shielded wiring in conduit.

(4) Check the system with two calibrating gases as follows: (a) 100 percent nitrogen, and (b) 3.5 percent oxygen and remainder nitrogen.

]

****

NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h.

****

[c. Direct Probe In-Situ Type: Oxygen analyzer shall be the direct probe type utilizing an in-situ zirconium sensing element. Insert element directly in the process flue gas stream and in direct contact with process gasses. Sensing element shall be contained within a protective shield mounted to the duct work by means of an adapter plate, all furnished by the manufacturer. Analyzer shall be equipped with a facility to allow daily automatic calibration check without removing the analyzer from the process. That is, sample gases may be injected directly on the sensing element while the analyzer is in the process. In order to eliminate the temperature effect of the flue gases, maintain the cell temperature in the probe at 843 degrees C 1,550 degrees F by means of an externally mounted temperature controller equipped with cold junction compensation and coupled to the probe with at least 6 meters 20 feet of flexible cable. Analyzer shall be FM APP GUIDE approved and certified for "in-stack" analysis technique. Output signal range shall be 4 to 20 milliamps and shall represent 0.25 percent to 25 percent oxygen as a logarithmic function, 0.1 percent to 10 percent oxygen as a logarithmic function, or zero percent to 10 percent as a linear function. [Circular chart recorder shall consist of a two-pen recording control mechanism having 110 volt ac electric motor drive. Chart shall be 300 mm 12 inch diameter and have 24-hour revolution. Output control signal will be 20 to 103 kPa (gage) 3 to 15 psig pneumatic. Sufficient blank charts and four ink cartridges per pen for 400 days operation shall be provided. Recorder shall have a dual 30 degrees strip indicator. Strip indicator and

chart paper scale shall be logarithmic or linear and consistent with the analyzer signal conditioning.] [Strip chart recorder shall consist of a two pen solid state electronic recording/controlling mechanism. Strip chart shall be 100 mm 4 inches wide and shall be driven at a speed of 19 mm per hour 3/4 inch per hour. Recording/controlling mechanism will operate on 110 volt ac power. Recorder shall be furnished with twelve usable 24-hour logarithmic or linear charts consistent with the analyzer signal conditioning. Inking system shall be a breakaway inking system with replaceable fiber tip pens and 12 ink cartridges. Strip chart recorder/controller shall have vertical scale and horizontal driven chart. Output control signal will be 4 to 20 milliamps dc.] Flue gas temperature scale shall be 149 to 427 degrees C 300 to 800 degrees F. Entire system response shall be not more than 3 seconds.

]

****

NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h. However, smoke density recorders are mandatory for all residual oil fired boilers having capacities above 2930 kW 10,000,000 Btu/h.

****

d. A smoke density [indicator] [recorder] of the [density limit] [continuous density] type with a scale calibrated in Ringlemann units. Indicating and recording systems shall include circuits for the audible warning of the maximum smoke density-limit. Supply a vibrating electric horn to sound the audible signal. Otherwise the smoke density [indicator] [recorder] shall conform to CID A-A-50566.

2.1.3 Boiler Plant Controls and Instruments

Provide the following plant [controls and] instruments:

a. Orsat Gas Analyzer : Provide a flue gas analyzer, Orsat type, conforming to CID A-A-50504. Analyzer shall determine the CO2, CO, and O2 in the flue gas and shall be complete with chemicals and accessories for use in such determinations.

b. Steam flow recorder: to remotely indicate, record, and totaling the steam flow per hour through the steam header. Provide the panel-mounted indicating recorder with a tamper proof case.

****

NOTE: Insert section number(s) for oil and/or gas piping systems in the blanks below.

****

c. Volumetric fuel flow meters in accordance with [_____] [and [_____]].

****

NOTE: The value of tolerance limit shall be 3 percent for modulating positioning type, shall be 5 percent for high/low/off type, and shall be 6 percent for on/off type. See paragraph 3 for which type of combustion control is specified.

****

d. Master Combustion Control: Provide a common boiler master controller

on the free standing boiler instrument and control panel to control all boilers with each individual boiler controller acting as a submaster controller. Boiler master control system shall provide for base loading one [or more] boilers. Base loaded boiler(s) shall be selected manually by an externally accessible switch. On call for heat, lead boiler shall cut in and moderate firing rate to satisfy demands. When maximum desired firing rate is reached, lag boiler or boilers shall cut in. Only one boiler shall be on modulating firing at one time. Maximum desired firing rate for base loaded boiler shall be adjusted initially for boiler peak efficiency and shall be capable of easy manual adjustment by operating engineer. Provide adequate indicators approved by the Contracting Officer to show the method of loading of each boiler, and load being carried by it. Make adjustments at front of panel and no linkage adjustment shall be necessary. Combustion control system shall be capable of maintaining the plant steam pressure at the main header within the tolerance limits of plus or minus [_____] percent expressed as a percent of the set point values. The specified tolerance shall apply to a load which, within a one-minute period, swings from a steady-state condition to an increase (or decrease) in load equal to a maximum of 10 percent of the plant. Regulation tolerances shall apply to any steady state condition within the plant turndown ratio of [_____]. Combustion efficiency shall not be less than that specified in the boiler specifications.

e. Pressure gage conforming to ASME B40.100 or indicating steam pressure in main steam header, [for indicating atomizing steam pressure,] and for indicating feedwater pressure.

