Preparing Activity: USACE Superseding without Revision
UFGS-23 70 02.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION TABLE OF CONTENTS

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

SECTION 23 52 30.02 10

CENTRAL STEAM GENERATING SYSTEM - COMBINATION GAS AND OIL FIRED

05/20

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 SYSTEM DESCRIPTION
1.3.1 Design Analysis and Calculations
1.3.2 Electrical Environment
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Experience
1.5.2 Welding
1.5.3 Use of Asbestos Products
1.5.4 Detail Drawings
1.6 DELIVERY, STORAGE, AND HANDLING
1.7 PROJECT/SITE CONDITIONS
1.8 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Standard Products
2.1.2 Nameplates
2.1.3 Equipment Guards and Access
2.2 MATERIALS
2.2.1 Brick, Common
2.2.2 Bricks, Refractory
2.2.3 Bricks, Refractory, Insulating
2.2.4 Coal-Tar Primer and Enamel
2.2.5 Draft Gauge
2.2.6 Exhaust Head
2.2.7 Expansion Joint
2.2.8 Gauge, Pressure and Vacuum
2.2.9 Low Water Cutoff
2.2.10 Mortar, Refractory

2.2.11 Pipe and Fittings
2.2.11.1 Clay Pipe
2.2.11.2 Nipple
2.2.11.3 Pipe
2.2.11.4 Flanges
2.2.11.5 Flange Gasket
2.2.11.6 Flexible Connector
2.2.11.7 Union
2.2.12 Pipe Support
2.2.13 Pipe Threads
2.2.14 Steel Sheet
2.2.15 Strainer
2.2.15.1 Body
2.2.15.2 Screen
2.2.15.3 Y-Type Strainer
2.2.15.4 Tee Strainer
2.2.15.5 Basket Strainer, including Duplex Basket Strainer
2.2.16 Tape
2.2.16.1 Threaded Pipe Joint
2.2.16.2 Pipe Joint Coating
2.2.17 Tile, Load Bearing, Hollow
2.2.18 Traps, Steam and Air
2.2.19 Thermometer
2.2.20 Valve
2.2.20.1 Reference Standards
2.2.20.2 Check, Globe, Angle, and Gate
2.2.20.3 Back Pressure Relief
2.2.20.4 Blowoff and Quick Opening
2.2.20.5 Pressure Reducing
2.2.20.6 Plug
2.2.20.7 Safety Relief
2.2.20.8 Steam Nonreturn
2.2.20.9 Thermostatic Regulating
2.2.20.10 Ball
2.2.20.11 Feedwater Control
2.2.21 Water Column
2.2.22 Meters
2.2.22.1 Natural Gas Flow
2.2.22.2 Water Flow
2.2.22.3 Fuel Oil Flow
2.2.23 Natural Gas Pressure Regulator
2.2.24 Fractional and Integral Horsepower Motors
2.3 ELECTRICAL WORK
2.4 BOILER AND APPURTENANCES
2.4.1 Boiler
2.4.2 Performance
2.4.3 Construction
2.4.4 Identification
2.4.5 Watertube, Packaged Type Steam Boiler
2.4.5.1 Drum
2.4.5.2 Tubes
2.4.5.2.1 Furnace and Boiler
2.4.5.2.2 Furnace Waterwall
2.4.5.2.3 Convection Tubes
2.4.5.3 Baffles
2.4.5.4 Supports
2.4.5.5 Boiler Casing and Insulation
2.4.5.6 Access Door and Observation Port
2.4.5.7 Settling Chamber

2.4.5.8 Soot Blower
2.4.5.9 Economizer
2.4.6 Firetube, Package Type Steam Boiler
2.4.6.1 Heating Surface
2.4.6.2 Boiler Firetubes
2.4.6.3 Flue Gas Exhaust
2.4.6.4 Boiler Supports
2.4.6.5 Refractory
2.4.6.6 Boiler Insulation
2.4.7 Boiler Trim
2.4.8 Prevention of Rust
2.4.9 Factory Coating
2.5 FUEL BURNING EQUIPMENT
2.5.1 Pilot
2.5.2 Burner Refractory Throat
2.5.3 Windbox
2.5.4 Combustion Air Fan
2.5.5 Combustion Air Damper
2.5.6 Fuel Oil Burner
2.5.7 Natural Gas Burner
2.5.8 Flame Safeguard System
2.5.9 Boiler Piping Trains
2.5.9.1 Fuel Oil Train
2.5.9.2 Steam Atomizing Train
2.5.9.3 Air Atomizing Train
2.5.9.4 Natural Gas Trains
2.6 CONTROLS
2.6.1 Instrument System
2.6.2 Indicating Instruments
2.6.3 Factory Tests
2.6.4 Sequence of Operation
2.6.5 Enclosures
2.6.6 Controllers
2.6.7 Plant Master Controller
2.6.8 Boiler Master Controller
2.6.9 Feedwater Controller
2.6.10 Draft Controller
2.6.11 Oxygen Trim Controller
2.6.12 Alarm Annunciator
2.6.13 Opacity Monitor
2.6.14 Vertical Scale Indicators
2.6.15 Digital Indicators
2.6.16 Draft Gauge
2.6.17 Recorder
2.6.18 Totalizer
2.7 FIELD DEVICES
2.7.1 Oxygen Analyzer
2.7.2 Fuel Oil Flow Transmitter
2.7.3 Natural Gas Flow Transmitter
2.7.4 Steam Flow Meter-Transmitter
2.7.5 Temperature Transmitter
2.7.6 Electric Drive
2.7.7 Pressure Transmitter
2.7.8 Differential Pressure Water Level Transmitter
2.7.9 Pressure Switch
2.7.10 Temperature Switch
2.7.11 Oxygen Trim Drive
2.7.12 Supervisory Computer Workstation
2.7.12.1 Software

2.7.12.2 Software Capabilities
2.7.12.3 Graphics Screen Format
2.7.12.4 Graphic Display
2.7.12.5 Historical Trending
2.7.12.6 Totalization of Data
2.7.13 Centralized Monitoring System (CMS)
2.7.13.1 System Controller
2.7.13.2 Interface Requirements
2.7.13.3 Alarm Interface
2.7.14 Monitoring Requirements
2.7.14.1 Monitoring of Boilers
2.7.14.2 Variables to be Accessed from Boiler Control systems
2.7.14.3 Alarms to be Accessed from Boiler Control Systems
2.7.15 Balance of Plant (BOP) Variables
2.7.15.1 BOP Variables to be Monitored:
2.7.15.2 BOP Alarms
2.7.16 Uninterruptible Power Supply (UPS)
2.7.17 Monitoring and Communication Cables and Associated Raceways
2.7.18 Remote Communication Interface Modem
2.7.19 Instrument Power Supply
2.7.20 System Architecture
2.7.20.1 Inputs
2.7.20.2 Outputs
2.7.20.2.1 Analog Outputs (AO)
2.7.20.2.2 Digital Outputs (DO)
2.7.20.3 Program Storage
2.7.21 System Software
2.7.21.1 Trend Logging.
2.7.21.2 Alarm Reporting.
2.7.21.3 Alarm Lockout Routine.
2.7.22 Documentation
2.7.22.1 List of Hardware
2.7.22.2 Input and Output Point List.
2.7.22.3 Operating and Maintenance Manuals.
2.7.22.4 Equipment Installation Details.
2.7.22.5 System Interconnection Block Diagram.
2.7.22.6 Software Manual
2.7.23 Equipment Cabinet Factory Wiring
2.7.23.1 Termination
2.7.23.2 Nameplate for Device Inside Equipment Cabinets.
2.7.24 Continuous Emissions Monitoring
2.7.24.1 Gaseous Emissions Monitor
2.7.24.2 Flue Gas Flow Monitor
2.7.24.3 Particulate Matter Opacity Monitor
2.7.24.4 Wiring
2.8 BOILER FEEDWATER SYSTEM
2.8.1 Deaerators
2.8.1.1 Components
2.8.1.2 Deaerator, General Requirements
2.8.1.3 Deaerator, Atomizing Spray-Type
2.8.1.4 Deaerator, Tray-Type
2.8.1.5 Deaerator, Atomizing Spray Two-Tank Type
2.8.1.6 Chemical Feed Quill
2.8.2 Boiler Feed Pump
2.8.2.1 Design Conditions
2.8.2.2 Construction Materials
2.8.2.3 Cooling Water Piping
2.8.2.4 Bearings
2.8.2.5 Shaft Sealing System

2.8.2.6 Shaft Coupling
2.8.2.7 Special Tools
2.8.2.8 Pump Characteristics
2.8.2.9 Horizontal Pump Accessory Equipment
2.8.3 Deaerator Control
2.9 CONDENSATE RETURN SYSTEM
2.9.1 Condensate Surge Tank
2.9.1.1 Gauge Glass
2.9.1.2 Makeup Valve and Controller
2.9.1.3 Sparge Tube
2.9.2 Condensate Pump
2.9.2.1 Design Conditions
2.9.2.2 Construction and Materials
2.9.2.3 Casing and Casing Bowls
2.9.2.4 Impeller
2.9.2.5 Pump Shaft
2.9.2.6 Pump Construction
2.9.2.7 Pump Column
2.9.2.8 Miscellaneous Hardware
2.9.2.9 Shaft Sealing System
2.9.2.10 Pump Bearings
2.9.2.11 Shaft Coupling
2.9.2.12 Painting and Corrosion Protection
2.9.2.13 Special Tools
2.9.2.14 Bedplate
2.9.2.15 Alignment
2.9.2.16 Pump Characteristics
2.9.3 Sump Pump
2.9.3.1 Design Conditions
2.9.3.2 Construction
2.9.3.3 Backwater Valve
2.9.3.4 Float Switch
2.9.4 Pump Drive
2.9.4.1 Steam Turbine Drive
2.9.4.2 Electric Drive
2.9.5 Condensate Return System Control
2.10 BOILER BOTTOM BLOWDOWN TANK
2.11 BOILER SURFACE BLOWDOWN HEAT RECOVERY SYSTEM
2.11.1 General Requirements
2.11.2 Materials
2.11.3 Monitor-Controller
2.12 CHEMICAL FEED SYSTEM
2.12.1 Chemical Feed Pump and Tank
2.12.2 Agitator
2.12.3 Boiler Chemical Treatment System
2.12.4 Deaerator Condensate Return System Chemical Treatment System
2.12.5 Testing Equipment
2.13 WATER SOFTENING EQUIPMENT
2.14 MAINTENANCE EQUIPMENT
2.14.1 Tube Cleaner
2.14.2 Tube Brush
2.15 FACTORY COATING

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION, EXCEPT FUEL SYSTEM
3.2.1 Piping
3.2.2 Joints

3.2.2.1 Threaded Joints
3.2.2.2 Welded Joints
3.2.2.3 Expansion Joints
3.2.2.4 Flanges and Unions
3.2.3 Supports
3.2.3.1 General
3.2.3.2 Pipe Hangers, Inserts, and Supports
3.2.3.3 Piping in Trenches
3.2.4 Pipe Anchors
3.2.5 Pipe Sleeves
3.2.5.1 Pipes Passing Through Roof or Floor Waterproofing Membrane
3.2.5.2 Counterflashing
3.2.5.3 Sealing Uninsulated Pipes or Conduits
3.2.6 Escutcheons
3.2.7 Clay Sewer Pipe
3.2.8 Pipe Expansion
3.2.9 Valves
3.2.9.1 Back Pressure Relief
3.2.9.2 Steam Pressure Reducing
3.2.9.3 Thermostatic Regulating
3.2.10 Flow Meter
3.3 FUEL OIL SYSTEM INSTALLATION
3.3.1 Fuel Storage Tank Installation
3.3.2 Underground Ferrous Metallic Piping
3.4 FIELD PAINTING AND FINISHING
3.5 ELECTRICAL
3.5.1 General
3.5.2 Splice
3.5.3 Identification
3.5.4 Grounding of Drain Wire of Shielded Cable.
3.5.5 Analog Signal Cable Connections
3.5.6 Digital Input-Output
3.6 INSULATION
3.7 BOILERS AND AUXILIARY EQUIPMENT
3.7.1 Inspection
3.7.2 Preparation
3.7.3 Installation
3.7.3.1 Boiler
3.7.3.2 Protection
3.7.3.3 Adjusting, Inspecting, and Cleaning
3.7.3.4 Field Quality Control.
3.7.4 Gaseous Emissions Monitor
3.7.5 Flue Gas Flow Monitor
3.7.6 Testing
3.7.6.1 Factory Testing
3.7.6.2 Field Testing
3.7.6.3 Hydrostatic Test
3.7.6.4 Inner Casing Air Tests for Packaged Force Draft Boilers
3.7.6.5 Efficiency and Capacity Test
3.7.6.6 Control System Operational Testing
3.7.6.7 Boiler Room Panels and Instruments
3.7.6.8 Temporary Piping for Testing
3.7.6.9 Fuel Burning Equipment Testing
3.7.6.10 Deaerating Feedwater Heater Testing
3.7.6.11 Water Treatment Testing
3.7.6.12 Steam Quality Testing
3.7.6.13 Water Level Stability Testing
3.7.6.14 Testing of Piping Systems
3.7.7 Cleaning of Boiler and Piping

3.7.8 Boiler Water Conditioning
3.7.9 Fuel Oil Leak Test
3.8 MANUFACTURER'S SERVICES
3.9 FIELD TRAINING

-- End of Section Table of Contents --

Preparing Activity: USACE

Superseding without Revision
UFGS-23 70 02.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023

SECTION 23 52 30.02 10

CENTRAL STEAM GENERATING SYSTEM - COMBINATION GAS AND OIL FIRED
05/20

NOTE: This guide specification covers the requirements for steam generation plants based on operating pressure above 200 kPa 30 psig to a maximum of 1030 kPa 150 psig.

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

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

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

PART 1 GENERAL

NOTE: Sustainable design factors which should be considered during design of steam generating systems include, but are not limited to, the following: use of cleaner burning fuels (natural gas, low sulfur No. 2 oil); design for minimal air emissions; specification of boilers and ancillary equipment in the upper 25 percent of available efficiency for the capacity range used; proper insulation of piping, fittings, and other heated surfaces; returning condensate to the steam plant for reuse; blowdown heat recovery; appropriate use of water treatment systems and chemicals; use of electric rather than steam turbine motor drives; recycling of dismantled

or demolished material and equipment; and for new plants, building on a previously developed or "brownfield" site if possible. These factors are generally subject to life-cycle cost analysis.
****

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 PETROLEUM INSTITUTE (API)

API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 15LR	(2001; R 2018) Specification for Low Pressure Fiberglass Line Pipe

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2022) 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 IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 4	(2013) Fired Steam Generators
ASME PTC 12.3	(1997; R 2014) Performance Test Code on Deaerators
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes
ASME PTC 19.11	(2008; R 2013) Steam and Water Sampling, Conditioning, and Analysis in the Power Cycle
ASME PTC 25	(2014) Pressure Relief Devices

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case

AMERICAN WELDING SOCIETY (AWS)

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

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2019) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A269/A269M	(2022) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A278/A278M	(2001; R 2020) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A290/A290M	(2016; R 2021) Standard Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears
ASTM A395/A395M	(1999; R 2022) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	(1984; R 2019; E 2019) Standard

	Specification for Ductile Iron Castings
ASTM A582/A582M	(2022) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C34	(2017) Standard Specification for Structural Clay Loadbearing Wall Tile
ASTM C62	(2017) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D888	(2012; E 2013) Dissolved Oxygen in Water
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D5543	(2009) Standard Test Methods for Low-Level Dissolved Oxygen in Water
ASTM F1139	(1988; R 2019) Steam Traps and Drains

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

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

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide

http://www.approvalguide.com/

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 5.2	(1976; R1992) Binary Logic Diagrams for Process Operations
ISA 5.3	(1983) Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems
ISA 51.1	(1979; R1993) Process Instrumentation Terminology

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-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
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 31	(2020) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2021) National Fuel Gas Code
NFPA 70	(2023) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-232	(1997f; R 2012) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023) Structural Engineering

UNDERWRITERS LABORATORIES (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 567	(2021) UL Standard for Safety Emergency Breakaway Fittings, Swivel Connectors and Pipe-Connection Fittings for Petroleum Products and LP-Gas
UL 574	(2003; Reprint Sep 2019) UL Standard for Safety Electric Oil Heaters
UL 726	(1995; Reprint Oct 2013) Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

1.2 DEFINITIONS

The definitions of the terms relating to process control instrumentation technology are those given in ISA 51.1. Use logic symbols in accordance with ISA 5.2. Use graphic symbols for distributed control in accordance with ISA 5.3.

1.3 SYSTEM DESCRIPTION

1.3.1 Design Analysis and Calculations

Submit manufacturer's design data and structural computations,and design analyses and calculations for walls, roofs, foundations, and other features, for specialty type of construction, with design data for lateral forces that may be encountered due to wind loads and seismic forces. Mount instrumentation on equipment in accordance with paragraph Supports in PART 3.

1.3.2 Electrical Environment

Provide electrical and electronic equipment that operate satisfactorily, both independently and in conjunction with other equipment. The operation of electrical and electronic equipment must not be adversely affected by interference voltages and fields from external sources, and that equipment provided must not be a source of interference that might adversely affect the operation of other equipment. Ensure the basic design of equipment, components, and assemblies limits the effects of radio frequency interference and electromagnetic interference.

1.4 SUBMITTALS

****

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

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

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

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

****

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

SD-02 Shop Drawings

Detail Drawings; G[, [_____]]

Variable Spring Hangers

Pipe Anchors

Setting Plans

Graphics Screen Format

SD-03 Product Data

Materials

Safety Data Sheets

Design Analysis and Calculations.

Welding; G[, [_____]]

Water Treatment Plan

Cleaning of Boiler and Piping.

Testing of Piping Systems; G[, [_____]]

Spare Parts

Framed Instructions; G[, [_____]]

SD-06 Test Reports

Test Schedule

Proposed Test Procedure

Boiler Emissions Report

Adjusting, Inspecting, and Cleaning

Fuel oil analysis; G[, [_____]]

Startup Test Hardcopy Printout; G[, [_____]]

SD-07 Certificates

Environmental Permit Compliance; G[, [_____]]

Experience; G[, [_____]]

Factory Testing

Certificate of Compliance

Performance Test Report

Certificates of Inspection, Test, and Calibration

SD-10 Operation and Maintenance Data

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

1.5 QUALITY ASSURANCE

1.5.1 Experience

Submit evidence of the Contractor's prior experience in installing similar equipment, including a list of 5 combustion control installations on boilers of equal or larger size that have been in satisfactory operation for 2 years prior to bid opening; also, the location of the combustion

control installations.

1.5.2 Welding

****
NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement regarding welds and the welding submittal, and use the second bracketed sentence. Non return valves are only required on multiple boiler installations.
****

Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Furnish this information regarding welds, internal to packaged boilers, if requested by the Government.

a. Weld and stamp steam piping between the boiler [steam nozzle] [nonreturn valve] and the second stop valve in accordance with ASME BPVC SEC I. [Weld other piping in accordance with qualified procedures using performance qualified welders and welding operators. Use qualified procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1.

b. Notify the Contracting Officer 24 hours in advance of tests. The welder or welding operator must apply the personally assigned symbol near each weld made as a permanent record.

c. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING].

1.5.3 Use of Asbestos Products

Products that contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.

1.5.4 Detail Drawings

Submit detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of the steam-generating units and associated equipment, and for piping, wiring devices, trenches and related foundations. Detail drawings for steam generators and appurtenances, including the fuel system. Indicate clearances required for maintenance and operation and also contain complete wiring and schematic diagrams, equipment layout and anchorage, and other details required to demonstrate that the system has been coordinated and will function properly as a unit. Manufacturers' confidential information concerning manufacturing techniques and proprietary data such as detailed fabrication shop drawings are not required.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather,

excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.7 PROJECT/SITE CONDITIONS

Design instruments located in furnace rooms for 79 degrees C 175 degrees F ambient temperature operation. Design other instruments for 40 degrees C 104 degrees F ambient temperature operation.

