****

USACE / NAVFAC / AFCEC	**UFGS-23 52 00.01 (August 2026)**

Preparing Activity: NAVFAC	**Superseding** **UFGS-23 52 00 (April 2008)** **UFGS-23 52 43.00 20 (May 2015)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2026

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 00.01

LOW PRESSURE (<260 PSIG) WATER HEATING BOILERS (UNDER 6,000,000 BTU/HR INPUT)

08/26

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DESIGN REQUIREMENTS
1.3.1 Boiler Installation Requirements
1.3.1.1 Location
1.3.1.2 Combustion Air
1.3.1.3 Sequence of Operation
1.3.2 Detail Drawings
1.3.2.1 Drawings
1.3.2.2 Fuel Train / Wiring Diagram
1.3.3 Water Analysis
1.4 SAFETY STANDARDS
1.5 ELECTRICAL REQUIREMENTS
1.6 SUBMITTALS
1.7 QUALITY ASSURANCE
1.7.1 Material and Equipment Qualifications
1.7.2 Alternative Qualifications
1.7.3 Service Support
1.7.4 Manufacturer's Nameplate
1.7.5 Definitions
1.7.6 Administrative Interpretations
1.8 DELIVERY, STORAGE, AND HANDLING
1.9 EXTRA MATERIALS
1.10 INSTRUCTION TO GOVERNMENT PERSONNEL
1.11 ACCESSIBILITY
1.12 WARRANTY

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products
2.1.2 Asbestos Prohibition
2.1.3 Nameplates
2.1.4 Equipment Guards
2.2 BOILERS
2.2.1 General Requirements
2.2.2 Firetube Boiler
2.2.3 Watertube Boiler
2.2.4 Cast Iron Boiler
2.2.5 Condensing Boiler
2.2.6 Modular Configuration
2.2.7 Hot Water Heating Boilers
2.3 FUEL BURNING EQUIPMENT
2.3.1 Burners
2.3.1.1 Gas and Combination Gas-Oil Fired Burners and Controls
2.3.1.2 Oil-Fired Burners and Controls
2.3.1.3 Steam or Air Atomizer
2.3.1.4 Mechanical Pressure Atomizer
2.3.2 Draft Fans
2.3.2.1 Draft Fan Control
2.3.2.2 Draft Fan Drives
2.3.3 Draft Damper
2.3.4 Ductwork
2.4 BURNERS AND CONTROL EQUIPMENT
2.4.1 Atmospheric-Type Gas Burner
2.5 BOILER TRIM AND CONTROL EQUIPMENT
2.5.1 Emergency Disconnect Switch
2.5.2 Relief Valves
2.5.3 Pressure and Altitude Gage or Combination Pressure/Altitude Gage
2.5.4 Thermometer
2.5.5 Drain Tapping
2.5.6 Make-up Water Station
2.5.6.1 Pressure Reducing Station
2.5.6.2 Backflow Preventers
2.5.7 Feedwater Treatment Feeder
2.5.8 Combustion Regulator
2.5.9 Air Vent Valve
2.5.10 High Temperature Limit Switch
2.5.11 Low Water Level Cutoff Switch
2.5.12 Boiler Safety Control Circuits
2.5.13 Indicating Lights
2.5.14 Alarm Bell
2.5.15 Post-Combustion Purge
2.5.16 Draft
2.5.17 Stack, Breeching, and Supports
2.5.18 Hot Water Coils
2.5.19 Stack Thermometer
2.6 ELECTRIC MOTORS
2.7 COMBUSTION CONTROL EQUIPMENT
2.7.1 Pneumatic Controls
2.7.1.1 Air Compressor Unit
2.7.1.2 Air Receiver
2.7.2 Electrical controls
2.7.3 Water Temperature Controller
2.7.4 Boiler Plant Master Controller
2.7.5 Boiler Combustion Controls and Positioners
2.7.6 Combustion Safety Controls and Equipment
2.7.6.1 Low-water Cutoff

2.7.6.1.1 Feedwater Regulator with Low-Water Cutoff
2.7.6.1.2 Pump Controller with Low-Water Cutoff
2.7.6.1.3 Supplementary Low-Water Cutoff
2.7.6.1.4 Water Flow Interlock
2.8 FITTINGS AND ACCESSORIES
2.8.1 Soot Blowers
2.8.1.1 Air Compressor Unit
2.8.1.2 Air Receiver
2.8.2 Continuous Emissions Monitoring
2.8.2.1 Gaseous Emission Monitors
2.8.2.2 Flue Gas Flow Monitor
2.8.2.3 Particulate Matter Monitor
2.8.2.4 Wiring
2.8.3 Tankless Water Heater
2.8.4 Conventional Breeching and Stacks
2.8.4.1 Breeching
2.8.4.2 Stacks
2.8.5 Direct Vents
2.8.5.1 Combustion Air Intake Vent
2.8.5.2 Exhaust Vent
2.9 TOOLS
2.9.1 Breeching Cleaner
2.9.2 Tube Cleaner
2.9.3 Tube Brush
2.9.4 Wrenches

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION
3.2 PAINTING OF NEW EQUIPMENT
3.2.1 Factory Painting Systems
3.2.2 Shop Painting Systems for Metal Surfaces
3.3 EXAMINATION
3.4 ERECTION OF BOILER AND AUXILIARY EQUIPMENT
3.5 EQUIPMENT FOUNDATIONS
3.6 BOILER CLEANING
3.7 FIELD QUALITY CONTROL
3.7.1 Operational Tests
3.7.1.1 Preliminary Operational Test
3.7.1.2 Acceptance Operational Test and Inspection
3.8 HEATING SYSTEM TESTS
3.8.1 Boiler/Piping Test
3.9 CLEANING
3.9.1 Boilers and Piping
3.10 FIELD TRAINING
3.11 FUEL SYSTEM TESTS
3.11.1 Fuel Oil System Test
3.11.2 Gas System Test

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC | **UFGS-23 52 00.01 (August 2026)**

Preparing Activity: NAVFAC | **Superseding**
UFGS-23 52 00 (April 2008)
UFGS-23 52 43.00 20 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2026

****

SECTION 23 52 00.01

LOW PRESSURE (<260 PSIG) WATER HEATING BOILERS (UNDER 6,000,000 BTU/HR INPUT)
08/26

****

NOTE: This guide specification covers the requirements for low pressure hot water heating boilers under 235 kilowatt 6,000,000 BTU/hr input and is intended for new construction boiler plant installations.

Adhere to UFS 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).

****

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.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2022) Gas-Fired Low Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC VIII D1	(2023) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2024) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 10	(2022) Performance Test Code on Compressors and Exhausters

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2025a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2025) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)

ASTM D1784	(2025) Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

HYI-005	(2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-23 PART 1	(2023) National Board Inspection Code - Part 1 Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2026; TIA 26-1; ERTA 26-1; TIA 26-2; TIA 26-3; TIA 26-4; TIA 26-5; TIA 26-6; TIA 26-7; ERTA 26-2; ERTA 26-3) National Electrical Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-430-07	2003; with Change 5, 2019) Operations and Maintenance: Inspection and Certification of Boilers and Unfired Pressure Vessels - INACTIVE
UFC 3-430-08N	(2004) Central Heating Plants

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Jan 2026) UL Standard for Safety Oil Burners

UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment
UL 1738	(2026) UL Standard for SafetyVenting Systems for Gas-Burning Appliances, Categories II, III and IV

1.2 RELATED REQUIREMENTS

****
NOTE: UFGS Sections that have been unified for use by all participating agencies have a level 3 or level 4 MasterFormat™ number. UFGS Sections that are agency-specific have a fifth level number indicating it as an agency-specific specification section. A Section that has a fifth level number "10" indicates USACE, a "20" indicates NAVFAC, and a "30" indicates AFCEC. The Preparing Activity is indicated in the banner of each UFGS Section.

Remove Sections not required for project.
****

The following guide specification sections apply to this section with the additions and modifications as stated in the paragraph cited:

01 78 23 OPERATION AND MAINTENANCE DATA

[01 78 24.00 20 FACILITY DATA WORKBOOK (FDW)

] 03 30 00 CAST-IN-PLACE CONCRETE

05 12 00 STRUCTURAL STEEL

09 90 00 PAINTS AND COATINGS

09 97 13.15 20 LOW VOC FLEXIBLE INTERIOR COATING OF STEEL FUEL TANKS

09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND BULKHEAD TIE RODS

11 82 19 PACKAGED INCINERATORS

13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS

21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION

22 00 00 PLUMBING, GENERAL PURPOSE

23 05 15 COMMON PIPING FOR HVAC

23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS

23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS

23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

[23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM

][23 21 13.23 20 [HIGH][MEDIUM] TEMPERATURE WATER SYSTEMS WITHIN BUILDINGS

] 23 25 00 CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS

23 20 00 INTERIOR DISTRIBUTION SYSTEM

[40 17 26.00 20 WELDED PRESSURE PIPING

] 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING

44 10 00 AIR POLLUTION CONTROL

1.3 DESIGN REQUIREMENTS

****
NOTE: Insert boiler output input or indicate in boiler schedule. Boiler operating and return temperatures are inserted here or in the boiler schedule.
****

Boiler must be suitable for installation in the space shown with ample room for opening doors and cleaning and removal and replacement of tubes. Boiler must have an input of [_____] kW BTU/hr. Boiler must be designed and tested in accordance with ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, NFPA 70 and ANSI Z21.13/CSA 4.9. Boiler must be installed in accordance with NBBI NB-23 PART 1. Boiler design working pressure must be [207 kPa (gage)] [30 psig] [_____]. Boiler operating pressure must be [83 kPa (gage)] [12 psig] [_____]. Boiler operating temperature must be [82 degrees C] [180 degrees F] [_____]. Boiler return water temperature must be [71 degrees C] [160 degrees F] [_____]. Provide a thermostatically controlled three-way mixing valve on boiler suitable for operating conditions of the boiler.