2.1.4 Boiler Control and Instrument Cabinet(s)

Provide boiler control and instrument cabinet(s) as specified in the referenced boiler specification(s) and may be mounted either on the boiler front or adjacent thereto. The arrangement may consist of a boiler mounted cabinet containing controls normally provided by the manufacturer and a supplementary cabinet containing additional controls and instruments required herein. Mount [plant master combustion control] [and] [steam flow recorder] on or adjacent to control panel for number [_____] boiler.

2.1.5 Free-Standing Multi-Boiler Plant Control and Instrument Panel

Provide a free-standing panel and locate as indicated. The panel shall contain all individual and multi-boiler controls, monitoring system, and panel-mounted instruments specified herein and in the reference specifications, except that flame safeguard system may remain separately mounted in a cabinet at each boiler.

[2.1.5.1 Control Panel Construction

****
NOTE: Select the applicable paragraph(s) from the following:
****

****
NOTE: Delete inapplicable paragraph(s).
****

Construct control panel of not less than 3 mm 11 gage reinforced steel for

face, top, and sides. The enclosed panel shall be not less than 610 mm 24 inches in depth with inside rigidly welded braces. Design control panel so that all indicating and recording devices and manually operated switches shall be flush mounted in a gasketed removable-top front panel with indicating and recording devices at eye-level. Provide a similar removable-top rear panel located opposite front panel to facilitate wiring, piping, and maintenance. Install other operating controls on a sub-panel within the enclosure. Access to panel enclosure shall be through gasketed, double piano-hinged doors of not less than 1.52 mm 16 gage steel. The doors shall be reinforced to prevent sagging and shall be provided with a three point compression type fastener and polished key lock handle. Include a full width fluorescent lighting canopy also. Prime coat complete control panel and lighting canopy and finished in baked enamel. Identify flush-mounted devices on panel with engraved lamicore nameplates. Adequately reinforce, skirt, and suitably design panel base to permit anchoring to the floor or foundation.

][2.1.5.2 Control Panel Wiring and Piping

****
NOTE: Delete inapplicable paragraph(s).
****

Control panel shall be factory pre-wired in accordance with NFPA 70. Wire shall be thermoplastic Type THW, THWN, XHHW, or UL approved for the intended use, color or number coded, and run in plastic ducts to numbered terminal blocks. Control circuits shall be separately fused with properly rated cartridge type fuses. Power leads to and from magnetic starters and contractors shall terminate at terminal blocks so that field wiring is necessary only from terminal blocks to external equipment. Control leads to and from external control devices shall terminate at separate terminal blocks from power leads. Steam-, draft-, and air-operated devices shall be factory piped to permanently affixed external connections. Pneumatic signals shall be either 20 to 103 kPa (gage) 3 to 15 psig or 20 to 207 kPa (gage) 3 to 30 psig. Piping connections to indicators shall be copper tubing conforming to ASTM B88M ASTM B88. The boiler operating switch shall be a dust-tight sealed snap-action type. The precision switches shall have cadmium, silver, or platinum contacts, wiping action type, rated at 10 amperes. Electrically or pneumatically tested, controls and equipment shall be to simulate complete operational sequence.

]2.1.6 Hot Water Heater

****
NOTE: Hot water heaters are only used on boilers operating at 103 kPa 15 psi or less.
****

[The] [Each] [Number [_____]] boiler shall be equipped with internal hot water heating coils conforming to the ASME BPVC SEC VIII. Heaters shall have gasketed cast iron or steel flange mountings and shall be designed, fabricated, and tested to withstand 207 kPa (gage) 30 psig maximum working pressure at 121 degrees C 250 degrees F. The heating coil shall be finned tube type not less than 19 mm 3/4 inch outside diameter and shall be constructed of seamless copper or copper alloy that meet the requirements of [ASTM B75/B75M,] [ASTM B111/B111M,] or [ASTM B395/B395M ASTM B395/B395M]. The heating coil while submerged in water under pneumatic pressure shall withstand 2068 kPa (gage) 300 psig. The pressure drop through the coil at maximum temperature and draw rate shall not exceed 34 kPa (gage) 5

psig, unless otherwise indicated. The coils shall terminate in threaded inlet and outlet connections on the exterior of the boiler and shall be designed for the indicated temperature rise and maximum draw rate. When applicable, provide instrumentation for metering hot water production load on boiler.

2.1.7 Noise Levels

Noise measurements and exposure analyses should be conducted under the overall supervision of an industrial hygienist or suitably qualified medical officer from the Navy Regional Medical Center (NRMC). Safety personnel, engineers and others who have been certified by the Chief, Bureau of Medicine and Surgery (BUMED) also may supervise the work. Exposure limits for potentially hazardous noise levels of 85 dBA, continuous or intermittent, and 140 dB peak sound pressure, impulse or impact, shall be maintained. The sound level meter shall conform as a minimum to the Type 2 requirements cited in ASA S1.4.