1.8 EXTRA MATERIALS

Submit spare parts data for each item of equipment provided, after acceptance of the detail drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies, with current unit prices and sources of supply. Include special tools necessary for the operation and maintenance of boilers, burners, pumps, fans, and other equipment. Furnish small hand tools with a suitable hardwood cabinet mounted where directed. Provide special wrenches for opening boiler manholes, handholes, and cleanouts.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

For each major item of equipment, secure a plate with the manufacturer's name, address, type or style, model or serial number, and catalog number to the item of equipment.

2.1.3 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personal contact. Properly guard or cover high temperature equipment and piping exposed to contact by personnel or where they create a fire hazard with insulation of the type specified. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown and construct in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 MATERIALS

Submit outline drawings, data sheets, parts lists, schedules, performance charts, installation instructions, brochures, diagrams, and other information to illustrate equipment, wiring related components, and material. Ensure performance charts provide information necessary to determine compliance to the specified and indicated requirements and include minimum capacity for stable operation of the equipment. Submit manufacturer's installation recommendations for each item of

instrumentation. Provide product data including catalogs, and characteristic curves; and manufacturer recommended cleaning procedure, interior and exterior, for applicable items. Provide materials complying with the following:

2.2.1 Brick, Common

ASTM C62.

2.2.2 Bricks, Refractory

ASTM A653/A653M, class as recommended by the boiler manufacturer.

2.2.3 Bricks, Refractory, Insulating

ASTM C155.

2.2.4 Coal-Tar Primer and Enamel

AWWA C203.

2.2.5 Draft Gauge

ASME B40.100, Style 1. Mount draft gauges for the windbox, combustion chamber, and last boiler pass in the panel front. Field-verify operating range for the draft gauges with normal reading in the middle of the scale range. Ensure draft gauges include piping between the gauges and the boiler.

2.2.6 Exhaust Head

One piece construction of plate steel, semisteel, or cast iron equipped with suitable baffle arrangement and drain connection for the removal of entrained condensate and oil. Flow area through unit must be larger than connecting pipe.

2.2.7 Expansion Joint

EJMA Stds Book of Standards and ASME B31.1. Provide packless, leak proof, externally pressurized bellows type expansion joint. Include integral guide rings, full thickness cover designed to contain full system pressure, and self-draining convolutions. Provide expansion jointthat is insensitive to flow direction. Provide expansion joint with a drain connection for condensate removal. Provide expansion joint consisting of welded construction with ASTM A240/A240M T-304 stainless steel bellows, ASTM A106/A106M GR B cover and ASTM A106/A106M GR B standard wall pipe with flanged ends. For pumped condensate, use Schedule 80 pipe. Use expansion joint that is rated for 1.03 MPa 150 psig and 425 degrees C 800 degrees F and has maximum axial movement rating of 100 or 200 mm 4 or 8 inches with a rated cycle life of 1,000 for the full rated movement.

2.2.8 Gauge, Pressure and Vacuum

ASME B40.100, Type I, Class 1 or 2, as applicable, style as required, suitable for pressure or vacuum specified, with 150 mm 6 inch minimum diameter dial except as otherwise specified.

2.2.9 Low Water Cutoff

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

2.2.10 Mortar, Refractory

As recommended by the boiler manufacturer.

2.2.11 Pipe and Fittings

2.2.11.1 Clay Pipe

ASTM C700, Class 1, Type I, Style a.

2.2.11.2 Nipple

ASTM A733, standard or extra strong weight to match adjacent piping.

2.2.11.3 Pipe

As specified in TABLE I for service use and size. Provide underground fuel piping in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.2.11.4 Flanges

As specified in TABLE II for service use and size. Convoluted steel flanges conforming to ASME BPVC SEC VIII D1 may be provided in lieu of flanges conforming to ASME B16.5. Provide convoluted flanges consisting of cold-formed steel conforming to ASTM A516/A516M. Mate flanges with ASME B16.5, Class 150 flanges.

2.2.11.5 Flange Gasket

Provide gasket consisting of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, of self centering flat ring type. Provide gasket containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Use NBR binder for hydrocarbon service. Use metallic spiral wound nonasbestos gaskets for steam lines.

2.2.11.6 Flexible Connector

****

NOTE: Listed flexible connectors may be used when allowed by NFPA 30 and when approved by local codes as an alternative for swing joints.

****

Provide flexible metal hose, corrugated type with braided wire sheath covering, close pitch annular corrugations, rated for a working pressure of at least 1.03 MPa 150 psig, 300 mm 12 inch minimum live length, threaded end connections and conforming to requirements of UL 567. Ensure

metal for hose and braided wire sheath is stainless steel, any type of AISI series.

2.2.11.7 Union

ASME B16.39, limited to 690 kPa 100 psig, type to match adjacent piping. For higher pressure, use ground joint cast steel or forged steel union. Use unions with appropriate pressure and temperature ratings.

2.2.12 Pipe Support

MSS SP-58.

2.2.13 Pipe Threads

ASME B1.20.2MASME B1.20.1.

2.2.14 Steel Sheet

Carbon, zinc-coated (galvanized) by the hot-dip process: ASTM A653/A653M. Gauges specified are Manufacturer's Standard Gauge.

2.2.15 Strainer

Unless otherwise specified, provide strainer with screwed ends to 50 mm 2 inches, flanged for 65 mm 2-1/2 inches and larger.

2.2.15.1 Body

For systems up to 1.03 MPa 150 psi, Class 150 150 pound WSP class, cast steel; and for higher pressure, 2.06 MPa 300 psi, Class 300 300 pound use WSP class forged steel or cast steel.

2.2.15.2 Screen

****
NOTE: Specify screen size for the needs of the equipment.
****

Provide Type 304 stainless steel screen with free area no less than 2.5 times inlet area. For water system, ensure perforation is 6.4 mm 1/8 inch for strainer size up to 200 mm 8 inches, and 4 mm 5/32 inch for strainer 250 mm 10 inches and larger. For steam and condensate system, ensure perforation is 0.4 mm 1/64 inch for strainer size up to 50 mm 2 inches, 0.8 mm 1/32 inch for strainer 65 mm 2-1/2 inches through 100 mm 4 inches, and 1.2 mm 3/64 inch for strainers 125 mm 5 inches and larger. Provide reinforced wire gauge screen, with continuous magnetic field around entire circumference of screen and magnets with stainless steel retaining lugs and threaded rods.

2.2.15.3 Y-Type Strainer

Provide Y-type strainer as shown. Provide Y-type strainer that is full line size of connecting piping, with ends matching piping system materials. Provide Y-type strainers with a globe valve blowdown.

2.2.15.4 Tee Strainer

Provide tee strainer as shown. Provide tee strainer that is the full line size of the connecting piping with ends matching the piping system materials. Provide tee strainer with a swing bolt closure.

2.2.15.5 Basket Strainer, including Duplex Basket Strainer

Provide basket strainer as shown. Provide basket strainer with bolted covers to allow removal of the basket for cleaning. Provide duplex basket strainer including a multiport plug valve to allow the operator to switch active strainer baskets without interrupting system operation.

2.2.16 Tape

2.2.16.1 Threaded Pipe Joint

ASTM D3308.

2.2.16.2 Pipe Joint Coating

AWWA C203.

2.2.17 Tile, Load Bearing, Hollow

ASTM C34, Grade LPX.

2.2.18 Traps, Steam and Air

ASTM F1139.

2.2.19 Thermometer

Unless otherwise specified, provide dial type thermometer, 90 mm 3-1/2 inch diameter, chromium plated case for indoor use and stainless steel for outdoor use, remote or direct type bulb as required, with plus or minus 0.5 Degrees C 1 degree F accuracy and white face with black digits in 2 degree increments. Use well and temperature range for use encountered. Install thermometer so as to be easily read from the operating floor. Do not use Mercury in thermometers.

2.2.20 Valve

****

NOTE: Valves operating above 170 kPa/130 degrees C 25 psig/267 degrees F will be minimum Class 150. Pressure class will be suitable for intended service.

****

2.2.20.1 Reference Standards

ASTM A126 and ASTM A278/A278M as applicable.

2.2.20.2 Check, Globe, Angle, and Gate

a. Sizes 40 mm 1-1/2 inches and smaller that are operating at or below 170 kPa 25 psig and also operating at or below 130 degrees C 267 degrees F, saturation temperature at 170 kPa 25 psig must be bronze, MSS SP-80, Class 125 with threaded connections.

b. Sizes 40 mm 1-1/2 inches and smaller operating above either 170 kPa 25 psig or 130 degrees C 267 degrees F, saturation temperature at 170 kPa 25 psig, must be [forged] [cast] steel, stainless steel trim, rising stem, Class [_____] with handwheels. Ensure connections are [socket weld] [threaded] end connections.

c. Sizes 50 mm 2 inches and larger must be cast steel, stainless steel trim, rising stem, outside screw and yoke, Class 150 with handwheels. Provide either butt weld or flanged connections.

2.2.20.3 Back Pressure Relief

Provide ASME PTC 25 back pressure relief valve with stainless steel or cast steel body with valve internals and seats constructed of stainless steel. Provide positive closing back pressure relief valve with guides. Adjust the desired back pressure to cover a range between 14 and 70 kPa 2 and 10 psig. Effect the adjustment externally and provide any shafts extending through the valve body with adjustable stuffing boxes having renewable packing. Provide self contained, internal pilot piston operated back pressure relief valve. Provide an external positioner on each valve.

2.2.20.4 Blowoff and Quick Opening

Provide blowoff and quick opening valves as required in ASME BPVC SEC I. Provide balanced seatless type or double seated rotating disk type valve. Ensure quick opening valve is the straightway type. Design blowoff and quick opening valves for a working pressure of 2.06 MPa 300 psig and suitable for safe blowdown through the installed piping system.

2.2.20.5 Pressure Reducing

****

NOTE: Valves requiring tight shutoff for steam service will be ANSI Class IV. Where a thermostatically controlled valve is installed after and near the reducing valve in a manner to cut off the passage of steam, valves with ANSI Class IV shutoff will be used. Where valves are used for reducing pressure to the deaerating heater, valves will have ANSI Class IV shutoff.

Consider silencers in pressure reducing valve trains where acoustics to adjacent spaces or maximum noise level in mechanical room is an issue.

****

Design pressure reducing valve for a working pressure of no less than 1.03 MPa 150 psig, and ensure valve is quiet and nonsticking in operation. Provide spring loaded, internal pilot piston operated type pressure reducing valve with an external position indicator. Pressure reducing valve body 65 mm 2-1/2 inches and larger must be cast steel. Provide pressure reducing valve with raised face flanges to match the raised face flanges on connecting piping. Pressure reducing valve 38 mm 1-1/2 inches and smaller must be bronze with screwed connections. Ensure pressure reducing valve trim is stainless steel or monel metal. Parts subject to wear must be renewable. Provide pressure reducing valve with seat and plug faced with cobalt tungsten carbide mixture, or made of heat treated stainless steel or high chromium steel. Provide seat and plug facing with

a Brinell hardness of no less than 450. Design pressure reducing valve for dead-end service. Do not exceed a resulting noise level of [_____] dBA.

2.2.20.6 Plug

Provide tapered plug, lubricated type plug valve. Use lubricant that is suitable for the intended application. Provide cast steel body. Provide carbon steel plug. Pressure class must be minimum ANSI Class 150. Plug valve 38 mm1-1/2 inches and smaller must be screwed. Plug valve 50 mm 2 inches and larger must be flanged.

2.2.20.7 Safety Relief

Size and construct safety relief valve in compliance with requirements set forth in ASME BPVC SEC I. Provide safety relief valve with a manual lifting device for testing.

2.2.20.8 Steam Nonreturn

Provide either angle type or straight type steam nonreturn valve with rising stem as shown. Operate steam nonreturn without chattering, hammering, or sticking over the entire operating range of the boiler. Provide valve complying with ASME BPVC SEC I. Provide steam nonreturn valve with Class 300 ASTM A216/A216M cast steel body. Provide steam nonreturn consisting of bronze trim, rising stem, bolted bonnet, outside screw and yoke and flanged ends.

2.2.20.9 Thermostatic Regulating

Design thermostatic regulating valve for a steam working pressure of 1.03 MPa 150 psig. Provide adjustable thermostatic regulating valve with an operating range of approximately 54 to 88 degrees C 130 to 190 degrees F and maintain the desired fluid temperature within plus or minus 2.5 degrees C 5 degrees F. Provide [bronze] or [cast] [forged] steel or stainless steel body.

2.2.20.10 Ball

Provide Teflon seated and packed ball valve. Ball valve must provide bubble tight shutoff. Provide [bronze] or [cast] [forged] steel or stainless steel body. Ball valve must be two-piece full-port design.

2.2.20.11 Feedwater Control

Provide feedwater control valve with the boiler. Supply feedwater control valve with filter, regulator, supply and control pressure gauges, [metric] converter and positioner with charactering cam. Control system must provide 4 to 20 mAdc control signal.

2.2.21 Water Column

Construct water column valve in accordance with ASME BPVC SEC I, fit with gauge glass and quick-closing gauge valves with chains and handles for operation from the boiler room floor. [Provide mirror and illuminating light to allow water levels to be read from the boiler room floor] [Provide gauge glass with illuminating light].

2.2.22 Meters

2.2.22.1 Natural Gas Flow

****

NOTE: Ensure the turndown ratio (TDR) of the natural gas flow meter is wider than that of the boiler burner TDR firing on natural gas.

****

Provide positive displacement type natural gas flow meter with an aluminum body and a pressure correcting device that will correct flow readings to atmospheric pressure. Use a minimum meter design pressure of 690 kPa 100 psig. Ensure accuracy is plus or minus 1 percent of calibrated span minimum. Turndown must be [_____]. Provide threaded connections for sizes 38 mm 1-1/2 inches and smaller. Provide flanged connections for sizes 50 mm 2 inches and larger.

2.2.22.2 Water Flow

Provide disk type water flow meter with reinforced disk for hot water above 65 degrees C 150 degrees F, and rubber or carbon disk for cold water, and constructed of bronze composition and cast iron protected by noncorrosive coating. Ensure moving parts subject to wear are easily replaceable. Provide waterflow meters conforming to the requirements of AWWA C700.

2.2.22.3 Fuel Oil Flow

****

NOTE: Ensure the turndown ratio (TDR) of the oil flow meter is wider than that of the boiler burner TDR firing on fuel oil.

****

Provide nutating disc, positive displacement fuel oil flow meter with direct mechanical shaft drive from meter to register. Use construction materials consisting of cast iron housing, bronze internals, aluminum ball and web disc, and Type 316 stainless steel diaphragm. Provide totalizing register as specified. Use floe oil meter suitable for maximum oil temperature.

2.2.23 Natural Gas Pressure Regulator

Provide pilot operated type natural gas pressure regulator. Use nitrile diaphragms. Natural gas pressure regulator valve body must be steel. Use minimum pressure rating of 1.03 MPa 150 psig. Make vent connection in accordance with NFPA. Provide natural gas pressure regulator with an external position indicator.

2.2.24 Fractional and Integral Horsepower Motors

Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

2.3 ELECTRICAL WORK

Provide specified electric motor driven equipment complete with motor, motor starter, and controls. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ensure electrical characteristics are as specified or indicated. Provide motor

starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Use motor of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified.

2.4 BOILER AND APPURTENANCES

****

NOTE: Delete types of boilers that are not used. Select appropriate fuels and fill in pressure and temperature requirements. Select efficiency in the upper 25 percent of the competitive range. Specify efficiencies that correlate to the fuel(s) required. Select applicable burner type and combustion control system. To accommodate shipping limitations or installation access requirements in existing boiler plants,the boiler may be specified to be knocked down and field assembled.

****

2.4.1 Boiler

****

NOTE: Coordinate turndown ratio with subparagraph "Fuel Oil Burner" and subparagraph "Natural Gas Burner" in paragraph FUEL BURNING EQUIPMENT.

****

Provide boiler as complete boiler-burner package, including integral forced draft burner, boiler trim, refractory, controls, fuel train and accessory components. Provide boiler-burner package [fully assembled] [field assembled] ready for floor mounting and connection to steam, feedwater, electrical, [fuel oil], [natural gas], vent, chemical feed, blowdown and control lines in accordance with the Setting Plans. Submit complete setting plans certified by the boiler manufacturer and burner manufacturer. Provide boiler with the capacity indicated. Ensure equipment design and accessory installations permit accessibility for maintenance and service. Provide boiler complying with NFPA 85. Design boiler for working pressure of [_____] kPa psig and operating pressure of [_____] kPa psig. Each boiler must be capable of continuously producing [_____] kg pounds per hour saturated steam [_____] degrees C degrees F while being supplied with [_____] degrees C degrees F feedwater. Boiler operation must be stable at a turndown ratio of [_____]. Provide [natural gas] [fuel oil] [combination natural gas fuel oil] burners of type, size and so located and arranged such that the flame in no case impinges on any surface in the boiler nor extends beyond the limits of the furnace.

2.4.2 Performance

Provide boiler with the specified capacity at the operating pressure, feedwater temperature and boiler site elevation specified. Base capacity on the evaporation rate in kg pounds per hour at boiler specified outlet steam temperature and pressure while firing [No.[_____] fuel oil] [natural gas] [No. [_____] fuel oil or natural gas]. [Use fuel oil supply temperature and pressure of [_____] degrees C degrees F and [_____] kPa psig]. [Use natural gas supply pressure of [_____] kPa psig]. Boiler must be capable of continuous operation at full rated capacity. Ensure

minimum efficiency is no less than [_____] percent when fired continuously at full rated capacity with [natural gas] [fuel oil] [natural gas or fuel oil]. Maintain both stable firing and efficiency over the entire firing range required by the turndown ratio. Base output capacity of the boiler on tests of the boiler and burner as a unit. Moisture in the steam must not exceed 0.5 percent at maximum continuous rated boiler capacity and during a load swing of 10 percent of boiler capacity per minute with boiler water dissolved solids concentration at approximately 3,500 ppm and total alkalinity not in excess of 700 ppm.

2.4.3 Construction

Build and stamp boiler in accordance with ASME BPVC SEC I and as specified.

2.4.4 Identification

Stamp boiler as follows:

a. Maximum capacity in MW Btu/Hr.

b. Maximum allowable working pressure.

c. Radiant heating area.

d. Total heating surface area.

e. Furnace volume.

2.4.5 Watertube, Packaged Type Steam Boiler

Provide shop assembled type boiler with either 2 or 3 drums and water cooled furnace roof, floor, front, rear and side walls. Ensure the furnace side and rear walls are completely suitable for pressurized firing. Arrange boiler faces to give maximum cooling effect to furnace refractories. Furnace waterwall tubes must enter steam drum below the normal operating drum level. Provide tube inspection ports in furnace to boiler division wall, along both the steam and lower drums. Size furnace for complete combustion of fuel in the furnace with no flame impingement on the water-cooled surfaces and no combustion in the convection area. Do not exceed furnace heat release rate, based on fuel analysis and required fuel input, of [_____] gigajoules/hr per cubic meter Btu/hr per cubic foot of furnace volume. Ensure furnace heating surface is no less than [_____] square meters square feet on a flat protected area.

2.4.5.1 Drum

a. Extend drums beyond the entire length of furnace setting. Fabricate drum of steel plate, weld in accordance with ASME BPVC SEC I, including stress relieving and X-raying of welded seams. Provide steam drum with steam separators and drum internals required to maintain the specified steam moisture content, and provisions for maintenance. Provide necessary baffling to separate steam from water in the drum and to maintain stable water level under a fluctuating load. Ensure variations in normal water level do not exceed boiler manufacturer's recommendations as approved during the shop drawing submittal stage with an increasing load change of 10 percent of boiler capacity per minute. The steam drum diameter must not be less than the following:

1. 915 mm 36 inch (steam flow of 5,455 to 31,800 kg/hr 12,000 to 70,000 pounds/hr).

2. 1,070 mm 42 inch (steam flow of 31,800 to 45,450 kg/hr 70,000 to 100,000 pounds/hr).

3. 1,220 mm 48 inch (steam flow of 45,450 to 68,180 kg/hr 100,000 to 150,000 pounds/hr).

