Preparing Activity: USACE Superseding
UFGS-33 60 00.00 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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02/16

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CENTRAL HIGH TEMPERATURE WATER (HTW) GENERATING PLANT AND AUXILIARIES
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NOTE: This guide specification covers the requirements for high temperature water plants of capacities over 2,930 kW 10,000,000 Btuh, producing water at temperatures of 115 to 227 degrees C 240 to 440 degrees F at pressures up to 2.8 MPa 400 psig.

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

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

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

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 BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 203	(2002) A Guide to Clean and Efficient Operation of Coal-Stoker-Fired Boilers

AMERICAN GAS ASSOCIATION (AGA)

AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems
ANSI Z83.19/CSA 2.35	(2017; R 2022) Gas-Fired High-Intensity Infrared Heaters

AMERICAN PETROLEUM INSTITUTE (API)

API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2017) Manual for Railway Engineering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2022) Power Piping
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VII	(2017) BPVC Section VII-Recommended Guidelines for the Care of Power Boilers
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

ASME PTC 4	(2013) Fired Steam Generators
ASME PTC 10	(1997; R 2014) Performance Test Code on Compressors and Exhausters

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A242/A242M	(2013; R 2018) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A514/A514M	(2022) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube

ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C34	(2017) Standard Specification for Structural Clay Loadbearing Wall Tile
ASTM C62	(2017) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

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

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION (CEMA)

CEMA B105.1	(2015) Welded Steel Conveyor Pulleys
CEMA Belt Book	(2014; Errata 2016; Tech Statement 1 2016) Belt Conveyors for Bulk Materials

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NACE INTERNATIONAL (NACE)

NACE SP0185	(2007) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-1	(2011) Conveyor and Elevator Belt Handbook; 3rd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 16	(2006; R 2015; E 2015) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

TUBULAR EXCHANGER MANUFACTURERS ASSOCIATION (TEMA)

TEMA Stds	(2007) Standards of the Tubular Exchange Manufacturers Association (TEMA)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023) Structural Engineering

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

30 CFR 1	Mine Safety and Health Administration; Establishment and Use of Official Emblem

UNDERWRITERS LABORATORIES (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Oct 2013) Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

1.2 SUBMITTALS

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

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

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

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

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

SD-02 Shop Drawings

High Temperature Water Generators

SD-03 Product Data

Calculations

Spare Parts

Support of the Equipment

Manufacturer's Instructions

Tests

Welding Qualifications

Field Training

SD-06 Test Reports

Tests

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G[, [_____]]

1.3 QUALITY ASSURANCE

1.3.1 Welding Qualifications

****
NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods. If the need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.
****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Submit a copy of qualified welding procedures and a list of names and identification symbols of qualified welders and welding operators. Qualifiy procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practicable. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.3.2 Calculations

Submit manufacturer's design data and structural computations,

calculations for walls, roof, foundations, and other features for specialty type of construction, along with design data for lateral forces that may be encountered due to wind loads and seismic forces.

1.4 DELIVERY, STORAGE, AND HANDLING

Store all equipment delivered and placed in storage with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of the drawings and not later than [_____] months before the date of beneficial occupancy. Include a complete list of spare 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] year[s] of service

PART 2 PRODUCTS

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 5 years prior to bid opening.

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.

2.1.2 Nameplates

Secure to each major item of equipment a plate with the manufacturer's name, address, type or style, model or serial number, thermal output or flow rate, and catalog number.

2.1.3 Prevention of Rust

Unless otherwise specified, factory prime paint surfaces of ferrous metal subject to corrosion with a rust inhibiting coating and subsequently factory finish paint in accordance with the manufacturer's standard practice. Prime and paint equipment exposed to high temperature when in service with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil.

2.1.4 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact. Provide guard or specified insulation cover for high temperature equipment and piping exposed to contact by personnel or where it creates a fire hazard. Provide items such as catwalks, operating platforms,

ladders, and guardrails where shown, and constructed in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.1.5 Use of Asbestos Products

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NOTE: The first clause in brackets should be used when it is known that substitutes are available for any asbestos products which might be included with the equipment. The second clause in brackets should be used when it is possible or definitely known that asbestos products for which no technically acceptable substitute exists may be included with the equipment.

****

[Products which contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.] [Except as provided below, products which contain asbestos are prohibited. This prohibition includes items such as packings and gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material. Asbestos products are acceptable only in exceptional cases where the Contractor states in writing that no suitable substitute material exists, and, in addition, the Contractor furnishes to the Contracting Officer a copy of U.S. Department of Labor, Occupational Safety and Health Administration "Material Safety Sheet" (Form OSHA-20), completed by the asbestos manufacturer, stating that the product is not an asbestos health hazard.]

2.2 HIGH TEMPERATURE WATER GENERATORS

Submit detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of the HTW generating units and associated equipment, and for piping, wiring, devices, trenches, and related foundations. Complete setting plans certified by the HTW generator and burner manufacturers. Detail drawings for HTW generators and appurtenances, including coal and ash handling equipment indicating clearances required for maintenance and operation containing complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Include manufacturer's written instructions indicating optimum pressure at all manometer connectors. Provide, for each HTW generator (boiler), with a label indicating the capacity when operating at [_____] degrees C degrees F entering water temperature and [_____] degrees C degrees F outlet temperature with a water flow of [_____] kg/second pounds/hour. Design the HTW generators for a maximum allowable working pressure of [_____] kPa psig at [_____] degrees C degrees F. Provide in the design, equipment layout and accessory locations permitting accessibility for maintenance and service with the following design conditions:

a. Site elevation, [_____] m feet.

b. Ambient air temperatures, [_____] degrees C degrees F to [_____] degrees C degrees F.

c. Reference air temperature, 27 degrees C 80 degrees F.

Provide HTW generators capable of operating continuously at maximum specified capacity without damage or deterioration to the generator, its setting, or firing equipment or auxiliaries with automatic operation while burning the fuel specified. Provide HTW generators to operate on [coal meeting the requirement of paragraph FUEL BURNING EQUIPMENT][fuel oil conforming to grade number of ASTM D396][a combination of coal and fuel oil conforming to ASTM D396][natural gas].

2.2.1 Capacity

Provide HTW generators which operate at rated capacity continuously without exceeding the furnace heat release, volumetric and radiant, furnace exit temperature, and gas exit temperature specified. Include generator fans, motors, drives, and similar equipment 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.

2.2.2 Electrical Equipment

Provide electric motor-driven equipment complete with motors and necessary motor control devices, specifying motors and motor control devices in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM including requirements for hazardous area locations with electrical characteristics and enclosure type indicated. Provide integral size premium efficiency type motors in accordance with NEMA MG 1.

2.2.2.1 Motor Ratings

Provide motors suitable for the voltage and frequency required. Provide three phase for 373 W 1/2 horsepower motor and larger unless otherwise indicated with ratings adequate for the duty imposed, but not less than indicated.

2.2.2.2 Motor Starters

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

Provide motor starters where a motor starters are not indicated, in a motor control center on the electrical drawings, under this section of the specifications with complete with properly sized thermal overload protection and other equipment at the specified capacity including an allowable service factor, and other appurtenances necessary. Provide, whether indicated or not, manual or automatic control and protective or signal devices required for the operation specified, and any wiring required to such devices. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function.

2.2.3 Heating Plant Requirements

Provide plant fired [package type][field-erected type], [coal-][fuel oil-][combination coal/fuel oil-], controlled circulation, HTW generators; expansion vessels; nitrogen pressurization system; makeup water equipment; fuel systems; pumps; and all controls, piping, insulation, miscellaneous

plant equipment and other accessories indicated or necessary to provide a complete and operable system.

2.2.4 HTW Generator Design Requirements

2.2.4.1 Radiant Heat Input

Limit the radiant heat input for the effective radiant heating surface of controlled circulation watertube HTW generators to a maximum of 394 kW/square meter 125,000 Btuh/square foot.

2.2.4.2 Maximum Heat Input

Limit the maximum heat input per cubic meter cubic foot of furnace volume to 931 MJ/cubic meter 25,000 Btu/cubic foot with spreader stokers and watertube boilers and 1,677 MJ/cubic meter 45,000 Btuh/cubic foot with underfeed stokers.

2.2.4.3 Combustion Gas Temperature

Provide the combustion gas temperature at the furnace exit with [minimum of 56 degrees C 100 degrees F less than the ash fusion softening temperature (reducing atmosphere) of the coal specified] [or] [maximum of 1150 degrees C 2100 degrees F when furnace is oil-fired].

2.2.4.4 Design Requirements

Provide manufacturer certification for the HTW generator controlled, forced-circulation, watertube, once-through type designed and constructed for high temperature water service conforming to, unless modified, the applicable construction and performance requirements of ASME BPVC SEC I and ASME BPVC SEC VII with the following additional requirements:

a. Water pressure drop not exceeding 105 kPa 15 psi based on a water temperature differential of 83 degrees C 150 degrees F, generator inlet to outlet.

b. The generator with no steam space or other spaces where steam can be trapped, with vented headers at high points as required.

c. Provide design for horizontal flow or upflow of water tubes and headers located in any radiant heat transfer zone.

d. Tubes and headers located outside the primary radiant heat transfer zones may be designed for downflow of water.

e. Provide generator designed for equalization of water flow through the tube circuits with radiant and convective heating surfaces arranged for series water flow to insure uniform flow distribution and temperature rise with proportioned flow to the heat input to prevent formation of steam in any tubes or headers to the extent that flow distribution becomes unbalanced. Distribution of flow may be controlled by limiting the number of flow paths in parallel, or by using restrictors (orifices), when required, in each group of parallel flow paths to increase pressure drop and to insure that all groups have the same pressure drop.

2.2.4.5 Spreader Stoker Units

Provide a maximum loading of 2206 kW/square meter 700,000 Btuh/square foot of grate area for spreader stoker units with continuous or intermittent automatic mechanical ash discharge grates, with a maximum loading of 1,419 kW/square meter 450,000 Btuh/square foot of grate area for the traveling grate type.

2.2.4.6 Underfeed Dumping Grate Units

Provide for underfeed dumping grate units, excluding side dumping areas, a maximum loading per square meter square foot of grate of 1,419 kW 450,000 Btuh, assuming a 10 percent maximum ash content and 1200 degrees C 2200 degrees F minimum ash softening temperature.

2.2.4.7 Effective Radiant Heating Surface

Effective radiant heating surface side receiving heat, excluding refractory lined surfaces, is defined as the heat exchange surface within the furnace boundaries which is directly exposed to radiant heat of the flame on one side and to the medium being heated on the other. This surface includes plain or finned tubes and headers and plain surfaces which may be bare, metal covered, or metallic core covered. Base computations of effective radiant heating surfaces on the following:

2.2.4.7.1 Bare, Metal Covered, or Metallic Core Covered Tubes and Headers

The projected area, external diameter times length, of the tube or header.

2.2.4.7.2 Extended Surfaces, Metal and Metallic Surfaces Extending from the Tubes or Headers

80 percent of the flat projected area, except metal blocks not integral with tubes or headers; extended surfaces less than 6.4 mm 1/4 inch thick or more than 32 mm 1-1/4 inches long; that portion of the extended surface which is more than one tube or header radius from the tube or header from which it extends, are not included.

2.2.4.7.3 Furnace Exit Tubes

The projected area of those portions of the first two rows of exit tubes receiving radiant heat from the fire.

2.2.4.8 Furnace Volume

Furnace volume is defined as the cubical volume between the top of the grate and the first plane of entry into, or between, the tubes. If screen tubes are utilized, they constitute the plane of entry.

2.2.4.9 Burners

Conform burners to requirements of NFPA 85, UL 296, and UL 726, except as otherwise specified. Equip flame safeguard controls with repetitive self-checking circuits.

2.2.4.10 Generator

Provide HTW generator with continuous capacity within the specified range at the specified pressure with boiler feed water at approximately [_____]

degrees C degrees F, with flue gas outlet temperature [_____] degrees C degrees F, based on excess air of [_____] percent and carbon loss of [_____] percent, at all loads above 50 percent of maximum continuous capacity. Base output capacity on tests of the HTW generator [and burner] as a unit.

2.2.4.11 Nameplates

Provide each HTW generator with nameplates stamped with:

a. Maximum continuous capacity in Watts Btuh.

b. Radiant heating surface in square meters square feet.

c. Total heating surface in square meters square feet.

d. Design pressure in Pa psig.

2.3 HIGH TEMPERATURE WATER GENERATOR DETAILS

Mercury is prohibited for use in thermometers.

2.3.1 HTW Generators and Components

Provide HTW generators [site assembled] [shop assembled] type and arranged to suit firing equipment as specified, designed for continuous operation at the capacity indicated and designed to burn [fuel oil specified] [and] [coal of size and analysis specified]. For watertube, waterwall type HTW generating units provide complete with [oil burners] [and] [stokers for coal firing], forced and induced draft fans, control and instrument panel with limit and automatic controls, soot blowers, [over fire air system,] feedwater regulator, low water flow cutoff and alarm, feed piping, and all other fittings, auxiliaries, and appurtenances necessary for safe and efficient operation, with matched firing equipment and boiler adjusted in accordance with the boiler manufacturer's requirements. [Provide factory-fabricated HTW generator assembled on a steel foundation or foundations, or shipped in not more than three complete subunits to minimize field erection.] Provide combustion controls.

2.3.1.1 Headers

Provide header-and-tube boiler construction with header diameter limited to accommodate the water flow and required distribution with a reasonable pressure drop. The use of drums or excessive header sizes is not acceptable. Provide seamless steel ASTM A106/A106M, Grade B headers which are not in primary radiant furnace section with uninsulated bottom portion of header at tube connection. Attach tube to headers by strength welding or by rolling, seal welding, and rerolling in accordance with ASME BPVC SEC I. Rolling of tubes into headers only is not acceptable.

2.3.1.2 Tubes

Provide electric welded or seamless steel tubes with boilers having water-cooled furnace walls of a design suitable for the application. Design tubes located in the primary furnace for horizontal or upflow of water. Distribute the water to the heating surface in proportion to the heat absorbing capacities of these surfaces. Locate tube heat absorbing surfaces so that radiant and convection sections provide for series flow of water, from generator inlet to outlet, to ensure uniform water

distribution and uniform temperature rise from inlet to outlet. Provide flow orifices where required with each orifice protected from clogging by individual strainers or by the master strainer located in the HTW generator return line. Provide individual access opening for individual strainers with machined surfaced shoulder type a. Provide individual access openings with stainless steel filled gaskets with all header gasket surfaces machined to provide proper seating of gasket.

2.3.1.3 Baffles

Arrange either water-cooled or a refractory material or metal suitable for temperatures encountered baffles to bring the products of combustion into contact with the heating surfaces. If used, provide steel plate or refractory baffles with water cooling on the radiant heat (furnace) side and the generator's convection section having counterflow, water-to-gas, to provide an integral economizer arrangement for optimum heat absorption, gas-to-water, with draft loss held to a minimum.

2.3.1.4 Furnace

Provide water-cooled furnace with the combustion space provided with water cooling on sidewalls, rear wall, roof, and front, except the portion of the front wall section required for [stoker installation] [and] [burner installation]. For stoker-fired generators, provide water-cooled furnace side walls and rear wall with vertical tubes with center-to-center spacing not to exceed twice the tube diameter, and furnished with cast-iron, water-cooled armor block at the grate line to a height of not less than 380 mm 15 inches above the grate line. Provide readily replaceable (without the use of special tools required) keyed armor block held in place without the use of bolts, pins, or mastic.

2.3.1.5 Supports

Support HTW generators and firing equipment from the foundations with structural steel independent of all brickwork, with HTW generator supports permitting free expansion and contraction of each portion of the HTW generator without placing undue stress on any part of the HTW generator or setting.

2.3.1.6 Access Doors

Provide access doors in sufficient number, of adequate size, and properly located for cleaning, inspection, and repair of all areas in the complete assembly with gas-tight doors, and with interior surfaces exposed to direct radiation and high temperature provided with approved lining refractory material to prevent excessive heat losses and warping of doors. Provide hinged doors for those too large or bulky for hand removal. Provide at least one observation port with cast-iron cover on the front and rear wall of the furnace.

2.3.1.7 Miscellaneous

Provide pipe connections for water inlet and drain outlet, with drain valves, relief valves, blowoff, air supply to soot blowers, gauge and vent, chemical feed, and instruments. Provide HTW generators with necessary jets for furnace turbulence, the number and arrangement as recommended by the HTW generator manufacturer. Provide soot blowers, if required by the manufacturer, and a suitable smoke outlet with steel frame, damper, and damper shaft, with damper having a high temperature

roller or ball bearings at both ends of the shaft and with suitable operating arm and rod.

2.3.2 HTW Generator Setting Materials

Provide materials conforming to the following:

a. Firebrick: ASTM C27, class as recommended by the HTW generator manufacturer.

b. Insulating Brick: ASTM C155, Class A.

c. Castable Refractory: ASTM C401. The minimum modulus of rupture for transverse strength must not be less than 4137 kPa 600 psi after being heat-soaked for 5 hours or more at a temperature in excess of 1370 degrees C 2500 degrees F.

d. Mortar, Air-Setting, Refractory: As recommended by the HTW generator manufacturer.

e. Brick, Common: ASTM C62.

f. Tile, Load-Bearing, Hollow: ASTM C34, Grade LBX.

g. Iron and Steel Sheets: Galvanized, ASTM A653/A653M; gauge numbers specified refer to United States Standard gauge. Uncoated, black: ASTM A568/A568M, or ASTM A36/A36M.

2.3.2.1 HTW Generator Casing

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NOTE: On water tube type HTW generators that will be used intermittently, welded wall construction is recommended to minimize corrosion. In other applications, or with fuels containing not more than 0.5 percent sulfur, a casing type enclosure is suitable.

****

[Provide HTW generator with steel-encased wall construction with fabrication details as recommended by the HTW generator manufacturer, and with wall and roof lining consisting of a continuous screen of closely spaced water tubes. Provide double wall construction for HTW generators with reinforced, welded, gas-tight inner casing constructed of not lighter than 3.416 mm 10 gauge black steel sheets, and outer casing constructed of not less than 1.897 mm 14 gauge steel sheets. Outer casing may be either bolted or welded. Reinforce inner casing with structural steel to provide rigidity and prevent buckling. Abut inner casing in furnace section with furnace tubes containing no foreign sealer between the tube steel and the casing steel, and with casing not attached to tubes. Support each horizontal tube independently of casing at intervals not exceeding 1.8 m 6 feet with inner casing applied so as to form expansion joints at the point of tube support. Where refractory is installed at access doors, provide the double casing constructed to form a gas-tight seal with combustion gases unable to enter between inner and outer casing. Check all welded joints and openings by a pressure test. Repair any casing leakage and make pressure-tight. Provide reinforced panels that do not exceed the maximum deflection of 1/360 of the length of the maximum span. Apply block insulation between the inner and outer casings and hold securely

with insulating pins. Provide the casing, when tested, capable of holding a pressure of 1.5 times the predicted maximum furnace operating pressure.] [Provide HTW generator walls of welded-wall construction with fin width limited to 19 mm 3/4 inch to prevent overheating of the fins under all operating conditions. Designs exceeding 19 mm 3/4 inch may only be used when provided with supporting calculations and are subject to Contracting Officer review for approval. Provide seamless type tubes with continuous fin-to-tube weld and on both the front (fireside) and back side of the fin. Provide a minimum of 6.4 mm 1/4 inch thick fins. Pressure test all welded joints and openings repairing any casing leakage making it pressure tight. Limit the maximum deflection of the reinforced panels to 1/360 of the length of the maximum span with the unit capable of holding a pressure of 1.5 times the predicted maximum furnace operating pressure.]

2.3.2.2 Walls

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NOTE: For personnel safety, the design temperature of the casing surface should not exceed 65 degrees C 150 degrees F. Should the designer wish to use a design surface temperature between 55 and 65 degrees C 130 and 150 degrees F, an economic evaluation must be performed. The evaluation must determine if the additional capital costs for insulation outweigh the cost savings due to reduced boiler radiation losses.

****

[Provide high-duty refractory behind the waterwall tubes of not less than 65 mm 2-1/2 inches thick conforming to manufacturer's requirements.] Provide high temperature block and mineral wool blanket between the refractory backup and steel casing or between an inner and outer casing with thickness of insulation such that an average casing temperature in the furnace area does not exceed [55] [_____] degrees C [130] [_____] degrees F with a surface air velocity of 508 mm/second 100 fpm, and an ambient air temperature of 25 degrees C 80 degrees F when operating at full capacity.

2.3.2.3 HTW Generator Roof

****

NOTE: For personnel safety, the design temperature of the casing surface should not exceed 65 degrees C 150 degrees F. Should the designer wish to use a design surface temperature between 55 and 65 degrees C 130 and 150 degrees F, an economic evaluation must be performed. The evaluation must determine if the additional capital costs for insulation outweigh the cost savings due to reduced boiler radiation losses.

****

Provide refractory lining conforming to manufacturer's requirements consisting of not less than 65 mm 2-1/2 inches of high-duty refractory backup behind the roof tubes and sufficient thickness of high temperature block insulation or mineral-wool blanket suitable for the temperature encountered to limit casing temperature in the furnace area to [55] [_____] degrees C [130] [_____] degrees F, with a surface air velocity of 508 mm/second 100 fpm and an ambient air temperature of 25 degrees C 80 degrees F when operating at full capacity. Provide insulation neatly

against a metal ring for manholes and other inspection and access openings, and identification plates and stamps.

2.3.2.4 Bridge Walls

Provide for bridge walls exposed on all sides to radiant heat and the products of combustion constructed of super-duty refractory not less than 457 mm 18 inches thick, conforming to manufacturer's requirements. Provide for walls having only the front side exposed to radiant heat and the products of combustion, a front facing and cap constructed of 225 mm 9 inches of super-duty refractory and back facing of not less than 225 mm 9 inches of low-duty firebrick with the base of the wall constructed of common brick.

2.3.2.5 Settling Chamber

Provide settling chamber for the removal of fly ash below the last pass of each HTW generator with easy means for frequent cleaning without shutting down the HTW generators.

2.3.2.6 Expansion Joints

Provide expansion joints as required and where indicated to permit all brickwork to expand freely without interference with the boiler, with joints of adequate width, tightly sealed against leakage and free from mortar, with the outer 100 mm 4 inches sealed with resilient mineral wool suitable for 925 to 1095 degrees C 1700 to 2000 degrees F. Provide a series of 3 mm 1/8 inch wide vertical openings, spaced 1.8 m 6 feet apart, on the furnace side of the wall. Make provision for expansion and contraction between boiler foundation and floor as specified.

2.3.2.7 Firebrick

Lay up firebrick in air-setting mortar with each brick dipped in mortar, rubbed, shoved into its final place, and then tapped with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel is not permitted. Provide a maximum mortar joint thickness not exceeding 3 mm 1/8 inch and an average joint thickness not exceeding 1.6 mm 1/16 inch.

2.3.2.8 Plastic Refractory

Install plastic refractory in accordance with the manufacturer's recommendation and by workmen skilled in its application.