1.3.1 Boiler Installation Requirements

1.3.1.1 Location

Install Boiler(s) and associated hot water pumps in a mechanical room inside the facility in accordance with NBBI NB-23 PART 1. Provide ample clearance around boilers to allow access for inspection, maintenance and repair. Passageways around all sides of boilers must have an unobstructed minimum width of 914 mm 36 inches or the clearances recommended by the boiler manufacturer whichever is greater.

1.3.1.2 Combustion Air

Provide supply of air for combustion and ventilation. In accordance with NFPA 31, NFPA 54, NFPA 211 and manufacturer's installation manual, calculate the amount of combustion air necessary to operate the boiler. Install and locate properly sized combustion air dampers and louvers.

1.3.1.3 Sequence of Operation

Local, manual starting of boilers is required. Remote starting and stopping of the boiler by the HVAC control system is not permitted. This is to ensure that an operator witness the initial firing of the boiler at the beginning of each heating season to verify proper operation of the boiler and to promote proper maintenance.

1.3.2 Detail Drawings

1.3.2.1 Drawings

Show boiler hot water isolation valves, emergency disconnect switch, and complete boiler gas train on the contract drawings.

1.3.2.2 Fuel Train / Wiring Diagram

Submit fuel train and wiring diagram.

1.3.3 Water Analysis

Provide test reports of water analysis. UFC 3-240-13FN Industrial Water Treatment must be followed for all boiler installations.

1.4 SAFETY STANDARDS

Hot water boilers, burners and supplementary control devices, safety interlocks, or limit controls required under this specification, must meet requirements of the following standards as applicable:

a. Oil-Fired Units: UL 726, NFPA 31, NFPA 70, ASME CSD-1.

b. Gas-Fired Units: ASME CSD-1, NFPA 54, NFPA 70, ANSI Z21.13/CSA 4.9 or UL 795.

c. Combination Gas- and Oil-Fired Units: ASME CSD-1, NFPA 54, NFPA 31, NFPA 70, UL 726, ANSI Z21.13/CSA 4.9, UL 795 or UL 296.

d. All Units: ASME BPVC SEC IV, NFPA 70 and ASME CSD-1.

Controls not covered by the above must have a UL label, UL listing mark, or must be listed in the Factory Mutual Approval Guide.

1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors must have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.6 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 and Air Force 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.

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. Submittals not having a "G" or "S" classification are 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:

****

NOTE: Submittals for this Section must be delivered to the project Contracting Officer, who will forward two complete sets of copies to the appropriate approving official for review and approval.

****

SD-02 Shop Drawings

Fuel Train

Wiring Diagram

Detail Drawings

SD-03 Product Data

Materials and Equipment

[Energy Star Label for Residential Gas Fired Hot Water Boiler Product; S

][Energy Star Label for Residential Oil Fired Hot Water Boiler Product; S

] Spare Parts

Heating System Tests

Fuel System Tests

Qualifications

Field Instructions

Boilers

Boiler Trim and Control Equipment

Burners and Control Equipment

Stack, Breeching, and Supports

SD-06 Test Reports

Operational Tests

Water Analysis

SD-07 Certificates

Continuous Emissions Monitoring

Boilers

Burners and Control Equipment

Boiler Trim and Control Equipment

SD-08 Manufacturer's Instructions

Boilers

Feedwater Treatment Feeder

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G, [_____]

Boilers, Data Package 4

SD-11 Closeout Submittals

Posted Operating Instructions for Heating Water Boilers

1.7 QUALITY ASSURANCE

1.7.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

1.7.2 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.7.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7.4 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.7.5 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.7.6 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.8 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.9 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. Submit Detail Drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and typical support details. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function as a unit and to show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

1.10 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.11 ACCESSIBILITY

****

NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designer's should not rely on it at all since enforcing this requirement in the

field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

1.12 WARRANTY

General Warranty: Boiler Package must be warranted against defects in workmanship and materials for[1 year][2 years][5 years] after start-up or[1 year][2 years][5 years] from ship date, whichever is less.

Thermal Shock Warranty: The boiler vessel must be warranted for 25 years against thermal shock on a non-prorated basis.

PART 2 PRODUCTS

****

NOTE: In order to comply with UFC 1-200-02, designs must achieve energy consumption levels that are at least 30 percent below the ASHRAE 90.1 baseline. In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and Federal Acquisition Regulation (FAR) Section 23.203 energy consuming products and systems must meet or exceed the performance criteria for ENERGY STAR®-qualified products as long as these requirements are nonproprietary. The ENERGY STAR product requirements are available on the web at www.energystar.gov/products. Where ENERGY STAR products are not applicable, energy consuming products and systems must meet or exceed the requirements of ASHRAE 90.1.

ENERGY STAR Eligibility Criteria Version 3.0 requires that residential boilers of less than 90 kW 300,000 Btuh energy input supplying low pressure steam or hot water for space heating applications have a minimum AFUE of 90 percent for gas-fired type or 87 percent for oil-fired type. Boilers intended only for commercial applications and/or with an input rating of 90 kW 300,000 Btuh or higher are not eligible for Energy Star.

If a FEMP efficiency is not stated for a particular boiler capacity, this document includes boiler efficiency requirements in conformance with ASHRAE 90.1. ASHRAE 90.1 requires that low and medium pressure boilers used primarily in commercial space heating applications meet the following thermal (Et) or combustion (Ec) efficiencies:

Natural Gas-fired Hot Water rated at 88 - 732 kW

300,000 - 2,500,000 Btuh capacity, Et = 80 percent.

Natural Gas-fired Hot Water rated greater than 732 kW 2,500,000 Btuh capacity, Ec = 82 percent.

Natural Gas-fired Steam (excluding natural draft) rated at 90 kW 300,000 Btuh capacity and larger, Et = 79 percent.
Natural Gas-fired - Natural Draft Steam rated at 90 kW 300,000 Btuh capacity and larger, Et = 77 percent.

#2 Oil-fired Water rated at 88 - 732 kW 300,000 - 2,500,000 Btuh capacity, Et = 82 percent.

#2 Oil-fired Water rated greater than 732 kW 2,500,000 Btuh capacity, Ec = 84 percent.

#2 Oil-fired Steam rated greater than 90 kW 300,000 Btuh capacity and larger, Et = 81 percent.

Include all equipment efficiencies on the equipment schedules on the drawings.

****

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit manufacturer's catalog data included with the detail drawings for the following:

a. Radiant floor heating system including tubing, joints, and manifold for radiant floor heating systems.

b. Data showing model, size, options, etc., that are intended for consideration. Data submitted must be adequate to demonstrate compliance with contract requirements. Data must include manufacturer's written installation instructions and manufacturer's recommendations for operation and maintenance clearances for the following:

(1) Boilers

(2) Fuel Burning Equipment

(3) Combustion Control Equipment

(4) Pumps

(5) Fittings and Accessories

(6) Fuel Oil Storage System

(7) Water Treatment System

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products will not be allowed.

2.1.3 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, display an Energy Star label as applicable. Each pressure vessel must have an approved ASME stamp.

2.1.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact must be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard must be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails must be provided where shown and must be constructed in accordance with Section[08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 BOILERS

****
NOTE: Also select between firetube, water tube, cast iron, and condensing type boilers. Condensing type boilers should only be considered for hot water service. Natural draft/atmospheric burners will not be used for any boiler exceeding 300 kW 1,000,000 Btuh input. Inapplicable references must be deleted. A Life Cycle Cost Analysis should be performed to determine the appropriate type of boiler.
****

****
NOTE: Select options based on fuel source, and boiler capacity. Efficiencies included below are based on Energy Star for residential applications and ASHRAE 90.1 for commercial applications.
****

Provide hot water heating boiler complete with firing equipment, combustion chamber, insulation with steel jacket, safety and operating controls, integral electrical wiring and other appurtenances, to make the boiler a complete, self-contained, fully-automatic unit, ready for service upon completion of utility connections.[Commercial boilers less than 88 kW 300,000 Btuhmust have an Annual Fuel Utilization Efficiency (AFUE) of at least 80 percent.][Gas fired boilers greater than 88 kW 300,000 Btuh input must have a thermal efficiency of at least 80 percent when fired at the maximum and minimum capacities which are provided and allowed by the controls.][Oil-fired boilers greater than 88 kW 300,000 Btuh input must have a thermal efficiency of at least 82 percent when fired at the maximum and minimum rated capacities which are provided and allowed by the controls.]

2.2.1 General Requirements

Design, construction, installation, testing, and operation of boiler and appurtenances must comply with NBBI NB-23 PART 1, ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, ANSI Z21.13/CSA 4.9, and the manufacturer's instructions.