2.2 BOILER BREECHING

2.2.1 Round Breeching

Construct round breeching of black iron or steel in accordance with NFPA 211 for metal connectors for medium-heat appliances and shall be constructed with welded beams and joints. Round breechings also may consist of approved factory-built chimney sections for medium-heat appliances if the sections are joined together with continuous welds, flanges, or couplings. Provided suitable cleanouts that will permit cleaning the entire breeching without dismantling.

2.2.2 Rectangular Breeching

****

NOTE: Specifier should check structural steelwork section of the project specification, if used, as well as notes on structural drawings to ensure against conflict of requirements.

****

Structural materials shall comply with the applicable sections of AISC 360. Shop connections may be welded or bolted as required for joining breeching to equipment. Supply hot dipped galvanized bolts and lock washers for bolted connections. Bolts shall be not less than 10 mm 3/8 inch in diameter, and spaced not more than 76 mm 3 inches apart. Furnish bolted joints with 3.20 mm 1/8 inch thick non-asbestos gaskets. Breeching [plate] shall be not less than [12 MS gage steel][4.80 mm 3/16 inch thick]. Welds shall conform to AWS D1.1/D1.1M. Breeching system shall provide for maximum expansion and contraction. Expansion joints shall be of the guided flexible crease type with flexible element of not less than 1.60 mm 0.0625 inch thick stainless steel. Provide access doors and cast iron or reinforced steel plate with non-asbestos gaskets 3.20 mm 1/8 inch thick and positive closing latches of sufficient number to ensure a gas-tight seal. Thoroughly clean breeching of rust and scale after fabrication by commercial sand blasting.

2.2.3 Breeching Hangers

Design breeching hangers to carry not less than five times the breeching weight. Hangers for round breeching shall be of the band type with hanger

rods. Provide steel trapeze type hangers for rectangular breeching with angle support member and hanger rods.

2.2.4 Cleanout Doors

Secure cleanout doors to the ends and sides of the breeching where indicated or where required to effectively clean the breeching. Construct cleanout doors of a gage steel not less than that of the breeching and secure to a 32 by 32 inch 1 1/4 by 1 1/4 inch angle frame not less than 3.20 mm 1/8 inch in thickness with mounting bolts welded to the angle frame and spaced not over 152 mm 6 inches on center; provide 1.60 mm 1/16 inch thick long fiber non-asbestos gasket between cleanout doors and frames. Doors shall be squared and shall be full height of diameter or side of breeching up to a size of 610 mm by 610 mm 24 inches by 24 inches maximum, except that cleanout doors less than 305 mm 12 inches in height shall be rectangular and shall be 305 mm 12 inches in length. Plug type cleanouts are not acceptable.

2.2.5 Stacks

Stacks shall be constructed of not less than [12] [10] MS gage steel, welded construction, and of proper size to adequately serve the respective boiler. Stacks shall project above the boiler house roof not less than that indicated and shall be supported by a substantial steel framework. Provide structural steel framework at boiler room roof around each stack and attached to roof joints to brace stack against swaying and to support new roof curb and stub stack. Construct stacks as indicated to include automatic damper access door, gas sampling connection, smoke density indicator, temperature sensing connection, and other features shown or required. When rain can fall into contact with internal boiler parts, provide stub stacks with rain caps or hoods. Provide stacks with the following:

a. Provide curb openings in roof and properly flash and counterblock to roofing. Furnish and install flashing hoods around stacks and over roof curbs.

b. Provide a bellows type flexible [fabric] [_____] type expansion joint approximately 152 mm 6 inches wide in the stacks at the location shown. Joint system shall consist of 4.80 mm 3/16 inch steel plate welded to inside of bottom section of stack. Top section of stack shall be free to move up and down outside the plate. Weld steel reinforcing angles around both top and bottom sections of stack. Fit and weld to the angles an expansion angle type bellows of 12 gage steel.

c. Clean stacks of dirt, rust, oil and grease by wire brushing and solvent degreasing and give one shop coat of heat-resisting aluminum paint conforming to FS TT-P-28 on the inside and outside. The coat of paint shall have a minimum dry film thickness of one mil.

2.3 BLOWDOWN EQUIPMENT

Furnish the [boiler] [plant] with all equipment, tanks, and controls necessary for bottom [and continuous] blowdown of the boilers. The equipment for bottom blowdown systems shall include a [blowdown tank] [and sample cooler]. [Continuous blowdown systems shall be of the packaged, proportional type consisting essentially of a heat exchanger, flow control valve, surge tank, [and] sample cooler, [and blowdown control console with

test sink].] Install and pipe blowdown equipment as indicated, and conform to recommendations of the NBBI NB-27, Recommended Rules for National Board Boiler Blowoff Equipment.