2.3.3 Boiler Fittings and Appurtenances

Provide HTW generator fittings and appurtenances suitable for a HTW working pressure of [_____] Pa psig and [_____] degrees C degrees F for each HTW generator in accordance with ASME BPVC SEC I.

2.3.3.1 Thermometer

Provide thermometer for HTW generator inlet water and outlet water for each HTW generator in a visible location on the HTW generator.

2.3.3.2 Pressure Gauge

Provide pressure gauge for each HTW generator in a visible location on the

HTW generator.

2.3.3.3 Relief Safety Valves

Provide HTW generator relief safety valves such that the discharge is through piping extended to the plant blowoff tank with relief valves sized, and constructed, with set pressures as determined in accordance with ASME BPVC SEC I.

2.3.3.4 Drain Valves

Provide drain valves in tandem at each drain point of blowdown as recommended by the HTW generator manufacturer. Provide piping conforming to the requirements of ASME BPVC SEC I and extra strong weight black steel pipe conforming to ASTM A53/A53M. Provide drain valves conforming to ASME BPVC SEC I, the balanced seatless type unless otherwise approved.

2.3.4 Soot Blowers

When required, provide HTW generator with air powered, automatic sequencing and intermittent puff type soot blower system, with a soot blower control unit suitable for mounting on the generator control panels. Provide controllers that automatically rotate the soot blower units in successive steps, each step involving no more than a 69 kPa 10 psi drop in air pressure at the receiver. After one unit is operated in successive steps through its cycle, the controller shifts the operation to the second soot blower unit, and so on, until all units on that generator have been operated, after which the controller shuts down automatically by the sequence controls. Provide the soot blower heads with elements of suitable chrome alloy material for the temperatures encountered in the HTW generator, and with a sequence timer provisioned for manual selection of the soot blower units to be used.

2.4 FUEL BURNING EQUIPMENT

****

NOTE: The designer must include all the required data for proper design of the boiler. Delete all references to coal and stokers where oil is the only fuel to be utilized.

Delete paragraphs describing stoker equipment that are not required. Stokers and stoking equipment selected will be based on the following:

Boilers having output capacities of 3,517 kW 12,000,000 Btuh or more will be equipped with mechanically-driven grates operating continuously or intermittently. Dump grates will not be permitted in boilers in this size range. Spreader stokers will be specified when bituminous coal with ash content on a dry basis in excess of eight percent or ash fusion temperature lower than 1200 degrees C 2,200 degrees F is to be used. Pulsating grate units will be water-cooled and complete with automatic coal feed and continuous ash removal. Conveyor stokers may be specified if suitable for the type of coal available. Chain or traveling grate may be specified by deletion of one type of

grate, or the choice between the two types may be left to the Contractor by including both types in the description. The following is a general guide in determining which type of grates to investigate:

MW Output MBtuh Output	(Size) Type of Grate and Stoker
735 - 5860 2,500 - 20,000	Single retort, stationary grate, underfeed stokers
5860 - 8800 20,000 - 30,000	Single retort, moving grate, underfeed stoker
1465 - 22000 5,000 - 75,000	Reciprocating grate, front continuous ash discharge stoker
1465 - 29500 5,000 - 100,000	Vibrating conveyor grate, front continuous ash discharge stoker
5860 - 36500 20,000 - 125,000	Water-cooled, incline grate, hopper fed vibrating grate stoker
8800 - 120,000 30,000 - 400,000	Spreader stoker, continuous front ash discharge

****

Provide manufacturer certification for the HTW generator that the stoker selected is satisfactory for the HTW generator design. Provide stokers and HTW generator capable of efficiently burning coal with fuel sizing conforming to ABMA Boiler 203 for Stoker Firing of Bituminous Coals, approximately [_____] mm inches in size with an approximate moisture content of [_____] percent and having the following analyses:

Proximate Analysis	Percent, Dry
Moisture	[_____]
Volatile matter	[_____]
Fixed carbon	[_____]
Ash	[_____]

Ultimate	Analysis Percent, Dry
Carbon	[_____]
Hydrogen	[_____]
Nitrogen (Calc)	[_____]
Sulfur	[_____]

Ultimate	Analysis Percent, Dry
Chlorine	[_____]
Ash	[_____]
Oxygen (Diff)	[_____]
kJ/kgBtu/lb. as received	[_____]
kJ/kgBtu/lb. - dry	[_____]
Grindability	[_____]
Raw Fuel Size	[_____]

Ash Analysis	Percent
SiO(2)	[_____]
Al(2)O(3)	[_____]
TiO(2)	[_____]
Fe(2)O(3)	[_____]
CaO	[_____]
MgO	[_____]
Na(2)O	[_____]
K(2)O	[_____]
SO(3)	[_____]

Ash Fusion Temperatures	Degrees CDegrees F
Initial deformation temperature	[_____]
Softening temperature	[_____]
Fluid temperature	[_____]

2.4.1 Spreader Stokers

Provide overfeed self-feeding type spreader stokers suitable for burning a portion of the coal in suspension, but sized assuming 100 percent combustion on the grate. [Coal must be evenly distributed across the full width of the grate by not less than [_____] feeder units. Provide unit designed for operation of any feeder independently of the others, or possible to operate all feeders simultaneously.] Provide feeders capable of handling and uniformly distributing coal over the grate area. Provide mechanical-rotating type feeders with no moving parts within the combustion chamber, and where moving parts are exposed to excessive heat,

protect bearings with suitable water jackets. Provide grease or oil lubrication for all bearings. Provide stoker designed for readily adjustable feed distribution of coal on the grates.

2.4.1.1 Grates

Provide high air resistant type grates for stoker spreader firing, arranged for powered mechanical or compressed air actuated dumping in sections. Provide openings for proper distribution of air under the fuel bed. [Provide grates in sections to match the feeders with provisions for shutting off the forced draft to each section so that any section of the grate can be cleaned while the others remain in service.] Provide heavy-duty, heat-resisting cast-iron grates. Provide mechanical dumping with [air-] [water-] actuated power cylinders connected to the grates, and furnish grates complete with cylinders, linkages, valves, and piping as required, with each section dumping independently of other sections. Provide necessary over fire air jets complete with fans, ducts, and air control valves as required for proper turbulence and combustion. Provide grate drives that operate independent of feeder drives to provide independent speed variation of feeders and grates.

2.4.1.2 Traveling Grates

Provide high air resistant type traveling grates especially designed for spreader stoker firing and for continuous ash discharge. Provide openings for proper distribution of air under the fuel bed with generator grates being heavy-duty, heat-resisting cast-iron, and individual replaceable sections without taking the grate out of service. Hold leakage to a minimum with air seals around grate. Furnish moving grates complete with supporting steel, shafts, sprockets, chain, gears, skid bars, and bearings as required, with the front end of the grates where the ash is discharged enclosed with a dust-tight enclosure made of heavy cast-iron plates not less than 16 mm 5/8 inch thick and properly protected with firebrick where exposed to the furnace or of refractory lined steel plate. Fit the vertical fronts of the enclosure with refractory lined inspection and access doors, one for each feeder. Seal the roof of the enclosure with refractory to protect the metal parts from the furnace temperature. Enclose the underside of the grates to form a chamber. Provide hopper for receiving the ashes constructed as indicated or as recommended by the manufacturer. Provide over-fire air jets as required for proper turbulence and combustion.

2.4.1.3 Vibrating Grate

Provide high air resistant type vibrating grate especially designed for spreader stoker firing and for continuous ash discharge, with either air- or water-cooled with openings to provide proper distribution of air under the fuel bed. Provide heavy-duty, heat-resisting cast-iron grates with individual replaceable sections. Provide a manual adjustment to regulate the ash bed thickness, with ashes automatically discharged to the ash pit. Enclose the front of the grates where the ash is discharged with a dust-tight enclosure of heavy cast-iron plates not less than 16 mm 5/8 inch thick and properly protected with firebrick where exposed to the furnace, or of refractory-lined steel plate. Fit the vertical fronts of this enclosure with refractory-lined inspection and access doors, one to each feeder. Seal the roof of this enclosure with refractory for protecting the metal parts from the furnace temperature. Enclose the underside of the grates to form a chamber with a hopper for receiving the ashes with over-fire air jets provided for turbulence and combustion.

2.4.1.4 Controls

Provide stoker controls that accurately regulate the coal feed rate, of the type required for connection to the combustion control system with a manual setting of the coal feed rate with variation of stoker feed as required to maintain any desired capacity between 50 and 110 percent of boiler capacity without disconnecting linkage. Provide separate feeder and grate drives, with grate driven through a variable speed transmission with devices for changing speed interlocked with fuel feed regulation. Provide manual adjustment of grate speed for allowing synchronization with fuel feed. Provide all gears and chains of the variable speed transmission and gear reduction units, as required, run in a bath of oil and enclosed in a dust-tight and oil-tight case.

Provide a forced lubrication system with fittings located outside the setting. Provide antifriction bearings with hardened inner and outer races fitted with dust seals and easily accessible forced lubrication fittings for front and rear shafts of the grates with safety release devices to protect the mechanism from foreign materials or obstructions. Provide electric motor driven stoker with electric motor [totally enclosed, fan-cooled] [totally enclosed fan-cooled for installation in Class II, Division 1, Group F hazardous location in accordance with NFPA 70], and motor starter magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [dust-tight] [explosion-proof] enclosure.

2.4.1.5 Hoppers

Construct hoppers of steel plates not less than 6.4 mm 1/4 inch thick and capacity of not less than [_____] kg pounds per feeder, provided with cleanout doors in the front of each feeder. Fit coal feed to the hoppers with concave type transitions to ensure the proper distribution of coal and coal fines across the width of the hoppers. Provide stoker front plate forming the front of the boiler for the full width of the boiler and from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide a front of cast-iron or steel plate refractory lined with [auxiliary firing doors and] cleanout doors of refractory lined cast-iron. Structurally frame as required to support the stoker and its components from the boiler foundation or boiler room floor. Divide the area under the grates into not less than four air-tight zones for supply of forced draft having zone control dampers with external indicating operating and locking devices with all pressure parts for water-cooled grates including watertubes, headers, and valves furnished by the stoker manufacturer for boiler pressure specified and constructed in accordance with ASME BPVC SEC I.

2.4.1.6 Air Systems

Provide spreader stokers with over-fire turbulence and cinder and dust reinjection systems. Use [air][or][steam] as the transport medium. Provide systems with operating air by a single, low volume high-pressure fan driven by a splash-proof electric motor. Provide reinjection system ejectors properly designed, located, and sized for maximum fly ash pickup from all points. Equip nozzles for each system with manometer connections and heavy-duty adjustable dampers fitted with locking devices and position indicators and with nozzles providing maximum combustion efficiency and furnace turbulence. Provide a manometer connection and a permanent manometer immediately downstream from the main reinjection air supply damper. Provide a portable manometer.

2.4.2 Underfeed Stokers

2.4.2.1 Ram-Type Stokers

For single retort, provide electric motor drive, with all necessary auxiliary equipment, heavy-duty ram-type stokers equipped with stationary or moving grates and side dump plates, with compressed air actuated dumping power cylinders, and stokers capable of handling the coal specified. Provide hopper feed into the retort by means of a that evenly distributes along the full length of the retort with auxiliary pusher blocks on a pusher rod located at the bottom of the retort actuated by the coal ram. Provide dampers between ash pits and main air chamber under stoker to permit control of air distribution to the grate surface arranged for operation from the front plate of the boiler. Provide a design where the air distribution is such that the air pressure is greatest where the fuel bed is the thickest with air quantity varying in direct proportion to the coal feed rate controlled automatically.

2.4.2.2 Grate Surface

Provide a grate surface with an underfeed retort area, air admitting tuyeres, side combustion grates, and the side dumping plates, with retorts being sectional construction of large capacity and proper shape to distribute coal uniformly over the entire grate surface with a minimum of moving parts within the furnace. Provide stokers having total grate width of more than 2.1 m 7 feet with movable grates providing positive lateral feeding of the coal from the retort toward the dump plates. Provide retort and grate sections constructed of heavy-duty, heat-resisting cast-iron, and cored for proper air distribution, being designed for easy replacement of individual sections. Provide ash dump plates with necessary levers and linkage for hand operation from the front of the boiler.

2.4.2.3 Ram Feed

Provide mechanical, pneumatic, or hydraulic driven by an electric motor connected through an efficient gear reduction unit, crank shaft, and connecting rod for ram feed. Provide [totally enclosed fan-cooled type] [totally enclosed fan-cooled type for installation in a Class II, Division 1, Group F hazardous location motors in accordance with NFPA 70]. [Provide motor starter with magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [dust-tight] [explosion-proof] enclosure.] Provide stoker controls for connection to the combustion control system to accurately regulate the coal feed rate with manual setting of the coal feed rate possible without disconnecting linkage, with variation of stoker feed as required to maintain any desired capacity between 25 and 110 percent of boiler capacity in 10 or more equal increments. Regulate the coal feed rate by varying the time increments between strokes of the ram. Provide a throw-out release protecting the coal feeding mechanism from injury in case foreign materials obstruct normal operation.

2.4.2.4 Hoppers

Provide hoppers constructed of steel plates not less than 6.4 mm 1/4 inch thick and capacity of not less than [_____] kg pounds, with cleanout doors. Provide stoker front plate to form the front of the boiler for the full width of the boiler and extend from the firing floor to some point

above the stoker where it connects to the boiler structural framing. Provide cast-iron or steel plate front, refractory lined with [auxiliary firing doors and] cleanout doors of refractory-lined cast-iron. Provide structural framing as required to support the stoker and its components from the boiler foundation or boiler room floor. Provide water spray pipes and nozzles for quenching the ashes in the ash pit.

2.4.3 Conveyor Stokers

Provide grate level feed, forced draft [chain grate] [traveling grate] type conveyor stokers complete with hoppers, feed gate, drive shaft, sprocket wheels, grate, drive, and all necessary auxiliary equipment. Provide stokers capable of handling the coal specified. Feed coal automatically at a constant rate from the hopper onto the moving grate and evenly distribute across the full width of the grate. Provide stoker frame with no less than four air-tight zones for supply of forced draft and have suitable zone control dampers with external indicating, operating, and locking devices.

2.4.3.1 Grates

Provide grates with individual sections constructed of heavy-duty, heat-resisting cast-iron, fitted or cored for proper air distribution, and designed for easy replacement of individual sections. [Provide chain grates with staggered links connected by pins to form a continuous flat chain the full width of the furnace.] [Provide traveling grates with grate blocks mounted on carrier bars which, in turn, are fastened to two or more drive chains to form a continuous flat grate surface the full width of the furnace.] Support continuous grates at the ends by suitable sprockets and at intermediate points on suitable tracks or skids.

2.4.3.2 Conveyor Grate

Drive conveyor grate by [electric motor connected through a suitable speed-reduction unit] [hydraulically-operated variable speed drive] with all gears and chains required for the drive enclosed in a dust-tight and oil-tight housing. Provide main shafts for the grates with a forced system of lubrication [with fittings located outside the casing] [having self-lubricating bearings]. [Provide a forced lubrication system with bearings fitted with dust seals and easily accessible forced lubrication fittings.] Provide stoker controls suitable for connection to the combustion control system to accurately regulate the coal feed rate with manual setting of the coal feed rate by varying stoker feed as required to maintain any desired capacity between 25 to 125 percent of boiler capacity possible without disconnecting linkage. Change feed rate by varying the speed of the grate. Automatically vary air volume in direct proportion with the feed rate with feed rate varying in not less than 10 equal increments. Provide [totally enclosed fan-cooled type] [totally enclosed fan-cooled type electric motor suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [dust-tight] [explosion-proof] enclosure.]

2.4.3.3 Hoppers

Construct hoppers of steel plates not less than 6.4 mm 1/4 inch thick, having a capacity of not less than [_____] kg pounds, and provided with suitable cleanout doors. Fit coal feed to the hoppers with concave type

transitions to insure the proper distribution of coal and coal fines across the width of the hoppers. Construct stoker frame of cast-iron, cast steel, or forgings, with all parts of the stoker, except the grates, properly cooled or otherwise protected from the furnace heat to prevent damage by warping or undue expansion. Provide stoker front plate to form the front of the boiler for the full width of the boiler and extend from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide cast-iron or steel plate, refractory-lined with cleanout doors of refractory-lined cast iron front with structural framing as required to support the stoker and its components from the boiler foundation or boiler room floor. Discharge ash at the end of the grate into a [bunker] [pit] as indicated. [Provide a bunker with a dust-tight enclosure made of steel plates not less than 6.4 mm 1/4 inch thick, properly protected with firebrick where exposed to the furnace, and fitted with cast-iron, refractory-lined inspection and access doors, and have provisions for ash removal.]

2.4.4 Vibrating Grate Stokers

Provide grate level feed, forced draft type vibrating grate stokers with the vibrating action of the grate used to feed the coal from the hopper through the furnace and to discharge the ashes into the ash pit. Provide stokers capable of handling the specified coal, complete with hopper, feed gate, grate, drive mechanism, and all necessary auxiliary equipment. Automatically feed coal from the hopper onto the grate and evenly distribute across the full width of the grate. Provide a manual adjustment to regulate the fuel bed thickness. Ashes must be automatically and continuously discharged to the ash pit. Divide the area under the grates into not less than four air-tight zones for forced draft supply with suitable zone control dampers with external indicating, operating, and locking devices.

2.4.4.1 Grates

Provide grates that are either air-cooled or water-cooled with grate bars in intimate contact with the water tubes and with individually replaceable sections of iron or steel suitable for the temperatures encountered. Provide all pressure parts including water tubes, headers, and valves suitable for boiler pressure specified and constructed in accordance with ASME BPVC SEC I, with grate sections properly designed for even air distribution over the entire grate area.

2.4.4.2 Controls

Provide stoker controls designed for connection to the combustion control system accurately regulating the coal feed rate and arranged for manual operation, independent of the combustion control system. Change the length of time of vibrations to vary the coal feed rate with a vibration generator belt-connected or gear-connected to the electric motor. Provide a unit free of any vibration that may damage other parts of the boiler or the building structure. Provide bearings requiring lubrication with easily accessible lubrication fittings. Automatically vary combustion air volume in direct proportion with the coal feed rate. Drive stoker by electric motor that are high starting torque [totally enclosed, nonventilated] [totally enclosed, fan-cooled] totally enclosed, fan-cooled suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70, with magnetic, reversing [across-the-line] [reduced voltage start] type motor starter and [general-purpose] [dust-tight] [explosion-proof] enclosure.

2.4.4.3 Hoppers

Construct hoppers of steel plates not less than 6.4 mm 1/4 inch thick, having a capacity not less than [_____] kg pounds, and provided with a suitable method of cleanout. Provide furnace arches of a design suitable for the intended use and a type that will insure proper combustion of the fuel. Inclue the lower furnace sidewall headers in a waterwall boiler to accommodate the inclined grate arrangement. Provide stoker front that forms the front of the boiler for the full width of the boiler and extends from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide cast-iron or steel plate refractory lined front with cleanout and access doors of refractory-lined cast-iron and structural framing as required supporting the stoker and its components from the boiler foundation or boiler room floor. Discharge the ash at the end of the grate the ash into a [bunker] [pit] as indicated. Provide dust tight enclosure for the bunker constructed of steel plates not less than 15.9 mm 5/8 inch thick, protected with firebrick where exposed to the furnace and fitted with cast-iron, refractory-lined inspection and access doors, and provisions for ash removal.

2.4.5 Burners

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NOTE: The designer must include all the required data for proper design of the boiler. Delete all references to coal and stokers where oil is the only fuel to be utilized.

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Provide each HTW generator with oil-fired burner or burners with burner assembly and control systems conforming to NFPA 85, UL 296, and UL 726, except as otherwise specified, and with supervised manual, semiautomatic, and fully automatic combustion safety controls conforming to NFPA 85 and ASME CSD-1.

2.4.6 Fuel Oil Pumping and Heating Sets

Provide a duplex integrated, shop-fabricated oil pumping and heating set, assuring 100 percent standby with the oil heated by medium temperature water. Provide two positive displacement oil meters, include with each set an electric oil heater of sufficient capacity to heat the specified fuel oil to ignition temperature at low generator load until enough HTW is generated to operate the high temperature water-to-low temperature water (LTW) heat exchanger and the LTW-to-oil heater. Control electric heater by a magnetic starter with a manually-operated ON-OFF switch in series with a thermostatic control. When oil temperature is raised to proper level and maintained by the LTW heater, automatically disconnect the electric heater by the thermostatic control. Provide electric-motor driven fuel pumps with each pump having the capacity of not less than [_____] L/second gpm at a discharge pressure of [_____] kPa psig and a suction lift of 3 m 10 feet.

2.5 COMBUSTION CONTROL EQUIPMENT

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NOTE: Paragraphs describing inapplicable types of combustion control equipment will be deleted. The type of combustion control system specified for a

project will depend largely on the boiler capacity, the fuel, initial cost, and cost of operation. Basically, the types should be as follows (the boiler capacities are expressed inMW Btuh):

Type of Control	Coal	Oil
Positioning	0.879-15 MW 3-50 million Btuh	0.870 - 12 MW3-40 million Btuh
Semimetering	7-21 MW 25-72 million Btuh	7-19 MW25-66 million Btuh
Metering	7 MW 25 million Btuh and above	7-19 MW 25 million Btuh and above
Metering with Oxygen Compensation	20 MW 68 million Btuh and above	20 MW 68 million Btuh and above

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Use a single manufacturer for the automatic combustion control equipment system to be installed for each boiler in accordance with the manufacturer's recommendations. Locate controllers on the designated heating plant master control center panel. Provide equipment capable of operating either pneumatically, electrically, or electronically. Pneumatic control systems must conform to CAGI B19.1. Install air filter regulator sets at each control valve and transmitter in the system with the master air filter regulator set on the control panel being the dual type where one side can be cleaned and repaired while the other is operating. Protect exterior control air piping and devices from freezing by use of regenerative desiccant dryers. Provide each system with a selector switch or other means of manual control of the firing rate when required. Provide electrical control devices rated at 115 volts and connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wire operating and limit controls to interrupt the ungrounded circuit conductor. Conform controls and instruments to the requirements of ASME CSD-1, NFPA 85, UL 296, and UL 726, except as otherwise specified. Provide individual control for each boiler. For multiple boiler installations, provide a means to base load on individual boilers while on automatic control.

2.5.1 Combustion Controls

Provide [positioning] [semi-metering] [metering] [metering with oxygen compensation] type combustion controls. Provide a plant master controller sensitive to temperature transmitter in return water header to provide anticipatory signals to all generator master controllers with generator master or submaster controllers reacting to anticipatory signals from plant master and then adjust firing rate as necessary in response to generator outlet temperature indication to maintain preset temperature at each generator outlet. Plus or minus 3 percent is the limit for precision of pressure or temperature control of the set point of the boiler pressure in kPa psig, or the temperature in degrees C degrees F during any load swings of up to 10 percent of the boiler capacity per minute over the entire turndown range.

2.5.2 Stoker Controls

Interlock the combustion control system with the grate drive to balance the ash discharge with the firing rate. The coal feed flow rate may be used as the index of fuel feed. Provide stoker controls to as outlined for the stoker specified.

