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USACE / NAVFAC / AFCEC	**UFGS-23 52 33.01 20 (November 2008)**
	Change 3 - 02/22

Preparing Activity: NAVFAC	**Superseding**
	UFGS-23 52 33.01 20 (July 2007))

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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

SECTION 23 52 33.01 20

STEAM HEATING PLANT WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL

11/08, CHG 3: 02/22

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USACE / NAVFAC / AFCEC	**UFGS-23 52 33.01 20 (November 2008)** **Change 3 - 02/22**
Preparing Activity: NAVFAC	**Superseding** **UFGS-23 52 33.01 20 (July 2007))**

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SECTION 23 52 33.01 20

STEAM HEATING PLANT WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL
11/08, CHG 3: 02/22

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NOTE: This guide specification covers the requirements for equipment for a steam heating plant which will generate from 2 1/2 to 9 1/2 kg per second 20,000 to 75,000 pounds per hour of steam.

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).

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NOTE: This specification is intended to be used in the procurement and installation of heating plant equipment. Requirements for materials and procedures for special or unusual design shall be added to and modifications made to this specification as necessary to fit specific projects. This guide specification shall be used in conjunction with the following NAVFAC definitive drawings and UFC 3-410-06N, "Central Heating Plants Operation and Maintenance".

NAVFAC NO./DRAWING TITLE

1429327 - STEAM HEATING PLANT NO. 4 2 1/2 to 9 1/2 KG PER SECOND 20,000 to 75,000 POUNDS PER HOUR

WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL SITE PLAN AND SECTIONS

1429328 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FLOOR PLAN

1429329 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL LONGITUDINAL SECTION

1429330 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL TRANSVERSE SECTION

1429331 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL PIPING SCHEMATIC

1429332 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL PIPING SCHEMATIC

1429333 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL CONTROL SCHEMATICS

1429334 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL COAL HANDLING CONTROLS

1429335 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL DETAILS

1429337 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FUEL OIL UNLOADING

1429338 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FUEL OIL STORAGE

1429339 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL SITE DETAILS COAL HANDLING

1429340 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR

WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL RESERVE COAL STORAGE

1429341 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL SITE PLAN - ELECTRICAL

1429342 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FLOOR PLAN - ELECTRICAL

1429343 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL ONE-LINE DIAGRAM - ELECTRICAL

****

****

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

1. Dimensions of construction

2. Relationship of materials

3. Quantities, location and capacity of equipment.

****

PART 1 GENERAL

1.1 REFERENCES

****

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

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

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

****

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 118	(1979) Coal-Tar Bitumen Used in Roofing, Damp-Proofing, and Waterproofing

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 103	(2001) Selected Codes and Standards of the Boiler Industry

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN PETROLEUM INSTITUTE (API)

API MPMS 2.2A	(1995; R 2017) Manual of Petroleum Measurement Standards Chapter 2-Tank Calibration Section 2A-Measurement and Calibration of Upright Cylindrical Tanks by the Manual Tank Strapping Method
API MPMS 2.2B	(1989; R 2019) Manual of Petroleum Measurement Standards Chapter 2: Tank Calibration - Section 2B: Calibration of Upright Cylindrical Tanks Using the Optical Reference Line Method
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats
API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
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	(2024) 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 B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
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 B29.100	(2011) Precision Power Transmission, Dbl-P-Power Transmission, Dbl-P-conveyor Roller Chains, Attachments and Sprockets
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
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 PTC 4	(2013; R 2023) Fired Steam Generators

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C510	(2017; R 2021) Double Check Valve Backflow Prevention Assembly
AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C651	(2023) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) 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 A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A211	(1975; R 1985) Specification for Spiral-Welded Steel or Iron Pipe
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D1047	(2016) Poly(Vinyl Chloride) Jacket for Wire and Cable
ASTM F1007	(2018; R 2022) Standard Specification for Pipeline Expansion Joints of the Packed

	Slip Type for Marine Application
ASTM F1120	(1987; R 2024) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications

FM GLOBAL (FM)

FM DS 12-17	(2001) Watertube Boilers

INTERNATIONAL CODE COUNCIL (ICC)

ICC UBC	(1997; Erratas Vol 1, 2 & 3 01/2001; Vol 1 & 2 03/2001; Vol 2 10/2001) Uniform Building Code

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

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 11.01	(1982; E 2004) Black (or Dark Red) Coal Tar Epoxy Polyamide Painting System

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5345-43	(2019; Rev J) Specification for Obstruction Lighting Equipment

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50555	(Basic) Pumping Units, Sewage, Duplex, Centrifugal, Automatic Wet-Pit Type
CID A-A-50558	(Basic; Notice 1) Valves, Pressure Regulating, Steam
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-59222	(Basic; Notice 1; CANC Notice 1 2021) Fans, Centrifugal, Draft, Forced and Induced
CID A-A-59224	(Basic; Notice 2) Meters, Fluid Quantity Volumetric
CID A-A-60001	(Rev A) Traps, Steam
FS F-B-2902	(Basic; Notice 1) Boilers, Steam Watertube (Bent Tube, Multi-Drum and Cross Drum) Packaged Type (10,000,000 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-F-351	(2019; Rev G; Notice 1) Filters and Filter Elements, Fluid Pressure: Lubricating Oil, Bypass and Full Flow
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

FS XX-C-2816	(Rev A) Compressor, Air, Reciprocating or Rotary, Electric Motor Driven, Stationary, 10 HP and Larger

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

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910-SUBPART Q	Welding, Cutting, and Brazing

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

NAVFAC MO 324	(1992) Inspection and Certification of Boilers and Unfired Pressure Vessels

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

WATER QUALITY ASSOCIATION (WQA)

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

1.2 RELATED REQUIREMENTS

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

01 78 23 OPERATION AND MAINTENANCE DATA

03 30 00 CAST-IN-PLACE CONCRETE

05 12 00 STRUCTURAL STEEL

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

09 90 00 PAINTS AND COATINGS

21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION

41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING

23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS

23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS

23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS

40 17 26.00 20 WELDED PRESSURE PIPING

22 00 00 PLUMBING SYSTEMS

23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES

23 51 43.03 20 FABRIC FILTER DUST COLLECTOR OF FLYASH PARTICULATES IN FLUE GAS

UFC 3-430-11 BOILER PLANT INSTRUMENTATION AND CONTROL SYSTEMS

1.3 DEFINITIONS

a. Standard Commercial Product: A product which has been sold or is being currently offered for sale on the commercial market through advertisements or manufacturer's catalogs, or brochures, and represents the latest production model.

b. System Supplier: A manufacturer, fabricator, erector, corporation or firm that regularly is employed in the design, fabrication, erection, or erection supervision, testing and startup of systems comparable in size and type to those specified and indicated. The system supplier shall arrange the equipment selected, design the equipment interconnections, produce related shop drawings, supervise the erection, and start up and test the equipment.

1.4 SYSTEM DESCRIPTION

1.4.1 Design Requirements

1.4.1.1 Boiler

Boiler design and service conditions:

a. Design pressure: [_____] kPa (gage) psig

b. Operating pressure: [_____] kPa (gage) psig

c. Steam temperature: [_____] degrees C F

d. Feedwater temperature: [_____] degrees C F

e. Site elevation: [_____] meters feet

f. Ambient air temperatures:

(1) Minimum: [_____] degrees C F

(2) Maximum: [_____] degrees C F

g. Maximum continuous output (steam): [_____] kg/sec lb/hr

h. Minimum continuous output (steam): [_____] kg/sec lb/hr (without smoking)

i. Continuous blowdown: [_____] percent

****
NOTE: Regarding the text below, the specified

efficiency for the boiler at maximum continuous load shall be not less than 80 percent for coal and 82 percent for oil. If an economizer is used, use 82 and 84 percent respectively for coal and oil firing. Depending on the particular application and fuel used, these efficiencies could be higher.

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j. Efficiency at maximum continuous rating [includes economizer]

(1) Coal: [_____] percent

(2) [Oil]: [_____] percent

1.4.1.2 Economizer

****

NOTE: Economizers shall be specified for all boilers with operating pressure greater than 345 kPa (gage) 50 psig and a capacity of 2 1/4 kg/sec 18,000 pounds per hour and larger. For boilers from 1/2 to 2/14 kg/sec 4,000 to 18,000 pounds per hour the designer shall make the decision based upon a specific economic analysis. This paragraph shall be included as applicable.

****

****

NOTE: Unless a coal or a fuel oil to be burned has an uncommon tendency to foul tubes, finned tube economizers should be suitable for both fuels. Feedwater temperatures should be 110 degrees C 230 degrees F when sulphur (S) content of oil is 0.5 percent; 116 degrees C 240 degrees F, S=1.5 percent - 2 percent; 121 degrees C 250 degrees F, S=2.0 percent - 2.7 percent. Where fuels having more than 1.5 percent sulfur content are to be fired, finned tubes shall not be used unless they are steel tubes covered with cast iron finned casing.

****

a. Design pressure: [_____] kPa (gage) psig

b. Operating pressure: [_____] kPa (gage) psig

c. Fuel: Coal [and No.: [_____] fuel oil]

d. Specific heat of the flue gas: [_____] kJ/kg - degrees C Btu/lb - degrees F

e. Feedwater flow: [_____] L/s gpm

f. Flue gas temperature entering economizer: [_____] degrees C F

g. Flue gas temperature leaving economizer: [_____] degrees C F

h. Feedwater temperature entering economizer: [_____] degrees C F

i. Maximum pressure drop, economizer gas side: [_____] Pa inches water

j. Maximum pressure drop, economizer water side: [_____] kPa psi

k. Fouling factor on feedwater side: [_____]

l. Fouling factor on gas side: [_____]

1.4.1.3 Forced Draft Fan (Coal Firing)

Design fan to handle air at temperatures from [_____] to [_____] degrees C F. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counter clockwise] rotation when viewed from the motor end.

1.4.1.4 Induced Draft Fan Design

Design fan of materials which will withstand flue gas temperatures up to 316 degrees C 600 degrees F without damage. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counterclockwise] rotation when viewed from the motor end.

1.4.1.5 Expansion Joints

a. Stacks (for installation without flue gas scrubbers):

(1) Temperature:

Maximum ambient: [_____] degrees C F

Minimum ambient: [_____] degrees C F

Inlet gas at maximum gas flow (coal): [_____] degrees C F

Inlet gas at maximum gas flow (oil): [_____] degrees C F

Inlet gas at minimum gas flow (coal): [_____] degrees C F

Inlet gas at minimum gas flow (oil): [_____] degrees C F

(2) Gas flow at inlet

Maximum: [_____] kg/sec lb/hr

Minimum: [_____] kg/sec lb/hr

(3) Required net available draft at stack inlet

At maximum gas flow: [_____] Pa inches water

(4) Gas exit velocity (cone exit)

Maximum at maximum conditions: [_____] m/sec ft/sec

(5) Flue gas acid dew point

Coal: [_____] degrees C F

Fuel oil: [_____] degrees C F

(6) Test pressures

Shop test: [_____] Pa inches water

(7) Thermal efficiency of stack: 96 to 98 percent

(8) Stack friction, max. at design condition: [_____] Pa inches water

(9) Stack height

Ground elevation: [_____] m ft

Roof elevation: [_____] m ft

Stack height: [_____] m ft

Foundation or footing elevation: [_____] m ft

(10) Wind pressure: [_____] kg/m2 psf

(11) Wind velocity, gusting: [_____] km/hr mph

(12) Stack Diameter, min. (below exit cone): [_____] mm inches

(13) Max. stack deflection (from vertical center line): [_____] mm inches

(14) Soil bearing stress, maximum: [_____] kg/m2 psf

(15) Seismic zone: [_____]

1.4.1.6 Fuel Oil Pump

****

NOTE: The values enclosed in brackets are for No. 6 low sulfur fuel oil. Adjust values to suit fuel oil used if other than No. 6.

Tabulated pump data is included in the specifications but it is preferred that such information to be shown on the drawings instead.

****

a. Transfer pumps (for fuel oil tank truck or railroad tank car unloading and transfer to tanks):

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

(3) Capacity each: [_____] L/s gpm at 450 ssu

(4) Suction lift required: [_____] kPa ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [27 to 54] [_____] to [_____] degrees C [80 to 130] [_____] to [_____] degrees F

(7) Viscosity range: [450 to 5000] [_____ to ____] ssu

(8) Specific gravity: [.92 to .99] [_____ to ____]

(9) Viscosity at brake power selection point: [9000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

b. Transfer pumps (for fuel oil transfer from tanks to heating plant):

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

(3) Capacity: [_____] L/s gpm at 450 ssu

(4) Suction lift required: [_____] kPa ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [49] [_____] degrees C [120] [_____] degrees F

(7) Viscosity range: [450 to 3000] [_____] to [_____] ssu

(8) Specific gravity: [.92 to .99] [_____] to [_____]

(9) Viscosity at brake power selection point: [5000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

c. Fuel oil recirculation pump sets (at remote storage):

(1) Number of assemblies: [_____]

(2) Tag numbers: As Indicated

(3) Capacity: 1.60 L/s 25 gpm at 450 ssu

(4) Suction lift required: [_____] kPa ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [49] [_____] degrees C [120] [_____] degrees F

(7) Viscosity range: [450 to 3000] [_____] to [_____] ssu

(8) Specific gravity: [.92 to .99] [_____] to [_____]

(9) Viscosity at brake power selection point: [5000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

[1.4.1.7 Fuel Oil Pump and Heater Set

a. Capacity each pump and each steam heater: [_____] L/s gpm

b. Suction lift: [_____] kPa ft of water

c. Discharge pressure at outlet of heater: [_____] kPa (gage) psig

d. Maximum pump speed: 1750 rpm

e. Specific gravity range: [.92 to .99] [_____] to [_____]

f. Viscosity at brake power selection point: 5000 ssu

g. Viscosity range: [500 to 5000] [_____] to [_____] ssu

h. Oil temperature at inlet of heater: [_____] degrees C F

i. Oil temperature at outlet of heater: [_____] degrees C F

j. Maximum oil pressure drop through heater: [_____] kPa psi

k. Heating medium: Steam

l. Steam pressure available: [_____] kPa (gage) psig

m. Steam temperature: [_____] degrees C F

n. Heater type: [Bare Tube] [Extended Surface]

]1.4.1.8 Electric Startup Heater

a. Oil temperature at inlet of heater: [_____] degrees C F

b. Oil temperature at outlet of heater: [_____] degrees C F

c. Maximum oil pressure drop through heater: [_____] kPa psi

d. Capacity of heater: [_____] L/s gpm

e. Heating power supply at three phase, 60 Hz: [_____] volts

f. Control power supply 120 volts, single phase, 60 Hz

1.4.1.9 Ash Handling System (Pneumatic)

a. Capacity:

(1) Ash Handling System: Estimated capacities at maximum plant output are listed below; ash handling system capacity shall be sized for twice the amounts listed.

[_____] Mg tons per hour for fly ash

[_____] Mg tons per hour for bottom ash at the farthest ash intake from the exhauster

[_____] Mg tons per hour in main ash line leaving the boiler house (minimum).

(2) Ash silo: Storage capacity of ash silo is specified in the paragraph ASH STORAGE SILO.

(3) Rotary unloader: [_____] Mg tons per hour

b. General Data

(1) Available water pressure: [_____] kPa (gage) psig

(2) Available air pressure: [_____] kPa (gage) psig

(3) Seismic Zone: [_____]

(4) Wind Velocity (Gusts): [_____] km/hr mph

(5) Altitude of plant: [_____] m ft

(6) Steam rating of plant: [_____] kg/sec lb/hr

(a) Maximum continuous rating of boiler No. 1 [_____] kg/sec lb/hr

(b) Maximum continuous rating of boiler No. 2 [_____] kg/sec lb/hr

[(c) Maximum continuous rating of boiler No. 3 [_____] kg/sec lb/hr

][(d) Maximum continuous rating of boiler No. 4 [_____] kg/sec lb/hr

] (7) Coal Analysis

(a) Ash: [_____] percent

(b) Carbon: [_____] percent

(c) Hydrogen: [_____] percent

(d) Sulfur: [_____] percent

(e) Moisture: [_____] percent

(f) Nitrogen: [_____] percent

(g) Oxygen: [_____] percent

(8) Ash Analysis

(a) Carbon: [_____] percent

(b) Calcium: [_____] percent

(9) Minimum velocities required for materials

(a) Fly Ash: 19.30 meters per second (m/s) 3800 feet per minute (fpm)

(b) Bottom Ash [Single Retort Underfeed] 28.40 m/s 5600 fpm [Traveling Grate] stoker

1.4.1.10 Ash Handling System (Mechanical)

a. Capacity:

(1) Ash Handling System: Estimated capacities at maximum plant output are listed below; ash handling system capacity shall be sized for twice the amounts listed.

[_____] Mg tons per hour for fly ash

[_____] Mg tons per hour for bottom ash

[_____] Mg tons per hour in bucket elevator leaving the boiler house (minimum).

(2) Ash Silo: Storage capacity of ash silo is specified in the paragraph ASH STORAGE SILO.

(3) Rotary unloader: [_____] Mg tons per hour

b. General Data:

(1) Available water pressure: [_____] kPa (gage) psig

(2) Available air pressure: [_____] kPa (gage) psig

(3) Seismic Zone: [_____]

(4) Wind Velocity (Gusts): [_____] km/hr mph

(5) Altitude of plant: [_____] m ft

(6) Steam rating of plant: [_____] kg/sec lb/hr

(a) Maximum continuous rating of boiler No. 1 [_____] kg/sec lb/hr

(b) Maximum continuous rating of boiler No. 2 [_____] kg/sec lb/hr

[(c) Maximum continuous rating of boiler No. 3 [_____] kg/sec lb/hr

][(d) Maximum continuous rating of boiler No. 4 [_____] kg/sec lb/hr

] (7) Coal Analysis

(a) Ash: [_____] percent

(b) Carbon: [_____] percent

(c) Hydrogen: [_____] percent

(d) Sulfur: [_____] percent

(e) Moisture: [_____] percent

(f) Nitrogen: [_____] percent

(g) Oxygen: [_____] percent

(8) Ash Analysis

(a) Carbon: [_____] percent

(b) Calcium: [_____] percent

1.4.1.11 Deaerating Heater

a. Design pressure: 207 kPa (gage) 30 psig

b. Normal steam operating pressure: [_____] kPa (gage) psig

c. Maximum steam operating pressure: [_____] kPa (gage) psig

d. Capacity (minimum): [_____] kg/sec lb/hr of feedwater

e. Inlet Conditions at Heater:

	Maximum Pressure kPa(gage)	Temperature Range Degrees C	Flow Rate kg/sec
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

	Maximum Pressure psig	Temperature Range Degrees F	Flow Rate lb/hr
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]

	Maximum Pressure psig	Temperature Range Degrees F	Flow Rate lb/hr
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

f. Outlet temperature of feedwater from heater at design capacity: [_____] degrees C F

g. Heating steam pressure: [_____] kPa (gage) psig

h. Heating steam enthalpy: [_____] kJ/kg Btu/lb

i. Storage capacity to overflow of storage tank: [_____] liters gallons

1.4.1.12 Water Softening System

Base the water softening system on the following:

****

NOTE: Analysis of the water available for makeup shall govern the softener system selected. A competent water treating consultant shall be obtained to formulate specific system recommendations if the makeup water analysis indicates any of the following:

1. Iron in excess of 0.1 ppm as Fe.

2. Mg Alkalinity in excess of 50 ppm as CaCO3.

3. Silica in excess of 6 ppm as Si02.

****

a. Raw Water Analysis: Source of raw water is [_____]. Raw water is available at pressures of [_____] to [_____] kPa (gage) psig. Analysis of water available for makeup is approximately as follows:

TABLE 1: MAKEUP WATER ANALYSIS

	Constituent	Analysis	Parts Per Million (PPM)
Cations	Calcium (Ca++)	as CaCO3	[_____]
	Magnesium (Mg++)	as CaCO3	[_____]
	Sodium (Na+)	as CaCO3	[_____]
	Hydrogen (H+)	as CaCO3	[_____]

TABLE 1: MAKEUP WATER ANALYSIS			
TOTAL CATIONS		as CaCO3	[_____]
Anions	Bicarbonate (HCO3 -)	as CaCO3	[_____]
	Carbonate (CO3 --)	as CaCO3	[_____]
	Hydroxide (OH -)	as CaCO3	[_____]
	Sulfate (SO4 --)	as CaCO3	[_____]
	Chloride (Cl -)	as CaCO3	[_____]
	Phosphate PO4 ---)	as CaCO3	[_____]
	Nitrate (NO3 -)	as CaCO3	[_____]
TOTAL ANIONS		as CaCO3	[_____]
	Total hardness	as CaCO3	[_____]
	Methyl orange alkalinity	as CaCO3	[_____]
	Phenolphthalein alkalinity	as CaCO3	[_____]
	Iron, total	as Fe	[_____]
	Carbon dioxide	as Free CO2	[_____]
	Silica	as SiO2	[_____]
	Suspended solids (Turbidity)		[_____]
	Total dissolved solids (TDS)		[_____]
	Free acids		[_____]
	Color		[_____]
	pH		[_____]
	Specific Conductance Microhms/cm		[_____]

b. Softener Effluent Analysis:

****

NOTE: Total solids of 175 ppm in the feedwater concentrated 20 times give 3,500 ppm in the boiler water.

****

(1) Hardness: Maintain hardness of softened feedwater near zero and in no case allow it to exceed 1.0 part per million (ppm) as CaCO3.

(2) Total Solids: Maintain total solids in softened feedwater at a level to ensure a total solids concentration in the boiler water of less than 3,500 ppm without excessive blowdown.

1.4.2 Detail Drawings

1.4.2.1 Steam Generating Unit

Submit steam generating unit (boiler) manufacturer's drawing for the following:

a. Refractory details, expansion joints;

b. Certified outline, general arrangement (setting plan), and anchor bolt detail drawings including foundation loading diagrams;

c. Plans and elevations detailing piping connections;

d. Detailed dimensional drawings of auxiliaries furnished with unit;

e. Piping schematics for auxiliaries, such as sootblowers or hydraulic stoker drives (when used);

f. Shop fabrication details of boiler/furnace: Including details showing tubing, spacing, radii, dimensions, and gage; sections through walls and expansion joints showing refractory construction and replacement details; internal and external dimensions of boiler;

g. Wiring diagrams for subsystems;

h. Economizer and economizer inlet breeching;

i. Sootblowers;

j. Auxiliaries furnished with boilers;

k. Forced draft fan, drives and ductwork;

l. Induced draft fan, drives and ductwork;

m. Structural steel and loading diagrams; and

n. Overfire air fan system.

1.4.2.2 Boiler Room Auxiliary Equipment

Include equipment arrangements, wiring diagrams, piping diagrams and details of valves and piping. Submit descriptive information for each item on the drawings.

a. Water softening equipment;

b. Brine storage tank;

c. Condensate receiver;

d. Condensate transfer pumps including certified performance curves;

e. Deaerator;

f. Boiler feed pumps including certified performance curves;

g. Steam turbines;

h. Continuous blowdown system;

i. Chemical feed units;

j. Air compressors;

k. Air dryers;

l. Cranes and hoists; and

m. Plant heating and ventilating equipment showing related ductwork.

1.4.2.3 Stokers

Include the following:

a. General arrangement drawings;

b. Foundation drawings;

c. Front plates;

d. Ash hoppers;

e. Fuel gate mechanism;

f. Grate details;

g. Zone dampers;

h. Air seal details;

i. Overfire air nozzle arrangement;

j. Coal feeder details;

k. Fuel feeder drives;

l. Piping schematics;

m. Wiring schematics; and

n. Access doors.

1.4.2.4 Ash Handling System

Include the following:

a. General arrangement;

b. Construction details of ash storage silo complete with loading diagrams;

c. Control panel arrangement and schematics;

d. Wiring and control diagrams;

e. Ash piping arrangement drawings and schematic drawings;

f. Wear back fitting details;

g. Piping and fittings;

h. Details of [steam] [motor driven mechanical] exhauster [and air washer - steam condenser];

i. Details of separators, tertiary bag filter, and ash silo vent bag filter; and

j. Silo fluidizing system and rotary ash conditioner.

1.4.2.5 Burners

Include the following:

a. General arrangement;

b. Piping details;

c. Burner control schematics;

d. Flame safety schematics;

e. Component details; and

f. Throat tile details.

1.4.2.6 Stacks, Dampers, and Breechings

Include the following:

a. General arrangement;

b. Breeching, reinforcing details;

c. Breeching hangers and support details;

d. Dampers and operators;

e. Access doors and frames;

f. Expansion joints; and

g. Stack details including anchor bolt and foundation details, stack sampling ports, platforms, and accessories.

1.4.2.7 Coal Handling Equipment Drawings

Include the following:

a. Certified outline and general arrangement drawings for complete coal handling system;

b. Dimensional equipment and fabrication drawings, including equipment weights, equipment locations, support details, and anchor bolt arrangements for items and equipment specified under the paragraph COAL HANDLING EQUIPMENT;

c. Control panel, coal presence indicators, and equipment response switch details; and

d. Control schematic diagrams and complete wiring diagrams.

1.4.2.8 Fuel Oil Equipment

Manufacturer's standard size for pumps, pump curves, valves, strainers and pump wiring and include the following:

a. Certified outline and general arrangement drawings;

b. Certified pump curves;

c. Equipment detail sheets including viscosity controller, heater and valves;

d. Electrical wiring diagrams; and

e. Oil tanks, foundations, tank heaters, appurtenances, water drawoff and level indication.

1.4.2.9 Piping and Specialty Items

Manufacturer's standard size and include the following:

a. Details of valves and fittings;

b. Feedwater regulator details and schematics;

c. Details and schematics of feedwater automatic recirculation; and

d. Installation details for ball expansion joints for saturated steam piping including allowable angular flex and minimum offset dimensions.

1.4.2.10 Furnishing Approved Drawings

Furnish one reproducible mylar shop drawing of each approved drawing sheet to the Contracting Officer for the following items:

a. Boiler layout, foundations, construction and details including economizers, and auxiliaries;

b. Breeching layout, construction and details;

c. Burner control and flame safety schematics;

d. Burner details;

e. Wiring diagrams;

f. Fuel tanks, foundations and appurtenances;

g. Feedwater automatic recirculation system;

h. Piping schematics;

i. Control diagram schematics including control panel construction and layouts;

j. Coal handling system;

k. Stoker details; and

l. Ash handling system.

1.4.3 Posted Operating Instructions

Provide posted operating instructions for each piece of equipment installed.

1.4.4 Performance Requirements

1.4.4.1 Boiler

Efficiency listed for coal burning shall be based on stoker firing with [_____] percent excess air.[Efficiency for fuel oil firing shall be based on [_____] percent excess air.] Efficiency shall allow for [_____] percent continuous blowdown and 1.5 percent unaccounted losses and manufacturer's margin. Base boiler performance on burning fuels in accordance with the Coal Analysis [and Fuel Oil Analysis] listed below.

a. Coal Analysis

(1) Ultimate Analysis (percent by weight)

Carbon	[_____]
Hydrogen	[_____]
Oxygen	[_____]
Nitrogen	[_____]
Sulfur	[_____]
Ash	[_____]
Moisture	[_____]
TOTAL	[_____]

(2) Proximate Analysis (percent by weight)

Moisture	[_____]
Volatile Matter	[_____]
Fixed Carbon	[_____]
Ash	[_____]
TOTAL	[_____]

(3) Coal Characteristics:

Heating Value: [_____] kJ/kg Btu per pound

Ash Softening Temperature Reducing: [_____] degrees C F, Oxidizing: [_____] Degrees C F

Free Swelling Index (Coke Button):
Size: 32 by 19 mm (percent): [_____]; 19 by 6.35 mm (percent): [_____]; 6.35 by zero mm (percent): [_____]Size: 1 1/4 by 3/4 inch (percent): [_____]; 3/4 by 1/4 inch (percent): [_____]; 1/4 by zero inch (percent): [_____]

(4) Coal Variations: Due to periodic changes in coal suppliers, boiler and stoker combination shall be designed to burn coal within the following limits (percent by weight unless indicated otherwise):

	Minimum	Maximum
Ash	[_____]	[_____]
Sulfur	[_____]	[_____]
Hydrogen	[_____]	[_____]
Carbon	[_____]	[_____]
Moisture	[_____]	[_____]
Nitrogen	[_____]	[_____]
Oxygen	[_____]	[_____]
kJ per kg Btu per pound	[_____]	[_____]
Ash softening temperature	[_____]	[_____]
Volatile matter	[_____]	[_____]
Fixed carbon	[_____]	[_____]

[b. Fuel Oil Analysis

****

NOTE: Use Fuel Oil Analysis Schedule only if fuel oil burners are used.

****

(1) Grade of Fuel Oil:
(2) Ultimate Analysis (percent by weight)

Carbon	[_____]
Hydrogen	[_____]
Oxygen	[_____]
Nitrogen	[_____]
Sulfur	[_____]
Ash	[_____]
Moisture	[_____]
TOTAL	[_____]

(3) Heating Valve: [_____] kJ/kg Btu per pound
(4) Specific Gravity: [_____] degrees API
(5) Viscosity at burner
(6) [_____] (SSF at 50 degrees C 122 degrees F
(7) [_____] Water and Sediment (percent by volume)
(8) [_____] Flash Point degrees C F

] Submit predicted economizer performance along with and as a part of the boiler predicted performance.

1.4.4.2 Economizer

Increase in efficiency due to the economizer shall be not less than [_____] percent at full load. Fully coordinate economizer with the boiler to which it is to be applied.

1.4.4.3 Oil Burner/Windbox Package

Burner turndown ratio on specified fuel oil shall be not less than eight to one, with excess air not over 15 percent at full steam load, and excess air not over 22 percent at 20 percent steam load.[Air flow shall be modulated through a single set of register louvers.]

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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

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

****

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

Make submittals within [60] [75] [90] days after award of the contract.

SD-02 Shop Drawings

Steam Generating Unit

Boiler Room Auxiliary Equipment

Stokers

Ash Handling System

Burners

Stacks, Dampers, and Breechings

Coal Handling Equipment

Fuel Oil Equipment

Piping and Specialty Items

Each drawing size shall be A1 841 by 594 mm 34 by 22 inches, unless otherwise noted.

SD-03 Product Data

Steam Generating Unit (Boiler)

Coal Handling System

Insulation

Fans

Pumps

SD-04 Samples

Insulation

Submit samples of each type of insulation with indications of its intended application and manufacturer's stamp or label attached giving name of manufacturer, brand and description of material.

SD-05 Design Data

Stack Manufacturer's Calculations

Submit as specified under the paragraph MANUFACTURER'S CALCULATIONS REQUIRED.

SD-06 Test Reports

Boiler Predicted Performance

Economizer Performance

Instrument Air Compressor Package

Variable Speed Motor Controller

Submit certified copies of variable speed motor controller design, production and conformance tests for approval before delivery of the equipment.

Heating Plant

Submit for tests and inspections specified under the paragraph FIELD QUALITY CONTROL.

SD-07 Certificates

List of Equipment Manufacturers

Proof of Experience; G, [_____]

Manufacturer's Installation Approval

Boiler Inspector's Report

System and Equipment Installation

[Vertical Fuel Oil Tank Calibration

] Backflow Preventer

SD-10 Operation and Maintenance Data

Heating Plant, Data Package 4

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

SD-11 Closeout Submittals

Posted Operating Instructions

Submit text for each piece of equipment.

1.6 QUALITY ASSURANCE

Equipment shall be factory assembled except for steam generators, coal handling equipment and ash handling equipment which shall utilize shop assembled components to the maximum extent to facilitate erection and minimize field labor.

1.6.1 Standard Commercial Product

Boilers and equipment shall, as a minimum, be in accordance with requirements of this specification and shall be the manufacturer's standard commercial product. Include additional or higher quality features which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product, in the boilers and equipment being provided.

1.6.2 Equipment Furnished

Equipment furnished by the Contractor shall be furnished by the manufacturers listed in the submittal letter listing equipment manufacturers.

1.6.3 Responsibility

The contract drawings show the required general arrangement configuration and location of equipment items. However, the contract allows for selection of any vendor's equipment at the option of the Contractor, provided the vendor's experience and equipment meet the requirements of these specifications and drawings. Because there may be significant variation between the drawings and the individual vendor's equipment as to foundations, physical dimensions and detailed arrangement of equipment items, the Contractor shall furnish detailed design and shop drawings and calculations for the systems selected. Show foundation arrangements, walkways and other information as required for a completely coordinated, useable and properly functional system. A single system supplier shall be responsible for a complete system including erection or erection supervision for each of the following systems:

a. Boiler system, including but not limited to the following: Boiler, stoker, oil burners, [economizer,] refractories, insulation, induced draft fan, sootblowers, steam separator, forced draft fan, overfire air fan, boiler trim, blowdown valves, safety valves and trim, and breeching. Ensure that the system manufacturer coordinates the required instrumentation and control logic with the controls and

instrumentation supplier. Controls and instrumentation are specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

b. Coal handling system, including but not limited to the following: Track and reclaim hoppers, belt feeders, belt conveyors and tube galleries, telescoping chute, flight conveyor, coal bunker, under bunker conveyor and triple valves, coal scale, controls, coal chutes and gates.

c. Ash handling system including ash piping, fittings, intakes, ash silo, separators, tertiary filter, [mechanical exhauster] [steam exhauster, air washer-condenser], and rotary unloader.

d. Stack system including steel stack, internal acid resistant lining and external coating.

1.6.4 Certification of Backflow Preventer

Certificate of Full Approval or current Certificate of Approval for each backflow preventer being provided for the project shall be from the Foundation for Cross-Connection Control Research, University of Southern California and shall attest that the design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval will not be acceptable in lieu of the above.

1.6.5 Modification of References

In the API publications referred to in this specification, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should" and "suggested" wherever they appear.

1.6.6 Certificates

1.6.6.1 List of Equipment Manufacturers

Submit to the Contracting Officer a letter listing the equipment manufacturers for the following equipment:

a. Boilers and stokers;

b. Boiler feedwater pumps;

c. Coal car handling equipment;

d. Induced draft fans;

e. Coal handling equipment; and

f. Ash handling equipment.

When the Contracting Officer determines that a manufacturer does not meet the qualification or experience requirements of the specifications, the Contractor shall submit, to the Contracting Officer, the name of another manufacturer within 15 days of notification.

1.6.6.2 Proof of Experience

Submit proof of experience of manufacturers, system suppliers and installers as follows.

a. Experience, Responsibility and Certification: Submit to the Contracting Officer, the required information and experience certificates within 30 days after award and prior to commencing work on the site.

****
NOTE: Regarding the text below, verify number of manufacturers' installations operating and years of operation for boiler, coal handling systems, ash handling systems, forced draft fan, burner/windbox package and control systems to avoid an unnecessarily restrictive experience requirement.
****

b. Experience Requirements: Boilers and equipment installed within or as a part of the heating plant shall be of proven designs. Each manufacturer or system supplier shall be regularly engaged in designing, fabricating, erecting or erection supervision, testing and starting up of the equipment or system. Within 30 days after contract award, or at any time during performance of the contract, if the Contractor is required to use a different manufacturer or system supplier from one that was designated previously, through no fault of the Contractor, the Contractor shall submit certification and other evidence of acceptable experience from each replacement manufacturer or system supplier. Such certification shall show that equipment and systems made or furnished by the manufacturers or system suppliers have operating characteristics which are substantially similar to the equipment or systems specified. The certification shall also state that essentially equivalent equipment or systems supplied by the manufacturer or system supplier have been successfully installed and reliably operated in at least [one] [two] [three] installation[s] under comparable operating conditions for a period of not less than two years.

c. Information Required: Submit to the Contracting Officer, evidence or proof of experience required from the equipment manufacturer or system supplier containing the following information:

(1) List of installations meeting requirements of the paragraph EXPERIENCE REQUIREMENTS including detailed description of equipment furnished for each one;

(2) Owner and location of each installation;

(3) Name and phone number of supervisory person at each installation; and

(4) Date of Owner acceptance of such installation.

[d. Vertical Fuel Oil Tank Calibration Experience: Submit to the Contracting Officer evidence or proof that the tank calibration organization has at least 2 years of prior successful and accurate experience in calibrating tanks of comparable type and size.

]1.6.6.3 Manufacturer's Installation Approval

Submit manufacturer's installation approval for the following systems and equipment as specified under the paragraph SYSTEM AND EQUIPMENT INSTALLATION:

a. Steam generating units (boilers) and auxiliary equipment;

b. Coal handling system;

c. Ash handling system;

d. Plant air compressors;

e. Steam turbines;

f. Variable speed motor controller; and

g. [_____].