2.3.1 Bottom Blowdown Tank

****

NOTE: Cathodic protection or magnesium anodes only required when steel tank is buried.

****

Blowdown tank shall be fabricated of welded steel plate in accordance with ASME BPVC SEC VIII. Tank shall be a vertical cylindrical tank designed for the working pressure of the boiler(s). Tank shall be equipped with a tangential blowdown inlet located so as to impinge on a carbon steel wear plate extending at least 180 degrees around the interior circumference of the tank from the point of inlet. Tank shall be equipped with an internal overflow, vent, drain, safety relief valve, and gage glass with try cocks, blowdown cock, and guard. Tank interior shall be protected by an epoxy coating system suitable for continuous water immersion and operation at a minimum temperature of [121] [149] degrees C [250] [300] degrees F. The tank [shall be fitted [with renewable magnesium anodes] [with cathodic protection equipment] to minimize galvanic corrosion of the exterior.] [shall be constructed of Class A reinforced concrete and shall be fitted with a bolted steel manhole frame and cover. Install blowoff pipe, vent pipe, and drain pipe in pipe sleeves built into concrete. Fill the space between the pipe and sleeves and caulk with lead wool or equivalent to make a watertight seal. Tank shall be divided into two sections by means of a baffle to form a sediment chamber.] Size and locate blowoff tank shall be size and located as shown.

2.3.2 Sample Cooler

Provide a water-cooled, shell-and-tube, or shell-and-coil type heat exchanger designed for cooling sample of boiler water prior to chemical testing. Furnish the sample cooler as a component of the packaged continuous blowdown system when such a system is being furnished. The cooler shall consist of a cast iron or steel shell with copper coil or copper alloy tubes and shall be equipped with a brass or bronze sampling cock. [The cooler shall be connected to a header and so valved that a sample can be withdrawn from any boiler as desired.] [Furnish a concentrometer kit containing necessary glassware, reagents, and instructions for determining boiler water concentrations.]

2.3.3 Continuous Blowdown System

****

NOTE: Specify continuous blowdown only where makeup water ratio is in excess of 20 percent of the boiler output or where the total dissolved solids of this makeup water are in excess of 500 parts per million.

****

****

NOTE: Include last sentence if a console type unit is indicated.

****

Provide a complete packaged unit of the [automatic-proportioning]

[manual-apportioning] type wherein the amount of blowdown from the [boiler] [plant] is automatically proportioned to the amount of make-up feedwater [and the total amount of blowdown from the plant is manually apportioned between boilers according to their steaming rate]. The system shall include either an automatic-proportioning valve and a heat exchanger or a concentric tube automatic proportioning control which shall be provided with a separate heat exchanger when necessary to meet the performance requirements indicated or specified herein. The system shall be designed for not less than boiler design pressure and shall be capable of heating the feedwater from [_____] degrees C degrees F to [_____] degrees C degrees F at the flow rates indicated. Heat exchanger shall consist of a steel shell and heads with Type 304 stainless steel tubes arranged in a removable U-bend bundle. Construct and test shell in accordance with ASME BPVC SEC VIII for the specified boiler operating pressure. Automatic proportioning valve shall be provided with a sensing orifice on both the makeup and blowdown lines and shall be of the adjustable ratio type in which the ratio of makeup to blowdown may be set anywhere within a range of [30:1] [_____] to [4:1] [_____]. Automatic proportioning control shall consist of two concentric tubes, the inner tube being of a thermostatic design which acts directly against an adjustable seat in response to the temperature differential between the blowdown in the inner tube and the makeup water between the inner and outer tubes. [Manual apportioning valves shall have bronze bodies with stainless steel seats and disks and shall be of the indicating type specifically designed for blowoff service.] Blowdown system shall be complete with strainers, stop valves, [blowdown meters,] thermometers, and other accessories necessary to form complete packaged units. [Blowdown control console shall include illuminated sight flow indicators, automatic flushing and cooling valves, and complete panelboard instrumentation as well as a cabinet type laboratory sink with drain board, back splash, hot and cold service water faucets, [air cock,] and electrical outlets.]

2.4 FEEDWATER EQUIPMENT

2.4.1 Boiler Feed Pumps

Conform to CID A-A-50562 for motor driven, horizontal split case or support head boiler feed pumps except as otherwise specified herein. Pumps may be of either the centrifugal or peripheral-turbine type with [cast iron] [or] [alloy steel] casing and shall be [bronze] [or] [alloy steel] fitted. For turbine type pumps, provide pressure relief valves and for centrifugal type pumps, provide by-pass orifice. Packed stuffing boxes or mechanical seals suitable for the design conditions indicated shall be provided. Pumps shall be designed for the net positive suction head, discharge head, and water temperature indicated. [Capacity under the above condition shall be not less than indicated.] [Capacity of each pump under the above conditions shall be not less than the following percentage of maximum total boiler capacity: Centrifugal pumps 125 percent; Turbine pumps 150 percent.] Pump motors shall be [totally enclosed] [dripproof] [dripproof with encapsulated windings].