4. 1,370 mm 54 inch (steam flow of 68,180 to 81,800 kg/hr 150,000 to 180,000 pounds/hr).

b. Lower drum must not be less than 610 mm 24 inches in diameter.

c. Provide drum with two 300 by 400 mm 12 by 16 inch elliptical manholes with double clamps, studs and gaskets.

d. Provide boiler with connections as shown.

2.4.5.2 Tubes

2.4.5.2.1 Furnace and Boiler

Provide furnace and boiler tubes no less than 50 mm 2 inches in diameter and thickness conforming to that given in ASME BPVC SEC I for the pressure specified. Bend tubes to a true radius. Tubes that are distorted in bending, flattened or ridged are not acceptable. Drill, ream and serrate tube holes in the drum. Design tubes to permit drums and tubes to drain by gravity.

2.4.5.2.2 Furnace Waterwall

Provide furnace waterwall that extend the entire length of furnace setting and consists of 50 mm 2 inch tangential electric resistance welded steel tubes or welded furnace membrane wall. Expand tubes connected to the drums and/or lower headers into bored tube seats. If headers are provided, use lower headers of sidewalls that are round or square design. Provide lower header with gasketed handhole covers for easy access to each wall tube. Size tube bend radii for standard turbine type cleaners for easy pass through for cleaning of the full length of the tubes.

2.4.5.2.3 Convection Tubes

Provide convection tubes consisting of electric resistance welded construction in accordance with ASME BPVC SEC I. Arrange convection tubes to ensure proper and effective soot blowing. Expand convection tubes in the boiler section into the upper and lower drums.

2.4.5.3 Baffles

Arrange baffles to direct products of combustion into contact with heating surfaces without short circuit of flue gas at the outlet or excessive loss of draft. Provide baffles that are either a refractory material, tangent tubes or a metal suitable for the temperature encountered.

2.4.5.4 Supports

Support boiler and firing equipment from the foundation with structural steel independent of brickwork. Boiler supports must permit free

expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. For lifting and handling of the boiler, weld lifting lugs to the steam drum. Reinforce boiler skid and provide with space beneath the end of the beam for jacking the unit during installation. Provide holes in the main beam for use by a rigger to drag or lift the unit by its base frame for final positioning, if this method is recommended by boiler manufacturer.

2.4.5.5 Boiler Casing and Insulation

Encase boiler completely in a double casing and fill with blanket insulation. Construct casing of welded black steel sheets no lighter than 3.4 mm 10 gauge. Provide gastight casing and reinforce with structural steel to provide rigidity and prevent buckling. Provide refractory or insulation behind the waterwall tubes that is no less than 65 mm 2 1/2 inches thick. Provide insulation of sufficient thickness to ensure an average casing temperature in the furnace area not in excess of 60 degrees C 140 degrees F with a surface air velocity of 0.25 meters per second 50 fpm and an ambient air temperature of 38 degrees C 100 degrees F when operating at full capacity. Provide insulation material and installation as recommended by the boiler manufacturer. Insulate exposed portion of the boiler drum with mineral wool block and enclose in a welded 3.4 mm 10 gauge steel casing, field installed. Use factory installed refractory and insulation.

2.4.5.6 Access Door and Observation Port

Provide boiler with access doors in sufficient number, size and location for cleaning, inspection and repair. Ensure access door is gastight and interior surfaces exposed to direct radiation and high temperature are lined with approved refractory material to prevent excessive heat loss. Access doors that are large or weigh more than 23 kg 50 pounds must be hinged. In addition, provide at least two observation ports with cast iron covers, one on the front and one on the rear wall of the furnace, so that the entire inner surface of the furnace is visible from one or more ports.

2.4.5.7 Settling Chamber

****
NOTE: Specify for No. 4 and No. 6 fuel oil.
****

Provide settling chamber for the removal of fly ash below the last pass of the boiler with suitable means for frequent cleaning without shutting down the boiler.

2.4.5.8 Soot Blower

****
NOTE: Specify for No. 4 and No. 6 fuel oil.
****

Provide boiler with soot blower for convection bank cleaning. Provide steam operated soot blower, valve-in-head type and furnish complete with wall sleeve, clamps, hangers, supports, manual operating chains and other appurtenances required for a complete installation. Arrange blower elements so that all parts of the heating surfaces are cleaned of soot deposits when rotated by electric motor actuated by [automatic sequence

from boiler control panel] [manual switch from boiler control panel]. Use soot blower elements of such length, diameter and total nozzle area such that for the operating pressure involved there will be no significant difference in the cleaning effect between the nozzle nearest the inlet and those farthest from the inlet of the element. Make soot blower of a material that will satisfactorily withstand the temperature in the zone where it is installed.

2.4.5.9 Economizer

a. Furnish boiler with a rectangular, package extended surface economizer. Provide shop assembled economizer and ship complete with structural steel frame, inner casing, shop applied insulation and [_____] mm gauge box ribbed metal lagging. Design and fabricate economizer in accordance with ASME BPVC SEC I. Flue gas flow through economizer must be vertical with orientation of economizer as shown.

b. Provide economizer of continuous tube, loop tube design and completely drainable by gravity after installation. Design and arrange economizer such that there will be no steaming in the economizer under any load or operating condition. Ensure minimum design temperature of the economizer is 370 degrees C 700 degrees F. Hydrostatically factory test economizer at 1.5 times the tube side design pressure or at least 2.07 MPa 300 psi in the presence of a Code Inspector. Provide ASME code stamped unit including nameplate and code documentation.

c. Extended surface must be of solid continuous, resistance welded carbon steel fins. Use maximum fin spacing of [_____] fins per meter foot. Fins must be no less than 1.9 mm 0.075 inches thick.

d. Provide SA-106-B headers with minimum Schedule 40 wall thickness and equip with minimum ANSI Class [_____] raised face weld neck flanged connections. Use header wall thickness and flange rating which is dependent on tube side design pressure in accordance with ASME BPVC SEC I requirements. Tube arrangement must be of the open lattice design. Drilled tube sheets are not acceptable.

e. Hot structure design must be gastight and designed for a minimum of 250 mm 10 inches wc gas side pressure.

f. Ensure pressure parts are not in contact with tube sheets.

g. Provide inner casing that is a minimum of 3.4 mm 10 gauge carbon steel.

h. Design the economizer for the maximum operating conditions of the boiler and capable of reducing boiler stack exit flue gas temperature to 148 degrees C 300 degrees F when the boiler is being fired with natural gas or oil and being supplied with feedwater at [107] [_____]degrees C [225] [_____] degrees F at all boiler loads.

i. The boiler feedwater head loss through the economizer must not exceed 103 Pa 15 psi at maximum boiler load.

j. Insulate economizer with a minimum 50 mm 2 inch thick blanket type mineral wool or approved equal.

k. Provide weatherproofouter casing with a minimum 7.5 mm 22 gauge corrugated galvanized carbon steel lagging. Paint exposed surfaces

not enclosed by outer casing with high temperature aluminum paint.

l. Provide minimum 19 mm 3/4 inch vent and drain connections on feedwater headers.

m. Provide economizer with electrically operated soot blowers. Use quantity of soot blowers as recommended by the manufacturer. Install soot blowers transversely to provide maximum cleaning capabilities.

n. Provide access door of carbon steel construction in the economizer design. Insulate access door.

o. Design the economizer to accept piping reactions without distortion or creating overstressed conditions in the piping.

2.4.6 Firetube, Package Type Steam Boiler

Construct and stamp boiler pressure vessel in accordance with the rules of Section 1 of the ASME BPVC SEC I. Excute ASME manufacturer's data reports by the manufacturer and an authorized inspector who holds a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors prior to shipment. Furnish ASME manufacturer's data to the Contracting Officer, the inspection agency and the state and local authorities at the place of installation. Stamp pressure vessel for 1030 kPa 150 psig design pressure.

2.4.6.1 Heating Surface

Provide boiler furnace tube with its centerline below the boiler centerline for maximum water coverage. Provide boiler with a minimum of 0.465 square meters 5 square feet of fireside heating surface per rated BHP. Provide furnace large enough for complete combustion of fuel at maximum capacity without flame impingement. Ensure heating surface is fully accessible for inspection and cleaning without disturbing the burner equipment. Locate observation and sight ports at each end of the boiler to allow inspection of flame conditions. Provide a rear access opening with observation port. Provide handholes and manholes in accordance with ASME BPVC SEC I.

2.4.6.2 Boiler Firetubes

Provide boiler firetubes which are no less than 50 mm 2 inches in diameter, seamless steel tubing expanded to the tube sheets. Welded welded firetubes are not acceptable.

2.4.6.3 Flue Gas Exhaust

Locate flue gas exhaust connection and stack thermometer on the top centerline. Furnish boiler flue outlet with a manual cast iron locking damper.

2.4.6.4 Boiler Supports

Support boiler and firing equipment from the foundation. Provide boiler supports consisting of heavy duty structural steel base with lifting lugs and rigging holes in the skid to facilitate installation. Locate two or more lifting lugs on top of pressure vessel.

2.4.6.5 Refractory

Provide either hinged or davited front boiler door, as required, to provide access to firetubes without disconnecting the burner or fuel train. Configure front boiler door such that front tube sheets are fully accessible for inspection and cleaning when open. Rear door must be davited. "Dry back" boilers having rear door refractory are not acceptable. Seal doors with ceramic fiber rope gaskets and fasten securely using lugs and nuts threaded onto studs welded into the vessel. Insulate rear door with blanket insulation with a steel covering. Contain front door refractory and insulation in the formed door which must swing open for inspection of brick work. Submit Safety Data Sheets detailing refractory materials contained within the boiler.

2.4.6.6 Boiler Insulation

Provide boiler insulation consisting of minimum 50 mm 2 inch fiberglass blanket covering entire circumference of pressure vessel and protect by preformed sheet metal lagging. Cover insulation with minimum 0.8 mm 22 gauge preformed sheet metal and factory paint before shipment using a hard finish enamel coating.

2.4.7 Boiler Trim

Provide boiler complete with the following trim:

a. Water column consisting of gauge glass set, gauge glass and water column blowdown valve.

b. Low water cutoff, as an integral part of the boiler feedwater control. Cutoff must be factory wired into the burner control circuit to prevent burner operation if the boiler water level falls below the safe operating level.

c. Mount an auxiliary low water cutoff below the primary unit, wire in series with the primary unit, and provide with a manual reset device.

d. Provide steam pressure gauge, range to suit operating pressure, on the boiler front, including siphon, cock and test connection.

e. Steam safety valve of type and size to comply with ASME Code requirements.

f. Two bottom blowdown connections, one at the bottom front and one at the bottom rear of the vessel.

g. A minimum of [_____] surface blowdown connection[s].

2.4.8 Prevention of Rust

Unless otherwise specified, factory prime paint surfaces of ferrous metal subject to corrosion with a rust-inhibiting coating and subsequently factory finish paint in accordance with the manufacturer's standard practice. Prime and finish paint equipment exposed to high temperature when in service with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil. Do not paint internal surfaces of tubes and piping that will not be in storage more than three months prior to being placed in service, but coat with a water soluble pipe oil for rust protection. Do not coat surfaces which will be exposed directly to

the flue gases (fireside furnace surfaces, OD surface of convection pass surfaces, inside of flues and ducts) with a high temperature heat resistant paint, but protect with a suitable coat of the manufacturer's standard primer. Paint surfaces that will be covered by insulation and lagging with a high temperature heat resistant paint.

2.4.9 Factory Coating

Factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish unless otherwise specified.

2.5 FUEL BURNING EQUIPMENT

****

NOTE: Determine the boiler emissions NO_x requirements. Boiler emissions must comply with local environmental permits. State regulations may be more stringent than Federal Regulations. Delete flue gas recirculation (FGR) if not required.

****

Provide fuel burning equipment complete with flame safeguard system, forced draft low NO_x burner, combustion air windbox, piping, fuel trains and instrumentation supplied as a factory assembled and mounted package on the boiler front. Provide packaged burner capable of firing the boiler at a continuous rating as scheduled, using [natural gas at 69 Pa 10 psi] [No. [2] [4] [6] fuel oil] as an [integral] [combination] unit[.] [suitable for firing either fuel separately, designed to permit a quick changeover without modification of equipment]. Incorporate provisions for withdrawing, shielding or otherwise preventing the oil burner from cooking while firing gas. Apply emissions guarantees through specified turndown range. Utilize flue gas recirculation to lower emissions, but limit to 15 percent and induce by the combustion air fan. Provide burner with a stable flame over the turndown range. Ensure primary air spinner zone, zone divider and main burner are removable without removing the entire register or windbox. Provide register front plate with a swivel scanner and observation port. Submit an Environmental Permit Compliance certificate regarding the boiler emissions.

2.5.1 Pilot

****

NOTE: Select one type of pilot (natural gas, liquified petroleum gas or fuel oil) and remove the others.

****

a. Provide natural gas-electric type pilot burner with the capacity required to reliably light off the boiler. Supply a 6,000 volt secondary side ignition transformer and mount backside of the windbox.

b. Provide liquefied petroleum gas (LPG) type pilot. Locate two 18 kg 40 lb cylinders on concrete pads outside of the building as shown. Include manifold and valves for cylinders to allow removal and filling of one tank without interrupting service to pilot. Provide regulators and gauges with adequate capacity to serve pilot.

c. Provide straight mechanical or atomizing type pilot as specified for the burner. Design pilot system to fire No. 2 oil and provide

complete with fuel oil pump, safety shut-off valve, integral metallic screen strainers and a cartridge type filter. Provide ignition transformer rated at no less than 10,000 volts on the secondary side.

d. Make provision in the burner housing for inspection of the pilot flame.

e. Provide pilot with individual manual shut-off valve, pressure gauge, pressure regulation separate from the main burner, self closing solenoid valve and vent valve in accordance with FM APP GUIDE and UL 795. Provide pilot and valving in accordance with NFPA 85.

2.5.2 Burner Refractory Throat

Make burner refractory throat of high quality castable refractory suitable for 1650 degrees C 3000 degrees F. Ship the precast refractory in a steel retaining ring with stainless steel anchors separately for field mounting on the boiler. Burner refractory throat must be concentric with the burner, contoured to ensure complete mixing of [air and natural gas] [air and oil] [air and natural gas and air and oil], and designed to assist in complete combustion by radiating heat to the fuel. Position burner so that the flame parallels the contour of the burner refractory throat but avoids striking the refractory.

2.5.3 Windbox

****

NOTE: Intent is to provide capability for flue gas recirculation (FGR) on all boilers specified, either for present use or future installation.

****

Windbox must provide even airflow. Windbox must not interfere with boiler smoke box door operation and have a flange bottom for easy firm mounting on a support structure. Provide windbox with an induced flue gas recirculation (FGR) inlet adaptor assembly.

2.5.4 Combustion Air Fan

Use centrifugal type combustion air fan with backwardly inclined air foil bladed wheel. Provide combustion air-fan wheel which is directly driven by a TEFC NEMA frame motor and complete with inlet cone and screen and flange outlet. Mount bottom flanged combustion air fan on same structural member as windbox. Size combustion air-fan to provide sufficient static pressure to overcome system losses when providing 15 percent excess air at maximum firing rate, plus the amount of flue gas induced to comply with the NO_x emission requirements.

2.5.5 Combustion Air Damper

Provide flanged combustion air damper and locate between combustion air fan and windbox. Provide combustion air damper suitable for specified turndown and provide same turndown performance when up to 15 percent flue gas is induced and mixed in the airstream.

2.5.6 Fuel Oil Burner

Provide [mechanical pressure atomizing] [steam atomizing][air atomizing] type fuel oil burner conforming to UL 296, UL 726 and NFPA 85, capable of burning [heated] [unheated] [No. 6] [No. 4] [No. 2] fuel oil. Ensure fuel

oil burner is capable of firing boiler to maximum capacity with turndown range of [eight (8) to one (1) for boiler above 2452 kW 250 horsepower] [four (4) to one (1) for boiler 2452 kW 250 horsepower or less]. Provide fuel oil burner that is quiet in operation without blowtorch effect or tendency to localize heat at any one part of combustion chamber and without depositing unburned oil on any part of combustion chamber or boiler. Ensure fuel oil burner is easily moved out of firing position for cleaning, inspection, adjustment and maintenance.

2.5.7 Natural Gas Burner

Natural gas burner must be a multi-spud burner with gas feed pipe in center of air register for easy removal. Provide forced draft type natural gas burner suitable for efficiently burning natural gas having a calorific value of [_____] Joules per cubic meter Btu per cubic foot when supplied at a pressure of approximately [_____] kPa psig. Discharge natural gas in burner throat area. Natural gas-air premix or natural gas discharged outside of burner throat are not acceptable. Main natural gas burner must be capable of firing the boiler to maximum capacity with a turndown of [ten (10) to one (1) for boilers above 2452 kW 250 horsepower] [four (4) to one (1) for boilers 2452 kW 250 horsepower or less].

2.5.8 Flame Safeguard System

****
NOTE: Edit for fuel choice and select appropriate options.
****

a. Provide flame safeguard system that is manufactured by burner manufacturer and mount in boiler control panel as a panel insert. Provide UL listed flame safeguard system components. Provide complete and automatic flame safeguard system in accordance with NFPA requirements safe start-up, on-line operation and shut-down of package burner.

b. Provide micro-processor based flame safequard system including, but not limited to, automatic burner sequencing, flame supervision, status indication, fire-out annunciation and self diagnostics.

c. House overcurrent protective devices, and motor starters for the combustion air fan motor, burner damper motor and electric oil heater. Also include control transformers and an RS-232C serial communication port.

d. Flame scanner must not require a separate purge air supply. Connect flame scanner output signal to flame amplifier module in microprocessor based unit. Within four seconds after loss of flame, flame safeguard controller must shut the automatic safety shut-off fuel valve[s] [and open the gas automatic vent valve]. Display flame failure signal on flame safeguard display or burner control panel.

e. Provide logic with flame safeguard system to:

(1) Prevent introduction of igniter flame (pilot) or main fuel flame to furnace until furnace, boiler passes, breeching and stack have been purged of combustible gases.

(2) Prevent opening of automatic fuel shut-off valves in main fuel

line until igniter flame is proven.

(3) Limit trial for main fuel ignition to ten (10) seconds from time igniter flame is proven.

(4) In event of burner failure, require operator intervention to manually reset flame safeguard controller prior to restart.

f. Provide first-out annunciation by an expansion module. Annunciate alarms and flame-outs individually at panel front and transmit along with other process points monitored by the panel to [Central Monitoring System (CMS)] [Supervisory Computer Workstation[s]] for graphic display. At a minimum, annunciate the following points individually by flame safeguard system:

(1) Low water level.

(2) Low water cutoff.

(3) High water level.

(4) High steam pressure.

(5) Low atomizing [steam pressure] [or] [air pressure].

(6) Low fuel oil pressure.

(7) Low fuel oil temperature.

(8) High natural gas pressure.

(9) Low oxygen concentration.

g. Provide flame safeguard system cabinet with [natural gas] [No. 6] [No. 4] [and] [No. 2] oil fuel selector. Integrate selector into controls such that when No. 2 oil is selected, low oil temperature switch [and electric heater] [is] [are] taken off line from oil train.

h. Also provide indicating lights for the following:

(1) Limits satisfied.

(2) Purging.

(3) Pilot ON.

(4) Main flame ON.

(5) Flame failure.

(6) Fuel oil ON.

(7) Natural gas ON.

i. Provide industrial, oil-tight construction indicating pilot lights with push-to-test feature or "All-Pilot Lights" test button.

2.5.9 Boiler Piping Trains

****

NOTE: Delete oil heater, oil temperature switches and oil temperature gauge for plants which will not burn oil heavier than No. 2 fuel oil now or in the near future. When heavy oil is burned, steam is typically used to heat it nearly to burning temperature and electric heat is used for trimming (approx. 11 to 17 degrees C 20 to 30 degrees F). However, full capacity electric oil heating (approx. 56 degrees C 100 degrees F rise) or other independent heat source is needed to cold-start the plant. Cold start capability should be provided for at least two boilers for multiple boiler plants. If the plant is operable on emergency power, consideration should be given to supplying the full capacity electric oil heaters from the emergency source.