1.6.6.4 Boiler Inspector's Report

Submit as specified under the paragraph BOILER INSPECTION.

1.6.6.5 System and Equipment Installation

Submit from each system supplier and each manufacturer of the equipment, written certification that the system and equipment installation is in accordance with the system supplier's and equipment manufacturer's instructions and recommendations, that the unit or system has been run, rotating parts have been dynamically balanced, fluid (including air) flows have been balanced, instrumentation and controls are properly functioning, adjusted and have been calibrated, and the equipment or system is ready for final testing. Certificates shall be submitted before the entire boiler plant may be given an acceptance test.

[1.6.6.6 Vertical Fuel Oil Tank Calibration

Submit four copies of the certified record.

]1.6.6.7 Backflow Preventer

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project.

1.7 ENVIRONMENTAL REQUIREMENTS

Boiler plant shall comply with all applicable Federal, State, and local environmental regulations.

1.7.1 Air Permits

Permits for construction and operation of the boiler plant must be obtained from and/or submitted to the local environmental regulatory agency prior to the start of construction.

1.7.2 Burner Emission Requirements

The emission requirements shall be met at the maximum required continuous output. The burner shall meet all applicable environmental rules and regulations. Emission requirements to be considered are oxides of nitrogen (NOx), opacity, particulate, sulfur dioxide, and carbon monoxide. Other emission requirements may be imposed.

1.7.2.1 NOx Emission Regulations

Compliance shall be met using [one] [a combination] of the following:

a. Low NOx burners

b. Flue gas recirculation equipment which conforms to UL 795

c. Other NOx reduction techniques. See Nitrogen oxide control for stationary combustion sources.

1.8 DELIVERY, STORAGE, AND HANDLING

Each assembly of components packaged as a unit shall be of a size that can be transported by common carrier without disassembly insofar as shipping clearances are concerned.

1.9 EXTRA MATERIALS

Furnish a spare set of refractory bricks for each railroad hopper car thawing system.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials free of defects which would adversely affect the performance or maintainability of individual components or of the overall assembly. Materials not specified shall be of the same quality used for the intended purpose in commercial practice. Unless otherwise specified, equipment, material, and articles incorporated in the work covered by this specification shall be new.

2.1.1 Identical Items

Provide physically and mechanically identical boilers and equipment of the same classification, size or capacity to permit the interchangeability of replacement parts. This requirement includes parts, assemblies, components, and accessories. Parts provided on the same type unit regardless of size and identifiable by identical part numbers shall be functionally and dimensionally interchangeable. No deviation is acceptable without prior written approval of the Contracting Officer.

2.2 BOILER

[Coal/Oil] [Coal] Fired. Submit steam generating unit (boiler) data for the following:

a. Safety valve calculation sheets;

b. Boiler predicated performance data, and

c. Economizer predicted efficiency calculations.

2.2.1 Packaged Watertube Boiler

Provide Type I boiler conforming to FS F-B-2902 except as modified below. Provide lifting attachments.

2.2.2 Operational Requirements

Boiler shall be capable of operating continuously at the maximum specified conditions without damage or deterioration to the boiler, settings, firing equipment or auxiliaries. Boiler shall be capable of automatically controlled operation while burning the specified fuel[s].

2.2.3 Tubes

****
NOTE: Use this paragraph if tube diameters larger than specified in FS F-B-2902 are desired and insert minimum acceptable diameter.
****

Boiler and furnace tubes shall be not less than [_____] mm inches in outside diameter. Furnace tubes and first two rows of main boiler bank shall be one gage heavier than other tubes.

2.2.4 Boiler Trim

Fitting, drain valves, drain piping, feed piping, pressure gages, feed valves, stop valves, check valves, safety valves, and remaining appurtenances shall comply with applicable requirements of the ASME Boiler and Pressure Vessel Code. Components shall conform to the following:

2.2.4.1 Boiler Blowoff Valves

Provide flanged [Class 250 cast iron] [Class 300 cast steel] body, seatless, sliding plunger type valves mounted in tandem at each boiler blowoff connection.

2.2.4.2 Steel Gate, Globe and Angle Valves

ASME B16.34.

2.2.4.3 Safety, Relief, and Safety Relief Valves

ASME BPVC SEC I.

2.2.4.4 Steam Gage

****
NOTE: Select gage scale to operate within the middle third of range.
****

Provide a 300 mm 12 inch diameter indicating steam gage with chromium plated trim and zero to [_____] kPa (gage) psig scale. Gage shall be complete with syphon, valve, piping, and fittings to properly connect same. Gage shall be flush mounted on a 368 mm square by 5 mm 14 1/2 inch

square by 3/16 inch thick steel plate. Provide plugged tee connection for connection to remote steam gage.

2.2.4.5 Water Column

Provide a safety water column with high and low water alarm suitable for the design pressure of the boiler. Column shall be complete with three-chain-operated gage cocks, heavy duty inclined gage glass, and quick-closing water gage valves having cross leavers and chains operated from floor. Gage glass shall be readable from any point directly below unit. Make connections to water column from boiler with extra strong steel pipe and forged steel fittings. Provide crosses instead of tees or elbows, with screwed plugs in open ends. Terminate bottom of water column and water column gage glass with plug-type valves accessible from operating floor. Provide screwed plugged connections in water column piping for remote level indicator. Provide gate valves immediately below water column and gage glass. Provide a suitable lamp fixture to illuminate water column.

2.2.4.6 Safety Valves

Provide not less than [_____] cast steel or cast iron body high capacity safety valves to give a total steam relieving capacity in accordance with the ASME BPVC SEC I requirements as to total boiler and water wall heating surface. Valves shall be set with a set pressure of [_____] kPa (gage) psig, [[_____] kPa (gage) psig] [, [_____] kPa (gage) psig] [and [_____] kPa (gage) psig] respectively. Valves shall have flanged inlet and outlet connections.

2.2.4.7 Non-Return Valve

Provide a non-return valve on each boiler steam outlet. Valve shall be a stop check angle body valve, flanged, [Class 250 cast iron] [Class 300 steel] body with handwheel shutoff, pressure operated disc and external equalizer. Assembly for manual operation shall be outside screw and yoke type.

2.2.4.8 Blowoff Connections

Bottom drum blowoff connection on boiler shall be [_____] mm inch diameter and extended to outside of setting terminating with tandem flanged blowoff valves as specified above. Boiler water wall blowoff connections and economizer inlet pipe blowoff shall be 40 mm 1 1/2 inch diameter and extended to outside of setting and equipped with same type valves. Provide stop valves for water column blowoff connections. Boiler blowoff connections shall conform to the applicable requirements of ASME BPVC SEC I, Part PG-59.

2.2.4.9 Miscellaneous Stop Valves

Provide stop valves near boiler for each connection to boiler; include valves for soot blowers, chemical feed, vent, continuous blowoff, and required drains.

2.2.4.10 Tube Cleaner

Provide one tube cleaner suitable for cleaning boiler tubes. Tube cleaner shall operate on water at 1034 kPa (gage) 150 psig pressure. Tube cleaner shall be complete with one motor, one wrench, one cutter head assembled,

one universal coupling for cutter head, two sets of cutters, two sets of cutter pins, one set of arm pins, one set of keeper pins, one brush with a set of refills, one tool box, and two 15 meters 50 foot lengths of heavy duty hose with 20 mm 3/4 inch diameter pipe connections.

2.2.4.11 Wrenches

Provide special wrenches required for proper maintenance of equipment.

2.2.5 Boiler Limit Interlocks

Provide applicable boiler limit interlocks required by FS F-B-2910 and connect to effect safety shutdown of the stoker[and oil burners]. Interlocks shall be compatible with and integrated into the control and instrumentation system.

2.2.6 Sootblowers

Provide boiler [and economizer] with a sootblowing system using [steam] [compressed air] for removing deposits of soot and fly ash from heat transfer surfaces. Sootblower elements shall be of a sufficient number and in a proper location to clean every heat transfer surface susceptible to soot or fly ash deposition. Fixed position, multi-nozzle rotating elements may be used in applications where flue gas temperatures do not exceed 982 degrees C 1800 degrees F. Retractable soot blowers shall be provided where flue gas temperatures exceed 982 degrees C 1800 degrees F.

[2.2.6.1 Fixed Position Soot Blowers (Steam)

****
NOTE: Choose this paragraph or the paragraph below, FIXED POSITION SOOTBLOWERS (AIR PUFF).
****

Steam, fixed position, multi-nozzled, rotating, valve-in-head type with electric motor operation to permit proper cleaning of heat transfer surfaces with cam operated valves arranged to automatically open steam valve through proper arc of rotation. Cams shall be adjustable to give proper operating arc or shall be specially designed for each location. Furnish and install soot blowers complete, including valve-in-head blower heads, wall sleeve bushings, high temperature elements, low temperature elements, [_____] volt, [_____] Hz, [_____] kW hp motor operators, hand operated drain valve, with drilled orifice and disc to prevent tight shutoff, element supports, clamps, bolts, and other required hardware. Furnish necessary piping and valves including drain lines, shutoff valves, piping supports and insulation. Weld sootblower piping and fittings. No screwed piping or fittings will be permitted. Install sootblower elements with care so that they do not rub on tubes and cause eventual tube failure. Provide scavenging air connections from forced draft fan where required to protect blower in non-blowing position. Provide a single control station containing start and stop pushbuttons and necessary relays to control motor operators.

][2.2.6.2 Fixed Position Sootblowers (Air Puff)

****
NOTE: Choose this subparagraph or the subparagraph above FIXED POSITION SOOTBLOWERS (STEAM).
****

Air puff type, fixed position, multi-nozzled rotating element type complete with air master controller for each boiler, entirely air-operated and designed for controlled automatic sequential operation. Units shall be operated in such a manner that air issues from the element in a series of sustained high pressure puffs of approximately one second duration each. During each puff, element shall be rotated through a predetermined and measured short arc (17 degrees) by means of a ratchet mechanism in the sootblower head. Between each puff, no air shall flow through blowers and there shall be sufficient time for system to be restored to full pressure. When each blowing cycle is complete, the controller shall automatically stop its operating sequence. Provide sootblowers complete, with wall sleeve bushings, element supports, clamps, bolts, and other required hardware. Provide necessary piping and valves, including shutoff valves, piping, and supports. Sootblower piping and fittings shall have welded connections. No threaded piping or fittings will be permitted. Install sootblower elements with care so that they do not rub on tubes and cause eventual tube failure.

]2.2.6.3 Retractable Sootblowers

Provide in lieu of fixed position type and use where flue gas temperatures exceed 982 degrees C 1800 degrees F. Sootblowers shall be [air] [electric] motor operated. Rotation of sootblower shall be continuous from the moment the lance or element begins to extend. Rotational and translational speeds shall be independently adjustable by changing sprockets. Sootblowers shall be complete with heavy steel housing, outside adjustment of nozzle pressure, alloy element or lance, wall sleeve, supports, and necessary hardware required for a completely workable system.

2.2.6.4 Sootblower Elements

Provide sootblowers with elements specially designed for use with [steam] [air]. Elements subjected to temperatures of 482 to 816 degrees C 900 to 1500 degrees F shall be chromium covered extra heavy carbon steel tubing or a chrome alloy as specified for high temperatures; between 817 to 927 degrees C 1501 to 1700 degrees F, elements shall contain not less than 20 to 23 percent chrome; from 928 to 982 degrees C 1701 to 1800 degrees F, not less than 24 to 27 percent chrome. Provide a flexible connection between each head and element.

2.2.6.5 Pushbutton

On the operating floor provide a pushbutton for each boiler for starting and stopping sootblower system.

2.2.6.6 Control for Sootblowing System

Provide sootblowing system with an automatic programmable control system which will automatically start and stop each soot blower in programmable sequence and monitor and display operation of soot blowers. Provide an override control which will permit manual start-stop operation of sootblowers.

2.2.7 Combustion Controls

As specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.3 ECONOMIZER

****
NOTE: Economizers shall be specified for all boilers with operating pressures greater than 345 kPa (gage) 50 psig and a capacity of 2 1/4 kg/sec 18,000 pounds per hour and larger. For boilers from 1/2 to 2 1/4 kg/sec 4,000 to 18,000 pounds per hour the designer shall make the decision based upon a specific economic analysis. This paragraph shall be included as applicable.
****

****
NOTE: Unless a coal or a fuel oil to be burned has an uncommon tendency to foul tubes, finned tube economizers should be suitable for both fuels. Feedwater temperatures should be 110 degrees C 230 degrees F when sulphur (S) content of oil is 0.5 percent; 116 degrees C 240 degrees F, S=1.5 percent - 2 percent; 121 degrees C 250 degrees F, S=2.0 percent - 2.7 percent. Where fuels having more than 1.5 percent sulfur content are to be fired, finned tubes shall not be used unless they are steel tubes covered with cast iron finned casing.
****

Provide a modular [bare tube] [cast iron finned, steel tube] unit constructed in accordance with the ASME BPVC SEC I. Water flow shall be parallel to flue gas flow (incoming water shall enter at the same end that the flue gasses enter the economizer).

2.3.1 Construction

Provide manufacturer's standard economizer design for the operating conditions and the fuel(s) specified. Coordinate the amount of heating surface with the flue gas conditions exiting the boiler or boilers on which the economizer is to be applied to preclude reaching the "acid dew point" for specified fuels. When necessary (sulfur is present in the specified fuel and the designed inlet temperature could fall below the "acid dew point"), provide a feedwater temperature control system. Provide casing of not less than 12 gage steel plate reinforced with steel support lugs and breeching flanges. Provide building framing steel to properly support the economizer.[Provide built-in rotary chain operated soot blowers for each economizer to thoroughly clean surfaces exposed to flue gas.] Economizer shall be designed so that internal construction can be easily cleaned and inspected.

2.3.2 Equipment

Provide the following equipment for each unit:

a. Relief valve

b. Shutoff gate valve on feedwater outlet and shutoff globe valve on inlet with globe valve bypass. Size valves as shown in economizer piping detail

c. Temperature indicator on feedwater outlet

d. Temperature indicator on feedwater inlet

e. Temperature indicator on flue gas outlet

f. Temperature indicator on flue gas inlet

g. Temperature alarm switches for high and low flue gas temperatures

h. Alarm with trouble light and silencing switch

i. Panel with annunciator and temperature indicators for feedwater inlet, feedwater outlet, flue gas inlet, flue gas outlet of each economizer

j. A drain valve downstream of the economizer before the shutoff valve

k. A stack flue gas temperature control system to control and limit flue gas temperature to not less than 149 degrees C 300 degrees F by modulating a motorized feedwater control valve in a bypass around the economizer. Provide a shutoff valve on each side of the control valve with a strainer upstream of each valve. Provide this system parallel to the manual shutoff and bypass described above

l. Differential pressure indicator on water side

m. Differential pressure indicator on gas side

n. Pressure gages on feedwater inlet and outlet

2.3.3 Insulation

Submit manufacturer's literature of each insulation type and installation, adhesives, coating mastic and accessories. Make reference to specification paragraph numbers where they apply. Insulate economizer with not less than the equivalent of 50 mm 2 inches of mineral wool insulation and lag with not less than 27 gage galvanized, weatherproof lagging.

2.4 COAL STOKERS

****
NOTE: The single retort underfeed stoker can be used for up to a maximum continuous rating of approximately 3 kilogram per second (kg/s) 25,000 pounds per hour steam flowrate and a two hour peak rating of 3.75 kg/s 30,000 pounds per hour depending upon the manufacturer.
****

****
NOTE: If the boiler is not part of this project insert Coal Analysis at end of this paragraph and delete the last sentence.
****

Provide for each boiler a single retort underfeed stoker with moving grates arranged for side dump ash discharge. Stoker shall be capable of continuous operation at such rate as required for continuous output of not less than that specified for the boiler and shall satisfactorily provide

for automatic operation, by means of a combustion control system, within the range given when burning specified coal and operated in accordance with manufacturer supplied instructions. Satisfactory operating conditions shall be obtained throughout the full operating range of the stoker. Stoker shall be considered as an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service conditions together with requirements of tests, performance guarantees and other warranties specified for the boiler. Coal analysis shall be as specified in the Coal Analysis Schedule for the boiler.

2.4.1 Stoker Grate Area and Heat Release Rate

****

NOTE: The designer shall refer to the graph of Stoker Allowable Rating - Percent Of Full Load Rating Versus Ash Fusion Temperature shown in NAVFAC DM-3.6, NAVFAC Design Manual, Figure 11 and select the appropriate combustion rate.

****

Provide a grate with area sufficient to give specified steam output when burning specified coal. Grate shall fit between furnace side wall headers and between the inside face of the front wall and face of the bridge wall. Maximum stoker heat release rate shall be not greater than [_____] watt per square meter Btu per square foot per hour at the specified maximum continuous rating for the boiler.

2.4.2 Construction

2.4.2.1 Coal Fuel Feed Control

Provide a stoker ram with a constant stroke for feeding fuel to the central retort and necessary auxiliary rams or pushers to secure an even distribution of fuel throughout the entire length of the retort and over the grate surface. Determine rate of coal feed by the length of the rest period between full strokes. Provide for control by adjustment at a single point. Design stoker controls for connection to a combustion control system.

2.4.2.2 Coal Hopper

Provide a [_____] mm inch thick Type 316 stainless steel coal hopper having a capacity of not less than [_____] kg pounds at the front of each stoker.

2.4.2.3 Stoker Front Enclosure

Provide stoker front with dusttight enclosure of cast iron, or not less than 10 gage steel plate, of height and width to match boiler front to eliminate dust from the boiler room and prevent air infiltration to grate.

2.4.2.4 Stoker Grates

Grate surface shall consist of air cooled lateral firebars or grates inclined downward from the central retort toward side walls of furnace. Provide for agitation of fuel bed by either an alternating arrangement of moving and stationary grate bars or an undulating grate bar motion. Moving grates shall be adjustable to obtain the degree of movement

necessary to suit characteristics of the fuel. Adjustments shall be capable of being made while unit is in operation. Design firebars or grates to prevent sifting of coal through spaces provided for air admission to the fuel bed. As a minimum, construct stoker grates of alloyed cast iron.

2.4.2.5 Stoker Drive

Stoker may be hydraulically or mechanically driven through cranks and machine cut, double reduction worms and gears, fully enclosed in an oiltight case and running in a bath of oil. Bearings shall be antifriction type, with hardened inner and outer races and fitted with forced lubrication fittings.

2.4.2.6 Stoker Drive Electric Motor

[_____] volt, [_____] phase, 60 Hz, [_____] rpm, totally enclosed, fan cooled not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES.

2.4.2.7 Air Distribution Control

Divide stoker plenum chamber into high and low pressure zones. High pressure zone shall be adjacent to retort where fuel bed is normally heaviest. Low pressure zone shall be under end of grate furthest from retort and shall compensate for thinner fuel bed normally carried in that area. Make provisions to admit air under pressure through the dump grates by manually operated blast gates.

2.4.2.8 Overfire Air System

Overfire air system shall consist of a blower, damper, manifold with properly sized nozzles and connecting air piping to ensure full penetration and proper turbulence. Blower volume shall not be less than 15 percent of total volume of combustion air. Blower pressure shall be sufficient for penetration of the full length of the furnace. Nozzles shall be located in rear of furnace wall and nozzle spacing shall be approximately 150 to 230 mm 6 to 9 inches o.c. Utilizing air from forced draft fan for overfire air system is not acceptable. Design shall conform to requirements of the stoker manufacturer to suit the boiler furnished.

2.4.2.9 Ash Discharge System

Provide each stoker with power operated dump grates extending from front wall to bridge wall on both sides adjacent to side walls and of sufficient area to handle ash resulting from burning of coal specified at the maximum capacity specified. Stoker dump cylinders shall be [steam] [air] [hydraulically] operated. Perforate dump grates for admission of air to burn out combustibles before refuse is discharged to ash pit. Provide ash spray pipes with manually operated valves on front of stoker beneath each dump grate.

2.4.2.10 Doors

Provide stoker front with not less than two lined furnace access doors not less than 460 mm wide by 400 mm high 18 inches wide by 16 inches high with observation ports, two ash pit doors not less than 350 mm wide by 300 mm high 14 inches wide by 12 inches high, and two air plenum cleanout doors.

2.4.2.11 Lubrication

Provide stoker drive mechanism with grease cups, oil cups, or splash pans to provide proper lubrication.

2.5 OIL BURNER/WINDBOX PACKAGE

****
NOTE: The designer shall fill in the appropriate information as defined in FS F-B-2910.
****

Provide a fully modulating, oil burner conforming to FS F-B-2910, Class [_____], except as modified below. Provide burner with windbox, burner blower fan, dampers, fuel train and associated controls to comprise a complete factory assembled package. Total heat input to the boiler furnace shall be provided by [_____] burners. Burner package shall be considered an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service together with the requirements of tests, performance guarantees and other warranties specified for the boiler.

2.5.1 Burner

2.5.1.1 Burner Characteristics

Burner shall be quiet in operation and shall operate with a balanced flame so as not to localize heat in any part of the combustion chamber. Burner shall be capable of completely atomizing and effectively mixing oil with air so as to ensure complete combustion. Air admitted shall be of sufficient quantity for complete combustion, but not of such quantity as to produce an undue percentage of excess air with attendant high stack loss. Oil burner shall operate without clogging or failure, and shall have sufficient capacity to develop not less than the specified capacity. Burner unit shall be easily removed from firing position and readily accessible for inspection, cleaning, and other purposes. Provide adequate observation ports on burner. Burner manufacturer shall guarantee that there will be no flame impingement on sidewalls, top, bottom, or rear walls of furnace. Install burner manufacturer furnished refractory throat tiles or other items required for proper installation of burner.

2.5.1.2 Atomization

****
NOTE: For boilers below 7100 kW 25,000 pounds per hour the designer shall select either compressed air or steam atomization after performing an economic analysis. For 7100 kW 25,000 pounds per hour and above, atomization shall be by compressed air unless steam pressure is required for greater turndown.
****

Burner shall be [steam atomizing; steam pressure at header is [_____] kPa (gage) psig; steam temperature at header is [_____] degree C F] [air atomizing; filtered compressed air shall be available for burner atomization and the maximum requirement for each burner shall not exceed [_____] L/s scfm of air at [_____] kPa (gage) psig]. Provide pressure reducing valve and controls as required.

2.5.1.3 Electric Ignition System

****
NOTE: Natural gas pilot ignition system may be considered only when natural gas is available at the site.
****

****
NOTE: Choose this subparagraph or the subparagraph below, NATURAL GAS PILOT IGNITION SYSTEM.
****

Burner shall be equipped with an electric ignition system. System shall be either high energy ignition or glow rod type. Gas ignition system is not acceptable. High energy ignition system shall use stored energy to develop 2000 Vdc pulses. Glow rod system shall use a low voltage, carbon rod electrode which develops a tip temperature of 1427 degrees C 2600 degrees F. Provide ignition system complete.

2.5.1.4 Natural Gas Pilot Ignition System

****
NOTE: Natural gas pilot ignition system may be considered only when natural gas is available at the site.
****

****
NOTE: Choose this subparagraph or the subparagraph above, ELECTRIC IGNITION SYSTEM.
****

Provide a complete interrupted type natural gas-fired, spark ignited pilot system for the burner assembly. Combustion air supply shall be from the burner windbox. Lighting system shall have capacity to stabilize firing during startup periods. Lighter shall be arranged for easy removal and servicing while boiler is in operation. Furnish igniter complete with spark rod and power pack. Power pack shall operate on 120 volt, 60 cycle, single phase power. Provide gas piping, to one point of supply, including necessary gas pressure regulators. Igniter system shall include controls, gages, flame safety systems, interlocks and accessories to comply with Industrial Risk Insurers' (I.R.I.) (formerly F.I.A.) requirements and applicable codes and regulations.

2.5.1.5 Windbox

Construct of carbon steel plate not less than 10 gage thickness with 6 mm 1/4 inch thick front plate. Design windbox to provide even and uniform air entrance into the burner register and seal weld to the boiler front wall. Provide windbox with support legs.

2.5.1.6 Purge Connection

Provide [steam] [air] purge connection, properly valved, for purging oil from gun prior to removal from burner.

2.5.1.7 Aspirating System

****
NOTE: Provide aspirating system only for boilers in which the expected furnace pressure exceeds 1245 Pa 5 inches water.
****

Provide an air aspirating system for fuel oil atomizer guide pipes to prevent blowback of hot furnace gases. Aspirating system shall use approximately [_____] L/s scfm of [_____] kPa (gage) psig compressed air.

2.5.1.8 Piping

Provide piping and flexible hoses for guide pipe purge[and aspirating] system[s]. Air from forced draft fan shall be used for guide pipe purging during normal operation.

2.5.1.9 Metal Parts

Metal parts exposed to radiant heat, including atomizer shield, shall be of stainless steel or other approved alloy.

2.5.1.10 Fuel Oil Control Valve

Fuel oil will be supplied at [_____] kPa (gage) psig and [_____] degrees C F at the inlet of the fuel piping train. Size fuel oil automatic control valve for 103 kPa 15 psi differential pressure.

2.5.1.11 Fuel

ASTM D396, Grade No. [_____].

2.5.1.12 Burner Blower Fan For Oil Fired Burner

Provide fan fully integrated with and mounted on windbox. Provide an inlet silencer, when required, to ensure operation at noise level below 85 dBA.

2.5.1.13 Electric Motor

Motor shall be [two speed,] [_____] volt, [_____] phase, 60 Hz, [totally enclosed, non-ventilated] [totally enclosed, fan cooled], not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES.

2.5.2 Flame Safeguard Controls

Provide a complete system of valves, interlocks and controls in accordance with NFPA 85 and as approved by Factory Mutual Engineering and Research.

2.5.2.1 Fuel Oil Train

Provide fuel oil train consisting of [steam] [air] atomizing oil gun, auxiliary [steam] [air] atomizing oil gun for changing guns without a shutdown, fuel oil control valve, two safety shutoff valves, recirculation valve, strainer, and flexible hose connections to oil burner. Provide low oil pressure and low atomizing air pressure switches, and all other safety interlocks and devices as required. Provide in panel mounted on burner package the following gages. Gages shall be 150 mm 6 inch with white

coated dials and black figures:

a. Fuel oil supply pressure (0 to 1034 kPa (gage) 150 psig)

b. Fuel oil pressure at burner (0 to 1034 kPa (gage) 150 psig)

[c. Atomizing air pressure at burner (0 to 1034 kPa (gage) 150 psig)

][d. Atomizing steam pressure at burner (0 to 1034 kPa (gage) 150 psig).

]2.5.2.2 Control Sequencing

Flame safeguard system shall be designed to ensure safe purge, light-off and shutdown procedures, and to monitor light-off, main flame and boiler operating conditions.

[a. Flame safeguard system shall be automatically sequenced type with programming timed and sequenced by a heavy duty, industrial type timer. Timer shall be tamper-proof and shall be designed so that advancement of timer to shorten purge will shut down unit.

] b. Provide system with [ultraviolet] [infrared] scanner and electronic relay located in the front wall which will shut down the fuel within 2 to 4 seconds of loss of flame.

c. Provide scanner output meter in panel for indication of scanner signal strength.

d. Safety system shall include the following limit devices incorporated into a limit circuit:

(1) Flame failure

(2) High boiler outlet pressure

(3) Low fuel oil pressure

(4) Low water level cutout

(5) Low combustion air flow

(6) Low atomizing [air] [steam] pressure

(7) Any additional as required by FM or NFPA

[(8) Low fuel oil temperature

] e. Safety System Limits: Safety system limits specified above shall be displayed on a first out annunciator mounted in the burner panel.[Provide a common alarm contact to be wired to the operator control console.]

2.5.2.3 Light Off

Failure shall require a manual restart of the programmer. Safety system shall provide a mandatory purge with forced draft fan vanes proven open, and a return to proven low fire position before light off. Main fuel valve shall open for a timed period of 10 seconds during trial for ignition.

2.5.2.4 Circuit Analyzer

Provide a circuit analyzer system, which, by means of 12 or more lights, will indicate which circuits are energized at any specific time, and will thereby indicate improperly operating circuits.

2.5.2.5 Control Panel

Programmer, limit control, relays, annunciator, shall be mounted in a [NEMA MG 1 control panel, modified with fully gasketed doors and panels mounted on burner package] [control panel as specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

2.6 FANS

Submit fans and blowers characteristic curves.

2.6.1 Forced Draft Fan (Coal Firing)

****
NOTE: The designer shall make a technical evaluation to determine if the coal forced draft fan should be integrated with the stoker front or mounted separately on the floor.
****

CID A-A-59222, Type [_____], Class 1, except as specified otherwise.

2.6.1.1 Fan Size

Size fans for complete combustion of fuel at maximum firing rate taking into account design allowances, corrections for burner pressure drop, furnace pressure, combustion air temperature, plant elevation, and other design factors[including allowance for economizer]. After fans have been sized in accordance with the above, add the following allowances for momentary overloads and normal deterioration of fans, firing equipment and boilers to obtain the required test block rating:

a. Excess volume: 20 percent

b. Excess pressure: 32 percent

2.6.1.2 Fan Construction

Construct fan wheel of steel. Direction of fan discharge shall be easily changed at angles of 45 degrees. Provide fan with roller bearings mounted in pillow blocks. Provide one coat manufacturer's shop prime paint over interior and exterior of fan and wheel.

2.6.1.3 Electric Motor

****
NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the fan drive motor shall be provided with variable speed control. Generally variable speed drives for fans over 7 1/2 kW 10 hp will be cost effective.
****

Motor for driving forced draft fan shall be [variable speed] [two speed], [_____] volt, three phase, 60 Hz, [open drip-proof] [totally enclosed, fan cooled] not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES, and shall not overload at the specified capacity with unheated cold air. Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be common for all four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.1.4 Noise Level for Forced Draft Fan

Not to exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above floor and 1 1/2 meters 5 feet from fan in any direction. Provide heavy duty sound attenuator with screen on fan inlet when required to meet sound pressure level requirements.

2.6.2 Induced Draft Fan

CID A-A-59222, Type [_____], Class 2 except as specified otherwise.

2.6.2.1 Fan Size

Size fans to handle combustion gases at maximum firing rate. Maximum fan speed shall not exceed [_____] rpm at test block rating. Design allowances and corrections for furnace, economizer, [scrubber,] [baghouse,] [dust collector,] breeching pressure drop when operating at [10] [20] [40] percent excess air, flue gas temperature, plant elevation and other design factors shall be made. Add the following allowances for momentary overloads and normal deterioration of fans, firing equipment and boilers after sizing in accordance with the above, to obtain the required test block rating:

	Excess Volume	Excess Pressure
Coal Fired		
Induced draft	20 percent	32 percent
Oil Fired		
Induced draft	10 percent	20 percent

2.6.2.2 Fan Construction

Fan wheel shall be radial tip design constructed of steel. Balance fan wheel both statically and dynamically at factory. Direction of fan discharge shall be easily changed at angles of 45 degrees. Provide fan with [air] [water] cooled sleeve type or roller bearings mounted in pillow blocks.

2.6.2.3 Dampers

Provide inlet dampers with multi-parallel-stream flow blades with anti-friction bearings with 80 mm 3 inch minimum spacers and stuffing boxes to keep bearings cool. Dampers shall be mounted in 200 mm 8 inch channel frames and interconnected with one extended, ball bearing mounted control level for connection to control actuator.

2.6.2.4 Painting

Interior of fan, including wheel, shall be coated with protective coatings suitable for flue gas conditions expected to be encountered by this fan. Exterior surface of fan shall have coatings of quality weather and heat resistant paint. Fan shall be shop assembled and match-marked by manufacturer before dismantling for shipment. Surface cleaning and painting shall be in accordance with manufacturer's standards for service expected.

2.6.2.5 Electric Motor

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the fan drive motor shall be provided with variable speed control. Generally variable speed drives for fans over 7 1/2 kW 10 hp will be cost effective.

****

Motor for driving induced draft fan shall be [variable speed] [two speed], [_____] volt, three phase, 60 Hz, [open drip-proof,] [totally enclosed fan cooled,] not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES, and shall not overload over the range of the fan with unheated air. Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be common for all four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.2.6 Noise Level for Induced Draft Fan

Noise level shall not exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above floor and 1 1/2 meters 5 feet from the fan in any direction. Provide sound attenuation to meet sound pressure level requirements.

2.7 COMPRESSED AIR SYSTEM

****

NOTE: Refer to utilities schedule on definitive drawings for suggested plant air requirements.

****

2.7.1 Plant Compressed Air System

Provide two packaged units conforming to FS XX-C-2816, Type [_____], except as modified below. Each compressor capacity shall be not less than [_____] standard L/s scfm of air, at 20 degrees C 68 degrees F and [_____] kPa (gage) psig (equivalent to pressure at an elevation of [_____] meters feet), compressed to 1379 kPa (gage) 200 psig at the discharge. Compressor speed shall not exceed [_____] rpm. Number of stages shall be [_____].[Compressor shall have water cooled cylinders and heads.][Oil free delivery is required.] Provide a safety valve between each compressor discharge and its shutoff valve. Provide a shutoff valve on the discharge piping of each compressor. Provide an electric thermostatically controlled immersion heater. Provide compressor with [[air] [water] cooled intercooler and] aftercooler.[Compressor and motor shall be tank mounted.] Provide lifting lugs and tie down attachments.

2.7.1.1 Air Filter

Air Filter on inlet shall act as a muffler. Provide filter of the [oil wetted type] [dry type] readily removable for cleaning.

2.7.1.2 Oil Filter

Provide full flow type filter for positive forced feed lubrication conforming to FS F-F-351.

2.7.1.3 Air Receiver

Receiver shall be [_____] liter cubic feet minimum volume designed in conformance with FS XX-C-2816 except that working pressure shall be 1724 kPa (gage) 250 psig. Provide the receiver, with a safety valve set for 1792 kPa (gage) 260 psig, a drain valve and an air trap with shutoff valve.[Provide a stand for mounting the receiver.] Provide a dial gage, not less than 114 mm 4 1/2 inches diameter, range zero to 2068 kPa (gage) 300 psig, on the receiver.

2.7.1.4 Electric Motor

Motor shall be [_____] volt, [_____] phase, 60 Hz, totally enclosed, fan cooled not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Control circuits for motors shall be nominal 120 volts.

2.7.1.5 Controls

Provide [constant speed] [dual control] regulation and the "optional safety controls" as specified in Table I of FS XX-C-2816 for the compressor system. In addition, provide a lead-lag control system with alternating lead-lag cycles.

2.7.2 Instrument Compressed Air System

Provide air compressor package with two compressors, two electric motors, one horizontal receiver, and control panel, [mounted on one supporting steel base with skids] [mounted separately].

2.7.2.1 Air Compressor

Each shall be a single stage, cross head type, vertical, double acting, water cooled, nonlubricated head type. Compressor shall be specially designed for non-lubricated service, with a honed cylinder, piston rod packing, piston rings and piston wear rings. Valve guide inserts and wear rings shall be TFE. Valves shall be reversible and hardened, with stainless steel seat plates for nonlubricated service. Provide necessary sleeves, baffles, and collars to prevent oil carryover. Provide air operated, piston type, free air unloaders for capacity reduction and starting. Mount filter-silencer directly on air inlet to cylinder.

Design and Performance: Each compressor shall deliver not less than [_____] standard L/s scfm of free air at a discharge pressure of 690 kPa (gage) 100 psig.

2.7.2.2 Air Receiver

Horizontal tank with a volume not less than [_____] liters cubic feet. Design unit for 1034 kPa (gage) 150 psig working pressure in accordance

with the ASME BPVC SEC VIII D1. A receiver bearing the ASME Code Symbol stamp will be accepted as meeting these requirements. Provide an automatic condensate trap, safety valve, and outlet connection.

2.7.2.3 Aftercooler

Aftercoolers shall be water cooled, with counter current flow, and shall be installed directly between each compressor cylinder and the air receiver. Design cooler to cool total output air flow of compressor to within 9 degrees C 15 degrees F of inlet cooling water temperature. Tube bundle shall be removable for cleaning and inspection.

2.7.2.4 Electric Motor

Each compressor shall be V-belt driven by a [_____] volt, [_____] phase, 60 Hz motor not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Provide a removable, totally enclosed belt guard.

2.7.2.5 Controls

Provide controls and shutdowns necessary for automatic operation of compressor package. House controls in NEMA 12 control cabinet. Controls shall include two, full voltage, automatic across-the-line starters; alternator to switch compressors from lead to lag and to run both compressors when needed; 120 volt control transformer; air discharge pressure gage; selector switches for constant speed or automatic dual control, along with necessary time delay and control relays. Provide automatic solenoid operated cooling water valve in the cooling water line to the compressors and aftercoolers. Factory wire control cabinet and mount as part of package.