2.5.3 Positioning Type Combustion Control Equipment

Provide separate parallel type positioning controllers for fuel feed and air flow, and both are modulated by the boiler load. Provide manual means for readily adjusting the fuel-to-air ratio for the most efficient combustion and an adjustable compensating device to maintain the proper ratio of fuel and air over the entire range of operation to provide combustion efficiency within the range specified. Provide a furnace draft controller, when required. Flush-mount all controllers on the control and instrument panel; all adjustments and calibrations of fuel feed, air flow and furnace draft, on the front of the panel.

2.5.4 Semi-Metering Type Combustion Control Equipment

Provide two controllers per boiler, one for fuel feed and one for air flow, with the first of these positioned in proportion to the boiler load to deliver a proportionate impulse to the second controller which functions in direct relation to that impulse; the second controller then measuring the fuel feed or air flow provided and automatically making necessary adjustments to maintain the fuel-to-air ratio for which it is set over the entire range of operation. Provide furnace draft or pressure controllers where required. Flush-mount all controllers on the control and instrument panel; make all adjustments and calibrations of fuel feed, air flow, and furnace draft or pressure, at the front of the panel, and provide indicators to show the amount of adjustment and the results obtained.

2.5.5 Metering Type Combustion Control Equipment

Provide metering controls with adequate means for automatically adjusting both fuel feed and air flow in strict relation to the load requirements, in addition to measuring the rates of fuel feed and air flow and maintaining the required ratios over the full range of boiler operation. In addition to the master controller, provide separate controllers for fuel feed and air flow responding either in parallel or series. Include air flow-fuel flow cross limiting devices. [If required by a particular system, a separate fuel-to-air ratio controller may be provided.] Measure the actual rate of fuel flow in the fuel line to the burner, and measure the actual air flow by a differential orifice in the forced draft duct. Operation of either controller for both functions is not acceptable. In addition, provide a separate controller to control the draft or pressure in the boiler furnace. Flush-mount controllers on the control and instrument panel; make all adjustments and calibrations of fuel feed, air flow, fuel-to-air ratio, and furnace draft or pressure, at the front of the panel and provide indicators to show the degree of adjustment.

2.5.6 Combustion Control with Oxygen Trim

Flue gas oxygen trim may be provided as an adjunct to the metering system of control. Determine the oxygen content in combustion gases; from this, send an impulse to the oxygen controller, which readjusts the air flow to maintain the required oxygen content. Provide the oxygen set point as a

function of generator load with operator biasing capability limiting the amount of oxygen controller trim to prevent potentially hazardous conditions created by equipment failure or faulty operation.

2.5.7 HTW Generator Limit Controls

Provide low generator water flow and high generator temperature controls with the limit controls interlocked with the combustion control system to provide for generator alarm and shutdown.

2.5.8 Burner Control/Fuel Safety System

2.5.8.1 Design Requirements

Provide a microprocessor-based (distributed digital or programmable controller) or relay type control system with a dedicated hardwired insert panel furnished for monitoring and operator interface with the burner control/fuel safety system with the panel also providing the operator with direct fuel tripping capability in emergency situations. Subdivide the burner control system to permit inservice checkout and maintenance without impairing the reliability of the overall control system. Provide logic cabinets that include status indicating lights for all logic inputs and outputs and for monitoring availability of control power to all subsystems as required to facilitate troubleshooting. Provide indication of equipment status and system permissives at the operator interfaces. Include, where common power supplies internal to the system are furnished, a full-capacity on-line backup supply. Provide alarm for failure of either power supply.

2.5.8.1.1 Maintenance and Reliability Requirements

In general, maintenance is accomplished on-line and without imposing any special restrictions on overall plant operation. Provide diagnostic routines, interchangeable electronic cards or boards, and clear written procedures as a minimum requirement of this specification. For reliability, incorporate both software and hardware into the system design, including redundancy, loop distribution, component specifications and testing, and quality control to assure the highest level of system reliability.

2.5.8.1.2 Adverse Electrical Conditions

Provide equipment capable of operating as specified and without damage within the electrical environment of the plant, including, but not necessarily limited to, high-voltage, high-frequency surges caused by electro-mechanical equipment, energy coupled between conductors by capacitance and mutual inductance, and imperfect grounds. Provide input and output isolation, shielding, separation of circuits, surge suppression, or other measures which may be required to meet these provisions. Inputs, outputs, and other connections must meet the surge to withstand requirements of IEEE C37.90.

2.5.8.2 System Design

Provide a compatible burner control system in all respects with the HTW generator and auxiliary equipment. The system design must meet the requirements specified in NFPA 85. Provide a burner control system incorporating a continuous purge of the furnace to insure that the HTW Generator is free of any accumulation of combustibles; in addition,

provide a burner control that supervises the operation of the fuel-air equipment associated with fuel oil burners, accepts operator commands and, if the required permissives are met, perform the required operation. Provide continuously monitored equipment and alarm any deviation while the system either corrects the deviation of shuts down equipment as necessary to avoid hazardous furnace conditions or equipment damage. Provide a system that monitors the operation of the fuel equipment and if the equipment fails to respond to command from the burner control system, initiates the equipment trip sequence. Provide system indications to allow the operator to determine the equipment that initiated a trip of fuel equipment, shutting down the tripped equipment reset of the trip is permitted. Include a fuel safety subsystem in the burner control system that includes a master fuel trip (MFT) system, ignition oil trip system, and main fuel oil trip system; including a hardwired relay in each system which may directly operate from the operator insert panel. Include inputs to the MFT, in addition to those associated with the burner control system, those that are required to provide overall HTW generator protection. Provide a system that interfaces with the combustion control system to position and monitor devices for startup and shutdown which are normally modulated during on-line operation. Design the burner control system to operate reliably, minimizing the number of false trips.

2.5.8.3 System Functional Requirements

2.5.8.3.1 Operating Modes

It is the operator's responsibility to initiate the start and stop sequences listed below. Once initiated the burner control system must automatically place the oil burner in service or remove it from service. The steps each of which require operator initiation are:

a. Purge

b. Igniter control

c. Feeder control

d. Main oil burner

2.5.8.3.2 Furnace Purge and Boiler Monitor

Provide a furnace purge control to incorporate prelight off and post purges of the furnace to insure that the HTW generator is free of any accumulation of combustibles, which indicates to the operator, after which the operator will reset the master fuel trip relay. Provide a furnace purge on any master fuel trip. Provide the HTW generator monitor that prevents starting any fuel equipment if the furnace firing permissives are not met, with the furnace purge control providing indications to the operator of the status and the progress of the furnace purge, extinguishing permissive indications when the MFT relay is reset.

2.5.8.3.3 Igniter Control

An igniter group consists of all the igniters associated with a main oil burner. Igniters associated with a burner group will be controlled from a separate electropneumatic igniter control package. Provide sequential starting of igniters between burner groups to be started and stopped from the insert panel and local pushbuttons. An igniter fuel trip (IFT) first out indication will be provided to indicate the initiating cause of the

IFT and extinguished only when the IFT relay is reset.

2.5.8.3.4 Main Oil Burner Control

Starting and stopping of each main oil burner may be accomplished either locally or from the insert panel. Proven igniter groups is one of the permissives required for starting. Provide fuel oil trip first out indications and a main fuel oil trip (FOT) relay.

2.5.8.3.5 Fuel Safety Subsystem

The fuel safety subsystem comprises the MFT system, main FOT system, and IFT system. Each fuel safety system provides the protection for its respective fuel and includes a dedicated hardwired relay which may be directly operated from operator insert panel. The MFT system provides overall HTW generator protection, also includes a dedicated hardwired relay, and directly trips all other fuel safety system relays. Design the system to de-energize to trip.

2.5.8.3.6 Flame Monitoring

Individual self-checking flame scanners are required for each burner. Igniter flame safety devices must discriminate individually from any flame that may exist at other burner locations. Discriminate burner flame individually from the associated igniter flame and any other flame that may exist in the furnace. Igniter and burner flame discrimination must cover the range from startup to full load operation. Blocking interlocks from closed valves in flame discrimination circuits to avoid false flame indication are not acceptable. If required to obtain satisfactory flame discrimination, include extended tube scanners. Individual flame detector output level indicators are required. If required, provide provisions for cooling and cleaning.

2.5.8.3.7 Enclosures

The system logic cabinets contain all control devices, power supplies, circuit protective devices, cable plugs, and terminal blocks. Provide spare space to accommodate a minimum of 20 percent additional devices. Make the cabinets accessible from both front and back, each having gasketed hinged doors with latches. Do not exceed door with of 610 mm 24 inches. Natural draft cooling of the control system cabinets is preferred. If cabinet cooling fans are furnished, alarm the loss of any fan.

2.5.8.3.8 Local Termination Boxes

Include local junction boxes, one at each burner level containing separate pushbuttons and indicating lights for local control of each igniter group. In addition, include terminals for field wiring, internal wiring, cable connectors for intersystem wiring, circuit breakers, and if required by the system, relays and reversing starters in the terminal boxes. Configure terminal boards for field wiring to allow 20 percent spare connections.

2.5.8.3.9 Interconnecting Cable Requirements

Interconnect cables between the logic cabinet, insert panel, and local burner junction boxes via prefabricated plug-in cables, including connectors. Also, provide flame scanner cables.

2.5.8.3.10 Buffered Output Signals

Fully isolate output signals required for tripping, control, and monitoring from each other. Isolate such that an open or short circuit in the related equipment does not affect other control systems.

2.6 HEATING PLANT PANELS AND INSTRUMENTS

Do not use Mercury in thermometers.

2.6.1 HTW Generator Instrument and Control Panel

Size the HTW generator instrument and control panel to contain all controls, instruments, gauges, and meters. Provide free-standing panel with faceplate of not less than 4.8 mm 3/16 inch steel, reinforced, and finished with the manufacturer's standard finish coating. Mount the units flush on the panel as far as practicable. Enclose the back of the panel with sheet metal and with adequate removable access panels or doors for maintenance and removal of any unit without interfering with other units. Provide latching equipment and hardware. Indentify each recorder, indicator, and control unit with engraved metal or laminated plastic nameplates securely fastened to the panel. Provide the panel with continuous, rapid-start, fluorescent light fixtures mounted with reflectors providing suitable shielding to illuminate all controls, instruments, gauges, and meters. Terminate all field piping connections in one bulkhead-mounted manifold located to conform with the installation requirements of the system. Terminal all field electrical wiring in a mounted color-coded terminal strip so located as to conform with the installation requirements of the system. If a pneumatic control system is provided, include duplex air supply filter and regulator set, mounted on the rear of the panel with properly identified pneumatic terminal blocks and low-point drain in the panel. No high-pressure lines are allowed to enter the panel. Provide control equipment with the necessary operating switches, indicating lights, gauges, alarms, the combustion control system, and the generator and fuel safety interlock systems. If the package type boiler burner units with integral controls are furnished, the control equipment for each boiler may be mounted on a separate free-standing panel in accordance with the requirements above for instrument and control panel. Ppanel-mount and test at the factory controllers and indicators specified or required, complete with relays, transformers, switches, wiring, valves, and piping. Color-code or otherwise identify all wiring and piping within the panel.

2.6.2 Indicators

Provide flush mounted indicators with a vertical scale from 100 to 150 mm 4 to 6 inch length with scales in engineering units with an accuracy of plus or minus 1 percent of full scale. Indicators may be either electronic or pneumatic with zero adjustments, receiving standard signals from locally mounted transmitters.

2.6.3 Recorders

Provide servo mechanism type, multiple pen type, [circular] [strip chart] type recorders with minimum chart width of 100 mm 4 inches, accuracy of plus or minus 1/2 percent of full scale, and each pen having a separate scale calibrated in engineering units. Provide 120 volts ac chart drive and 1 year's supply of chart paper.

2.6.4 Panel Display

As a minimum, display the following parameters on the panel:

		Indicator	Recorder Point
Pressure			
	Main hot water header	x	x
	Boiler drum	x	
	Feedwater	x	x
	Instrument air	x	
Draft			
	Windbox	x	x
	Furnace	x	
	Gas outlet	x	
	ID fan inlet	x	
Temperature			
	Hot water outlet		x
	Boiler gas outlet		x
	Windbox		x
	Feedwater		x
	HTW differential temperature		x
	HTW zone inlet and outlet (each zone)		x
Level			
	Bunker or silo		x
Flow			
	Hot water outlet (including totalizer)		x
	Feedwater		x
	Air		x

		Indicator	Recorder Point
	Fuel		x
	HTW (each zone)		x
Analyzers			
	Flue gas opacity		x
	Flue gas oxygen		x

2.6.5 Hot Water and Feedwater Flow Measurement

Provide square edge, concentric, paddle type, designed for flange taps orifice plates to measure hot water and feedwater flow to each generator with nozzles and orifice plates flange-mounted type, made of stainless steel. Minimum straight pipe runs in accordance with AGA XR0603.

2.6.6 Pressure Gauges

Provide heavy-duty industrial type pressure gauges with phenolic case, solid front, rear blowout, threaded ring, shatterproof glass, and 13 mm 1/2 inch NPT bottom connection installed for proper operation with stainless steel Bourdon spring-type having 114 mm 4-1/2 inch dial sizes installed where it is clearly visible from the operating level, and all requisite piping and gauge cocks described, or required above. Provide pressure gauges on high temperature service with pigtail siphons. Provide pump discharge gauges located on pump discharge lines with pulsation dampeners or snubbers with gauge ranges selected so that at normal operation the pointer is at approximately 50 percent of range. Provide gauges for the following services:

Expansion Tank
Dump Tank
Master Control Center
Circulation Pump Panel
Distribution System Mains
Master Control Panel
Makeup Pumps
Emergency Feed Pump
Water Main
Chemical Feed Pumps
Air Compressors
Fuel Oil Supply Header
Generator Pressure
HTW Water Inlet and
Outlet Duplex

2.6.7 Dial Indicating Thermometers

Provide bimetallic type with stainless steel case and stem, with thermowells and having a 127.0 mm 5 inch dial and plus or minus 1 percent accuracy.

2.6.7.1 Expansion Tank and Dump Tank Thermometers

Provide three thermometers on each tank; at the drum centerline, at the top 1/3 point, and at the lower 1/3 point of the drum.

2.6.7.2 Inlet and Outlet Gauges of HTW Generators

Provide inlet and outlet gauges of HTW generators as above, as applicable.

2.6.8 Remote Reading Temperature Indicators

2.6.8.1 Pump Thermometers

Provide HTW generator and distribution system circulation pump panel dial type, liquid filled, surface panel mounting, back-connected thermometers in 150 mm 6 inch turret type phenolic case, with range 35 to 260 degrees C 100 to 500 degrees F, with self-compensating stainless steel 3 m 10 foot long capillary having a stainless steel separable socket with a 65 mm 2-1/2 inch extension neck, 150 mm 6 inch bulb length, 19 mm 3/4 inch IPS connection.

2.6.8.2 Pipeline Thermometers

Provide pipeline thermometers similar to above, with 65 mm 2-1/2 inch extension neck separable sockets, where accessible, and with required capillary length where not accessible, for direct reading.

2.6.8.3 Flue Gas and Fuel Oil (if Oil-Fired) Thermometers

Provide vertical scale, moving pointer type temperature indicators, in semiflush mounting dust-tight case, with curved translucent scales, internally illuminated, with instrument scale graduations, figures, and range suited for the indicated service, employing a diaphragm measuring element with linkage actuation of the indication pointer. Provide gas-filled bulb type thermal sensing element with spirally wound, bronze armored flexible copper connection tubing to the instrument, and instrument accuracy of 2 percent of full scale range with a sensitivity of 0.2 percent of full scale range.

2.6.8.4 Separable Sockets

At all points of recording, controlling, or integrating instrument temperature bulb insertion, install a stainless steel separable socket having a screwed cover and attachment chain adjacent to a temperature bulb for insertion of a test thermometer.

2.6.9 Oxygen Analyzer

If oxygen compensation controls are furnished, provide an oxygen analyzer to indicate, record, and control the percentage of net excess oxygen in, and the average temperature of the flue gas leaving, the boiler. Provide a direct probe type oxygen analyzer utilizing an in situ zirconium sensing element inserted directly into the process flue gas stream and in direct contact with the process gases. Provide a sensing element contained within a protective shield mounted to the ductwork by an adapter plate. Provide analyzer equipped to allow daily automatic calibration check without removing the analyzer from the process, where as sample gases may be injected directly on the sensing element while the analyzer is in the process. Include any temperature compensation of control required with

the output signal range from 4 to 20 mA dc and representing 0 to 10 percent as a linear function.

2.6.10 Flue Gas Opacity Monitor

Provide a flue gas monitoring system with continuous measurement, indication, and recording of smoke opacity from each boiler, and with the stack units including a light source and a light detecting or receiving unit mounted in the stack or main breeching, as recommended by the manufacturer. Provide a control or transmitter unit with electronic solid-state circuitry and meter or digital type indicator, and provide an output signal for 0 to 100 percent opacity. In addition, provide the control unit with calibration and alarm adjustments for compliance with Federal, State, and local environmental regulations, and a control or transmitter unit and recorder with a dust-tight metal enclosure. Provide a purging air system to clean light source lens and light detector lens. Provide the control unit with adjustable alarm output contacts for various smoke densities.

2.6.11 Fuel Flow Meter

Provide a volumetric measurement type flow meter incorporating a rotary, positive displacement piston body with gear train driven generator and totalizing register, a panel-mounting meter to indicate fuel oil rate of flow in gallons per minute, and a transmitter output signal of 4 to 20 mA dc to be used for combustion control, with a bronze with hard-cast bronze measuring piston. Provide a totally enclosed generator with grease-packed ball bearings, silver commutator, and brushes. Mount the totalizing register on top of the generator housing and calibrate in liters U.S. gallons.

2.6.12 Water Flow Meter

Provide a water flow recorder with totalizer for each generator and a recorder conforming to the requirements specified for the HTW temperature recorder except that flow rates are to be recorded in L/sec gpm.

2.6.13 Btu Recorder

Provide a recording totalizer which integrates temperature difference and water flow to provide the net J Btu output of the generator for each HTW generator.

2.6.14 Makeup Water Meter

Provide a makeup, positive displacement type water meter in the treated water line suitable for operation with water at 21 degrees C 70 degrees F and 450 kPa 65 psig with the complete meter assembly to include meter isolation valves and a valved bypass and strainer on the inlet side of the meter, and 254.0 mm 10 inch diameter vertical type dial calibrated in L gallons having two hands; 380 L 100 gallons indicated on one hand and 7570 L 2000 gallons on the other hand. Provide the hands with a manual reset device. Provide a totalizing register with all bearings self-lubricating if submerged. Provide a meter capacity of [_____] L/sec gpm.

2.6.15 Master Control Center

Provide a centrally located master control center to serve as the central control and recording station for the plant, also serving as a central

point for miscellaneous functions including the various alarm circuits with their annunciators and audible signals, and the controls for the system. The units to be installed on the panel are specified under the various paragraphs of this specification. Install all necessary electric wiring for instruments, panel lighting, and equipment requiring electrical connections. Install all necessary transformers, separate relays, switches, and fuses in a fully enclosed junction box with a safety switch with fuses serving the 120-volt power supply to the plug-in strip and any other power supply as required for control circuits. Provide all wire suitable for boiler room requirements and install according to NFPA 70. Install and support in place on the rear of the panel and test at the factory all necessary interconnecting piping, terminal block, valves, and fittings required for the control equipment.

2.6.15.1 Panel Board

Provide a free-standing master panel board, floor-mounted on a 100 mm 4 inch concrete curb and provided with vibration isolators between panel and anchor bolts. Construct the control panel of specially leveled steel sheet not less than 4.8 mm 3/16 inch thick with adequate structural steel framework to provide a rigid unit, and with the panel gaskets and other seals necessary to form a dust-tight enclosure of the controls conforming to NEMA ICS 1 standards. Identify all controls and instruments using nameplates. Match the panelboard with the boiler control units and distribution panel in appearance, unless it is a console type. Provide each panel with a suitable plug-in strip on the rear of the panel for any required plug-in electrical connections of the instruments with all necessary piping or electrical connections and all necessary devices for a complete operating installation. Provide suitable single strip, rapid start fluorescent lighting with a panel-mounted toggle switch for a panel hood, with a single, pull chain, ceiling light receptacle installed in the interior of the panel enclosure and wired to the common point of electrical supply.

2.6.15.2 Distribution Zone Valve Controls

Provide a manual valve control for each zone control valve on the master panel, with instruments to indicate the position of each valve operator.

2.6.15.3 Expansion Tank Water Level Indicator

On the master control panel provide a remote reading, liquid level indicator type water level indicator, with the indicating scale showing uniform divisions for all level changes, and requiring no liquids for calibration other than the expansion drum water, suitable for 2,758 kPa 400 psig operating pressure, and connected and calibrated to show indicated levels of [_____] mm inches to [_____] mm inches above the outside bottom of the expansion tank. Locate the primary or transmitting elements at the liquid level control station, so located and calibrated that the center point of the indicator shows the normal water level in the tank at [_____] mm inches above the tank bottom.

2.6.15.4 Annunciator

Provide an annunciator system with a semiflush mounted panel which indicates and alarms on the following:

a. Expansion Tank:

Overflow level
Normal level
Combustion cutout level
High pressure
Low pressure

b. Dump tank:

Overflow level
High pressure
Low pressure

c. HTW generator (each) - safety shutdown

d. Fuel (to suit firing system):

Low fuel oil header pressure
Low fuel oil storage level
Low stoker hopper level
Low coal bunker level

e. Air:

Low service air pressure
Low instrument air pressure if pneumatic controls are used

f. Distribution zones (each) - low return pressure

Provide the annunciator with lamp test and acknowledge push buttons, with the operational sequence as follows:

Condition normal	Light off, horn off
Alarm	Light flashing, horn on
Alarm acknowledged	Light on, horn off
Return to normal	Light off, horn off

Provide the system with devices to actuate the annunciator from the above sources, unless otherwise specified.

2.6.15.5 Liquid Level Control Stations

Provide liquid level control stations at the expansion tank and dump tank, and include adequate detection, sensing, and actuating devices to provide signals for the annunciator system and to control the overflow system. The levels for carrying out the above functions are as indicated.

2.6.15.5.1 Expansion Tank Overflow Controller

Provide overflow control system from the expansion tank. Provide the expansion tank that overflows on control signal from the control station specified above which actuates a motorized normally-closed valve allowing water to relieve to the dump tank.

2.6.15.5.2 Dump Tank Overflow Controller

Provide an overflow control system from the dump tank with the dump tank overflowing on a control signal from the controller which actuates a motorized normally-closed valve allowing water to relieve to the blowdown tank.

2.6.15.6 Distribution Zones Control Station

Provide a control station for distribution zones valve control with one manual valve control for each zone. Provide the instrument that indicates the position of the valve operator with remote control and adjustment of the valve. Provide a motorized gate valve for the controlled valve in the distribution zone supply line for emergency shutoff and flow modulation, with the motorization of the valve being such that any partial opening of the valve may be held positively without drift or consumption of a power means. Conform the valve body to the requirements for valves specified in paragraph PIPING.