****

Provide completely prepiped piping train, wire and mount on boiler. Provide [fuel oil and [steam] [air] atomizing systems] [and] [natural gas] train in accordance with NFPA and FM standards and requirements and including, but not limited, to the following items:

2.5.9.1 Fuel Oil Train

a. NFPA 31.

b. Adjustable fuel oil pressure regulating and relief device.

c. Fuel oil flow control valve with characterizing adjustments to match airflow.

d. Dual (NC) motorized oil shut-off valve with proof of closure.

e. Low fuel oil pressure switch.

f. Fuel oil flow transmitter.

g. Fuel oil pressure gauge for fuel oil supply and burner pressure.

h. Manual shut-off valves at connections to supply and return headers.

i. "Y" type strainer.

j. Fuel oil check valve.

k. High fuel oil temperature switch.

l. Low fuel oil temperature switch.

m. Fuel oil temperature gauge.

n. Electric fuel oil preheater capable of raising oil temperature 56 degrees C 100 degrees F at rated firing rate and comply with UL 574.

2.5.9.2 Steam Atomizing Train

a. Manual shut-off valve at connection to atomizing supply.

b. Y-type strainer in atomizing steam line.

c. Automatic shut-off solenoid and check valve in atomizing steam branch line to allow automatic purging of burner.

d. Check valve to prevent backflow in steam line.

e. Pressure gauge with isolating valve for servicing in atomizing steam supply and at burner.

f. Solenoid shut-off valve to close when burner shuts down.

g. One self-contained pressure regulating valve to maintain atomizing steam pressure.

h. Low atomization steam pressure switch.

i. Steam trap.

2.5.9.3 Air Atomizing Train

a. Manual shutoff valve at connection to atomizing supply.

b. Y-Type strainer in atomizing air line.

c. Automatic shutoff solenoid and check valve in atomizing air line to allow automatic purging of burner.

d. Check valve to prevent backflow in air line.

e. Pressure gauge with isolation valve for servicing in atomizing air supply and at burner.

f. Solenoid shutoff valve to close when the burner shuts off.

g. One self-contained pressure regulating valve to maintain atomizing air pressure.

h. Low atomization air pressure switch.

2.5.9.4 Natural Gas Trains

a. NFPA 54.

b. Natural gas flow control valve with characterizing adjustments to match airflow.

c. Manual shut-off valve (NO) at supply and discharge of vent and drain valves.

d. Manual shut-off valve (NO) at igniter natural gas supply and discharge of vent and drain valve.

e. Y-type strainer supplied in igniter natural gas and main natural gas lines.

f. Two (NC) solenoid safety shut-off valves, in series, in igniter line with one (NO) solenoid vent valve located between safety shut-off valves, piped to atmosphere through the roof.

g. Two shut-off valves with proof of closure, piped in series in main gas line with one (NO) solenoid vent valve located between safety shut-off valves, piped to atmosphere through the roof.

h. One pressure regulating valve in igniter natural gas line to regulate natural gas pressure to igniter.

i. One pressure regulating valve to regulate main natural gas pressure at natural gas train inlet.

j. Natural gas meter.

k. Natural gas flow transmitter for main natural gas to burner.

l. Pressure gauge, with shut-off valve for main natural gas supply.

m. Pressure gauge, with shut-off valve for main natural gas at burner.

n. Pressure gauge, with shut-off valve for natural gas supply to igniter.

o. Pressure gauge, with shut-off valve for natural gas igniter.

p. Low natural gas pressure switch.

p. High natural gas pressure switch.

2.6 CONTROLS

****

NOTE: This paragraph specifies several levels of available control systems. Bracketed text or section denotes designer's options. The base level of required controls is an integrated system of local control and monitoring panels. An upgrade to this system would include a remote supervisory workstation to monitor and alarm functions of the boiler plant via a network controller LAN.

****

a. Provide boiler controller and plant master controller systems, and other sub-control systems specified herein by a single control manufacturer.

b. For multiple boiler installation, boiler No. 1 control panel must act as the plant master control and contain controls common to all boilers. Provide interfaces between flame safeguard, combustion control and burners.

c. Provide electronic, solid state, microprocessor type system components. Operate control components on 120 VAC power.

d. Provide 4-20 mA DC analog signals to and from field-mounted devices. Provide [4-20 mA] [1-5V] DC analog signals between rack or panel-mounted devices.

2.6.1 Instrument System

Power instrument systems by 120 volts alternating current, 60 Hertz or 24 volts direct current 2-wire system. The 24 volts direct current powered systems must receive power from the central control system. Provide instrument enclosures conforming to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Transmitter output signals must be 4 to 20 mADC.

2.6.2 Indicating Instruments

Provide indicating instruments that have the normal operating point marked in green on instrument. Provide transmitters which include output meters in integrally mounted housings. Ensure calibration is set by manufacturer, and adjustment access is internal only.

2.6.3 Factory Tests

Inspect, calibrate, and test instruments, units, and other accessories. Calibrate to manufacturer's standard for accuracy of input versus output. Submit Certificates of inspection, test, and calibration tags of instrumentation to be used during boiler acceptance test ensuring compliance with standards; certificate of compliance with applicable codes after boiler installation and one certificate for each boiler. Control system manufacturer must configure, program, stage, and burn-in the control system prior to shipment to construction site. Perform programming of configuration and constants data at this time, and store on disks. Perform burn-in for a minimum of 10 days of continuous operation. The Government reserves right to witness factory tests. Give a thirty-day advance notice to the Government prior to commencing any factory tests.

2.6.4 Sequence of Operation

a. Using plant master controller vary firing rate of [all] boiler[s] [in parallel]. Plant master controller must receive a pressure signal from main steam header and generate a signal to drive boiler master controller[s].

b. Boiler master controller must increase or decrease firing rate based on comparison to setpoint.

c. Provide steam pressure control including proportional plus reset control modes.

d. Integrate combustion controls fully with flame safeguard system to assure low-fire startup and complete purge regardless of boiler master output signal.

e. Ensure combustion control strategy is single point positioning with oxygen trim.

f. Control boiler firing rate by actuating burner jackshaft drive motor to move jackshaft that mechanically links fuel and combustion airflow.

g. Accomplish boiler oxygen trim by modulating combustion air damper to alter fuel-air ratio based on input from oxygen analyzer.

h. Ensure control loops include manual-automatic stations to provide for control of system. Provide each manual-automatic station with a built

in indicator to graphically depict variable being controlled.

i. Arrange control system so that failure of control system for one boiler does not affect automatic and manual operation of other boilers. Electrically isolate common electrical signals in each boiler section.

2.6.5 Enclosures

a. Provide free-standing or boiler-mounted factory-assembled steel enclosure with indicators, control switches, flame safeguard cabinet and indicating lights on cabinet front and relays and other components mounted on interior subbases for each boiler. For multiple boiler installations, the boiler No. 1 panel must contain controls common to all boilers. Provide enclosure with locking doors and complying with NEMA ICS 6.

b. Provide NEMA 12, 11 gage steel enclosure, consisting of all welded construction with minimum radius corners, stiffened as required and framed with angles. Construct door of 14 gage steel with key-locking vault handle and three (3)point latches. Ensure doors are fully gasketed.

c. Clean, phosphatize, prime and finish metal surfaces. Interior must be glass white enamel. Exterior must be gray texture polyurethane enamel to provide resistance to fuel oil, solvents and abrasion. Provide engraved plastic laminated nameplates for devices on the front of the cabinet except where devices themselves are provided with a service engraving. Provide nameplates with white letters on a black background and minimum height of 6.5 mm 0.25 inch, mount with screws or epoxy or secure by pilot light or switch. List equipment title and identification number. Abbreviations are not acceptable.

d. Support enclosure mounted devices properly, front and rear and must occupy the upper portion of the enclosure front.

e. Provide enclosure wiring in compliance with acceptable standard panel practice.

f. The 120 volt, 60 Hz circuit wiring must be number 16 AWG minimum, THWN 600 volt insulation, color coded. Signal circuits, less than 50 volts, must be number 18 AWG minimum or number 20 AWG in multi-conductor cable.

g. Wire devices requiring power so that when wires are removed from one device, power will not be interrupted to other devices. Wire enclosure-mounted devices to numbered lug and screw terminals so that field wiring can easily be terminated in the panel.

h. Supply signal common and power common buses. Connect signal common to earth ground at one point.

2.6.6 Controllers

****

NOTE: Single loop controllers are specified. Consider programmable logic controllers (PLCs) as an option.

****

a. Provide microprocessor-based controller of single loop design. Flush-mount controller with splash-proof mylar faces in control cabinet. Provide membrane type operator pushbuttons with tactile feedback. Provide a 4-1/2 digit numeric display on front of controller.

b. Provide two bar graphs on the front of controller to give an analog interpretation of process variables, setpoints or deviation. Ensure these are of the 100 segment LED type. Provide a dedicated 20 segment LED bar graph for the controller main output.

c. Provide each controller that drives a final control device (damper, valve or other) with a hard manual backup station to ensure operator control in the event of a memory failure or service requirement.

d. Provide controller output logic including proportional, plus integral, plus derivative (PID) modes.

e. Multiple loops on single controller are not acceptable. During integral hard manual backup mode, ensure operator has control of output via up-down pushbutton and output indication.

f. Should the controller or memory fail, controller must deenergize a dead-man relay and alert operator to use backup station.

g. Backup station may be separate station or may be integral to main controller. If Integral, backup circuitry must function when controller is removed for servicing.

h. Provide controller capable of being configured in field without use of external computers, hand-held terminals, EPROM programmers or other devices.

i. Accomplish configuration changes and tuning adjustments y means of key pad on controller front. Protect controller digital circuitry from power surges and spikes by optical isolation or by uninterruptible power supply.

j. Maintain configuration in (2) removable battery backed RAM chips. Failure in primary memory must cause backup memory to be downloaded automatically.

k. Equipment Controller Self-Tuning PID Loop Routine

(1) Self-Tuning PID Loops: Three methods of tuning PID Loops must be available: Manual, Automatic, and Adaptive. Provide tuning utility allowing collection of data and process tuning in real time.

(2) The tuning utility must display following information on display upon operator request: Control loop being tuned, Input process variable, Output control variable, setpoint of loop, Integral reset interval, and Proportional band, Derivative rate interval.

(3) Display above information on supervisory workstation in graphic format with automatic scaling such that the input and output variable are superimposed on a graph of time versus variable. Ensure program allows operator to affect output variable by

modifying setpoint, and tuning parameters, and view results on display.

(4) Automatic Tuning: Provide controller with on-line or manual utility to disturb process. Monitor the results and calculate new parameters for sample interval, Proportional band, Integral gain, and Derivative gain. Ensure utility is usable during commissioning process to establish reasonable values, then turned off.

(5) Adaptive Tuning: Provide controller with on-line utility which may run continuously.

(6) Initiate adaptive tuning automatically whenever operator-defined change in the process input variable is detected. Utility must monitor process (control loop) after natural disturbance, and automatically recalculate Proportional gain, Integral gain, and Derivative gain. Use this utility to keep a system tuned, as the equipment ages and occupancy and loads change, after commissioning.

l. The tuning utility must display following information on the CRT upon operator request:

(1) Adaptive control is enabled or disabled.

(2) Maximum bump: output step change required to produce a change in input, greater than noise level, but not so great as to damage equipment.

(3) Setting time: time it takes PID output process variable to settle down after a process disturbance. For automatic tuning, time interval between setting PID output to control point and beginning of tuning cycle. For adaptive tuning, minimum time that will be observed between parameter calculations.

(4) Maximum overshoot: percent allowed.

(5) Target damping: desired reduction in process variable overshoot from first overshoot (maximum overshoot) to second, in percent.

(6) Noise band: minimum process variable perturbation that will initiate adaptive calculation of PID parameters, in percent of input range.

m. Provide controller with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controller [and to supervisory computer workstation].

2.6.7 Plant Master Controller

a. Plant master controller [must match individual boiler master controller[s] and] must provide for proportional, integral, and derivative (PID) control of firing rate demand based on steam header pressure. [Locate plant master controller in the boiler No.1 cabinet.] The output of the plant master controller must go to the boiler master plant master controller. Provide digital display of the following:

(1) Controller output.

(2) Steam pressure.

(3) Steam pressure setpoint.

(4) Outdoor temperature.

(5) Total plant steam flow.

b. Provide inputs as follows:

(1) Steam pressure (Analog).

(2) Steam flow signal from individual boiler (Analog.)

(3) Outdoor temperature (Analog).

[(4) Fuel oil temperature (Analog).]

[(5) Fuel oil pressure (Analog).]

[(6) Natural Gas pressure (Analog).]

c. Provide outputs as follows:

(1) Boiler master signal (Analog).

(2) Total plant steam flow.

(3) Totalized steam flow pulse.

d. Provide controller with protocol converter/gateway with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.]

2.6.8 Boiler Master Controller

a. Provide each boiler with a boiler master controller. Control jackshaft in response to plant master demand signal or in response to boiler pressure and local setpoint. Use primary analog output to modulate jackshaft actuator of boiler. Logic required to ensure that prepurge, postpurge, lightoff and burner modulate cycles are handled correctly and according to local regulation is the burner manufacturer's responsibility. Controller digital display must include the following in their respective engineering units:

(1) Controller output.

(2) Natural Gas flow.

(3) Fuel Oil flow.

(4) Local setpoint.

b. Controller inputs are:

(1) Plant master signal.

(2) Steam flow.

(3) Steam pressure (Analog).

(4) Natural gas flow (Analog).

(5) Fuel oil flow (Analog).

(6) Firing rate hold (Contact).

(7) Purge from flame safeguard system (Contact).

(8) Auto from flame safeguard system (Contact).

(9) Remote alarm silence (Contact).

c. Controller outputs are:

(1) Jackshaft drive (Analog).

(2) Remote audible alarm (Contact).

(3) Flow pulse for natural gas flow totalizer (Contact).

(4) Pulse for fuel oil flow totalizer (Contact).

d. Provide controllers with protocol converter/gateways with an TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.]

2.6.9 Feedwater Controller

****

NOTE: Specify two-element boiler water level control for smaller capacity plants with relatively stable loads, such as space heating. Specify three-element control for larger capacity plants and unstable loads, such as industrial process and Navy pier facilities.

****

a. Feedwater controller must match other controllers in system and provide [two] [three] element PID control of boiler water level in response to changing boiler level and feed forward signal of steam flow. Automatically switch to single element feedwater control strategy during cold startup when steam and feedwater flow signals are not active. Ensure controller digital displays are as follows in their respective engineering units:

(1) Controller output.

(2) Water level.

(4) Steam flow.

(5) Feed water flow.

b. Controller inputs are:

(1) Water level.

(2) Steam flow.

(3) Feed water flow.

(4) Remote alarm silence (Contact).

c. Controller outputs are:

(1) Feedwater control valve (Analog).

(2) Remote audible alarm (Contact).

(3) Steam flow (Analog).

d. Provide controllers with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.]

2.6.10 Draft Controller

a. Draft controller must match other controllers in system and have capability of PI control of furnace draft in response to changing furnace pressure and feed forward signal of boiler load.

b. Control system includes logic required to interface with flame safeguard system so as to insure that prepurge, postpurge, lightoff and burner modulate cycles are handled correctly and in accordance with local regulations.

c. Provide controller with characterizable setpoint curves for feed forward signal based on load.

d. Ensure controller digital displays are as follows in their respective engineering units:

(). Controller output.

(2) Furnace draft.

(3) Furnace draft setpoint.

e. Controller inputs are:

(1) Jackshaft output (Analog)

(2) Furnace draft (Analog).

(3) Purge from flame safeguard system (Contact).

(4) Auto from flame safeguard system (Contact).

(5) Remote alarm silence (Contact).

f. Controller outputs are:

(1) Flue gas damper actuator (Analog).

(2) Remote audible alarm (Contact).

g. Provide controller with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.].

2.6.11 Oxygen Trim Controller

a. Oxygen trim controllers must match other controllers in the system and have the capability of PID control of fuel/air ratio in response to flue gas oxygen content.

b. Provide controller capable of calculating and displaying boiler efficiency using ASME "By Losses" method.

c. Control system includes logic required to interface with flame safeguard system so as to ensure the prepurge, postpurge, lightoff and burner modulation cycles are handled correctly and in accordance with local regulations.

d. Ensure controller digital displays are as follows in their respective engineering units:

(1) Controller output.

(2) Flue gas temperature.

(3) Combustion air temperature.

(4) Boiler efficiency.

(5) Flue gas oxygen percentage.

(6) Jackshaft position.

e. Controller inputs are:

(1) Fuel flow (oil or natural gas) (Analog).

(2) Flue gas temperature (Analog).

(3) Flue gas oxygen (Analog).

(4) Combustion air temperature (Analog).

(5) Fuel selection (Contact).

(6) Remote alarm silence (Contact).

(7) Jackshaft position (Analog).

f. Controller outputs are:

(1) Oxygen trim actuator (Analog).

(2) Boiler efficiency.

(3) Remote audible alarm (Contact).

g. Provide controllers with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory workstation.]

2.6.12 Alarm Annunciator

a. Provide each boiler master panel with single horn and single alarm silencing pushbutton. Provide first out alarm annunciation for following alarm points to activate alarm horn:

(1) Low steam pressure.

(2) High steam pressure.

(3) Low water level.

(4) Low oxygen.

(5) Low draft.

(6) Low efficiency.

(7) High flue gas temperature.

(8) High opacity.

b. Each alarm condition must activate separate visual indication to allow operator to locate cause of alarm. This may be accomplished with first out annunciator having labeled windows and individual clearly labeled lights or with microprocessor based English language alarm message display. Sound horn for every new alarm, even if previously silenced.

c. Provide controllers with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory workstation.]

2.6.13 Opacity Monitor

a. Provide double pass system to provide continuous stack opacity indication.

b. Provide system consisting of transceiver and retro-reflector module mounted on opposite sides of the stack, and electronic monitor.

c. Use bi-directional digital communications link to connect electronics processor and transceiver module.

d. Provide transceiver with backlit pushbutton for calibration offline.

e. Provide light source and receiver with air purge system for use with plant air.

f. Ensure electronics withstand air failures and maintain on-line service without shutdown. Provide field-mounted device in NEMA 4 enclosure.

g. Ensure system is suitable for operation on 120 volt single-phase power.

h. Provide system in compliance with latest requirements of [_____] City air pollution control code, [_____] City engineering criteria for fuel burning equipment and [_____] State Department of Environmental Protection Opacity Monitoring Requirements.

i. When performing on-stack calibration, check each component of opacity system including: light, source, receiver, optics on stack and associated electronics.

j. Provide a minimum of two (2) months unattended operation. At selected intervals the system must perform fully automatic, on-stack calibration including zero and span. Automatically and continuously correct the measurement for variations in temperature, line voltage, lamp aging and component drift. Provide dirty lens detection system with alarm and four independently selectable optical density filters with range switches. System must sample and mold control output during calibration.

k. The output from the system includes:

(1) 4-20 mADC output.

(2) Digital display of opacity.

(3) Two digital violation occurrence meters, one for total elapsed time and one for number of occurrences.

l. Program is as follows: When opacity exceeds setpoint, instant flashing alert light signals; at 20 seconds, alarm light lights and contacts close. At 60 seconds, lights and contacts lock and require manual reset.

2.6.14 Vertical Scale Indicators

Provide vertical scale indicators that are 150 mm 6 inches high for steam header pressure, outdoor air temperature and combustion air temperature.

2.6.15 Digital Indicators

Provide oversized digital indicators for fuel oil flow and gas flow. [At manufacturer option, controller displays may be used if they show each value in engineering units, include 16 character alphanumeric display describing what is displayed and include dedicated bar graph that can be used for each value.]

2.6.16 Draft Gauge

Mount draft gauges for wind box, combustion chamber and last boiler pass on panel front. Field verify operating ranges for draft gauges with normal reading in middle of scale range. Include piping between gauge and boiler with three (3) way cocks for shutoff and zero check.