2.4.2 Boiler Feed Tank

Feed tank and stand construction shall conform to FS F-P-2908 for horizontal, cylindrical, stand-mounted receivers and shall be [hot dip galvanized or cement lined] [epoxy coated] [coated]. Provide tanks with vents, gage glass, drain and overflow connections, pressure gage, thermometer, [float operated makeup water feeder] [float switch and makeup water solenoid valve] [and preheater assembly consisting of corrosion

resistant steam diffuser tube, steam corrosion resistant steam diffuser tube, steam pressure reducing valve, strainer, and thermostatic steam valve]. Boiler feed tank assembly shall include boiler feed pumps as herein specified, interconnecting piping including strainer and pump control box. Tank capacity and connection sizes shall be as indicated.

2.4.3 Deaerator

Provide pressurized packaged type conforming to FS W-H-2904, be constructed and stamped in accordance with ASME BPVC SEC VIII D1, and requirements specified herein. Deaerating assembly and deaerated water storage may be in the same or separate shells. When external vent condensers are provided, they may be located as recommended by the manufacturer. Provide a pressure relief valve sized [as indicated] [in accordance with Table II of FS W-H-2904]. Inlet piping and accessories shall be as indicated. Provide feedwater pumps, as specified herein, interconnecting piping, and control box as part of the deaerator package. Deaerator capacity shall be not less than [indicated] [1.25 times that required to supply the boiler(s) at maximum firing rate]. The temperature of the water delivered at maximum capacity shall be equivalent to saturated steam temperature at the operating pressure of the deaerator, which shall be as indicated and the oxygen content shall not exceed [0.005] [0.003] cubic centimeters per liter as determined by the Referee Method A (Colorimetric Indigo Carmine) of ASTM D888. Water storage capacity shall be sufficient to operate the boilers at maximum capacity for [10] [_____] minutes.

2.4.4 Surge Tank and Transfer System

The condensate storage and surge tank shall be a cylindrical welded steel tank mounted and supported as indicated. The tank shall be designed and constructed in accordance with the ASME BPVC SEC VIII D1 for the indicated working pressure. Storage capacity shall be [as indicated] [sufficient to provide adequate water to the deaerator for [10] [_____] minutes of [boiler] [plant] operation at maximum capacity]. Inlet connections for condensate and make-up water shall be as indicated. The tank shall be equipped with liquid level controllers and valves and alarms as indicated. Tank shall be equipped with pressure and temperature gages, water level gage, vent, drain, and overflow. Tank shall be [hot dip galvanized or cement lined] [epoxy coated] [_____]. Surge tank assembly shall include condensate transfer pumps and interconnecting piping including strainer and control box as indicated. Transfer pumps, except for head and temperature requirements which shall be as indicated, shall conform to requirements for boiler feed pumps specified herein.

2.4.5 Feedwater Treatment Equipment

2.4.5.1 Feedwater Characteristics

****
NOTE: Insert source of water supply.
****

Equipment for the chemical treatment of the boiler makeup feedwater shall be designed to reduce the boiler water concentrations to the limits specified herein when handling raw water having the following impurities reported as milligrams per liter (mg/liters) (formerly parts per million):

a. Total hardness as $CaCO_3$_____

b. Calcium hardness as $CaCO_3$_____

c. Magnesium hardness as $CaCO_3$_____

d. Alkalinity as $CaCO_3$_____

e. Sodium as Na_____

f. Chlorides as Cl_____

g. Sulfates as SO_4_____

h. Sulfites as SO_4_____

i. Phosphate as PO_4_____

j. Silica as SiO_4_____

k. Nitrates as NO_3_____

l. Iron as Fe_____

m. Free carbon dioxide as CO_2_____

n. Total dissolved solids_____

o. Suspended solids_____

Raw water shall be delivered to the plant [from the water distribution system of the [_____]] [from [_____]] at a normal pressure of [_____] kPa (gage) psig measured at the meter to the plant. See NAVFAC MO 225 for additional guidance on boiler water concentration limits.

2.4.5.2 Water Softener

Equipment shall be of the type, size, and arrangement indicated. When operating [under the indicated design conditions] [with an inlet water flow of [_____] liters per second gpm] effluent analysis shall be as follows:

a. Total hardness as $CaCO_3$ less than [_____] Mg/liter

[b. pH [_____] to [_____]

c. Total dissolved solids less than [_____] Mg/liter

d. [_____]

]

(1) Zeolite Water Softener: Conform to WQA S-100 and shall have [automatic] [manual] controls. The softener(s) shall be equipped for [a sodium cycle] [a hydrogen cycle] [the type of cycle necessary to provide the treated water analysis specified above]. [Each softener tank shall be provided an operating valve to permit the regeneration of one tank while the other is in service.]

(2) Lime Soda Softener: Conform to CID A-A-50573 for the type indicated.

(3) Ion Exchange Softener: Refer to NAVFAC MO 225 for additional information.