2.7.2.6 Accessories

Factory assemble compressors, electric motors, controls, air receiver, aftercoolers, and miscellaneous hardware and mount on steel supporting base. Provide lifting lugs and tiedown attachments. Provide air, water, and condensate piping and terminate them at the edge of the supporting base.

[2.7.2.7 Desiccant Air Dryer

****
NOTE: Choose this subparagraphs or the subparagraph below, REFRIGERATED AIR DRYER.
****

Provide for systems exposed to freezing temperatures a compressed air desiccant dryer with noncorrosive desiccant housed in twin pressure vessels, capable of drying [_____] standard L/s scfm of air to [_____] degrees C F pressure dewpoint. Unit shall be field adjustable to maintain pressure dewpoint of dried air at any preselected value below operating temperature, to minus 40 degrees C F. As an integral part of the unit, provide an indicator showing the water content of the dry air and a calibrated adjustment control to change water content to any preselected level.

a. Design: Design unit for maximum temperature of not less than 49 degrees C 120 degrees F and maximum operating pressure of not less than 1034 kPa (gage) 150 psig. Pressure drop through unit operating at

full rated flow shall not exceed 27 kPa 4 psi.

b. Controls: Provide continuous supply of dry air by automatically cycling operation of desiccant beds. Dryer shall be complete with panel mounted gages showing pressure in each drying tower and spark suppressor to protect microswitch in timer circuit. Total electrical power requirements shall not exceed 75 watts at 110 Vac.

c. Filters: Provide prefilter upstream of dryer to remove oil vapor, liquid water, and solid particles. It shall have greater than 99 percent efficiency in removing both 0.5 micron diameter solid particles and 0.5 micron diameter oil aerosol. Filter shall have replaceable oil absorbing filter element which turns red to indicate saturation with oil and which shall be mounted in a transparent cast methyl methacrylate tube for visibility and inspection while on stream. Protect transparent acrylic tube by a safety shield. Provide afterfilter for removal of solid particles down to 5 microns size.

][2.7.2.8 Refrigerated Air Dryer

****
NOTE: Choose this subparagraph or the subparagraph above, DESICCANT AIR DRYER.
****

Provide for systems not exposed to freezing temperatures a compressed air dryer of the self contained refrigerated type complete with heat exchanger, a commercial quality refrigeration system, a moisture separator and condensate trap, and internal wiring and piping. Install dryer between receiver and distribution line.

a. Heat Exchanger: Provide air and refrigerant coils surrounded by aluminum granules of sufficient mass to ensure adequate cooling capacity for varying air flow loads without causing excessive refrigeration cycling. Provide an automatic control system, for heat exchanger with a sensing element located in the aluminum granules, to shut down refrigeration system on low or no-load conditions. Provide means to determine exchanger temperature.

b. Moisture Separator: Provide a centrifuge type located within the heat exchanger to provide for moisture separation at point of minimum air temperature.

c. Refrigeration Unit: Provide hermetically sealed type which operates intermittently at all but maximum load conditions. Unit shall be capable of drying [_____] standard L/s scfm of air to an atmospheric dew point of not less than minus 23 degrees C 10 degrees F with entering air at 38 degrees C 100 degrees F, saturated. Maximum operating pressure of dryer shall be [_____] kPa (gage) psig. House entire unit in a steel cabinet. Provide cabinet with access door and panel for easy access to parts for maintenance and inspection.

]2.7.3 Pressure Reducing Regulator

Provide self-operating type designed for not less than a 1724 kPa (gage) 250 psig operating pressure, and a normal operating temperature range of minus 29 degrees C 20 degrees F to plus 65 degrees C 150 degrees F. Regulator shall have an adjustable outlet pressure range not less than 34 to 690 kPa (gage) 5 to 100 psig with not less than four ranges. Provide

external adjusting screw for adjustment throughout each spring range. Provide internal pressure tap for outlet pressure regulation.

2.8 BREECHING, EXPANSION JOINTS, STACKS, DAMPERS, AND ACCESSORIES

2.8.1 Breeching

Provide with rectangular cross section stiffened on sides, top and bottom and fabricated of not less than 5 mm 3/16 inch thick black steel plate unless otherwise noted. Stiffeners shall be not less than 65 by 50 by 6 mm 2 1/2 by 2 by 1/4 inch steel angles welded to exterior with 50 mm 2 inch leg outstanding. Stiffeners shall not exceed one meter 3 feet on center. Breeching shall connect to [each boiler flue gas outlet,] [intermediate heat recovery equipment,] [air pollution control equipment,] [and to stack as required].

2.8.1.1 Breeching Connections and Joints

Weld or bolt breeching joints unless indicated otherwise. Welding shall conform to AWS D1.1/D1.1M and AWS D1.3/D1.3M. Bolts for bolted connections shall be not less than 15 mm 1/2 inch diameter and spaced not more than 80 mm 3 inches apart, with bolts, lockwashers and nuts being hot-dipped galvanized. Provide bolted joints with a minimum of 3 mm 1/8 inch thick non-asbestos gaskets, suitable for the intended use. Bolt breeching connections to all boilers, equipment items, dampers, expansion joints, and breeching accessories. Flanged breeching connections to equipment shall be drilled to match flanges on equipment. Seal weld flanged joints to make connection gas-tight.

2.8.1.2 Uninsulated Breeching

Thoroughly wire brush breeching which is not to be insulated and clean by degreasing with nonflammable solvent such as trichloroethylene prior to painting.

2.8.1.3 Breeching Access Doors

Provide where indicated. Construct access doors with frame and hinged door of cast iron or reinforced steel plate. Frame shall be not less than 635 by 940 mm 25 by 37 inches with access opening of 457 by 762 mm 18 by 30 inches. Connection to breeching shall be gasketed and made with minimum 15 mm 1/2 inch diameter hot-dipped galvanized bolts, lockwashers, and nuts spaced not more than 125 mm 5 inches on center. Each side of access door shall have not less than two quick-clamp positive closing latches, with long side opposite hinges containing three clamps to give a gastight seal. Side of access door opposite hinges shall contain a minimum 80 by 125 mm 3 by 5 inch size handle. Provide a gasket consisting of 10 mm 3/8 inchdiameter fire resistant resilient rope seal and mastic compound between access door and access door frame.

2.8.1.4 Breeching Cleanout Doors

Provide where indicated. Construct cleanout doors of not less than 5 mm 3/16 inch thick steel plate. Secure cleanout doors to a 32 by 32 by 5 mm 1 1/4 by 1 1/4 by 3/16 inch thick angle frame with 10 mm 3/8 inch hot-dipped galvanized mounting bolts welded to the angle frame and spaced not more than 150 mm 6 inches on center. Weld frame to breeching and provide a 1.60 mm 1/16 inch non-asbestos gasket suitable for the intended service between frame and cleanout door. Cleanout doors shall be not less

than 610 mm 24 inches square except where breeching dimensions are smaller, in which case cleanout door shall be full height of the breeching and not less than 305 mm 12 inches in length.

2.8.1.5 Breeching Structural Materials

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NOTE: The designer shall detail breeching supports and breeching stiffening. Breeching hangers shall be designed to carry not less than 5 times the breeching weight, or the breeching weight plus 136 kg 300 pounds whichever is greater. Hangers for rectangular breeching shall be of the trapeze type with angle or channel support members and hanger rods. Breeching shall be stiffened with angle or channel members as required to withstand internal breeching static pressure.

****

Structural and support materials shall be steel and shall comply with applicable sections of the AISC 360.[Support and stiffen breeching as indicated.]

2.8.2 Expansion Joints

2.8.2.1 Metallic Breeching Expansion Joints

Provide factory fabricated metallic breeching expansion joints[where indicated]. Expansion joints shall be guided metal bellows type capable of a minimum of [_____] mm inches of axial travel. Form metal bellows from not less than 1.60 mm 1/16 inch thick type 321 stainless steel plate. Cover plates shall be not less than 3 mm 1/8 inch thick steel plate.

2.8.2.2 Non-Metallic Expansion Joints

Provide factory fabricated non-metallic breeching expansion joints 3 mm 1/8 inch minimum thickness[where indicated]. Expansion joints shall be constructed of a fluoroelastomer vulcanized to two plies of knitted wire mesh capable of a minimum of [_____] mm inches of axial compression, [_____] mm inches of axial extension and [_____] mm inches of lateral offset [unless indicated otherwise]. Joints shall have a continuous operatingtemperature rating of 204 degrees C 400 degrees F, with excursion design standards up to 400 degrees C 750 degrees F. Operating pressure range shall be minus 34 kPa (gage) 5 psig to plus 34 kPa (gage) 5 psig. Expansion joints shall be preformed with integrally molded corners, suitable for mounting against a 150 mm 6 inch flange. Provide carbon steel backup bars with slotted holes, bolts, and nuts.

2.8.3 Stacks (For Installation Without Flue Gas Scrubbers)

Free standing, dual wall with insulated annular space, self supporting, steel construction. Provide stack manufacturer's calculations for supporting steel and concrete foundations, that suit specified design conditions. Provide each stack complete with accessories and appurtenances, including test ports, sampling platforms, caged safety ladders, anchors, sleeves, insulation, base and chair rings, and cleanout door.

2.8.3.1 Manufacturer's Calculations Required

a. Foundation (including bearing and moment forces) and anchor bolts

b. Stack (Static and Dynamic Analysis)

(1) Stresses due to various loading conditions including wind and seismic loads

(2) Damping of vortex shedding and seismic response

(3) Vibration and damping

(4) Heat transfer at various design and ambient conditions

(5) Expansion profiles

(6) Shipping and erection stress analysis

2.8.3.2 Construction

a. Provide in annular air space between the two steel shells insulation with sealing means to accommodate thermal expansion differentials and lateral deflections or sway of inner and outer shells.

b. Provide openings with adequate reinforcement to minimize stress concentrations.

c. Design wall thickness of inner shell to be 1.60 mm 1/16 inch thicker than that required by dynamic and static structural design but not less than 5 mm 3/16 inch.

d. Construct outer shell of ASTM A242/A242M steel with a plate thickness not less than [_____] mm inch.

e. Construct expansion devices of corrosion resistant stainless steel suitable for the temperatures and flue gas combinations to be experienced by stacks.

f. Base construction of stack shall transmit forces and moments in the shell to the [foundation] [supporting steel] without local stresses of appreciable magnitude being induced in the shell or exceeding allowable stresses of the supporting [concrete] [steel].

g. Provide openings in breeching and stack for test equipment for sampling flue gas and for monitoring devices. Openings shall be properly reinforced and designed for differential expansion. Breeching opening shall be of double wall construction. Penetrations through inside shell of stack shall be completely welded to provide proper sealing between the stack and the opening.

h. Provide top 1.22 meters 4 feet cone section of stack of corrosion resistant steel.

i. Provide suitable anchor bolts furnished by the stack manufacturer.

j. Accessories to be provided.

(1) Provide double wall insulated steel plate door cleanout complete

with 25 mm one inch round hinge pin, gasket and not less than 18 swing bolts.

(2) Provide a ring of Type 304 Corrosion Resistant Steel (CRES) to support an inspection or painter's trolley. Weld ring and support from stack plates with not less than three brackets 10 by 65 by 381 mm 3/8 by 2 1/2 by 15 inches. Space brackets at not more than 610 mm 2 feet on center around circumference of stack.

(3) Provide a three wheel CRES flat rail trolley of 227 kg 500 lbs capacity. Trolley shall have guides to prevent it from leaving the track [_____] meters of 8 mm feet of 1/4 inch CRES plow steel cable.

(4) Provide each stack with an external ladder with cage for full height of stack. Construct ladder and cage of corrosion resistant steel.

(5) Provide a flue gas sensing thermocouple well with thermocouple one meter 3 feet above breeching opening and 1 1/2 meters 5 feet below top of stack. Wells shall be CRES and shall extend about halfway into stack.

2.8.3.3 Finish

Stacks shall be shop coated prior to shipping from factory.

2.8.3.4 Obstruction Lighting

****

NOTE: Stack obstruction lighting requirements are dependent on a number of factors including the location and height of the stack. The designer shall refer to NAVFAC DM-23.1, NAVFAC DM-23.2, and FAA AC 150/5345 to determine if obstruction lighting is required.

****

Provide an obstruction lighting system for each heating plant stack, consisting of one red, flashing, 300 millimeter hazard beacon atop each stack, two steady burning, red obstruction marker lights halfway up each stack, photoelectric and flasher controls, weather-tight terminal boxes, cable, and conduit.

a. Hazard Beacons: FAA AC 150/5345-43 Type L-866.

b. Obstruction Lights: FAA AC 150/5345-43 Type L-810.

[2.8.3.5 Stack Sampling Platform

****

NOTE: Designer shall detail a stack sampling platform if required. If not required delete this paragraph. If required the platform will have to be located at a point as approved by air pollution control agency having jurisdiction. Many local and state codes incorporate Title 40 Code of Federal Regulations, Part 60. Depending upon final air pollution control equipment arrangement this

location may be on the stack or possibly on a long length of horizontal breeching. Stack sampling platform should have the following features:

1. Sampling ports located according to 40 CFR 60 Appendix A, Method.

2. Platform should be 914 mm 36 inches wide but at ports location it should project away from breeching or stack a minimum of 610 mm 2 feet plus the diameter of the breeching or stack for up to 3 meters 10 feet in diameter stack.

3. If any type of continuous air pollution monitoring devices are located at stack sampling point or anywhere else on breeching, a non-vertical access (stairs or catwalk) is required. For stack sampling purposes a non vertical ladder is preferred but is not required. Platform with grating shall be designed for a live loading of 1464 kg/m2 300 lbs/sq. ft; platform should have railing with two intermediate railings and 100 mm 4 inch toeplate. Four 30 amp weatherproof receptacles and adequate lighting including lights over the test ports should be provided.

****

Provide stack sampling platform conforming to requirements of 29 CFR 1910-SUBPART D, Walking and Working Surfaces.

]2.8.4 Dampers

2.8.4.1 Multilouver Dampers

****

NOTE: Opposed blade dampers shall be used for throttling service and parallel blade dampers shall be used for two-position service.

****

Provide factory fabricated multilouver dampers with [parallel][or][opposed] blade type operation. Construct damper frame of distortion resistant welded steel channels with raised seat to ensure free nonbinding operation of blades and to keep blades square in the frame. Construct blades of 6 mm 1/4 inch thick steel plate in a stressed skin airfoil-shape with fully welded seams containing no external ribs. Blade shafts shall be stainless steel. Blades shall be pinned to blade shafts. Louver shaft bearings shall be outboard type and shall be self-lubricating and self-cleaning. Bearing seals shall be gas-tight.

a. Multilouver damper linkage shall be adjustable and of pinned construction for easy removal and shall be designed to handle full operation torque. Linkage on dampers in clean flue gas areas shall operate from a single connection point. Design linkage on dampers in dirty flue gas areas, between boiler outlet and inlet to air pollution equipment, so that bottom blade linkage arm is not connected to above linkage, to allow this blade to operate separately. Remaining linkage for this damper shall be constructed to operate from a single operating point.

b. Provide control damper operators as noted. Operators may be either electrically or pneumatically operated with positive positioning, manual override, and hydraulic or oil immersed gear trains. Each operator shall be full-proportioning type, with spring return to position indicated in case of loss of power. Damper operating speeds shall be selected or adjusted so that operators will remain in step with controller. Operators acting in sequence with other operators shall have adjustment of control sequence as required by operating characteristics of system.

c. Two-position damper operators shall be pneumatically operated with air cylinder, four way valve, and solenoid valve arrangement.

2.8.4.2 Guillotine Dampers

****
NOTE: Guillotine dampers shall be used for open-shut service where tight shutoff is required; for example, for air pollution control equipment bypass dampers.
****

Provide factory fabricated guillotine dampers with heavy structural frame rigid enough to support extended blade and external loads through the breeching flange. Damper shall be capable of operating without precleaning or manual assistance under normal operating conditions. Enclosed bonnets will only be required where indicated. Provide 80 mm 3 inch diameter cleanout ports on both sides for cleaning bottom sections.

a. Provide stress-relieved flat plate guillotine damper blades. Damper blade shall be nonwarping. Intermediate blade supports are acceptable to limit blade deflection. Leading edge of damper blade shall be beveled and capable of guiding damper blade into frame seat. Blade guides shall be continuous and self-cleaning and capable of preventing binding from deposits and damage from misalignment. Bonnet guides shall be removable. Design damper so that a damper blade can be replaced without opening the frame.

b. Provide guillotine damper bonnet seal to effectively seal against atmospheric leakage under normal operating conditions.

c. Guillotine damper drive shall be a positive dual endless chain drive capable of driving damper in both directions. Chain drive headshaft shall have sufficient torsional rigidity to prevent binding of blade when blade is stalled. Damper shall be motor operated with manual override. Design drive mechanism to prevent back driving of motor. Entire drive mechanism shall be of a simple design and require no routine maintenance other than inspection. Chain shall be capable of operating up to the stall torque of the damper drive motor.

d. Electric motor shall be [_____] volt, [_____] phase, 60 Hz, [totally enclosed, fan cooled] [open drip-proof], not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Provide removable, totally enclosed chain guard.

2.9 COAL HANDLING EQUIPMENT

Submit coal handling system manufacturer's data for the following:

a. Railroad hopper car thawing system;

b. Railroad hopper car shaker;

c. Railroad hopper car puller;

d. Coal scale;

e. Belt scraper; and

f. Coal dust suppression system.

2.9.1 Railroad Hopper Car Thawing System

****

NOTE: Pit type railcar thawing system is capable of operating on natural gas, liquified petroleum gas or No. 2 fuel oil. The radiant heat (infrared) type railcar thawing system can only burn natural gas or liquified petroleum gas or use electric resistance heaters. The radiant heat (infrared) type provides a slower method of thawing but causes less damage to the railroad car finish and is preferred provided natural gas or liquified petroleum gas or electrical power is economically available and permitted by current DoD policy.

****

[Pit-type] [Prefabricated surface mounted enclosed type] [or electric radiant type] hopper car thawing unit including burners, controls, combustion air blowers, fuel storage and handling, and related work. Design system to thaw 56 Mg, 71 Mg and 102 Mg 55 ton, 70 ton and 100 ton capacity coal cars. System shall be capable of thawing [_____] bottom hopper unloading coal cars simultaneously. Railroad hopper car thawing system shall utilize [No. 2 fuel oil] [natural gas] [liquified petroleum gas] as a fuel. Provide a sufficient number of heaters to have a minimum heat input of 2198 kW 7,500,000 Btu/hr per car station, with heaters distributed under hopper car, or under and beside hopper car, such that entire car is heated. Locate [burner pits] [heater units] for even heating of hopper cars without subjecting air hoses, air brake equipment, and bearings to excessive heat.

[2.9.1.1 Pit-Type Railroad Hopper Car Thawing System

****

NOTE: Choose this subparagraph or the subparagraph below SURFACE MOUNTED ENCLOSED RAILROAD HOPPER CAR THAWING SYSTEM.

****

a. Pit-Type Thawing Unit: Pit-type hopper car thawing unit shall be complete with a refractory lined steel box, burner assemblies, steel burner enclosure with cover, valves, piping, and hinged main pit protective covers. Each pit shall have the capacity to generate 366 kW 1,250,000 Btu/hr when burning [No. 2 fuel oil] [natural gas] [liquified petroleum gas]. Burners shall fire horizontally and tangentially into pit from opposite sides to heat refractory lined pit up to radiant temperature. Heat shall be transferred to hopper car by

radiation from hot refractory surfaces and by convection from exhaust gases and evaporated moisture to rail car bottom and sides. Construct pit outer shell of not less than 6 mm 1/4 inch thick corrosion resistant steel plate, with end plates of 10 gage (3.42 mm 0.1345 inch) steel. Provide supporting flanges and handling loops on both ends and provide cap strips on top of both sides. Place cast iron heat deflecting plates with overlapping edges on pit sides and bottom supported off ledge on outer shell. Provide a minimum 25 mm one inch air space between plates and outer shell. Pit side walls and bottom shall have a minimum 65 mm 2 1/2 inch thickness of standard firebrick with one course of standard end skew brick along top of side walls. Firebrick shall be easily replaceable. End section shall have not less than 114 mm 4 1/2 inch thick precast high temperature refractory panels. Provide burner refractory ignition tiles with steel jacket casings having mounting lugs for bolting to end plates of pit. Provide concrete railroad ties adjacent to each thawing pit. Deliver combustion air to burners by means of pressure blowers which take fresh air from outside thawing area. Factory wire and assemble heaters, control panels, blowers, and zone controls. Shop fabricate burner piping and control valve assemblies.

****
NOTE: Designer shall make selections in the text below based on fuel to be used in thawing system.
****

b. Fuel System:[Provide complete fuel system for operation with, [natural] [liquified petroleum] gas including piping, regulators, low and high pressure limit switches interlocked with combustion controls, gages, solenoid valves, shutoff valves, and accessories which may be required for each manufacturer's particular system.][Provide complete fuel system for operation with duplex fuel oil pump set with [_____] liters gallon horizontal [below] [above] ground fuel tank and accessories which may be required for each manufacturer's particular system. Provide fuel oil system in accordance with the requirements specified under the paragraph FUEL OIL SYSTEM.]

c. Burner controls shall meet Industrial Risk Insurers' (I.R.I.) (formerly F.I.A.) requirements. Connect fuel system piping to fuel supply piping as indicated. Burners shall be controlled (modulate) to regulate heat output to suit the operating requirements. Provide a manual light-off, low pressure [gas] [oil] pilot for automatic light-off of each thawing unit.

d. Air System: Provide complete air systems for operation with blowers, inlet silencers, gages, shutoff valves, low pressure limit switches interlocked with combustion controls, and accessories which may be required for each manufacturer's particular system.

e. Control Panel: Provide centrally located control panel, with panel front consisting of a graphic display of the thawing system. Display shall be approximately to scale and coordinated with control and light indication for combustion air blowers and on-off control of convenient groups of heaters. Provide on-off control with indicating light for each thawing pit. Panel shall have a NEMA [12] [3R-8], dust-tight enclosure with internal equipment and wiring accessible from panel front. Provide nameplates on panel front to designate function of switches and indicating lights. Controls shall be suitable for [_____] volt, [_____] phase, 60 Hz operation. Provide and mark

terminals for connections with the exception of the neutral. Terminal blocks shall be 600 volt rated. Control relays shall have convertible contacts and shall have rating suitable for intended services but not less than 10 amp, 600 volt rating. Components shall be oiltight type. Connections to panel shall be watertight. Motor starters for combustion air blowers shall be installed in each respective blower cabinet.

][2.9.1.2 Surface Mounted Enclosed Railroad Hopper Car Thawing System

****
NOTE: Choose this subparagraph or the subparagraph above PIT-TYPE RAILROAD HOPPER CAR THAWING SYSTEM.
****

****
NOTE: Choose item a. or item b. that follows.
****

[a. Surface Mounted Enclosed Thawing Unit (Gas): Burner shall be of multiport cast iron construction and provide for even heating of radiant elements. Heater design shall be essentially the same for undercar and sidecar heaters, with heat transmitted to hopper car by both radiation and convection. Design burner and radiant element for radiation being the primary mode of heat transfer. Radiant element over burner shall be of a heavy corrosion-resistant metal material. Design burner to operate on [natural gas] [liquified petroleum gas], and such that open flame from combustion will not extend beyond emitter surface either during normal operation or in the event of emitter deterioration or burnout. Provide shields where necessary to direct radiation and hot exhaust gases to hopper car surface. Provide means for shielding car air hoses, air brake equipment, and bearings from excessive heat. Provide each heater with individual heater control boxes constructed as to provide positive air pressure inside control box. Control boxes shall contain mixing valve for maintaining proper gas-air ratio for satisfactory combustion. Locate gas and air piping connections for easy removal of individual burners. Deliver combustion air to heaters by means of pressure blowers which take fresh air from outside thawing area to ensure continued satisfactory combustion of gaseous fuels. Factory wire and assemble thawing units, control panels, blowers, and zone controls.
]

****
NOTE: Choose item b. or item a. above.
****

[b. Surface Mounted Enclosed Thawing Unit (Electric): Thawing unit may be an electric radiant heat thawing unit which includes self-contained heater banks such as under-car heater sections, outside the rail heater sections, lower side car heater sections and vertical side car heater sections, with reflectors, hinged cover, waterproof and weatherproof wired terminal blocks and zone controls for flexibility of operation.

] c. Burner Controls (for Gas Fired Units): Burners shall be electrically ignited with controls meeting Industrial Risk Insurers' requirements. Provide a gas pressure regulator for serving not more than eight individual burners. Regulator shall reduce gas pressure in supply line to pressure required for burners. Provide each burner with an

air regulating valve for fuel-air ratio adjustment. Regulating valve shall contain positive vibration-proof locking device for maintaining critical adjustment.

d. Control Panel: Provide centrally located control panel with panel front having a graphic display of the thawing system. Display shall be approximately to scale and coordinated with control and light indication for combustion air blowers and on-off control of individual heaters. Provide a modulating control for each heater to regulate heat output to suit the operating requirements. Panel shall be NEMA [12] [3R-8], dust-tight enclosure with internal equipment and wiring accessible from the panel front. Provide nameplates on panel front to designate function of switches and indicating lights. Controls shall be suitable for [_____] volt, [_____] phase, 60 Hz operation. Provide and mark terminals for connections, with the exception of the neutral. Terminal blocks shall be 600 volt rated. Control relays shall have convertible contacts and shall have rating suitable for intended service but not less than 10 amp, 600 volt rating. Components shall be an industrial design of the oiltight type. Connections to the panel shall be watertight. Motor starters for combustion air blowers shall be installed in each respective blower cabinet.

]2.9.1.3 Shed

****
NOTE: Shed should be used in the severe climate areas.
****

Provide shed of pre-engineered metal space frame construction with corrugated siding as indicated. Provide ventilation with roof vents and openings along bottom of sides.

2.9.2 Top-Mounted Railroad Hopper Car Shaker (Unloader)

****
NOTE: If noise is a major factor of concern, design a shaker enclosure with acoustical treatment which will be capable of reducing the noise to a tolerable level.
****

Provide top-mounted rail car shaker complete with shaker, frame, vibrator, motors, hoists, hoist frame, [enclosure,] and controls. Design unit for operation under all weather conditions.

2.9.2.1 Shaker

Shaker shall operate with a nominal 4 mm 5/32 inch stroke at 1200 rpm. Stroke shall be generated by large eccentric SAE 1045 steel shaft mounted in high capacity, self-aligning, spherical roller bearings. Seal bearings with a double piston ring labyrinth seal and dust and water slinger to retain lubricant and prevent entry of contaminants. Shaker frame shall be stress-relieved, all welded steel construction. Fabricate frame of heavy steel plate, with bearing housing seats machined after stress relieving. Provide four lifting eyebolts of heat-treated forged alloy steel for connecting to hoist chains.

Shaker Electric Motor and Drive:

Motor shall be totally enclosed, fan cooled, 1800 rpm, [_____] volt, three phase, 60 Hz, not less than 15 kW 20 hp, as specified in the paragraph MOTORS AND DRIVES. Motor shall be mounted on heavy spring isolated supporting frame with adjustable motor base. Shaker shall be belt driven with special deep groove sheaves, taper locking type hubs, and constant belt tensioning spring.

2.9.2.2 Shaker Hoist

Twin hook type having a rated capacity exceeding the weight of the shaker unit. Hoist shall have a lift of not less than 7.50 meters 25 feet with a hoist speed of not less than 0.08 m/sec 16 fpm. Hoist shall have not less than 460 mm 18 inch long sling chains for connecting hoist to shaker lifting eyes, and hooks shall have U-bolt safety latches. Hoist shall be mounted on an electrified trolley as specified in Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING.

Shaker Hoist Electric Motor:

Totally enclosed, [fan cooled,] [non ventilated,] 1800 rpm, [_____] volt, three phase, 60 Hz, not less than 5 1/2 kW 7 1/2 hp as specified in the paragraph MOTORS AND DRIVES. Motors shall be high slip type with thermal overload protection embedded in the windings.

2.9.2.3 Controls

Provide [remote] [pendant] pushbutton station for both shaker and hoist operation. Provide automatic controls with upper and lower screw type limit switches to limit hook travel, slack cable limit switch to stop lowering of hooks when car shaker has been lowered on top of car, electrical interlock to prevent operation of car shaker motor until shaker is lowered on car, and electrical interlock to prevent operation of hoist motor while car shaker is running. Mount electrical equipment in NEMA 4 enclosures.

2.9.2.4 Frame [and Enclosure]

****

NOTE: If noise is a major factor of concern, design a shaker enclosure with acoustical treatment which will be capable of reducing the noise to a tolerable level.

****

Provide frame [and enclosure] as indicated for support of hoist and shaker unit[and for attenuation of noise].

[2.9.3 Capstan Car Puller

****

NOTE: Designer shall select either a capstan type or drum type car puller. A capstan type puller is satisfactory for handling rail cars on level grade provided the pulling capacity is not exceeded. For high pulling capacities and locations where rails are not on level grade, the drum type puller should be used. Designer shall detail required footings

and foundations based on the selected puller and soil conditions at each plant site.

****

****

NOTE: Choose this paragraph and subparagraphs or the paragraph REVERSIBLE DRUM TYPE CAR PULLER, and its subparagraphs below.

****

Capstan-type designed with capacity of not less than 4540 kg 10,000 pounds of starting pull and an average rope speed of approximately 0.23 m/sec 45 fpm. Assembly shall be totally enclosed, weatherproof, and suitable for exterior installation with vertical capstan. Capstan shall be semisteel alloy construction designed for use with marlin-covered wire rope.

2.9.3.1 Accessories

Provide capstan complete with accessories, including controls, rope, rope storage reel, car hooks, sheaves, snatch blocks, anchors, and ratchet holdback.

2.9.3.2 Rope

Capstan rope shall be not less than 25 mm one inch o.d. marlin clad wire rope with a breaking strength of not less than 13,620 kg 30,000 pounds.

2.9.3.3 Rope Storage Reel

Construct of metal, hand operated with the drum not less than 300 mm 12 inches in diameter and the reel faces not less than one meter 3 feet in diameter. Drum shall have not less than [_____] mm inches face width and store not less than [_____] meters of 25 mm feet of one inch diameter marlin clad wire rope.

2.9.3.4 Electric Motor

Totally enclosed, [fan cooled,] high starting torque, reversing type, [_____] volt, three phase, 60 Hz, not less than 7 1/2 kW 10 hp as specified in the paragraph MOTORS AND DRIVES.

][2.9.4 Reversible Drum Type Car Puller

****

NOTE: Designer shall select either a capstan type or drum type car puller. A capstan type puller is satisfactory for handling rail cars on level grade provided the pulling capacity is not exceeded. For high pulling capacities and locations where rails are not on level grade, the drum type puller should be used. Designer shall detail required footings and foundations based on the selected puller and soil conditions at each plant site.

****

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NOTE: Choose this paragraph and subparagraphs or the paragraph CAPSTAN CAR PULLER, and its subparagraphs above.

****

[Single drum reversing] [Double drum] type designed with a capacity of not less than [_____] kg pounds of running rope pull. Starting pull capacity shall be not less than twice the running pull capacity. Provide assembly on one-piece heavy steel base with weatherproof motor and gear reducers suitable for exterior location.

2.9.4.1 Puller

Unit shall consist of a [_____] mm inch pitch diameter by [_____] mm inch face, spirally grooved for [_____] mm inch diameter wire rope with sealed anti-friction bearings, alloy steel ring mounted spur gear and SAE 1045 steel shaft. Provide an SAE 1045 steel countershaft with anti-friction pillow blocks and heat-treated alloy steel spur pinion roller chain drive with steel sprockets and enclosed guard. Speed shall be a minimum of [_____] m/sec fpm.

a. Electric Motor: [Totally enclosed,] [fan cooled,] high starting torque, reversing type, [_____] volt, [_____] phase, 60 Hz, not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Provide clutch for engaging and disengaging power to drum.

b. Reduction Gears: AGMA Class I sized for the motor power with motor base and coupling. Motor shall include motor mounted disc brake in dust and watertight enclosure. Provide rope overwind switch assembly and rotary type limit assembly.

2.9.4.2 Accessories

a. Rope Sheaves: Provide four stationary type, 762 mm 30 inch pitch diameter single sheaves and one 762 mm 30 inch takeup sheave assembly. Sheave shall be cast steel, grooved for [_____] mm inch diameter rope and shall be oriented horizontally and mounted in a welded steel frame with self-lubricating bronze bushings. Provide removable steel rope guards over sheaves.

b. Wire Rope: Not less than [_____] mm inch in diameter with a breaking strength of not less than [_____] kg pounds. Rope shall consist of six 19 wire strands of improved plow steel rope with hemp center.

c. Safety Warning System: Provide a safety warning system, including an audible horn and three flashing lights to indicate cars in motion. System shall activate 30 seconds before puller motor is energized and shall not deactivate until puller motor is de-energized. Provide a permanent warning sign at each light indicating "Railcar in Motion."

d. Miscellaneous: Provide reversing controls, car hooks, snatch blocks, and anchors.

]2.9.5 Track Hopper

****

NOTE: Determine if a track hopper will be required.

****

Welded construction of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate not less than 4.50 meters wide and

8.50 meters long 14 feet wide and 28 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.5.1 Track Girders

Two wide flanged beams designed for Cooper's E-[_____] loading with 50 percent impact allowance and sized at W [_____] by [_____]. Provide beams with cross struts for rigidity and bearing plates for mounting on pit wall as indicated.

2.9.5.2 Grating

Hopper grating between the rails of [_____] by 10 mm 3/8 inch steel bars and [_____] by 10 mm 3/8 inch steel cross bars with openings [100] [150] by [100] [150] mm [4] [6] by [4] [6] inches. Grating outside rails shall have openings 100 by 100 mm 4 by 4 inches and be constructed of same size steel bars as specified above. Construct grating in removable panels and support from concrete pit walls and by steel angle supports resting on track girders.

2.9.5.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Cover for portions of hopper outside rails shall be hinged with edges turned down. Construct cover between rails in easily removable sections with handles.

2.9.5.4 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a water-collecting reclaim hopper type coal gate not less than [_____] by [_____] mm inches in size along with a dusttight all metal slip joint, constructed of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate. Slip joint shall be of split construction to allow for disassembly and replacement. Design slip joint to allow for necessary flexibility to take care of deflection of the hopper outlet due to varying coal loads and temperature variations without imposing load on the feeder enclosure. Provide rope packing or other resilient gasket material to make the slip joint completely dusttight.

2.9.6 Truck Hopper

****
NOTE: Determine if a track hopper will be required.
****

Welded construction of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate not less than 3 meters wide and 3 meters long 10 feet wide and 10 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.6.1 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 125 by 13 mm 5 by 1/2 inch steel bars and 25 by 10 mm

one by 3/8 inch steel cross bars. Weld grating and make in sections for ease of removal. Provide two intermediate support beams sized not less than W8 by 31 arranged for a maximum grating span of 1016 mm 3 feet 4 inches.

2.9.6.2 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a water-collecting reclaim hopper type coal gate not less than [_____] by [_____] mm inches size.

[2.9.6.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Construct cover in sections with handles for ease of removal.

]2.9.7 Reclaim Hoppers

Welded construction of not less than 6 mm 1/4 inch thick structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel plate not less than 3 meters wide and 3 meters long 10 feet wide and 10 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.7.1 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 125 by 13 mm 5 by 1/2 inch steel bars and 25 by 10 mm one by 3/8 inch steel cross bars. Weld grating and make in sections for ease of removal. Provide two intermediate support beams sized not less than W8 by 31 arranged for a maximum grating span of 1016 mm 3 feet 4 inches.

2.9.7.2 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a special reclaim hopper gate not less than [_____] by [_____] mm inches.

2.9.7.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Construct cover in sections with handles for ease of removal.

2.9.8 Belt Feeder

Totally enclosed, dusttight, approximately [_____] meters feet between pulley centers, designed to operate at a speed not to exceed [_____] m/sec fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide belt feeder complete with continuous belt, shafts, pulleys, idlers, belt cleaner, frame, enclosure, reduction gear, and drive motor.

2.9.8.1 Head and Foot Shafts

Cold rolled steel, not less than [_____] and [_____] mm [_____] and [_____] inches in diameter respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not

less than a [_____] mm inch adjustment. Shafts shall fit tight in pulley hubs.