2.6.17 Recorder

a. Provide circular chart type recorder with direct reading having evenly divided graduation. Drive charts by 120 volt, 60 Hz motors. Provide pens with different color ink and arrange to pass each other without interference. Each chart must show 24 hours.

b. Record up to four points. Ensure recorder unit is fully programmable in order that each channel can be configured to accept 4-20 mA DC voltage, thermocouple and RTD inputs. Ensure nonlinear inputs are linearized and make provisions for special linearizations.

c. In addition to recording, make provisions for individual 16 character tags and messages per channel and provide up to four integrators which are selectable either as reset or non-reset type. Fit each channel with two alarms selectable as absolute, rate of change or deviation.

d. Measure the following points:

(1) Steam flow.

(2) Percent oxygen.

(3) Flue gas temperature.

(4) Opacity.

e. Provide recorder with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory workstation.]

2.6.18 Totalizer

Provide eight-digit, non-resettable totalizers for: natural gas, fuel oil and steam flow flush-mounted in each boiler control panel. Display directly in engineering units. Only powers of ten (10) are allowable as scale factors. Back up power by a lithium battery with a life span of no less than 8 years. [Smart transmitters may be used to communicate to associated controllers on a device level network LAN. Smart transmitters are not allowed to reside on controller LAN]

2.7 FIELD DEVICES

Furnish and install the following field devices to provide a complete working system.

2.7.1 Oxygen Analyzer

****

NOTE: Consider specifying a reference and calibration gas system for plants having two or more boilers at 11,700 kW 40,000 lb/hr or greater capacity. Otherwise, delete.

****

a. Provide oxygen analyzer for each boiler. Stack-mount oxygen analyzer and utilize zirconium sensing element. Insert sensing element directly in flue gas stream and in direct contact with process gases.

Contain sensing element within a protective housing mounted to flue gas outlet by means of adapter plate, both furnished by manufacturer.

b. Equip oxygen analyzer to allow daily calibration check without removing analyzer from process.

c. Sample gases may be injected directly on sensing element while analyzer is in process.

d. In order to eliminate temperature effect of flue gases, provide externally-mounted temperature controller. Provide isolated 4-20 mA DC temperature controller output representing 0-10 percent oxygen content as linear function.

e. Provide reference and calibration gas system for each boiler consisting of gas supply, regulator with relief valve, gauge and necessary valving and piping. Provide electrical power connections and piping for distribution to calibration gas connection on each analyzer.

2.7.2 Fuel Oil Flow Transmitter

a. Provide fuel oil flow transmitter for each fuel oil flow meter. Ensure transmitter output is isolated 4-20 mA dc.

b. Connect panel-mounted totalizer to transmitter. Provide necessary signal conditioning devices to integrate fuel oil flow transmitter with control and recording instrument panels.

c. Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.

2.7.3 Natural Gas Flow Transmitter

Provide natural gas flow transmitter for each natural gas meter. Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.

2.7.4 Steam Flow Meter-Transmitter

a. Provide steam flow meter-transmitter consisting of a Vortex-Bar meter probe designed for pipe insertion type installation by means of hot tap or other non-disruptive method. Measure media flow by means of a vortex shedding flow element located in flow stream.

b. Provide steam flow meter-transmitter with sliding-type stem passing through two pressure seals allowing proper positioning of sensor in flow stream and isolation valve so that transmitter can be completely removed from pipeline without disruption of process. Supply steam flow meter with a two-wire preamplifier with analog 4 to 20 mA dc output signal.

c. Meet the following performance criteria:

(1) Pressure Rating: To [950 kPa 125 psig] [205 degrees C 400 degrees F][_____].

(2) Seals: Teflon.

(3) Wetted Parts: Type 316 stainless steel with 304 stainless steel body.

(4) Flow Rangeability: 10:1.

(5) Linearity: Plus or minus 1.0 percent (to 24 mA output).

(6) Repeatability: Plus or minus 0.25 percent at maximum.

(7) Current Limit: To approximately 30 mA.

d. Meet the following materials of construction criteria:

(1) Sensor: Type 316 stainless steel.

(2) Sensor Support: Type 304 stainless steel.

(3) Bushings: Stellite or stainless steel hardened with stellite.

(4) Stem: 300 Series stainless steel.

e. Provide with steam flow meter-transmitter a full port gate valve with proper flanged connection that allows steam flow sensor to be inserted and removed from pipe under full pressure. Provide both valve and pipe tap with a minimum [48 mm 1.875 inches] [_____] internal diameter clearance.

f. Provide NEMA [4] [4X] electronics enclosure.

g. Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.

2.7.5 Temperature Transmitter

a. Provide platinum resistance temperature detector (RTD) temperature transmitter. Ensure resistance is 100 ohms at [0 degrees C 32 degrees F] [_____] with tolerances in accordance with BS 101-4 and DIN 43760.

b. Make connections to control cabinet via three identical copper conductors of No. 14 AWG minimum.

c. Insert RTD in protective sheath or well suitable for the environment.

d. Utolize platinum RTD input to provide 4-20 mA dc output to control cabinet. Ensure transmitter is plus/minus 0.2 percent accuracy of calibration span, to include combined effects of transmitter repeatability, hysteresis, linearity and adjustment resolution.

e. [Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.]

f. Monitor the following temperatures.

(1) [Fuel oil (each boiler)].

(2) Flue gas (each boiler).

(3) Combustion air (each boiler).

(4) Outdoor air (one (1) per plant).

2.7.6 Electric Drive

a. Provide electric drive for jackshaft and flue gas dampers. Accept signal input from control system and provide feedback of actuator position by means of integral potentiometer. Include four adjustable end switches.

b. Provide electric drive with 90 degree rotation in 15 seconds and capable of [_____] Newton Meter ft-lbs of torque under continuous duty.

2.7.7 Pressure Transmitter

Provide pressure transmitter with 0.25 percent of full scale accuracy, process fluid isolating diaphragms, 5:1 field calibration adjustability, NEMA 4 housing and 4-20 mA dc output. Provide pressure transmitter with a calibration valve manifold. Include an isolating siphon with pressure transmitter for steam service. Provide the following transmitters:

a. Steam pressure (one per plant).

[b. Fuel oil pressure.]

[c. Natural gas pressure.]

d. Furnace draft.

2.7.8 Differential Pressure Water Level Transmitter

a. Provide boiler with differential pressure type water level transmitter.

b. Provide differential pressure type water level transmitter with 0.25 of full scale accuracy, process fluid isolating diaphragms, 5:1 field calibration adjustability, NEMA 4 housing and 4-20 mA dc output.

[c. Smart transmitters may be used to communicate to associated controllers on a device level network LAN. Smart transmitters are not allowed to reside on the controller LAN.]

2.7.9 Pressure Switch

Provide pressure switch with repetitive accuracy of plus or minus 1 percent of the operating range. Adjust pressure switch actuation over the operating range. Provide pressure switch with snap-action Form C contacts rated for the application.

2.7.10 Temperature Switch

Provide temperature switch with repetitive accuracy of plus or minus 1 percent of the operating range. Adjust temperature switch actuation over operating temperature range. Provide temperature switch with a snap-action Form C contacts rated for the application.

2.7.11 Oxygen Trim Drive

Provide oxygen trim drive that is the in-line piston type actuator in linkage from jackshaft to combustion air damper. Use oxygen trim drive to position combustion air damper based on signal from oxygen trim controller.

2.7.12 Supervisory Computer Workstation

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NOTE: For new central steam plants or as an upgrade of existing central steam plants consider the following section to provide remote monitoring capability trend logging and graphical system interface.

****

a. Provide dedicated monitoring and data collection system supervisory computer workstation, complete with custom software as specified. Collect and store data transmitted from system controllers and other sensing and monitoring devices, and log alarms. Use software described to generate periodic reports. Data collection function takes priority over report generation function and do not interrupt by generation of reports.

b. Log data at five (5) second interval that is adjustable as required. In event of alarm condition or unusual plant operating condition, immediately initiate data logging.

c. Design supervisory computer workstation computer such that a failure of the CPU, the storage disk, or any other device does not result in the loss of any previously stored data.

d. Include the computer, keyboard, printer, monitor, and other peripherals and locate as shown. Provide cabling between the work station and the system controllers. Provide all prefabricated cabling required between the work station and peripheral devices.

e. Ensure authorized personnel is capable of editing and modifying programs with access code. Provide password protection for all levels of access. Ensure multiple level password protection system is acceptable to the Owner.

f. Ensure supervisory computer workstation computer is a microprocessor based personal computer. Provide computer with eight expansion slots. Ensure computer is Microsoft Windows (R) compatible, each with a floppy disk drive, 17 inch high resolution SVGA color monitor for graphic displays. Provide hard disk drive with sufficient capacity to perform required data substitution routines without accessing other data storage media. [Provide a 650 MB CD-RW reader-writer-rewriter drive with minimum of 8X write, 4X rewrite and 24X read speeds and 25 preformatted rewritable and 100 preformatted writable CD media disks or archival and routine backup.] Include the following minimum equipment as part of the supervisory computer workstation:

(1) Intel Pentium III Class 633 Mhz Micro Processor or approved equal.

(2) 128 MB RAM.

(3) 4 MB RAM video adapter.

(4) [20] [_____] GB hard disk.

(5) 2 Parallel Ports.

(6) 2 Universal Serial Bus (USB) Ports.

(7) 56,600 Baud Modem.

(8) Synchronous adapter with dual port compatible with supervisory computer workstation interface hardware.

(9) Equip the keyboard with thirty-two function keys with custom legends for each key, to allow report generation, graphic display selection, alarm silencing, and data retrieval with single key strokes. Provide keyboard with a high resolution track ball.

g. Provide the following additional peripheral equipment as shown:

(1) Inkjet printer, 1200 dpi by 1200 dpi, tri-color and black ink cartridges or four ink cartridges (red, blue, yellow and black).

(2) Inkjet printer, 1200 dpi by 1200 dpi, dual ink cartridges (tri-color and black) or red, blue, yellow and black ink cartridges or color laser printer.

2.7.12.1 Software

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NOTE: Text within brackets denotes the designer's options.

****

a. Provide software required for efficient operation of automatic system functions required by this specification. Software must be modular in design.

b. Provide available supervisory computer workstation application and system software with system, which resides in supervisory computer workstation computer. Unbundled software packages for which vendor can charge user extra fees, require dedicated work stations or require system rebooting for access, are unacceptable.

c. Provide licensing agreement from PC manufacturer for each software program or package specified to ensure customer support from PC manufacturer for each copy of software program or package provided at supervisory computer workstations.

d. Provide software in system consisting of both firmware, resident in the controller, and software resident in the supervisory computer workstation computer. Distribute architecture of system, application software and firmware with no single system component responsible for a control function for entire LAN. Provide each controller with the necessary firmware, control software and I/O capability to function independently in case of network failure. Ensure controller is able to stage, rotate and fully control the equipment during a communication failure with network LAN. Active control sequences are prohibited in supervisory computer workstation or central control unit. Provide workstation and controllers that are removable from

system without loss of control function. Only alarm monitoring, long-term history collection and operator monitor, command, and edit functions may be lost.

e. Provide software upgrades while maintaining full operational control of loss of any operating features for five years after Government acceptance of system at no additional cost. Software upgrades include new versions, releases, upgrades and wholesale revisions in software. This does not include labor required to update graphic pages or revise control sequences, except as caused by revisions in software.

f. Provide necessary hardware, software and programming to allow remote access to system via the Internet. Access will allow user located off-site to view and monitor current conditions at site. Acceptable configurations are software program making the host PC accessible through the Internet or development of Internet web pages specifically for site.

2.7.12.2 Software Capabilities

[a. Provide primary operator interface to system through graphical, object oriented, and interactive presentation using mouse and cursor for object selection and commands. Use Microsoft Windows based plant management software.]

[b. Support pop-up windows for point commands. On selecting object with cursor, open up a window to present operator with choices corresponding to operator's password authorizations. These point commands include state changes, manual override of application software, test mode activation and test value entry. This window includes the point descriptor (name), the point hardware address and alarm status.]

[c. Support pop-up windows for point editing. On selecting object with cursor, open up a window to present operator with a list of active point data base editors, if permitted by the operator's password level. Allow operator to modify basic parameters associated with a point, as well as access to programs assigned to the point such as time schedules, calculations, and events by selecting one of these editors.]

[d. Base system on interactive prompts and choices, using dialogue boxes as opposed to memorization of commands, syntax or exact spellings. Use interactive prompt and choices approach in monitoring, issuing commands, and editing. Use command choices which entail clicking cursor to select correct work choice prompts, for example: ON-OFF, without typing in letters. Provide editing mode choices that prompt ranges or options, for example: 16 CHARACTERS for point name, or DIRECT-REVERSE for control action).]

[e. Zoom: Make it possible for operator to locate system point to monitor status, issue commands, or edit associated database without knowledge of the point name, address, or associated controller, and without having to refer to a tree directory. Ensure operator is able to locate control points by, for example, zooming in on a floor in a building graphic or zooming in on a system in a floor plan graphic.]

f. Compile system software for faster execution speeds and offer the following features and capabilities.

(1) Input/Output Capabilities: From the connected supervisory computer workstation, the system operator must have ability to:

(2) Request displays of current values or status using a tabular [or graphic format.] [Use a global data base sorting utility which allows an expanded tabular display of only points on current graphic display.] This [expanded tabular] display must list point name, hardware address, dynamic state or value, alarm status, override and test mode status.

(3) Initiate logs and reports.

(4) Change analog limits.

(5) Change point input and output descriptors, status, alarm descriptors and engineering unit descriptors while system is on-line.

(6) Modify and set up maintenance scheduling parameters.

(7) Develop, modify, delete or display full range of color graphic displays. Ensure development, editing and display work is possible with system fully on-line and in full communications with the Controller LAN without disruption of system function.

(8) Select discrete or analog sample data from the field to be automatically archived in the assigned workstation. This archiving must occur even if workstation is running third party software such as word processing or electronic spreadsheets.

(9) Comprehensive report writer capability to sort and extract data from archived files and to generate finished custom reports. Initiate reports manually or print automatically. Provide system with capability to print reports on daily, weekly, monthly, yearly or scheduled basis. Provide capability for statistical data manipulation and extraction. As a minimum, the custom report writer must provide capability to generate following types of reports:

(a) Statistical detail reports

(b) Summary reports.

(c) Trend graphic plots.

[(d) X-Y graphic plots.]

(10) Ensure report function is on-line for both development and printout, and does not require export to a third party spreadsheet program for execution.

(11) [In addition to on-line function, ensure historical database is capable of being converted to Data Interchange Format (DIF) for use in spreadsheet for off-line manipulation. Ensure transmission to DIF files is manual or automatic based on operator selectable parameters including: time of day, frequency (daily, weekly, monthly, yearly), scheduled days (32 days minimum).]

(12) File transfer must support appending new data to existing file data.

(13) Print alarm annunciations and normal operator acknowledgments, action messages, system alarms, operator sign-on and sign-off. Operator control activities include the operator's initials in the printed and disk record. The data printer will be reserved for printing reports, page prints, and data base prints.

(14) Provide operator the option of selecting daily, weekly or monthly scheduled frequency to synchronize time and data in controllers from the supervisory computer workstation. Perform synchronization for dialup as well as direct connected locations. Accommodate automatic daylight savings time adjustments.

(15) Provide a feature to indicate audibly [and visually,] when Off-Normal conditions and messages exist.

[(16) Ensure operator is able to request a summary of points on controller LAN currently in test mode or in off-normal condition.]

g. Supervisory Computer Workstation: The supervisory computer workstation must:

(1) Accept data from Controller LAN on an as needed basis without having to scan entire network for updated point data.

(2) Interrogate Controller LAN for updated point data as requested by operator.

(3) Allow operator command of equipment connected to controllers.

(4) Store duplicate data base on file for every controller and allow database to be downloaded to remote panel while system is on-line.

(5) Develop, store and modify dynamic color graphics utilizing system supplied mouse and mouse supported software.

(6) Provide data archiving of assigned points throughout system [and to support overlaid graphing of utilizing up to four (4) variables.]

h. Alarm Processing: Provide the following alarm processing features, all of which are definable through the input keyboard:

(1) Each OFF-NORMAL condition must cause an alarm and appropriate message, including time and date of alarm, system and point descriptor and alarm condition. Ensure operator has the ability to select, at any time, which state or value are considered alarms and which alarms cause automatic dial-out to occur.

(2) Display each critical alarm or change-of-state message . Store controller LAN network alarm messages on disk which may be reviewed on the display printed on operator selected printer at any time. Ensure it is possible to sort this alarm and change-of-state database by date, time or item fields.

(3) Provide automatic user defined time delay of alarms during equipment start-up or shut-down.

(4) Unacknowledged alarms will continue to blink even if alarm condition has returned to normal.

(5) Only operator acknowledgment can remove the blinking alarm indication.

(6) Operator workstation will notify an operator of an alarm condition in one or more points or controllers anywhere in the system.

(7) Provide alarm notification consisting of an automatic print of the alarm condition.

i. Prepared Historical Report: Provide an on-line, historical, data base sort report utility with: Prompts to select data base sort by time, by date, by point or range of points with system supplied default values of 24 hours, today, all Controller LAN points, respectively. Prompts for activating "conditional" sorts, including: changes-of-state, alarms, returns to normal, operator sign on/off, operator acknowledgements, command errors, program control of a point, test on/off, manual on/off, program control (Demand, Event) override, power restore, LAN reconfiguration, controller off line, time/data modifications and archive disk memory 90 percent full, 95 percent full and full. Single keystroke retrieval resulting in a report listing the most recent condition first, along with the time, date, address, name, condition type, and value. The supervisory computer workstation must provide functions listed below.

2.7.12.3 Graphics Screen Format

Submit graphics screen format showing process variable in engineering units, such as process variable setpoints, analog or digital input or output conditions, and to meet requirements of the Centralized Monitoring System of this specification. Include the proposed input conditions shown on flow diagrams created by the Contractor based on Drawings, including process and instrumentation drawings and shop drawings from boiler manufacturer.

2.7.12.4 Graphic Display

At a minimum, make the following screens available:

a. Plant overview.

b. Individual Boilers.

c. Individual controllers.

d. Display of all measured variables and setpoint s.

2.7.12.5 Historical Trending

Provide system capable of storing values from transmitters as well as system computed values, such as efficiency and compensated flow rates, at selected intervals for archival storage and future analysis.

2.7.12.6 Totalization of Data

a. Provide system capable of totalizing the following data:

(1) Steam Utilization.

(2) Total Feedwater Flow.

(3) Total Natural Gas Consumption.

(4) Run Time for monitored motors.

(5) Total Fuel Oil Consumption.

b. Run time logged for each motor driven equipment must enable the plant maintenance to schedule regular maintenance for each motor driven device. Once a motor driven device has been serviced or repaired as a part of regular maintenance or due to emergency, plant maintenance must be able to log servicing or repair data in the supervisory computer. Plant maintenance must also be capable of logging servicing or repair data for equipment monitored in the steam plant.

2.7.13 Centralized Monitoring System (CMS)

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NOTE: The CMS paragraphs apply to existing plants without a supervisory computer workstation.

****

a. Use CMS for centralized monitoring and data acquisition of various plant variables.

b Provide services required for installation, programming, testing and startup of system.

c. Employ industrial grade equipment in CMS that is Underwriter Laboratories (UL) listed.

d. Provide CMS to include, but not be limited to, the following functions:

(1) System engineering.

(2) System hardware.

(3) System programming and configuring.

(4) System documentation.

(5) System installation.

(6) System testing.

(7) Packing and shipping.

(8) Maintenance training program.

(9) Operator training program.

(10) System startup.

(11) Scheduled system maintenance.

(12) Attend construction review meetings and provide progress reports.