2.4.6 Pressure Filter

Provide [a] pressure filters of the type and arrangement indicated and with [manual] [automatic] controls. The filter shall conform to CID A-A-59249. Performance shall be as specified in CID A-A-59249 with raw water analysis as specified herein, and operating conditions as indicated. Filter shall be equipped to operate properly for not less than 2 days without operator attention to renew or regenerate filter coatings, chemicals, or other filter media.

2.4.7 Chemical Feeder

Size and connect as indicated. Chemical feeder shall be suitable for the flow, pressure, and temperature conditions at the point of connections. Provide chemical feed storage as indicated. [The feeder shall be of the [automatic proportioning type] [shot-type] conforming to FS F-F-2901.] [The feeder shall be of metering pump type conforming to the requirements of CID A-A-50573 for chemical feeders.]

2.4.8 Feedwater Test Equipment

Provide for the determination of boiler water condition which includes an assembly of indicator solutions, standardized solutions, and test glassware with cabinet. The solution types shall permit tests for water hardness, total alkalinity, hydroxide, carbonite alkalinity, and chloride content in milligrams per liter. Feedwater test equipment shall employ a standardized soap solution for hardness test and a dilute sulfuric acid solution with a methyl orange indicator for total alkalinity. The hydroxide and carbonate alkalinity shall be determined with a phenolphthalein indicator and the chloride content, with a silver nitrate solution. Furnish standardized phenolphthalein color slides for accuracy in alkalinity tests.

2.5 ELECTRIC MOTORS

****

NOTE: Select standard efficiency for motors used less than 750 hours per year and high efficiency for motors used over 750 hours per year. Packaged boilers should utilize the manufacturer's standard efficiency motor.

****

Motors which are not an integral part of a packaged boiler shall be rated for [standard] [high] efficiency service per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors which are an integral part of the packaged boiler system shall be the highest efficiency available by the manufacturer of the packaged boiler.

PART 3 EXECUTION

3.1 INSTALLATION

Arrange work in a neat and orderly manner so that minimum storage of equipment and material is required at the project site. Install equipment and material in accordance with the best commercial practices. A

competent installation engineer or technician as stated in paragraph QUALIFICATIONS OF ENGINEER shall assemble an unassembled boiler-burner package in strict accordance with the manufacturer's instructions. Systems shall be neat in appearance, compact, adequate in construction and assembly, and installed for long and continuous service. Parts shall be readily accessible for inspection, repair, and renewal. Inspect equipment and material upon delivery and test after installation. Protect material and equipment from the weather. Repair damage caused by the Contractor in execution of the work and leave in a condition equal to that existing before work was started.

3.1.1 Equipment Foundations

Locate as shown and construct of sufficient size and weight and of proper design to preclude shifting of equipment under operating conditions or under abnormal conditions that could be imposed upon the equipment. Foundations shall meet requirements of equipment manufacturer. Grout equipment mounted on concrete foundations before installing piping. Concrete shall conform to Army Corps of Engineers Guide Specification Section [03 30 00] CAST-IN-PLACE CONCRETE, and grout shall be non-shrinkable type approved by the Contracting Officer. Install piping in such a manner so as not to place a strain on equipment.

3.1.2 Welding

****
NOTE: Use of the ASME code or the Federal Construction Guide Specification section on welding depends upon the agency's requirements.
****

****
NOTE: Insert appropriate Section number in blank below.
****

Work shall be in accordance with [the applicable sections of the ASME BPVC SEC I] [[_____] WELDING] and AWS Z49.1.

3.1.3 Painting

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for the particular end item. Field paint equipment not factory finished as specified herein. Retouch damaged areas of factory-finished equipment on which the finish has been damaged and then give a complete finish coat to restore the finish to its original condition. The finish coat shall be suitable for exposure in the intended end use environment. Spray painting shall comply with OSHA 29 CFR 1910.

3.1.3.1 Cleaning and Application

Remove dirt, rust, oil, and grease by wire brushing and solvent degreasing prior to application of paint. Apply paint to clean and dry surfaces only. Where more than one coat of paint is specified, apply the second coat after the first coat is thoroughly dry. Retouch damaged painting before applying the succeeding coat. Finished surfaces shall be smooth. The painting of zinc coated and other corrosion-resistant metal surfaces is not required unless otherwise specified herein.

3.1.3.2 Smoke Flues, Boiler Casing, and Draft Ducts

In unfinished areas, paint smoke flues, boiler casing, and black steel draft ducts with heat-resisting aluminum paint, two coats on the inside of flues and ducts and one coat on the outside, each coat to a minimum dry film thickness of 0.025 mm one mil applied directly to clean bare metal surfaces. Paint exposed surfaces of protective metal covering over insulation, including zinc-coated surfaces, with two coats of heat-resisting black paint to a minimum dry film thickness of 0.05 mm two mils applied directly to the clean bare metal surfaces. Do not paint zinc-coated ducts.