Each boiler must have the input capacity in kilowatts (kW) British thermal units per hour (Btuh) as indicated when fired with the specified fuels. The boiler must be furnished complete with the[oil][gas][combination oil/gas] burning equipment, boiler fittings and trim, automatic controls,[[forced][induced] draft fan,][natural draft/atmospheric burner,] electrical wiring, insulation, piping connections, and protective jacket. The boiler must be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment must be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices must not be sized for a 10 percent excess capacity. The boiler and its accessories must be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers must be designed, constructed, and equipped in accordance with ASME BPVC SEC IV. Each boiler must be of the[firetube][watertube][cast iron][condensing] type and designed for water service as specified herein. The boiler capacity must be based on the ratings shown in HYI-005 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

2.2.2 Firetube Boiler

Boiler must be self-contained, multipass, packaged type, complete with all accessories, mounted on a structural steel base. When the boilers are operating at maximum input capacity, the heat input rates must not be greater than 21 Kw/square meter 6,700 Btuh per square ft of fireside heating surface. Provide additional features, such as observation ports for burner/flame observation, jacketed steel enclosure with hinged full-height access door or fully removable access panels,[dry-back][wet-back] removable firetubes.

2.2.3 Watertube Boiler

****

NOTE: Select between standard, finned, or bent/flexible tube boiler. If bent or flexible tube boilers are not selected, remove all references to bent or flexible tube boilers. Standard water tube boilers are steel tube boilers that have historically been used for most heating applications. Finned tube boilers are typically small boilers (residential type) that utilize a finned tube arrangement. Bent or flexible tube boilers are steel tube boilers with bent tubes that experience multiple water tube passes. Bent/Flexible tube boilers typically require less space than standard water tube boilers. The bent or flexible tubes are also easier to replace than the standard water tubes; however, the interior surface of the tubes cannot be cleaned mechanically; they can only be chemically cleaned. Bent or flexible

tube boilers also have a higher ratio of heat output to heating surface area.
****

The boiler must be a[standard][finned][bent or flexible] type of water tube boiler. Boiler must be self-contained, packaged type, complete with all accessories, mounted on a structural steel base.[The boiler heating surface area for bent or flexible tube boilers must be at least 0.03 square meters/kW 4 square feet/boiler horse power.[The heat input rate for finned tube steam boiler or hot water generator must not be greater than3.5 kW 12,000 Btuh based on internal heating area.] Bent or flexible tube boilers must be provided with single or multiple downcomers for circulation without the need for exterior pumping. The tubes for bent or flexible tube boilers must be designed for replacement without requiring welding or rolling of tubes. Any special tools required for bent or flexible tube removal or installation must be provided with the boiler.]

2.2.4 Cast Iron Boiler

Boiler must be of the rectangular, sectional type, self-contained, packaged type, complete with accessories, mounted on a structural steel base. Cast iron sections must be free of leaks under all operating conditions. Access must be provided to permit cleaning of internal tube surfaces.

2.2.5 Condensing Boiler

****
NOTE: Due to the sulfur content of fuel oil, condensing boilers should only be considered if natural gas is used.

The lower the return temperature of water entering the boiler the higher the resulting boiler efficiency. (See ASHRAE HVAC Equipment and Applications Handbook). The return water temperature should be at or below the dew point of the flue gas to result in the formation of condensate. This condition may not occur within a steam heating system. Therefore, condensing boilers should only be used for hot water service. In addition, the water distribution system and heating coils should be designed for higher temperature differentials. The water distribution system and heating coils should be designed for lower supply water temperature into the coils and higher temperature differentials across the coils.

Condensing boilers may be in the form of fire tube boilers with pulse combustion, copper fire tube boilers, or multiple heat exchanger boilers. The military specifications listed in the preceding paragraphs concerning fire tube and water tube boilers do not apply to condensing boilers.
****

Each boiler must be a self-contained packaged type, complete with accessories, mounted on a structural steel base or a steel base which is integral to the boiler shell. Each boiler must conform to the commercial

design used by the manufacturer and must permit free thermal expansion without placing undue stress on any part of the boiler. Each boiler which experiences the formation of condensate within the flue gas must be specifically designed for condensing application. Each boiler must withstand the corrosive effects of condensate for each part which may be in contact with the condensate at all possible operating conditions. Each boiler must be provided with a separate air intake, exhaust, and condensate drain. Each boiler must be designed to withstand the water temperature differentials anticipated at the required operating conditions without experiencing any damage due to thermal shock. Combustion chamber must be of sealed combustion type with combustion air blower. Provide external viewing port permitting visual observation of burner operation.

2.2.6 Modular Configuration

****

NOTE: A modular configuration is a series of small cast iron type and/or condensing type boilers. The smaller boilers are manifolded together to provide heating for larger loads. This arrangement may be economical when heating load variances are expected. Delete this paragraph if a modular configuration is not desired.

****

Modular configurations must be arrangements of multiple boilers consisting of either all non-condensing cast iron types or hybrid arrangements of non-condensing cast iron types in combination with condensing type. Each modular boiler must have the capability of independent operation. Upon failure of any module, the remaining modules must be capable of operating at their design capacity.

Refer to UFC 3-430-08N Central Heating Plants and its recommended method for selecting the minimum of 3 boilers to overall provide 150 percent of total design capacity. Hybrid boiler configurations must require a specialized controller as specified in section 2.7.4 Boiler Plant Master Controller to achieve the lower supply/return water temperatures for condensing level efficiencies in the condensing boiler and to avoid exposure of non-condensing boilers to condensing operation.

2.2.7 Hot Water Heating Boilers

****

NOTE: Hot water heating boilers will operate at pressures not over 1100 kPa 160 psi and at temperatures not above 120 degrees C 250 degrees F at or near the boiler outlet. If a pressure above 200 kPa 30 psi is selected, the boiler may be required to be manned 24 hours a day. Consult AR 420-49 for boiler attendance requirements. Fill in blank spaces to define operating conditions, under the listed subparagraphs which are not applicable to the design. Indicate the elevation of the project site and outdoor ambient air temperature range expected at the project site. Site conditions affect fan selection, boiler design, and stack design. Select appropriate boiler types. Allow adequate space around each boiler to permit accessibility for operation, maintenance, and

service (including space for tube removal). A minimum clearance of 1200 mm 4 feet around the boiler will be required unless modular boilers are specified. Some modular boilers installations require little or no room between the individual boilers.

****

The hot water heating boiler must be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity must be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. Boiler design requirements are found in Section 1.2; Additional design requirements are as follows:

a. Temperature differential between boiler discharge and system return [_____] degrees C degrees F.

b. Water pressure drop [70][_____] kPa [10][_____] psig.

c. Outdoor ambient air temperature [_____] degrees C degrees F (max), [_____] degrees C degrees F (min).

d. Site elevation [_____] m feet.

e. Maximum continuous capacity [_____] kW Btuh.

f. Rated capacity [_____] kW Btuh.

g. Maximum exhaust stack temperature [_____] degrees C degrees F.

****

NOTE: Energy efficiency data for residential boilers provided in item "k" below is from Energy Star Program Requirements Product Specification for Boilers, Eligibility Criteria Version 3.0. Energy efficiency data for commercial boilers provided in item "k" below is from ASHRAE 90.1 Table 6.8.1F.

****

h. [Residential gas fired hot water boilers with a capacity less than 90 kW 300,000 Btu must have an Annual Fuel Utilization Efficiency of at least 90 percent, and must be Energy Star Labeled. Provide proof of Energy Star label for residential gas fired hot water boiler product.][Residential oil fired hot water boilers with a capacity less than 90 kW 300,000 Btu must have an Annual Fuel Utilization Efficiency of at least 87 percent, and must be Energy Star Labeled. Provide proof of Energy Star label for residential oil fired hot water boiler product.][Hot water boilers with a capacity less than 90 kW 300,000 Btuh must have an Annual Fuel Utilization Efficiency of at least 80 percent.][Gas fired boilers with a capacity of greater than or equal to 90 kW 300,000 Btuh and less than or equal to 733 kW 2,500,000 Btuh must have a thermal efficiency of at least 80 percent when fired at the maximum and minimum ratings allowed by the controls.][Gas fired boilers with a capacity of greater than 733 kW 2,500,000 Btuh must have a combustion efficiency of at least 82 percent when fired at the maximum and minimum ratings allowed by the controls.][Oil fired boilers with a capacity of greater than or equal to 90 kW 300,000 Btuh and less

than or equal to 733 kW 2,500,000 Btuh must have a thermal efficiency of at least 82 percent when fired at the maximum and minimum ratings allowed by the controls.][Oil fired boilers with a capacity of greater than 733 kW 2,500,000 Btuh must have a combustion efficiency of at least 84 percent when fired at the maximum and minimum ratings allowed by the controls.]

****

NOTE: Minimum boiler efficiencies will either be presented in this specification or on the design drawings. Delete boiler efficiencies in the specification if efficiencies are shown on the drawings. If the efficiencies are shown on the drawings, reference the applicable standard.

****

2.3 FUEL BURNING EQUIPMENT

****

NOTE: Include all the required data for proper design of the boiler. Delete all references to fuels which will not be used. When firing fuel oil, include nitrogen and sulfur content of fuel for emission requirements.

Review the Clean Air Act Amendment of 1990 (CAAA) and other applicable Federal, state, and local regulations early in the design phase to determine the appropriate emission limitations and monitoring requirements.

The CAAA does not require the application of low NOx burner (LNB) technology for boilers within the size range of this specification. The CAAA limits SO2 emissions for fuel oil fired boilers over 10.55 gJ 10,000,000 Btu to 21.5 kg/nJ 0.5 lb per million Btu input or to firing oil with less than 0.5 weight percent sulfur. However, state implementation plans may place limits on NOx and particulates and more stringent requirements on SO2.