2.7.13.1 System Controller

a. Monitor various plant variables, log data and generate summary reports as required by plant operations. Provide system controller capable of data reduction and backup data logging. Perform data and alarm interfaces between CMS equipment and Government equipment at system controller.

b. Provide an industry standard programmable logic controller (PLC), or direct digital controller (DDC), rack mounted in NEMA 12 CMS equipment cabinets. Use compatible interconnecting cabling and fittings and clearly label as to the equipment and termination points they are to interconnect.

c. Provide backup digital storage of CMS data. Provide backup data storage device with sufficient memory to store at least seventy two (72) hours of CMS data in event of failure of monitoring and data acquisition system computer or communications hardware. Upon restoration of communications with monitoring and data acquisition system computer, transfer data logged during communications failure period automatically to monitoring and data acquisition system computer. Provide battery backup for backup data storage device if required to preserve data in event of a power supply failure.

d. Provide system controller consisting of solid-state control system which has a user programmable memory for storage of instructions to implement specific instructions such as input-output control, Boolean logic, timing, counting, arithmetic, and data manipulation. Provide system controller consisting of central processors, input-output interfaces, memory, power supplies, a programming device, and tape or disk drive for storing and rapidly loading programs. Make provision for portable operator interface panel with CMS system to provide the capability of viewing access to data stored in the CPU and input of constants required by system controller.

e. Provide central processing unit consisting of solid-state design on modular printed circuit boards. Provide hardware, source code, and programming parameters required for internal programming of controller.

2.7.13.2 Interface Requirements

a. Ensure system controller is capable of interfacing with plant controllers, computers, or printers in accordance with TIA-232 or another communications interface common to all plant microprocessor-based control equipment.

b. Electrically isolate inputs and outputs from other input-output and from all cabinet wiring.

2.7.13.3 Alarm Interface

Provide CMS with 2 annunciator cabinets, each equipped with one (1) white indicating light, one (1) flashing red indicating light, 1 audible horn, 1 Acknowledge pushbutton and 1 Test pushbutton as shown. Locate one of

these annunciator cabinets [_____] and locate the other in the plant control room. Provide momentary Acknowledge and Test pushbuttons. Connect equipment in these cabinets directly to the CMS input-output ports as shown. When alarm condition is detected, sound horn at both annunciator cabinets and flash the red indicating lights. When Acknowledge button is pressed in any one of the annunciator cabinets, or when the alarm is acknowledged at either of the work stations, silence horn, stop red flashing lights, and turn on the white indicating light. At this point the system is ready to annunciate new alarm condition detected. The white indicating light must stay on until the alarm condition is removed. If the Test pushbutton is pressed, the horn must sound and the red indicating light must flash. Pressing the Acknowledge button must silence horn and reset alarm system. Provide lamptest pushbutton to allow verification that all indicating lights are operational.

2.7.14 Monitoring Requirements

2.7.14.1 Monitoring of Boilers

Boiler may be supplied from manufacturer with stand-alone controller. System controller must receive output signals from stand-alone boiler controller by means of data communication link. Send other variables requiring monitoring to CMS as analog or discrete contact closure signals. If existing boiler control system is utilized, make provision to acquire data from these controllers, preferably by means of serial communication links. If it is not feasible to establish serial communication links, send variables to be monitored to CMS as appropriate analog or discrete signals. Apply calibration factors to analog inputs accessed from recorders, controllers and transmitter as required.

2.7.14.2 Variables to be Accessed from Boiler Control systems

At a minimum, access data for the following variables from boiler control system:

a. Steam pressure in kPa psig.

b. Steam pressure setpoint in kPa psig.

c. Steam flow in thousands of kg/hr lb/hr.

d. Flue gas temperature in degrees C degrees F.

e. Flue gas oxygen in percent.

f. Opacity in percent.

g. Fuel oil flow in R/sec GPH.

h. Fuel oil supply pressure in kPa psig.

i. Fuel oil supply temperature in degrees C degrees F.

j. Natural gas flow in thousand standard cubic meters.

k. Natural gas supply pressure in psig.

l. Boiler control system power ON or OFF.

m. Fuel selected: GAS, OFF or OIL.

n. Purging.

o. Ready.

p. Pilot ON.

q. Fuel oil ON.

r. Natural gas ON.

s. Emergency trip.

t. Boiler efficiency.

2.7.14.3 Alarms to be Accessed from Boiler Control Systems

At a minimum, access the following alarms from boiler control system:

a. High steam pressure.

b. High water level alarm.

c. Low water level alarm.

d. Low water cutoff.

e. High natural gas pressure.

f. Low natural gas pressure.

g. Low atomizing steam pressure.

h. Low fuel oil pressure.

i. Low fuel oil temperature.

j. Low oxygen level.

k. Flame failure.

l. High opacity.

2.7.15 Balance of Plant (BOP) Variables

a. Monitor status of equipment common to all boilers and any other plant variables not part of any boiler control system directly by the CMS controller via input-output interface modules. Input-output modules must be analog, discrete or communication ports as required. Provide isolated or nonisolated discrete inputs-outputs as required by prevailing conditions. Apply calibration factors to raw analog transmitter output as required.

b. Controller inputs-outputs include, but are not limited to, those indicated.

2.7.15.1 BOP Variables to be Monitored:

Access the following balance of plant variables from dedicated instruments or controllers:

a. Outside air temperature in degrees C.

b. Steam header pressure in [KPA] [MPA].

c. Boiler feedwater temperature in degrees C.

d. Boiler feedwater flow in litersgallons per minute.

e. Boiler feedwater pressure in [KPA] [MPA]PSI.

f. Boiler water makeup flow in litersgallons per minute.

g. Air Compressor status (one per compressor).

h. Boiler Feed Pump status (one per pump).

i. Condensate Transfer Pump status (one per pump).

j. City water supply valve status ("OPEN" or "CLOSE").

k. Fuel Oil Pump status (one per pump).

2.7.15.2 BOP Alarms

Access the following alarms from dedicated instruments or controllers:

a. Air Compressor Low Pressure (one per compressor).

b. Condensate Transfer Pump Trip (one per pump).

c. Fuel Oil Pump Trip (one per pump).

d. Deaerator Tank Level High.

e. Deaerator Tank Level Low.

f. Atmospheric Condensate Receiver Level High.

g. Atmospheric Condensate Receiver Level Low.

h. Heating Plant Pressure Receiver Trouble.

i. Water Softener Trouble.

j. Blow Off Separator High Level.

2.7.16 Uninterruptible Power Supply (UPS)

Provide a [_____] kVA UPS, with a minimum run time of thirty five (35) minutes at full load to power work stations and their peripherals, controllers and input-output systems.

2.7.17 Monitoring and Communication Cables and Associated Raceways

Provide monitoring and communication cables, wiring, and associated raceways, including conduit, junction boxes, and fittings in accordance with applicable sections of specifications. Contractor is responsible for providing cables required as indicated in these specifications and to provide a complete and working system. Provide cables as required for connection between CMS equipment, boiler controllers and field devices.

2.7.18 Remote Communication Interface Modem

Provide system with auto dial-auto answer modem suitable for use with voice grade telephone lines. Provide communications in English language and limit to ASCII character codes. Ensure system is capable of automatically dialing up in both pulse and tone dial mode.

2.7.19 Instrument Power Supply

Provide instrument power supplies, as necessary, to power panel and field mounted instruments, including instruments within instrument cabinets and back-of-panel components. Provide regulated plus-minus 24 V dc or as required for transmitter and transducer power requirements. Select power supply current rating based on loop burden. Meet the following requirements:

a. Provide 120 V ac, 60 Hz, single-phase input power to the instrument power supply. Wire power supply as a tap circuit through a separate pull-out type fusible block rated 300 V ac minimum at rated amperes, and wire to the same branch circuit as CMS controller.

b. Provide power supply with output current protection.

c. Supply power supply with brackets for installation on mounting panels within the CMS cabinet.

2.7.20 System Architecture

Design system in modular fashion. Provide spare capacity of the following:

a. Input, digital- 25 percent.

b. Input, analog - 25 percent.

c. Controller memory - 25 percent spare.

d. Output digital - 10 percent.

e. Output analog - 10 percent.

2.7.20.1 Inputs

CMS controller must be capable of accepting inputs as described below:

a. Analog Inputs (AI): Monitor analog inputs originating from sensing elements and buffer as AI, except that automatic conversion to proper engineering units must occur without any additional signal conditioning as follows:

(1) Convert temperature inputs from thermistors or RTDs or

temperature transmitters to degree C,

(2) Convert flow inputs from flow transmitters to liter per minute, cubic meter per minute or as specified in process and instrumentation diagram.

(3) Convert valve or damper position from potentiometer or similar device to percent open.

(4) Convert pressure input from pressure transmitter to mm of water kPa as specified in process and instrumentation diagram.

b. Discrete Inputs: CMS controller must accept discrete signal from device such as contactor, relay, limit switch, pressure switch, and temperature switch. Provide input device capable of withstanding continuous shorting to 120 V ac or to 1500 volts for fifty (50) microseconds.

2.7.20.2 Outputs

Provide controllers that are capable of directing outputs as follows:

2.7.20.2.1 Analog Outputs (AO)

Analog outputs as direct or reverse function of associated analog inputs must modulate final elements in response to controller algorithms. Final element actuators must be industrial grade capable of accepting a modulated [electronic] [pneumatic] signal from the controller [via a signal converter, current to pneumatic]. Electronic signal must be 4-20 mA dc with a minimum of 16 [_____] bit resolution. [The pneumatic signal must be 21 to 34 kPa 3 to 15 psi. Each pneumatic output must have feedback for monitoring of the actual pneumatic signal.]

2.7.20.2.2 Digital Outputs (DO)

Command equipment to the selected position via schedules and programs. Provide contact closure with contacts rated at a minimum of 1 ampere at 24 volts. The output signals include, but are not limited to:

a. Enable-Disable.

b. Start-Stop.

c. On-Off.

d. Open-Close.

e. Demand Limit

f. Temperature Reset.

g. Boiler Selection

h. Floating Control.

2.7.20.3 Program Storage

CMS controller must be able to store programs on a solid state memory PC card, a hard disk drive, or a CD-RW reader-writer-rewriter disk drive

requiring no front end computer for the data conversion.

2.7.21 System Software

Document CMS controller program code sufficiently that operator can modify controller logic and setpoints. Software provided includes, but is not limited to, operating systems, communication control, definition of process, operator interface, and system services. Provide Read Only Memory [ROM] and Programmable Read Only Memory [PROM]as required, as resident operating system. Application software must be RAM resident. Do not use bulk storage devices, such as magnetic disks, in an interactive on-line mode, but may be added for extended data storage.

2.7.21.1 Trend Logging.

Initiate a custom log for any variable value in the control program. Select type of log, number of values log contains, and time interval between values. Assign trend log activation period from keypad by day, month, year, and time span desired for each log.

2.7.21.2 Alarm Reporting.

Provide control capable of analyzing any variable in the program and evaluate for alarm condition. Alarm can be generated based on analog value out of limits or based on a programmed sequence of events. Store alarms in log upon each occurrence and report them immediately.

2.7.21.3 Alarm Lockout Routine.

Provide alarm lockout routine to inhibit nuisance alarms.

2.7.22 Documentation

Provide the following documentation:

2.7.22.1 List of Hardware

Complete list of hardware required to provide a complete and fully functional CMS.

2.7.22.2 Input and Output Point List.

Complete input and output point list.

2.7.22.3 Operating and Maintenance Manuals.

Provide functional description of proposed equipment, and descriptions of maintenance on system components. Ensure operating and maintenance manuals cover inspection, periodic preventive maintenance, fault diagnosis, replacement and repair of defective components.

2.7.22.4 Equipment Installation Details.

Submit detail drawings showing installation requirements for each component of the CMS.

2.7.22.5 System Interconnection Block Diagram.

Show the interconnection of components in the CMS network.

2.7.22.6 Software Manual

Provide software manuals describing programming and testing for CMS controller and containing system overview with detailed description of software features. Instruct operator on programming CMS controller, including control programs, algorithms, mathematical equations, variable, setpoints, time periods, messages, and other information necessary to load, alter, test, and execute system operation. Include the following in the software manual:

a. Complete description of programming language, including commands, algorithms, printouts and logs, mathematical calculations, and passwords.

b. Instructions on modifying any algorithm or parameter, verifying errors, status, changing passwords, and initiating or disabling control programs.

c. Software documentation providing easy reference from summary sheets which compare pertinent information about hardware, and wiring information in the field. Include the following documentation:

(1) Complete point identification, including terminal number, symbol, engineering units, control program reference number, and logic printout.

(2) setpoint s for various analog input loops.

(3) Field information including location, device, device type and functions

(4) Location identification of the CMS hardware.

2.7.23 Equipment Cabinet Factory Wiring

Factory install internal equipment cabinet wiring, color code and bundle neatly or route via wiring duct. Install cables and wiring as specified.

2.7.23.1 Termination

Make terminations with pressure type connectors or lugs. Do not wrap stranded conductors around screw type terminals. Connect incoming cables to CMS controller via terminal blocks. Terminate internal wiring at one side of the terminal blocks.

2.7.23.2 Nameplate for Device Inside Equipment Cabinets.

Stamp nameplate for device mounted inside equipment cabinet with the device number only. Provide nameplate consisting of 10 mm 3/8 inches wide stainless steel tape. Attach to the device with stainless steel wire.

2.7.24 Continuous Emissions Monitoring

****

NOTE: A continuous emissions monitoring system (CEMS) is required by the Clean Air Act Amendment (CAAA) of 1990 if the fuel utilized is oil or coal and the heat input is 3 megawatt 10 million BTU/HR

or greater. A CEMS may also be required by state or local laws. If a CEMS is necessary the designer must review the CAAA and the relevant state or local law early in the project to allow time to incorporate the required CEMS specification and to determine which flue gas emissions will be included in the required reports. Before acceptance of the installation, furnish a written test report which provides documentation that the CEMS equipment has passed factory and field certification tests required by federal, state and local regulations to the Contracting Officer. The investigation will determine if the reported values may be calculated or should be direct measurements. The CAAA includes measurement options for gas/oil fired units depending upon the particular category of unit as defined by the regulations. Fill in the data to state what method of measurement or calculation will be utilized for the determination of the report variable.

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

****

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

b. Reported data includes [sulfur dioxide ($S0_2$)] [oxides of nitrogen (NO_x)] [carbon monoxide (CO)] [carbon dioxide ($C0_2$)] [particulate matter (PM)] and other information required by federal, state, and local regulations. Base SO_2 reporting on [analyzer measurement] [fuel flow and percent sulfur calculation] [daily heat input calculation]. Base nitrous oxides, carbon oxides and particulate matter reporting on analyzers.

c. Include central processing unit, printer, hard disk drive, and floppy disk drive. Provide floppy disk drive to function as recorder. Provide software to generate required reports in format acceptable to federal, state and local regulatory agencies. Provide operator interface to CEMS equipment by means of CRT display.

2.7.24.1 Gaseous Emissions Monitor

Provide dxtractive or in-situ gaseous emissions monitors. Combination of extractive and in-situ monitors is not acceptable. Gaseous emissions monitors include automatic calibration checks. Provide alarm horn and annunciator to alarm when any monitored parameter is out of range or

gaseous emissions monitor malfunctions. Construct surfaces exposed to corrosive gas of boiler of noncorrosive materials such as 316 SS, Teflon or Hastelloy.

Provide [wet][dry][diluted] extractive systems. [Provide rack-mounted analyzing equipment for extractive system.][Locate analyzing equipment for extractive system in a walk-in cabinet].

2.7.24.2 Flue Gas Flow Monitor

Utilize the pitot tube principle to measure flue gas flow. Provide flue gas flow monitor base which is across-the-duct average pitot tube and properly design and locate to obtain representative measurement. Use differential pressure transmitters to sense the difference between the static and total pressure of the flowing flue gas stream. Ensure calibrations are stable.

2.7.24.3 Particulate Matter Opacity Monitor

Base particulate matter opacity monitor on principle of transmissometry. Include automatic simulation of zero opacity and up scale check of calibration while boiler is in service without dismounting monitor. Include analyzer internal circuitry and electronic circuitry in calibration check. Provide alarm horn and annunciator to annunciate excess opacity and system malfunction. Provide monitor with fans to keep sending and receiving lenses pressurized and blown clean at all times.

2.7.24.4 Wiring

Provide CEMS equipment with plug in prefabricated cable for interconnection between components. Use 2 wire, 120 volt nominal or less, 60 Hz, power supply to the equipment with one side grounded. Connect electrical devices as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.8 BOILER FEEDWATER SYSTEM

2.8.1 Deaerators

****

NOTE: Deaerator manufacturers should be consulted regarding specific features of construction for a particular application. Specifications are included for atomizing spray-type, tray-type, and atomizing spray, two tank type deaerators. Careful consideration will be given to the type of deaerator selected. Tray type is preferred however it requires more space than the other types. To satisfy shipping requirements or where access is limited, the deaerator may be knocked down and field assembled. Select applicable pump type and control.

****

2.8.1.1 Components

Provide deaerator as a complete package by one manufacturer including receiver with deaerating section, pumps, electrical control and accessories. Deaerator components include but are not limited to the following:

a. Storage tank.

b. Deaerator [spraymaster][or][column.] ASME PTC 12.3.

c. Water inlet atomizing valve.

d. Steam inlet atomizing valve.

e. Deaerator manual and automatic vents.

f. Gauge glass.

g. Steam pressure gauge.

h. Feedwater thermometer.

i. Tappings.

j. Water level controller with makeup valve.

k. Three valve by-pass and strainers for control devices.

l. Steam relief valve.

m. High water level alarm.

n. Low water level alarm.

o. High temperature condensate diffuser.

p. Boiler feed pump and motor sets.

q. Recirculation orifice.

r. Pump suction shutoff valve.

s. Suction strainer.

t. Suction flexible fitting.

u. Pump discharge shutoff valve.

v. Pump discharge pressure gauge.

w. Pump discharge manifold.

x. Overflow drain connection.

y. Control panel.

z. Chemical feed quill.

aa. Vacuum breaker.

bb. Sentinel relief valve.

cc. Tank drain valve.

2.8.1.2 Deaerator, General Requirements

Provide deaerator water storage tank with a [_____] mm inches diameter, and [_____] mm inches long.

a. Provide storage tank section with [_____] minutes of storage and a capacity of [_____] liters gallons measured to overflow. Provide an 280 by 380 mm 11 by 15 inch elliptical manhole for access. Provide deaerator rated at [_____] kg pounds of steam per hour.

b. Design deaerator to remove dissolved oxygen in boiler feedwater to 0.005 cc/liter or less and eliminate carbon dioxide at any load between 5 and 100 percent of rated capacity.

c. Provide tank consisting of welded steel construction built in accordance with Section VIII of the ASME pressure vessel code for 345 kPa 50 psig at [_____] degrees C degrees F and stamped accordingly. Construct internal surfaces which come in contact with underaerated water of Type 316 stainless steel.

d. Provide deaerator with manual and automatic vent valves. Control automatic vent valve thermostatically to provide fast venting of sudden buildup of gases. Provide manual vent valve with an orifice for continuous minimum venting. Do not exceed a manual minimum venting rate of 0.1 percent of rated deaerator capacity. Provide deaerator that is suitable to operate from 13.6 to 102 kPa 2 to 15 psig.

e. Provide steel fabricated deaerator stand of appropriate height for the feed pump-motor set, and mount on a solid base. Reinforce base to prevent vibration.

f. Nozzles 100 mm 4 inches and under must be 1350 kg 3000 pounds forged steel couplings. Nozzles 63.5 mm 2-1/2 inches and over must be 1.03 MPa 150 psig rated flat face flanges.

g. Mount pump-motor set on individual base before mounting on the stand base. Provide individual suction piping, including strainer, shutoff valve and flexible connector, for pump. Provide pump suction nozzle with vortex breakers to eliminate loss in NPSH and cavitation. Make connections as shown.

h. Provide factory-lined tank interior with high quality baked epoxy lining. Apply lining to white metal surface in accordance SSPC SP 5/NACE No. 1. Apply four to six coats with each dry coat being approximately 0.38 mm 1.5 mils dry, for a total thickness of 0.152 mm 6 mils dry minimum. Holiday spark test lining using low voltage and a wet sponge to ensure uniform coating free of pin holes.

i. Prime exterior with a high heat silicone acrylic primer, 0.05 mm 2 mil minimum DFT.