2.9.8.2 Pulleys

Welded steel type with detachable compression grip-type hubs, steel plate ends, and crown faces 50 mm 2 inches wider than the belt width. [Provide an adjustable spring loaded or counter weighted type rubber bladed belt wiper beneath the head pulleys.]

2.9.8.3 Belt

Mine Safety and Health Administration (MSHA) approved fire resistant construction, belt not less than [_____] mm inches wide, [_____] ply, [_____] kg per square meter ounces per square foot, with 3 mm 1/8 inch thick oil and chemical resistant cover on carrying side, 0.79 mm 1/32 inch thick oil and chemical resistant rubber cover on under side. Cover shall be fire resistant. Belt shall have a cover tensile strength of not less than [_____] kPa pounds per square inch (psi) and friction between plies of not less than [_____] kPa pounds per inch. Belt shall have vulcanized splice.

2.9.8.4 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Motor shall be direct connected by means of flexible coupling with guard to a reduction gear.

2.9.8.5 Reduction Gear

Alloy steel helical gear type enclosed in oiltight housing. Provide an adjustable base for motor and reducer unit. Drive from the output shaft of the speed reducer to the conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B16.39 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall also conform to ASME B29.100. Properly tension drive chain.

2.9.8.6 Backstop

Differential band brake type, cam type, or internal type to prevent reversal of belt.

2.9.8.7 Idlers

Flat type with 125 mm 5 inch diameter steel shells, malleable iron end brackets, grease sealed roller-type antifriction bearings, and self-cleaning angle bases. Idler spacing shall be not greater than 1372 mm 4 feet 6 inches. Return idler shall be of the flat single-pulley type having 125 mm 5 inch diameter steel shells, grease sealed roller-type antifriction bearings spaced on not more than [_____] meters feet on center. Provide self-aligning training type idlers, as required, to ensure proper training of the belt. Provide additional idlers, as required, beneath track or truck hopper for support of belt and coal and to properly protect belt from impact caused by coal. Extend grease pipes to one side for four point lubrication from tunnel walkway.

2.9.8.8 Load Skirts

Steel plate 6.35 mm 1/4 inch thick supported by structural brackets from conveyor frame. Skirts shall have rubber strips along bottom edge to seal the belt. Strips shall be easily adjustable by means of a clamp bar arrangement not requiring slotted bolt holes.

2.9.8.9 Frame, Supports, and Enclosure

Construct frame of either structural steel channel side stringers properly tied and braced for support of head and foot shafts with 12 gage (2.66 mm 0.1046 inch) steel deck plate full length of feeder, or integrally formed plate conveyor and deck frame. Support idlers from conveyor frame. Support frame from floor of tunnel [by steel channel legs] [as indicated]. Completely enclose feeder in a dust-tight enclosure constructed of not less than 10 gage (3.42 mm 0.1345 inch) steel plate with easily removable gasketed side panels containing handles at each panel end.

2.9.8.10 Loading Hopper

Constructed of not less than 10 mm 3/8 inch thick steel plate connected to bottom flange of the track or truck hopper. Provide an adjustable regulating gate adjacent to loading hopper for regulating height of coal on the belt.

2.9.8.11 Vibrating Feeder

Flat pan type vibrating feeder to convey coal from day hopper to belt conveyor. Pan shall be [_____] mm inches wide by [_____] mm inches long, with 150 mm 6 inch sides, constructed of 6 mm 1/4 inch thick stainless steel. Provide feeder with integral electromechanical drive and a remote controller. Controller shall contain operating switches and rate of flow adjustment and the power source for the feeder drive. Controller shall be designed for 460 volt, 60 Hz. supply voltage. Support feeder from hopper.

[2.9.9 Shallow-In-Built Bar Flight Feeder and Receiving Hopper

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NOTE: Determine by an economic analysis and a technical evaluation if shallow-in-built bar flight feeders and receiving hoppers might be used instead of track or truck hoppers with belt feeders.
****

Bar flight feeder shall be totally enclosed, dusttight type with shallow-in-built [track] [truck] hopper. Bar flight feeder shall have a horizontal length of [_____] meters feet [_____] mm inchesbetween sprocket centers, operate at not greater than [_____] m/s fpm, and have a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide feeder complete with continuous chains and attached bars, terminal sprockets, gears, shafts, bearings, troughs, enclosure, frames, [truck] [track] hopper, grating, regulating gate, hinged inspection doors, discharge chute, electric motor, reduction gear, and supports.

2.9.9.1 Head and Foot Shafts

Head and foot shafts shall be not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Construct shafts of cold

rolled steel and mount in antifriction roller bearings. Mount head shaft in fixed pillow blocks and foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.9.2 Terminal Sprockets

Cast iron with chilled rims not less than 380 mm 15 inches in diameter. Foot shaft sprockets shall be split type in two 180 degree sections to facilitate removal in shallow pit.

2.9.9.3 Chains and Flights

Chains shall be bar link type each having a pitch of not greater than 150 mm 6 inches and an ultimate strength of not less than 20,430 kg 45,000 pounds. Construct chain of heat treated carbon steel components with not less than a 22 by 38 mm 7/8 by 1 1/2 inch wide center link, 10 mm wide by 38 mm 3/8 inch wide by 1 1/2 inch thick side bars, fastened with 18 mm 5/8 inch diameter pins. Construct bar flights of 10 mm 3/8 inch thick steel bars not less than 50 mm 2 inches high with flight width of not less than [_____] mm inches. Flight spacing shall be such that feeder shall move the required coal with a head shaft speed not greater than [_____] rpm.

2.9.9.4 Frame and Enclosure

Construct feeder frame of structural steel properly tied and braced, complete with guides and track for both carrying and return runs, of not less than 80 by 80 by 10 mm 3 by 3 by 3/8 inch steel angles with not less than 6 mm 1/4 inch high renewable carbon steel wear bars. Enclosure shall be dusttight of not less than 10 gage (3.42 mm 0.1345 inch) commercial hot rolled steel plate. Enclosure shall be removable in sections. Top and side panels at head and foot sections shall be hinged and removable for access to chain sprockets.

2.9.9.5 Trough

Construct with flat bottom of not less than 10 mm 3/8 inch thick steel plate. Trough shall be removable and constructed with flanged discharge opening.

2.9.9.6 Hopper

Construct not less than 2 1/2 meters long and 3 meters wide 8 feet long and 10 feet wide of structurally reinforced 10 mm 3/8 inchthick steel plate lined with 10 gage (3.42 mm 0.1345 inch) 410 stainless steel plate. Hopper sides shall not slope less than 55 degrees from the horizontal. Construct hopper with a shield over return run so that coal is fed directly to bottom conveying run.

2.9.9.7 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 65 by 10 mm 2 1/2 by 3/8 inch steel bars and 20 mm 3/4 inch diameter steel rods. Weld grating and make in sections for ease of removal. Provide intermediate beams to support grating.

2.9.9.8 Flight Feeder Drive

Flight feeder shall be driven by an electric motor direct connected by means of flexible coupling to a reduction gear unit having alloy steel

helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and gear. Drive from output speed shaft of the reduction gear to the conveyor head shaft shall be by means of standard finished steel roller chain running over cut tooth sprockets, both conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall also conform to ASME B29.100. Properly tension drive chain.

2.9.9.9 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES.

]2.9.10 Bucket Elevator

Dusttight [centrifugal discharge] [continuous bucket] type having approximately [_____] meters feet [_____] mm inch sprocket centers, vertical chain and bucket, operating at a speed not to exceed [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide bucket elevator complete with continuous double chains and attached buckets, upper and lower sprockets, gears, shafts, bearings, casing, top hood, discharge spout, bottom boot, access doors, electric motor drive, reduction gear, service platform, and accessories.

2.9.10.1 Head and Foot Shafts

Cold rolled steel not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than a [_____] mm inch adjustment. Shafts shall fit tight in sprocket hubs.

2.9.10.2 Terminal Sprockets

Cast iron with chilled rims. Head sprockets shall be not less than [_____] mm inches in diameter and foot sprockets not less than [_____] mm inches in diameter.

2.9.10.3 Buckets and Chain

Construct buckets of [malleable iron] [not less than [_____] mm inch steel plate] not less than [_____] mm inches long, [_____] mm inches wide, and [_____] mm inches deep. Buckets shall be mounted by not less than four bolt attachments to double strand of steel bushed chain each having an ultimate strength of not less than [_____] kg pounds and pitch of [_____] mm inches. Bucket spacing shall not be greater than [_____] mm inches.

2.9.10.4 Backstop

Differential band brake type, cam type or internal type to prevent reversal of chain and buckets in case of power failure.

2.9.10.5 Elevator Casing

Not less than [_____] by [_____] mm inches inside of not less than [_____] [gage] [mm inch thick] commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator

casing. Construct casing in standard sections from 3048 to 3658 mm 10 to 12 feet high with 50 by 50 by 6 mm 2 by 2 by 1/4 inch angle flanges at the end of each section. Provide a hinged inspection door not less than 610 by 760 mm 24 by 30 inches in the section immediately above the boot section [and where indicated]. Casing and inspection doors shall be of dust-tight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Casing interior shall be given a 1.60 mm 1/16 inch thick coating of coal tar primer and enamel in accordance with SSPC PS 11.01.

2.9.10.6 Head Section

Not less than [_____] mm inch thick commercial hot rolled mild steel plate in heavy angle frame with split, hinged, and removable top cover hood. Construct hood of not less than [_____] mm inch thick commercial hot rolled mild steel plate with flanged discharge throat built of not less than [_____] mm inch thick commercial hot rolled mild steel plate. Design head section to support drive machinery and head bearings. Provide maintenance access ladder and platform conforming to applicable OSHA regulations [as indicated].

2.9.10.7 Boot Section

Not less than [_____] mm inch thick commercial hot rolled mild steel plate in heavy rolled mild steel plate in heavy angle frame with curved and renewable bottom plate built of not less than [_____] mm inch thick commercial hot rolled mild steel plate, and flanged inlet. Mount take up and foot terminal bearing on one side of boot in a bolted removable side panel so foot shaft and [sprocket] [sprockets] may be removed through side of door. Bolt end panels so they are removable for cleanout and inspection.

2.9.10.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Motor shall be direct connected by means of flexible coupling to a reduction gear.

2.9.10.9 Reduction Gear

Alloy steel herringbone or helical gear type enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive from the output shaft of the reduction gear to the elevator head shaft shall be by means of standard finished steel roller chain running over cut tooth sprockets, both conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall also conform to ASME B29.100. Properly tension drive chain.

2.9.10.10 Anchoring Brackets

Provide steel brackets at intervals [as indicated] at [not less than [_____] meters feet over centers] for anchoring elevator and to increase rigidity.

2.9.11 Flight Conveyor

Dusttight double strand chain-type with [_____] meters feet sprocket

centers, operating speed not greater than [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide flight conveyor complete with continuous chain and attached flights, terminal sprockets, gears, shafts, bearings, trough, casing, frame, hinged inspection doors, electric motor drive, reduction gear, and supports. [Design flight conveyor for future length of [_____] meters feet for future plant expansion.]

2.9.11.1 Head and Foot Shafts

SAE 1045 steel not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively, mounted in antifriction tapered roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.11.2 Terminal Sprockets

Cast iron with chilled rims and not less than 8 teeth. One sprocket shall be keyed on shaft and the other shall be free to turn.

2.9.11.3 Flights and Chain

Construct flights not less than [457] [508] [610] [762] mm [18] [20] [24] [30] inches long and [200] [250] mm [8] [10] inches high of not less than 6 mm 1/4 inch thick abrasion resistant steel. Mount flights at not greater than [457] [508] [610] [914] mm [18] [20] [24] [36] inch intervals between two matched strands of steel bushed roller chain having [_____] mm inch pitch and an ultimate strength of not less than [_____] kg pounds per each strand. Chain shall have [_____] by [_____] mm inch high carbon steel side bars, high carbon steel, heat-treated pins, carbon steel case-hardened bushings, and [_____] mm inch diameter single flange chilled gray iron or chrome iron rollers. Support chain so that chain does not lie or run in coal.

2.9.11.4 Frame and Enclosure

Construct conveyor frame of structural steel properly tied and braced, complete with track for both the carrying and return run of chain of not less than 80 by 80 by 10 mm 3 by 3 by 3/8 inch steel angles with not less than 6 mm 1/4 inch high renewable molybdenum steel wear bars. Enclosure shall be dust-tight of not less than 10 gage (3.42 mm 0.1345 inch) hot rolled steel plate with easily removable side panels containing handles at each panel end. Enclosure shall have hinged inspection doors 600 mm 24 inches wide and full height of the enclosure opposite loading hopper and at each discharge chute. End panels shall be hinged and removable for access to the chain sprockets.

2.9.11.5 Trough

Not less than 6 mm 1/4 inch thick corrosion resistant steel plate made in boxlike U-shape. Trough shall be removable in not more than 2.44 meters 8 foot long sections and constructed with flanged discharge openings where indicated.

2.9.11.6 Loading Hopper

Steel plate not less than 6 mm 1/4 inch thick sloped at not less than 60 degrees.

2.9.11.7 Outlets

Bottom of trough shall have [_____] outlets not less than [457] [508] [610] [762] mm [18] [20] [24] [30] inches long with gates to discharge coal into cylindrical bunkers. Provide outlets with deflection plate type baffle designed to make coal drop straight down into bunker.

2.9.11.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Motor shall be directly connected by means of flexible coupling to a reduction gear.

2.9.11.9 Gates

Provide coal gates on bottom trough of flight conveyor, immediately under outlets. Opening shall be [_____] mm inch square with motor operated slide gates for controlling discharge to each bunker. Provide double rack and pinion type gates driven by not less than 0.56 kW 3/4 hp motor. Provide limit switches for signal lights, control and interlocking. Provide outlets from gates with a 6 mm 1/4 inch abrasion resistant steel plate discharge chute.

2.9.11.10 Reduction Gear

Alloy steel helical or herringbone gear type with antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear. Drive from output shaft of motor reducer to conveyor head shaft shall be by means of standard finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100. Provide means to properly tension drive chain.

2.9.12 Belt Conveyor

Inclined and approximately [_____] meters feet between pulley centers, operated at a speed not to exceed [_____] m/s fpm, and have a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide belt conveyor complete with continuous belt, shafts, pulleys, idlers, takeups, belt cleaner, frame with conveyor cover and walkway, transfer chute, hopper, emergency stop cord and switch, alignment switch, reduction gear, electric motor, bin high level limit switch and alarm.

2.9.12.1 Head and Foot Shafts

Construct shafts of turned and polished cold rolled steel not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.12.2 Takeups

[Three pulley guided vertical counter weighted type] [Screw type] to maintain proper belt tension. Shafts shall be as specified above and not

less than [_____] mm inches in diameter. Provide a safety device to prevent free fall of takeup pulley. Takeups shall provide a minimum adjustment of 1.5 percent of total belt length.

2.9.12.3 Pulleys

Welded steel type with detachable compression grip-type hubs, steel plate ends, and crown faces 50 mm 2 inches wider than the belt width. Provide a multiple belt scraper at each head pulley.

2.9.12.4 Magnetic Pulley

Drive pulley of [_____] conveyor shall be a nonelectric permanent magnet type designed to remove tramp iron. Provide a removable pan to collect tramp iron.

2.9.12.5 Belt

Synthetic fabric, not less than [_____] mm inches wide, a minimum of [_____] ply, with 3 mm 1/8 inch thick oil and chemical resistant cover on carrying side, [1.59] [0.79] mm [1/16] [1/32] inch thick oil and chemical resistant rubber cover on under side. Cover shall be fire resistant. Belt shall have a tension pull strength of not less than [_____] N per mm pounds per inch of belt width. Belt shall have vulcanized splice.

2.9.12.6 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Motor shall be direct connected by means of flexible coupling with guard to a reduction gear.

2.9.12.7 Reduction Gear

Alloy steel helical gear type enclosed in an oiltight housing. Provide an adjustable base for mounting motor and reducing unit. Drive from output shaft of speed reducer to conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100. Provide means to properly tension drive chain.

2.9.12.8 Backstop

Differential band brake type, cam type, or internal type to prevent reversal of belt.

2.9.12.9 Emergency Stop Cord and Switch

Provide emergency stop cord the length of the conveyor to actuate a switch for stopping the conveyor. Switch shall have flag to indicate actuated switch and shall have positive safety lock that cannot be accidentally reset. Cord shall be not less than 2.38 mm 3/32 inch galvanized aircraft cable with a minimum 1.19 mm 3/64 inch vinyl or nylon protective coating. Provide sufficient number of switches to prevent cable weight from actuating switch.

2.9.12.10 Belt Alignment Switch

Provide belt alignment switches on each side of the belt mounted off conveyor frame or discharge chute to stop conveyor under belt misalignment or runoff conditions. Mount switches on breakaway mounts to prevent damage from runaway belt.

2.9.12.11 Idlers

Troughing idlers shall be [20] [35] degree three-pulley type with 125 mm 5 inch diameter steel shells, malleable iron end brackets, grease sealed roller type antifriction bearings, and self-cleaning angle bases. Troughing idler spacing shall be not greater than 1.37 meters 4 feet 6 inches, with additional idlers at the loading point. Return idler shall be flat single-pulley type having 125 mm 5 inch diameter steel shells, grease sealed roller type antifriction bearings and spaced not more than 3 meters 10 feet on center. Provide self-aligning training type trough and return idlers at not greater than 15.24 meters 50 foot intervals to ensure proper training of belt. Extend grease pipes to one side for four point lubrication from walkway.

2.9.12.12 Load Skirts

Not less than 6 mm 1/4 inch thick steel plate and supported by structural brackets from conveyor frame. Skirts shall have rubber strips along bottom edge to seal belt. Strips shall be easily adjustable by means of a clamp bar arrangement not requiring slotted bolt holes.

2.9.12.13 Frame, Supports, and Walkway

Frame shall be structural steel truss type with head and foot terminals framed of structural steel. Support frame from grade on structural A-frames set on concrete footings as indicated. Support idlers on not less than 150 mm 6 inch channel stringers braced and tied to structural steel truss frame. Provide a 12 gage (2.66 mm 0.1046 inch) steel deck plate for full length of conveyor. Provide a curved belt cover constructed of not less than 16 gage (1.52 mm 0.0598 inch) corrugated galvanized metal having removable panels on walkway side for access to idlers. Provide walkway not less than 914 mm 36 incheswide, supported from structural steel framing for entire length of conveyor. Walkway shall be complete with handrails and metal nonslip grating meeting requirements of 29 CFR 1910-SUBPART D, Walking and Working Surfaces.

2.9.12.14 Discharge Hopper

Construct of not less than 6 mm 1/4 inch thick steel plate to discharge on a discharge chute. Provide a discharge hood built of 10 gage (3.42 mm 0.1345 inch) steel plate enclosing top, front, and sides above discharge hopper.

2.9.13 Coal Scales

Stationary, automatic, dust-proof, belt-fed, batch type with rated capacity of not less than [_____] Mg tons per hour and a hopper capacity of 91 kg 200 pounds. Coal scales shall be complete units, including body, belt feeder, feeder drive, bypass, weighing mechanism, weigh hopper, controls, counters, and remaining items required to make a completely automatic coal scale.

2.9.13.1 Body

Dusttight, of welded heavy steel plate construction with base angles not less than 6 mm 1/4 inch thick. Top plate, bypass plate, and reducer mounting plate shall be not less than 6 mm 1/4 inch thick, with other plates of not less than 11 gage (3.04 mm 0.1196 inch) steel plate. Provide large, gasketed, dusttight doors with adjustable pre-set compression type latches and forged steel hinges for inspection and maintenance purposes. Door openings shall be sufficient to allow removal of feeder and hopper without removal of screws or bolts.

2.9.13.2 Feeder

A self-contained unit with an endless belt which is capable of being removed from one end or side. Construct feeder of heavy rigid steel frame with an 11 gage (3.04 mm 0.1196 inch) stainless steel plate to support the belt on the carrying run. Head and takeup shafts shall be cold rolled steel carried on self-aligning ball bearings equipped with dust seals and fitted for pressure lubrications. Bearings shall be capable of being lubricated during scale operation. Takeup shaft shall have screw-type takeup bearings and pulleys shall be crown faced steel for proper belt tracking.

2.9.13.3 Feed Belt

Channel type and of endless construction without splice. Belt shall be not less than 7.94 mm 5/16 inch thick of three ply heavy fabric core construction with chemical and abrasion resistant rubber coating. Feeder skirts and leveling plate shall be stainless steel and shall be arranged to provide a continuous stream of constant width and depth coal on the feed belt.

2.9.13.4 Electric Motor And Drive

Totally enclosed [_____] volt, [_____] phase, 60 Hz, with heavy duty reduction gear not less than 0.56 kW 3/4 hp as specified in the paragraph MOTORS AND DRIVES. Scale shall be capable of bypassing coal without disconnection of drive. Drive disconnection shall not be required for feeder removal unless special provisions are made for a quick and simple drive disconnection.

2.9.13.5 Coal Bypass

Provide a quick-operating coal bypass with an easily operable lever located on the outside of scale body. Operating lever operation shall instantly bypass coal around the feeder section and weighing mechanism without release of belt tension to prevent entry of coal between belt and pulley or support plates. Bypass construction shall not restrict inlet opening size for normal scale operation.

2.9.13.6 Weighing Mechanism

Enclose in a dusttight compartment. Construct of cold rolled steel for minimum deflection, warp, and twist. Pivot points shall be self-aligning with hardened double bearing surfaces. Weighing mechanism shall be complete with weight lever, tare adjustment, and compensator [, with design subject to approval by the Contracting Officer] and scale shall be guaranteed to weigh coal accurately within 0.25 percent.

2.9.13.7 Scale Weigh Hopper

Construct scale weigh hopper and discharge gate of not less than 14 gage stainless steel plate, continuously welded and stiffened with angle irons. Weigh hopper shall be of such design and construction to ensure clean discharge.

2.9.13.8 Controls

Provide controls, except those required for weigh hopper discharge, prewired and located in a NEMA [12] [3] dusttight enclosure. Provide circuit breaker interlocked with electrical panel door. Control circuits shall be two wire nominal 120 volt systems obtained by using an isolation transformer with one side grounded and wired to a single terminal block which shall be included in the electrical panel. Segregate circuits of different voltage levels. Controls shall include large, oiltight, industrial type pushbuttons for use as "start-stop," "test," and "dump" switches mounted on the scale body adjacent to the electrical panel.

2.9.13.9 Counters

Mount a mechanical type coal counter on the scale body. Counter shall be rugged, reliable, with heavy duty register and designed so that double counting is impossible.[A remote motor operated counter shall be furnished located on the coal handling control panel in the control room. Counter shall be designed so that double counting is impossible.][Provide a contact closure for sending a pulse signal of each weigh hopper discharge to the operator control console.]

2.9.13.10 Scale Inlet

Scale inlet shall contain coal gate with opening not less than 457 by 457 mm or 406 by 508 mm 18 by 18 inches or 16 by 20 inches along with a dusttight all metal slip joint constructed of not less than 4.76 mm 3/16 inch thick steel plate. Slip joint shall be of split construction to allow for installation after coal scale is in place. Design slip joint to allow necessary flexibility to take care of deflection of [bunker] [silo] outlet due to varying load and temperature variations without imposing load on the scale. Provide rope packing or other resilient gasket material to make slip joint completely dusttight.

2.9.13.11 Scale Outlet Hopper

Not less than 6 mm 1/4 inch thick 410 stainless steel plate of capacity not less than 227 kg 500 pounds and 13 mm 1/2 inch thick steel plate flanges.

2.9.14 Stoker Hopper Extension

Dusttight and bolted to hopper furnished with stokers. Construct hopper extensions as indicated of 6 mm 1/4 inch thick 410 stainless steel plate with structural stiffeners. Hopper extension shall hold not less than [_____] Mg tons of coal at a density of 800 kg per cubic meter 50 pounds per cubic foot. Hopper extensions shall have bolted emergency firing doors of not less than 610 by 610 mm 24 by 24 inches which shall contain a 152 by 152 mm 6 by 6 inch glass observation window. Connections shall be dusttight.

2.9.15 Coal Valve

Dusttight and dripproof of the double ladder rack-and-pinion type sized as indicated for each valve. Valve shall be capable of closing through a standing coal column. Valve opening shall be full size with no bridges, internal braces, or other barriers.

2.9.15.1 Valve Body

Not less than 6 mm 1/4 inch thick formed 410 stainless steel with heavy 19 mm 3/4 inch thick flanges. Continuously weld joints in contact with coal both inside and out and grind smooth. Valve body shall have dusttight steel gate assembly cover with molded gasket for removal of gate without removing coal valve. Provide a minimum of two dusttight poke holes with rigid covers and molded gaskets.

2.9.15.2 Valve Gate

Dripproof and siftproof of 10 mm 3/8 inch thick steel plate with an 11 gage (3.04 mm 0.1196 inch) 410 stainless steel liner. Support gate by ball bearing rollers with 16 gage (1.52 mm 0.0598 inch) stainless steel shells equipped with felt grease seals and stainless steel grease retainers. Provide rollers with grease fittings extended through valve body for pressure lubrication. Design gate so that supporting rollers, racks, and pinions are located completely out of the coal stream. Provide cold formed, self cleaning racks, with stainless steel self cleaning pinions located over racks for positive tooth engagement.

2.9.15.3 Operating Shaft

Mount operating shaft in ball bearings with felt seals, stainless steel shells, stainless steel grease retainers, and grease fittings. Provide handwheels with proper finger clearance or pocket sheaves with heavy hot-dipped galvanized chain and chain guard as indicated. Handwheels and sheaves shall be not less than 457 mm 18 inches in diameter. Provide valves with mechanical type position indicator consisting of large pointer and legend to indicate position of valve gate.

2.9.15.4 Electric Motor Operators

Provide motor operators where indicated and capable of remote operation from the coal handling control panel. Operator shall consist of totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz motor as specified in the paragraph MOTORS AND DRIVES with reduction gear, clutch and limit switches. Motor horsepower shall be as recommended by the manufacturer. Provide motorized valves that have manual operators, with fail-safe interlocks that make manual operation impossible while motor is operating.

2.9.16 Track and Reclaim Hopper Valves

Dusttight, double rack and pinion type, with water collecting trough. Valve shall have inlet opening not less than [_____] by [_____] mm inches in direction of gate travel with a larger outlet opening. Inlet and outlet shall be flanged and constructed of mild steel.

2.9.16.1 Valve Body

Not less than 10 mm 3/8 inch thick mild steel continuously welded both

internally and externally and lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate where body comes in direct contact with coal. Construct inlet skirt of not less than 6 mm 1/4 inch thick 410 stainless steel with outlet body plates constructed of 10 mm 3/8 inch thick mild steel lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate. Construct water collecting trough of not less than 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate and containing water sprays for flushing. Valve body shall have dust-tight steel gate assembly cover with molded gasket for removal of gate without removing the coal valve. Provide a hinged access panel not less than [_____] by [_____] mm inches in the direction of gate travel with compression-type latches over water collecting trough for removing obstructions.

2.9.16.2 Valve Gate

Slope gate plate toward water collecting trough and mount it on large ball bearing rollers with 16 gage (1.52 mm 0.0598 inch) stainless steel shells equipped with felt grease seals and stainless steel grease retainers. Provide rollers with grease fittings extended through valve body for pressure lubrication. Gate shall be U-shaped with ladder racks on both sides and shall be constructed of not less than 15.90 mm 5/8 inch thick mild steel lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate. Gate design shall be such that supporting rollers, racks, and pinions are located completely out of coal stream. Racks shall be cold formed and self-cleaning, with stainless steel, self cleaning pinions over racks.

2.9.16.3 Operating Shaft

Mount operating shaft in ball bearings with felt seals, stainless steel shells, stainless steel grease retainers, and grease fittings. Mount a reduction gear on the gate shaft and provide an ample gate clearance pocket in the body to ensure ease of operation through a standing column of coal. Handwheel for operating valve shall be not less than 457 mm 18 inches in diameter.

2.9.17 Chutes

Construct coal chutes dusttight as indicated of not less than 6 mm 1/4 inch thick 410 stainless steel plate. Weld chutes with flanges located as indicated to facilitate equipment and chute section removal. Flanges shall be not less than 10 mm 3/8 inch thick steel and gasketed to maintain dust-tight seal. Provide poke holes and access panels where indicated.

2.9.18 Coal Presence Indicators and Equipment Response Switches

May be of the following types and shall be interlocked with coal handling controls to indicate equipment failures, coal stoppages, and provide for a semi-automatic system. Enclosures for components shall meet requirements of NEMA Type 7, Class I, Division I, Groups C and D, and NEMA Type 9, Class II, Division I, Groups E, F, and G.

2.9.18.1 Type A - Diaphragm Type Presence Indicator

Pressure-sensitive to presence of coal consisting of housing, diaphragm, limit switches, wiring, and mounting bracket flanges. Housing shall be either cast iron, stainless steel, or protected cast aluminum, with synthetic diaphragm as recommended for coarse slightly abrasive materials. Diaphragm deflection shall actuate a limit switch to indicate coal

presence. Design unit so that maintenance, diaphragm replacement and sensitivity adjustment can be made from outside the bin. Type and number of contacts and voltages shall be as indicated on control diagrams.

2.9.18.2 Type B - Paddle Type Presence Indicator

Paddle mounted on a counterweighted horizontal shaft so that deflection of paddle rotates a cam which actuates a limit switch in a control box mounted on the shaft. Unit shall consist of paddle, shaft, enclosure, limit switches, wiring, and mounting brackets. Shaft shall be cold rolled steel and paddle shall be stainless steel with control enclosure of cast iron, stainless steel, or suitably protected cast aluminum. Type and number of contacts and voltages shall be as indicated on control diagram. Mount shaft in ball bearings equipped with suitable dust seals and fittings for pressure grease lubrication.

2.9.18.3 Type C - Tilt Type Presence Indicator

Conical steel float that shall be tilted by presence of coal. Unit shall consist of housing, conical float, universal pivot-collar, pendant mechanism, dust seal, limit switches, wiring, and mounting brackets. Unit shall operate so that tilting of float actuates a limit switch in enclosed housing above. Provide a hood constructed according to manufacturer's recommendations for the indicator's location of not less than 5 mm 3/16 inch thick steel plate. Provide access panel for servicing the unit. Tilt type indicator may be a totally enclosed type in which tilting causes a ball to roll off the center actuating a limit switch. Design unit to be cable hung and to tilt on presence of coal. Type and number of contacts and voltages shall be as indicated on control diagram.

2.9.18.4 Type D - Rotating Type Presence Indicator

Rotating paddle where presence of coal stalls motor and actuates a limit switch. Unit shall have either cast iron or cast aluminum housing, stainless steel paddle, couplings, and flexible shaft. Shaft seal shall be spring loaded and shall prevent buildup of fines between shaft and hub. Operation shall be such that when paddle stalls motor continues to operate until limit switch is actuated, which in turn shuts off current to motor. Vane and baffle arrangements shall be according to manufacturer's recommendations for each indicator location. Type and number of contacts and voltages shall be as indicated on control diagrams.

2.9.18.5 Type E - Vibrating Type Presence Indicator

Vibrating sensing rod so that presence of coal dampens vibrations actuating a control signal. Sensing rod shall be stainless steel not less than 10 mm 3/8 inch in diameter. Control unit shall be solid state, with type and number of contacts and voltages as indicated on control diagrams.

2.9.18.6 Equipment Speed Response Switch

Actuates a control signal when preset abnormal equipment operating conditions are encountered. Switch shall be adjustable so that it may be used as an underspeed switch, overspeed switch, or zero speed switch. Switch shall consist of input shaft from which the equipment speed is measured and compared to a preset point. Enclosure shall be cast iron or suitably protected cast aluminum. Mount speed response switches as indicated. Type of switch adjustment, type and number of contacts, and voltages shall be as indicated on control diagrams.

2.9.18.7 Presence Indicators and Response Switches

Provide at hoppers and conveyor discharges located and protected according to manufacturer's recommendations to ensure safe and reliable operation. Mount presence indicators in such a manner that they will not be damaged by occasional large lumps or falsely operated by stray lumps or collected amounts of coal.

2.9.19 Control Panel and Controls

Provide a semi-automatic control system for coal handling system as indicated.

2.9.19.1 Control Panel

NEMA 12 construction, centrally located in main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline each item with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to front of panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz ac. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in door shall be dust-tight and oil tight with push-to-test transformer type indicating lights. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG type THHN stranded. Neutral wire shall be white. Color code and label wiring of 120 volts or less. Provide plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with requirements of NFPA 70.

a. Panel Devices: Control panel shall include the following indicating lights and color:

(1) Power - ON	red
(2) System Run (3 required)	
Rail unloading hopper to boiler plant	green
Rail unloading hopper to storage yard	green
Reclaim hopper to boiler plant	green
(3) Rail unloading hopper surfactant sprays - ON	green
(4) Reclaim hopper surfactant sprays - ON	green
(5) Belt feeders - ON (one required for each feeder)	green
(6) Reversible belt conveyor to stackout conveyor - ON	green

(7) Reversible belt conveyor to transfer belt conveyor - ON	green
(8) Transfer belt conveyor - ON	green
(9) Stackout tube belt conveyor - ON	green
(10) Reclaim belt conveyor - ON	green
(11) Bucket elevator belt conveyor - ON	green
(12) Bucket elevator - ON	green
(13) Bunker - HIGH LEVEL	green
(14) Bunker - LOW LEVEL	red
(15) Underbunker conveyor to emergency discharge - ON	green
(16) Coal scale - ON	green
(17) Stoker hopper - HIGH LEVEL (one required for each hopper)	
(18) Stoker hopper - LOW LEVEL (one required for each hopper)	

b. Provide momentary contact pushbuttons or selector switches for the following:

(1) System START (3 required)
Rail unloading hopper to boiler plant
Rail unloading hopper to storage yard
Reclaim hopper to boiler plant

(2) System - STOP (red head)

(3) Rail unloading surfactant spray system - ON-OFF

(4) Rail unloading hopper surfactant spray - START/STOP

(5) Reclaim surfactant spray system - ON-OFF

(6) Reclaim hopper surfactant spray - START/STOP

(7) Coal to stackout tube (SELECT)

(8) Alarm - ACKNOWLEDGE

c. Annunciator panel shall include the following:

(1) Bunker - HIGH LEVEL

(2) Bunker - LOW LEVEL

(3) Stoker hopper (one required for each hopper) - HIGH LEVEL

(4) Stoker hopper (one required for each hopper) - LOW LEVEL

(5) EMERGENCY SHUTDOWN (Auxiliary contacts for remote alarm)

(6) Blank (3 required)

d. Size panel to accommodate future addition of one stoker hopper and associated equipment.

e. Provide auxiliary devices required for control functions indicated above.

f. Provide laminated plastic name plates for devices on panel face.

2.9.19.2 Remote Controls

Provide controls for the following items in the main plant control room as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS:

a. Conveyor system - EMERGENCY STOP

b. Bunker - HIGH LEVEL ALARM

c. Bunker - LOW LEVEL ALARM

d. Stoker hopper (one required for each hopper) - HIGH LEVEL

e. Stoker hopper (one required for each hopper) - LOW LEVEL

f. Under Bunker conveyor system - START/STOP

g. Coal scale - START/STOP

2.9.19.3 Control Sequence

To ensure that coal does not back up during system startup or shutdown, design controls so that on startup, the last piece of equipment to handle coal starts first and on shutdown, stops last.

2.9.19.4 Additional Controls

Provide as shown. These controls include local START and STOP pushbuttons or three-position selector switches for the following:

a. Belt feeders

b. Belt conveyors (at head pulley)

c. Flight conveyor

d. Coal scale

e. EMERGENCY STOP pushbuttons which stop the entire system shall be provided where indicated.

2.9.20 Multiple Belt Scrapers

Equip conveyor belts at the head pulley, with multiple belt scrapers. Provide adequate room and service access in head chute design for multiple cleaners. Provide a doctor blade on face of head pulley to remove most of the carryback material and a torsion arm type multiple blade cleaner to scrape and remove material that bypasses primary cleaner. Provide tail

pulley takeups with a plow to protect against material being carried back between belt and pulleys. Both cleaners and plows shall have features that enable the operator to safely inspect and adjust the blades. Dribble chutes shall be designed to resist material buildup and shall be plastic lined. Provide a convenient dust tight door for clean out and inspection purposes on each side of the dribble chute.