Many options are available to reduce NOx emissions. The nitrogen and sulfur content of fuel oil should be specified in the fuel purchase contract. Restrictions on the nitrogen content will limit fuel flexibility. A careful analysis of proposed NOx reduction technologies must be performed to account for any required changes to auxiliary equipment and to identify future increase in O&M costs. Important questions that should be answered and be a part of the evaluation include the performance of NOx reduction over the entire load range, performance during backup fuel firing, and performance over the lifetime of the unit.

The majority of NOx control techniques can be defined as combustion modifications. The goals of combustion modification include redistribution of air and fuel to slow mixing, reduction of O2 in NOx

formation zones, and reduction of the amount of fuel burned at peak flame temperatures.

Combustion modifications primarily deal with the control of fuel and air. Vertical staging includes overfire air (OFA) ports above the main combustion zone. Horizontal staging use registers or other devices to introduce air at different points along the flame. Fuel staging establishes a fuel rich zone above an air lean main combustion zone. Burner Out of Service (BOOS) techniques direct fuel to lower burner levels, while operating upper burners with air only. Flue Gas Recirculation (FGR) reduces O2 available to react with nitrogen and cools the flame. In addition to low NOx burners (LNB), OFA and BOOS other combustion modification techniques include fuel biasing, low excess air (LEA) and fuel reburning. Oil fired burners have successfully used advanced oil atomizers to reduce NOx without increasing opacity. Oil/water emulsion is a technique to reduce NOx on smaller industrial boilers.

Consideration will be given to the unique installation and space requirements of various NOx reduction systems. LNB may or may not require pressure port modifications. FGR involves routing large ductwork. OFA is very effective and involves modification to pressure parts. Fuel staging requires pressure port modifications for reburn fuel injection and/or OFA ports.

****

Boiler must be designed to burn[gas][oil][combination gas and oil]. Each boiler must comply with Federal, state, and local emission regulations. As a minimum, the following emission requirements must be met:

NOx - [[_____] kg/joule lb/million Btu input][parts per million (ppm) corrected to 3 percent 02].

SO2 - [[_____] kg/joule lb/million Btu input][parts per million (ppm) corrected to 3 percent 02].

Particulate - [[_____] kg/joule lb/million Btu input][parts per million (ppm) corrected to 3 percent 02].

2.3.1 Burners

****

NOTE: If No. 4, 5, or 6 oil will be one of the fuels, requirements for burners and accessories for these heavy oils will be inserted in the project specification.

****

2.3.1.1 Gas and Combination Gas-Oil Fired Burners and Controls

Burners must be UL approved[mechanical draft burners with all air

necessary for combustion supplied by a blower where the operation is coordinated with the burner][natural draft/atmospheric burners]. Burner must be provided complete with fuel supply system in conformance with the following safety codes or standards:

a. Gas-fired units with inputs greater than 0.117 MW 400,000 Btuh per combustion chamber must conform to UL 795.[Gas fired units less than 3.66 MW 12,500,000 Btuh input must conform to ANSI Z21.13/CSA 4.9.]

b. Combination gas and oil-fired units must conform to UL 296.[Combination gas and oil-fired units less than 3.66 MW 12,500,000 Btuh input must conform to ASME CSD-1.]

2.3.1.2 Oil-Fired Burners and Controls

Oil-fired burners and controls for oil-fired units firing No. [_____] oil must be atomizing, forced-draft type in conformance with UL 726.[Oil-fired units less than 3.66 MW 12,500,000 Btuh input must conform to ASME CSD-1.]

[2.3.1.3 Steam or Air Atomizer

****
NOTE: Delete this paragraph if steam or air atomization is not used.
****

[Steam][or][air] atomizer must be of the inside mix type utilizing[steam][or][air] mixing with the oil inside the nozzle. No moving parts must be required within the atomizer assembly. Unit must be capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates and when supplied with[steam][or][air] at a maximum pressure of [100][_____] kPa [15][_____] psig. Capacity of unit must be adjustable. Unit must be furnished with a blowout valve so that[steam][or][air] may be blown through the oil passages to clear them of any accumulation. A diffuser designed to stabilize the flame must be mounted near the furnace end of the atomizer in such a position that oil will not strike it.

][2.3.1.4 Mechanical Pressure Atomizer

****
NOTE: If mechanical pressure atomization is not used delete this paragraph.
****

Mechanical pressure atomizer must operate solely by the use of oil pressure and must have no moving parts within the atomizer. Unit must be capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates and when furnished with oil at a constant pressure of [_____]. A constant volume of oil must be supplied to the atomizer. Variable capacity must be obtained by adjusting control valve. A diffuser provided to stabilize the flame must be mounted near the furnace end of the atomizer, but in such a position that oil will not strike it.

]2.3.2 Draft Fans

****

NOTE: If natural draft/atmospheric burners are utilized, all draft fan paragraphs will be deleted. Select between forced draft and induced draft fan or a combination of both. In most applications, a forced draft fan will be adequate. Fan bearings on induced draft fans must have adequate means to prevent overheating and provision for lubrication. Choice of type of cooling will depend on availability of water for the particular site. Water-cooled bearings are generally used for induced draft fans but air-cooled, sealed-type bearings are available; however, their use must be approved by the fan manufacturer for the application if specified. Forced draft fans are typically air cooled.

****

Fans conforming to AMCA 801[forced-draft][and][induced-draft] must be furnished as an integral part of boiler design. Fans must be centrifugal with[backward-curved blades][radial-tip blades] or axial flow type. Each fan must be sized for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Noise levels for fans must not exceed 85 decibels in any octave band at a 0.914 m 3 foot station.[Forced draft fan bearings must be air cooled.][Induced-draft fans must be designed for handling hot flue gas at the maximum outlet temperature in the boiler. Induced draft fan housings must be provided with drain holes to accommodate the drainage of condensation. Induced draft fan bearings must be[air-cooled][water-cooled]. Induced draft fan scroll sheets and rotor blades must have protective liners.]

2.3.2.1 Draft Fan Control

[Forced-draft centrifugal fans must have inlet vane controls or must have variable speed control where indicated. Inlet vanes must be suitable for use with combustion control equipment.][Induced-draft centrifugal fans must have outlet dampers and must have variable speed control.][Induced-draft fans must have inlet vane controls.] Axial propeller fans must have variable propeller pitch control.

2.3.2.2 Draft Fan Drives

****

NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

****

Fans must be driven by electric motors. Electric motor must be[drip proof][totally enclosed nonventilated][totally enclosed fan cooled][totally enclosed fan-cooled, suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70].[Motor starter must be[magnetic across-the-line][reduced voltage start] type with[general purpose][weather-resistant][watertight][dust-tight][explosion-proof] enclosure and must be furnished with four auxiliary interlock contacts.]

2.3.3 Draft Damper

****
NOTE: Select between manual and automatic dampers. Normally, manual dampers are adequate for single boilers less than 600 kW 2,000,000 Btuh capacity. Select automatic dampers for modular boilers.
****

Boilers must be provided with[manual][automatic] dampers, draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler. Draft damper must be provided in a convenient and accessible location in the flue gas outlet from the boiler. Automatic damper must be arranged for automatic operation by means of a[damper regulator][furnace draft regulator][damper motor].

[2.3.4 Ductwork

****
NOTE: In colder climates, tempering of combustion air may be required. Add an appropriate paragraph for tempering combustion air, if required. Delete this paragraph, if a plenum chamber is not needed.
****

Air ducts connecting the forced-draft fan units with the plenum chamber must be designed to convey air with a minimum of pressure loss due to friction. Ductwork must be galvanized sheet metal conforming to ASTM A653/A653M. Ducts must be straight and smooth on the inside with laps made in direction of air flow. Ducts must have cross-break with enough center height to assure rigidity in the duct section, must be angle iron braced, and must be completely free of vibration. Access and inspection doors must be provided as indicated and required, with a minimum of one in each section between dampers or items of equipment. Ducts must be constructed with long radius elbows having a centerline radius 1-1/2 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Duct joints must be substantially airtight and must have adequate strength for the service, with 38 x 38 x 3 mm 1-1/2 x 1-1/2 x 1/8 inch angles used where required for strength or rigidity. Duct wall thickness must be 16 gauge (1.5 mm) (0.0598 inch) for ducts 1500 mm 60 inches or less and 12 gauge (2.66 mm) (0.1046 inch) for ducts larger than 1500 mm 60 inches in maximum dimension. Additional ductwork must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

]2.4 BURNERS AND CONTROL EQUIPMENT

****
NOTE: Indicate fuel trains on the drawings. Conform to the requirements of ASME CSD-1.
****

2.4.1 Atmospheric-Type Gas Burner

Atmospheric-type gas burner (under 117 kW 400,000 BTU/hr input). ASME CSD-1 and ANSI Z21.13/CSA 4.9. Automatic recycling burner. ON-OFF type combustion control system.[Interrupted][Intermittent] pilot type

ignition system, and pilot must be electrode-ignited natural gas type. Design burner and combustion control equipment for firing natural gas having a specific gravity of [0.6][_____] and a heating value of approximately 37,300 kJ per cubic meter 1000 BTU per cubic foot and be an integral part of the boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1 and ANSI Z21.13/CSA 4.9, including complete gas shut-off and pilot gas. Gas pressure available: [[_____] inches of water gage (WC)] kPa gage psig.

2.5 BOILER TRIM AND CONTROL EQUIPMENT

Provide in accordance with ASME CSD-1 and ASME BPVC SEC IV and additional requirements specified below.