2.6.15.7 Plant Master Controller

Provide a plant master controller for nitrogen pressurized systems that reacts in response to temperature transmitter signals from a temperature sensing element in the return water header and provides the necessary signals to the HTW generator master controllers with a manual selector station for selecting either automatic control or manual control and a means for adjusting the set point return water temperature control.

2.6.15.8 Clock

Provide an electric synchronous motor type clock, except as modified herein. Provide a surface mounted, suitable for operation on 115-volt, 60 Hz single-phase electric service with a white dial, 380 mm 15 inch size, easy-to-read black numerals, black hands, red sweep second hand, and external manual reset knob at bottom of case. Provide a motor gear train sealed in a permanent oil bath.

2.6.16 Panel Piping and Wiring

Pneumatically or electrically, or both, transmit high-pressure and high-temperature values to the panel. Transmit pneumatic signal at 0.69 to 104 kPa 3 to 15 psig and include piping connectors to indicators with 6.4 mm 1/4 inch OD copper tubing conforming to ASTM B68/B68M. Transmit flow signals either pneumatically or electrically to the panel-mounted receiver. Run copper tubing connections and electric wiring to a terminal block located on the inside of the panel front near the bottom with wiring terminated at an identified terminal strip. Provide wiring suitable for boiler room requirements and install according to NFPA 70.

2.6.17 Pilot Lights

Provide factory-built cabinet with assembled pilot lights, suitable for flush mounting in cutouts in boiler control panel, complete with extruded trim, clamps, and sheet metal rear housing, and finished in baked black enamel. Provide white plastic and engraved in black ink lens with lettering 19 mm 3/4 inch high and black. Provide two 6 watts, 24 volts dc, S-6 incandescent type lamps, supplied with color caps, one red and one green per pilot light, independently wired lamps per pilot, with black lens bezels unless otherwise indicated.

2.6.18 Continuous Emissions Monitoring

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NOTE: A continuous emissions monitoring system (CEMS) is required by the Clean Air Act Amendment (CAAA) of 1990 if the fuel utilized is oil or coal and the heat input is 3 megawatts 1 million BTU/HR or greater. A CEMS may also be required by state or local laws. If a CEMS is necessary, review the CAAA and the relevant state or local law early in the project to allow time to incorporate the required CEMS specification and to determine which fine gas emissions will be included in the required reports. Before acceptance of the installation, furnish the Contracting Officer with a written test report which provides documentation that the CEMS equipment has passed factory and field certification tests required by federal, state and local regulations. The investigation will determine if the reported values may be calculated or should be direct measurements. Fill in the data to state what method of measurement or calculation will be utilized for the determination of the report variable.

Emerging flue gas flow monitor technologies are available. The traditional differential pressure technique specified uses 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 in-house maintenance capabilities.

****

a. Provide continuous emissions monitoring system (CEMS) equipment as a system by a single manufacturer, meeting the requirements of applicable federal regulations, State of [_____] and local regulations, for each boiler in accordance with manufacturer's recommendations and under the direct supervision of the CEMS equipment manufacturer.

b. Include in the reported data [sulfur dioxide (SO2)] [oxides of nitrogen (NOx)] [carbon dioxide (CO2)] [particulate matter (PM)] and other information required by federal, state, and local regulations. Base SO2 reporting on [analyzer measurement] [fuel flow and percent sulfur calculation] [daily heat input calculation]. Base nitrous oxides, carbon dioxide and particulate matter reporting on analyzers.

c. Provide the CEMS equipment with the central processing unit, printer, hard disk drive, and optical disc drive, with the optical disc drive functioning as a recorder. Provide the manufacturer's software to generate the required reports in a format acceptable to the federal, state and local regulatory agencies. Provide a CRT screen as the operator interface to the CEMS equipment.

2.7 NITROGEN PRESSURIZATION SYSTEM

Provide a complete system of nitrogen pressurization, including necessary equipment, parts, pressure vessels, piping, valves, devices, and accessories allowing proper HTW expansion and contraction, and control of makeup water with a minimum loss of nitrogen and HTW while maintaining the system pressures corresponding to the operating range of the combustion control of 5.5 degrees C 10 degrees F above or below the boiler-outlet water temperature, without steaming in the system.

2.7.1 Expansion Tank

Provide one expansion tank constructed, hydrostatically tested at the factory, stamped, and certified in accordance with ASME BPVC SEC VIII D1 for an operating pressure of [_____] kPa psig and temperature of [_____] degrees C degrees F, with connections and piping inserts adequately supported structurally as required for the service. Provide a standard manhole, actuating device for feed water control, alarm devices, gauge glasses, floats, and controls as required, for the proper functioning of the expansion tank.

2.7.2 Dump Tank

Provide dump tank, hydrostatically tested at the factory, constructed, stamped, and certified in accordance with ASME BPVC SEC VIII D1 for an operating pressure of [_____] kPa psig and [_____] degrees C degrees F, with connections and piping inserts adequately supported structurally as required for the service, also with a standard manhole, actuating services for makeup water control, alarm devices, gauge glasses with shields, floats, and controls as required, for the proper functioning of the dump tank.

2.7.3 Expansion Tank and Dump Tank Fittings

Tank fittings conforming to ASME BPVC SEC VIII D1 and including the following:

a. Pressure gauge.

b. Water level gauge.

c. Level controls.

d. Thermometer.

e. Drain valves; hard seat, seatless pattern; rating 400 to 600 pound class.

f. Vent valves; Class 600 600 pound steel bar stock, OS&Y.

g. Safety relief valves conforming to ASME B16.34, and suitable for a HTW expansion drum at working pressure of [_____] kPa psig, with all internal parts are of steel or stainless steel with hard facing allowable.

2.8 BLOWOFF SYSTEM

2.8.1 Sample Cooler

Provide a water-cooled, shell-and-tube type heat exchanger with stainless steel tubes suitable for cooling the blowoff (before sampling) sample cooler. Connect the cooler to a header and valved so that the operator can obtain a sample of properly cooled blowoff from any boiler as desired. Support the cooler and provide a steel sampling cock with a sampling glass container suitable for handling the water temperature to be encountered and a hydrometer or equivalent device suitable for measuring the concentration of solids in the boiler blowoff and reading in parts per million.

2.8.2 Blowoff Tank

Provide a concrete blowoff tank with bolted manhole cover, cover plate with disappearing lifts, inlet blowoff connection equipped with mixing nozzle, vent, overflow and drain connection.

2.9 WASTE HEAT RECOVERY EQUIPMENT

****

NOTE: For the efficiencies specified, waste heat recovery will be required. Designer must consult with HTW generator manufacturers to select the most appropriate unit for the size of HTW generator being designed.

****

Equip each boiler with [an economizer] [an air preheater], which may be separate from or integral with the boiler and complete with insulation and jackets, casings, supports, and access doors, and with provisions for tube or tube bundle removal and for cleaning.

2.9.1 Economizers

Provide economizers of a type normally provided by the boiler manufacturer and including [finned tubes] [bare tubes] baffles and headers, and provisions for cleaning and tube bundle removal, constructed of materials capable of withstanding the maximum boiler exit gas temperature plus 28 degrees C 50 degrees F. Use tubes conforming to ASME BPVC SEC I. Design and install as to preclude cold-end corrosion under any load condition, with economizer tube metal temperature being above the maximum flue gas dewpoint for the fuel being fired under all load conditions.

2.9.2 Air Preheaters

Provide air preheaters normally provided by the boiler manufacturer and being the recuperative tube plate or regenerative type constructed of materials adequate to withstand the corrosion effects of the flue gases with the overall installation precluding cold-end corrosion of the air preheater under any load condition. Temperatures of all metals in contact with flue gas must be above the flue gas maximum dewpoint temperature for the fuel being fired under all load conditions. Provide air-preheat or automatic bypass control integrated with the combustion control system.

2.10 DRAFT FANS

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NOTE: Induced draft fan outlet dampers may not be required in single fan/single boiler installations, except to eliminate the stack effect during outages.
****

Provide [backward curved blades] [radial tip blades] or axial flow type centrifugal fans conforming to AMCA 801 [Type I] [Type II] furnished as an integral part of boiler design. Size each fan for an output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner or grate, leakages, temperature, and elevation corrections for a dirty boiler with worst ambient conditions, all at full combustion to meet net rated output at normal firing condition, with fan sizing including minimum margins of 10 percent volume and 21 percent static pressure, plus margins of 5 degrees C 10 degrees F for forced-draft fans and 22 degrees C 40 degrees F for induced-draft fans. Design induced-draft fans for handling hot flue gas at the maximum outlet temperature adjusted for surface fouling. [Provide induced-draft fans with outlet dampers.] Noise levels for fans must not exceed 85 decibels at 914 mm 3 foot station, with [air cooled] [or] [water-cooled] fan bearings, and backward curved fan blade type with bearings not requiring water cooling may be of the self-aligning antifriction type. [Provide scroll sheets and rotor blades with liners.]

2.10.1 Draft Fan Control

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NOTE: Variable speed control, inlet vane control and inlet damper control are, in descending order of efficiency, capable of control draft fan conditions. The choice is based on economics. However, in erosive services, inlet vane control is not desirable.
****

Provide forced-draft centrifugal fans with [inlet vane controls] [variable speed control]. Provide induced-draft centrifugal fans with [inlet vane control] [inlet damper control] [variable speed control] and [axial propeller fans having variable propeller pitch control.] Provide inlet vanes or dampers suitable for use with combustion control equipment.

2.10.2 Draft Fan Drives

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

Provide electric motor driven fans with electric motor being [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]. [Provide magnetic [across-the-line] [reduced voltage start] type motor starters with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure and furnished with four auxiliary interlock contacts.]

2.11 AIR DUCTS

Design air ducts connecting the forced-draft fan units with the stoker plenum chamber to convey air with a minimum of pressure loss due to friction. Provide galvanized sheet metal ductwork conforming to , with ducts straight and smooth on the inside with laps made in direction of air flow, and externally braced, installed and anchored as to be completely free from vibration. Provide access and inspection doors as required. Construct ducts with long radius elbows having a centerline radius 1.5 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. Provide substantially air-tight duct joints of adequate strength for the service, with 38 x 38 x 3.2 mm 1-1/2 x 1-1/2 x 1/8 inch structural steel angles used where required for strength or rigidity. Duct walls thickness as follows:

Duct, Maximum Dimension	Galvanized Steel Sheet, Minimum Thickness
Up through 1525 mmUp through 60 inches	1.613 mm16 gauge
1526 m and larger61 inches and larger	2.753 mm12 gauge

2.12 BREECHING

Construct breeching of not less than 3.416 mm 10 gauge steel sheets conforming to ASTM A36/A36M and with adequate reinforcement and bracing with structural steel angles not smaller than 50 x 50 x 6.4 mm 2 x 2 x 1/4 inches, and all welded joints, longitudinal seams and angles. Provide expansion joints as required to suit the installation, being flexible type requiring no packing. Providing breeching with angle flanges and gaskets for connection to boilers, fans, equipment, or stacks. Provide gas-tightbreeching connections, caulked-tight all around and sealed with cement to form an air-tight joint. Provide clean-out openings of suitable size and at approved locations for access to all sections of the breeching with tight-fitting, hinged, cast-iron doors with cast-iron frames. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping for combustion gases.

2.13 STACKS

Provide self-supporting, double-wall insulated type stacks for individual boilers. Provide for each stack, unless otherwise indicated, complete with structural steel base, base plates, anchor bolts and nuts, cleanout door, [induced-draft fan] [boiler] connection and a thermometer well. Stub stacks for packaged boiler units may be supported directly on the boiler providing the boiler structure is designed to accommodate such an arrangement. Provide insulation suitable for sustained flue gas temperature of 485 degrees C 900 degrees F with intermittent temperatures up to 650 degrees C 1200 degrees F and the wall section "U" factor of approximately 0.26. Fabricate stacks of high-strength, low alloy, structural steel resistant to atmospheric corrosion and conforming to ASTM A242/A242M for both inner and outer shell. Provide inner shells of

each section with an air-sealed and concealed expansion and contraction device to allow for differential expansion of inner and outer shells. Extend stacks above the roof to the height indicated. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping for combustion gases.

2.14 ELECTRIC MOTOR-DRIVEN PUMPS

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

****

Provide electric motor-driven pumps with motors that are [splash-proof] [totally enclosed, nonventilated] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type, suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.

2.14.1 HTW Circulating Pumps

Design and size HTW circulating pumps for specific applications. Provide pumps having a combined rating of flow and head that results in a power rating less than 185 kW 250 bhp to meet the design requirements of API STD 610, being end-suction, top discharge, and supported at its centerline. Provide horizontal-split case, multi-stage centrifugal pumps for sizes above 185 kW 250 bhp. Provide volute or diffuser design casing construction, supported at its casing centerline. Provide all pumps nominally rated for excess capacity of 10 percent above the maximum continuous rating of the service. Provide the required Net Positive Suction Head (NPSH) at the pump design flow, head, and speed not exceeding 80 percent of the available system NPSH at the same flow, assuming a low level in the storage tank. Provide the pump's suction specific speed not to exceed 9000 at the pump's best efficiency point (BEP) reflecting a guaranteed NPSH requirement of 3 percent breakdown criteria. Select a pump based on a constantly rising to shutoff with no point of inflection, and with no restriction to operation at any point from minimum continuous flow to design flow.

2.14.1.1 Suction and Discharge Flanges

Provide pumps with integrally cast suction and discharge flanges drilled to meet the design pressure of the application. Provide feed pumps designed for an operating temperature of not less than 205 degrees C 400 degree F, with casings drilled, tapped, and provided with vent and drain connections. Pumps designed for this service do not require cooling at ratings below 375 kW 500 bhp for both frame cooling and seal cooling. For pumps below 375 kW 500 bhp, provide antifriction radial and thrust bearings, lubricated by flinger rings in a sealed housing with mechanical seals, and with air-cooled flush piping conforming to API STD 610, Plan 23. For pumps above 375 kW 500 bhp, provide a single cooling circuit for both cooling the oil being delivered by a forced oil system to sleeve radial bearings and a floating shoe thrust bearing, coupled with the seal coolers for both stuffing boxes and mechanical seals. In both cases, provide site-convertible stuffing to a packed box. Provide for maximum leakage no more than 0.025 L/hour 25 cc/hr for a seal life of no less than

25,000 hours, and bearing rating not less than 100,000 hours (L-10 life) at the point of maximum load, as defined by ABMA 9.

2.14.1.2 Structural Steel Bases

Support pumps on structural steel bases that do not require grouting in order to impart strength to the pump for static and dynamic loading from the piping system, with bases pitched to a low point drain. Shop align complete pump and motor assembly using shims on both the pump and the motor.

2.14.1.3 Pump Coupling and Guard

Provide pumps with nonlubricated flexible-disc couplings and a coupling guard. Provide spacer-type couplings to permit removal of the mechanical seals and limited-end-float-type for pumps with sleeve bearings.

2.14.1.4 Recirculation Control Valve

Provide pumps with a self-contained automatic recirculation control valve sized for nominally 25 percent of the pump's BEP flow.

2.14.1.5 Pump Testing

Subject pumps to shop hydrostatic testing. Subject one pump in each service to complete shop performance tests to demonstrate that, at rated capacity, head is within a margin of plus 3 percent and minus 0 percent of design; efficiency is within a tolerance of minus 0 percent; NPSH at the pump's BEP and at the rated condition is within a margin of plus 0 percent and minus 10 percent. Conduct performance tests in accordance with API STD 610. Procedures and results are subject to the approval of the Contracting Officer.

2.14.1.6 Instrument Panel

Provide each HTW circulation pump with an instrument panel, with construction and arrangement of the gauge panel as indicated. Provide nameplates having letters 6 mm 1/4 inch high designating the pump number and service. Provide surface panel mounted gauges. Provide the instruments specified above and include one single-element pressure gauge for the pump suction, one duplex pressure gauge with two elements to indicate flow pressure on each side of the pump discharge regulating valve, and one dial type thermometer to indicate the discharge temperature. Provide identification letterings located either on the gauge dial or on a nameplate adjacent to the gauge identifying the service of the gauge, with a stainless steel socket with cover for a separable socket-type test thermometer installed in the pump discharge piping at each circulation pump for future insertion of a test thermometer. PProvide pressure gauges with a gauge valve and a pigtail siphon as specified installed at the point of connection with the main piping. Provide pulsation dampeners or snubbers for pressure gauges connected to the pump discharge.

2.14.2 Emergency Makeup Water Pump

Provide centrifugal type emergency makeup water pump; split case, 2 stage type with closed impellers and radial or mixed flow. Design the pump to handle high temperature water at 122 degrees C 250 degrees F, specific gravity of 0.942, pH of 9.5 to 10.5, and the capacity and head indicated.

2.14.3 Makeup Water Pumps

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NOTE: If inadequate NPSH is available, give consideration to substituting either a double suction or positive displacement pump.

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Provide horizontal, end-suction, single-stage, centrifugal, motor-driven makeup water pumps. Provide pumps having stainless steel shafts, bronze impellers, and stuffing boxes. Lubricate by splash oil with oil level sight glass provided. Subject pumps to the same tests specified for the HTW circulating pumps.

2.14.4 LTW Circulation Pump

Provide centrifugal type, end suction, single stage type with closed, open, or semi-open impellers, radial or mixed flow, designed to handle low temperature water at 110 degrees C 225 degrees F, and the capacity and head indicated.

2.15 LTW EXPANSION TANK

Provide LTW expansion tank in connection with the LTW water heater constructed in accordance with ASME BPVC SEC VIII D1 and with a protected gauge glass and manual air vent. Hydrostitically test the tank at 1-1/2 times the working pressure or at 690 kPa 100 psig, whichever is greater.

2.16 HEAT EXCHANGERS

2.16.1 Water Heaters

Provide water heaters of the types scheduled and with thermostatic control valves, valved bypasses, strainers, and temperature/pressure relief valves. Provide thermometers where indicted, and temperature and pressure relief valves conforming to the requirements of ANSI Z21.22/CSA 4.4. Provide separate valves if input exceeds 29.3 kW 100,000 BTU/H or storage capacity exceeds 454 L 120 gallons. Provide thermostatic control valves installed in the HTW return line from each water heater coil, installed to operate in conjunction with a remote bulb temperature controller, and conforming to the requirements of paragraph THERMOSTATIC REGULATING VALVE. Provide flanged valves, minimum Class 300 300 pound class, and sized for the service by the manufacturer. Provide shell-and-tube design instantaneous water heaters conforming to the applicable requirements of TEMA Stds, Class C with the heater shell being steel and designed for [_____] kPa psi and [_____] degrees C degrees F temperature, and U-tube type coil designed for high temperature water at [_____] kPa psi pressure. Provide 16 mm 5/8 inch or 19 mm 3/4 inch size, constructed of No. 16 AWG cupronickel (90 percent/10 percent) coil tubing.

2.16.2 LTW Heat Exchanger for Fuel Oil Heating

Provide instantaneous shell-and-tube type heater conforming to the applicable requirements of TEMA Stds, Class C, with a steel shell and designed for [_____] kPa psi pressure and [_____] degrees C degrees F temperature. Provide with U-tube type coil designed for HTW at [_____] kPa psi pressure, constructed of No. 16 AWG 16 mm 5/8 inch or 19 mm 3/4 inch cupronickel (90 percent - 10 percent) tubing.

2.17 CHEMICAL TREATMENT AND WATER SOFTENING EQUIPMENT

2.17.1 Chemical Feeder

Provide an automatic proportioning, shot type, or pump type chemical feeder unit for each boiler, including all appurtenances necessary for satisfactory operation, with size and capacity of feeder based on local requirements and water analysis.

2.17.2 Chemical Feed Pumps and Tanks

Provide chemical feed pumps with pump cylinders, plungers, ball check valves, and check valve bodies of corrosion resistant materials suitable for the chemicals being pumped and tanks as a complete package assembly with the pumps mounted on and piping connected to the tank. Volumetric accuracy of the pumps must be within one percent over the range indicated. Provide with adjustable pump capacities by positioning crank pin with micrometer setscrews. Provide stroke length scale divided in percentage graduations engraved on scale. Provide replaceable cylinders for increased or reduced pressure or capacity ranges. Provide drive motors suitable for the electrical power available and having drip-proof enclosures. Provide tanks made of polypropylene and mounted on legs with filling and drain connections, gauge glass and hinged cover. Provide each tank with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Provide tank with bottom dished concave to a radius equal to the diameter of the tank. Provide tanks suitable for phosphate or caustic feed and sulfite feeding. provide a motor-driven agitator. Design the pump to feed the chemical solutions into the HTW return line to the system circulating pumps and have the capacity to feed a maximum of 5.3 mL/sec 5 gph.

2.17.3 Water Softening Equipment

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NOTE: If softening equipment for makeup water is not required, as determined in accordance with UFC 3-410-01, entire paragraph should be deleted. If water softening equipment is required, list desired water treatment conditions; e.g., pH level, hardness, chemical concentrations.

****

Provide a [single] [double] unit automatic water softener system as indicated, designed for a working pressure of [_____] Pa psig, complete with raw and regenerate water distribution; under drain; inlet and outlet connection in upper and lower header respectively; resin removal connecting pipe legs; control valve for service, backwash, regenerate, and rinse; water meters, pressure gauges, brine storage, and measuring tank and controls for automatic operation. Provide either hot-dipped galvanized after fabrication or polypropylene brine tank[s], brine piping either all copper pipe and fittings or Schedule 80 PVC and fittings. Provide equipment having a total capacity between regenerations of not less than [_____] liters gallons of water of [_____] g grains hardness when operating at a sustained softening rate of [_____] L/sec gpm, and based on the data below. Provide test sets for pH comparator for the range [_____] to [_____] sulfide comparator, and phosphate comparator.

2.17.3.1 Water Analysis

The source of the raw water is [_____]. The analysis of the water is approximately as follows:

Constituents*	
Sodium as (Na)	[_____] ppm
Silica as (SiO(2))	[_____] ppm
Calcium as (Ca)	[_____] ppm
Magnesium as (Mg)	[_____] ppm
Iron and aluminum oxides as (Fe(2)O(3)), (Al(2)O(3))	[_____] ppm
Bicarbonates as (HCO(3))	[_____] ppm
Bicarbonates as (HCO(3))	[_____] ppm
Hydroxides as (OH)	[_____] ppm
Sulphates as (SO(4))	[_____] ppm
Chlorides as (Cl)	[_____] ppm
Phosphates as (PO(4))	[_____] ppm
Carbon dioxide (free CO(2))	[_____] ppm
Total hardness as (CaCO(3))	[_____] ppm
Total solids in solution	[_____] ppm
Volatile and organic matter	[_____] ppm
Suspended matter	[_____] ppm
Free acid	[_____] ppm
Color	[_____]
pH	[_____]
*Numbers in parentheses are subscripts.	

2.17.3.2 Zeolite

Provide high capacity polystyrene base sulphonic synthetic type zeolite, with not less than [_____] cubic meters cubic feet of zeolite with each reactor tank.