2.9.21 Steel Coal Bunker

Cylindrical shaped type having a storage capacity of not less than [_____] Mg tons of coal having a density of 800 kg per cubic meter 50 pounds per cubic foot.

2.9.21.1 Construction

All welded construction, not less than [_____] meters feet in diameter with a vertical cylindrical section [_____] meters feet [_____] mm inches high. Construct vertical cylindrical section of not less than 7.90 mm 5/16 inch thick steel plate. Slope bottom cone shaped hopper section at not less than 55 degrees and fabricate from not less than 10 mm 3/8 inch thick 410 stainless steel plate. Top of bunker shall be conical 35 degree sloped structurally reinforced 6 mm 1/4 inch thick steel plate. Provide ladder inside bunker. Provide dusttight, weather tight access hatch of not less than 610 by 610 mm 24 by 24 inches in bunker top immediately above ladder. Shell and bottom plates shall be beveled for full penetration butt weld on inside of bunker and a finish weld on outside of bunker. Provide bunker with flanged outlet drilled to match inlet of gate.

a. Responsibility: Ensure that full responsibility for final design and details of construction of steel coal bunker is assumed by the manufacturer.

b. Supports: Bunker shall be self supporting from four stub columns which shall be supported from on top horizontal structural steel framing. Structural steel framing for supporting the stub columns is specified in Section 05 12 00 STRUCTURAL STEEL.

c. Liner: Surface blast vertical inside surfaces of the bunker to a near white metal, and then coat with 6 mm 1/4 inch thick troweled-on heavy duty three compound corrosion resistant liner consisting of a resin, a hardener and graphite aggregate. Liner shall have an operating temperature limitation of not less than 66 degrees C 150 degrees F.

2.9.21.2 Accessories:

a. Alarm Switches: Provide bunker with two automatic bin level indicators with neoprene rubber diaphragm and a single pole, double throw switch mounted in explosion proof aluminum housing to signal high and low level alarms. Provide mounting plates on bunker shell and holes for installation of indicator housing on outside of bunker. Wiring shall be as specified in Division 26.

b. Vibrators: Provide on cone bottom of coal bunker a heavy duty pulsating magnet electric vibrator, semi-noiseless type, complete with mounting plate. Provide one vibrator controller panel arranged for mounting in wall mounted control panel. Panel shall contain an "ON-OFF" switch, power control dial, fuses and rectifier. Power supply to panel shall be 460 volt, single phase, 60 Hz current.

2.9.22 Stackout Tube

Provide a stackout type discharge tube not less than 10 mm 3/8 inch thick, reinforced, stainless steel plate for discharging coal from stackout conveyor to coal storage yard. Tube shall be 1220 mm 4 feet in diameter, and designed as the structural support for a portion of the stackout conveyor and support steel as indicated. Tube shall be a window chute designed to discharge coal at not more than 1829 meters 6 feet above coal pile.

2.10 FUEL OIL SYSTEM

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NOTE: In reference to the following text, choose either Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, for below ground tanks, or Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION), for above ground tanks. The rest of the fuel oil system is covered in Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

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The fuel oil system shall be designed and built in accordance with Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION)[.][, except for below grade level fuel tanks, which shall be constructed to Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.]

2.11 ASH HANDLING SYSTEM (PNEUMATIC)

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NOTE: Designer shall select type of ash handling system most suited for each project. For plants over 4 kg per second 31,500 pounds per hour steam ultimate capacity use a pneumatic ash handling system. For plants under 4 kg per second 31,500 pounds per hour steam ultimate capacity use a mechanical system. Refer to NAVFAC DM-3.6, Section 5, paragraph 4d for design criteria.

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NOTE: Choose this article (and the paragraphs and subparagraphs following) or the article, (paragraphs and subparagraphs) below, ASH HANDLING SYSTEM (MECHANICAL).

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2.11.1 System Requirements

Provide a complete integrated, pneumatic, semi-automatic sequencing, ash handling system with air intakes, material intakes,[ash doors and enclosures,] iron alloy conveyor line, fittings, rotary slide gates, primary and secondary material separators, tertiary bag filter, [steam exhauster,] [electric motor driven positive displacement blower (mechanical exhauster),] [air washer,] silo vent filter, ash silo, rotary ash conditioner, and equipment that may be necessary for a complete pneumatic ash handling system. Provide related electrical work required to operate the ash handling system. Design system so that the ash silo is never placed under a partial vacuum.

2.11.2 Type

System shall be the intermittent vacuum type, whereby the vacuum is interrupted permitting periodic discharge of collected materials into the silo on a programmed time cycle. System shall have sufficient air velocity to pick up ash that may be deposited in the pipe.

2.11.3 Ash Silo

System shall receive, and on a sequenced basis convey to the ash silo, ash from the stoker fired boiler [ash storage hoppers,] [ash storage pits,] [siftings hoppers,] [soot hoppers,] [economizer hoppers,] [baghouse hoppers,] and other pollution control equipment hoppers. Convey ash from only one pickup point at a time.

2.11.4 Ash

Discharge ash into the ash storage silo in a dry condition. Arrange silo equipment for disposal of conditioned ash to trucks. The operation shall be as nearly dustless as possible.

2.11.5 Maximum Noise Level

The noise level of the operation shall not exceed 85 decibels sound pressure level 1.50 meters 5 feet from the equipment in any direction.

2.11.6 Dry Ash Storage Hopper

Provide for each boiler to receive and store bottom ash as it is discharged from the traveling grate. Hopper shall be compatible with the grate ash discharge enclosure and shall have a net volume to receive and to store material for an 8 hour period at maximum boiler output. Size hopper for mean ash level for one meters 3 feet below the stoker floor with ash density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing.

2.11.6.1 Construction

Not less than 6 mm 1/4 inch thick, ASTM A36/A36M, steel plate, dusttight, floor supported steel structure with refractory lining. Provide required steel columns, beams stiffeners and cross bracing. Bolt top section of hopper to stoker support steel. Base design load of hopper on 1120 kg per cubic meter 70 pounds per cubic foot. Slope sides at not less than 45 degrees from horizontal to maintain positive feed to outlet.

2.11.6.2 Refractory Materials

As recommended by the manufacturer; minimum total thickness of refractory and insulating block lining shall not be less than 178 mm 7 inches. Refractory shall be minimum of 114 mm 4 1/2 inches thick.

2.11.6.3 Discharge Doors or Gates

Provide each hopper with refractory lined, dusttight, water cooled, vertical lift doors, of an opening size not less than 560 by 560 mm 22 by 22 inches. Each door shall be [air-cylinder operated] [chain wheel operated].[Provide intermediate positioning capability with air cylinder operators.] Provide each door with guide rollers and support arms to

ensure smooth operation without binding. When doors are vertical, minimum number of guide rollers shall be 4; for a sloping surface, minimum number of guide rollers shall be 6.

2.11.6.4 Hopper Lift Door Enclosure

Provide not less than 6 mm 1/4 inch thick steel, dusttight, enclosure, for each vertical lift door. Match enclosure to housing of clinker crusher and make enclosure large enough to enclose the outlet and the vertical lift door. Provide hinged inspection and cleanout door on enclosure front.

2.11.6.5 Hinged Hopper Access Door

Provide on one side wall of each hopper. Door shall be cast iron, air tight swingaway locking type with refractory lining. Install door so that it is conveniently accessible and easy to use.

2.11.7 Clinker Crusher

Provide mounted below each hopper discharge outlet, under vertical lift door enclosure, capable of reducing clinkers from bottom ash to a maximum size of 50 mm 2 inches at a rate not less than conveyor system capacity.

2.11.7.1 Construction

Single roller crusher unit with extra heavy housing, outboard bearings sealed against grit infiltration, motor and drive. Housing shall be 15 mm 1/2 inch thick. Crusher rollers shall have replaceable cam segments (teeth) with a minimum Brinell hardness of 450. Each cam tooth shall be designed to permit resurfacing with hard material. Stationary heavy cast iron or manganese steel abrasion resistant wear plates, of a Brinell hardness not less than 350, shall be mounted about the crusher rollers. Cam shaft rotational speed shall not exceed 20 rpm.

2.11.7.2 Fluid Gear Drive

Crushers shall be driven by a fluid gear drive including a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp, as specified in the paragraph MOTORS AND DRIVES, fluid coupling and reduction gear, integrally mounted in dust and oil tight enclosures. Fluid drive shall protect unit from excessive shock. Drive shall automatically reverse when stalled; crusher shall reverse and move forward three times and, after third time, shut down and alarm when still stalled.

2.11.8 System Valving

2.11.8.1 Side Intake Valves for Fly Ash Collection

Provide at each hopper, including dust collection hoppers and rear pass hoppers, and other collection points. Side intake valve shall be pneumatically opened, spring closed, totally enclosed disc valve of cast iron construction with wearing surfaces of Brinell hardness not less than 350. Provide valve complete with flanged inlet hopper, handhole with gasketed cover and clamp and couplings. Side intake valve shall feed ash to conveyor line on an angle, thus permitting air to mingle with ash in the proper proportion to eliminate clogging. Valves shall provide positive and automatic air tight shutoff and dust tight pickup. Valve shall close on failure of operating air and before discharge cycle of intermittent

conveyor operation. A full load regulating switch shall control each valve to prevent overloading of conveyor system.

[2.11.8.2 Manual Valve Intakes for Bottom Ash

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NOTE: Choose this subparagraph or the subparagraph ROTARY VALVE INTAKE FOR BOTTOM ASH.
****

Provide in front of stoker ash pit doors, a 610 by 610 mm 24 by 24 inch cast iron grid and hopper complete with a self-feeding bottom ash intake, seal plug and pull-out rod that may be lifted to permit ash to enter system.

][2.11.8.3 Rotary Valve Intakes for Bottom Ash

Provide a rotary valve, designed for regulating bottom ash to the a conveyor pipeline, under each crusher. Valve shall provide intake isolation and prevent overfilling or plugging of the conveyor line. Construction of valve shall be of cast iron with wearing surfaces of Brinell hardness not less than 350. Valve shall be pneumatically operated.

]2.11.8.4 Air Intake

Provide spring loaded, swing disc, check valve type air intake, designed for air induction, at the end of each conveyor branch. When intake is located exposed to weather, provide a rain hood.

2.11.8.5 Isolating Valves (Line Valves)

Provide an air operated, totally enclosed rotary slide gate isolating valve at each branch pipe line connection to prevent air flow through an unused branch line. Construct valve of abrasion resistant metal, machined and fitted to ensure a vacuum tight fit and guard against leakage and excessive maintenance. Provide purge air connection and a solenoid valve in the valve housing or cavity for purging the gate cavity of ash.

2.11.8.6 Silo Discharge Valve

Provide a rotary feeder for discharging bottom ash and fly ash from the ash silo. Feeders shall be of ductile iron or cast steel and shall be complete with motor, motor support, chain drive, and necessary guards. Chain shall be driven through a torque limiting clutch on the driven sprocket equipped with electric cutout switch and alarm.[Feeder shall have spring-loaded hinged bypass plate to permit passage of clinkers.] Inlet and outlet flanges shall be standard drilled pipe flange. Rotor blades and sealing arrangement shall be the manufacturer's standard for the intended service. When rotors are equipped with adjustable tips, provide a service door in the valve body for tip adjustment. Provide packing gland type shaft seals with suitable packing materials. Shaft bearings shall be outboard sealed ball bearings. Periphery seals shall be such that a complete seal is accomplished at a differential of [_____] Pa inches of water static pressure.

2.11.9 Ash Conveyor Pipe and Fittings

Abrasion resistant cast iron alloy free of blowholes and other defects and suitable for use in ash conveying systems.

2.11.9.1 Conveyor Piping

Centrifugally cast, abrasion resistant cast iron alloy pipe with a Brinell hardness of not less than 280.

2.11.9.2 Elbows and Fittings

Cast iron alloy with a Brinell hardness of not less than 350 and shall have renewable wearbacks not less than 25 mm one inch thick.

2.11.9.3 Hangers and Supports

Provide adjustable roller supports and pipe hangers to properly support the pipe. System supplier shall design support system and furnish supports.

2.11.9.4 Contractor's Option

At the Contractor's option, conveyor pipe handling only fly ash may be Schedule 80 black steel pipe in lieu of the iron alloy pipe; however outlet fitting, elbows, tees and laterals shall be iron alloy with wearbacks. Pipe for a distance of one meter 3 feet after the cast iron alloy fittings shall be cast iron alloy pipe. Provide pipe with couplings or split flanges, bolts and gaskets all rated not less than 538 degrees C 1000 degrees F.

2.11.9.5 Expansion Joints

Stainless steel bellows type with abrasion resistant liners of a Brinell hardness not less than 350 or slip tube expansion joints fabricated of cast iron alloy, of Brinell hardness not less than 280, machined for smooth sliding fit with its mating part to absorb system thermal movement and shock loads.

2.11.10 Vacuum Air Piping

Provide from the secondary separator to the tertiary bag filter and from the tertiary bag filter to the [steam exhauster] [mechanical exhauster] not less than 10 gage, ASTM A211, spiral welded, vacuum air piping with ASTM A1011/A1011M, standard radius, mitered 10 gage elbows.

2.11.11 Compressed Air Piping and Accessories

Provide pressure reducing valves, safety valves, pressure gages, manual plug or ball valves, compressed air piping, as specified under the paragraph PIPING and other items required for a complete, operable, pneumatic system.

2.11.12 Primary Ash Receiver-Separator and Secondary Ash Separator

Provide on top of ash silo two stages of receiving and separating, with each stage a complete self-contained unit with efficient dust and air separation and gravity dump bottom gates to open with interruption of vacuum and discharge into a silo. Design system so that suction is positively shut off from receiver during its dumping period, so that no dust can be sucked out through exhaust while discharge of the receiver is open or opening. Air from the primary receiver shall enter the external secondary separator which shall remove approximately 85 percent of the

dust not collected by the primary receiver. Combined efficiency of primary and external secondary separators shall be not less than 95 percent. Provide completely contained gate assemblies in a dust-tight enclosure fitted with access doors large enough to remove the entire gate assembly. Provide receivers of hard abrasion-resistant cast alloy iron with a Brinell hardness of not less than 500 constructed as specified below:

2.11.12.1 Primary Receiver-Separator

Not less than [914] [1219] mm [36] [48] inches inside diameter with cast sections 19 mm 3/4 inch thick and 50 mm 2 inch thick impingement section. Cylinder, along with discharge hopper shall be of segmental bolted construction. Construct receiver to ensure dropping of maximum quantity of solids from transporting air. Provide carbon steel outlet pipe and discharge gate. Receiver-separator shall have an internal baffle assembly to prevent reentrainment of ash.

2.11.12.2 Secondary Separator

Not less than [406] [508] [610] mm [16] [20] [24] inches inside diameter of not less than 8 mm 5/16 inch thick one piece construction with at least 13 mm 1/2 inch thick inlet wear section. Design receiver to minimize carryover of fly ash into the [air washer] [tertiary bag filter]. Separator shall have an internal baffle assembly to prevent reentrainment of ash once it has fallen into the collection hopper of the separator.

2.11.12.3 Dusttight Enclosure

Support primary and secondary receivers on not less than 6 mm 1/4 inch thick, dust tight, carbon steel support boxes with hinged access doors or removable panels on each side for servicing the receiver swing gates. Provide support box with airtight roller bearings, hinged, counterweighted swing gates with removable neoprene seals. Gates may as an option, be air cylinder operated gates in lieu of the counterweighted gates.

2.11.13 Mechanical Exhausters

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NOTE: When environmental restraints, availability of steam or water or economics preclude the use of steam exhausters, use a mechanical (electrical driven) exhauster with a pulse jet bag filter to produce the required system air flow.
****

Provide two, V-belt drive, positive displacement, blowers with electric motors and accessories with each capable of producing a vacuum of at least 41 kPa 12 inches of mercury and with air flow necessary for handling ashes through the system. One blower (exhauster) shall be used as a prime mover and the other as a standby unit.

2.11.13.1 Isolation Gates

Each exhauster shall include a manual bolt-up type gate for isolation and crossover. Gates shall include limit switches for status indication.

2.11.13.2 Accessories

Exhauster shall be complete with belt guard, air inlet silencer, air discharge snubber, support stand, expansion joint on inlet and outlet, belt and shaft guards, high temperature safety switch and vacuum relief valve.

2.11.13.3 Electric Motor

Totally enclosed, fan cooled, [_____] volts, three phase, 60 Hz as specified in the paragraph MOTORS AND DRIVES.

2.11.13.4 Noise Level

Not to exceed 85 dBA sound pressure level at 1.50 meters 5 feet above the floor and 1.50 meters 5 feet from blower in any direction.

2.11.14 Pulse Jet Self-Cleaning Bag Filter Assembly

Provide as a tertiary means of removing fine ash particles from the conveying air system. Installation of the assembly shall be on the silo roof, downstream of the two-stage cyclone type mechanical separator so as to permit a combined minimum separating efficiency of 99.5 percent (by weight), with a guaranteed outlet emission less than 0.005 grains particulate per dry standard cubic foot of exhaust air. Filter assembly shall include a main housing, bag assemblies, bag cleaning mechanism, discharge gate and control panel. Equipment shall be integrated with cyclone type separators, vacuum breakers, vacuum switches and conveying system controls as specified elsewhere. Bag filter shall be capable of operating at 25 percent above the system design vacuum. Filter housing shall be capable of withstanding a vacuum of 96 kPa 28.5 inches of mercury.

2.11.14.1 Cloth Area

Size filter on the basis of not greater than 25.40 L/s 5 acfm of air per square meter foot of cloth area. The acfm shall be calculated on the maximum system air flow.

2.11.14.2 Filter Construction

All welded construction housing or body of, ASTM A36/A36M plate with an upper clean gas plenum, bag compartment, hopper bottom, internal access platform and support structure. Plate thickness shall be a minimum of 6 mm 1/4 inch with exception of plenum tube sheet, which shall be a minimum of 13 mm 1/2 inch thick. Housing shall be cylindrical, having a minimum diameter of [_____] meters feet [_____] mm inches.

a. Upper Gas Plenum: Dished head, with flanged inlet and discharge connections, tube sheet, venturis and blow tubes. These appurtenances shall be welded airtight. Venturis shall be fabricated from carbon steel having a minimum thickness of 16 gage. Minimum centerline spacing between venturis shall be 191 mm 7 1/2 inches. A series of blow tubes shall be employed over the venturis. Each tube shall extend through dished housing wall and be manifolded externally. Include support of external manifold.

b. Bag Compartment: Of sufficient height to allow internal access by maintenance personnel. Base of compartment shall include metal platform supported by steel angle cross bracing. Platform shall

extend over entire base area of compartment. Sidewall of compartment shall include a hinged access door with locking handle. Door shall be gasketed and opening shall be a minimum of 762 mm high by 406 mm wide 30 inches high by 16 inches wide.

c. Hopper Bottom: Conical having a slope angle of not greater than 45 degrees with a flanged outlet.

d. Access Platform: With [stairs] [ladder] and safety handrail for external mounting to filter housing. Mount platform at a height to allow convenient access through hinged door located on bag compartment sidewall. Platform floor area shall be not less than 1.40 square meter 15 square feet.

e. Provide filter housing with required columns and cross bracing to support structure from silo roof to discharge directly into silo. This support shall be of sufficient height to allow convenient installation of filter discharge gate.

2.11.14.3 Discharge Gate

Air cylinder operated swing disc type. A rotary feeder type gate is not acceptable. When in the open position, gate disc shall swing out of the path of material being discharged. Both gate disc and seal shall be replaceable. Include handhole on gate housing for easy access to both disc and seat.

2.11.14.4 Bag Cleaning Mechanism

Provide venturis, blow tubes, manifold, solenoid air valves, diaphragm valves and differential pressure switch conveniently located at the filter unit. Operation of these devices shall be on a sequential basis (adjustable setting) to allow periodic surges of compressed air through the filter venturi sections. Compressed air requirement for bag cleaning shall not be greater than 7.08 standard L/s at 690 kPa (gage) 15 scfm at 100 psig.

2.11.14.5 Filter Bag Assemblies

Each shall include the filtering media, wire retainer and stainless steel clamping device. Filter bag shall slide over retainer and both shall be clamped to the venturi by a stainless steel common band clamp. Top portion of retainer shall have the inside dimension equal to the mating venturi to ensure a tight fit.

a. Retainers: Cage type construction, fabricated from No. 1018 rounds or equal, using minimum of 3 mm 1/8 inch diameter rounds on vertical strands and 5 mm 3/16 inch diameter rounds on horizontal strands. Coat retainer with nickel and zinc after completion of fabrication.

b. Filter Bags: Not less than 474 g per square meter 14 ounces per square yard felted material. Provide felted polyester or dacron bags when operating temperatures are below 135 degrees C 275 degrees F. Provide Nomex bags or bags of similar abrasion and temperature resistant qualities when temperatures are above 135 degrees C 275 degrees F but not greater than 218 degrees C 425 degrees F. Bags shall have an exterior finish to aid in dust release.

2.11.14.6 Control Panel

NEMA 4, wall mounted control panel to sequentially control bag cleaning and dump operations of the filter unit. Locate panel near filter unit to permit easy field adjustment of sequence timers. Panel overall dimensions shall be not less than 610 mm wide by 762 mm high by 200 mm deep 24 inches wide by 30 inches high by 8 inches deep. As a minimum, panel instrumentation shall include a dump cycle timer, pulse valve sequence timer, two high differential pressure delay relays, alarm relay, time delay relay, manual/auto selector switch, pulse valve "ON" indicating light, high differential indicating light, terminal blocks and internal wiring. Welds and scratches of panel enclosure shall be polished smooth and thoroughly cleaned before painting. Surface finish shall be free from blemishes. Paint panel exterior with manufacturer's standard enamel. Interior of panel shall be white enamel. Shop inspect panel and test prior to shipment.

2.11.14.7 Vacuum Breakers

Provide two air cylinder operated vacuum breakers. One shall be a pop-up or single ported type for installation in the air line between the secondary separator and tertiary bag filter. Second breaker shall be a three-ported type for locations in the air line between the tertiary bag filter and the exhauster. Each breaker shall use a disc type gate or equivalent to ensure full closure of the gate against its mating seat.

2.11.15 Steam Exhauster

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NOTE: The steam exhauster system requires 0.32 kg os stream per second 2500 pounds of steam per hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg of steam per second 3500 pounds of steam per hour for an 200 mm 8 inch system (13.60 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a steam jet exhauster of cast iron construction with venturi throat of the high efficiency type for producing the vacuum necessary for handling ashes through the system. Make inlet air connection on the steam jet exhauster through a special spiral fitting so that air enters the exhauster unit tangentially, avoiding direct impingement on the nozzle. Provide a unit capable of producing a vacuum of at least 40.56 kPa 12 inches of mercury column at shutoff and not requiring more than [0.32] [0.44] kg of steam per second at 690 kPa (gage) [2,500] [3,500] pounds of steam per hour at 100 psig.

2.11.15.1 Steam Condenser, Air Washer and Silencer

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NOTE: The steam exhauster system requires 0.32 kg of steam per second 2500 pounds of steam per hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg of steam per second 3500

pounds of steam per hourfor an 200 mm 8 inch system (13.60 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a double stage cyclone type steam condenser, which also extracts the remaining solids from the steam-air system. Construct steam condenser body of hard metal castings not less than 16 mm 5/8 inch thick suitable for this special service except that inlet connector shall be not less than 19 mm 3/4 inch thick. Castings shall have a Brinell hardness of not less than 250. Remaining metal used in the condenser shall be at least 6 mm 1/4 inch thick steel with the top not less than 13 mm 1/2 inch thick steel plate. Provide drain connection not less than 76 mm 3 inches and water connection not less than 38 mm 1 1/2 inches. Provide silencer as required for quiet operation.

2.11.16 Ash Storage Silo

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NOTE: Use enclosure for silo roof and unloader level in climates where protection of equipment and personnel from the weather is desired.

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[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. Design of support steel shall be approved by the ash system supplier. Design silo in accordance with the ICC UBC. Design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and shall be of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access stair tower with intermediate platforms at 3.66 meters 12 feet intervals for access to ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms must then be also provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo.[Provide silo roof enclosure and unloader room enclosure each with single one by two meters 3 by 7 feet access door, [_____] by [_____] meters feet double door, two windows, ventilator, [heater,] insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.11.16.1 Construction

Construct silo of steel with refractory lining or of concrete staves with

steel hoops and concrete roof. Roof accessories shall include manhole, relief valve and vent filter. Bottom of silo shall be [conical, sloped a minimum of 45 degrees] [flat with a steel plate feeding hopper in bottom of silo to funnel the ash into the inlet of the rotary vane feeder]. Provide hopper with expansion joints and sufficient poke holes with cover or cap.

2.11.16.2 Concrete Stave Silo

Construct of either lightweight solid or hollow precast concrete staves with post-tensioned steel reinforcing hoops around the exterior. Mechanically measure and mix materials in concrete staves. Vibrate and shape staves under pressure and steam or air cure.

a. Wall Coating: Coat interior surface with a three-step process of a brush coat, scratch coat, and finish trowel coat of a mixture of fine sand and portland cement in accordance with silo manufacturer's recommendations. Apply each coat successively to produce a smooth interior surface. Work mixture into the formed horizontal and vertical grooves to permanently interlock the concrete staves. Brush coat the exterior surface with a double application of waterproof mixture. Mixture shall include a chemical agent for waterproofing and portland cement, sand, and water. Work coating into joints and over the steel reinforcing hoops to form a weatherproof protective coating.

b. Steel Reinforcing Hoops: Galvanized steel rods not less than 14 mm 9/16 inch in diameter with not less than 16 mm 5/8 inch rolled threads. Join hoop ends together with nuts and heavy malleable galvanized iron lugs or heavy duty galvanized steel lugs to a close tolerance for a tight fit. Electrogalvanize rods, nuts, and lugs to ensure adequate protection against corrosion. Rods shall be high quality, metallurgically sound steel with tensile strength not less than 448 MPa 65,000 pounds per square inch, yield point not less than 276 MPa 40,000 pounds per square inch, and a minimum elongation of 14 percent in 229 mm 9 inches. Reinforcing shall be sufficient to resist maximum lateral pressure and loads imposed by ash pressure within the silo. Structurally connect together hoop rods that pass through silo outlets on inspection frames.

c. Hollow Concrete Stave Silos: Construct silo of precast concrete staves with lateral air spaces. Cast staves from a well proportioned mix of portland cement and an expanded clay light weight aggregate. Minimum compressive strength of concrete at 28 days shall be 34.50 MPa 5,000 psi. Hollow staves shall be 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick by 10 inches wide by 30 inches long with five lateral air cores per stave, except that shorter starter staves may be used to permit horizontal joints to be staggered.

d. Solid Concrete Stave Silos: Construct silo of solid lightweight precast concrete staves. Solid staves shall be not less than 92 mm thick and 250 mm wide by 762 mm long 3 5/8 inches thick and 10 inches wide by 30 inches long, except starter staves may be shorter. Solid staves shall be constructed from a well proportioned mix of portland cement, washed sand and gravel which is free from injurious organic impurities and contains less than 5 percent of deleterious substances. Grade aggregate from coarse to fine. Compressive strength of solid concrete staves at 28 days shall be 34.50 MPa 5,000 psi.

2.11.17 Bag Filter Vent

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NOTE: Consult the manufacturer of ash handling equipment for venting requirements.
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Provide pulse jet bag filter vent for silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter 9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s per square meter at 249 Pa 15 to 20 cfm per square foot at one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.11.18 Rotary Ash Conditioner (Unloader)

Provide a complete dustless horizontal, floor mounted unloading device to discharge ashes from silo to a [truck] [railroad car]. Unloader (ash conditioner) shall include a 762 mm 30 inch diameter revolving drum which rotates about fixed spray nozzles, and shall be complete with conditioner and discharge compartments, scrapers, and other accessories as required. Unloader drum shall be constructed of steel plate not less than 10 mm 3/8 inch thick and shall be roller chain driven by a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp as specified in the paragraph MOTORS AND DRIVES. Unloader shall discharge conditioned ashes to a truck through a 6 mm 1/4 inch thick steel plate chute. Unloader shall be designed to eliminate most dust in unloading ash from the ash silo. Unloaders that utilize screws as a means of mixing are not acceptable. Dustless unloader shall add water to ash, but not to the extent that there is free or surplus water running or dripping from the ash after discharge. Discharge ash shall be in a semi-fluid, loose, free flowing condition.

2.11.19 Fluidizing System

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NOTE: Delete fluidizing system if not necessary.
****

Provide a fluidizing system on the silo floor to ensure a constant and uniform feed of ash through silo discharge outlet. System shall consist of a series of diffuser modules, a conical diffuser hood, designed to support the total weight of ash when the silo is full, and compressed air piping. Each diffuser module shall be mounted on the silo floor using sloped concrete pads. System shall operate from plant air system. Provide pressure reducing valves, safety valves, and controls for a complete system.

2.11.20 Control Panel and Controls

Provide a semi-automatic control system for the ash handling system[as indicated].

2.11.20.1 General

Provide a centrally controlled operation, with auxiliary local operation,

and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start pushbuttons and indication stations for [clinker crusher and ash hopper vertical lift door at each bottom ash hopper] [mechanical exhausters] and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid vales, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system.[Provide detailed control logic diagrams from ash handling system manufacturer to the manufacturer of the digital process control and data acquisition system.]

2.11.20.2 Control Panel

Provide a [separate control panel] [subpanel mounted in the main plant control panel] of NEMA 12 construction, centrally located in the main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline items with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to front of panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz ac. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in the door shall be dusttight and oil tight with push-to-test transformer type indicating lights. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG type THHN stranded. Neutral wire shall be white and remaining wiring of 120 volts or less shall be color coded and labeled. Provide a plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with requirements of NFPA 70.

a. Provide capability to perform the following functions from the ash handling system control panel[operator interface console].

(1) System Start

(2) System Stop

(3) Auto/Manual/Index Mode of Operation Selection

(4) Selection of Bypass of any Boiler [Bottom Ash,] [Siftings,] [Economizer] Hoppers

(5) Manual Index to any Intake

(6) Selection of Ash Silo for Baghouse Ash

b. Provide sensors or contact closures for status indication on the ash handling system control panel annunciator[operator interface console].

(1) Conveyor On

(2) Unit on (one required for each unit)

(3) Final Line Purge On/Complete

(4) Baghouse Ash to Ash Silo

c. Provide sensors such that the following items can be alarmed on the ash handling system control panel annunciator[operator interface console].

[(1) Blower Failure

][(2) Blower High Temperature

] (3) Bag Filter Failure

(4) Bag Filter High Differential

(5) Bag Filter Off

(6) Plugged Hopper

(7) Conveying Complete

[(8) Clinker Crusher Abnormal Shutdown
(a) 1 required for each boiler)

] (9) Low Conveying Air

(10) High Conveying Vacuum

d. Vacuum Transmitter: To measure conveying system vacuum. Range shall be zero to 101 kPa 30 inches mercury with 4 to 20 mA dc linear transmitter output. Display vacuum on the ash handling system control panel[operator interface console].

2.11.20.3 Operation

a. Normally operated in the automatic mode. Automatically sequence through the automatic intakes except [clinker crusher] [bottom ash intake] for each boiler after system is started. When a unit is not in operation, selecting the "bypass mode" shall cause intakes on that unit to be skipped. For manual operation, "index" is used to select the desired intake. As conveying system shuts down automatically, main conveyor line shall be purged for approximately one minute to remove ash remaining in it.

b. Sequence system under control of vacuum switches and timers. Maximum vacuum will be when system is conveying material. When a hopper is empty, vacuum will drop and a "no load" vacuum switch shall cause system to shift to the next intake. Prevent premature sequencing due to momentary low vacuum with a timer. When a plugged hopper occurs, vacuum will be between "no load" and normal value. Provide a timer to allow packed or arched material to break loose before alarming the condition.

c. Provide solenoid air valves for each air operated device, timers, contactors, relays and devices and equipment required for system control, measuring and operation. Identify each device with an engraved plastic identification plate[in accordance with a system graphic display] to be provided by the ash handling system supplier.

d. Bottom Ash Hopper Local Control Stations: Provide a wall mounted, NEMA [_____], control station at each bottom ash hopper with front

access door, lock, circuit breakers, selector switches, lights and pushbuttons.

(1) Selector Switches:

(a) Crusher: three position switch, "Reverse (momentary)-Off-Forward"

(b) Rotary Valve Intake: two position switch "Open-Close"

(c) Vertical Lift Door: position switch "Open-Intermediate-Close"

(2) Emergency "Stop" Pushbutton, for clinker crusher, with manual reset.

(3) Indicating Lights:

(a) "On-Manual"

(b) "Crusher Stalled"

[2.12 ASH HANDLING SYSTEM (MECHANICAL)

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NOTE: Designer shall select type of ash handling system most suited for each project. For plants over 4 kg per second 31,500 pounds per hour steam ultimate capacity use a pneumatic ash handling system. For plants under 4 kg per second 31,500 pounds per hour steam ultimate capacity use a mechanical system. Refer to NAVFAC Design Manual DM-3.6, Section 5, paragraph 4d for design criteria.

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NOTE: Choose this article, paragraphs and subparagraphs or the article, paragraphs and subparagraphs above ASH HANDLING SYSTEM (PNEUMATIC).

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NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine the degree of sophistication of the mechanical ash handling system. Preference should be given to keeping the system as simple as possible. An example of this would be an arrangement where the plant would not require an ash silo and ash is simply removed by the operators raking the ash pits and shoveling the ash into wheeled dumpsters for removal. Mechanical collector hoppers would have ash removed by means of rotary airlock valves dumping through chutes into additional wheeled covered dumpsters. For greater ash removal rates screw conveyors could be used for removing ash from the stoker ash pits. These could convey ash to wheeled ash dumpsters or into a drag conveyor, bucket elevator, ash silo system.

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Provide a complete integrated, mechanical, semi-automatic, ash handling system with chain drag conveyor, screw conveyors, bucket elevator, material intakes, rotary valves,[ash doors and enclosures,] silo vent filter, ash silo, rotary ash conditioner, and other equipment that may be necessary for a complete mechanical ash handling system. Provide related electrical work required to operate the ash handling system.

2.12.1 Ash Silo

The system shall receive, and convey to the ash silo, ash from the stoker fired boiler ash storage pits, [economizer hoppers,] [baghouse hoppers,] and other pollution control equipment hoppers.

2.12.2 Ash

Discharge ash into the ash storage silo in a dry condition. Arrange silo equipment for disposal of conditioned ash to trucks. Operation shall be as dustless as possible.

2.12.3 Maximum Noise Level

Noise level of operation shall not exceed 85 decibels sound pressure level 1.50 meters 5 feet from the equipment in any direction.

2.12.4 System Valving

2.12.4.1 Rotary Valves

Provide rotary valve feeders of carbon steel construction complete with drive, guard, motor mount and gaskets, carbon steel adjustable blade tips, adjustable shoe type air seal and right angle gearhead drive motor. Rotor blade tips and shoes shall have a minimum Brinell hardness of 500. Valves requiring part of the housing to form an airlock seal are not acceptable. The electric motor for the rotary valve feeders shall be totally enclosed, fan cooled, [_____] volt, [_____] phase, 60 Hz., and not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES.

2.12.4.2 Manual Valve Intakes for Bottom Ash

Provide in front of stoker ash pit doors, a 610 by 610 mm 24 by 24 inch cast iron grid and hopper with opening approximately sized for the conveyor. Provide intake with dusttight, removable 6 mm 1/4 inch thick checkered steel plate cover.

2.12.4.3 Silo Discharge Valve

Provide a rotary feeder for discharging bottom ash and fly ash from the ash silo. Feeders shall be of ductile iron or cast steel and shall be complete with motor, motor support, chain drive, and necessary guards. Chain shall be driven through a torque limiting clutch on the driven sprocket equipped with electric cutout switch and alarm.[Feeder shall have spring-loaded hinged bypass plate to permit passage of clinkers.] Inlet and outlet flanges shall be standard drilled pipe flange. Rotor blades and sealing arrangement shall be manufacturer's standard for the intended service. When rotors are equipped with adjustable tips, provide a service door in body of valve for tip adjustment. Provide packing gland type shaft seals with suitable packing materials. Shaft bearings shall be

outboard sealed ball bearings. Periphery seals shall be such that a complete seal is accomplished at a differential of [_____] Pa inches of water static/pressure.