2.5.1 Emergency Disconnect Switch

****
NOTE: Indicate location of emergency disconnect switch on drawings. Insert emergency switch amperage required.
****

Provide and locate on wall outside boiler room entrance or just inside door, when boiler room door is on building exterior as required by ASME CSD-1 to allow rapid and complete shutdown of the boiler in the event of an emergency. Emergency switch must be a [_____]-amp. fuse-type safety switch. Switch must be red and furnished with a label indicating function of switch.

2.5.2 Relief Valves

Provide relieving capacity for the full output of boiler installed. Safety relief-valve piping must conform to ASTM A53/A53M, schedule 40 steel pipe and be piped full-size[to a floor drain][to 150 mm 6 inches above floor].

2.5.3 Pressure and Altitude Gage or Combination Pressure/Altitude Gage

For open hot water systems, provide one[pressure][altitude][pressure/altitude] gauge located on supply water piping and one on return water piping, to show open system level.

2.5.4 Thermometer

Provide thermometer with a scale equivalent to 1.5 times outlet water temperature. Provide one located on supply water piping and one on return water piping.

2.5.5 Drain Tapping

Provide drain valve and piping[to a floor drain][to 150 mm 6 inches above floor].

2.5.6 Make-up Water Station

2.5.6.1 Pressure Reducing Station

****
NOTE: Select operating pressure required.

****

Provide a water pressure-reducing valve and relief valve, or a combination of the two in the makeup water line to the boiler to maintain a water pressure of [83 kPa (gage)] [12 psig] [_____] in the hot water system. Provide a 20 mm 3/4 inch globe valve by-pass around this valve.

2.5.6.2 Backflow Preventers

Section 22 00 00 PLUMBING, GENERAL PURPOSE. Locate upstream of by-pass.

2.5.7 Feedwater Treatment Feeder

Provide floor mounted, Type II - Shot-Type Feeder (manual, intermittent feed), as indicated for use with pressures up to 1379 kPa (gage) 200 psig maximum.

2.5.8 Combustion Regulator

Provide adjustable temperature, thermostatic immersion type that must limit boiler water temperature to a maximum of 121 degrees C 250 degrees F. Control must actuate burner through an electric relay system to maintain boiler water temperature within normal prescribed limits at loads within rated capacity of boiler.

2.5.9 Air Vent Valve

Provide with screwed connection, stainless steel disk, and stainless steel seats to vent entrapped air.

2.5.10 High Temperature Limit Switch

****

NOTE: Specify alarm and indicating lights if input exceeds 117 kW 400,000 BTU/hr.

****

Provide adjustable immersible aquastat type with a temperature setting above that of the combustion regulator and below that of the lowest relief valve setting. Aquastat must function to cause a safety shutdown by closing fuel valves[,][and] shutting down burner equipment[, activating a red indicating light, and sounding an alarm] in the event that boiler water temperature rises to the high temperature limit setting. A safety shutdown due to high temperature must require manual reset before operation can resume and prevent recycling of burner equipment. Pre-set high temperature limit devices that cannot be easily tested are not allowed.

2.5.11 Low Water Level Cutoff Switch

****

NOTE: Specify alarm and indicating lights if input exceeds 117 kW 400,000 BTU/hr.

****

Low water level cutoff must cause a safety shutdown by closing fuel valves[,][and] shutting down burner equipment[, activating a red indicating light, and sounding an alarm] in the event that water level drops below the lowest safe permissible water level established by the

boiler manufacturer and ASME BPVC SEC IV. A safety shutdown due to low water must require manual reset before operation can resume and prevent recycling of burner equipment.

2.5.12 Boiler Safety Control Circuits

****
NOTE: Include draft fan if power burner is specified.
****

Provide boiler safety control circuits, including control circuits for burner[and draft fan], must be single-phase, two-wire one-side grounded, and not over 120 volts. Provide safety control switching in ungrounded conductors. Provide overcurrent protection. In addition to circuit grounds, ground metal parts which do not carry current to a grounding conductor.

2.5.13 Indicating Lights

Each safety interlock requiring a manual reset must have an individually labeled red indicating light. Non-recycling control interlocks must have the reset located on the control itself. Red indicating lights on the control panel may be omitted if the burner combustion control system has a Keyboard Display Module installed that will identify the lockout information required in Item c. below. Indicating lights must have colors as follows:

a. Amber: Ignition on

b. Green: Main fuel safety shut-off valves open

c. Red (One for Each): Safety lockout, flame failure, low water level, and high temperature

[d. Blue: Draft

]2.5.14 Alarm Bell

Provide alarm bell, electrically operated, with a manual disconnect switch. Disconnect switch must be type and wired so that switching off alarm following a safety shutdown will not prevent alarm from sounding again upon recurrence of a subsequent safety shutdown condition.

[2.5.15 Post-Combustion Purge

****
NOTE: Delete entire paragraph if atmospheric burner is specified.
****

Provide controls and wiring necessary to ensure operation of draft fan for a period of not less than 15 seconds or of sufficient duration to provide four complete air changes in the boiler combustion chamber (whichever is greater) following shutdown of burner upon satisfaction of heat demand and in accordance with ASME CSD-1 . Upon completion of post-combustion purge period, draft fan must automatically shutdown until next restart.

]2.5.16 Draft

Comply with boiler manufacturer's recommendations.

2.5.17 Stack, Breeching, and Supports

****
NOTE: NFPA 211, Type B vent can only be used with an atmospheric burner.
****

****
NOTE: Boiler stacks must conform to the boiler manufacturer's installation and operational manual.
****

[Provide boiler stack constructed of sheet steel having a thickness of not less than 2.47 mm 0.0972 inches with welded joints. Insulate stack located inside the building with 38 mm 1 1/2 inches of mineral wool conforming to applicable requirements of ASTM C592, Class II - for use up to 649 degrees C 1200 degrees F. Insulation must receive a finish coat of finishing cement not less than 19 mm 3/4 inch thick, trowelled to a smooth finish. Provide stack supports, umbrella collar and cap, and flue transition piece. Stack diameter and height must be in accordance with manufacturer's recommendations and conform to NFPA 211.

][NFPA 211,[Type B - gas][Type L - oil and gas/oil], prefabricated multi-wall type, flashed to the roof, and complete with rain cap. Stack diameter and height must be in accordance with manufacturer's recommendations and conform to NFPA 211.

][2.5.18 Hot Water Coils

****
NOTE: Delete entire paragraph unless hot water coils are required to instantaneously heat domestic water.
****

Provide coils capable of heating [_____] L/s GPM of water with [_____] degree C F rise conforming to ASME BPVC SEC IV.

]2.5.19 Stack Thermometer

Provide flue gas dial type thermometer with scale calibrated from 66 to 399 degrees C 150 to 750 degrees F and mounted in flue gas outlet.

2.6 ELECTRIC MOTORS

Electric motors must meet requirements of NEMA MG 1. Motors less than 3/4 kW 1 hp must meet NEMA High Efficiency requirements. Motors 3/4 kW 1 hp and larger must meet NEMA Premium Efficiency requirements. Motors which are an integral part of the packaged boiler system must be the highest efficiency available by the manufacturer of the packaged boiler. Motors must be variable speed.

2.7 COMBUSTION CONTROL EQUIPMENT

****

Controls for facilities with operating Energy Monitoring and Control Systems (EMCS) will be specified to be compatible with existing EMCS controls. Delete reference to multiple boilers if a single boiler is used.

Delete "pneumatic controls" for new systems. Use only pneumatic controls for existing pneumatic controls systems that require new parts be purchased.

****

Combustion control equipment must be provided as a system by a single manufacturer. Field installed automatic combustion control system must be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer.[The boiler water temperature must be controlled by a water temperature controller.] The equipment must operate[electronically][either electrically or pneumatically as applicable]. On multiple boiler installations, each boiler unit must have a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, a 1 year supply of ink and 400 blank charts for each recorder must be furnished.

[2.7.1 Pneumatic Controls

If pneumatic operation is provided, a regenerant desiccant air dryer unit must be provided. Boiler must shut down on loss of control air pressure. Pneumatic control systems must conform to CAGI B19.1. Air filter regulator sets must be installed at each control valve and transmitter in the system. The master air filter regulator set on the control panel must be the dual type where one side can be cleaned and repaired while the other is operating. Exterior control air piping and devices must be protected from freezing.

2.7.1.1 Air Compressor Unit

The air compressor unit must be electric-motor driven, polytetrafluoroethylene or carbon ring type automatic air compressor. The compressor unit must be sized to run not more than 60 percent of the time when all controls are in service. The air compressor unit must be complete with necessary accessories including automatic pressure control equipment, relief valves, check valves, air filters, moisture traps, and a receiver with ample capacity for emergency operation of the controls for 15 minutes after compressor shutdown. Compressor speed must not exceed 900 rpm. Motor speed must not exceed 1750 rpm. The compressor air intake must be provided with a low drop type air suction filter/silencer suitable for outdoor installation.

2.7.1.2 Air Receiver

****

NOTE: The condensate drain line will be located in such a manner as to prevent freezing.

****

The air receiver must be constructed in accordance with ASME BPVC SEC VIII D1for unfired pressure vessels for 1379 kPa 200 psi working pressure, and must be equipped with inlet and outlet connections, valved drain connection, minimum 150 mm 6 inch dial pressure gauge, pop

safety valves, and regulator connections.