2.8.1.3 Deaerator, Atomizing Spray-Type

Provide atomizing spray-type, pressurized horizontal type deaerator. Provode ASME torispherical type heads constructed of ASTM A516/A516M GR 70 carbon steel with a minimum thickness of 6.35 mm 0.25 inch. Fabricate shell plate of ASTM A36/A36M carbon steel with minimum thickness of 6.35 mm 0.25 inch. Provide main deaerating portion, located internally, consisting of water collector and steam atomizing valve. Build spring

loaded water spray nozzle which includes automatic and manual vent valves into a flange on top of the tank.

2.8.1.4 Deaerator, Tray-Type

Provide tray-type deaerator with spray manifold in a 300 Series stainless steel deaeration dome with integral cascade trays, pressurized horizontal type. Flange mount deaeration dome with integral cascade trays containing a spray manifold with stainless steel spray nozzles to the boiler feed receiver. Flange mount manifold to the dome. Make flange opening large enough to permit the manifold to be easily withdrawn for servicing. Install direct injection steam heating assembly in the receiver. Provide heating assembly consisting of double flange mounted injection pipe, steam control valve, pressure-temperature regulator, wye strainer and pressure gauge.

2.8.1.5 Deaerator, Atomizing Spray Two-Tank Type

a. Provide atomizing spray-type two-tank deaerator, divided into two separate sections. Divide deaerator water storage and condensate surge sections by a double inner head. Pack air space between 2 inner spaces with fiberglass insulation and provide a breather and drain connections. Fabricate shell plate of ASTM A36/A36M carbon steel with minimum thickness of 6.35 mm 0.25 inch. Provide ASME torospherical type heads constructed of ASTM A516/A516M GR 70 carbon steel with a minimum thickness of 6.35 mm 0.25 inch.

b. Provide surge tank section with [_____] minutes of storage and a capacity of [_____] liters gallons flooded. Provide a 280 by 380 mm 11 by 15 inch elliptical manhole for access. ASME stamp is not required for the surge tank.

c. Surge tank must receive returning condensate and be supplemented by makeup by water to maintain desired operating level. Vent surge tank to the atmosphere. Transfer collected water to deaerator. Locate main deaerating portion, consisting of water collector and steam atomizing valve, in deaerator storage tank. Build a spring loaded water spray nozzle which includes an automatic and manual vent valve into a flange on top of deaerator storage tank.

d. Provide deaerator and surge tank support of appropriate height to meet the NPSH requirements of the transfer pumps and feedwater pump/motor set.

e. Height of deaerator support must not exceed 1220 mm 48 inches.

2.8.1.6 Chemical Feed Quill

Locate chemical feed quill beneath the normal tank water level. Use stainless steel chemical feed quill material. Provide even distribution and bleeding of chemicals.

2.8.2 Boiler Feed Pump

****

NOTE: Pump manufacturers should be consulted regarding specific features of construction for a particular application. In general, for lower pressure and flow applications vertical in-line

pumps with stainless steel shafts and impellers can be applied. Cast iron or cast steel casings could also be used for these applications. Horizontally split pump casing specifications should require nozzles on the suction and discharge and feet on the lower half of the casing so the top half of the casing can be removed without disturbing the main piping. Designer is required to determine the upper temperature limit for pumps based on the project requirements. Delete design conditions if pump schedule is shown on the drawings.
****

For installations including more than one boiler feed pump, each boiler feed pump must be identical [_____] L/hour gpm, [vertical in-line] [horizontally split case, multi-volute or diffuser], centrifugal, self-contained, multistage pump. The nomenclature used in these specifications pertaining to pumps and hydraulic conditions is as used by the Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps.

2.8.2.1 Design Conditions

Number of pumps	[_____]	
Rated capacity of each pump	[_____]	L gpm
Total dynamic head at rated capacity	[_____]	L gpm
Net positive suction head available	[_____]	m Feet
Maximum allowable shutoff head	[_____]	m Feet
Minimum allowable shutoff head	[_____]	m Feet
Type of fluid pumped	Boiler Feedwater	
Max. expected temp. of fluid	[_____]	degrees C degrees F
Maximum speed of pump	3600	rpm

2.8.2.2 Construction Materials

Provide pump with [_____] Class [_____] suction flange and [_____]Class [_____] discharge flange. Provide stainless steel shaft, impeller, and internals including sleeves and wearing rings containing no less than 11 percent chromium. [Provide closed type horizontal pump impellers, cast in one piece.] Ensure casing is 11 to 13 percent chromium steel. [Provide cast iron suction and discharge chamber.] [Design horizontal pump to pump water at any temperature from 10 to [_____] degrees C 50 to [_____] degrees F without undue temperature strains within pump. Properly balance rotating parts. Dynamically balance assembled rotor. Stagger casing volutes to ensure radial balance of the assembled rotor under operating conditions. On volute pumps, mount impeller on the shaft half facing in one direction and the other half facing in the opposite direction to give axial balance to the motor.]

2.8.2.3 Cooling Water Piping

Furnish pump with complete cooling water system which connects jacket cooler to common header. Factory assemble piping as completely as possible on the pump. Provide Type 316 stainless steel seal flush piping. Provide Type 304 stainless steel seal flush cooler tubing. Provide flow regulating valve and 6.35 mm 1/4 inch bypass needle-valve on each supply branch.

2.8.2.4 Bearings

[Provide horizontal pump including a double row ball type thrust bearing on the outboard end and a single row deep groove radial bearing on the inboard end. Provide splash type bearing lubrication .]

[Provide vertical type pump bearings that are water lubricated sleeve type constructed of babbitted graph alloy with Type 304 stainless steel shaft sleeves.] Design bearings for L-10 bearing life of [_____].

2.8.2.5 Shaft Sealing System

[Equip vertical pump with an effective mechanical shaft seal to seal.] [Fit horizontal pump with balanced mechanical seals, pressurized type, tungsten carbide and carbon sealing faces especially designed for high temperature, high pressure boiler feed pump service. Provide mechanical seals with pumping rings. Provide complete field flush piping from each mechanical seal to its respective seal cooler with a temperature alarm thermometer, adjustment for silencing, range of 10 to 204 degrees C 50 to 400 degrees F with contacts suitable for 100 milliamperes at 125 V dc, closing on rise of temperature.]

2.8.2.6 Shaft Coupling

[Provide direct coupled type shaft coupling between vertical pump and drive.] [Connect horizontal pump directly to its motor by means of a spacer disc type coupling. Provide spacer piece between motor and pump to facilitate removal of coupling flanges and mechanical seals without disturbing the pump or motor hold-down bolts. Disc coupling must be limited and float. Use stainless steel disc. Furnish suitable coupling guards.]

2.8.2.7 Special Tools

Furnish complete set of special tools as required for assembly, disassembly or maintenance of pumps.

2.8.2.8 Pump Characteristics

a. Provide pump discharge head such that the maximum discharge head occurs at shutoff and continually decreases as pump delivery increases. Ensure head capacity characteristics permit stable operation when pump is operating alone or in parallel with another pump.

b. Provide pump with shutoff head of no greater than 150 percent and no less than 115 percent of design head. Ensure design point capacity on the selected pump curve is within 25 percent of the capacity at the best efficiency point for the impeller selected. Ensure minimum flow

required for continuous pump operation is no greater than 30 percent of the specified design flow for each pump.

c. Provide pump with an efficiency of 60 percent or greater at rated capacity.

2.8.2.9 Horizontal Pump Accessory Equipment

Provide the following as package from pump manufacturer:

a. Pump and drive, mounted on a suitable, full length baseplate.

b. Suitable vent valves for the pump.

c. Stainless steel orifice plate for minimum flow across the pump.

d. Standard accessories and integral piping required for complete unit.

e. One flanged end suction tee type strainer of corrosion resistant materials, of size compatible with suction piping. Use tee type strainer with fine mesh screen fitted over it for use during startup period. Remove fine mesh screen after condensate system is clean.

f. One set of spare pump gaskets and "O" rings.

g. Renewal parts for mechanical pump seal.

2.8.3 Deaerator Control

Furnish completely wired control cabinet, mounted on pump unit or free-standing. Provide cabinet with hinged door and include the following:.

a. Combination magnetic starters having 3 overload relays, with circuit breakers and cover interlocks.

b. Auto Lead-Lag-Off-Continuous selector switches.

c. Pilot lights indicating pump operation.

d. Control circuit disconnect switch.

e. Terminal block.

f. Control circuit transformer, fused.

g. Momentary contact Test pushbuttons.

h. Deaerator Control Panel meeting the following requirements:

(1) Construction: Properly size deaerator control panel to contain control devices, instrument gauges and meters. Provide unit mounted or free-standing deaerator control panel with face-plate of no less than 4.7 mm 3/16 inch reinforced steel plate. Ensure control cabinet is factory-assembled steel enclosure with locking door. Provide panel consisting of NEMA 4 construction, 12 gauge steel all welded construction with minimum radius corners, stiffened as required and framed with angles. Construct the door of 12 gauge steel with door clamps and continuous hinge. Ensure

door is fully gasketed.

(2) Wiring: Wire deaerator control panel in accordance with NFPA 70 and provide individual motor starter with 120 volt holding coil and fuse protection. Provide individual green oil-tight pump run lights. Provide NEMA 4 rated switches and light with nameplate identification. Paralleling of individual control power transformers will not be permitted. Provide panel with main disconnect device, consisting of nonfused disconnect or nonautomatic circuit breaker. Equip disconnect with mechanical door interlock preventing door opening the disconnect in closed position. Provide cartridge type fusing. Provide multiple horsepower rated, heavy duty type dual element, current limiting, time delay safety switches. Provide NEMA type, full voltage, non-reversing magnetic motor starter for motor assembly , which isoverload protected for each phase, and with auxiliary contacts. Ensure overload relay is trip-free, thermal bimetallic, manual reset with trip heaters based on actual full load current of motor. Provide spare NO and NC auxiliary contacts wired to the terminal block. Provide control power transformer with primary fuse disconnect and secondary fusing. Provide factory mounted and wired control, arrange to receive a signal from the boiler plant master controller and water regulating valve assembly. Match quantity of deaerator feedwater pumps to the quantity of boilers. Provide panel mounted Lead-Lag-Off-Continuous switch for each feedwater pump.

(3) Sequence of Operation: From cold start of plant, when plant master controller indicates one boiler to start, start lead pump. When second boiler is indicated to start, start lag pump and continue this process for additional boiler starts. Run feedwater pumps continuously. When one boiler shuts down, shut down one feedwater pump. When all boilers are off, all pumps must be off. Should there be a failure of any pump, operate the next pump in sequence automatically. Provide audible and visual high and low water level alarms by bell or horn with silence switch and individual red oil tight lights. Use a low-low water level signal to cut off feedwater pumps. Deaerator water level control system must provide a 4-20 mA dc signal to the condensate receiver control panel to start transfer pumps.

2.9 CONDENSATE RETURN SYSTEM

****
NOTE: Coordinate the components of this system with the deaerator selection. Some components are specified with the two tank-type deaerator.
****

Provide condensate return system that is a factory assembled package system including condensate surge tank, transfer pumps, controls, auxiliary equipment and piping as shown.

2.9.1 Condensate Surge Tank

Provide condensate surge tank with a [_____] mm inch diameter by [_____] mm inch long with 280 by 380 mm 11 by 15 inch elliptical manhole. Provide condensate surge tank with [_____] minutes of storage and capacity of [_____] liters gallons flooded. Provide condensate surge tank, base,

piping nozzle construction as specified. Include the following:

a. Required tappings and manway.

b. Thermometer.

c. Gauge glass.

d. Water level controller with make-up valve.

e. Three-valve bypass and strainer for control devices.

f. Suction shutoff valve.

g. Suction strainer.

h. Suction flexible fitting.

i. Pump discharge check valve.

j. Discharge shutoff valve.

k. Pump suction and discharge gauge.

l. Discharge manifold.

m. Chemical feed quill.

n. Sparge tube.

o. High water level alarm.

p. Low water level alarm.

q. Low water pump cut-off.

r. Recirculation orifice.

s. Insulation and lagging.

t. Transfer pump and motor.

u. Control panel.

2.9.1.1 Gauge Glass

Provide surge tank with gauge glass assembly that covers entire tank diameter. Provide quartz gauge glass with 16 mm 5/8 inch diameter by 610 mm 24 inch maximum length. Furnish gauge glass with bronze gauge cock set and protector rods.

2.9.1.2 Makeup Valve and Controller

a. Provide motorized makeup valve with steel body and threaded connections. Provide gear type makeup valve directly coupled to the valve stem and control electronically by solid state controller with internally mounted capacitance probes. Maintain water level setpoint. Provide controller with hand selector for automatic and manual operation. Ensure makeup valve does not exceed 69 kPa 10 psig

pressure drop and is rated for 150 degrees C 300 degrees F.

b. Provide makeup valve rated for [_____] kPa psi 1/hr. inlet pressure and ensure valve C_v does not exceed [_____]. Include two additional probes for high and low water level alarms.

2.9.1.3 Sparge Tube

Locate sparge tube beneath normal tank water level. Construct sparge tube of 50 mm 2 inch pipe. Provide even distribution of high pressure condensate return.

2.9.2 Condensate Pump

****
NOTE: Pump manufacturers should be consulted regarding specific features of construction for a particular application. Specifications are included for horizontal end suction and vertical type pumps. Careful consideration will be given to the type of pump selected. The Pump Column paragraph applies only to vertical type pumps and should be deleted if horizontal type pumps are selected. Delete design conditions if pump schedule is shown on drawings.
****

Condensate pumps must be [_____] identical [_____] L/hour gpm, [horizontal end suction ANSI size A70 type pumps][vertical type pumps with suction barrels] type. Nomenclature used in this specification pertaining to pumps and hydraulic conditions is that used by the Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps.

2.9.2.1 Design Conditions

Number of pumps	[_____]	
Rated capacity of each pump	[_____]	L gpm
Total dynamic head at rated capacity	[_____]	L gpm
Net positive suction head available	[_____]	m Feet
Maximum allowable shutoff head	[_____]	m Feet
Type of fluid pumped	Boiler Feedwater	
Maximum expected temperature of fluid	[_____]	degrees C degrees F
Maximum speed of pump	1800	rpm

2.9.2.2 Construction and Materials

Provide [centrifugal, horizontal end suction, top discharge type] [vertical, multistage, self contained type with suction barrel] pump. Include [_____] Class [_____] suction flange and [_____] Class [_____] discharge.

2.9.2.3 Casing and Casing Bowls

Flange pump [casing] [casing bowls] and bolt with jacketing top bolt. [Construct casing of ductile iron ASTM A395/A395M, Grade 60-40-18.] Provide flanged casing bowls, constructed of ASTM A48/A48M Class 30 cast iron equipped with pinned, replaceable wearing rings constructed of ASTM A276/A276M Type 316 stainless steel with 11 to 13 percent chrome hardened to 450 BHN. Provide unlined bowls. Design bowl assemblies to withstand an operating pressure of 4.3 MPa 630 psi. [Use minimum casing thickness for horizontal pumps of 12.7 mm 1/2 inch with an additional 3.2 mm 1/8 inch corrosion allowance.]

2.9.2.4 Impeller

[Impeller for horizontal type pump must be totally open type, screw mounted directly to shaft with an 0-ring seal and constructed of ductile iron ASTM A536, Grade 60-40-18. Balance impeller dynamically to the maximum rated speed.] [Provide enclosed, split ring, key mounted type impeller for vertical can type pumps constructed of 11 to 13 percent chrome steel in accordance with ASTM A743/A743M or 316 SS ASTM A290/A290M GR CF-8M. Provide impeller with replaceable wearing rings constructed of 11 to 13 percent chrome hardened to 300 BHN. Statically and dynamically balance impeller to maximum rated speed. Ensure impeller is 95 percent of maximum allowable impeller diameter.]

2.9.2.5 Pump Shaft

[Construct pump shaft and shaft sleeve for horizontal pumps of Type 316 stainless steel. Ensure shaft diameter and design is sufficient to transmit at least 2.5 times rated motor power of the pump.] [Provide one piece pump shaft for vertical type pumps constructed of ASTM A582/A582M Type 416 stainless steel. Supply largest diameter shaft available for use with selected impeller that is able to transmit at least 2.5 times rated motor power.]

2.9.2.6 Pump Construction

[Construct pump and bearing frame and housing of cast iron, ASTM A48/A48M.] [Provide discharge head and suction barrel with mounting flange constructed of carbon steel, designed in accordance with ASME BPVC SEC VIII D1 with a 7.6 mm 300 mil corrosion allowance. Also provide sole plate constructed of a minimum of 25 mm 1 inch thick carbon steel plate with a minimum of four 19 mm 3/4 inch anchor bolts. Ensure welds on the pressure containing section of the pump are the full penetration type with welders and welding procedures in accordance with ASME BPVC SEC IX. Size suction barrel so that the velocity in the barrel does not exceed 915 mm 3 feet per second at 150 percent of design flow. Discharge head and can type must be the "T" type configuration so that discharge and suction are above baseplate. Provide suction barrel of sufficient length to accommodate installation of 2 additional turbine stages.]

2.9.2.7 Pump Column

Provide flanged pump column constructed of carbon steel. Design pump column assembly to withstand 4.1 MPa 600 psig and incorporate 7.6 mm 300 mil corrosion allowance. Construct bearing retainers located in the pump column in a manner that will assure concentric alignment of the shaft

within 0.13 mm 0.005 inches.

2.9.2.8 Miscellaneous Hardware

Provide Type 316 stainless steel bolts, lock washers, nuts and miscellaneous hardware used with casing, pump frame and gland.

2.9.2.9 Shaft Sealing System

Equip pump with effective mechanical shaft seal to seal against discharge pressure when pump is operating. Provide cartridge type seals with Hastalloy "C" bellows mounted on Type 316 stainless steel shaft sleeve. Use tungsten carbide seal faces versus silicon carbide. Provide one spare mechanical seal. Provide flush vent and drain type gland constructed of ASTM A276/A276M Type 316 stainless steel. Also provide bypass line, constructed of ASTM A269/A269M Type 316 stainless steel, from the stuffing box to the suction side of the pump.

2.9.2.10 Pump Bearings

[Provide anti-friction type horizontal end suction pump bearings and operate in oil bath. Design pump bearings for radial and unbalanced axial loads imposed by the pump.] [Provide vertical type pump bearings that are water lubricated sleeve type constructed of babbitted graph alloy with Type 304 stainless steel shaft sleeves.] Design bearings for L-10 bearing life of [_____] hours.

2.9.2.11 Shaft Coupling

Provide shaft coupling between the pumps and motors of the flanged, adjustable, rigid, spacer type with OSHA approved coupling guard. [On horizontal end suction type pump, this coupling must facilitate removal of the mechanical seal without removing the driver.] Also design shaft coupling to transmit at least 2 1/2 times the motor power rating.

2.9.2.12 Painting and Corrosion Protection

Protect pumps, motors and accessories prior to initial startup. Thoroughly clean and smooth unfinished work. Factory paint surfaces which will not be in contact with the pumping fluid with a finish coat. Coat internal surfaces with a water soluble rust preventative material.

2.9.2.13 Special Tools

Provide complete set of special tools, if required for assembly, disassembly or maintenance of pump.

2.9.2.14 Bedplate

Provide horizontal type pump which includes single bedplate long enough to accommodate pump, motor drive and cooler. Provide bedplate in accordance with API and of heavy rigid construction, made of suitably structural steel members and plate to provide a stable platform for pump, drive and accessories. Suitably reinforce and brace bedplate to minimize deflection or bending during shipment and erection. Provide sufficient grout holes, minimum 75 mm 3 inch diameter, and grouting area vent holes in each corner of each grout space. Provide bedplate including horizontal jacking screws and vertical leveling screws along the length and width. Make provisions on the bedplate to collect drainage from the unit at one point. Locate

and drill hold down bolts and dowel holes in field. Mount pump on bedplate at factory and ship as unit with bedplate mounted on a suitable skid to prevent deformation of the bedplate during shipment and erection.