2.17.3.3 Reactor Tank

Provide reactor tank sized on allowing a freeboard above the zeolite bed of not less than 50 percent of the zeolite bed depth, and a maximum flow rate of 0.679 L/square meter per second one gallon/square foot per minute for each 111 mm 4-3/8 inches of zeolite bed depth.

2.17.3.4 Softening System

Provide the softening system complete with all piping, control, and power wiring, and a complete initial charge of rock salt installed in the brine tank as recommended by the softener manufacturer.

2.17.3.5 Water Test Kit

Provide a water test kit in a strong carrying case, complete with test containers, reagents, and instructions for testing the raw and effluent water.

2.17.3.6 Treated Water Storage Tank

Provide a treated water storage tank as indicated, having a capacity of not less than [_____] liters gallons, fabricated from steel plates not less than 4.76 mm 0.1875 inch thick for shell and heads, constructed in accordance with ASME BPVC SEC VIII D1 for a design working pressure of 520 kPa 75 psig, with dished or concave heads to a radius equal to the diameter of the tank, and hydrostatically tested at the factory at not less than 690 kPa 100 psig. Provide the tank with the connections indicated, an 200 mm 8 inch copper ball float, lever-operated control valve, valve bypass and accessories, and a protected gauge glass.

2.18 HTW SPECIALTIES

2.18.1 Sediment Trap and Blender

Provide a hydrostatically tested sediment trap constructed, stamped, and certified in accordance with ASME BPVC SEC VIII D1 for an operating pressure of [_____] Pa psig and [_____] degrees C degrees F, with the receiver sized for maximum plant flow condition of [_____] L/second gpm and maximum flow velocity of 150 mm/second 0.5 fps. Flange and dish receiver heads and flange all tank nozzles 50 mm 2 inches and larger Class 300 300 pound class. Provide an inspection handhole.

2.18.2 Line Mixer

Fabricate the line mixer as indicated using seamless steel welding pipe fittings with the area of holes drilled in the HTW injector pipe equal or exceed 1.5 times the cross-sectional area of the injector pipe.

2.18.3 Liquid Level Control Column

Provide the column fabricated as indicated of seamless steel pipe and standard welding fittings, using forged steel pipe weldolets for gauge glass piping connections and float switch connections.

2.19 AIR COMPRESSORS

Provide the air compressor units conforming to ASME PTC 10, with compressor speeds not to exceed 900 rpm and motor speed not to exceed 1750

rpm, except as specified otherwise.

2.19.1 Service Air Compressors

Provide the service air requirements as indicated with receivers sized as indicated. Provide units suitable for heavy-duty service (soot blowing), with simplex type compressors, single-stage, double-acting, with water-jacketed cylinder; fitted with intake and discharge valves of the lightweight feather, disc or plate type; and provided with all necessary controls, water-cooled aftercooler, moisture separator, drive, receiver, relief valves, and cooling water controls as indicated or required. Provide the compressor air intake with a low drop type air suction filter/silencer suitable for outdoor installation. Provide shell-and-tube type after cooler designed for air flow through the tubes with steel shell internal baffle plates and Admiralty metal tubes expanded into Muntz metal tube sheets. Provide moisture separator with an automatic water discharge trap and level gauge. Provide vertical type air receiver constructed in accordance with ASME BPVC SEC VIII D1 and equipped with flanged inlet and outlet connections, valved drain connection, 150 mm 6 inch dial pressure gauge, pop safety valves, and regulator connections. Provide cooling water controls for regulating compressor cylinder water temperature and after cooler water temperature of the thermostatic valve type and being installed with a three-valve bypass in the water outlet lines ahead of open sight drain funnels. Equip the compressor with adjustable, pressure type unloader controls suitable for continuous compressor operation.

2.19.2 Instrument Air Compressors

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NOTE: The designer should determine if two redundant full size instrument air compressors will be required as loss of air will cause unit shutdown unless other provisions are made, such as crossties to the soot blower/service air system. Delete paragraph if not required.

****

Provide an electric motor-driven oil-free automatic air compressor unit and a refrigerating drying unit, with he air compressor capable of delivering at a pressure of [_____] kPa psig not less than 0.00472 cubic meter/sec 10 scfm dry air at an atmospheric dew point of -18 degrees C 10 degrees F with entering air at 35 degrees C 95 degrees F, saturated, and the air compressor unit sized to run not more than 60 percent of the time when all controls are in service. Provide the air compressor unit complete with all 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. Provide a vertical constructed receiver in accordance with ASME BPVC SEC VIII D1, with relief valve and drain fittings. Provide a self-contained, refrigerated type air dryer, complete with refrigeration compressor, heat exchanger, automatic controls, and moisture removal trap or a regenerative desiccant type dryer, as required. Provide a hermetically-sealed type refrigeration unit capable of continuous operation at maximum load conditions.

2.20 PIPING

Unless otherwise specified herein, provide pipe and fittings conforming to the requirements of ASME B31.1.

2.20.1 Pipe

Pipe material as specified in TABLE I, except fuel oil pipe material must comply with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.20.2 Fittings

Pipe fittings as specified in TABLE II, except fuel oil fittings must comply with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.20.3 Nipples

Nipples conforming to ASTM A733, Type I or II, as required to match adjacent piping.

2.20.4 Unions

Unions conforming to ASME B16.39, type as required to match adjacent piping.

2.20.5 Pipe Threads

Pipe threads conforming to ASME B1.20.2MASME B1.20.1, right- or left-hand tapered thread as required.

2.20.6 Pipe Expansion

2.20.6.1 Expansion Joints

Design expansion joints for a HTW working pressure not less than [_____] kPa psig and in accordance with applicable requirements of ASME B31.1 and EJMA Stds. Provide flanges for end connections. [Provide service outlets where indicated or required.] Provide Type II joints suitable for repacking under full line pressure.

2.20.6.2 Flexible Ball Joints

Construct flexible ball joints of [stainless steel] [carbon steel] or other alloys as appropriate for the service intended, complete with flanged joints or welded end as required and capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Design and construct the ball-type joint in accordance with ASME B31.1 and ASME BPVC SEC VIII D1 where applicable. Conform flanges to the diameter and drilling of ASME B16.5. Provide molded gaskets suitable for the service intended.

2.20.7 Valves

Install valves at all indicated locations, where specified, and where required for proper functioning and servicing of the system. Provide motor-operated valves capable of closing speeds of 2.5 to 5.1 mm/sec 6 to 12 inches/minute, with motor operators equipped with position indicators, valve stem protectors above the motor operating units, and auxiliary handwheels for manual operation of the valves in the event of power failure, and motors suitable for operation on the electric current characteristics indicated.

2.20.7.1 Check Valves

****
NOTE: The designer will indicate the type of valves, vertical lift or horizontal, on the drawings.
****

a. Valves for Class 125 125 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 3 or 4, Class 125.

(2) Sizes 80 mm 3 inches through 600 mm 24 inches, cast-iron: MSS SP-71, Type III or IV, Class 125.

b. Valves for Class 150 150 poundclass steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Class 150 minimum.

(2) Sizes 80 mm 3 inches through 600 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends, swing disc.

c. Valves for Class 300 300 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Class 300 minimum.

(2) Sizes 80 mm 3 inches through 600 mm 24 inches, steel: ASME B16.34, Class 300 minimum flanged ends, swing disc.

2.20.7.2 Gate Valves

Unless otherwise indicated or specified, gate valves used as shutoff valves at main headers and elsewhere, as indicated, provide chain-operated type with sufficient chain for easy operation from the operating floor or walkway for gate valves 200 mm 8 inches and larger provide a globe valve bypass. Provide wedge disc type gate valves with outside screw and yoke and bonnet bushings. Provide valve bodies with straight-through ports without recesses except between seats to assure minimum turbulence, erosion, and resistance to flow. Provide motor-operated gate valves installed in the HTW supply and return mains, where indicated, to isolate the distribution zones from the plant in case of a line break. Provide valves that close by a pressure switch operated by return main water pressure with Bourdon tube, actuated mercury switch type pressure switch and with an adjustable operating range of 345 to 2413 kPa 50 to 350 psi. Provide a three-position selector switch for automatic or manual operation of the valve position.

a. Valves for Class 125 125 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 125.

(2) Sizes 80 mm 3 inches through 1200 mm 48 inches, cast-iron:

MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

b. Valves for Class 150 150 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 150 minimum.

(2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends.

c. Valves for Class 300 300 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 300 minimum.

(2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34, Class 300 minimum, flanged ends.

2.20.7.3 Globe Valves and Angle Valves

Provide globe type valves having outside screw and yoke with bolted bonnets, stainless steel trim, and flat seats, and large and deep boxes, but not the reversed cup type. Install valves with the stem horizontal or above. Provide a distribution system bypass motor-operated globe-valved piping connection between the supply and return mains, where required, installed to ensure uninterrupted water flow to the HTW generator in case of low return pressure. While in operation, valve must modulate to the open position on low return main pressure signal. Provide a three position selector switch for automatic or manual selection of valve position. Install for each distribution zone, a manually-operated handwheel or chainwheel globe valve in each high temperature return main to control the flow and the resultant differential temperature drop through each system.

a. Valves for Class 125 125 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 125.

(2) Sizes 80 mm 3 inches through 300 mm 12 inches, cast-iron: MSS SP-85, Type III and Type IV, Class 125.

b. Valves for Class 150 150 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 150 minimum.

(2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends.

c. Valves for Class 300 300 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 300 minimum.

(2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34, Class 300 minimum, flanged ends.

2.20.7.4 Thermostatic Regulating Valve

2.20.7.4.1 Cooling Water Control Valves

Install a thermostatically-operated flow control valve in the cooling water piping from each HTW circulating pump, each air compressor, and each aftercooler to control the flow of the cooling water automatically, to prevent the waste of water, and provide proper operating temperature for the bearings. Provide a valve matching the piping size to which it is connected, suitable for operation on 1,034 kPa 150 psi water pressure, with threaded ends, and direct-acting to open on temperature increase. Provide the valve body to have a 3.2 mm 1/8 inch hole drilled through the wall separating the inlet and outlet ports so that water circulation is not completely shut off. Provide the valve with a nonmetallic disc and means for preventing the water from coming in contact with the range spring and sliding parts, with a manual adjustment of the setting of 29 to 51 degrees C 85 to 125 degrees F and factory set for 38 degrees C 100 degrees F. Provide a temperature bulb for closed tank immersion with 13 mm 1/2 inch NPT connector.

2.20.7.4.2 Makeup Water Heater Control Valve

Install a temperature controller in the high temperature return water line from the feedwater heater coil. Provide a motor-operated valve and operate in conjunction with the remote bulb temperature controller, with both valve and controller the reverse-acting type failing in the closed position. Provide the normal operating range fully open at 79 degrees C 175 degrees F and fully closed at 100 degrees C 210 degrees F feedwater temperature with the controller modulating the flow between these points. Provide a valve with a cast steel body, stainless steel trim, and lubricated deep-type stuffing box with packing suitable for the conditions, and with the valve disc top-and-bottom guided of the equal percentage type. Provide a single seated valve for tight closing, [_____] mm inch body size, flanged, passing [_____] kg/sec pounds/hour of HTW at a maximum pressure drop of 15 m 50 foot head.

2.20.7.4.3 LTW Heater Control Valve

Install a thermostatic control valve to operate in conjunction with a remote bulb temperature controller with the valve operating range of 93 to 110 degrees C 200 to 225 degrees F and with valve modulating the flow of HTW to maintain LTW between these temperatures. Provide valve with a cast steel body with stainless steel trim, and lubricated deep-type stuffing box with packing suitable for the temperature and pressure conditions and be single-seated, [_____] body size, to pass [_____] kg/sec pounds/hour of HTW at a maximum pressure drop of 15 m 50 foot head. Provide the temperature bulb for pipeline insertion with 19 mm 3/4 inch NPT connector with all necessary appurtenances including bypass valve and combination temperature-pressure relief valve

2.20.7.4.4 Domestic Water Heater Control Valve

Install a thermostatic control valve to operate in conjunction with a remote bulb temperature controller with the valve operating range of 38 to 70 degrees C 100 to 160 degrees F, adjustable and modulating the flow of

HTW to the heater between these temperatures. Provide valve with a cast steel body with stainless steel trim and lubricated deep-type stuffing box with packing suitable for the temperature and pressure conditions, and be single-seated, [_____] body to pass [_____] kg/sec pounds/hour of HTW at a maximum pressure drop of 15 m 50 foot head. Provide temperature bulb for pipeline insertion with 19 mm 3/4 inch NPT connector with all necessary appurtenances including bypass valve, strainer, and combination temperature-pressure relief valve.

2.20.8 Back Pressure Relief Valves

Provide back pressure relief valves with steel bodies and equipped with corrosion resistant trim and valve seats, which are guided and provide positive closing so that no leakage can result, with adjustment of the desired back pressure covering the range between 13 to 70 kPa 2 to 10 psig. Provide external adjustment with adjustable stuffing boxes having renewable packing for any shafts extending through the valve body.

2.20.9 Exhaust Heads

Provide exhaust heads for the discharge of flash steam to atmosphere, constructed of one-piece steel plate, semisteel, or cast-iron with suitable baffle arrangement for the removal of entrained condensate and oil, and with drain connection, and with flow area through unit being larger than connecting pipe.

2.20.10 Strainers

Provide strainer body connections of the same size as the pipelines in which the connections are installed. Provide heavy and durable cast steel strainer bodies that have arrows clearly cast on the sides to indicate the direction of flow. Equip each strainer with an easily removable cover and sediment basket, with the basket not less than 0.063 mm 0.0025 inch thick stainless steel, with enough small perforations to provide a net free area through the basket of at least 3.30 times that of the entering pipe, and with the flow into the basket and out through the perforations.

2.20.11 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports conforming to MSS SP-58, except as modified herein.

2.20.11.1 Types 5, 12, and 26

Do not use Types 5, 12, and 26.

2.20.11.2 Type 3

Do not use Type 3 on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

2.20.11.3 Type 18

Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

2.20.11.4 Types 19 and 23

Torque Types 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

2.20.11.5 Type 20

Provide Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

2.20.11.6 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

2.20.11.7 Type 39 Saddle or Type 40 Shield

Where Type 39 saddle or Type 40 shield is permitted for a particular pipe attachment application, use the Type 39 saddle on all pipe 100 mm 4 inches and larger.

2.20.11.8 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and install a support not over 300 mm 1 foot from the pipe fitting joint at each changes in direction of the piping. Do not space pipe support over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. For spacing of the base support members, do not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 3 mm 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

2.20.11.9 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet not more than 2.4 m 8 feet from end of risers, and at vent terminations.

2.20.11.10 Type 35 Guides with Slides

Provide Type 35 guides of steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides, where required, to allow longitudinal pipe movement. Provide lateral restraints as required. Use slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

a. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

b. Where there are high system temperatures and welding to piping is not desirable, then include a pipe cradle with , welded to the guide structure and strapped securely to the pipe. Separate the pipe from

the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

2.20.11.11 Pipe Hangers on Horizontal Insulated Pipes

Size pipe hangers on horizontal insulated pipes, except Type 3, based on the outside diameter of the insulation.

2.20.11.12 Piping in Trenches

****
NOTE: Detail of piping supported in trenches will be shown on the drawings.
****

Support piping in trenches as indicated.

2.21 INSULATION

Shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.22 TOOLS

Furnish special tools and all uncommon tools necessary for the operation and maintenance of boilers, stokers, pumps, fans, controls, meters, special piping systems, and other equipment. Provide a cabinet for small hand tools, mounted where directed.

2.22.1 Smoke Pipe Cleaner

Provide jointed handle cleaner of sufficient length to clean breeching and smoke connections without dismantling.

2.22.2 Firing Tools

Provide firing tools including hoe, poker, and slice bar for each boiler.

2.22.3 Wrenches and Gaskets

Provide wrenches as required for opening boiler manholes, handholes, and cleanouts. Also provide one set of extra gaskets, packaged and identified, for boiler manholes and handholes, for pump barrels, and other similar items of equipment.

2.23 FUEL OIL TANKS

2.23.1 Fuel-Oil Storage Tanks

Provide in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.23.2 Hot-Water Coil

Provide coil constructed of 25 mm 1 inch seamless steel tubing in each tank for No. 6 fuel oil and install around the suction end of the oil line. Provide coil in each tank with the capacity to heat from [_____] to [_____] degrees C degrees F the maximum demand of all oil burners connected to the tank when supplied at 115 degrees C 240 degrees F.

Provide heater with automatic temperature-control valve, with strainer and three-valve by-pass in heated water supply line, and with check valve and cutoff valve in return line. Provide an additional manhole located above the heater for removal of the heater as a unit.

2.23.3 Tank Accessories

Provide accessories in compliance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.24 COAL HANDLING EQUIPMENT

2.24.1 Screw Conveyor

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

provide screw conveyor for the lateral distribution of coal, consisting of steel screw conveyor with capacity of not less than [_____] cubic meters/sec cubic feet/hour when handling coal of the specified maximum lump size. Base the maximum capacity of the conveyor on the screws carrying not more than 30 percent of their cross section (except feeder conveyors), and the maximum speed of conveyor at 60 rpm. Assemble conveyor and housing in sections, with the sectional flights mounted on steel pipe and connected by coupling shafts. A feeder conveyor may be installed to assume the proper distribution of the load. Mount both the feeder screw and the extended screw flights on the same pipe. Provide conveyor with sectional supporting hanger bearings of the babbitted type. Do not exceed 3.6 m 12 feet conveyor length between bearings. Provide trough ends fabricated of cast-iron type with feet and fitted with babbitted bearings, with the drive located at the discharge end of the conveyor, and consisting of an electric gear motor and chain drive. Provide the chain drive from the motor to the reducer enclosed in an oil-tight casing. Absorb the thrust in either direction by the thrust bearings. The motor may be mounted on top of the trough. Provide a dust-proof trough conveyor housing of not less than 4.8 mm 3/16 inch steel with a 1.897 mm (14 gauge) 14 gauge steel cover. Provide discharge spout and coal gate as indicated. Also provide an approved type of supporting saddle. Space supports at not more than 3 m 10 foot intervals. Provide [totally enclosed, nonventilated] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in conformance with NFPA 70] motor enclosure. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [weather-resistant] [dust-tight] [explosion-proof] enclosure.] Provide dust controlling covers and inlet and discharge enclosures for each conveyor.

2.24.2 Belt Conveyor

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.
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Provide belt trough type conveyor, as indicated, with the belt conveyor on

a maximum incline not exceeding 15 degrees. Provide conveyor support frame of sufficient rigidity to maintain belt alignment, at least 75 mm 3 inches clearance to prevent damage to the edge of the belt on its return run, and adjustments for aligning shafts. Provide decking placed on top of the stringers to protect the return belt from coal sifting and to provide lateral stiffness. Provide idlers as a rigid framework that maintains permanent alignment of well-balanced, smooth-running, easy turning idler rolls in accordance with CEMA Belt Book. Pressure lubricate ball or roller bearings. Provide 20-degree or 35-degree three-roll type idlers spaced on 1200 mm 4 foot centers, except under loading points and skirts. Space return idlers on 3 m 10 foot centers. Provide Grade 2 belting with field-vulcanized splices as defined in RMA Conveyor and Elevator Belt Technical Information. Design pulleys in accordance with CEMA B105.1, constructed of heavy welded steel, true to diameter and accurately bored, key seated and tightly fitted to the shafts. Provide pulley face width for belts 1.1 m 42 inches wide and smaller, that are 150 m 500 feet or more in length, to belt width plus 100 mm 4 inches; less than 150 m 500 feet in length, to belt width plus 75 mm 3 inches. Pulley face width for belts 1200 mm 48 inches and larger must be belt width plus 150 mm 6 inches. Provide drive pulleys with 19 mm 3/4 inch thick vulcanized and grooved lagging. Provide snub pulleys with 9.5 mm 3/8 inch vulcanized smooth lagging. Support all conveyor pulley shaft assemblies by two heavy-duty antifriction bearings having a minimum life expectancy of 50,000 hours for 90 percent of bearings in accordance with ABMA 11 for roller bearings. The pulley diameter must be sufficiently large to meet the requirements of the duck weight and ply of the belt to permit flexing of the belt around the pulley circumference without damaging the belt or shortening the belt life. Drive the conveyor by a [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in Class II, Division 1, Group F hazardous location in conformance with NFPA 70] electric motor connected to a drive-shaft-mounted speed reducer unit by a [roller chain drive] [V-belt drive] [flexible coupling]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Provide belt conveyors with belt misalignment switches, emergency stop pull cords and pull switches, galvanized expanded metal shields over tail pulley, zero speed switches, loading skirts, plugged chute switches, walkways, supports, belt takeups, belt cleaners, skirt boards, and pulley scrapers. Provide dust controlling covers and inlet and discharge enclosures for each conveyor.

2.24.3 Flight Conveyor

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.
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Provide [scraper] [shoe-suspended] flight conveyor arranged generally as indicated and of the single-strand type having capacity not less than [_____] metric tons/hour tons/hour when handling coal with approximate weight of 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches diameter. Base the capacity on a maximum speed of 508 mm/sec 100 fpm with conveyor operating up a [_____] degree incline. Provide drop-forged steel type chain with flights made of either steel or malleable-iron, spaced at least three times the largest lump size. Protect foot shaft screw takeup with adjustment of not less than 300 mm 12

inches. Make trough of 4.8 mm 3/16 inch steel plate, minimum. Line all sliding surfaces in contact with the chain or flights with 19 mm 3/4 inch thick, removable, ultra high molecular weight polyethylene liners. Provide each side of trough with a warning sign, visible on each floor level and at frequent intervals; "DANGER - DO NOT WELD - FLAMMABLE PLASTIC LINER." Provide conveyor with discharge openings as indicated, each of which provided with rack-and-pinion-operated gates with handwheels. Provide motor to drive conveyor through a speed reduction unit which is either direct-connected or roller-chain-connected to the drive shaft. Provide [totally enclosed, nonventilated type motor] [totally enclosed, fan-cooled type motor] [totally enclosed, fan-cooled type motor suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] motor starter type with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Construct conveyor frame essentially as indicated, with additional bracing as required for rigidity, and with dust controlling covers and inlet and discharge enclosures.

2.24.4 Bucket Elevators

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

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Provide dust tight vertical bucket elevators complete with continuous chain and attached buckets, upper and lower sprockets, gears, shafts, bearings, casing with flanged connections including top hood and discharge spout, bottom boot, access doors, electric motor drive, and all accessories. Provide [vertical spaced centrifugal discharge] [positive discharge] [continuous bucket type] bucket elevators with capacity of not less than [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meter 50 pcf, and with linear velocity as indicated below:

Type of Bucket Elevator	Linear Velocity (meters per second) (feet per minute)
Centrifugal discharge	1.1-1.6225-305
Continuous bucket	0.51-0.69100-135
Positive discharge	0.61 120 Max

Construct the head shaft and foot shaft of cold-rolled steel with the shaft diameters in accordance with manufacturer's standards, and with both shafts mounted in roller bearings with forced-type lubricating fittings. Provide screw takeup with adjustment of not less than 229 mm 9 inches for the foot shaft. Install an automatic backstop on the head shaft to prevent any backward motion of the chain. Provide boot plates [, loading legs of continuous bucket elevator,] and bottom plate of stub discharge chute a minimum of 4.8 mm 3/16 inch thick steel, and other flat casing members a minimum of 2.657 mm (12 gauge) 12 gauge thick steel. Provide corner angles and stiffeners to make the elevator self-supporting. In addition, tie the elevator to the adjoining structure at close enough spacing to increase the rigidity of the elevator. Provide the boot section with clean-out doors, as well as front and back removable panels.