2.12.5 Conveyors

2.12.5.1 Chain Drag Conveyor

Provide with endless chain for dragging coal ashes from front of boilers along a recessed trough to the inlet chute of a bucket elevator. Conveyor shall have [_____] meter feet sprocket centers, operate at speed not greater than 35 mm/sec 7 fpm, and have a capacity of not less than [_____] Mg tons per hour of 640 kg per cubic meter 40 pounds per cubic foot ash. Provide conveyor complete with continuous chain, drive, and take up terminals, gears, shafts, bearings, return rolls, hard white iron trough, ash intake gratings, floor plates, discharge chute, electric motor, reduction gear, and supports.[Chain drag conveyor shall be designed for future length of [_____] meters feet.]

a. Head and Foot Shafts: Provide SAE-1045, steel head and foot shafts not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively, mounted in anti-friction roller bearings in pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

b. Terminal Sprockets: Gray iron chilled rim not less than [_____] mm inches in diameter with solid web and not less than eight teeth each.

c. Chain: Combination drag type of riveted construction. Design chain symmetrically so that it can be turned over after one side is worn. Chain shall be [_____] mm inches wide with a pitch not greater than 200 mm 8 inches and an ultimate strength of not less than [187] [249] kN [42,000] [56,000] pounds. Construct chain of promal, a pearlitic malleable iron, center links not less than [_____] mm inches high, and heavy [_____] mm inch thick heat treated carbon steel side bars. Steel pins shall be cold rolled steel not less than [_____] mm inch in diameter, press-fitted into sidebars, and machined flat on one side to prevent rotation. Center section shall be rugged block type forming a rigid rectangle for maximum resistance to distortion with broad wearing shoes contoured to prevent snagging and damage to chain or trough. Barrels of center section shall be chambered to provide lubricant reservoir and still provide maximum bearing area for pins. Shape barrel with pushing surface on one side and for contact with sprocket on the other side.

d. Trough: Concrete lined with not less than [_____] mm inch thick hard white iron approximately as indicated. Trough shall be [_____] mm inches wide with hinged 6 mm 1/4 inch thick checkered steel plate covers. Covers shall be installed to be dusttight. Coordinate concrete work with conveyor manufacturer's requirements.

e. Return Rollers: Chilled rim, single flange, enclosed-oiling type on [_____] mm inch diameter carbon steel shafts spaced at not more than 3 meters 10 feet apart.

f. Discharge Chute: Construct of not less than 10 mm 3/8 inch steel plate and slope at not less than 60 degrees.

g. Electric Motor and Drive: Totally enclosed, fan cooled, high torque,

[_____] volt, [_____] phase, 60 Hz not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES, in this section, direct connected by means of flexible coupling to a reduction gear unit having alloy steel helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear. Drive, from output shaft of reduction gear to conveyor head shaft, shall be by means of finished steel roller chain running over cut tooth sprockets complete with steel plate chain guard. Roller chain, sprockets and roller chain attachments shall conform to ASME B29.100.

2.12.5.2 Screw Conveyors

Provide each screw conveyor dusttight and furnished complete, with trough, screw, inlet and discharge spouts, discharge gates, bearings, bearing hangers, dust cover, electric motor, reduction gear,[service platform,] and supports. Each screw conveyor shall meet the following minimum design and performance specifications when handling dry flyash of density not greater than [_____] kg per cubic meter pounds per cubic foot:

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] Mg/hr	[_____] Mg/hr
Screw diameter	[_____] mm	[_____] mm
Length	[_____] meters	[_____] meters
Coupling diameter	[_____] mm	[_____] mm
Motor horsepower	[_____] kW	[_____] kW
Screw flight thickness	[_____] mm	[_____] mm
Trough thickness	[_____] mm	[_____] mm
Trough cover thickness	[_____] mm	[_____] mm
Trough end plate thickness	[_____] mm	[_____] mm
Maximum speed	[_____] rpm	[_____] rpm

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] tons/hr	[_____] tons/hr
Screw diameter	[_____] inches	[_____] inches
Length	[_____] feet	[_____] feet
Coupling diameter	[_____] inches	[_____] inches
Motor horsepower	[_____] hp	[_____] hp

	CONVEYOR NO. 1	CONVEYOR NO. 2
Screw flight thickness	[_____] inches	[_____] inches
Trough thickness	[_____] inches	[_____] inches
Trough cover thickness	[_____] inches	[_____] inches
Trough end plate thickness	[_____] inches	[_____] inches
Maximum speed	[_____] rpm	[_____] rpm

a. Inlet and Discharge Spouts: Arrange as indicated. Spouts shall be flanged and square with opening dimensions equal to inside diameter of trough.

b. Screw Trough: Provide dusttight screw trough with trough covers. Support trough by 6 mm 1/4 inch thick steel plate feet at not less than 3 meter 10 foot intervals. Individual trough sections shall not be greater than 3 meters 10 feet long with steel angle end flanged connections.

c. Bearings and Hangers: Provide thrust bearings and trough end dust seals for both drive and tail bearings. Thrust bearings shall be bronze in antifriction pillow blocks. Screw hanger bearings shall be babitted-type, with cast iron hangers having removable bearing caps held in place by a U-bolt. Design hangers to fit inside the conveyor trough and equip bearings for grease lubrication with grease fittings penetrating dust cover to allow bearings to be greased without removing dust cover. Hangers shall not be located at trough joints, feed, or discharge openings. Locate hangers at not less than [3.66 meter 12 foot intervals for screw diameters larger than 250 mm 10 inches][and][3 meter 10 foot intervals for screw diameters 250 mm 10 inchesin diameter and smaller].

d. Conveyor Screws and Couplings: Construct conveyor screws of helocoid-type flights and connect with cold rolled steel couplings. Assemble conveyor screws so that at the hangers there is 180 degrees rotation between flight ends of each adjacent screw section. Screw flight shall end over last discharge spout so bare pipe extends across this area to prevent material carry-over.

e. Electric Motor: Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Install motor at discharge end of conveyor. Motor shall be supported by a unit bracket attached to the screw conveyor trough end plate and connected to reduction gear through a V-belt drive. Reduction gear shall be shaft mounted, double reduction type mounted directly on the conveyor shaft. Provide tie rods, when required, to prevent reduction gear rotation and for adjusting belt tension.

f. Service Platforms: Conform to OSHA regulations as indicated to properly maintain and service conveyor drive unit.

2.12.6 Bucket Elevator

Provide a dusttight bucket elevator centrifugal discharge type, having approximately [_____] meters feet [_____] mm inch sprocket centers, vertical chain and bucket, operating at a speed not to exceed [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of 640 kg per cubic meter 40 pounds per cubic foot ash. Provide bucket elevator complete with continuous chain and attached buckets, sprockets, gears, shafts, bearings, casing, top hood, discharge spout, bottom boot, access doors, electric motor, reduction gear, service platform, and accessories.

2.12.6.1 Head and Foot Shafts

Not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Construct shafts of cold rolled steel and mount in antifriction roller bearings with forced lubricating type fittings. Mount foot shaft in fixed pillow blocks. Head shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.12.6.2 Terminal Sprockets

Cast iron with chilled rims. Head sprocket shall be not less than [_____] mm inches in diameter and foot sprocket not less than [_____] mm inches in diameter.

2.12.6.3 Buckets ands Chain

Construct buckets of malleable iron not less than 200 mm long, 127 mm wide, and 140 mm deep 8 inches long, 5 inches wide, and 5 1/2 inches deep. Buckets shall be mounted by not less than four bolt attachments to a single strand of steel bushed chain having an ultimate strength of not less than 178 kN 40,000 pounds and pitch of 100 mm 4 inches. Bucket spacing shall not be greater than 406 mm 16 inches.

2.12.6.4 Backstop

Differential band brake type to prevent reversal of chain and buckets in case of power failure.

2.12.6.5 Elevator Casing

Not less than 298 by 991 mm 11 3/4 by 39 inch internal dimension and constructed of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator casing. Fabricate casing in standard sections from 3 to 3.66 meters 10 to 12 feet high with 50 by 50 by 6 mm 2 by 2 by 1/4 inch angle flanges at the end of each section. Provide a hinged inspection door not less than 610 by 762 mm 24 by 30 inches in the section immediately above the boot section and where indicated. Casing and inspection doors shall be of dusttight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Coat casing interior with not less than 1.60 mm 1/16 inch thick coal tar primer and enamel conforming to SSPC PS 11.01.

2.12.6.6 Head Section

Construct of not less than 5 mm 3/16 inch commercial hot rolled mild steel

plate in heavy angle frame with split, hinged, and removable top cover hood built of not less than 10 gage (3.42 mm 0.1345 inch) commercial hot rolled mild steel plate and flanged discharge throat built of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate. Design head section to support the drive machinery and head bearings. Provide access ladder and service platform conforming to applicable OSHA regulations as indicated for providing proper service and maintenance of elevator.

2.12.6.7 Boot Section

Construct of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate in heavy angle frame with curved and renewable bottom plate and renewable internal loading leg, both built of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate, and flanged inlet. Mount take-up and foot terminal bearing on one side of boot in a bolted removable side panel so foot shaft and sprocket may be removed through side of the door. Bolt end panels so they are removable for cleanout and inspection.

2.12.6.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES, direct connected by means of flexible coupling to a reduction gear unit having alloy steel herringbone or helical gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive, from the output speed shaft of the reduction gear to the elevator head shaft, shall be by means of finished steel roller chain running over cut tooth sprockets, complete with steel plate chain guard. Roller chain, sprockets, and roller chain attachments shall conform to ASME B29.100.

2.12.6.9 Anchoring Brackets

Provide steel brackets as indicated at intervals for anchoring elevator to increase rigidity.

2.12.6.10 Discharge Chute

Construct of not less than 10 mm 3/8 inch thick steel plate and attach to ash silo.

2.12.7 Ash Storage Silo

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NOTE: Use enclosures for silo roof and unloader level in climates where protection of equipment and personnel from the weather is desired.
****

[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. Provide support steel design approved by the ash system supplier. Design silo in

accordance with ICC UBC. Design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access stair tower with intermediate platforms at 3.66 meters 12 feet intervals for access to ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms shall then be also provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo.[Provide silo roof enclosure and unloader room enclosure each with single one by 2 meters 3 by 7 feet access door, [_____] by [_____] meter [_____] by [_____] feet double door, two windows, ventilator, [heater,] insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.12.7.1 Construction

Construct silo of steel with refractory lining or of concrete staves with steel hoops and concrete roof. Roof accessories shall include manhole, relief valve and vent filter. Bottom of silo shall be [conical, sloped a minimum of 45 degrees] [flat with a steel plate feeding hopper in bottom of silo to funnel the ash into the inlet of the rotary vane feeder]. Provide hopper with expansion joints and sufficient poke holes with cover or cap.

2.12.7.2 Concrete Stave Silo

Construct of either lightweight solid or hollow precast concrete staves with post-tensioned steel reinforcing hoops around the exterior. Mechanically measure and mix materials in concrete staves. Vibrate and shape staves under pressure and steam or air cure.

a. Wall Coating: Coat interior surface with a three-step process of a brush coat, scratch coat, and finish trowel coat of a mixture of fine sand and portland cement in accordance with silo manufacturer's recommendations. Apply each coat successively to produce a smooth interior surface. Work mixture into the formed horizontal and vertical grooves to permanently interlock the concrete staves. Brush coat exterior surface with a double application of waterproof mixture. Mixture shall include a chemical agent for waterproofing and portland cement, sand, and water. Work coating into joints and over steel reinforcing hoops to form a weatherproof protective coating.

b. Steel Reinforcing Hoops: Galvanized steel rods not less than 14 mm 9/16 inch in diameter with not less than 16 mm 5/8 inch rolled threads. Join hoop ends together with nuts and heavy malleable galvanized iron lugs or heavy duty galvanized steel lugs to a close tolerance for a tight fit. Electrogalvanize rods, nuts, and lugs to ensure adequate protection against corrosion. Rods shall be high quality, metallurgically sound steel with tensile strength not less than 488 MPa 65,000 pounds per square inch, yield point not less than 276 MPa 40,000 pounds per square inch, and a minimum elongation of 14 percent in 229 mm 9 inches. Reinforcing shall be sufficient to resist the maximum lateral pressure and loads imposed by the ash pressure within the silo. Structurally connect together hoop rods that pass through silo outlets on inspection frames.

c. Hollow Concrete Stave Silos: Construct silo of precast concrete staves with lateral air spaces. Cast staves from a well proportioned mix of portland cement and an expanded clay light weight aggregate. Minimum compressive strength of the concrete at 28 days shall be 34.50 MPa 5,000 psi. Hollow staves shall be 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick by 10 inches wide by 30 inches long with five lateral air cores per stave, except that shorter starter staves may be used to permit the horizontal joints to be staggered.

d. Solid Concrete Stave Silos: Construct silo of solid lightweight precast concrete staves. Solid staves shall be not less than 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick and 10 inches wide by 30 inches long, except starter staves may be shorter. Solid staves shall be constructed from a well proportioned mix of portland cement, washed sand and gravel which is free from injurious organic impurities and contains less than 5 percent of deleterious substances. Grade the fine aggregate from coarse to fine. Compressive strength of the solid concrete staves at 28 days shall be 34.50 MPa 5,000 psi.

2.12.8 Pulse Jet Bag Filter Vent

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NOTE: Consult the manufacturer of ash handling equipment for venting requirements.

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Provide for the silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter 9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s 15 to 20 cfm per square meter foot at 249 Pa one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.12.9 Rotary Ash Conditioner (Unloader)

Provide a complete dustless horizontal, floor mounted unloading device to discharge ashes from silo to a [truck] [railroad car]. Unloader (ash conditioner) shall include a 762 mm 30 inch diameter revolving drum which rotates about fixed spray nozzles, and be complete with conditioner and discharge compartments, scrapers, and other accessories as required. Unloader drum shall be constructed of steel plate not less than 10 mm 3/8 inch thick and shall be roller chain driven by a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp as specified in the paragraph MOTORS AND DRIVES. Unloader shall discharge conditioned ashes to a truck through a 6 mm 1/4 inch thick steel plate chute. Unloader shall be designed to eliminate most dust when in operation. Unloader may utilize screws as a means of mixing. Dustless unloader shall add water to ash, but not to the extent that free or surplus water is running or dripping from ash after discharge. Discharge ash shall be in a semi-fluid, loose, free flowing condition.

2.12.10 Fluidizing System

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NOTE: Delete fluidizing system if not necessary.
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Provide a fluidizing system on silo floor to ensure a constant and uniform feed of ash through the silo discharge outlet. System shall consist of a series of diffuser modules, a conical diffuser hood, designed to support the total weight of ash when silo is full, and compressed air piping. Each diffuser module shall be mounted on the silo floor using sloped concrete pads. System shall operate from the plant air system. Provide pressure reducing valves, safety valves, and controls for a complete system.

2.12.11 Control Panel and Controls

Provide a semi-automatic control system for the ash handling system[as indicated]. Provide a centrally controlled operation, with auxiliary local operation, and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start pushbuttons and indication stations for chain drag conveyor, screw conveyors, bucket elevator, and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid valves, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system.[Provide detailed control logic diagrams from ash handling system manufacturer to manufacturer of the digital process control and data acquisition system.]

2.12.11.1 Control Panel

Provide a [separate control panel] [subpanel mounted in the main plant control panel] of NEMA 12 construction, centrally located in the main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline items with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to front of panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz ac. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in the door shall be dusttight and oil tight with push-to-test transformer type indicating lights. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG type THHN stranded. Neutral wire shall be white and remaining wiring of 120 volts or less shall be color coded and labeled. Provide a plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with requirements of NFPA 70.

a. Panel Devices: Control panel shall include the following indicating lights and color:

(1) Power - ON	red
(2) System Run (3 required)	

Chain drag conveyor to elevator	green
Screw conveyors to drag conveyor	green
Bucket elevator to silo	green
(3) Ash Silo - HI LEVEL	red
(4) Ash Silo - LOW LEVEL	red
(5) Silo Vent Filter - ON	green

b. Provide momentary contact pushbuttons or selector switches for the following:

(1) System - START (3 required)
Bucket elevator
Chain drag conveyor
Screw conveyors

(2) System - STOP (red head)

c. Provide sensors such that the following items can be alarmed on an ash handling system control panel annunciator.

(1) Ash silo - HIGH LEVEL

(2) Bucket elevator - EMERGENCY SHUTDOWN

(3) Screw conveyor - EMERGENCY SHUTDOWN

(4) Chain drag conveyor - EMERGENCY SHUTDOWN

(5) Silo vent filter - OFF

(6) Plugged Hopper

d. Provide auxiliary devices required for the control functions above and laminated plastic name plates for devices on the panel front.

e. Provide local control panel for operating and indication of the rotary ash conditioner with the following functions:

(1) Power - ON (red)

(2) Water - ON/OFF

(3) Ash feeder - ON/OFF

(4) Rotary ash conditioner - START/STOP/JOG

(5) Normal Stop

(6) Wash out - START/STOP

(7) Emergency Stop: Provide control panel mounted at grade level for remote operation of the rotary ash conditioner with the following

functions:

(a) Rotary ash conditioner - START/STOP

(b) Normal stop

(c) Emergency stop

]2.13 AIR POLLUTION CONTROL EQUIPMENT

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NOTE: Mechanical cyclone collectors should be used for soot blowing and as a prefilter on baghouse fabric filters or electrostatic precipitators. The fabric filter should be used where necessary to meet local, state or federal regulations or statutes for particulate emissions, when sulfur emissions are within regional limits through the burning of low sulfur "compliance coal." When coal containing more than 2 percent sulfur is burned, an electrostatic precipitator is generally more economical for control of particulates than the fabric filters, if sulfur emissions will meet regional limitations. When sulfur emissions are not within the regional limits, a scrubber with a prefilter mechanical cyclone and possibly a baghouse filter may be required to meet the emission limitations.

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2.13.1 Mechanical Cyclone Collectors

As specified in Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.2 Fabric Filter Baghouse

As specified in Section 23 51 43.03 20 FABRIC FILTER DUST COLLECTOR OF FLYASH PARTICULATES IN FLUE GAS.

2.13.3 Electrostatic Precipitator Filters

As specified in Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.4 Scrubbers

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NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

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As specified in [_____].

2.14 MISCELLANEOUS EQUIPMENT

2.14.1 Condensate Receiver

Provide a [horizontal] [vertical] type tank not less than [_____] meters feet [_____] mm inches in diameter by [_____] meters feet [_____] mm inches

[long] [high] overall with a storage capacity of not less than [_____] liters gallons. Tank shall be constructed of welded steel plate not less than 10 mm 3/8 inch thick. Provide condensate tank with a 610 mm 24 inch diameter manway, dual gage glasses with protective guards, saddles, and other connections as indicated.

2.14.1.1 Coating

Surface blast interior of tank to bare metal and coat with a bake-on phenolic lining or corrosion resistant liner consisting of a resin and hardener suitable for immersion in water at not less than 121 degrees C 250 degrees F. Coat exterior of tank with one shop coat of manufacturer's standard primer rated for service of not less than 121 degrees C 250 degrees F.

2.14.1.2 Accessories

Provide condensate receiver with the following:

a. Connections for condensate pumped return, vent, water outlet, drain, sampling outlet, level transmitter and controls.

b. [_____] mm inch vent.

c. Reflex type water gage glasses with shutoff valves and guards.

d. One, 125 mm 5 inch dial, thermometer, 10 to 149 degrees C 50 to 300 degree F range, with lagging extension type wells, for steam and water space.

e. [_____] mm inch overflow trap.

f. One high water alarm switch with stainless steel float and trim. Circuit shall close as liquid level rises. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of receiver.

g. One low water alarm switch with stainless steel float and trim. Circuit shall close as liquid level falls. Locate switch to close circuit when water level drops to 25 percent of the storage capacity of the storage tank.

h. Install switches on a single column with valved connections to tank. Provide unions in pipe on each side of each float switch.

i. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, valves, necessary for a complete unit and install at jobsite.

j. Provide automatic control system to control level in condensate tank by modulating discharge from condensate pumps.

2.14.2 Deaerating Heater

Provide a deaerating feedwater heater with storage tank conforming to FS W-H-2904, except as modified below and to ASME BPVC SEC VIII D1. Tank shall be ASME Code stamped. Provide stainless steel trays. No test model will be required.

a. Model A - Pressurized operation.

b. Type I - Tray-type heating and deaerating element.

c. Class 3 - 10 minute water storage capacity (minimum).

d. Grade A - Guaranteed removal from water of all dissolved oxygen in excess of 0.005 cubic centimeters (cc) per liter 0.0012 cubic inches per gallon, over a ten to one load swing.

2.14.2.1 Heater Capacity

Provide deaerating heater capable of heating and deaerating makeup water consisting of [_____] kg per second pounds per hour of softened makeup water from [_____] to [_____] degrees C F (outlet temperature).

2.14.2.2 Inlet Water Characteristics

Softened makeup water:

a. Ph: [_____]

b. Total hardness (as CaC03): [_____]

2.14.2.3 Storage Tank

Horizontal design with steel supports[drilled for bolting] of approved design. Provide storage tank with not less than a 410 by 510 mm 16 by 20 inch minimum size manhole and cover and provide heater section with not less than a 300 by 460 mm 12 by 18 inch minimum size tray access handhole and door.

2.14.2.4 Vent Condensing Arrangement

Provide deaerating heater with a vent condenser which shall condense vented steam when heater is operating at full capacity with inlet water mixture at a temperature not exceeding 82 degrees C 180 degrees F. Construct vent condenser, when of the direct contact type, with stainless steel baffling.

2.14.2.5 Materials

Construct trays, tray supports, water distributors, and all other parts coming in contact with underaerated water or air laden steam of 430 stainless steel.

2.14.2.6 Accessories

Provide the deaerating heater with the following accessories:

a. Pressure Relief Valve: Sized in accordance with FS W-H-2904.

b. Thermometers: Two, 125 mm 5 inch dial thermometers, 10 to 149 degrees C 50 to 300 degrees F, with lagging extension type wells for the storage tank and heater section. Provide a thermometer similar to above but with range of minus [_____] degrees C F to plus [_____] degrees C F for the makeup water connection.

c. Lifting attachments for tray section and storage tank.

d. Water Gage Glasses: Reflex type with shutoff valve and guards.

e. Pressure Gages: One 150 mm 6 inch dial compound pressure gage for the heater section with range from [_____] kPa inches of mercury (vacuum) to [_____] kPa (gage) psig.

f. Float Controllers:

(1) Inlet condensate controller

(2) Makeup water controller

(3) Overflow controller

g. Overflow Control Valve: With pneumatic controller arranged for local automatic operation.

h. Storage Tank Gage Glass: Full height, shielded, for storage tank including shutoff valve and drain cocks.

i. Makeup Water Inlet Control Valve: With pneumatic controller.

j. Switches: For low water level alarm in the storage tank, high water level alarm, condensate pump shutdown in the storage tank, and low steam pressure alarm. Install switches on a single column with connections valved and unions provided in pipe on each side of each float switch.

k. Special Tools: One set for maintenance.

l. Condensate Pump Reset: With stainless steel float and trim to reset pump shutdown switch on fall of liquid level in tank to [_____] mm inches below level of overflow level of storage tank.

m. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, and valves, necessary for proper attachment of accessories and trimmings and install.

[n. Oil separator

]2.14.2.7 Connections

Provide necessary connections for condensate, steam, makeup water, removal of vented gases, vacuum breakers, discharge of deaerated water, and instruments and controls.

a. Provide heater connections as follows:

(1) [_____] mm inch steam inlet

(2) [_____] mm inch makeup water inlet

(3) [_____] mm inch condensate

(4) [_____] mm inch high pressure trap return

(5) [_____] relief valves sized as required

(6) [_____] mm inch vent

(7) [_____] mm inch for thermometer well

(8) [_____] mm inch for pressure gage

(9) Vacuum Breakers: As required

(10) [_____] mm inch heater drain

(11) [_____] mm inch spare [capped] [flanged]

(12) [_____] mm inch spare [capped] [flanged]

(13) Handholes And Manhole: With covers

b. Tank connections shall include:

(1) [_____] mm inch drain

(2) [_____] mm inch boiler feed recirculation ([_____] required)

(3) 25 mm One inch sampling

(4) 25 mm One inch chemical feed

(5) [_____] mm inch for sight glass ([_____] sets required)

(6) [_____] mm inch for high and low level alarm switches

(7) [_____] mm inch thermometer well

(8) Vacuum Breakers: As required

(9) [_____] mm inch spare (capped)

(10) [_____] mm inch spare (flanged)

(11) [_____] mm inch level transmitter and controller ([_____] sets required)

(12) Downcomer And Equalizer: As required

(13) [_____] mm inch feedwater outlet

(14) [_____] mm inch overflow outlet with internal water seal

2.14.2.8 Level Control

Provide an automatic control system to control the water level in the storage tank, by modulating valves in the makeup water lines. Output of condensate pump shall be controlled by level in condensate storage tank.

a. Controllers: Provide external cage type air operated level controllers for both the condensate and makeup water lines complete with 40 mm 1 1/2 inch screwed connections, external cage, and controller. Cage body shall be Class 125 cast iron construction. Internal components including displacer, torque tube, displacer rod, displacer rod driver and bearings shall be 316 stainless steel. Displacer shall be 356 mm 14 inches long. Controller shall be direct

acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band adjustment. Locate controller to maintain an operating level at 2/3 full point of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

b. Air Operated Regulating Valves: Provide air operated control valves for both the condensate and makeup water lines. Valves shall have Class 125 or Class 150 rating with iron or semi-steel bodies and 316 stainless steel internals. Provide condensate valve which fails open on loss of air and makeup water valve with an air lock mounted on valve diaphragm to hold valve in last position on loss of air. Design valves for the following conditions:

	Condensate	Makeup Water
Valve size	[_____] mm	[_____] mm
Capacity	[_____] L/s	[_____] L/s
Maximum pressure drop at above capacity	[_____] kPa (gage)	[_____] kPa (gage)
Available pressure	[_____] kPa (gage)	[_____] kPa (gage)
Minimum Cv at 100 percent open	[_____]	[_____]

	Condensate	Makeup Water
Valve size	[_____] inch	[_____] inch
Capacity	[_____] gpm	[_____] gpm
Maximum pressure drop at above capacity	[_____] psig	[_____] psig
Available pressure	[_____] psig	[_____] psig
Minimum Cv at 100 percent open	[_____]	[_____]

2.14.2.9 Low Pressure Steam Control

Provide an automatic control system to control steam to the deaerating heater. Maintain steam pressure in the heater by modulating a pressure reducing valve in the steam supply line. Control shall be local and remote from the control panel.

a. Controller: Adjustable proportional band, 0 to 103 kPa (gage) 15 psig brass bellows for input signal, and 20 to 103 kPa (gage) 3 to 15 psig output air pressure range, pilot controller complete with air set (valve, filter, drier and pressure regulator) mounted on control valve yoke.

b. Pressure Reducing Station Control Valve: Provide a [_____] mm inch air operated pressure reducing valve with proper internals to pass a flow of [_____] kg per second pounds per hour of steam. Steam at the valve inlet shall be [_____] kPa (gage) psig saturated, and outlet

shall be controlled at [_____] kPa (gage) psig. Minimum steam flow shall be approximately [_____] kg per second pounds per hour. Minimum valve Cv shall be [_____] at 100 percent open. Valve shall be Class 250 or Class 300 flanged, iron or semi-steel body with stainless steel internals equal percentage flow characteristics and a full size port. Provide valve actuator including travel indicator, hand jack, valve positioner, and air supply filter-reducer set. Valve shall move to open position in case of failure.

2.14.2.10 Gage Glasses

Provide to cover the entire range of water level in the storage section. Gage glasses shall not be greater than 610 mm 24 inches center-to-center. Provide gage glasses complete with[chain operated] ball check shutoff and drain cock valves and safety shield.

2.14.2.11 Alarms

Provide high and low water level alarms for storage tank as follows:

a. High Water Level Alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of storage tank.

b. Low Water Level Alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level falls to [_____] meters feet [_____] mm inches above bottom of storage tank.

c. Coordinate alarms with annunciator panel as indicated.

2.14.2.12 Multiport Back Pressure Relief Valve

****

NOTE: Use multiport valve on systems where deaerating heater will be subject to occasional overpressuring.

****

Provide valve capable of relieving not less than [_____] kg per second pounds per hour of steam with not more than a [_____] kPa (gage) psig pressure rise when set at [_____] kPa (gage) psig initial operating pressure. Set pressure shall be fully adjustable by means of an external handwheel or chain operator for a range of zero to 172 kPa (gage) 25 psig. Locate on low pressure steam header manifold for the deaerating heater. Valve shall be multiport vapor cushion type rated for operating temperatures up to but not greater than 149 degrees C 300 degrees F with Class 125 cast iron body, bronze trim and carbon steel springs.

2.14.2.13 Exhaust Head

Type [I (cast iron)] [II (fabricated steel plate)] of [_____] mm inch size with [_____] mm inch diameter drain, and a capacity of [_____] kg per second pounds per hour of steam at [_____] kPa (gage) psig.

2.14.3 Boiler Feed Pumps

****

NOTE: Use this paragraph for centrifugal boiler feed pumps. If regenerative type turbine pumps are

required for the smaller capacities, they must be specified. Use Style 1, horizontal split case pumps in all sizes where available. Pump service requirements shall include pump capacity of a minimum of 135 percent of boiler requirements at maximum load for modulating service and 200 percent for on-off service. Discharge head must include all change in elevation, friction losses through pipe, valves and fittings and be sufficient to deliver water to the boiler at a pressure 6 percent higher than the setting of the lowest set boiler safety valve.

****

CID A-A-50562, Type II (boiler feed), Style 1 (horizontal split case), Class [1 single] [2 multi-] stage except as modified below.Submit pump characteristic curves superimposed on system curves at various pumping rates, 20, 40, 60, 80, 100 percent capacity.

2.14.3.1 Pump Service Requirements

a. Capacity: [_____] L/s gpm

b. Pumping temperature: [_____] degrees C F

c. Liquid pH: [_____]

d. Discharge head: [_____] meters feet

e. Available NPSH: [_____] meters feet

f. In addition to the operating point established above, pump curve shall run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

2.14.3.2 Construction

Bronze fitted including bronze impeller and impeller wear rings, and ASTM A48/A48M, Class 30, cast iron casing. Provide casing with suction and discharge gages in tapped openings. Mount each pump and prime mover on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments to enable equipment to be set into its normal position and to enable pumps to be easily dismantled in place.

2.14.3.3 Drives

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the boiler feed or condensate pump motors shall be provided with variable speed control. Generally variable speed drives for pumps over 5 1/2 kW 7 1/2 hp will be cost effective.

****

[Variable speed] electric motors [or turbines] direct connected to respective pumps with a gear type, forged steel, flexible coupling. Provide a shaft and coupling guard.

a. Electric Motors: [Variable speed,] [open dripproof,] [totally enclosed,] [fan cooled,] [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified in paragraph[s] MOTORS AND DRIVES[and VARIABLE SPEED MOTOR CONTROL].

[b. Steam Turbines: Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F and normal exhaust back pressure of 34 kPa (gage) 5 psig or a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg per BkW per second pounds per BHP per hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

(1) Turbine Construction: Turbine casing split on the horizontal centerline constructed ofASTM A48/A48Mcast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

(2) Turbine Bearings and Shaft: Horizontal split, ring oiled, sleeve type, water cooled. Shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

(3) Speed Governor: Variable speed oil relay, NEMA SM 23, Class D governor for speed control and pneumatic operator to maintain an adjustable, preset pump discharge header pressure by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the control acquisition system.

(4) Emergency Overspeed Governor: Completely independent of the speed governor and shall operate a separate trip valve.

(5) Insulation: Turbine shall be insulated and lagged by the manufacturer as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

]2.14.3.4 Minimum Flow Protection for Boiler Feed Water Pumps

a. Automatic Flow Control Valve: Provide with each pump an automatic bypass valve. Valve shall automatically program recirculation flow,

detection of low flow, cycling of control valve and pressure letdown for high pressure boiler feedwater return to the feedwater heater. Bypass valve shall be cast steel with stainless steel internals, and shall have a rating of not less than 2068 kPa (gage) at 204 degrees C 300 psig at 400 degrees F. Valve shall have a line size body with a 25 mm one inch recirculation connection.

b. Boiler Feedwater Automatic Recirculation System: (Option to Automatic Valve). Provide to protect feedwater pumps at low flow conditions. System shall be capable of recirculating the minimum flow recommended by the pump manufacturer. System shall be an engineered system consisting of various functional components specified or shall be a self-contained and self-powered mechanical system. Components of the engineered system shall include a flow transmitter with orifice in feedwater line, bypass flow controller with bypass flow control valve, and a bypass pressure reducing orifice.

(1) System Bypass Flow Controller: Include detection of low flow and modulation of a control valve in a bypass line returning to a low pressure sink. Incorporate a pressure let-down feature or device to reduce pressure from boiler feedwater pump discharge pressure to that of the low pressure sink.

(2) System Bypass Control Valve: Modulate to provide minimum flow recommended by the pump manufacturer and to provide shutoff or recirculation flow when feedwater flow to boilers exceeds minimum flow required for pump protection.

2.14.3.5 Feedwater Stop and Check Valves

Provide a Class 300, flanged, cast steel feedwater stop gate valve and check valve on the feedwater outlet of each pump. Provide piping from valves to economizer inlet, and from economizer to flanged connection on boiler drum. Provide connection on pipe at economizer outlet for remote recording thermometer.

2.14.4 Condensate Pumps

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NOTE: Use this paragraph for centrifugal condensate pumps. If regenerative type turbines are required for the smaller capacities, they must be specified. Use Style 1, horizontal split case pumps in all sizes where available. Pump service requirements shall include pump capacity of a minimum of 135 percent of boiler requirements at maximum load for modulating service to the deaerator and 200 percent for on-off service. Discharge head must include all change in elevation and friction loses through pipe, valves and fittings.

****

CID A-A-50562, Type I (general service), Style [1 (horizontally split case)] [2 (end suction)], Class 1 (single stage) unless modified below.

2.14.4.1 Pump Service Requirements

a. Capacity: [_____] L/s gpm

b. Pumping temperature range: [_____] to [_____] degrees C F

c. Liquid pH: [_____]

d. Discharge head: [_____] meters feet

e. Available NPSH: [_____] meters feet

f. In addition to the operating point established above, pump curve shall also run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

2.14.4.2 Construction

Bronze impellers and impeller wear rings. [Cast iron] [ductile iron] pump casing designed for the specified conditions. Bearings shall be oil lubricated. Equip casing with tapped openings for suction and discharge gages. Provide gages in openings. Mount pump and driver on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments for installation and maintenance.

2.14.4.3 Drives

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the boiler feed or condensate pump motors shall be provided with variable speed control. Generally variable speed drives for pumps over 5 1/2 kW 7 1/2 hp will be cost effective.

****

[Variable speed] electric motors or [turbines] direct connected to respective pumps with a gear type flexible coupling. Provide shaft and coupling guards.

a. Electric Motors: [Variable speed,] [open dripproof,] [totally enclosed,] [fan cooled,] [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified in paragraph[s] MOTORS AND DRIVES [and VARIABLE SPEED CONTROL FOR MOTORS].

[b. Steam Turbines: Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F, normal exhaust back pressure of 34 kPa (gage) 5 psig and a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full

load and normal steam conditions shall not exceed [_____] kg per BkW per second pounds per BHP per hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

(1) Turbine Construction: Turbine casing split on the horizontal or vertical centerline constructed ofASTM A48/A48M cast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

(2) Turbine Bearings Shaft: Ring oiled, anti-friction type. Shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

(3) Speed Governor: Variable speed governor for speed limiting and pneumatic operator to maintain an adjustable preset level in [deaerator tank] [condensate receiver] by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal and vary the turbine speed from minimum to full speed in a linear response. Maximum and minimum speed shall be adjustable. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller.

(4) Emergency Overspeed Governor: Completely independent of the speed governor and shall operate a separate trip valve.

(5) Insulation: Turbine shall be insulated and lagged as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

]2.14.5 Variable Speed Motor Control

Remotely installed cabinet housed units with solid state rectification and inverter equipment to vary frequency of electrical power to drive motors.

2.14.5.1 Housing

House controller in a [wall] [floor] mounted, NEMA [_____] enclosure finished with manufacturers standard painted finish. Provide control panel complete with fused disconnect switches, magnetic [across the line] [part winding] starters with thermal overload protection, transformer, hand-off-automatic selector switches, hand potentiometer for manual speed control, fuses and running lights.

a. Provide the manual switch within the control panel so that in the event failure of a component, motor can be put across the line at full voltage to maintain air or pump pressure. Provide a mechanical door interlock that allows panel to open only when fused disconnect is in the off position.

b. Variable Frequency Controllers: Variable frequency controllers shall use solid-state semiconductor power conversion equipment. Provide controllers as integrated and assembled products. Controllers shall be furnished by the same manufacturer.