]2.7.2 Electrical controls

Electrical control devices must be rated at [120][24] volts and must be connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.7.3 Water Temperature Controller

****

NOTE: Consideration will be given to the utilization of outside air reset controls. Outside air reset control is typically used for boilers whose primary loads are due to space heating applications. Information on outdoor air reset controls for space heating application is located in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and UFC 3-410-02 or inactive UFC 3-540-02N (https://www.wbdg.org/dod/ufc/ufc-3-540-02n). Consideration will be given to the use of control based on return water temperature rather than supply water temperature.

****

The controller must be of sturdy construction and must be protected against dust and dampness. The thermostatic element must be inserted in a separable socket installed[in the upper part of the boiler near the water outlet][in the boiler return piping].[Fixed position (on-off) and three position (high-low-off) controller must operate on a 5.56 degree C 10 degree F differential over an adjustable temperature range of approximately 60 to 104.4 degrees C 140 to 220 degrees F.][Modulating controllers must control the fuel burning equipment to maintain set boiler water temperature within 2 percent.][Controller must be furnished with necessary equipment to automatically adjust the setting to suit the outside weather conditions. The outside air reset controller must be operated in such a manner that the operating temperatures required by the boiler manufacturer are not compromised.]

[2.7.4 Boiler Plant Master Controller

****

NOTE: If only one boiler is utilized, the following paragraph will be deleted. A master controller will be provided for applications involving multiple boilers and for boilers arranged in a modular configuration.

****

A boiler plant master controller, sensitive to a temperature transmitter in the return water header for the boiler must be furnished to provide anticipatory signals to all boiler controllers. Boiler controllers must react to anticipatory signals from the plant master controller as necessary in response to the boiler[temperature][pressure] indication to maintain the preset[temperature][pressure]. An automatic-manual switch must be provided to allow the sequence of boiler loading to be varied to distribute equal firing time on all boilers in the plant. The plant master controller must load the boilers one at a time as the plant load increases. For a modular hybrid boiler configuration (refer to paragraph MODULAR CONFIGURATION), the boiler plant master controller must utilize

outside air temperature reset to achieve: the lower supply/return water temperatures for condensing level efficiencies in the condensing boiler; and the supply and/or return water temperature switchover setpoints to avoid exposure of non-condensing boilers to condensing operation. The reset control must establish a minimum and maximum supply and/or return water temperature and an operating relationship between those extremes for varying supply[and][or] return water temperature setpoints based on outside air temperatures. A switchover water temperature setpoint must be established and govern operation of condensing and non-condensing boilers to avoid exposure of non-condensing boilers to condensing operation.

]2.7.5 Boiler Combustion Controls and Positioners

****

NOTE: A pilot is required for all oil fired boilers over 875 kW 3,000,000 Btuh. However, a pilot is recommended for all fired boilers.

Select between fixed rate (on-off), three position (high-low-off), and modulating controls. Combustion controls will be fixed-rate, on-off for gross inputs up to 200 kW 700,000 Btuh; high-low-off or fixed-rate on-off, depending on anticipated load profile, for gross input from 200 to 600 kW 700,000 to 2,000,000 Btuh; high-low-off or modulating, depending on anticipated load profile, for gross input from 600 to 1200 kW 2,000,000 to 4,000,000 Btuh; modulating for gross inputs above 1200 kW 4,000,000 Btuh. Modular boilers will be fixed-rate on-off for each module. Delete inappropriate paragraphs.

****

a. [Gas][Combination gas-oil fired] boiler units must be provided with[fixed rate (on-off)][three position (high-low-off)][modulating] combustion controls with gas pilot or spark ignition. Modulating controls must be provided with a means for manually controlling the firing rate.

b. Oil fired boiler units must be provided with[on-off][high-low-off][modulating] combustion controls with[direct electric spark ignition system][spark ignited[No. 2 oil][natural gas][liquified petroleum gas] pilot]. Modulating controls must be provided with a means for manually controlling the firing rate.

c. Modulating control function must be accomplished using positioning type controls. Air flow ratio and fuel control valve must be controlled by relative positions of operative levers on a jackshaft responding to a water temperature controller. Positioning type combustion control equipment must include draft controls with synchronized fuel feed and combustion air supply controls, while and must maintain the proper air/fuel ratio. The desired furnace draft must be maintained within 0.25 mm 0.01 inch of water column.

d. [Fixed rate on-off][High-low-off]controls for boilers with capacities up to 600 kW 2,000,000 Btuh must use a water temperature controller in a temperature well in direct contact with the water.

2.7.6 Combustion Safety Controls and Equipment

****

NOTE: All control and safety devices must conform to ASME CSD-1 for boilers with a fuel input rating of 400,000 btu/hr to 12,500,000 btu/hr or NFPA 85 for boilers with a fuel input rating greater than 12,500,000.

****

Combustion safety controls and equipment must be UL listed, microprocessor-based distributed process controller. The system must include mounting hardware, wiring and cables, and associated equipment. The controller must be mounted completely wired, programmed, debugged, and tested to perform all of its functions. The controller must process the signals for complete control and monitoring of the boiler. This must include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program must be documented and include cross references in description of coils and contacts. Microprocessor must be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers for each boiler must be mounted on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Control systems and safety devices for automatically fired boilers must conform to ASME CSD-1. Electrical combustion and safety controls must be rated at 120 volts, single phase, 60 Hz and must be connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. A 100 mm 4 inch diameter alarm bell must be provided and must be located where indicated or directed. The alarm bell must ring when the boiler is shut down by any safety control or interlock. Indicating lights must be provided on the control panel. A red light must indicate flame failure, and a green light must indicate that the main fuel valve is open. The following shutdown conditions must require a manual reset before the boiler can automatically recycle:

a. Flame failure.

b. Failure to establish pilot flame.

c. Failure to establish main flame.

d. [Low-water][Supplementary low-water]cutoff.

e. [High temperature cutoff][High pressure cutoff].

2.7.6.1 Low-water Cutoff

Low water cutoff must be float actuated switch or electrically actuated probe type low-water cutoff. Float chamber must be provided with a blow-down connection. Cutoff must cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water must require manual reset before operation can be resumed and must prevent recycling of the burner. The cutoff must be in strict accordance to ASME CSD-1.

2.7.6.1.1 Feedwater Regulator with Low-Water Cutoff

Regulator must be an approved design sized for the application. A regulator must be provided for each boiler. The feeder must be so

arranged that water will be fed to the boiler automatically when the water level in the boiler drops below a preset point and will actuate the alarm bell when the water level reaches the low danger point. The boiler feeder must be arranged so that the burner and forced-draft fan will stop whenever the water level drops below a preset danger point. The boiler feeder must be constructed so that the feedwater valve and seat are isolated from the float chamber to prevent overheating of the feed water and precipitation of scale on either the valve or seat. Each float mechanism, valve, and seat must be constructed of an approved, durable, corrosion-resistant steel alloy. Valve seats must be removable and renewable. The regulator must be equipped with a large, self-cleaning strainer. The drain valve on the regulator must be the gate or other straight-through type.

2.7.6.1.2 Pump Controller with Low-Water Cutoff

Controller must be a design approved by the boiler manufacturer. A pump controller must be provided for each boiler which is used for space heating or long distribution lines. Pump controller must control the operation of the burner, forced-draft fan, and pump. Pump controller and low-water cutoff must have a float-operated[mercury][non-mercury] switch arranged to start and stop the pump at preset boiler water levels. If the water level in the boiler reaches the low danger point, a second switch must shut down the burner and actuate the alarm bell.

2.7.6.1.3 Supplementary Low-Water Cutoff

Supplementary low-water cutoff of the[electrically operated probe type][float activated type] must be provided in addition to the low-water cutoff required above on each boiler. Supplementary low-water cutoff must be mounted directly in the boiler shell and must be set below the low-water cutoff required above.

2.7.6.1.4 Water Flow Interlock

Hot water boiler limit controls must be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls must be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls must not allow boiler startup unless hot water flow is proven.

2.8 FITTINGS AND ACCESSORIES

Boiler fittings and accessories must be installed with each boiler in accordance with ASME BPVC SEC IV, unless otherwise specified.

2.8.1 Soot Blowers

****
NOTE: Soot blowers will normally be required on large water tube units burning No. 5 or 6 fuel oil. Manufacturers of boilers should be consulted to determine if soot blowers are applicable for the design contemplated. Small units are usually manually cleaned.
****

Where indicated, each boiler must be provided with soot blowers using compressed air as the blowing medium. The soot blower system must be the

automatic sequencing and intermittent puff type. The soot blower units must be sequenced automatically using successive steps by their controller, each step involving no more than a 70 kPa 10 psi drop in air pressure at the receiver. After one unit is operated in successive steps through its cycle, the controller must shift the operation to the second soot blower unit, and so on, until all units on that boiler have been operated, after which the controller must be shut down automatically by the sequence controls. The soot blower heads must have elements of suitable material for the highest temperatures encountered in the boiler. The sequence timer must have provision for manual selection of the soot blower units to be used.