Also provide an inspection door in the intermediate section at operating level large enough to remove a bucket from either run of the chain. Drive the elevator by an electric motor installed in a housing at the top of the flight. Provide [totally enclosed, nonventilated motors] [totally enclosed, fan-cooled type motors] [totally enclosed, fan-cooled type motors suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Install a platform and a compliant safety access ladder adjacent to the motor for servicing the motor and equipment mounted in the hood. Locate controls for the operation of the elevator as indicated. Provide dust control covers and inlet and discharge enclosures for each conveyor.

2.24.5 Vibrating Conveyor

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.
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Provide electric-motor driven, mechanical vibrating type vibrating conveyor with a capacity of [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meters 50 pcf, with maximum lump size of [_____] mm inches in diameter, and with conveying length as indicated. Fabricate the conveyor trough of [_____] mm gauge steel, [_____] mm inches in width and [_____] mm inches deep [and provided with dust-tight cover]. Provide conveyor pans of 9.5 mm 3/8 inch thick, Type 304L solid stainless steel plate. Mount the trough on vibrator bars, torsion bars, or coil springs attached to yoker legs of rigid cross brace construction and fabricated of corrosion-resistant material with hardened steel encased rubber bushings at articulation points. Fabricate the base of steel channels or angles bolted directly to [building support] [concrete foundations]. Drive through an eccentric shaft supported by a double row of self-aligning ball-or roller-bearing pillow blocks. Impart positive action motion to the trough by a cast steel connecting rod attached to the trough by rubber-bushed wristpin and securely locked by taper lock bushings. Provide [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type suitable for installation in Class II, Division 1, Group F hazardous location in accordance with NFPA 70] electric motor connected to the eccentric shaft by V-belt drive. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.]

2.24.6 Gravimetric Weigh Feeder

Provide metering belt type weigh feeder device designed to operate at a variable rate ranging from 10 percent of maximum capacity to [_____] metric tons/hour tons/hour with an automatic flow rate. Provide a silicon-controlled, rectifier dc drive to automatically adjust the belt speed to maintain the rate of material flow, as set on the controller. The weight feeders conforming to or exceeding the requirements of NIST HB 44, [Southern] [Eastern] [Western] Weighing and Inspection Bureau. Provide the weigh feeders with an accuracy of 1/2 of 1 percent of flow rates over their total variable rated capacity. Provide the feeder with a flexible boot for connecting the gate to the feeder inlet chute

which, in turn, is flared to produce a feed opening tapering from [_____] wide to [_____] wide with the direction of flow of material. The belts for feeders conforming to the RMA IP-1, fire-resistant type conforming to the standards of 30 CFR 1 Schedule 28, Part 34 of the MSHA. Provide top belt cover thickness of 6 mm 1/4 inch with bottom cover 3 mm 1/8 inch thick. Provide belt edges with a minimum 25 mm 1 inch flanges and sealed by carrying the cover around the carcass edges during manufacture. Provide cover and skim coat material comparable to those meeting the requirements of RMA IP-1, Grade 2 for impact and abrasion resistance. Provide the weight sensor constructed of heavy-duty, industrial, electronic force transducer flexure-mounted to the force collection system. Provide remote indicating meter and a six-digit totalizing counter located, installed, and connected in the boiler control panel. Provide unit frame of rigid support for the material load, belt, and idlers. Shop assemble the unit complete with drive and all appurtenances, being dust-tight in operation.

2.24.7 Track Hoppers

Provide standard double hopper design with a belt or vibrating-type feeder as indicated, having a capacity of approximately [_____] metric tons tons and constructed of not less than 9.5 mm 3/8 inch thick, Type 304L stainless steel plates, with slopes of not less than 55 degrees and stiffened with angles. The hoppers may also be of ASTM A36/A36M mild steel, minimum 6 mm 1/4 inch thick with replaceable liners 6 mm 1/4 inch thick, ASTM A167, Type 304L, stainless steel. Provide flat heads on all rivets and field bolts inside the hopper. Suspend the hopper from the track girders by heavy bolts and cast washers, or carry the sides to the bottom of the track and support by flanges fastened to concrete ledge continuously around the hopper with the concrete forming the top portion of hopper sides. Provide track girders consisting of wide flange beams conforming to AREMA Eng Man for loading plus impact, complete with bearing plates, WF cross struts, and rail clips. Fit the top of hopper with sections of grating made with steel bars sized [_____] by [_____] mm inches, and cross rods [_____] mm inches in diameter, to form openings [_____] mm inches square.

2.24.7.1 Rack-and-Pinion Gate

Provide a self-cleaning type rack-and-pinion gate at each hopper outlet. Provide [hand] [motor]-operated sliding plate of 9.5 mm 3/8 inch thick carbon steel, formed into the shape of a winged U with the gate plate surface completely protected by an overlapping liner of 3 mm 1/8 inch thick, ASTM A167, Type 304L stainless steel. Use 4.8 mm 3/16 inch thick ASTM A167, Type 304L stainless steel where in contact with coal flow for gate body material, except for the dust cover.

2.24.7.2 Vibrating or Belt Feeders

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

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provide vibrating or belt feeders of manufacturer's standard design for the service required. Provide [totally enclosed, nonventilated] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in

accordance with NFPA 70] motor. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starters with [weather-resistant] [dust-tight] [explosion-proof] enclosure.]

2.24.8 Truck Hoppers

Provide standard double hopper design with a belt or vibrating type feeder as indicated having the capacity of approximately [_____] metric tons tons and constructed of 9.5 mm 3/8 inch thick Type 304L stainless steel plates, minimum, with slopes of at least 55 degrees, and stiffened with 6.4 mm 1/4 inch angles, minimum. The hopper may also be of ASTM A36/A36M mild steel, minimum 6.4 mm 1/4 inch thick with replaceable liners 6.4 mm 1/4 inch thick, ASTM A167, Type 304L stainless steel. Use flat head type rivets and field bolts inside the hopper. Support the hopper by a flange fastened to the concrete ledge continuously around the hopper, with the concrete forming the top portion of hopper sides. Fit the top of hopper with section of bar grating made with [_____] by [_____] mm inch mild steel bars and [_____] mm inch diameter cross rods to form openings [_____] mm inches square. Provide a supporting beam not less than [_____] mm inches deep, [_____] kg/meter pounds/foot, in a wide flange member, under the grating.

2.24.8.1 Rack-and-Pinion Gate

Provide a self-cleaning type rack-and-pinion gate at each hopper outlet. Provide a [hand] [motor]-operated sliding plate of 9.5 mm 3/8 inch thick carbon steel, formed into the shape of a winged U with the gate plate surface completely protected by an overlapping liner of 3.2 mm 1/8 inch thick, ASTM A167, Type 304L stainless steel. Provide the gate body material, except for the dust cover, of 4.8 mm 3/16 inch thick ASTM A167, Type 304L stainless steel where in contact with coal flow.

2.24.8.2 Vibrating or Belt Feeders

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

Provide vibrating or belt feeders complete with control of manufacturer's standard design for the service required. Provide [totally enclosed, nonventilated] [totally enclosed, fan-cooled] [totally enclosed, fan-cooled type, suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] motors. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [weather-resistant] [dust-tight] [explosion-proof] enclosure.]

2.24.9 Vibrator

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

Provide electromagnetic type vibrator with variable power control that produces mechanical pulsating motion, with the net weight of the vibrator [_____] kg pounds and power input [_____] watts, [_____] amperes at

[_____] volts ac, and provide 3600 vibrations per minute or 7200 vibrations for heavy duty applications. Provide semi noiseless vibrator with mounting plates for welding to hoppers as indicated, each complete with an eye bolt for attaching a safety chain. Provide vibrator electric control suitable for separate wall mounting complete with an electronic valve for changing alternating current to mechanical pulsating waves and a dial switch or rheostat to vary the power of vibration. Provide vibrators with Division I, Class II, Group F rating in the areas where coal dust is present, in accordance with NFPA 70.

2.24.10 Car Heaters

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NOTE: The designer will determine if electrical facilities are sufficient to provide the power requirements of electric car heaters or if gas-fired heaters must be used. The designer will determine if the location and climatic conditions will require sidecar panels or undercar heaters, or a combination of both types of heaters.

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2.24.10.1 Gas-Fired Heaters

Provide infrared radiant type gas-fired heaters located between rails and along the walls of the shed with heater input capacity of approximately 90 kW 300,000 Btuh. Provide perforated, heavy-gauge stainless steel cover for the heater, that is not affected by water or coal falling from the car, with windproof burner pilot, main gas solenoid valve, safety switch to interrupt gas supply to burner if pilot is not burning, furnished with manual cutoff valves and pressure regulator, with electric blower for furnishing combustion air to the burner, and with all other controls and accessories as recommended by the heater manufacturer for a complete installation, in compliance with ANSI Z83.19/CSA 2.35 and UL 795.

2.24.10.2 Electric Infrared Radiant Heaters

Provide electric infrared radiant heaters as weatherproof car thawing equipment, with radiating surfaces of alloy tubing enclosing electrically insulated conductors, designed for hazardous area locations. Provide equipment in modular lengths suitable for both 45 and 90 metric tons 50 and 100 ton capacity cars and designed for not requiring [manual] [automatic] disconnection of units during thawing operations. Provide heaters for sidecar or undercar heating banks, or both, capable of operating as independent units designed for maintaining a balanced three-phase distribution system with heating conductor units, including factory assembled connections for attachment to water-tight terminal boxes, supported on corrosion-resistant metal framing and having rust-resistant steel reflectors with an approved coating. Provide heaters connections wired using NEMA 4 enclosures, in accordance with NEMA ICS 1, suitable for cleaning by hosing down with water.

2.24.11 Coal Spouts, Chutes, Inlet Boxes, and Outlet Hoppers

Construct coal spouts, chutes, inlet boxes, and outlet hoppers of ASTM A36/A36M steel members not lighter than 3.416 mm (10 gauge) 10 gauge, adequately reinforced and braced with angle frames, and with all joints dust tight. Slope as steep as possible, but not less than 55 degrees off horizontal. Provide stainless steel or ultra-high molecular weight

polyethylene (UHMWP) liners. If UHMWP liners are used, provide each side of chute at each floor level with a warning sign "DANGER - DO NOT WELD - FLAMMABLE PLASTIC LINER." Provide impact liners. Provide access openings and inspection openings with cover plates as indicated and required. [Provide silo frames constructed of heavy channel frames the full size of the silo opening and with concealed steam pipe and coil around opening.] [Provide outlet hoppers with rack-and-pinion type gates and lined with austenitic stainless steel [_____] mm inches thick, conforming to ASTM A167, Type 304L]. Use rack-and-pinion type gates for track hoppers.

2.24.12 Car Spotter

Provide electric-motor driven car spotter having a capstan mounted vertically on a rigid housing that completely encloses the gears, including helical gears and worm gear; fabricate the helical gears of high grade steel accurately finished and splash-lubricated, and fabricate the worm gear of bronze. Mount all of the mechanism on a steel base rigidly welded to maintain alignment. Provide the unit coupled to, and driven by, a separate, [_____] W hp, totally enclosed, nonventilated, hoist-type motor with a full-load speed of 1720 rpm. Provide roller-chain flexible type coupling enclosed in a revolving casing and protected by a heavy steel guard. Provide a unit with a starting pull of 23 kN 5000 pounds, a running pull of 11 kN 2500 pounds, and an average rope speed not in excess of 230 mm/sec 45 fpm, complete with [_____] m feet of [32 mm 1-1/4 inch diameter manila rope with a breaking strength of 60 kN 13,500 pounds, minimum,] [19 mm 3/4 inch diameter marline-covered standard steel wire rope with a breaking strength of 170 kN 37,600 pounds, minimum,] and a steel car pulling hook with an allowable rope pull of 45 kN 10,000 pounds, so fabricated as to be readily attachable to, and removable from, the car frames.

2.24.13 Coal Bunkers

Provide suspension coal bunkers of size and capacity indicated, constructed of ASTM A36/A36M steel plate, reinforced and braced as required, and installed dust-tight, of a design optimized for coal flow, not susceptible to rat-holing or hangups. Provide cylindrical or silo type bunkers to reduce stagnation for each boiler, each with conical discharge hoppers and slopes not less than 70 degrees, with the outlet cone manufactured of, or lined with, ASTM A167, Type 304L stainless steel. Provide rack and pinion type coal shutoff valves, self-cleaning, and dust tight for bunkers. Use corrosion resistant steel for valve materials exposed to flowing coal. Provide an emergency diverter for emptying the bunker.

2.24.14 Coal Storage Silos

2.24.14.1 Silo Walls

Silo walls may be slip-formed, cast-in-place reinforced concrete, precast concrete, or other approved construction materials. use concrete having a 28-day compressive strength in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide silo roof of reinforced concrete complete with 600 mm 24 inch square, weatherproof, hinged access door, and handrail and steel toe-board all around roof of the silo. Provide live storage shelf for the silo of reinforced concrete sloped not less than 60 degrees from horizontal and supported by steel beams corbelled from the inside walls of the silo. Provide live storage outlet hopper to chute and feeders constructed of not lighter than 9.5 mm 3/8 inch steel with a silo

reserve storage floor constructed of reinforced concrete, sloped not less than 60 degrees and laid on well-tamped fill material. Provide reclaim outlet hopper to the chute feeding the flight feeder constructed of of not lighter than 9.5 mm 3/8 inch steel.

2.24.14.2 Concrete Stave Silo

Finish the interior finish with a three-coat concrete parget, consisting of a brush coat, scratch coat, and a finish trowel coat applied, one after the other, to produce a smooth monolithic finish. Work the parget into the vertical and horizontal grooves to permanently interlock the concrete staves.

2.24.14.3 Exteriors of Stave And Concrete Silos

Cover the exteriors of stave and concrete silos with a brush coat of gray cement applied over all hoops, lugs, and staves to produce a homogeneous finish.

2.24.14.4 High- and Low-Level Switch

Mount a normal high-level and emergency high-level control switch at the top of the silo to shut off the feeding system when the silo is full of coal. Provide a low-level switch at the low level of the silo's live storage shelf, as indicated, to signal by light that coal is at a low level in the live storage compartment and also provide switches near the bottom of the silo, as indicated, to signal by light that coal is at a low level in the reserve storage compartment. provide switches for Class II, Division 1, Group F hazardous location in accordance with NFPA 70.

2.24.15 Coal Crusher

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

Select the appropriate type of crusher, based on the throughput requirements and an economic analysis.

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Provide [roll crusher] [hammermill] coal crusher for maximum lump size of [_____] mm inches with a minimum capacity of [_____] metric tons/hour tons/hour when handling average size bituminous coal. Provide a heavy-duty cast or welded heavy steel plate housing with the interior of the housing fitted with replaceable liners, constructed of abrasion resistant steel. Provide replaceable breaker plate, grates, rolling rings, swing hammers, and other parts of the unit subject to excessive wearing. Fit the crusher with provisions to trap and reject hard foreign objects without damaging the crusher. Provide shafts constructed of forged, heat-treated alloy steel with bearings mounted in dust-tight housings. Provide [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] motor. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.]

2.24.16 Vibrating Feeders

Provide [electro-magnetic] [electro-mechanical] [single input (Brute Force)] type vibrating feeders with a capacity of 0 to [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches in diameter, and fitted with replaceable feeder pans and skirts [6.4] [9.5] [12.7] mm [1/4] [3/8] [1/2] inch thick, Type 304 solid stainless steel plate without liners. Fabricate the feeder pan to [_____] mm inches in width, [_____] mm inches in length, and [_____] mm inches deep. Provide dust control covers of 3.416 mm (No. 10 gauge) No. 10 gauge thick steel for each unit. Provide [two] [four] rectangular poke holes ([one] [two] each side) with 6.4 mm 1/4 inch thick Type 304L stainless steel sliding covers. Fabricate all feeder parts coming in contact with coal of, or lined with, Type 304 stainless steel. All feeders must automatically compensate for material headloads and weight effect to maintain a constant feed and must not damper out when operating under full silos or bins. Do not exceed 10 degrees slope on pan. Provide the vibratory feeders with [foot] [suspension] mounted supports. Provide suspended feeders with safety cables with their drives located [above] [below] trough. Provide [totally enclosed, nonventilated type motors] [totally enclosed, fan-cooled type motors suitable for installation in Class II, Division I, Group F hazardous location in accordance with NFPA 70].

2.24.17 Tripper

Provide the tripper of steel construction, motor propelled, automatically reversible, or manually controlled; equipped with antifriction bearings throughout, rolled or forged steel wheels, hand-operated rail clamps for optional operation in a fixed location, scraper, and crossover walk with handrail and with the traversing speed not exceeding 127 mm/second 25 fpm, and include a motor brake. Provide the chute one way toward the center of the silo sloping at not less than 55 degrees. Provide a plow type seal with all necessary components for installation to suit the bunker/silo slot. Provide the tripper with [_____] W hp motor, all reversing and end travel limit switches, cable reel, and 14 No. 12 AWG conductor cable (13 slip rings) and supports for the starter,with two push-button stations mounted, one on each side of the tripper. Provide both stations with forward-reverse and tripper stop-run push buttons. Provide the conveyor frame with a ladder type cable tray to contain the cable from the reel. Mount reversing switches on the tripper and actuate by track dogs to permit reversal of the tripper over each extreme silo. Mount limit switches on the tripper to operate immediately beyond both extreme limits of tripper reversal. Provide a plugged chute switch. Provide all tripper controls, including limit switches and reversing switches, in explosion-proof enclosures approved for Class II, Division 1, Group F service, in accordance with NFPA 70. Include pulley assemblies, shafts, bearings, carrying and return idlers, tripper framing and supports.

2.24.18 Trackmobile

Provide trackmobile with a [_____] liter cubic inch industrial gasoline engine for moving/switching [_____] rail cars on the track and hauling carts and other portable vehicles while traveling on its road wheels. Design the trackmobile to ride on [_____] mm inch gauge track with heat treated, cast steel, rail wheels keyed on tapered axles, and solidly mounted suspension system. Provide heavy duty, [_____] ply, [_____] by [_____] tires, roller-bearing mounted road wheels, with retractable suspension. Provide heavy-duty, cast steel coupler, remotely controlled

from cab. Do not exceed maximum speed on rail of (km/hour) (mph) low [_____], high [_____]; on road, low [_____], high [_____]. The trackmobile must be able to operate on a maximum grade of [_____] percent and minimum curve of [_____] foot radius and be equipped with [air brakes] [self-energizing drum and shoe type, hydraulic service], cab heater and defroster, sanders, [electric horn] [air horn] strobe light, front and rear lights, back-up alarm, [enclosed cab] [open cab] with windshield wipers [,radio remote control,] and power steering.

2.24.19 En-Masse Chain Conveyors

These conveyors move materials horizontally and/or vertically, with multiple discharge points and in a dust-tight and completely enclosed unit. Provide conveyors at length indicated but do not exceed 75 m 250 feet, and capacity of [_____] metric tons/hour tons/hour when handling coal with approximate weight of 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches diameter. Base the maximum capacity on a chain speed not to exceed 800 mm/sec 160 fpm. provide a drop-forged, case hardened, steel alloy of the single-strand type chain with flights welded to the chain links, or integral chain and flights type, with link hardness at 500-600 BHN. Provide a dust tight conveyor casing of 6.4 mm 1/4 inch thick ASTM A242/A242M high strength, low alloy steel with 3.416 mm (No. 10 gauge) No. 10 gauge cover of the same material. Provide the casing with T-1 steel (ASTM A514/A514M, Type B) removable liners, with liners being 19 mm 3/4 inch thick on the bottom, and 13 mm 1/2 inch thick on the sides, 19 mm 3/4 inch T-1 steel wear bars provided for the empty run of the conveyor. Attach liners and wear bars to the casing using countersunk stainless steel bolts with stainless steel nuts and washers. Provide heat treated, induction hardened to a minimum depth of 6.4 mm 1/4 inchdrive sprocket with heat treated drive shaft designed and sized based on ANSI/AGMA 6113AGMA 6013 requirements. Provide spherical double roller bearings with a dust seal where the drive shaft ends go through the casing. Provide the conveyor with inlet and outlet spouts, inspection doors giving access to the drive sprocket, cleaner and wear surfaces, with chain tension controlled by a screw take-up. Provide each discharge opening with rack-and-pinion-operated gates with [handwheels] [motor operated] [air operated]. Drive conveyor through a speed reduction motor unit which is either direct-connected or roller-chain-connected to the drive shaft with motor being [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled] type suitable for installation in a Class II, Division 1, Group F Hazardous location in accordance with NFPA 70. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Construct conveyor frame as indicated, with supports and additional bracing as required for rigidity.

2.25 ASH HANDLING SYSTEM

2.25.1 Boiler Room Ash Handling System

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NOTE: When specifying boilers with capacity of 4.1 MW 14 million Btuh or less per boiler, paragraph Ash Hopper and subsequent paragraphs will be deleted, except applicable portions of paragraph Ash Silo through paragraph Rotary, Dustless Unloader will be retained.

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Provide dry pneumatic type ash handling system in stoker fired boilers, which gathers ash from the boiler forward ash discharge grate hopper and from [economizer] [air preheater] ash discharge hopper and other filtration systems and discharges to the ash storage silo located outside of the building. Coordinate the entire system to fit the equipment supplied. Include ash dust control conditioners to reduce fugitive dust emissions during discharge of ash from the storage silo.

2.25.1.1 Ash Hopper

Construct the ash removal hopper for each boiler of 6.4 mm 1/4 inch thick steel plate, minimum, with suitable external structural steel supports for connection to boiler ash hopper and necessary internal anchors for holding refractory lining in place, with refractory lining 225 mm 9 inches thick on vertical walls and 150 mm 6 inches thick on feed plates. Provide each hopper with a sliding ash gate and dach boiler sliding gate unit with an access compartment to allow gathering and cooling of ash. provide a cast-iron grate along with a manually-operated air-tight inlet valve for feeding ash into the pneumatic gathering line. Provide a hinged, steel access gate at each compartment. Provide spring loaded air intakes at the end of each header. Base the structural integrity of the hopper on the ash weight of 1120 kg/cubic m 70 pcf.