3.1.3.3 Gratings, Pipe Railings, and Pit Covers

Apply a pre-treatment coating to gratings, pipe railings, pit covers, and similar plant appurtenances to a dry film thickness of 0.008 to 0.013 mm 0.3 to 0.5 mil. After installation, touch up damaged surfaces with then paint with two coats of finish paint matching type and color of adjacent areas. Do not paint zinc-coated surfaces.

3.1.4 Boiler Cleaning

After installation, [the] [each] boiler shall be boiled out, under supervision of the manufacturer, with soda ash or equivalent solution to clean internal surfaces of oil, grease, mill scale, and dirt. Following treatment, the boiler(s) shall be flushed, drained and then opened and washed down and inspected to ensure that no traces of oil or foreign matter are present. The boiler and associated piping shall then be drained and refilled with treated softened water. At all times after initial cleaning, the Contractor shall protect the boiler, tanks, and piping against internal corrosion until testing is completed and the boiler(s) [is] [are] accepted. Provide chemicals, labor for introducing chemicals, and professional services for control and supervision of the treatment process.

3.1.5 Piping

Material and installation requirements including welding shall be as specified in Section 23 11 20 FACILITY GAS PIPING, Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM DISTRIBUTION PIPELINES, Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION), and Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS.

3.2 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that the boiler(s) and auxiliary equipment, as installed, are in compliance with contract requirements. During boiler system start-up tests, factory-trained engineers or technicians employed by individual suppliers of such components as the burner, flame safeguard and combustion controls, feedwater treatment equipment, and other auxiliary equipment shall be present, as required, to ensure the proper functioning, adjustment, and testing of individual components and systems. No bypassing, use of jumpers, or other disablement of control systems will be allowed unless specified elsewhere. Labor, equipment, fuel, and test apparatus required for testing shall be furnished by the Contractor. Rectify defects disclosed by the tests by the Contractor within time period specified by the Contracting Officer.

3.2.1 Inspections and Test

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Make inspections and tests at the site under the direction of and subject to the approval of the Contracting Officer. The Contractor shall operate [the] [each] boiler and appurtenances prior to final testing and shall ensure that necessary adjustments have been made. A [24-] [48-] [_____] hour written notice shall be submitted to the Contracting Officer indicating the equipment is ready for inspection or testing. Provide testing equipment, including gages, thermometers, calorimeter, Orsat apparatus, thermocouple pyrometers, fuel flow meters, water meters, and other test apparatus and set up and calibrate prior to the test. Draft, fuel pressure, and steam flow may be measured by permanent gages and meters installed under the contract. [Gas flow may be measured by utility company meters.] Provide an analysis of the fuel being used for tests. Control of noise levels developed by exhaust steam including muffler, globe, and gate valves shall be conducted in such a manner as not to create a nuisance or hazard and shall be subject to the approval of the Contracting Officer. Tests shall include the following, and shall be performed when feasible, in the sequence listed:

a. Strength and tightness tests

b. Standards compliance tests

c. Combustion tests

d. Operational tests

e. Capacity and efficiency tests

f. Tests of auxiliary equipment

g. Feedwater equipment test

3.2.2 Strength and Tightness Tests

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Subject boiler to the following strength and tightness tests:

3.2.2.1 Hydrostatic Test

After installation and connection, subject [the] [each] boiler to an inspection and hydrostatic test to determine that the boiler and

appurtenances have not been damaged in transit or handling. The hydrostatic test shall be in accordance with the ASME Code with the test pressure applied for a period required by the Contracting Officer. This test shall be in addition to the hydrostatic tests performed at the factory. [The hydrostatic test at the site shall be certified by an inspector holding an authorized commission from the National Board of Boiler and Pressure Vessel Inspectors.]

3.2.2.2 Pneumatic Tests

Pneumatically test air casing and ducts exterior to the furnace at the maximum working pressure. Use the soap bubble method to verify tightness. Test gas sides of boilers normally operated under pressure for tightness at 2.5 kPa (gage) 10 inches water gage. For this test, tightly seal the boiler with a suitable means to blank off openings. Admit air to the boiler until test pressure is reached and then hold. If in a 10-minute period the pressure drop does not exceed 250 kPa one inch water gage, the casing shall be regarded as tight and accepted. Use air pressure and soap bubble tests or comparative carbon dioxide readings for induced draft boilers.

3.2.2.3 Internal Component Pressure Tests

[Hydrostatically test at 1-1/2 times the maximum operating pressure] the part of the pre-assembled fuel oil system that is furnished integrally with the boiler. [The part of the pre-assembled gas system that is furnished integrally with the boiler shall be pneumatically tested at operating pressure. Use the soap bubble test method to verify tightness of the gas system.]