2.8.1.1 Air Compressor Unit

The air compressor unit must conform to ASME PTC 10 except as specified otherwise. Compressor speed must not exceed 900 rpm. Motor speed must not exceed 1750 rpm. The service air requirements must be as indicated with receivers sized as indicated. The units must be suitable for heavy-duty service (soot blowing). The compressors must be simplex type, single-stage, double-acting, with water-jacketed cylinder, fitted with intake and discharge valves of the lightweight feather, disc or plate type, and must be provided with necessary controls, water-cooled aftercooler, moisture separator, drive, receiver, relief valves, and cooling water controls as required. The compressor air intake must be provided with an air suction filter/silencer suitable for outdoor installation. The filter must have a collection efficiency of 99 percent of particles larger than 10 microns. The filter body and media must withstand a pressure of 850 kPa 125 psi. The aftercooler must be the shell-and-tube type designed for air flow through the tubes with steel shell internal baffle plates. The cooling capacity of the after cooler must be sized for the total capacity of the compressor. The moisture separator must be provided with an automatic water discharge trap and level gauge. Cooling water controls for regulating compressor cylinder water temperature and after-cooler water temperature must be thermostatic valve type and must be installed with a three-valve bypass in the water outlet lines ahead of open sight drain funnels. The compressor must be equipped with adjustable, pressure type unloader controls suitable for continuous compressor operation.

2.8.1.2 Air Receiver

The air receiver must be a vertical type constructed in accordance with ASME BPVC SEC VIII D1 for unfired pressure vessels for 1379 kPa 200 psi working pressure, and must be equipped with flanged inlet and outlet connections, valved drain connection, minimum 150 mm 6 inch dial pressure gauge, pop safety valves, and regulator connections.

2.8.2 Continuous Emissions Monitoring

****

NOTE: Emerging flue gas flow monitor technologies are available. The traditional differential pressure technique specified used familiar equipment that can be maintained by plant personnel. This type of measurement device has reliably satisfied regulatory requirements. The possible use of other technologies should include a thorough investigation of flue gas flow monitor regulatory requirements and inhouse maintenance capabilities.

****

a. Continuous Emissions Monitoring System (CEMS) equipment must be provided as a system by a single manufacturer. A CEMS, meeting the requirements of applicable federal, State of [_____] and local regulations, must be provided for each boiler in accordance with manufacturer's recommendations and under the direct supervision of the CEMS equipment manufacturer. Before acceptance of the installation, the Contracting Officer must be furnished a written test report which provides documentation that the CEMS equipment passed factory and field certification test required by federal, state, and local regulations. Submit written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. The certification must also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, the certification must indicate the reason for the exemption.

b. The reported data must include[sulfur dioxide (SO2)][oxides of nitrogen (NOX)][carbon dioxide (CO2)][and][particulate matter (PM)] and other information required by Federal, state, and local regulations. SO2 reporting must be based on[analyzer measurement][fuel flow and percent sulfur calculation]. Nitrous oxides, carbon dioxide and particulate matter reporting must be based on analyzers.

c. The CEMS equipment must include the central processing unit, printer, hard disk drive, and floppy disk drive. The floppy disk drive must function as a recorder. The manufacturer must provide the software to generate the required reports in a format acceptable to the Federal, state and local regulatory agencies. The operator interface to the CEMS equipment must be via CRT screen.

2.8.2.1 Gaseous Emission Monitors

Extractive or in situ gaseous monitors must be provided. A combination of extractive and in situ monitors is not acceptable. Gas monitors must include automatic calibration checks. An alarm horn and annunciator must be provided to alarm when any monitor parameter is out of range or a gaseous monitor malfunctions. The surfaces that are exposed to the corrosive gas of the boiler must be constructed of noncorrosive materials such as 316 SS, teflon or hastelloy.

a. In situ monitor must be mounted on the ductwork at the location[shown on the plans][recommended by the manufacturer]. The situ system must not be affected by the presence of particulate matter in the flue gas.

b. Extractive systems must be[wet][dry][diluted]. Analyzing equipment for the extractive system must be located in a walk-in cabinet. The equipment must be arranged to provide access for maintenance. Extractive system sampling between the probes and the analyzers must be heat traced to maintain the temperature recommended by the manufacturer when the ambient temperature is [_____] degrees C F. Probes must be mounted on the ductwork at the location[shown on the plans][recommended by the manufacturer].

2.8.2.2 Flue Gas Flow Monitor

Flue gas flow monitor must utilize the pitot tube principle to measure the flow. The probe must be an across-the-duct-average pitot tube and must be

designed and located to obtain representative measurement. Differential pressure transmitters must be used to sense the difference between the static and total pressure of the flowing gas steam. Calibrations must be stable. Lines must be arranged to prevent collection of condensate. A purge system must be provided as required to keep the pitot pressure taps clear.

2.8.2.3 Particulate Matter Monitor

Particulate matter (opacity) monitor based on the principle of transmissometry must be provided. The transmissometer must include automatic simulation of zero opacity and upscale check of calibration while the boiler is in service without dismounting the unit. The calibration check must include analyzer internal circuitry and electronic circuitry. An alarm horn and annunciator must be provided to annunciate excess opacity and any system malfunction. Units must be provided with fans to keep the sending and receiving lenses pressurized and blown clean at all times.

2.8.2.4 Wiring

The CEMS equipment must be provided with plug-in prefabricated cable for interconnection between components. Power supply to the equipment must be 2-wire, 120 volt nominal or less, 60 Hz, with one side grounded. Electrical devices must be connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[2.8.3 Tankless Water Heater

****
NOTE: If the system will not be used to heat domestic hot water delete this paragraph.
****

A seamless copper immersion type tankless water heater of the specified capacity must be installed in the boiler. The heater must be equipped with an approved water-tempering valve which must be set to supply hot water at approximately 60 degrees C 140 degrees F. Instead of the immersion type coil, an approved external shell and tube type or plate type heat exchanger may be installed as specified in Section 23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS.

][2.8.4 Conventional Breeching and Stacks

****
NOTE: Intakes, Breaching and Stacks shall be in strict accordance with Manufacturers direction. Delete this paragraph for condensing boilers.
****

2.8.4.1 Breeching

Each boiler must be connected to the stack or flue by breeching constructed of black steel sheets not less than 1.2 mm 0.0478 inch thick nor less than thickness of stack, whichever is larger. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The clear distance between any portion of the breeching surface and any combustible material must not be less than that specified in NFPA 211. Joints and seams must be securely

fastened and made airtight. Suitable hinged and gasketed cleanouts must be provided, which will permit cleaning the entire smoke connection without dismantling. Flexible-type expansion joints must be provided as required and must not require packing.

2.8.4.2 Stacks

****

NOTE: Frequently boiler outlets are designed to support no more than the weight of a 6 m 20 foot stack section, when installed directly above the boiler outlet. Ensure that the stack is properly supported.

****

[Individual stub stacks must extend above the roof to the heights indicated. Individual stub stacks must be [6][_____] m [20][_____] feet in height when assembled on the boiler and measured from the ground line. Stack section must be sheet steel having a thickness of not less than 2.47 mm 0.0972 inch.][Prefabricated double wall stacks system must extend above the roof to the height indicated. The stacks must be [6][_____] m [20][_____] feet in height when assembled on the boiler and measured from the ground line. The inner stack must be[304 stainless steel][316 stainless steel] having a thickness of not less than 0.89 mm 0.035 inch. The outer stack must be sheet steel having a thickness of not less than 0.635 mm 0.025 inch. A method of maintaining concentricity between the inner and outer stacks must be incorporated. The joints between the stack sections must be sealed to prevent flue gas leakage.] A 7.92 mm 0.3125 inch diameter hole must be provided in the stack not greater than 150 mm 6 inches from the furnace flue outlet for sampling of the exit gases. A method must be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each stack must be provided complete with rain hood. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

][2.8.5 Direct Vents

****

NOTE: Delete this paragraph if condensing boilers are not used. A conventional stack is not needed for condensing boilers due to the low exhaust air temperature. Precautions should be taken due to the acidic condition of the condensate. The location and size of the vents should be shown on the drawings. Consult NFPA 54, UL 1738, and available vendor data to design the vents. The vents can be mounted on the roof or exterior wall with proper separation. The vents should be extended above the typical snow level. Vents should be located in such a manner as to prevent vandalism and to prevent discharge of condensate across walkways.

****

Direct venting must be used for condensing type boilers. Both the air intake and exhaust vents must be sized and located as indicated on the drawings and as recommended by the boiler manufacturer.

2.8.5.1 Combustion Air Intake Vent

The combustion air intake piping must be constructed of Schedule 40 PVC in accordance with ASTM D1784. The vent must be suitable for the temperature at the boiler combustion air intake connection point. Each intake must be provided complete with bird screen.

2.8.5.2 Exhaust Vent

The exhaust vent piping must be constructed of Schedule 40 CPVC or stainless steel conforming to UL 1738 and the boiler manufacturer's recommendations. Plastic materials polyetherimide (PEI), polyethersulfone (PES) and Polyvinyl chloride (PVC) are forbidden to be used for vent piping of combustion gases. The exhaust vent must be suitable for the maximum anticipated boiler exhaust temperature and must withstand the corrosive effects of the condensate. A 8 mm 0.3125 inch diameter hole must be provided in the stack not greater than 152 mm 6 inches from the boiler flue outlet for sampling of the exit gases. A method must be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each exhaust stack must be provided complete with bird screen.

]2.9 TOOLS

Special tools must be furnished. Special tools must include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Small hand tools must be furnished within a suitable cabinet, mounted where directed.

2.9.1 Breeching Cleaner

A cleaner must be provided to clean the breeching. The cleaner must have a jointed handle of sufficient length to clean the breeching without dismantling.

2.9.2 Tube Cleaner

If a watertube boiler is being furnished, a water-driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation must be provided. Tube cleaner and rotary brush must be provided for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings must be provided to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

2.9.3 Tube Brush

If a firetube boiler is being furnished, a tube brush, with steel bristles and jointed handle of sufficient length to clean full length of firetubes, must be provided.