2.25.1.2 Clinker Grinder

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NOTE: Delete this paragraph if coal analysis indicates no possibility of slag formation.
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Provide the clinker grinder unit with [_____] mm inch wide double roll for each hopper outlet gate housing, with grinders having manganese steel rolls and cast-iron housings and with grinder shafts mounted on outboard bearings protected by a stuffing box and gland assembly. Provide grinder shafts through stuffing boxes equipped with packing rings and lantern rings for seal water flow. Provide a reversing mechanism to reverse direction of the clinker grinder rolls should an obstruction stall the grinder. Provide a 9.5 mm 3/8 inch steel plate ejector feed hopper below each clinker grinder to feed the inlet of the pneumatic ash gathering system, with fixed passages in the clinker grinders preventing discharge of particles too large to be handled by the pneumatic conveying system. Drive each clinker grinder with a totally enclosed type motor and provide with a reversing starter, pressure switch for seal water control, diaphragm-operated seal water valve, and a solenoid valve. Design units for the characteristics of the coal specified and provide capability of handling bottom ash at a rate exceeding the conveying system capacity.

2.25.1.3 Conveyor Piping

Make conveyor pipe and fittings of an abrasive-resisting alloy metal cast by the sand-spun process, having a minimum Brinell hardness of 280, with wall thickness not less than 13 mm 1/2 inch and pipe lengths not exceeding 5.5 m 18 feet. Make joints air tight with flanges or sleeve pipe couplings. Provide fittings to have a Brinell hardness number of approximately 400 and with removable wearbacks, where applicable, or of the integral wearback type. Design ash inlet fittings so that the ash cannot overload or clog the conveyor pipeline. Provide adjustable supports or hangers. Provide vacuum hose connections as indicated and

include 4.6 m 15 foot lengths of vacuum hose with quick connectors and four floor sweep-up nozzles.

2.25.1.4 Vacuum and Combination Vacuum/Pressure Systems

2.25.1.4.1 Vacuum System

Provide pneumatic suction type ash conveying equipment, complete with vacuum pumps and all component parts necessary for complete and successful operation, sized approximately twice the predicted accumulation rate. The system must have the capacity to convey and empty not less than [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf. Base the tonnage on average handling rate and not on the instantaneous rate.

2.25.1.4.2 Combination Vacuum/Pressure Systems

Provide vacuum/pressure equipment that is commercially produced for this particular type of service and including a pressure vessel equipped with a filter section at the top and an aeration ring at the bottom. Draw material into the unit by vacuum, with the air separated from the material in the top filter section and exhausted through a silencer. Provide a high level indicator within the vessel that can through a silencer and filter unit and discharging the pressurized air into the vessel. Utilize part of the air to clean the filter and pass part of the air through the aeration ring of the vessel to pick up material and convey it under pressure to the storage silo. Furnish the unit complete with all automatic air control valves to control air flow to and from the vessel continuously through the two modes of the operating cycle continuing automatically until switched off at the control cabinet. Provide skid mounts for all automatic valves, interconnecting piping, and the vacuum/pressure vessel must be skid-mounted with vacuum/pressure pump mounted separately. The control cabinet may be mounted separately or skid-mounted on the vacuum/pressure vessel skid. Provide unit capacity to be approximately [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf. Provide piping sizes for ash collection system designed to fit the unit supplied. Use a vacuum/pressure system where storage silo is more than 150 m 500 feet from the boiler plant. Provide a vacuum system should be used for capacities of less than 45 metric tons/hour 50 tons/hour per system.

2.25.1.4.3 Pump Unit

****

NOTE: Where characteristics of the fly ash require additional treatment, incorporate a water spray in the filtering unit. If not required, delete the portion included in the brackets. Air discharged to the atmosphere must meet the local air pollution standards.

****

Size the vacuum or vacuum/pressure pump unit to match system design requirements with pump unit being liquid-ring type having round rotor with curved blades rotating in an elliptical casing. Provide the required pumping action with water alternately entering and leaving the chambers within the rotor vanes. Provide water within the casing that does not act as an air cleansing agent with the operation and maintenance of the unit not being affected by dust-laden air. Provide base-mounted unit with

electric motor drive and all required heat exchangers, separators, and control valves. Provide the vacuum pump inlet piping with a vacuum filter unit to remove the fly ash obtained from the economizer ash hopper. Provide a filter unit in a metal housing that contains filter bags removing all fly ash before discharge to the atmosphere and an automatic air purge back-washing system. [Incorporate a water spray into the filtering unit.]

2.25.1.4.4 Control Cabinet

Provide a control cabinet for the complete operation of the system and include all running indicating lights as required. Provide a push-button switch conveniently located in the boiler house to start and stop the system. Provide a vacuum breaker, operating automatically from a timer, in the bottom ash conveyor line to break the system vacuum.

2.25.1.4.5 Controls

Provide a selector switch set to automatic position to start the unit in the vacuum cycle with the controls for the combination vacuum/pressure system . Provide a high-level indicator in vacuum/pressure vessel to actuate necessary controls to cut off the vacuum gathering system and pressurize the vessel for pressure discharge of collected material. Provide a low-pressure switch in the control panel that senses the pressure drop in conveying pressure and returns the unit to vacuum operation. Provide a unit that operates continuously in this manner until manually shut down. Provide a selector switch that in the manual position shuts the unit down after filling. Discharge is then accomplished by pressing the manual discharge button. Provide a high vacuum switch with time delay to shut the system down automatically in the event none of the inlet valves are actuated. Provide heavy duty switches and controls in accordance with NEMA ICS 1.

2.25.1.4.6 Automatic Air Valve

Provide an automatic air valve at economizer or air preheater ash inlet hopper discharge slide gate to allow air into system without causing a vacuum within the boiler ash hopper. Provide slide gate as part of the ash system to be manually-operated and interlocked to actuate the automatic air inlet valve.

2.25.1.5 Ash Silo

Provide an ash storage silo with a capacity of not less than [_____] metric tons tons of ash and fly ash considered to have an average weight of [_____] kg/cubic meter pcf with the capacity based on a minimum of 24 hours [60 hours if ash cannot be removed on weekends]. Construct the silo of welded steel with a cone bottom for truck filling and supported on a structural steel tower with all elements exposed to the exterior designed for wind loads of [_____] kg/square meter psf. Provide a 4.3 m 14 foot clearance under the hopper outlet fitting or appurtenance. Provide silo with steel ladder and safety cage from the ground level to roof, steel ladder inside storage bin, and an angle railing around the roof perimeter, with a minimum plate thickness of 6.4 mm 1/4 inch. Provide silo complete with all accessories required for an operable installation including, but not limited to, high ash level detector, roof manhole, pressure and relief valve, and other roof openings, as necessary. Finish the interior coating with coal-tar epoxy conforming to SSPC Paint 16.

2.25.1.5.1 Ash Storage Silo

Provide an ash storage silo for vacuum system with two stage separators [and a tertiary bag filter], with the primary receiver being cylindrical and constructed entirely of sectional steel or cast plates suitable for this special service. Provide a receiver not less than 900 mm 3 feetin diameter. Provide flanges and bolts on the outside, and the impact of ash directed against heavy iron wear plates of abrasive-resistant alloy. Provide the receiver with an air-tight discharge passage not less than 450 mm 18 inches in diameter for free flow of clinkers and include a means for positive, periodic, and automatic operation in dumping its entire contents into the silo. Design the system so that all suction is positively shut off from the receiver during its dumping period so that no dust can be sucked out through the exhaust while the discharge of the receiver is open or opening with the air from the primary receiver entering an external secondary separator removing 90 percent of the dust not collected by the primary receiver. Provide a combined efficiency of the primary and external secondary separators [and tertiary bag filter] of not less than 98 percent. Provide the secondary separator similar to the primary receiver in construction but of smaller and of lighter material. Do not allow any part of the discharger to extend into the main storage bin. Construct the housing of 6.4 mm 1/4 inch steel plate with a tight-closing access door provided as an enclosure for the discharger.

2.25.1.5.2 Silo Vent Filter

Mount the silo vent filter unit on top of the silo, acting as an air release unit to separate the air from the ash, with the ash dropping into the silo. Provide automatic back cleaning of the bag filters utilizing plant air at approximately 690 to 860 kPa 100 to 125 psig that is actuated whenever the ash handling system is in use, and with dust released from the filter bags in the back cleaning operation falling into the storage silo. Provide housing to allow the unit to operate exposed to the weather in ambient temperatures ranging from -40 degrees C to plus 55 degrees C -40 to plus 130 degrees F.

2.25.1.5.3 Rotary, Dustless Unloader

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

Provide a rotary, dustless unloader to eliminate all dust in unloading ash and dust from the ash storage silo. Do not add water to the ashes in the conveyor or in the storage bin. Provide a dustless unloader to add water to the ash in controlled quantities so that no surplus water runs or drips from the ash after discharge with the discharged ash being muddy but loose and free flowing. Water valve must open only when drive motor is running. Provide an unloader with capacity of not less than 27 metric tons 30 tons of conditioned ash per hour. Design the rotating unit so that all bearings are located on the outside and not in contact with the material handled. Provide a platform for access to unit, with a handrail and a safety ladder to grade. Provide a totally enclosed type motor for outdoor operation. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [weather-resistant] [water-tight] [dust-tight] enclosure.]

2.25.1.6 Conveyor Type Ash Handling System

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NOTE: When specifying boilers with capacity greater than 4.1 MW 14 million Btuh per boiler, this paragraph through paragraph Elevator Conveyor will be deleted.
****

Provide funnel shaped ash pits, constructed of 6.4 mm 1/4 inch steel plate, minimum, and covered with a heavy grating with openings approximately 50 mm 2 inches square to receive ashes and clinkers discharged from the boiler ash hoppers into ash pits located directly below the ash hopper doors. Arrange combination drag chain conveyor for horizontal conveying and an elevator conveyor for vertical conveying of ashes as indicated to take ashes from the bottom of the ash pits for discharge into the ash silo. Provide conveyors to have a capacity of not less than [_____] metric tons/hour tons/hour when handling ashes weighing approximately [_____] kg/m pcf at a maximum speed of 508 mm/second 100 fpm. Provide doors for access to all parts, as required. Provide [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type motors] [totally enclosed, fan-cooled type motors suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starters with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.]

2.25.1.6.1 Drag Chain Conveyor

Provide a drag chain conveyor of a single strand of wide, heat treated, high alloy, drop forged rivetless drag chain with a [_____] mm inch pitch, [_____] mm inch overall width, and [_____] kg pounds working strength, and having a hardness of 460-510 Brinell, with the upper strand of the chain conveying the ash in a trough constructed of 9.5 mm 3/8 inch cast-iron extending from [_____] mm inches in front of the foot shaft to [_____] mm inches behind the head shaft and set flush with the floor. Carry the return strand of chain in angle runways set flush with the trench floor. Drive the drag chain conveyor by a [_____] mm inch pitch roller chain and [_____] mm inch pitch diameter, [_____] tooth sprocket on the drive shaft, and a [_____] mm inch pitch diameter, [_____] -tooth sprocket on the elevator foot shaft.

2.25.1.6.2 Elevator Conveyor

Provide elevator conveyor of a single strand chain positive discharge type with head and takeup with the casing constructed of 2.657 mm (12 gauge) 12 gauge steel, minimum, with 9.5 mm 3/8 inch thick boot plates. Provide the head-end drive to include a gear motor and steel roller chain complete with drive brackets, guards, and backstop. Equip the elevator with head-end platform and ladder.

2.25.2 Ash Handling Controls

Provide a control panel for the ash handling system control containing all necessary instrumentation, including selector switches, annunciators, push buttons, and ammeters required for monitoring and operation of the ash handling system, with graphically display of the system. In addition, provide a panel containing all necessary timers, relays, and terminal blocks that are required for the control system with control and

monitoring of the ash removal system from a single panel having pushbuttons to start automatic operation of each system and also pushbuttons for individual control of each component. Provide the panel with sufficient instrumentation to observe the removal operations and controls to permit effective emergency control, with local control stations at each ash removal point for local manual operation. Provide local selector switches so that equipment may be operated manually for test and maintenance purposes. Control the operation of the bottom ash system by a microprocessor-based control system, a solid-state programmable controller, or an electro-mechanical system. Provide for controls and instrumentation located indoors with NEMA 12 rating, in accordance with NEMA ICS 1. Provide NEMA 4 rating for all outdoor components in accordance with NEMA ICS 1. Factory mount ,major equipment components, including control panels and devices, prewired, tubed, and tested to the maximum practical extent with the controls for fully automatic and sequential operation of the ash handling system. Design these controls so that manual steps, such as continuous monitoring and regulation are not required. Incorporate safety interlocks to assure that proper permissive conditions have been met prior to changing the operating status of major system components. Provide automatic shutdown of the ash handling system, or portion thereof, with alarms, should unsafe conditions arise during operation of the system. Provide facilities for monitoring and control of the ash handling system for the following functions:

a. Manual start of the automatic control operations.

b. Selection of operating components.

c. Override of the automatic control sequences, both at the ash handling control panel and locally.

d. Manual operation, either remotely from the control center or locally.

e. Emergency shutdown on a unit or system basis.

f. Status monitoring at the ash handling control panel of the operation of the ash handling system and its components.

The automatic controls for bottom ash collection transport must operate as specified. When a start command has been manually initiated, the automatic ash collection and transport sequences for the unit progress through their complete cycles, shutting down the after completion of the cycles. Include an annunciator system, complete with audio and visual alarms, as part of the ash handling control panel, with the annunciator system receiving inputs from devices and system logic, indicating any out-of-specification or trip condition. Provide recorders to provide a permanent record of selected variables that relate to the ash handling system's performance and operation. Provide control stations supplied with analog control loops that provide bumpless transfer between the manual and automatic modes of operation, with the manual mode of operation providing direct control of the end device with no intervening analog control components unless those components are powered by the same source as the end device.

2.25.3 Submerged Drag Chain Conveyor (SDCC)

Design submerged drag chain conveyor to extract ash at normal capacity [_____] metric tons/hour TPH and maximum capacity [_____] metric tons/hour TPH, based on a dry ash density of approximately [_____] kg/cubic meter pcf

with the maximum chain speed of 76 mm/sec 15 fpm. Design the SDCC for continuous operation having a storage capacity of [_____] cubic meters cubic feet accumulation with the SDCC having an upper compartment filled with water and a dry lower compartment, and with the equipment maintaining water temperature at approximately 60 degrees C 140 degrees F. Provide a dewatering slope an angle of [_____] degrees with the horizontal and a top trough of not less than 9.5 mm 3/8 inch thick carbon steel plate, welded construction, lined with renewable abrasion resistant steel wear plates, with a minimum thickness of 13 mm 1/2 inch and 380 BHN. Grind all welds smooth. Provide the necessary track guide angles, hold-down angles, and carbon steel chain protectors. Provide the minimum depth of water in the upper trough [_____] meters feet. The return chain bottom trough must be dry, constructed of 9.5 mm 3/8 inch thick steel plate, stiffened and braced with structural shapes and water-tight. Provide chain track angles with a minimum 13 mm 1/2 inch thick steel replaceable wear flats with a minimum 300 BHN and include wear strips under the return flights, minimum 13 mm 1/2 inch thick and 50 mm 2 inches wide. Provide a double strand round-link or ship-type conveyor chain, case hardened, corrosion and abrasion resistant, chrome-nickel-alloy, annealed and carburized with surface hardness between 500-630 BHN, with design strength and pitch based on operating conditions. Provide conveyor flights [_____] mm inches deep by [_____] mm inches thick T-1 steel plates attached on both ends to the chain with each flight provided with top wear pads and bottom wear strips of abrasion resistant steel plate of 300 BHN minimum. Provide a chain tensioner at the tail end of SDCC for maintaining proper tension in both strands of the chain. Include cast-iron idler wheel, bearings, shaft, guide block and bearing housing for the assembly. Fabricate the idler assemblies for both troughs to include heavy duty spherical roller type bearings with external lubrication fittings. Iinclude cast iron wheels with removable, surface hardened, toothed segments, drive shaft, bearings for the chain drive assembly. Provide a hydrostatic driven unit coupled with a low speed, high torque hydraulic motor, built-in torque limiting valves for preventing damage to load train or electric motor for the conveyor, with speed regulation, self-lubrication, internal cooling, and dynamic braking provided with the drive, and include inching capability. Provide hinged inspection doors, windows, and removable panels along the conveyor to permit access and observation at critical points. Construct inspection doors, windows, and removable panels in mild steel with stainless steel hardware and make completely water-tight. Provide water cooling and drainage connections through flanged connections to the conveyor trough with provision for continuous water flow into the top trough of the conveyor including two overflow connections, one for normal level and one high level, including high level alarm and an overflow weir box to prevent drain clogging. Provide chain cleaning sprays.

2.25.4 Dense Phase Ash Handling

Provide a pneumatic dense phase type, complete with transfer vessels, solenoid valves, air receiver tank, air producer and ash conveying piping for the ash conveying system. Design the ash handling system to handle [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf with each transport vessel bolted to the hopper discharge flange where ash flows into vessel by gravity until a level indicator indicates the vessel is full. The transport vessel inlet valve then closes, and transport air between 170 to 345 kPa 25 to 50 psi enters the vessel through a fluidizing unit located at the bottom of the vessel. When the vessel has been brought to transport air pressure, the transport line valve opens and a "slug" of fly ash is transported to the storage silo. Provide Schedule 40 transporting pipe, standard black iron pipe

[_____] mm inches diameter. Base design on the material velocities in the transportation pipe of [_____] meters/sec fpm but not in excess of 5 meters/sec 1000 fpm utilizing 210 to 415 kPa 30 to 60 psi compressed air to fluidize the transmit ash.

2.25.5 Fly Ash Collectors

Fly ash collectors are as specified in Section 44 10 00 AIR POLLUTION CONTROL. Provide and size ash collectors to handle total flue gas at maximum boiler load and stack temperature, and include induced draft equipment. Coordinate fly ash collector requirements with boiler draft and control requirements.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Install boiler and auxiliary equipment as indicated and in accordance with manufacturers' instructions.

3.3 EARTHWORK

Perform excavation and backfilling for tanks and piping as specified in Section 31 00 00 EARTHWORK, except conform backfill for fiberglass reinforced fuel tanks to the manufacturer's installation instructions.

3.4 STORAGE TANK INSTALLATION

Install storage tank installation in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.5 PIPING INSTALLATION

Cut pipe accurately to measurements established at the jobsite, install without cold springing, and clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted. Free piping of burrs, oil, grease, and other foreign matter and install to permit free expansion and contraction without damaging building structure, pipe, joints, or hangers. Use fittings to make changes in direction, except that bending of pipe 100 mm 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Carbon steel piping to be bent conforming to ASTM A53/A53M, Grade A, standard, or Grade B extra-heavy weight. Carry vent pipes through the roof and properly flash. Unless otherwise indicated, pitch down horizontal supply mains in the direction of flow with a grade of not less than 25 mm in 12 m 1 inch in 40 feet. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the systems. Undercoat pipe not otherwise specified. Unless otherwise specified or shown, make connections to equipment with malleable-iron unions for steel pipe 65 mm 2-1/2 inches or less in diameter and with flanges for pipe 80 mm

3 inches or more in diameter, with unions for copper pipe or tubing made of brass or bronze. Provide cathodic protection for connections between ferrous piping and copper piping, electrically isolated from each other with dielectric couplings or other approved methods. Use reducing fittings for changes in pipe sizes. For horizontal HTW lines, provide eccentric type reducing fittings to maintain the top of the lines at the same level.

3.5.1 Pipe Sleeves

Provide pipe sleeves fitted into place at the time of construction for pipes and tubes passing through concrete or masonry walls or concrete floors or roofs. Install a waterproofing clamping flange as indicated. Do not install sleeves in structural members except where indicated or approved. Provide details for rectangular and square openings. Extend each sleeve through its specified wall, floor, or roof, and cut flush with each surface, except extend sleeves through floors and roofs above the top surface at least 150 mm 6 inchesfor proper flashing or finishing. Provide membrane clamping rings where membranes are penetrated. Unless otherwise indicated, size sleeves to provide a minimum clearance of 6 mm 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Provide galvanized steel pipe sleeves in bearing walls, waterproofing membrane floors, and wet areas. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls, partitions, and floors as indicated and specified in Section 07 92 00 JOINT SEALANTS and in fire rated walls, partitions, and floors seal as indicated and specified in Section 07 84 00 FIRESTOPPING. Provide metal jackets over insulation passing through exterior walls, fire walls, fire partitions, floors, or roofs, no thinner than 152.4 micrometers 0.006 inch thick aluminum, if corrugated, and 0.4064 mm 0.016 inch thick aluminum, if smooth, and secured with aluminum or stainless steel bands not less than 10 mm 3/8 inch wide and not more than 200 mm 8 inches apart. When penetrating roofs, before fitting the metal jacket into place, run a 13 mm 1/2 inch wide strip of sealant vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 900 mm 36 inches above the roof. If the pipe turns from vertical to horizontal, run the sealant strip to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, extend the metal jacket must extend from a point below the backup material to a minimum distance of 50 mm 2 inches above the flashing. For other areas, the metal jacket from a point below the backup material to a point 300 mm 12 inches above floor; or when passing through walls above grade, extend jacket a minimum of 100 mm 4 inches beyond each side of the wall.

3.5.1.1 Pipes Passing through Waterproofing Membranes

In addition to the pipe sleeves referred to above, provide for pipes passing through roof or floor waterproofing membranes with a 1.8 kg 4 pound lead flashing or a 453 g 16 ounce copper flashing, each within an integral skirt or flange, with flashing formed, and the skirt or flange extending not less than 200 mm 8 inches from the pipe and must set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing up the pipe a minimum of 250 mm 10 inches above the roof or floor. Seal the annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation as

indicated. Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a galvanized steel sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical-type sealing assembly may be installed. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates, with the links loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolts to cause the rubber sealing elements to expand and provide a water-tight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. If the use modular mechanical-type seals is elected, provide sleeves of the proper diameters.

3.5.1.2 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter; lead flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; tack-welded or banded-metal rain shield around the pipe and sealing as indicated.

3.5.2 Pipe Joints

Provide welded or flanged joints between sections of pipe and fittings on all HTW piping. On auxiliary piping, except as otherwise specified, provide threaded fittings 25 mm 1 inch and smaller. Provide threaded or welded fittings 32 mm 1-1/4 inches up to, but not including, 65 mm 2-1/2 inches Provide flanged or welded fittings 65 mm 2-1/2 inches and larger. Weld pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches beneath concrete floor slabs. Provide black malleable-iron unions for pipe 50 mm 2 inches or smaller in diameter, and with flanges for pipe 65 mm 2-1/2 inches or larger in diameter for connections to equipment.

3.5.2.1 Threaded Joints

Make threaded joints with tapered threads properly cut and made perfectly tight with a stiff mixture of graphite and oil, or polytetrafluoroethylene tape or equal, applied to the male threads only, and in no case to the fittings.

3.5.2.2 Welded Joints

Fusion weld joints in accordance with ASME B31.1, unless otherwise required. Provide only weld fittings for changes in direction of piping; mitering or notching pipe to form elbows and tees or other similar type construction is not acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Provide forged and flared branch outlet fittings, where used, for improvement flow where attached to the

run, reinforced against external strains, and designed to withstand full pipe bursting strength.

3.5.2.2.1 Beveling

Field and shop bevels in accordance with the recognized standards and done by mechanical means or flame cutting. Where beveling is done by flame cutting, clean surfaces of scale and oxidation before welding.