3.2.3 Combustion Tests

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Test the fuel burning and combustion control equipment with [the] [each of the] specified fuel at the minimum limit of the turndown range and at increments of 50, 75, and 100 percent of full rated load [plus [_____] percent overload]. Tests shall be conducted by factory-trained combustion equipment engineers as previously specified. [The combustion control system shall demonstrate that equipment installed will meet the requirements of the specification, and that an overall efficiency as specified, with not over 15 percent excess air, can be obtained with boiler operating at 100 percent capacity.] Analyze test data and graphically present to show for [the] [each] boiler at tested loads: rates of steam flow; flue gas temperature; percent excess air; steam quality; and percentages of carbon dioxide, carbon monoxide, and oxygen in the flue gas. Monitor concentrations of sulfur oxides, particulate, and nitrogen oxides in the flue gas to ensure compliance with environmental requirements. Run tests on each fuel until stack temperatures are constant and conformance with the combustion requirements of this specification has been verified and recorded. Verify proper operation of instrumentation and gauges in the control panel during the test.

3.2.4 Operational Test

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Continuously test the boiler(s) under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control, and safety interlocks. Conduct this test after the adjustment of the combustion controls has been completed under the combustion test. The operational test shall continue for a period of at least [8] [_____] hours and shall include the following:

3.2.4.1 Sequencing

The boiler shall start, operate, and stop in strict accordance with the specified operating sequence.

3.2.4.2 Flame Safeguard

Verify the operation of the flame safeguard controls by simulated flame and ignition failures. Test burners having intermittent pilots by simulating main flame failure while the pilot is burning. Verify by stop watch the trial-for-pilot ignition, trial-for-main flame ignition, combustion control reaction, and valve closing times.

3.2.4.3 Immunity to Hot Refractory

Operate the burner at high fire until the combustion chamber refractory reaches maximum temperature. Then manually close the main fuel valve. The combustion safeguard shall drop out immediately causing the safety shutoff valves to close within the specified control reaction and valve closing times.

3.2.4.4 Pilot Intensity Required

Gradually reduce the fuel supply to the pilot flame to the point at which the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. If the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, readjustment of fire eye is required.

3.2.4.5 Immunity to Ignition Spark

Where ultra violet flame detectors are employed, the pilot and main burner manual safety shut off valves shall be closed. The burner shall then be operated through the trial for pilot ignition period. The flame safeguard relay shall not respond to the presence of electric spark. If the flame safeguard relay responds to the presence of electric spark, reject the boiler.

3.2.4.6 Boiler Limit and Fuel Safety Interlocks

Safety shutdowns shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

3.2.4.7 Combustion Controls

Demonstrate the accuracy, range, and smoothness of operation of the combustion controls by varying the steam demand through the entire firing range required by the turndown ratio specified for the burner [and in case of automatic recycling burners, by further varying the firing rate to require "on-off" cycling]. Control accuracy shall be as specified

3.2.4.8 Safety Valves

The high-pressure limit switch shall be locked out or otherwise made inoperative, and the boiler safety valves shall be lifted by steam. Determine the relieving capacity, popping pressure, blowdown, and reseating pressure by observation and measurement to be in accordance with the ASME Boiler and Pressure Vessel Code. The ASME standard symbol will be accepted only as indicating compliance with the design and material requirements of the code.

3.2.5 Capacity and Efficiency Tests

Perform the capacity and efficiency tests after satisfactory completion of all tests previously specified herein and after the boilers have been operating [continuously] for [one] [5] [_____] days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. Perform these tests on each boiler. Conduct tests using [the] [each of the] specified fuels. Test procedures shall be in accordance with the heat loss method of the ASME PTC 4 and shall be reported on the ASME Test Form for Abbreviated Efficiency Test. The duration of the tests shall be sufficient to record necessary data but in no case shall test duration be less than [4] [_____] hours [on each fuel].

3.2.6 Auxiliary Equipment and Accessory Tests

Observe and check blowdown valves, stop valves, try cocks, draft fans, fuel oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading, as applicable.

3.2.7 Feedwater Equipment Tests

Perform the test of the feedwater treatment equipment in two steps. Conduct one test by the Contractor concurrently with either the combustion test or the capacity and efficiency test. A second test will be performed by the Government during the first period of heavy loading after the plant has been accepted and put in service. Deficiencies revealed during the Government tests will be corrected under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with the limits for oxygen content and hardness concentrations of this specification. Equipment for taking samples and the test kit for analyzing the samples shall be supplied by the Contractor and shall revert to the Government when the tests are completed.

3.2.8 Preliminary Operational Test

Operate each boiler and appurtenances prior to final testing and insure that necessary adjustments have been made. Provide testing equipment required to perform tests. During this testing period, provide operating instructions and training to persons tasked with operation of the boiler. Tests shall be accomplished with both fuels on dual fuel units.

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NOTE: Insert the appropriate Engineering Field Division.

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Conduct a preliminary operational test prior to requesting an acceptance operational test and inspection by a [_____] Division, Naval Facilities Engineering Systems Command Boiler Inspector. The Contracting Officer, upon receipt of the notice from the Contractor, shall request the boiler be inspected by [_____] Division, Naval Facilities Engineering Systems Command. Ten days advance notice is required for scheduling the inspector to conduct acceptance operational test and inspection.

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Boilers Capacity	= 500,000 Btu/hr	= 150 kW
	= 10,000,000 Btu/hr	= 2930 kW
	= 18,000,000 Btu/hr	= 5275 kW

-- End of Section --