2.9.4 Wrenches

Wrenches must be provided as required for specialty fittings such as manholes, handholes, and cleanouts. One set of extra gaskets must be provided for all manholes and handholes, for pump barrels, and other similar items of equipment. Gaskets must be packaged and properly

identified.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Install equipment in accordance with manufacturer's installation instructions and NBBI NB-23 PART 1. Maintain manufacturer's recommended clearances around and over equipment, and as required by Part 1 of the NBIC and/or local Jurisdictional Code. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets. Feedwater treatment feeders must be mounted so that the top of the feeder is no higher than 1219 mm 48 inches above the finished floor.

3.2 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.2.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand [500][3,000] hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

3.2.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm 1 mil; and two coats of enamel applied to a minimum dry film thickness of

0.0255 mm 1 mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F must receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F must receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

3.3 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

3.4 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

****
NOTE: Consult boiler manufacturers for foundation requirements. Delete the requirement for packing the joint between the boiler and floor with nonasbestos rope, if not required. This packing is typically not required for smaller units.
****

Boiler and auxiliary equipment must be installed in accordance with manufacturer's written instructions. Proper provision must be made for expansion and contraction between boiler foundation and floor. This joint must be packed with suitable nonasbestos rope and filled with suitable compound that will not become soft at a temperature of 40 degrees C 100 degrees F. Boilers and firing equipment must be supported from the foundations by structural steel completely independent of all brickwork. Boiler supports must permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching must be as indicated with full provision for expansion and contraction between all interconnected components.

3.5 EQUIPMENT FOUNDATIONS

Locate equipment foundations as indicated, designed, and made of sufficient size and weight to preclude shifting of equipment under operating conditions or under abnormal conditions that could be imposed upon the equipment. Foundations must meet requirements of the equipment manufacturer. Concrete and grout must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.6 BOILER CLEANING

Before being placed in service, boiler must be boiled out for a period of 24 hours at a pressure not exceeding 83 kPa (gage) 12 psig. Solution to be used in the boiler for the boiling out process must consist of two pounds of trisodium phosphate per 379 liters 100 gallons of water. Upon completion of boiling out, flush out boiler with potable water, drain, and charge with chemically treated water. Protect boiler and appurtenances against internal corrosion until testing is completed and boiler is

accepted. Professional services are required for cleaning/treatment process.

3.7 FIELD QUALITY CONTROL

Perform and furnish everything required for inspections and tests as specified herein to demonstrate that boiler and auxiliary equipment, as installed, are in compliance with contract requirements. Start-up and operate the system. During this time, clean strainers until no further accumulation of foreign material occurs. Exercise care to minimize loss of water when strainers are cleaned. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence. Test instrumentation must be calibrated and have full scale readings from 1.5 to 2 times test values.

3.7.1 Operational Tests

Furnish the services of an engineer or technician approved by the boiler manufacturer of installation, startup, operational and safety testing. This person must remain on the job until each boiler has been successfully operated. Furnish and perform everything required for inspections and tests of the boiler and auxiliary equipment. Test instrumentation must be calibrated and have full-scale reading from 1.5 to 2 times test values. Demonstrate proper operability of combustion control, flame safeguard control and safety interlocks. Provide a detailed description of all boiler startup and operational tests in the Commissioning Plan.

3.7.1.1 Preliminary Operational Test

Operate the boilers continuously for a period of at least 8 hours to demonstrate proper operability of the combustion control, flame safeguard control, and safety interlocks.

3.7.1.2 Acceptance Operational Test and Inspection

****

NOTE: For Air Force projects, retain the first paragraph in accordance with the latest version of Air Force Manual AFMAN 32-1608. For Army projects, retain the second paragraph in accordance with the latest version of Army Manual AR 420-1. For Navy/Marine projects, retain the third paragraph in accordance with UFC 3-430-07.

****

[a. Per latest version of AFMAN 32-1068, the Base Civil Engineer (BCE) must inspect high pressure steam boilers (greater than 105 kPA 15 psig) and HTW generators (greater than 1105 kPa 160 psig and 175 degrees C 350 degrees F) and expansion tanks in active use with NBIC certified inspectors. For low pressure steam boilers (less than 105 kPa 15 psig), hot water boilers (less than 310 kPa 45 psig relief valve), or specially constructed pressure vessels of less than 10 kW 33,500 btu/h in active use, inspection and evaluation must be performed by properly qualified personnel as determined by the BCE or contracted boiler owner/operator.

][b. Per latest version of AR 420-1, for high pressure boilers (greater than 105 kPa 15 psig) and all high-temperature water (greater than 102

degrees C 250 degrees F), annual inspections must occur in accordance with NBIC.

][c. For all boilers over[117124.2 W 400,000 btu/hr] capacity, per UFC 3-430-07 a NAVFAC Certified Boiler Inspector must perform the boiler inspection of all newly installed boilers.

] Prior to requesting an acceptance test, conduct a satisfactory operational test for at least 8 hours, and provide a certified statement that the equipment is installed per all requirements of this guide.

3.8 HEATING SYSTEM TESTS

****

NOTE: Whenever possible, the testing of heating systems will be done under adverse winter conditions and low outside temperatures. The test data included will be modified as required to suit the particular heating system.

Select a 4-hour hydrostatic test for radiant floor heating systems in accordance with HYI 400. All other systems should be tested for 2 hours.

****

Submit the Qualifications of the firms in charge of installation and testing as specified. Submit a statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section. Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units must be hydrostatically tested and proved tight at a pressure of 1.5 times the design working pressure, but not less than 689 kPa 100 psi. Submit proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

a. Vent hot water system prior to pressure testing.

b. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure must be blanked off or replaced with spool pieces.

c. Before balancing and final operating test, test blanks and spool pieces must be removed; and protected instruments and equipment must be reconnected. With equipment items protected, the system must be pressurized to test pressure. Pressure must be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks must be repaired and repaired joints must be retested.

d. Repair joints must not be allowed under the floor for floor radiant heating systems. If a leak occurs in tubing located under the floor in radiant heating systems, the entire zone that is leaking must be replaced. If any repair is made above the floor for floor radiant heating systems, access must be provided for the installed joint. Caulking of joints must not be permitted.

e. System must be drained and after instruments and equipment are reconnected, the system must be refilled with service medium and maximum operating pressure applied. The pressure must be held while inspecting these joints and connections for leaks. The leaks must be repaired and the repaired joints retested.

Upon completion of hydrostatic tests and before acceptance of the installation, submit test reports for the heating system tests. Upon completion of testing complete with results, balance the heating system in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS and operating tests required to demonstrate satisfactory functional and operational efficiency. The operating test must cover a period of at least 24 hours for each system, and must include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

a. Certification of balancing.

b. Time, date, and duration of test.

c. Outside and inside dry bulb temperatures.

d. Temperature of hot water supply leaving boiler.

e. Temperature of[heating return water from system at][condensate feed to] boiler inlet.

f. Quantity of water feed to boiler.

g. Boiler make, type, serial number, design pressure, and rated capacity.

h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.

i. [Circulating][Condensate][Vacuum]pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.

j. Flue-gas temperature at boiler outlet.

k. Percent carbon dioxide in flue-gas.

l. Grade or type and calorific value of fuel.

m. Draft at boiler flue-gas exit.

n. Draft or pressure in furnace.

o. Quantity of water circulated.

p. Quantity of fuel consumed.

q. Stack emission pollutants concentration.

Indicating instruments must be read at half-hour intervals unless otherwise directed. Furnish all instruments, equipment, and personnel required for the tests and balancing. Obtain necessary natural gas, water and electricity as specified in the[SPECIAL CONTRACT REQUIREMENTS][

Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS]. Provide necessary quantities of propane gas or No. [_____] fuel oil when propane gas or fuel oil is require for testing. Operating tests must demonstrate that fuel burners and combustion and safety controls meet the requirements of[ASME CSD-1][ANSI Z21.13/CSA 4.9].

3.8.1 Boiler/Piping Test

At the conclusion of the 1 year period, the boiler and condensate piping must be inspected for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company must provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

Engage an independent testing agency to perform tests. Contractor, water treatment contractor and Government must be given advance notice of testing, and must all be present to witness boiler/piping tests.

3.9 CLEANING

3.9.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the boilers and piping must be thoroughly cleaned by filling the system with a solution consisting of either 0.5 kg 1 pound of caustic soda or 0.5 kg 1 pound of trisodium phosphate per 190 L 50 gallons of water. The proper safety precautions must be observed in the handling and use of these chemicals. The water must be heated to approximately 65 degrees C 150 degrees F and the solution circulated in the system for a period of 48 hours. The system must then be drained and thoroughly flushed out with fresh water. Strainers and valves must be thoroughly cleaned. Prior to operating tests, air must be removed from all water systems by operating the air vents.

3.10 FIELD TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total of [_____] hours of normal working time and must start after the system is functionally completed but prior to final acceptance tests.

a. The field instructions must cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations and boiler safety devices.

b. Submit system layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items must be posted where directed.

c. Submit [6][_____] complete operation and maintenance instructions listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals must include the manufacturer's name,

model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization must be capable of providing [4][_____] hour onsite response to a service call on an emergency basis.

d. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.11 FUEL SYSTEM TESTS

Submit test reports for the fuel system tests, upon completion of testing complete with results.

3.11.1 Fuel Oil System Test

The fuel oil system must be tested in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.11.2 Gas System Test

The gas fuel system must be tested in accordance with the test procedures outlined in NFPA 54.

-- End of Section --