(1) Each controller shall be rated for a supply of [_____] volts, three phase, 60 Hz. Output shall be [_____] volts, three phase with frequency variable between zero and 60 Hz. Controllers shall

be rated to operate motors continuously at their rated horsepower and frequency. Speed regulation shall be three percent or better without tachometer feedback. Electrical supply system has an available short circuit rating of [_____] amperes symmetrical.

(2) Each controller shall be capable of driving motor continuously at a lower speed no greater than 20 percent of full rated motor speed with stable operation and without overheating the motor under rated ambient conditions. Provide estimate of minimum speed at which motor can be operated continuously without overheating or problems of instability due to overhauling of load.

c. Provide controller fault protection so that a single or three phase short circuit at the controller terminals or inverter commutation failure will not result in damage to power circuit components. Provide overload protection so that motor and controller are protected against operating overloads.

d. Provide adjustable time delay undervoltage protection so that motors will continue to operate during momentary voltage fluctuation or loss of voltage. Time adjustment shall be zero to 5 seconds. Provide for orderly shutdown on undervoltage conditions exceeding the time delay interval.

e. Provide adjustable timed linear acceleration and deceleration.

f. Provide volts/Hz control to prevent motor overheating throughout the speed range.

g. Provide door interlocks to prevent opening of enclosure doors unless power is disconnected.

h. Controllers shall be self protecting and shall provide orderly shutdown for, but not limited to, the following conditions:

(1) Loss of input power

(2) Undervoltage

(3) Sustained gradual overload

(4) Fault or large instantaneous overload

(5) Overtemperature

(6) Failure of ventilating system

(7) Overvoltage

(8) Control circuit failure

Provide contacts for remote annunciation of shutdown or abnormal condition.

i. Electrical Bypass: Provide each controller with manual isolation and bypass switching. Switch shall be manually operated with controller deenergized. Switch shall be two position with provisions for locking switch in either position.

(1) Normal Position: Bypass shall be open and controller shall be

connected to supply circuit and load.

(2) Bypass Position: Bypass shall be closed and controller shall be electronically isolated from supply and load. Isolating contacts shall be located so that it is possible to verify by visual inspection that contacts are open and controller is electrically isolated. In the bypass position the motor shall be operated at constant speed and controlled from the air circuit breaker. Provide auxiliary contacts that close in the bypass position. Auxiliary contacts shall be used to activate the damper control to provide fan load control in the bypass position.

2.14.5.2 Controller Environmental Protection

a. Ventilation: Design controllers enclosed and ventilated for installation in a moderately dusty area. Provide forced filtered ventilation including fans, filters, controls and accessories required for operation. Enclosures shall be operated under positive pressure at all times. Provide filtered ventilating openings and gasketed doors to prevent infiltration of dust.

b. Heating: Provide electric heaters to prevent condensation in the enclosure and to prevent low ingoing air temperatures that exceed the equipment rating. Provide a low temperature alarm to sound when enclosure temperature falls below required minimum temperature. Provide contacts for remote annunciation of alarm condition.

2.14.5.3 Method of Control

Supply each controller from an electrically operated air circuit breaker or motor starter. Controller ventilation and heating shall be from another circuit.

a. Start Signal: Closes the electrically operated air circuit breaker or motor starter to energize the controller. Controller shall accelerate fan to operating speed. Fan speed shall be controlled from the load control signal.

b. Stop Signal: Opens electrically operated air circuit breaker or motor starter to deenergize the controller. Upon deenergization, controller control system shall revert to stop condition.

c. Boiler Feedwater Pump Speed Control System: Matches pump discharge to system demand and maintains a system header pressure controlled to the set point values. Provide Manual/Automatic control stations for master pressure and for each boiler feed pump. Provide indicators for feedwater header pressure and individual boiler feedwater pump flow.

2.14.5.4 Variable Speed Motor Controller

Conduct burn-in tests for at least 50 hours at rated conditions. If a component fails during burn-in test, replace it, and run test again on entire assembly for another 50 hours. Burn-in test shall not be complete until entire assembly has operated for 50 hours without failure.

2.14.6 Valve Actuators

[Electrically][or][pneumatically] operated and designed so that valve may be manually operated by removing drive pins. Actuators shall be

operated by push button control. Locate one push button at a position adjacent to the valve. Locate a second push button within the boiler control room. Provide a valve position indicator utilizing indicating lights. A green light shall indicate valve is fully open and an amber light shall indicate valve is fully closed. Both lights on shall indicate when valve is partially open.[Provide torque limit controls to protect valve during opening and closing for electrically operated valves.] Actuator electric motor shall be totally enclosed, [_____] volts, [_____] phase, 60 Hz as specified in the paragraph MOTORS AND DRIVES. Provide NEMA 4 control enclosures.

2.14.7 Sump Pumps

CID A-A-50555 with automatic float switch and disconnect switch in NEMA 6 enclosure.

2.14.8 Water Softening System

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NOTE: One hundred percent makeup shall be assumed in calculating the sustained softening rate.
****

Ion exchange resin type conforming to WQA S-100 except as modified below. [Manual] [Push button automatic] [Fully automatic] in operation with operating controls housed in a NEMA 12 enclosure having a minimum total capacity between regenerations of [_____] liters gallons of water of [_____] grams grains hardness when operated at a sustained softening rate of [_____] L/s gpm. Maximum effluent water temperature shall be [_____] degrees C F.

2.14.8.1 Softener Equipment

Including but not limited to the following:

a. Water Hardness Monitor: Provide with an alarm point at 1.0 ppm to ensure compliance for boilers rated above 3150 grams/sec 25,000 lb/hr.

b. Total Solids Monitor and Controller: Provide a continuous monitor and controller (when required) to control concentration of dissolved solids and treatment chemicals in water for boilers rated above 3150 grams/sec 25,000 lb/hr.

c. Water Meter: Provide a [_____] mm inch cold water meter on each softener unit.

d. Ion Exchange Resin: High capacity, polystyrene base, sulfonated synthetic type except that exchange capacity shall be not less than 68.70 kg per cubic meter 30 kilograins per cubic foot at a salt dosage of 240 kg per cubic meter 15 pounds per cubic foot.

e. Tank Sizing: Minimum acceptable bed depth of 762 mm 30 inches; maximum acceptable bed depth of 1829 mm 72 inches. Base reactor tank sizes on allowing a freeboard above the resin bed of not less than 75 percent of resin bed depth, and flow rate between 1.11 and 7.13 L/s per cubic meter 0.5 and 3.2 gpm per cubic foot of resin.

2.14.8.2 Brine Storage System

Provide complete, including fiberglass storage tank, sight level gage, bulk salt delivery tube, internal distribution system, level control system, tank vent with dust collection system, top and side manholes, access ladder, and other required appurtenances.

a. Storage Tank: Filament wound fiberglass with flat bottom and domed top as recommended by the manufacturer for brine storage. Tank shall be [_____] meters feet [_____] mm inch in diameter by [_____] meters feet [_____] mm inch wall height with a nominal capacity of [_____] liters gallons and a dry salt storage capacity of [_____] Mg tons. Design water distribution system, internal piping distributors, and brine collection system so that system shall be capable of dissolving [_____] kg pounds of rock salt per second minute to produce [_____] L/s gpm of brine. System shall be able to dissolve [_____] Mg tons of salt before cleanout.

b. Accessories: Provide the following accessories:

(1) Steel holddown lugs securely bonded to tank in adequate number to properly anchor tank to concrete base;

(2) Side bottom flanged drain not less than 100 mm 4 inches in diameter;

(3) Side and top manholes not less than 559 mm 22 inches in diameter;

(4) Flanged top connections for delivery pipe and vent;

(5) Ladder for access to top manhole;

(6) Water inlet connection;

(7) Brine outlet connection;

(8) Level control system; and

(9) Sight level gage

c. Pneumatic Delivery Pipe: Not less than 100 mm 4 inches in diameter.

d. Dust Collection Vent System and Safety Relief Valve: Provide storage tank with dust collection vent system and safety relief valve.

e. Access Ladder: Of steel construction to be bolted to tank by means of FRP (fiberglass reinforced plastic) mounting lugs complete with safety cage. Platform shall connect ladder to tank for safe access to the manhole.

f. Tank Internals: Construct tank internals including water distribution piping and brine collectors of FRP or polyvinyl chloride (PVC).

g. Tank Nozzles: ASME B16.5, Class 150, FRP or PVC flanges.

h. Level Control System: Electrode holder and electrodes mounted in a standpipe exterior to the tank. Position electrodes so that a solenoid operated water makeup valve will be opened or closed to maintain liquid level to within plus or minus 25 mm one inch of the

set level. Provide tank with a high water alarm. Electrodes shall be easily removable for cleaning and constructed of materials, that will allow continual immersion in brine.

2.14.9 Chemical Feed Systems

Provide systems complete with storage tank, supporting framework, hinged cover, mixer, strainers, level indicators, proportioning pumps, relief valves and interconnecting piping for a complete chemical feed packaged unit.

2.14.9.1 Storage Tank

Capacity of 190 liters 50 gallons constructed of FRP. Provide removable, hinged cover.

2.14.9.2 Exterior Gage Glass

Protected, full height of tank complete with gage cocks.

2.14.9.3 Low Level Alarm

Provide tank with a low level switch to sound alarm and shut down pumps should level drop to preset minimum.

2.14.9.4 Dissolving Baskets

****
NOTE: The chemical feed solution to be used shall be inserted here.
****

Construct baskets of a corrosion resistant material suitable for continuous immersion in a [_____] solution.

2.14.9.5 Tank Strainer

In suction line to pump.

2.14.9.6 Supporting Steelwork

Provide to adequately support tank, mixer, and the number of proportioning pumps specified.

2.14.9.7 Agitator

Provide with mounting bracket to mount to storage tank. Agitator shaft and propeller shall be of stainless steel.

2.14.9.8 Proportioning Pumps

Provide [two] [three] [_____] [simplex] [duplex] proportioning pump[s]. Each pump shall have a minimum capacity of [_____] L/s gallons per hour at a [_____] kPa (gage) psig discharge pressure. Capacity shall be adjustable from zero to 100 percent by a convenient screw adjustment of stroke length. Provide pump with integral check valves. Electric motors shall be [totally enclosed,] [fan cooled,] [_____] volts, [_____] phase, 60 Hz as specified in the paragraph MOTORS AND DRIVES.

2.14.9.9 Safety Relief Valve

Provide for each pump to discharge back into the tank in event of excessive line pressure.

2.14.10 All Welded Blowdown Tank

Provide in accordance with the NBBI NB-27 (supplemental to the National Board Inspection Code) latest edition published by the National Board of Boiler and Pressure Vessel Inspectors, Columbus, Ohio.

2.14.10.1 Construction

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NOTE: The volume of the blowdown tank shall be calculated to be twice the volume of water removed from one boiler when the normal water level is reduced not less than 100 mm 4 inches.

****

Construct equipment and accessories in accordance with requirements of ASME BPVC SEC VIII D1 for a working pressure of at least the maximum allowable working pressure of the boiler but in no case shall plate thickness be less than 10 mm 3/8 inch. Provide corrosion allowance of [2.54] [_____] mm [0.1] [_____] inch. Tank dimensions shall be [_____] meters feet [_____] mm inches o.d. by [_____] meters feet [_____] mm inches long over the heads (overall). Provide tank with wear plate not less than 10 mm 3/8 inch thick and [279 by 381 mm] [457 by 508 mm] [11 by 15 inch] [18 by 20 inch] manhole.

a. Provide the following tank connections:

(1) Blowdown inlet for bottom blowdown: [20] [25] mm [3/4] [one] inch;

(2) Tangential blowdown inlet: [_____] mm inch;

(3) Steam vent, flanged: [_____] mm inch;

(4) Discharge water outlet, flanged: [_____] mm inch with internal water seal and 20 mm 3/4 inch siphon breaker;

(5) Drain: 50 mm 2 inch;

(6) Thermometer connection: 20 mm 3/4 inch;

(7) Pressure gage connection: 6 mm 1/4 inch;

(8) Cold water inlet: [_____] mm inch with temperature regulating valve and backflow preventer; and

(9) Two gage glass connections: 15 mm 1/2 inch.

b. Angle Supports and Coating: Provide tank with steel angle support legs extending [_____] meters feet below bottom of tank. Coat tank with one coat of manufacturer's standard high temperature primer.

2.14.10.2 Accessories

a. Gage Glass: 300 mm 12 inch reflex type with shutoff valves and guard.

b. Thermometer: Bi-metal dial type with separable socket, 125 mm 5 inch dial, 10 to 149 degrees C 50 to 300 degrees F range.

c. Pressure Gage: Zero to 172 kPa (gage) 25 psig range.

d. Internal Baffles and Pipes: As detailed.

2.14.10.3 Controls

Provide a self operating regulator to control the flow of cooling water to the tank. Regulator shall include a 20 mm 3/4 inch screwed bronze body with stainless steel trim, reverse acting actuator (for cooling), capillary tubing and a union connection bulb with a stainless steel well. Control setting shall be 60 degrees C 140 degrees F with a minimum Cv of [_____].

2.14.11 Continuous Blowdown System

Provide a complete automatic continuous boiler blowdown system which shall include a controller/programmer unit and flow assembly for each boiler, plus a continuous blowoff heat exchanger, flash tank and boiler water sample cooler.

2.14.11.1 Automatic Blowdown Controller

Intermittent type boiler blowdown system rated for not less than 1724 kPa (gage) 250 psig steam pressure.

a. Flow Assembly: Include a 25 mm one inch ball valve with 316 stainless steel ball and stem and stainless steel electrode assembly.

b. Controller/Programmer: Include a conductivity meter with zero to 6000 microhms range, valve open/closed indicators and manual/auto control switch. Cycle interval and sample duration shall both be adjustable over a wide range. Mount units at the operating floor near the boiler front.

c. Accessories and Connections:

(1) Continuous Blowdown Connection: At each boiler, provide a gate valve and extend piping to header at flash tank.

(2) Header Connections: Provide with a tee with valved sampling connection. Provide a 20 mm 3/4 inch, three globe valve bypass around each flow assembly.

(3) Common Header: Provide from valved outlet connections on flow assembly units to connection on flash tank.

2.14.11.2 Flash Tank

Designed for [_____] kPa (gage) psig and constructed in accordance with ASME BPVC SEC VIII D1. Tank shall be [_____] mm inches in diameter by [_____] mm inches long including heads and shall be ASME Code stamped.

a. Provide tank with blowdown inlet, steam outlet, gage glass, float operated outlet valve, relief valve, and inspection openings. Tank shall have steel angle legs with plate feet for bolting to floor.

Legs shall be of sufficient length so that bottom of lower head of tank will be not less than 457 mm 18 inches above floor.

b. Automatic Control System: Control level in the flash tank, by modulating a valve in the water outlet line.

(1) Level Controller: External cage type air operated level controller, complete with 40 mm 1 1/2 inch screwed connection, 350 mm 14 inch stainless steel float and Class 125 cast iron body. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band. Locate controller to maintain an operating level at center line of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

(2) Outlet Water Valve: [_____] mm inch air operated control valve with a capacity to pass [_____] L/s gpm at a pressure drop of [_____] kPa (gage) psig. Cv shall not be less than [_____] at 100 percent open. Valve shall be Class [_____], flanged, iron or semi-steel body with stainless steel internals. Valve shall have equal percentage flow characteristics with a full size port. Provide an air lock mounted on valve diaphragm and piped to hold valve in last position on air failure.

2.14.11.3 Sample Cooler

Water cooled shell and tube type with valves and accessories required to safely withdraw a water sample from the boiler drum. Provide drain under sampling valve terminating with a 20 mm 3/4 inch splash proof funnel, 229 mm 9 inches below outlet of valve.

2.14.11.4 Heat Exchanger

Provide an ASME code stamped continuous blowoff heat exchanger designed and constructed in accordance with ASME BPVC SEC VIII D1, to transfer heat from the continuous blowoff water leaving continuous blowoff flash tank to treated makeup water entering the feedwater heater. Heat exchanger shall be a bare tube, helical coiled bundle, installed in a one piece casing with removable front plate. Bundle shall be removable. Tube diameter shall be not less than 20 mm 3/4 inch. Tubes shall be ASTM B111/B111M copper alloy with cast iron shell. Design tube side for not less than [_____] kPa (gage) psig pressure at [_____] degrees C F. Design shell side for not less than [_____] kPa (gage) psig pressure at [_____] degrees C F.

2.15 PIPING

Piping work shall include the provision of piping systems, including valving and specialty items, for steam plant and related external auxiliary equipment. Piping shall be in accordance with ASME B31.1 except as modified below or indicated otherwise.

2.15.1 Expansion

Compute expansion of pipe with operating temperatures above minus 19 degrees C zero degrees F with minus 19 degrees C zero degrees F in lieu of 21 degrees C 70 degrees F specified in ASME B31.1.

2.15.2 Steam Heating and Distribution and Hot Water

Requirements of ASME B31.1 apply to building steam heating and steam distribution piping designed for 103 kPa (gage) 15 psig or lower and hot water heating systems 207 kPa (gage) 30 psig or lower.

2.15.3 Materials

Suitable for the maximum pressure at the maximum temperature at which equipment must operate.

2.15.3.1 Pipe Materials

a. Steel Pipe:

(1) Steam Pipe, Boiler Feedwater Pipe, Relief Pipe and Steam Tracer Pipe: Black, ASTM A53/A53M or ASTM A106/A106M seamless steel pipe, Grade A or B. Wall thickness not less than Schedule 40. Steam tracer pipe, with steam up to 103 kPa (gage) 15 psig, may be ASTM B88M ASTM B88, Type K copper tubing.

(2) Condensate Pipe and Boiler Blowdown Pipe: Black, welded or seamless ASTM A53/A53M or ASTM A106/A106M, steel pipe, Grade A or B. Wall thickness not less than extra strong (XS or Schedule 80).

(3) Chemical Feed Pipe: ASTM A312/A312M austenitic stainless steel.

(4) Fuel Oil Pipe: ASTM A53/A53M or ASTM A106/A106M, seamless black steel pipe, Grade A or B.

(5) Treated Water, Hot Water Heating, High Temperature Water, Drains (Other Than Sanitary), and Overflow Pipe: ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

(6) Gas Pipe and Compressed Air Pipe: ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

b. Copper Tubing:

(1) Instrument Air Pipe: ASTM B88M ASTM B88hard copper tubing, Type K or L; except in a corrosive atmosphere or outside pipe shall be copper tubing, Type K or L, with ASTM D1047 PVC jacketing.

(2) Steam Tracer Pipe: Contractor may provide ASTM B88M ASTM B88, Type K, copper tubing for steam up 103 kPa (gage) 15 psig.

(3) Potable Water, Sanitary Drains and Storm Drains: As specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE unless otherwise specified. Chlorinated polyvinyl chloride (CPVC) and other plastic tubing and fittings shall not be used in the steam heating plant.

2.15.3.2 Fittings

a. Fittings for Steel Pipe:

(1) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.3 malleable iron, screwed end fittings, for working pressures not greater than 2068 kPa (gage) 300 psig at temperatures not greater than 232 degrees C

450 degrees F or ASME B16.11 forged steel.

(2) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.11 steel, socket welded end fittings.

(3) Sizes 6 to 65 mm 1/8 to 2 1/2 inches: ASME B16.9 steel, butt welding fittings.

(4) Sizes 65 to 600 mm 2 1/2 to 24 inches: ASME B16.5 forged steel, flanged fittings.

b. Welded Outlets and Welding Saddles: Make branch connections of 45 and 90 degrees either with ASME B16.9 forged steel welded outlet fittings or welding saddles. Welding outlets and saddles shall not be smaller than two pipe sizes less than main pipe sizes.

c. Fittings For Copper Tubing: ASME B16.18 cast bronze solder joint or ASME B16.22 wrought copper solder joint. For instrument air, fittings may be ASME B16.26 compression joint type.

d. Unions:

(1) Unions For Steel Pipe: ASME B16.11, ASME B16.39 threaded. Unions for zinc coated pipe shall be zinc coated.

(2) Unions For Copper Tubing: ASME B16.22. For instrument air, unions may be compression joint type.

2.15.3.3 Flanges

ASME B16.5, forged steel, welding type. Remove raised faces on flanges when used with flanges having a flat face. Unless specified otherwise, pressure and temperature limitations shall be as specified in ASME B16.5 for the proper class and service, and type face specified.

2.15.3.4 Valves

a. Valves for maximum working pressure of 1034 kPa (gage) 150 psig saturated steam or 1550 kPa (gage) 225 psig W.O.G. (Water, Oil, Gas) at 93 degrees C 200 degrees F (non-shock service). For working pressures not exceeding 862 kPa (gage) 125 psig saturated steam or 1379 kPa (gage) 200 psig water at 93 degrees C 200 degrees F non shock service, Class 125 may be used in lieu of Class 150 or Class 250.

(1) Valve Sizes 50 mm 2 Inches and Smaller:

(a) Non Throttling Valves: Gate valves, bronze, wedge disc, rising stem, Class 150, MSS SP-80 or ball valves, bronze, double stem seals, stainless steel ball and shaft, tight shutoff.

(b) Globe Valves and Angle Valves: Bronze, Class 150, MSS SP-80.

(c) Check Valves: Bronze, Type [IV, swing check] [III, lift check], Class 150, MSS SP-80.

(2) Valve sizes 65 mm 2 1/2 inches and larger.

(a) Gate Valves: Flanged, cast iron, Class 250, MSS SP-70 or

steel, Class 150, ASME B16.34. Valves shall have wedge disc, outside screw and yoke (OS&Y), rising stem; valves 200 mm 8 inches and larger shall have globe valved bypass.

(b) Globe Valves and Angle Valves: Flanged, cast iron, Class 250, MSS SP-85 or steel, Class 150, ASME B16.34.

(c) Check Valves: Flanged, cast iron, Class 250 or steel, Class 150, Type [_____], [lift] [swing] check, style [_____], ASME B16.34.

b. Valves for maximum working pressure of 1724 kPa (gage) 250 psig steam at a maximum temperature of 232 degrees C 450 degrees F or 3447 kPa (gage) 500 psig W.O.G. at 93 degrees C 200 degrees F (non-shock).

(1) Valve sizes 65 mm 2 1/2 inches and larger.

(a) Gate Valves: Flanged or butt welded, cast iron, Class 250, MSS SP-70 (Maximum size 300 mm 12 inches) or steel, Class 300, ASME B16.34. Valves shall have wedge disc, OS&Y, rising stem; each valve 200 mm 8 inches and larger shall have globe valved bypass.

(b) Gate Valves, Globe Valves and Angle Valves: Flanged or butt welded, cast iron, Class 250, MSS SP-85 or steel, Class 300, ASME B16.34.

(c) Check Valves: Flanged or butt welded, iron body, Class 250 or steel, Class 300, Type [_____] [lift] [swing] check, style [_____], ASME B16.34.

c. Valves for maximum working pressure of 2068 kPa (gage) 300 psig steam at a maximum temperature of 454 degrees C 850 degrees F or a maximum W.O.G. pressure of 4653 kPa (gage) at 149 degrees C 675 psig at 300 degrees F (non shock).

(1) Valve sizes 65 mm 2 1/2 inches and larger:

(a) Gate Valves, Globe Valves, and Angle Valves: Flanged or butt welded, ASME B16.34, steel, Class 300, rising stem, OS&Y. Gate valves 200 mm 8 inches and larger shall have globe valved bypass.

(b) Check Valves: Flanged or butt welded, steel, Class 300, Type [_____], [lift] [swing] check, style [_____], ASME B16.34.

d. Ball Valves: ASME B16.5 and API Std 607 double stem seal type for bubble tight shutoff. Seats and seals shall be TFE material. Ball and shaft shall be stainless steel. Provide mechanical stops to prevent cycling valve in wrong direction and self-aligning stem seal.

e. Valve Accessories: Valve operating mechanisms include chain wheels, gear operators, floor stands, electric motors, air motors and cylinder-type actuating devices. Provide accessories as follows and as indicated.

(1) Power Operators: [Electric] [Pneumatic]. Power operated valves shall open and close at rates no slower than 254 mm 10 inches per

minute for gate valves and 100 mm 4 inches per minute for globe and angle valves. Valves shall open fully or close tightly without requiring further attention when actuating control is moved to the open or closed position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve shall cause motor to automatically stop. Power operators shall be complete with gearing and controls necessary for size of valve being provided. Power operators shall be designed to operate on the [electric] [compressed air] power supply indicated. Provide power operators with remote position indicators on the following valves: soot blowers, [_____], [_____].

(2) Floor Stands and Extension Stems: Floor stands shall be cast iron or steel, constructed for bolting to floor and shall include an extension stem, an operating handwheel and a position indicator for non-rising stems. Floor stand shall be not less than 762 mm 30 inches high. Handwheel shall identify rotation direction for closing valve and shall be of such diameter as to permit operation of valve with a force of not more than 18 kg 40 pounds. Extension stems shall be corrosion resisting steel designed for rising and non-rising stems, as applicable, and for connection to valve stem by a sleeve coupling or universal joint. Provide in length required to connect valve stem and [handwheel] [operating mechanism] and of sufficient cross section to transfer torque required to operate valve. Provide floor stands and valve extensions on floors and platforms for the following valves: deaerator drain valves, [_____] [_____].

(3) Provide motorized actuators or chain wheels with chain and guides on valves with handwheel centerline higher than 2 meters 7 feet above floor or platform except where specified otherwise. Chainwheel operator shall be fabricated of cast iron or steel and shall include a wheel, endless chain and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending from valve to within one meter 3 feet of floor or platform. Provide impact chain wheels on steam headers and other locations where the valve has a tendency to stick. When a valve is motorized, provide hand operation for emergency.

(4) Provide gear operators on ball valves larger than 80 mm 3 inches and on gate valves 200 mm 8 inches and larger.

f. Steam Pressure Regulating Valves: CID A-A-50558, minimum of Class [125] [150] [250] [300], except as specified otherwise. [Cast iron], [cast steel] valve body with valve seats and disc of replaceable heat treated stainless steel. Valves shall be single seated, shall seat tight under dead end conditions, and shall go to the closed position in the event of pressure failure of the operating medium. Valves shall be spring loaded diaphragm operated type, except valves exposed to ambient temperature of less than 2 degrees C 35 degrees F or exposed to the weather shall be piston operated type. Capacity of valves shall be not less than that indicated. Pilot valves shall have strainer at inlet from external feeder piping:

(1) Spring Loaded Diaphragm Operated Valves: Fabricate main spring of stainless steel, and it shall not be in the path of steam flow through the valve. Control valve by pilot valve through external feeder piping.

(2) Piston Operated Valves: Control valve by integral pilot valve through external feeder piping.

g. Safety Relief Valves: ASME BPVC SEC I, with Class [150] [300] inlet flange, with test lever, designed for the intended service.

2.15.3.5 Bolts and Nuts

a. Bolts: ASTM A193/A193M, Grade B8. Lengths of bolts shall be such that not less than two full threads will extend beyond nut with bolts tightened to the required tensions and washers seated.

b. Nuts: ASTM A194/A194M, Grade 8.

2.15.3.6 Gaskets

ASME B31.1 and as specified below, except provide spiral wound metal covered non-asbestos gaskets in lieu of compressed sheet non-asbestos. Gaskets shall be as thin as the finish of surfaces will permit. Do not use paper, vegetable fiber, rubber, or rubber inserted gaskets for temperatures greater than 121 degrees C 250 degrees F. Provide metal or metal jacketed non-asbestos gaskets with small male and female and small tongue-and-groove flanges and flanged fittings; they may be used with steel flanges with lapped, large male and female, large tongue-and-groove, and raised facings. Provide fullface gaskets with flat-faced flanges. Raised face cast iron flanges, lapped steel flanges, and raised faced steel flanges shall have ring gaskets with an outside diameter extending to inside of bolt holes. Widths of gaskets for small male and female and for tongue-and-groove joints shall be equal to widths of male face and tongue. Gaskets shall have an inside diameter equal to or larger than port opening. Dimensions for nonmetallic gaskets shall be in accordance with ASME B16.21. Materials for flanged gaskets shall be as listed below for service specified:

a. Steam, Boiler Blowdown, Exhaust Steam: Spiral wound metal composition or copper

b. Boiler Feed Water: Metal jacketed non-asbestos, copper or monel

c. Hot Water, (above 38 degrees C 100 degrees F): Spiral wound metal non-asbestos

d. Cold Water: Red rubber or neoprene rubber

e. Heavy Fuel Oil (No. 6): Spiral wound metal non-asbestos, soft steel, or monel

f. Diesel Fuel (No. 2): ASME B16.21 metallic

g. Compressed Air: Spiral wound metal non-asbestos

2.15.3.7 Expansion Joints

a. Slip Tube Expansion Joints: ASTM F1007, single or double slip tube as indicated, designed for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Expansion joints shall be of the type which permits injection of semi plastic type packing while joint is in service under full line pressure. Slip tube shall be of

chromium plated, wrought steel construction, guided by internal and external guides integral with joint body. Fit slip tube ends with forged steel pipe flanges or bevel for welding into pipe line where indicated. Deliver joints complete with packing and ready for installation.

b. Ball Expansion Joints: Capable of 360 degrees rotation plus 15 degrees angular flex movement. Ball joints shall have steel bodies and polished steel balls. Provide end connections to suit class of piping hereinbefore specified. Seals shall be of pressure molded composition designed for the working pressure. Design joints for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Cold set joints as necessary to compensate for temperature at time of installation. Do not use ball joints on superheated steam or on joints subject to frequent flexure. Ball joints shall be installed in strict accordance with recommendations of the manufacturer.

c. Bellows Expansion Joints: ASTM F1120 flexible guided type with stainless steel expansion element, internal sleeves and external covers. Joints shall be designed for a working pressure of [_____] kPa (gage) psig and a temperature of [_____] degrees C F.

2.15.3.8 Pipe Hangers and Supports

MSS SP-58, Type [_____] or Type [_____] of the adjustable type, except as specified or indicated otherwise. Suspended steam and condensate piping shall have pipe hangers Type [_____] with insulation protection saddles Type [_____]. Provide insulated piping, except steam and condensate piping, with insulation protection shields Type 40. Provide bronze or copper plated collars on uninsulated copper piping. Support rods shall be steel. Rods, hangers and supports shall be zinc plated, except for uninsulated copper piping which shall be copper plated; cast iron rollers, bases and saddles may be painted with two coats of heat resisting aluminum paint in lieu of zinc plating. Axles for cast iron rollers shall be stainless steel. Size hanger rods with a 150 percent safety factor for a seismic design.

2.15.3.9 Instrumentation

a. Pressure and Vacuum Gages: Conform to applicable requirements of ASME B40.100.

b. Indicating Thermometers: Liquid-in-glass or MIL-T-19646 dial type. Thermometer shall include a separable immersion well.

2.15.3.10 Miscellaneous Pipeline Components

a. Cold and Hot Water Meters: CID A-A-59224 for maximum flow of [_____] L/s at 38 degrees C gpm at 100 degrees F and reduced flow of up to [_____] L/s at 121 degrees C gpm at 250 degrees F.

b. Air Traps: Float controlled valves arranged to close properly when water enters traps. Air traps shall conform to requirements for float operated steam traps (non-thermostatic), CID A-A-60001, except that valve mechanism shall be inverted so as to be closed, not opened, by rising water.

c. Steam Traps: CID A-A-60001. Inverted bucket high pressure steam

traps designed for use at [_____] kPa (gage) psig at [_____] degrees C F. Low pressure steam traps shall be float and thermostatic type for pressures up to 103 kPa (gage) 15 psig. Provide traps with separate strainers unless specified otherwise.

d. Strainers: FS WW-S-2739, Style Y for Class [125] [250] with blow off outlet. Construct strainers for Class 300 of cast carbon steel in accordance with ASME B16.5 for minimum of 2068 kPa (gage) 300 psig saturated steam pressure. Provide blow off outlet with pipe nipple and gate valve.

2.15.3.11 Backflow Preventers

Reduced pressure principle type conforming to applicable requirements of [AWWA C510 and AWWA C511] [Section 22 00 00 PLUMBING, GENERAL PURPOSE].

2.15.3.12 Insulation

Materials and application shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.3.13 Pipe Sleeves

a. Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade: Galvanized steel pipe having an inside diameter at least 15 mm 1/2 inch larger than outside diameter of pipe passing through it. Provide sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs shall extend 13 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction shall include flange and clamping ring.

b. Partitions: Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

2.15.3.14 Piping Identification

Conform to MIL-STD-101 and place in clearly visible locations; except paint piping in the boiler room the primary color of the color code. Provide labels and tapes conforming to ASME A13.1 in lieu of band painting or stenciling. Labels shall be outdoor grade acrylic plastic. Markings on labels shall indicate direction of flow, flowing media, and media design pressure and temperature. Spacing of identification marking shall not exceed 3 meters 10 feet. Provide two copies of complete color and stencil codes used. Frame codes under glass and install where directed.

2.16 FIRE PROTECTION SYSTEM

Provide fuel oil room with a wet sprinkler system as specified in Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION.

2.17 MARKING

Identify equipment, valves, switches, motor controllers, and controls or indicating elements by printed, stamped or manufactured identification plates or tags of rigid plastic or non-ferrous material. Lettering for identification plates or tags shall be not less than 5 mm 3/16 inch high. Nomenclature and identification symbols used on the identification plates

or tags shall correspond to those used in maintenance manuals, operating instructions, and schematic diagrams. Rigidly affix identification plates or tags to the equipment or devices without impairing functions or, when this is not possible, attach using a non-ferrous wire or chain. In addition to identification plate or tag, each major component of equipment shall have a nameplate listing manufacturer's name, model number, and when applicable, electrical rating and other information required by pertinent standards or codes.

2.18 TOOLS AND TESTING EQUIPMENT

Provide special tools and wrenches required for installation, maintenance, and operation of equipment. Testing equipment to be provided shall include necessary equipment to perform routine tests:

a. On lubricating oil for acidity (pH-potentiometer), viscosity (saybolt test), and dirt (gravimetric).

b. On softened water for hardness (soap test or colorimetric test), and boiler blowdown water for pH (colorimetric) and conductivity (potentiometer).

c. For water (distillation) and sediment (gravimetric) in fuel oil.

2.19 WELDING MATERIALS

Comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

2.20 MOTORS AND DRIVES

Alternating current electric motors shall meet requirements of NEMA MG 1. Motors shall be designed for continuous operation at rated load under usual service conditions as defined by NEMA. Unless specifically noted otherwise, motors less than 3/8 kW 1/2 hp shall be 115 volt, 60 Hz, single phase, capacitor-start, or permanent split capacitor, with Class B insulation for 40 degrees C 104 degrees F ambient. Unless specifically noted otherwise, motors 3/8 kW 1/2 hp and larger shall be 460 volt, 60 Hz, three phase, Design B, squirrel cage induction with a minimum insulation of Class F for 40 degrees C 104 degrees F ambient. Size motors to meet power requirements of driven unit at design conditions, including drive and coupling losses which are incurred, without loading motor beyond its nameplate horsepower rating. Minimum service factor for open drip-proof motors shall be 1.15 and for totally enclosed, fan cooled motors 1.0. Motor shall be quiet operating. Bearings shall be heavy duty, grease lubricated, anti-friction, single shielded, regreasable type and shall have approved lubricating fittings extended to an easily accessible location for field servicing. Provide sole plates for motors installed on concrete pads. Motor shall have copper windings.

2.20.1 Motors

Motors used to drive equipment specified under "Coal Handling Equipment" shall be designed to operate in Class II, Division II, Group F atmosphere.

2.20.2 SOURCE QUALITY CONTROL

2.20.3 Instrument Air Compressor Package

Factory test air compressor package at full load for not less than 2 hours. Check capacity, smoothness of operation, alternation of units, and proper operation of air unloaders during test.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with manufacturer's recommendations.

3.1.1 Boiler and Equipment Installation

Boiler and equipment installation shall be strictly in accordance with this specification, and installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. Do not bolt flanged joints tight unless they match adequately. Expansion bends shall be adequately extended before installation. Grade, anchor, guide and support piping, without low pockets.

3.1.1.1 Boiler and Equipment Foundations

Of sufficient size and weight, and proper design to preclude shifting of equipment under operating conditions, and under abnormal conditions which could be imposed upon equipment. Design boiler foundation to accommodate and support stoker and incorporate stoker ash pits. Limit equipment vibration to within acceptable limits, and isolate. Foundations shall be adequate for soil conditions of the site and shall meet requirements of the equipment manufacturer. Trowel exposed foundation surfaces smooth except properly roughen surfaces to receive grout.