3.5.2.2.2 Alignment

Before welding, align the component parts to be welded so that no strain is placed on the weld when finally positioned. Align height so that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Set flanges and branches true, preserving the alignment during the welding operation. Provide welds of the same quality for tack welds, made by the same procedure as the completed weld; otherwise, remove tack welds during the final welding operation.

3.5.2.2.3 Erection

Where the temperature of the component parts being welded reaches 0 degrees C 32 degrees F or lower, heat the material to approximately 38 degrees C 100 degrees F for a distance of 900 mm 3 feet on each side of the weld before welding, finishing the weld before the materials cool to 0 degrees C 32 degrees F.

3.5.2.2.4 Defective Welding

Remove and replace defective welds, repairing defective welds in accordance with ASME B31.1.

3.5.2.2.5 Electrodes

After filler metal has been removed from its original package, protect or store so that its characteristics or welding properties are not affected. Do not use electrodes that have been wetted or that have lost any of their coating.

3.5.2.3 Flanges and Unions

Face flanges and unions true, and make square and tight. Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full-face or self-centering flat ring type. Provide gaskets with aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) using NBR binder for hydrocarbon service. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.5.3 Supports

3.5.3.1 General

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 23 kg 50 pounds must have

the excess hanger loads suspended from panel points.
****

Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support by variable spring hangers and supports or by constant support hangers, piping subjected to vertical movement, when operating temperatures exceed ambient temperatures. [Do not exceed 23 kg 50 pounds for pipe hanger loads suspended from steel joist between panel points. Suspend pipe loads exceeding 23 kg 50 pounds from panel points.]

3.5.3.2 Seismic Requirements

****
NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.
****

Support and brace piping and attached valves to resist seismic loads [as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC] [as indicated]. Provide structural steel required for reinforcement to support piping, headers, and equipment as specified under Section 05 12 00 STRUCTURAL STEEL.

3.5.3.3 Structural Reinforcements

Provide structural steel reinforcements required to support piping, headers, and equipment, but not shown, as specified under Section 05 12 00 STRUCTURAL STEEL.

3.5.4 Anchors

Provide anchors wherever necessary, or indicated, to localize expansion or prevent undue strain on piping. Provide anchors of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results, using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.5.5 Pipe Expansion

3.5.5.1 Expansion Loop

****
NOTE: Wherever possible, provisions for expansion of supply-and-return pipes will be made by changes in the direction of the run of the pipe or by field fabricated expansion bends. Where restrictions in

space prevent such provisions for expansion, expansion joints will be installed and blank will filled as appropriate. Bracketed portion will be deleted if inapplicable.

****

Provide expansion loop to ensure adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Cold spring loops and install where indicated. Provide pipe guides as indicated. Except where otherwise indicated, utilize expansion loops and bends to absorb and compensate for expansion and contraction instead of expansion joints.

3.5.5.2 Expansion Joints

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NOTE: If expansion joints are required, this paragraph will be deleted. Where restrictions in space prevent such provisions for expansion, expansion joints will be installed and blank will be filled as appropriate. Bracketed portion will be deleted if inapplicable.

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Provide expansion joints for either single or double slip of the connected pipes, as required and indicated, and for not less than the traverse indicated. Provide anchor bases or support bases as indicated or required. Make initial setting in accordance with the manufacturer's recommendation to allow for an ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer, but in any case not more than 1.5 m 5 feet from expansion joint, except that in lines 100 mm 4 inches or smaller install guides no more than 600 mm 2 feet from the joint.

3.5.6 Valves

Install gate valves and globe valves with the stem horizontal or above. Install swing check valves in horizontal piping with the cap or bonnet up, or in vertical piping with the flow upward. Always install lift or piston check valves in horizontal piping with the cap or bonnet up.

3.6 BURIED PIPING INSTALLATION

3.6.1 Protective Coating for Underground Steel Pipe

Provide steel pipe installed underground with a protective covering, mechanically applied in a factory or field plant especially equipped for the purpose. Apply for specials and other fittings which cannot be coated and wrapped mechanically with a protective covering applied by hand, preferably at the plant applying the covering to the pipe. Do not field apply coatings until the piping has satisfactorily passed the leak or hydrostatic test. Coat and wrap field joints by hand in a manner and with materials that will produce a covering equal in effectiveness to that of the mechanically-applied covering.

3.6.2 Cleaning of Surfaces to be Coated

Solvent wash steel surfaces to assure an oil-and-grease-free surface, and blast-clean to bare metal as specified in SSPC SP 6/NACE No.3. For areas

that cannot be cleaned by blasting, clean to bare metal by powered wire brushing or other mechanical means. Provide an air supply for blasting that is free from oil and moisture. Following cleaning, wipe the surfaces with coal-tar solvent naphtha and allow to dry. Ensure the surfaces to be coated are free of all mill scale and foreign matter such as rust, dirt, grease, oil, and other deleterious substances. Apply coating to surfaces as soon as practicable after the cleaning operation.

3.6.3 Coating

Coat buried steel piping with one of the following methods:

3.6.3.1 Epoxy Coating System

The epoxy coating system, conforming to the AWWA C213. Factory coat fittings, valves, and joints with materials identical to those used on the pipe, or may be field-coated with a 2-part epoxy system recommended by the manufacturer of the pipe coating system. Field protection may also be provided for joints and fittings with a coal tar tape hot applied over a compatible primer.

3.6.3.2 Bituminous Pipe Coating

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NOTE: If coating system similar to coal tar coating and wrapping is required using different materials, rewrite this paragraph. Where excessively corrosive soils are encountered, give the piping a second coating of coal-tar enamel and a second wrapper of felt.

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Provide bituminous protective system of coal-tar enamel and primer coating system, consisting of a coal-tar priming coat, a coal-tar enamel coat, a wrapper of coal tar saturated felt, and a wrapper of kraft paper, or a coat of water-resistant white-wash, applied in the order named and conforming to the requirements of AWWA C203 in all respects as to materials, methods of application, tests, and handling, except do not apply an interior lining. Coat and wrap joints and fittings.

3.6.3.3 Polyethylene Pipe Coating

Provide factory-applied system, with continuous extruded polyethylene coating and adhesive undercoat application procedure, including surface preparation, conforming to NACE SP0185, Type A. Provide tape wrapped joints, valves, flanges, and other irregular surfaces as outlined under the tape wrapping system, except apply the tape half-lapped, and prime all extruded polyethylene coating and adhesive undercoat surfaces to be tape-wrapped with a compatible primer before application of tape. Use the primer recommended by the tape manufacturer and approved by the applicator of the extruded polyethylene coating. Repair damaged areas of extruded polyethylene coating by tape-wrapping as described under the tape-wrapping system, except press any residual material from the extruded polyethylene coating into the break or trim off. Prime all areas to be taped and apply the tape half-lapped.

3.6.3.4 Tape-Wrap Pipe Coating

Prime cleaned surfaces before applying tape as recommended by the

manufacturer of the tape. Provide approved, pressure-sensitive, organic plastic tape with a minimum nominal thickness of 0.51 mm 0.020 inch, conforming to ASTM G21 for fungus resistance. Apply tape to clean, dry, grease-free, and dust-free surfaces only. Wire brush all weld beads and remove all burrs and weld spatter. Cover weld beads with one wrap of tape before spiral wrapping. At each end of straight runs, apply a double wrap of one full width of tape at right angles to the axis of the spiral wrapping. Remove any kraft paper protective wrapping from the pipe before the tape is applied. Provide wrap protection for material which is wrapped before it is placed in its final position at sling points with roofing felt or other approved heavy shielding material, or handle with canvas slings. Repair damaged wrapping as specified. Wrap pipe in straight runs spirally, half-lapping the tape as it is applied. For pipe smaller than 100 mm 4 inches, apply one layer half-lapped. For pipe 100 mm 4 inches and larger, apply two layers half-lapped with the second layer wrapped opposite-hand to the first. Spirally wrap joints, coupling fittings, and similar units and damaged areas of wrapping, beginning with one complete wrap 75 mm 3 inches back from each edge of the corresponding size of straight pipe. On irregular surfaces such as valves and other accessories, apply one layer half-lapped and stretched to conform to the surface, followed by a second layer half-lapped and applied with tension as it comes off the roll.

3.6.3.5 Coating Inspection and Testing

After field coating of the pipe joints, inspect the entire pipe with an electric holiday detector having an operating crest voltage of from 12,000 to 15,000 volts when using a full-ring, spring-type coil electrode. Provide a holiday detector equipped with a bell, buzzer, or other audible signal which operates when a holiday is detected. Repair detected holidays in the protective covering. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Perform the inspection for holidays just before covering the pipe with backfill and take every precaution during backfill to prevent damage to the protective covering. Furnish all equipment and labor necessary for inspection.

3.6.4 Installing Buried Piping

Carefully handle pipe and accessories to assure a sound, undamaged condition with special care taken to not damage coating when lowering pipe into a trench and when backfilling. Install nonmetallic pipe in accordance with pipe manufacturer's instructions.

a. Submit Proposed diagrams, instructions, and other sheets, before posting. Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Prepare in typed form, and frame as specified, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system above, including the wiring and control diagrams posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

b. Lay underground pipelines with a minimum pitch of 25 mm/15 m 1 inch/50 feet. Provide minimal coverage for horizontal pipe sections of 450 mm 18 inches, laying piping free of traps and draining toward tank. Solidly rest the full length of each section of underground pipe on

the pipe bed with piping connections to equipment as indicated, or as required, by the equipment manufacturer.

c. Provide two swing elbows [or flexible connectors] at each tank connections to allow for differential settlement. Thoroughly clean the interior of the pipe of all foreign matter before being lowered into the trench and keep clean during installation. Do not lay the pipe in water or when the trench or weather conditions are unsuitable.

d. Securely close open ends of pipe and fittings so that water, earth, or other substances cannot enter the pipe or fittings when work is not in progress. Replace any pipe, fittings, or appurtenances found defective after installation. Make threaded joints with tapered threads perfectly tight with joint compound applied to the male threads only. This requirement does not apply for the gauging hatch or similar connections directly over the tank where the line terminates in a fitting within a cast-iron manhole designed to allow for differential settling.

e. Weld pipe to structural steel where steel piping is to be anchored to the structural steel member of the anchor and patch the abraded area with protective coating or covering as specified. Fit piping passing through concrete or masonry construction with sleeves of sufficient length to pass through the entire thickness of the associated structural member and large enough to provide a minimum clear distance of 13 mm 1/2 inch between the pipe and sleeve, except where otherwise indicated. Sleeves through concrete may be 0.912 mm (20 gauge) 20 gauge metal, fiber, or other approved material. Accurately locate sleeves on center with the piping and securely fasten in place. Caulk and fill the space between the sleeves and the pipe with bituminous plastic cement or mechanical caulking units designed for such use.

3.7 FIELD PAINTING AND COATING

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NOTE: Where identification of piping is required by the using service, this paragraph will be amplified to include appropriate requirements either directly or by reference to a separate section. Air Force requirements are covered in AFM 88-15.

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Except as otherwise specified, prepare, clean and paint ferrous metal as specified in Section 09 90 00 PAINTS AND COATINGS. Apply protective coating to buried steel as specified. Paint exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

3.8 MANUFACTURER'S SERVICES

3.8.1 Manufacturer's Representative

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified, to supervise the installing, adjusting, and testing of the equipment.

3.8.2 Field Training

Conduct a field training course for designated operating staff members.

Submit proposed schedule for field training, at least 2 weeks prior to the start of related training. Provide training for a total period of [_____] hours of normal working time, starting after the system is functionally complete, but prior to final acceptance tests. Provide field training to cover all of the items contained in the approved operating and maintenance instructions. Submit operating instructions, prior to the field training course and [6] [_____] copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features in the instructions. Submit maintenance instructions, prior to the field training course; [6] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed in the instructions.

3.9 TESTS

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NOTE: Before occupancy of a facility inspect the boilers in accordance with the Code of Boiler and Pressure Vessel Inspectors (BPVI) and the American Society of Mechanical Engineers (ASME). Inspectors must be certified in accordance with BPVI standards.

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Submit the proposed performance test procedure for required tests, 30 days prior to the proposed test date, containing a complete description of the proposed test, along with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not commence the testing until the procedure has been approved. Submit the complete plan for water treatment, including proposed chemicals to be used and nationally recognized testing codes applicable to the system, prior to system startup. Submit all test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate for each test report, the final position of controls. Include the action settings for all automatic controls in the form of a typed, tabulated list indicating the type of control, location setting, and function. Provide a written statement from the manufacturer's representative certifying that combustion control equipment has been properly installed and is in proper operating condition, upon completion of the installation.

3.9.1 Hydrostatic Tests

Following erection, hydrostatically test each HTW generator proving tight under a gauge pressure of 1.5 times the specified working pressure. Following the installation of all piping and boiler house equipment, but before the application of any insulation, perform hydrostatic tests to prove the system tight under gauge pressures of 1.5 times the specified working pressure. Conduct tests under the direction of, and subject to, the approval of the Contracting Officer. Adjust all equipment and controls before the scheduled operational test. Submit the testing schedule least 15 days before scheduled test.

3.9.1.1 Water Sides Including Fittings and Accessories

Hydrostatically test water sides in accordance with the requirements of ASME BPVC SEC I and ASME BPVC SEC VIII D1 as applicable. The ASME stamp will be accepted as evidence of this test.

3.9.1.2 Generator Casing, Air Casings, and Ducts

Pneumatically test air casing and ducts exterior to the generators at the maximum working pressure using the soap bubble or smoke bomb method to verify tightness. Test the gas sides of the generators normally operated under pressure for tightness at 1-1/2 times the predicted operating pressure in the furnace at maximum predicted output. Tightly seal, by suitable means blanking off all generator openings, prior to testing. Admit air to the generator until the test pressure is reached and then hold. If in a 10-minute period the pressure drop does not exceed 1.2 kPa 5 inches water gauge, the casing is regarded as tight and accepted. Use air pressure and smoke bomb or comparative CO(2) readings for induced draft generators.

3.9.1.3 Fuel Oil Test

After the system has been flushed and operationally tested, leak test the underground portion of the system in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.9.1.4 Fuel Systems for Oil-Fired HTW Generators

Hydrostatically test the part of the preassembled fuel oil system that is furnished integrally with the generator at 1.5 times the maximum operating pressure. Pneumatically test the part of the preassembled gas system that is furnished integrally with the generator at operating pressure using the soap bubble test method to verify tightness of the gas system.

3.9.2 Fire Safety for Oil-Fired HTW Generators

Conduct test as necessary to determine compliance with the applicable UL safety standards. The presence of the UL label may be accepted as evidence of compliance in this respect.

3.9.2.1 Oil-Fired Generators

Oil-fired generators must meet the test requirements of UL 726.

3.9.2.2 Oil Burners

Oil burners must meet the test requirements of UL 296.

3.9.3 Capacity and Efficiency Tests

Determine the capacity and efficiency at the specified capacity of the generator in accordance with the ASME PTC 4 for steam generating units. Determine the efficiency by the direct input-output method and check with the loss method computation. Make test runs at the maximum capacity for 4 hours; at the minimum capacity and at 50 percent capacity for 2 hours each, respectively. Submit est reports and performance curves. Balance the system within 5 percent of that indicated before any operational tests are conducted. Make corrections and adjustments as necessary to produce the required conditions. Use approved methods to measure all rates of

flow. Provide a qualified test engineer, observed by a representative of the Contracting Officer, to conduct efficiency and general performance tests on the boilers. Set up, calibrate, test, and ready test apparatus for testing the boiler before the arrival of the Contracting Officer's representative. Furnish calibration curves or test results furnished by an independent testing laboratory for each instrument, meter, gauge, and thermometer to be used in efficiency and capacity test before the test. Provide a test report including logs, heat balance calculations, and tabulated results together with conclusions, [delivered in quadruplicate,] including an analysis of the fuel being burned on the test. Include in the analysis all pertinent data tabulated in the ASME PTC 4 abbreviated efficiency test. Provide and install all necessary temporary piping valves, controls, heat exchanger, and cooling water provisions to provide a load for testing each HTW generator. If any system load is available, the Contracting Officer will provide for loading the heating system for the test, but full-load capability will probably require a supplementary heat exchanger for the test.

3.9.4 Operating Tests

After adjustment and achievement of stable operation of the HTW generators, test each continuously for 12 hours, minimum, to demonstrate control and operational conformance to the requirements of this specification under varying load conditions ranging from the specified capacity to the minimum burner or stoker turndown ratio without on-off cycling. In each case, cover the periods for the capacities tabulated below:

Waterwall Watertube Boilers	
Time (minimum)	Percent of Capacity
First 2 hours	50
Next 2 hours	75
Next 6 hours*	100
Next 2 hours	110
* The efficiency tests may be conducted either concurrently with the operating tests or separately at the option of the Contractor. Efficiency may be no less than that specified.	

3.9.5 Test of Fuel Burning Equipment

Test automatic oil burners for capability to provide high temperature water in accordance with demand when on-off cycling is required. Fuel burning equipment that exhibits excessive or unexplained loss of ignition, nuisance shutdown due to faulty burner, stoker, or control operation, improper flame, excessive carbon deposits or slag, or necessity for difficult or frequent adjustments must be rejected. Include the following as applicable to the type of HTW generator.

3.9.5.1 Sequencing

[Start, operate] [Operate,] and stop the HTW generator in accordance with the specified operating sequence.

3.9.5.2 Flame Safeguard

Verify the operation of the flame safeguard control on oil- or gas-fired generators by simulated flame and ignition failures. Test burners having continuous or intermittent pilots by simulating main flame failure while the pilot is burning. Use a stop watch for the trial-for-pilot ignition, trial-for-main-flame ignition, combustion control reaction, and valve closing verified times.

3.9.5.2.1 Immunity to Hot Refractory

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

3.9.5.2.2 Pilot Intensity Required

Gradually reduce the fuel supply to the pilot flame to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame must be capable of safely igniting the main burner. If the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, reject the generator.

3.9.5.2.3 Turndown Ratio

Verify the specified turndown ratio by firing at the minimum firing rate.

3.9.5.2.4 HTW Generator Limit and Fuel Safety Interlocks

Simulate the interlock actuating conditions for each generator limit and fuel and safety interlock for the safety shutdown. Specify specific manner in which the safety shutdowns occur.

3.9.5.2.5 Combustion Controls

Demonstrate the accuracy range and smoothness of operation of the combustion controls by varying the demand throughout the entire firing range required by the turndown ratio specified for the [burner] [and] [stoker] and in the case of automatic sequenced burners by further varying the firing rate to require on-off cycling. Note the control accuracy as specified.

3.9.5.2.6 Safety Valves

Do not test safety valves on HTW generators under operating conditions.

3.9.5.2.7 Blowdown Valves and Try Cocks

Test blowdown valves and try cocks for proper operation.

3.9.5.2.8 Fans, Heaters, Pumps, and Motors

Test draft fans, fuel oil heaters, fuel pumps, and electric motors when necessary to determine compliance with the referenced standards. Closely observe the operation of fans, [fuel oil heaters] [stokers] [fuel pumps] and electric motors for possible defects or nonconformance.

3.9.6 Test of Water Treatment Equipment

Test of water treatment equipment must meet the requirements specified for capacity and quality of effluent. Tests for ion-exchange units must cover at least two complete regenerations and capacity runs.

3.9.7 System Balancing

During operating tests, observe the preliminary system balancing results and log the flow rates. Where an auxiliary heat exchanger is not required for the test load, perform final system balancing during the operating test. Where the auxiliary heat exchanger is required, provide sufficient temporary piping to shunt the water flow through the various system control valves to allow an approximate flow balance of the system.

3.10 CLEANING OF HTW GENERATORS AND PIPING

3.10.1 HTW Generator Cleaning

After the hydrostatic tests have been made, and before performance of the operating tests, thoroughly and effectively clean the boilers of foreign materials. Wherever possible, wire brush surfaces in contact with water to remove loose material. The following procedure may be used or an alternate standard procedure may be submitted for review and approval. Fill HTW generators with a solution consisting of the following proportional ingredients for every 3785 L 1000 gallons of water, and operated at approximately 210 to 345 kPa 30 to 50 psig for a period of 24 to 48 hours:

a. Use 11 kg caustic soda 24 lb. caustic soda; 3.6 kg sodium nitrate 8 lb. sodium nitrate; 11 kg disodium phosphate, anhydrous 24 lb. disodium phosphate, anhydrous; and 230 g approved wetting agent 1/2 lb. approved wetting agent.

b. Thoroughly dissolve chemicals in the above proportions, or as otherwise approved, in the water before being placed in the HTW generator. After the specified boiling period, allow the boilers to cool, and then drain and thoroughly flush. Clean piping by operating the HTW generators for a period of approximately 48 hours.

3.10.2 HTW Generator Water Conditioning

Provide HTW generator water conditioning including chemicals, chemical treatment, and blowdown during periods of boiler operation to prevent scale and corrosion in HTW generators and in supply and return distribution systems from the initial startup of the system, through the testing period, and to final acceptance of the completed work, but for at least 30 days of operation. Use approved chemicals and method of treatment.

3.11 SCHEDULES

TABLE I. PIPE				
Service	Pressure (kPa) (PSI)	Material	Specification	Type
Boiler feed, drain lines & HTW lines	0-41500-600	Black steel (2)	ASTM A53/A53M	Type E Grade A
Feedwater piping	0-8600-125	Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Cold water piping	0-8600-125	Std. wt. zinc-coated	ASTM A53/A53M	Type E Grade A
Water column (1)	0-41500-600	Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Vent and exhaust	0-1750-25	Std. wt. black pipe steel	ASTM A53/A53M	Type E Grade A
Compressed air	0-8600-125	Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Gauge piping	0-1750-25	Copper tubing	ASTM B88MASTM B88	Type K or L
	0-41500-600	Black steel (2)	ASTM A53/A53M	Type E Grade A
Fuel oil (Nos. 4, 5 & 6	0-10500-150	Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Control air	0-10500-150	Copper tubing	ASTM B68/B68M	[_____]
		Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Note 1: No bending of pipe will be permitted. Provide crosses with pipe plugs at connection.				
Note 2: Extra Strong (XS) minimum weight. Conform to ASME B31.1 for wall thickness.				

TABLE II. FITTINGS				
Service	Size	Title	Materials	Specification
Vent pipe	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Compressed air	Under 80 mm 3-inches	Threaded	Zinc-coated Malleable-iron	ASME B16.3

TABLE II. FITTINGS				
Service	Size	Title	Materials	Specification
Exhaust pipe	Under 80 mm 3-inches	Threaded	Zinc-coated Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Boiler feed (1)	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Feedwater pipe	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Drain lines (1) & HTW lines	All	Buttwelded	Steel	ASME B16.9
		Socket Welded	Steel	ASME B16.11
		Flanged with long radius elbows	Steel	ASME B16.5
Water column piping (1)	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
Gauge pipe	All	Flared or or soldered	Cast or wrought bronze	ASME B16.18 ASME B16.26
Note 1: Conform to ASME B31.1 for wall thickness except minimum being extra strong pipe. Match piping requirements.				
Note 2: Fuel oil piping and fittings, complying with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.				

-- End of Section --