3.1.1.2 Installing Stoker Ash Pit Firebrick

Lay up in air-setting mortar. Dip each brick in mortar, rub, place into its final position, and then tap with a wooden mallet until it touches adjacent bricks. Mortar thick enough to lay with a trowel will not be permitted. Maximum mortar joint thickness shall not exceed 3 mm 1/8 inch and average joint thickness shall not exceed 1.60 mm 1/16 inch.

3.1.1.3 Forced and Induced Draft Fans

Set, shim level, anchor and grout each fan assembly into place prior to setting driver. Properly shim driver on base plate using steel shim stock. Shims shall be full size of feet and shall have slotted hole for installation. After drive has been properly aligned and shimmed, by an approved millwright, millwright shall drill and ream foot and base plate and install taper pins with nut on top for pullout removal. One front foot and diagonally opposite rear foot shall be pinned to base plate. Equipment shall be adequately bolted in place in an approved manner. Level and grout fan and bearing pedestal sole plates in place.

3.1.1.4 Stack

Install level and plumb. Erected stack shall be no more than 25 mm one

inch out of plumb per 15 meters 50 feet. Remove roughness, marks, and lifting lugs, from stack and grind surfaces smooth and flush with surrounding surfaces.

[3.1.1.5 Horizontal Fuel Oil Tanks (Below Ground)

****

NOTE: Choose this subparagraph or the subparagraph below, HORIZONTAL FUEL OIL TANKS (ABOVE GROUND), or the following subparagraph VERTICAL FUEL OIL TANK.

****

Provide concrete ballast slabs for tanks and concrete protective ground level slabs for FPR tanks. Ballast slabs shall be full length and width of tanks and protective slabs shall extend 610 mm 2 feet beyond tanks. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

a. Install and backfill fiberglass reinforced tanks as recommended by the manufacturer; backfill adjacent to tanks shall be pea gravel unless otherwise recommended by the manufacturer. Backfill for steel tanks shall be sand.

b. Set steel tanks on a bed of sand not less than 152 mm 6 inches deep over the concrete slab and strap in place with stainless steel hold-down straps with stainless steel turnbuckles. Set FRP tanks on a bed of pea gravel not less than 305 mm 12 inches thick and pre-shape for tank contours for FRP tanks. Fabricate straps for FRP tanks from FRP resins reinforced with stainless steel to prevent breaking of straps and floating of empty tanks.

c. Slope tank toward sump not less than 25 mm one inch in each 1 1/2 meters 5 feet.

][3.1.1.6 Horizontal Fuel Oil Tanks (Above Ground)

Continuously support steel tank saddles along the full length of the base and level and grout to ensure full bearing.

][3.1.1.7 Vertical Fuel Oil Tank

Provide [sand, crushed stone or fine gravel cushion] [concrete base].

a. Sand, Crushed Stone or Fine Gravel Cushion: Cover area beneath tank with a fuel resistant plastic membrane with a thickness of not less than 0.51 mm 20 mils. Carefully fuse or cement plastic membrane seams. Lay plastic over a thoroughly compacted select subgrade free from rocks that could puncture the plastic. Over plastic, provide a bed of sand, crushed stone or fine gravel not less than 152 mm 6 inches thick. Stabilize bed with an approved material and shape to tank bottom. Slope bed down to center sump approximately 152 mm 6 inches for each 3 meters 10 feet of tank radius. When in place, tank shell shall be plumb.

b. Concrete base shall be as indicated and in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

c. Mastic Seal: Place mastic seal between tank and concrete ring to the cross section indicated. Compact mastic thoroughly. Immediately

before placing mastic, coat tank surfaces to be in contact with concrete ring with a coat of AASHTO M 118bituminous material.

]3.1.2 Piping

Unless specified otherwise, erection, welding, brazing, testing and inspection of piping shall be in accordance with ASME B31.1 and Section 40 17 26.00 20 WELDING PRESSURE PIPING. Piping shall follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings shall be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until piping has been inspected, tested, and approved. Where pipe passes through building structure, conceal pipe joints but locate where they may be readily inspected and building structure not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, run vertical piping plumb and straight and parallel to walls. Install piping connected to equipment to provide flexibility for vibration. Support and anchor piping so that strain from weight of piping is not imposed on equipment.

3.1.2.1 Fittings

Provide long radius ells on welded piping to reduce pressure drops. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or similar construction shall not be used. Make branch connections with welding tees, except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be provided.

3.1.2.2 Grading of Pipe Lines

Unless indicated otherwise, install horizontal lines of steam and return piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where flow may be either direction. Pitch air lines to source of supply, and make provisions for draining off condensate. Install water lines to drain to a shutoff valve.

3.1.2.3 Anchoring, Guiding, and Supporting Piping

Anchor and support piping in a manner such that expansion and contraction will take place in the direction desired, prevent vibration by use of vibration dampeners, and prevent undue strains on boilers and equipment served. Fabricate hangers used for the support of piping of 50 mm 2 inch nominal pipe size and larger to permit adequate adjustment after erection while still supporting the load. Provide wall brackets where pipes are adjacent to walls or other vertical surfaces which may be used for supports. Provide supports to adequately carry weight of the lines and maintain proper alignment. Provide inserts and sleeves for supports in concrete where necessary and place in new construction before pouring concrete. Provide insulated piping with a pipe covering protection saddle at each support. Provide pipe guides and anchors of approved type at points where necessary to keep pipes in accurate alignment, to direct expansion movement, and to prevent buckling and swaying and undue strain. Provide pipe guides for alignment of pipe connected to free unanchored end of each expansion joint. Support pipe rollers in concrete conduits and

trenches by extra strong steel pipe with ends inserted in slots provided in concrete walls. Set pipe supports for rollers at correct elevations either by metal shims or by cutting away of concrete and after pipe lines have been placed in alignment, grout ends of pipe supports and fix in place. Space pipe supports to provide adequate support for pipes. Pipe shall not have pockets formed in the span due to sagging of pipe between supports, caused by weight of pipe, medium in the pipe, insulation, valves, and fittings. Maximum spacing for pipe supports for steel pipe shall be in accordance with ASME B31.1; maximum spacing for supports for copper tubing shall be in accordance with MSS SP-58.

3.1.2.4 Copper Tubing

Copper tubing shall have solder joints with solder suitable for pressure-temperature ratings of piping system. Tubing 20 mm 3/4 inch and smaller for instrument air may be compression joint in lieu of soldered joint. Tin-antimony (95/5) solder is suitable for saturated steam up to 103 kPa (gage) 15 psig but tin lead (50/50) solder is not acceptable for steam service. Flux shall be non corrosive. Wipe excess solder from the joints.

3.1.2.5 Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry and concrete walls, floors, and partitions. Space between pipe, tubing, or insulation and the sleeve shall be not less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, and slabs. Sleeves in floor slabs shall extend 13 mm 1/2 inch above the finished floor. Firmly pack space between pipe or tubing and the sleeve with oakum and caulk on both ends of sleeve with elastic cement.

3.1.2.6 Flashing for Buildings

Where pipes pass through building roofs and outside walls, provide proper flashing and counter flashing and make tight and waterproof.

3.1.2.7 Outlets for Future Connections

Locate as directed capped or plugged outlets for connections to future equipment, when not located exactly by project drawings.

3.1.2.8 Screwed Joints in Piping

Use teflon tape or suitable pipe joint compound applied to male threads only for making up screwed joints. Piping shall be free from fins and burrs. Ream or file out pipe ends to size of bore, and remove chips.

3.1.2.9 Welded Joints

Weld joints in piping by the metal-arc or gas welding processes in accordance with ASME B31.1 and as specified in Section 40 17 26.00 20 WELDING PRESSURE PIPING. Number or mark each weld to identify the work of each welder on welds on which stress relieving or radiographic inspection is required.

a. Contracting Officer reserves the right to require the Contractor to provide re-examination and recertification of welders.

b. Radiographic testing of circumferential butt welded joints of pipe with operating temperature of 177 degrees C 350 degrees F and above shall be required on ten percent of the joints, the location of which will be determined by the Contracting Officer; when more than ten percent of the radiographically tested joints show unacceptable defects radiographically test every joint of this type piping.

c. Equipment and Protection: Items of equipment for welding shall be so designed and manufactured, and shall be in such condition as to enable qualified operators to follow procedures and to attain results specified. Protect welders and gas cutters from the light of the arc and flame by approved goggles, shields, helmets, and gloves. Replace cover glasses in helmets and shields when they become sufficiently marred to impair the operator's vision. Take care to avoid risk of explosion and fire when welding and gas cutting near explosive or flammable materials. Ventilate welding and gas cutting operations in accordance with paragraph 1910.252 (f) of 29 CFR 1910-SUBPART Q.

d. Surface Conditions: Do not weld when atmospheric temperature is less than minus 18 degrees C zero degrees F, when surfaces are wet, when rain or snow is falling or moisture is condensing on surfaces to be welded, nor during periods of high wind, unless welder and work are protected properly. At temperatures between 0 degrees C and minus 18 degrees C 32 degrees F and zero degrees F, heat with a torch the surface for an area within 80 mm 3 inches of the joint to be welded to a temperature warm to the hand before welding. Free surfaces to be welded from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth, uniform and free from fins, tears, and other defects which might affect proper welding. Remove slag from flame-cut edges to be welded by grinding, but temper color need not be removed. Thoroughly clean each layer of weld metal by wire brushing prior to inspection or deposition of additional weld metal.

3.1.2.10 Cleaning of Piping

Before installing pipe, thoroughly clean pipe of sand, mill scale and other foreign material. After erection but before making final connections to apparatus, thoroughly clean interior of piping. Flush piping with water except air and fuel lines. In addition, blow out steam lines with intermittent high pressure steam blows to promote shedding of internal scale. Blow compressed air and fuel oil lines clean with 552 to 690 kPa (gage) 80 to 100 psig air dried to a 2 degrees C 35 degree Fdew point at 552 kPa (gage) 80 psig. Sterilize potable water piping by means of liquid chlorine or hypochlorite in accordance with AWWA C651 before placing water system in service. Take care during fabrication and installation, to keep piping, valves, fittings and specialties free of loose welding metal chips of metal or slag, welding rods and foreign matter. Blowing or flushing shall in no case be channeled through equipment, pump, control valve, regulating valve, instrument gage or specialty in the system. Provide temporary screens, strainers, connections, spool pieces and bypasses consisting of piping or hoses, pumps and other required equipment temporarily installed for the purpose of cleaning and flushing piping. Drain flushing water and test water to the sanitary sewer system.

3.1.2.11 Reduction in Pipe Size

Provide reducing fittings for changes in pipe size; bushings will not be permitted. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain bottom of lines in the same plane. In horizontal water mains, reducers shall be set to maintain top of lines in the same plane.

3.1.2.12 Expansion Control

Provide bends, loops, and offsets wherever practical to relieve overstressed piping systems due to thermal expansion and to provide adequate flexibility. Cold spring piping system as indicated but not more than 50 percent of the total linear expansion.

3.1.2.13 Connection to Equipment

Provide unions or flanges where necessary to permit easy disconnection of piping and apparatus. Provide unions and gate valves at each connection to threaded end control valves, strainers and equipment.

3.1.2.14 Valve Installation

Install valves in positions accessible for operation and repair. Install stems in a vertical position with handwheels or operators on top or in a horizontal position. Do not install handwheels on stop valves below the valve. When centerline of valve is more than 2 meters 7 feet above floor or platform, provide valve with a chain-operated handwheel. When valve is motorized, provide hand operation for emergency use.

a. Gate Valves: Arrange back outlet gate valves for turbine exhaust for hand operation and provide with a floor stand.

b. Globe Valves: Pressure shall be below the disc. Install globe valves with stems horizontal on steam and exhaust lines, when better drainage is required or desired.

c. Steam Pressure-Reducing Valves: Provide steam line entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two shutoff valves and with a globe or angle bypass valve and bypass pipe. A bypass around a reducing valve shall be of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure-reducing valve unit with indicating steam gages to show reduced pressure and upstream pressure and an adequately sized safety valve on low pressure side.

d. Valve Tags and Charts: Permanently tag each valve with a black and white engraved laminated plastic tag showing valve number, valve function and piping system and whether another valve must be opened or closed in conjunction with this valve. Furnish a typed chart which will show required valve tagging plus the location of each valve. Frame valve charts under glass and install as directed.

3.1.2.15 Traps and Connections

Traps shall be of the type and capacity for the service required, and shall be properly supported and connected. Except for thermostatic traps in pipe coils, radiators, and convectors, install traps with a dirt pocket

and strainer between trap and piping or apparatus it drains. When it is necessary to maintain in continuous service, apparatus or piping which is to be drained, provide a three valve bypass so that trap may be removed and repaired and condensate drained through the throttled bypass valve. Provide a check valve on the discharge side of the trap when trap is installed for lift or operating against a back pressure, or trap discharges into a common return line. Provide test connections on the discharge side of the high and medium pressure traps when specifically required. Test connection shall include a 1/2-inch globe valve with open blow.

3.1.2.16 Pressure Gage Installation

Provide with a shutoff valve or petcock between the gage and the line, and provide gage on steam lines with a siphon installed ahead of the gage.

3.1.2.17 Thermometers and Thermal Sensing Element of Control Valves

Provide with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of the flowing fluid and minimize obstruction to flow.

3.1.2.18 Strainer Locations

Provide strainers with meshes suitable for the services upstream of each control valve and where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.1.2.19 Dissimilar Piping Materials

Provide dielectric unions or flanges between ferrous and nonferrous piping, equipment, and fittings, except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or nonferrous-to-nonferrous connections. Dielectric fittings shall utilize a nonmetallic filler which will prevent current flow from exceeding one percent of the short circuit current. Spacer shall be suitable for pressure and temperature of the service. Fittings shall otherwise be as specified in this section.

3.1.2.20 Surface Treating, and Pipe Wrapping

Uninsulated steel piping buried in the ground shall have exterior surfaces protected with a tape wrapping system or a continuously extruded polyethylene coating system as specified in Section 09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS.

3.1.3 PAINTING

3.1.3.1 Piping, Fittings, and Mechanical and Electrical Equipment

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for particular end item. Retouch damaged areas on factory finished equipment on which finish has been damaged and then give a complete finish coat to restore finish to original condition. Finish coat shall be suitable for exposure in the intended end use environment.

3.1.3.2 Painting

Unless specified otherwise, paint pipe hangers, structural supports, pipe and pipe fittings, conduit and conduit fittings, air grilles, pipe coverings, insulation, and metal surfaces associated with mechanical and electrical equipment including zinc-coated steel ducts as specified in Section 09 90 00 PAINTS AND COATINGS. Zinc-coated steel duct in unpainted areas shall not be painted. Apply a protective coating to piping to be insulated, except zinc-coated and copper pipe, prior to installing insulation.

3.1.3.3 Boilers

After erecting and testing boilers, clean as necessary exposed surfaces of the boiler normally painted in commercial practice to remove grease, coal dust, flyash and other foreign matter and finish with one coat of aluminum heat resisting paint applied to minimum dry film thickness of 0.025 mm one mil.

3.1.3.4 Vertical Fuel Oil Tank

Clean interior surfaces to bare metal in accordance with SSPC SP 10/NACE No. 2. Clean to bare metal by powered wire brushing or other mechanical means surfaces that cannot be cleaned satisfactorily by blasting. Wash members which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Remove weld backing plates prior to blast cleaning; when left in place, round off corners prior to blast cleaning and coating.

3.1.3.5 Surfaces Not to be Painted

Unless specified otherwise, do not paint equipment having factory applied permanent finish, switchplates and nameplates, motor starters, and concrete foundations.

3.1.4 INSULATION

Insulate mechanical equipment, systems and piping as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2 FIELD QUALITY CONTROL

Provide labor, equipment, test apparatus and materials required for preparation and performance of tests and inspections specified to demonstrate that boilers and auxiliary equipment as installed are in compliance with contract requirements. During start up and during tests, ensure that factory trained engineers or technicians employed by the boiler manufacturer and system suppliers or manufacturers of such components as the boiler, burner, forced draft fan, feedwater treatment equipment, and other auxiliary equipment be present, to ensure the proper functioning, adjustment, and testing of the individual components and systems. Furnish a detailed written record of test conditions, test procedures, field data, and start up and operational performance of the entire heating plant to the Contracting Officer before the Contractor's operational and test personnel leave the site. The Government will furnish, if available, water, electricity and fuel for the tests, except fuel required for retesting. The Contractor shall rectify defects disclosed by tests and retest equipment. The Contractor's boiler plant personnel shall be experienced in starting up and operating boiler plants.

3.2.1 Tests and Inspections (Piping)

Examine, inspect, and test piping in accordance with ASME B31.1except as modified below. Rectify defects disclosed by tests. Necessary subsequent tests required to prove system tight after additional work by the Contractor shall be provided by the Contractor. Make tests under the direction of and subject to the prior approval of the Contracting Officer.

3.2.1.1 Hydrostatic and Leak Tightness Tests

a. Perform hydrostatic and leak tightness test on piping systems attached to the boilers and included under jurisdiction of ASME BPVC SEC I in accordance with requirements of that Code. Piping bearing ASME Code symbol stamp will be accepted only as indicating compliance with the design and material requirements of the code.

b. Test piping which is a part of the steam generation or auxiliary systems, including piping within the boiler room and external to the boiler room, by the following methods:

(1) Perform hydrostatic test at 150 percent of design pressure for welded and screwed steel piping systems except those for air, oil, and gas. Hold hydrostatic tests for a period of one hour with no pressure loss. Temperature of testing fluid shall not exceed 38 degrees C 100 degrees F.

(2) Test air and oil lines in accordance with requirements of ASME B31.1 for pneumatic tests with exception that the test pressure shall be held for one hour. Examination for leaks shall be by a soap or other foaming agent test.

(3) Inspection and test of gas piping shall conform to the requirements of NFPA 54.

c. For tests install a calibrated test pressure gage in the system to observe loss in pressure.

3.2.2 Preliminary Operation

The Contractor under the direction of the respective manufacturer's representative shall place in operation equipment provided by the Contractor except as specifically noted otherwise. Make adjustments to equipment that are necessary to ensure proper operation as instructed by the equipment manufacturer.

a. Lubricate equipment prior to operation in accordance with manufacturer's instructions. Provide lubricants. Furnish lubrication gun with spare cartridges of lubricant to operating personnel.

b. Dry out motors before operation as required to develop and maintain proper and constant insulation resistance.

c. Check drive equipment couplings for proper alignment at both ambient and operating temperature conditions.

3.2.3 General Start-Up Requirements

Prior to initial operation of complete system, check each component as

follows:

a. Inspect bearings for cleanliness and alignment and remove foreign materials found. Lubricate as necessary and in accordance with manufacturer's recommendations. Replace bearings that run roughly or noisily.

b. Adjust direct drives for proper alignment of flexible couplings. Provide lubrication when a particular coupling so requires. Check security of couplings to driver shafts. Set drive components to ensure free rotation with no undesirable stresses present on the coupling of attached equipment.

c. Check motors for amperage comparison to nameplate value. Correct conditions that produce excessive current flow and that exist due to equipment malfunction.

d. Check speeds of each motor and driven apparatus to ensure that motors are operating at the desired point.

e. Check actual suction and discharge pressure of each pump against desired performance curves.

f. Check pump packing glands or seals for cleanliness and adjustment before running each pump. Inspect shaft sleeves for scoring and proper placement of packing; replace when necessary. Ensure piping system is free of dirt and scale before circulating liquid through pumps.

g. Inspect both hand and automatic control valves. Clean bonnets and stems, tighten glands to ensure no leakage, but permit valve stems to operate without galling. Replace packing in valves that require same to retain maximum adjustment after system is judged complete. Replace entire packing in valves that continue to leak after adjustment. Remove and repair bonnets that leak. Coat packing gland threads and valve stems with a suitable surface preparation after cleaning.

h. Inspect and make certain that control valve seats are free from foreign matter and are properly positioned for intended service.

i. Check flanges and packing glands after system has been placed in operation. Replace gaskets in flanges that show signs of leakage after tightening.

j. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.

k. Thoroughly blow out strainers through individual valved blow-off connection on each strainer prior to placing in operation.

l. Thoroughly blow out or dismantle and clean strainers after systems have been in operation one week. Thoroughly clean, repair, and place back in service traps or other specialties in which foreign matter has accumulated, causing malfunction or damage.

m. Adjust pipe hangers and supports for correct pitch and alignment.

n. Remove rust, scale and foreign materials from equipment and renew

defaced surfaces. When equipment is badly marred, the Contracting Officer shall have authority to request new materials be provided.

o. Adjust and calibrate temperature, pressure and other automatic control systems.

p. Inspect each pressure gage and thermometer for calibration, and replace those that are defaced, broken or read incorrectly.

[q. Vertical Fuel Oil Tank Calibration: After completing installation of tank, prepare a calibration table for the tank showing fuel volume in liters gallons in the tank to any height of liquid in meters and mm feet, inches, and eighths of an inch when measured by a steel tape lowered through the roof. Calibrate tank in accordance with[API MPMS 2.2A][API MPMS 2.2B] for "critical measurement" "operating control." Perform calibration of tank by a qualified organization that can certify to at least 2 years of prior successful and accurate experience in calibrating tanks of comparable type and size. Correct data obtained for use with product to be stored.

]3.2.4 Plant Equipment Tests

3.2.4.1 Plant Air Compressors

Test plant air compressors in service to determine compliance with contract requirements and warranty. During tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.2.4.2 Instrument Air Compressors

Test air compressor package at full load for not less than 2 hours. Check capacity, smoothness of operation, alternation of units, and proper operation of the air unloaders during the test.

3.2.4.3 Coal Handling System

Test coal handling system under operating conditions and demonstrate that work is in conformance with the specified requirements. Conduct this test in the presence of the Contracting Officer.

3.2.4.4 Ash Handling System

Test ash handling system under operating conditions and demonstrate that work is in conformance with specified requirements. Conduct test in the presence of the Contracting Officer.

[3.2.4.5 Horizontal Fuel Oil Tanks (Below Ground)

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NOTE: Choose this subparagraph or the subparagraph below, VERTICAL FUEL OIL TANK.
****

a. Test tanks before placing in service, in accordance with applicable paragraphs of the code under which tanks were built.An UL label, ASME Code Stamp, or API monogram on a tank shall be evidence of compliance with code requirements.

b. Holiday Detection Test: Inspect coal tar epoxy coating system for film imperfections using a low voltage (75 volt) holiday tester. Inspect FRP coated tanks with a 10,000 volt spark test for imperfections or holidays. Repair holidays or pinholes in the coatings.

][3.2.4.6 Vertical Fuel Oil Tank

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NOTE: Choose this subparagraph or the subparagraph above, HORIZONTAL FUEL OIL TANKS (BELOW GROUND).
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Inspect and test vertical fuel oil tank as specified in API Std 650. Use the radiographic method of inspection of butt welds as required by API Std 650; sectioning method will not be acceptable as an alternative to radiographic inspection.

]3.2.4.7 Blowdown Valves and Try Cocks

Test blowdown valves and try cocks for proper operation.

3.2.4.8 Draft Fans, Fuel Oil Heaters, Fuel Pumps, and Electric Motors

Test draft fans, fuel oil heaters, fuel pumps, and electric motors to determine compliance with the referenced standards. Standard symbols and certifications from the referenced organization may be accepted at the discretion of the Contracting Officer. Closely observe the operation of fans, fuel oil heaters, fuel pumps, and electric motors[including variable speed motor controllers] and correct defects.

3.2.5 Boilers and Auxiliaries Tests and Inspections

The Contractor, with qualified personnel provided by the Contractor, shall make tests and inspections at the site under the direction of and subject to the approval of the Contracting Officer. The Contractor's boiler plant personnel under the direction of the respective manufacturer's representatives and consultants, shall operate each boiler and appurtenances through the entire testing period and shall ensure that necessary adjustments have been made. Notify the Contracting Officer in writing at least 7 days in advance that equipment is ready for testing. The Contractor shall provide testing equipment, including gages, thermometers, calorimeter, Orsat apparatus, thermocouple pyrometers, fuel flow meters, water meters and other test apparatus and calibrate instruments prior to testing. Draft, fuel pressure and steam flow may be measured by permanent gages and meters installed under the contract. The Contractor is responsible for providing an analysis of the fuel being used for the tests. Control of noise levels developed by exhaust steam shall be as directed by the Contracting Officer to satisfy environmental conditions of the surrounding area. Perform the following tests and, when feasible, in the sequence listed:

a. Strength and tightness tests

b. Standards compliance tests

c. Preliminary operational tests (steady state combustion test and variable load combustion test)

d. Tests of auxiliary equipment

e. Feedwater equipment test

f. Capacity and efficiency tests

3.2.5.1 Strength and Leak Tightness Tests

Subject the boiler[s] to the following strength and tightness tests:

a. Watersides Including Fittings and Accessories: Hydrostatically test watersides in accordance with requirements of ASME BPVC SEC I. The ASME label will be accepted as evidence of this test.

b. Boiler Casing, Breeching and Ductwork: Prior to installing breeching and ductwork, boiler[s] [on the furnace side] shall be pneumatically tested, at the maximum possible draft pressure of the boiler furnace; the soap bubble method [and] [or] a smoke test shall be used to verify tightness of the casing. Boiler casing, breeching and ductwork shall be pressurized with the forced draft fan to the maximum draft pressure; the smoke test shall be used to verify tightness of the casing, breeching and ductwork. Leaks observed or detected shall be sealed.

3.2.5.2 Boiler Inspection

Ensure that the Boiler Inspector is present to witness the appropriate tests which need to be observed in order to certify the safety of the boiler. The inspection shall include requirements of NAVFAC MO 324. The Boiler Inspector shall complete NAVFAC form 9-11014/40, Data Record Sheet; NAVFAC form 9-11014/41, Inspection Report; NAVFAC form 9-11014/32 Inspection Certificate for each boiler after boiler has been inspected and found to be safe. No boiler may be fired until it has passed the inspection of the Boiler Inspector. The boiler inspection forms shall be submitted through the Contractor to the Contracting Officer. Place the Inspection Certificate under framed glass, and mounted on or near the boiler in a conspicuous location.

3.2.5.3 Boiler Cleaning and Startup

Dry out, boil out, and operate the firing rate of the new boiler[s] under direct responsibility and supervision of the manufacturer[, and in the presence of the boiler room operating personnel]. Provide chemicals that are required. Allow sufficient time for the boiling out process to ensure interior surfaces are clean. This time shall be at least 24 continuous hours and generally not more than 36 hours; boil out shall continue until water is clear. Boil out, cleaning and starting procedures shall be in accordance with requirements of ASME BPVC SEC VII and FM DS 12-17.

3.2.5.4 Boiler Preliminary Operational Tests

Conduct a boiler operational test on each unit continuously for two weeks. Operate one boiler at a time to demonstrate control and operational conformance to requirements of the specifications including ability to respond to load swings from the specified capacity to minimum turndown. Operational test shall be under the supervision of a registered professional engineer or a licensed power plant operator and shall serve to prove safeties, controls, maintenance of stable combustion at low

loads, [proper coal distribution and combustion, and ability to operate without furnace slagging,] [proper flame lengths and patterns to avoid flame impingement on the tubes for oil firing,] and proper mechanical and electrical functioning of each system. Test shall include items specified in this section as well as items mentioned in the specification of the particular pieces of equipment. Conduct tests with factory trained combustion equipment engineers as previously specified. Test and record steam quality, steam flowrates, flue gas temperature, percentages of carbon dioxide, carbon monoxide, oxygen and nitrogen in flue gas and percent excess air for each boiler at tested load and graphically present the test data.

3.2.5.5 General Operational Tests

a. Steady State Combustion Tests: Test fuel burning and combustion control equipment with each of the specific fuels at the minimum limit of the turndown range and at increments of 50, 75 and 100 percent of full rated load. Each test run shall be at least two hours on each fuel and until stack temperatures are constant and capacity and efficiency requirements of this specification have been verified and recorded. Verify proper operation of instrumentation and gages during the tests.

b. Varying Load Combustion Tests: Test boiler continuously under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control and safety interlocks. Conduct these tests after adjustment of combustion controls has been completed under the steady state combustion tests. Continue variable load operational tests for a period of at least 8 hours.

(1) Sequencing: Boiler shall start, operate and stop in strict accordance with the specified operating sequence.

(2) Flame Safeguard: Verify operation of the flame safeguard controls by simulated flame and ignition failures. Verify trial-for-main flame ignition, combustion control reaction and valve closing times by stop watch.

(3) Immunity to Hot Refractory: Operate burner at high fire until combustion chamber refractory reaches maximum temperature. Main fuel valve shall then be closed manually. Combustion safeguard shall drop out immediately causing the safety shutoff valves to close within the specified control reaction and valve closing times.

[(4) 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 shall be capable of safely igniting the main burner. When the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, the boiler shall be rejected.

] (5) Boiler Limit and Fuel Safety Interlocks: Safety shutdown shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

(6) Combustion Controls: Demonstrate accuracy, range and smoothness of operation of the combustion controls by varying steam demand through the entire firing range required by the turndown ratio specified for the burner. The control accuracy shall be as specified.

(7) Safety Valves: High pressure limit switch shall be locked out or otherwise made inoperative and boiler safety valves shall be lifted by steam. Determine relieving capacity, popping pressure, blowdown and reseating pressure by observation and measurement in accordance with ASME BPVC SEC I. The ASME standard symbol will be accepted only as indicating compliance with design and material requirements of the code.

3.2.5.6 Auxiliary Equipment and Accessory Tests

Observe and test blowdown valves, stop valves, try cocks, draft fans, fuel oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during operational and capacity tests for leakage, malfunctions, defects, and for compliance with referenced standards.

3.2.5.7 Feedwater Equipment Tests

Perform test of the feedwater treatment equipment in two steps. Conduct one test concurrently with the combustion tests. The Government will perform a second test during the first period of heavy loading after the plant has been accepted and put in service. Correct deficiencies revealed during the Government tests under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with the limits for chemical concentrations of this specification. Supply equipment for taking samples and test kit for analyzing the samples. Sampling equipment and test kit shall become the property of the Government when tests are completed.

3.2.5.8 Capacity and Efficiency Tests

Perform capacity and efficiency tests after operating tests have been satisfactorily completed and boiler has been operated continuously for at least 14 days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. Perform capacity and efficiency tests on each boiler. Conduct tests using specified fuel[s]. Test procedures shall be in accordance with the heat loss method[and the input-output method] of ASME PTC 4. Before performing tests, the Contracting Officer and the Contractor shall reach agreement on those items identified in ASME PTC 4, Section 3, paragraph 3.0l "Items on Which Agreement Shall be Reached." A test run shall not start until boiler and accessories have reached an equilibrium and stabilization condition for at least one hour in duration. Duration of tests shall be sufficient to record necessary data but in no case shall each run be less than [4] [10] [24] hours.

a. Accomplish maximum output testing by means of a single 2 hour run at 110 percent load on the boiler under test. Calculate boiler efficiency, both input-output and heat loss, from the consistent readings taken during the runs. Runs shall be made at four different loads 30, 50, 70, and 100 percent of boiler rating during which both heat loss and input-output data shall be taken. Predict unmeasured losses used in conjunction with heat loss calculations and include with equipment data when submitted for approval. Subsequent tests

required because of failure of the equipment to perform adequately during specified capacity and efficiency tests shall be the financial responsibility of the Contractor, including the cost of fuel.

b. Should analysis of the fuel being burned during performance tests vary from that specified as the performance fuel, adjust guarantees in accordance with accepted engineering practice to determine compliance. Carbon loss shall be determined in accordance with ABMA Boiler 103.

3.2.5.9 Temporary Waste Steam Connection

When necessary to obtain sufficient load for these tests, provide a temporary steam line at a point outside the building. Provide necessary pipe, fittings, supports, anchors and appurtenances including a field fabricated silencer as directed by the Contracting Officer. Remove temporary piping and silencer after satisfactorily completing tests.

[3.2.5.10 Fire Safety for Oil-Fired Boilers

Conduct tests as necessary to determine compliance with the applicable UL Safety Standards. The presence of the applicable Underwriters' label may be accepted as evidence of compliance in this respect.

a. Oil-fired Boilers: Meet test requirements of UL 726.

b. Oil Burners: Meet test requirements of UL 296.

]3.2.5.11 Plant Acceptance Operation

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NOTE: Include bracketed portion if project is for coal fired installation with flue gas desulfurization system.

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After satisfactory completion of tests specified, operate the complete plant including each boiler[, its related flue gas cleaning equipment] and subsystems for a period of 30 continuous 24 hour operational days prior to final acceptance by the Government. Furnish labor, chemicals, test equipment and apparatus; the Government will furnish fuel, electricity and water. During this 30 day period, provide readily available, the services of qualified representatives from manufacturers of plant components and systems for the purpose of additional operational assistance, component and system adjustment and repairs. Government personnel will observe Contractor's operational procedures and will be asking pertinent questions, which the Contractor's representatives shall answer, about plant operation.

3.2.5.12 NAVFACENGCOM Acceptance

Operational, piping systems, auxiliary equipment and accessory tests shall be conducted prior to requesting an acceptance inspection by a Naval Facilities Engineering Systems Command (NAVFACENGCOM) Boiler Inspector. The Contracting Officer, upon receipt of 14 calendar days advance notice from the Contractor, shall request the boiler be inspected by a NAVFACENGCOM Boiler Inspector. The Contractor shall perform final operational performance testing of all plant systems in the presence of the NAVFACENGCOM Boiler Inspector, at the discretion of the NAVFACENGCOM

Boiler Inspector. The NAVFACENGCOM Boiler Inspector shall receive copies, and review the results, of all pertinent operational test reports before approving acceptance of the boiler plant by the Government.

3.2.6 Manufacturers Field Services

3.2.6.1 Erection/Installation Supervisors and Service Engineers

a. Boiler: Furnish the services of a competent supervisor who is in the direct employ of the boiler manufacturer. Supervisor shall remain on the construction site the full 8 hours per day, 5 days per week, or the same hours, that the boiler installation takes place. Supervisor shall be responsible for the complete steam generating unit, including steam generator, stoker,[burner,] fans and related work, such as refractory, or insulation regardless of whether stoker,[burner,] fans or other related items of work are furnished by manufacturers other than the boiler manufacturer.

b. Stoker: Furnish a competent erection supervisor for the equipment furnished by the stoker manufacturer.

c. Fans: Furnish a company service engineer to advise on the erection or installation of fans and related equipment.

d. Service Engineers: Services of the manufacturing companies' service engineers and the system suppliers' service engineers shall be provided by the Contractor to advise during erection and installation of other systems and equipment such as control system, coal handlings system, ash handling system, air compressors, air dryers, boiler feedwater pumps, fuel oil pumps, condensate pumps, water treatment equipment, chemical feed pumps, deaerating feedwater heater and stacks.

3.2.6.2 Boiler and System Representatives

a. Furnish factory trained engineers or technicians who are representatives of the boiler manufacturer and system suppliers to supervise testing of the boilers and auxiliary equipment.

b. Furnish the services of a Boiler Inspector who is qualified and certified as such by the National Board of Boiler and Pressure Vessel Inspectors and who is presently employed full time by an independent firm, such as Hartford Steam Boiler Inspection and Insurance Company, which has a business of inspecting boilers.

3.2.7 Instruction to Government Personnel

In accordance with the provisions of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, supervisors and service engineers shall provide instruction for the Government's operators in the operation and maintenance of the equipment furnished under this section. The minimum number of hours provided shall be as follows:

Equipment	Operation Instruction	Maintenance Instruction
Boiler and auxiliaries	40 hours	16 hours

Equipment	Operation Instruction	Maintenance Instruction
Stoker	40 hours	16 hours
FD and ID fans	16 hours	16 hours
Coal handling system	16 hours	32 hours
Ash handling system	24 hours	8 hours
Air compressors and dryers	8 hours	16 hours
Boiler feedwater pumps	8 hours	8 hours
Miscellaneous equipment	16 hours	16 hours

3.2.8 SCHEDULE

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

Products	Inch-Pound	Metric
Steam Gage	12 inch diameter	300 mm diameter
Boiler	4,000-18,000 #/hr capacity	1/2-2 1/4 kg/sec capacity
Electric Motor	10 hp	7 1/2 kW
Thermometer	5 inch Dial	125 mm Dial
Pressure Gage	6 inch Dial	180 mm Dial

-- End of Section --