2.9.2.15 Alignment

Precision align pump unit. Mount and matchmark pump coupling, mechanical seal and motor prior to shipment. Maximum allowable shaft runout must be 0.05 mm 0.002 inch as measured at impeller end.

2.9.2.16 Pump Characteristics

a. Pump discharge head must be such that maximum discharge head occurs at shutoff and continually decreases as the capacity increases. Ensure head capacity characteristics permit stable operation when pump is operating alone or in parallel with another pump.

b. Pump must have a shutoff head of no greater than 150 percent and no less than 115 percent of design head. Design point capacity on the selected pump curve must be within 25 percent of capacity at best efficiency point for impeller diameter selected to meet design point conditions. Minimum flow required for continuous pump operation must not be greater than 30 percent of specified design flow for each pump.

c. Provide pump with efficiency of 50 percent or greater at rated capacity.

2.9.3 Sump Pump

Provide sump pump for sump pit shown. Provide heavy duty, upright type sump pump, certified by the Sump and Sewage Pump Manufacturers' Association.

2.9.3.1 Design Conditions

Motor Power	[_____]	kW
Minimum capacity (including suction and friction losses)	[_____] L/hr at head of [_____] m [_____] gph at head of [_____] feet	
Shutoff head	[_____]	m feet
Maximum fluid temperature	[_____]	degrees C degrees F

2.9.3.2 Construction

Bronze fitted cast iron volute with non-clogging cast bronze impeller and stainless steel sediment screen. Use brass upright column. Discharge connection must be ISO NPT. Furnish high efficiency non-clogging impeller with stainless steel shaft journal and bearing suitably designed for intended service.

2.9.3.3 Backwater Valve

Provide a backwater valve in the pump discharge.

2.9.3.4 Float Switch

Actuate float switch by an adjustable copper float mounted on stainless steel rod.

2.9.4 Pump Drive

****
NOTE: Delete the Steam Turbine Drives paragraph if all-electric motor drives are used and the Electric Drives paragraph if all-steam turbine drives are used.
****

2.9.4.1 Steam Turbine Drive

Provide steam turbine drive rated for the specified operating conditions and designed in accordance with NEMA SM 23. Provide turbine of the single or multiple valve design and utilize impulse type blading. Provide flexible support for thermal expansion at governor end of turbine. Ensure turbine is horizontally or vertically split case with metal to metal joints without the use of gaskets. Properly lubricate journal bearings as recommended by turbine manufacturer for operating conditions. Provide anti-friction bearings that have L-10 bearing life of [_____] hours. Use thrust bearings of [ball] [tilting pad] design. Do not weld turbine blading. Ensure turbine blading issecurely anchored and renewable. Provide blading material consisting of minimum stainless steel and suitable for steam quality and purity. Seal steam glands [interstage diaphragms] with carbon rings or labyrinths. Finish turbine shaft with hard chrome in gland sealing zones. Provide turbine with single governor to control valve(s). Ensure governor is NEMA SM 23 Class [_____]. Furnish hand valves in cases where operating conditions will be substantially different than design or where future operating conditions will change. Provide overspeed trip set at 110 percent of the normal operating speed. Ensure overspeed trip is NEMA SM 23 Class [_____]. Include manual trip lever. Factory test turbine to check operation.

2.9.4.2 Electric Drive

Motor must be [splashproof] [totally enclosed, nonventilated] [totally enclosed, fan cooled] [totally enclosed, fan cooled suitable for installation in a class II, division 1, group G hazardous location as defined in NFPA 70]. Motor starter must be [manual] [magnetic] [across the line] [reduced voltage] type with [general purpose] [weather resistant] [watertight] [dust tight] [explosion proof] enclosure.

2.9.5 Condensate Return System Control

Furnish completely wired control cabinet, mounted on condensate return equipment or free-standing. Provide cabinet with hinged door and include the following:

a. Auto Lead-Lag-Off-Continuous selector switch.

b. Pump running Pilot light.

c. Control circuit disconnect switch.

d. Terminal block.

e. Control circuit transformer, fused.

f. Momentary contact Test pushbutton.

g. Control Panel meeting the following requirements:

(1) Construction: Size the condensate return surge tank control panel properly to contain all control devices, instrument gauges and meters. Ensure control cabinet is factory assembled steel enclosure with locking door. Provide panel consisting of NEMA 12 construction, 11 gauge steel with key-locking vault handle, three (3) point latches, and continuous hinge. Provide fully gasketed door.

(2) Wiring: Wire control panel in accordance with NFPA 70 and include individual motor starter with 120 volt holding coil and fuse protection. Provide individual green oil-tight pump run lights. Provide switches and lights with nameplate identification. Paralleling of individual control power transformers is not permitted. Provide panel with a non-fuse disconnect or non-automatic circuit breaker main disconnect device . Equip disconnect with mechanical door interlock preventing door opening with the disconnect in the closed position. Use cartridge type fusing. Use dual element, current limiting, time delay safety switches which are multiple horsepower rated, heavy duty type. Provide magnetic motor starter for each motor assembly that is NEMA type, full voltage, non reversing, overload protected for each phase, with auxiliary contacts. Ensure overload relay is trip-free, thermal bimetallic, manual reset with trip heaters based on actual full load current of motor. Provide spare NO and NC auxiliary contacts wired to the terminal block. Provide control power transformer with primary fuse disconnect and secondary fusing. Provide factory mounted and wired control, arrange to receive a signal from the deaerator water level assembly. Provide a panel mounted Lead-Lag-Off-Continuous switch for feedwater pump.

(3) Sequence of Operation: From a cold start, when the plant master controller indicates one boiler to start, start the lead pump and operate continuously. When all boilers are off, all pumps must be off. Should there be a failure of any pump, operate the next pump in sequence automatically.

2.10 BOILER BOTTOM BLOWDOWN TANK

Provide blowdown tank with [_____] mm inches diameter by [_____] mm inches high. Provide supports, associated accessories and appurtenances as specified and shown. Provide blowdown tank consisting of welded steel construction built in accordance with ASME BPVC SEC VIII D1 and stamped for a 1.03 MPa 150 psig rating. Include a tangential inlet, size to match boiler blowdown pipe, stainless steel striking plate at point of inlet impingement, internal stainless steel flow restrictor plates, waterleg type drain vent, gauge glass opening, inspection opening and clean-out connections. Use materials in fabrication of boiler blowdown tank equipment in compliance with ASME BPVC SEC II-C. Provide inspection openings on tank as required in paragraphs UG-45 and 46 of ASME BPVC SEC VIII D1 and as shown. Provide connections as shown. Ensure interior surface preparation is in accordance with SSPC SP 5/NACE No. 1

and the coating manufacturer's recommendations. Coat interior with a suitable baked epoxy phenolic coating, minimum 0.13 mm 5 mil DFT. Ensure exterior surface preparation is in accordance with SSPC SP 6/NACE No.3 and the coating manufacturer's recommendations. Prime exterior with a high heat silicone acrylic primer, minimum 0.05 mm 2.0 mil DFT. Supply the blowdown tank with drain aftercooler and temperature regulating valve. Provide aftercooler with cold water inlet, flanged body for easy removal, 6.35 mm 1/4 inch NPTF connection for temperature regulating valve sensing bulb. Use valve adjustable range of 43 to 65 degrees C 110 to 150 degrees F. Provide a thermostatic regulating valve to inject potable water to maintain acceptable discharge temperature to the sewer.

2.11 BOILER SURFACE BLOWDOWN HEAT RECOVERY SYSTEM

2.11.1 General Requirements

Provide blowdown flush separator that is [_____] mm inches in diameter by [_____] mm inches high. Provide supports, associated accessories and appurtenances in accordance with these specifications and as shown. Provide steel tank consisting of welded construction in accordance with ASME BPVC SEC VIII D1 and stamped for a 1.0 MPa 150 psig rating. Provide tank with a tangential inlet connection sized to match the boiler blowdown pipe, stainless steel striking plate at the point of inlet impingement, internal stainless steel flow restrictor plates, float level control, gauge glass openings, inspection opening and clean-out connection. Provide thermostatic regulating valve to inject potable water to maintain acceptable discharge temperature to sewer.

2.11.2 Materials

Use materials in fabrication of boiler blowdown equipment in compliance with ASME BPVC SEC II-C. Provide inspection openings on tank as required in Paragraphs UG-45 and 46 of ASME BPVC SEC VIII D1 and as shown. Provide connections as shown. Ensure interior surface preparation is in accordance with SSPC SP 5/NACE No. 1 and the coating manufacturer's recommendation. Coat interior with a suitable baked epoxy phenolic coating, minimum 0.13 mm 5 mil DFT. Ensure exterior surface is in accordance with SSPC SP 6/NACE No.3 and coating manufacturer's recommendations Prime exterior with high heat silicone acrylic primer, minimum 0.05 mm 2.0 mil DPT. Pipe flash separator to heat exchanger. Provide heat exchanger consisting of horizontal U-tube with removable tube bundle and of self-draining type. Blowdown water must pass through shell and cooling water must pass through tubes. Provide stainless steel tubes with rear supporting baffle. Provide steel side welded shell with anti-vibration hold-down clamps, ASME Code stamping for 1.03 MPa 150 psig rated for 208 degrees C 400 degrees F and supporting structural steel stand. Supply heat exchanger with drain aftercooler and temperature regulating valve. Provide aftercooler with cold water inlet, flanged body for easy removal, 6.35 mm 1/4 inch NPT connection bimetallic thermometer, and 25.4 mm 1 inch NPTE connection for temperature regulating valve sensing bulb. Use valve adjustable range of 43 to 65 degrees C 110 to 150 degrees F.

2.11.3 Monitor-Controller

Provide one electronic monitor-controller for use in boiler surface blowdown line for each boiler, consisting of:

a. Control concentration of total dissolved solids (TDS). House

monitor-controller in a painted steel NEMA 12 enclosure. Interlock boiler surface blowdown control with boiler operation.

b. Ensure panel display includes the following:

(1) Long-life LED indicators on front panel and labeled power and control.

(2) Manually-operated two position switch to allow operator to turn monitor-controller on or off. Manually-operated two position switch to allow operator to test the output circuits.

(3) Manually operated two position switch to allow the operator to select either a low or high scale of conductivity.

(4) A manually operated two position switch to allow the operator to continuously read system conductivity level or to set or read the front panel operator adjustable trip point.

(5) Calibration adjustment.

(6) Timer for adjustment of intervals between sampling periods.

c. Provide one prepiped blowdown piping assembly installed in each boiler surface blowdown line. Provide assembly consisting of:

(1) Shut-off valve 19 mm 3/4 inch rated for system operating pressure and temperature.

(2) Conductivity probe.

(3) Normally closed motorized flow control valve [[19 mm 3/4 inch] rated for system operating pressure of [1150 kPa 150 psig] and temperature up to [200 degrees C 400 degrees F]] [_____].

(4) Throttling valve [19 mm 3/4 inch] [_____] rated for system operating pressure and temperature.

(5) Temperature compensation probe.

2.12 CHEMICAL FEED SYSTEM

Provide chemical feed system for steam and condensate chemical treatment consisting of introduction of chemical solutions into deaerator, boiler and boiler feedwater lines. Ensure chemical feed system is the automatic proportioning pump type for single or multiple boiler installation and consists of pumps, tank, piping, control and accessories. Provide chemical feed system consisting of a completely preassembled package, factory tested, hydraulically and electrically, and furnish with required special tools, lubricants, and installation instructions. Provide chemical feeding and control equipment for the following:

a. For each boiler:

(1) Boiler scale inhibitor and antifoaming chemical treatment.

(2) Alkalinity supplement.

(3) Neutralizing amines.

b. For deaerator feedwater condensate return systems: chemical treatment consisting of oxygen scavenger such as sodium sulfite.

Provide a 1 year supply of chemicals. Ensure chemical products are compatible with system materials of construction and operating conditions and comply with all applicable regulatory agencies. Interlock the chemical feeder with boiler and deaerator operation.

2.12.1 Chemical Feed Pump and Tank

Provide chemical feed pump and tank as indicated. Ensure chemical feed pump and tank is a package with pump mounted and piping connected to the tank. Provide chemical feed pump capacity as indicated. Provide positive displacement metering type chemical feed pump. Provide chemical feed pump with micrometer capacity adjustment from 0-100 percent while the chemical feed pump is running and metering accuracy within plus or minus one (1) percent. Provide chemical feed pump components constructed of materials suitable for the chemicals being pumped. Provide 120 volts ac, 60 Hz, single phase drive motors, with general purpose dripproof enclosure. Fabricate chemical feed tank of materials suitable for chemicals used and provide with fill and chemical feed drain connections and gauge glass. Furnish chemical feed tank with one chemical feed pump, mounted and piped with piping and fittings constructed of materials suitable for the chemicals being pumped, and include a suction strainer and 13 mm 1/2 inch relief valve. Provide chemical feed tank with hinged cover. Ensure chemical feed tank bottom is dished concave to radius equal to diameter of tank.

2.12.2 Agitator

Equip chemical feed tank with agitator. Provide motor driven agitator with Type 316 stainless steel impeller and drive shaft. Maximum speed is 1750 rpm. Mount agitator and support on chemical feed tank.

2.12.3 Boiler Chemical Treatment System

****
NOTE: For steam boiler plant with more than one boiler select a bulk storage system 800 liters 200 gallons for each chemical or dedicated feeder system for each chemical with individual drums 200 liters 50 gallons for the chemical treatment for boilers listed above.
****

Provide the following for each boiler:

a. Three chemical feed pumps. Provide each pump with a pressure relief valve piped on discharge side of the pump to divert overpressurized chemical solution back to the storage tank. Ensure chemical feed pumps have the capability of accepting 4 to 20 mA dc signal.

[b. One 800 liter 200 gallon bulk storage tank.]

[c. Three 200 liter 50 gallon drums.]

d. One connecting head water meter. Use maximum operating pressure of 1650 kPa 225 psig and maximum temperature of 120 degrees C 250 degrees

F. Provide turbine type water meters with cast iron Maine cases.

e. Proportional chemical feed controller and electronic pulse timer. Control proportional feed of treatment chemicals based on feedwater as measured by a contacting head water meter. Provide controller with the following features:

(1) Painted steel NEMA 12 enclosure.

(2) Panel display including: proportional pulse timer, automatic-off-manual switch, push-to-test momentary switch which simulates a water meter pulse and runs the timer for one cycle, 12-volt signal to water meter, and pulse accumulator.

2.12.4 Deaerator Condensate Return System Chemical Treatment System

****
NOTE: Select 200 liters 50 gallons drum for boiler plant up to 22,650 kg/hr
****

Provide one feedwater chemical treatment system for deaerator including the following:

a. One chemical feed pump. Provide chemical feed pump with pressure relief valve piped on discharge side of chemical feed pump to divert overpressurized chemical solution back to the storage tank. Ensure chemical feed pump is capable of accepting 4 to 20 mA dc signal.

b. [One 8000 liter 200 gallon tank.][or][One 200 liter 50 gallon tank.]

c. Provide one contacting head water meter. Use maximum operating pressure of 1650 kPa 225 psigand maximum temperature of 120 degrees C 250 degrees F. Provide turbine type meter with cast iron Maine case.

d. Proportional chemical feed controller and electronic pulse timer. Control proportional feed of treatment chemicals based on makeup water as measured by contacting head water meter. Provide controller with the following features:

(1) Painted steel NEMA 12 enclosure

(2) Panel display including one proportional pulse timer, Automatic-Off-Manual switch. Test momentary switch which simulates a water meter pulse and runs timer for one cycle, and pulse accumulator.

2.12.5 Testing Equipment

Provide testing equipment, including carrying case and spare reagent, for maintaining control of a program of water treatment standards in steam boiler system in accordance with the water treatment plan. Submit a plan for water treatment, including proposed chemicals to be used and nationally recognized testing codes applicable to the system, prior to system startup. Provide testing equipment consisting of the following:

a. Reagents and apparatus for determination of phosphate and sulfite levels in the boiler water.

b. Reagents and apparatus for determination of PH, P and M alkalinity and chloride.

c. Reagents and apparatus for determination of neutralizing amine level in the steam and condensate return lines.

d. One conductivity meter with temperature compensation and multiple measurements ranges of 0-10, 0-100, and 0-10,000 micromhos.

e. Wall mounting test equipment cabinet for storage of testing glassware and reagents. Provide cabinet with one shelf, keylock door and fluorescent light. Construct cabinet of 1 mm No. 18 gauge thick cold-rolled steel, primed and painted with white polyurethane enamel for corrosion protection.

f. Prefabricated steel corrosion nipple bypass assembly to monitor program effectiveness. Include inlet and outlet shut-off valve, wye strainer, and two corrosion nipples.

2.13 WATER SOFTENING EQUIPMENT

****

NOTE: Insert water analysis specific to the site. Insert desired water treatment conditions, e.g. pH level, hardness, chemical concentrations.

****

a. Provide a [single] [double] unit automatic water softener system as indicated. Design water softener system for working pressure of [_____] MPa psi. Provide water softener system complete with raw and regenerate water distribution; under drain, inlet and outlet connections in upper and lower header respectively; resin removed connecting pipe legs; control valve for service, backwash, regenerate, and rinse; water meters, pressure gauges, brine storage, measuring tank and controls. Provide test sets for pH comparator for range [_____] to [_____], sulfide comparator, and phosphate comparator.

b. Influent water analysis for which system must be designed is [_____].

c. Treatment conditions to be maintained in circulation water are [_____].

2.14 MAINTENANCE EQUIPMENT

2.14.1 Tube Cleaner

Provide water turbine driven tube cleaner that includes three rotary cutters, complete with necessary length of armored water hose, valves, and other appurtenances necessary for operation. Provide tube cleaner for each size of watertube in boiler, with one extra set of cutters for each size cleaner. Provide necessary valves and fittings to permit convenient connection of tube cleaner hose boiler feed pump to supply cold raw water for operation of tube cleaner. Arrange piping such that one boiler feed pump may be used to operate tube cleaner without interfering with normal operation.

2.14.2 Tube Brush

****

NOTE: The tube brush applies only to firetube boilers and will be deleted if not applicable.
****

Provide brush with steel bristles and jointed handle of sufficient length to clean full length of fire tubes.

2.15 FACTORY COATING

Factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish unless otherwise specified.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, EXCEPT FUEL SYSTEM

Install work as indicated and in accordance with manufacturer's diagrams and recommendations and applicable requirements of FM and NFPA.

3.2.1 Piping

a. Unless otherwise specified, use pipe and fittings conforming to requirements of ASME B31.1. Cut pipe to measurements established at the jobsite and work into place without springing or forcing, completely clearing windows, doors, and other openings.

b. Install pipes a minimum of 2.4 m 8 feet above walkway elevations.

c. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval.

d. Remove burrs from pipes by reaming and install to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Wipe filings, dust, or dirt from interior of pipe or tubing before connections are made.

e. Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Ensure centerline radius of bends is no less than 6 diameters of pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Carry vent pipes through the roof as directed and flash.

f. Unless otherwise indicated, pitch horizontal supply mains down in direction of flow with a grade of no less than 25 mm in 12 meters 1 inch in 40 feet.

g. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

h. Pipe not otherwise specified must be uncoated. Provide brass or bronze unions for copper pipe or tubing.

i. Electrically isolate connections between ferrous piping and copper piping from each other with dielectric couplings or other approved methods.

j. Provide pipe and fittings of the types indicated in TABLES I and II for the applicable service and pressure.

3.2.2 Joints

Provide threaded, flanged, or welded joints between sections of pipe and between pipe and fittings as specified. Except as otherwise specified, ensure fittings 38 mm 1-1/2 inches and smaller are either threaded or socket welded, and fittings 50 mm 2 inches and larger are either flanged or butt welded. Weld pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches under concrete floor slabs. Unless otherwise specified or indicated, make connections to equipment with black malleable iron unions for pipe 38 mm 1-1/2 inches or smaller in diameter, and with flanges for pipe 50 mm 2 inches or larger in diameter.

3.2.2.1 Threaded Joints

Make threaded joints with tapered threads properly cut, and make tight with PTFE tape, or equivalent joint compound material applied to the male threads only. Do not apply joint compound to fittings.

3.2.2.2 Welded Joints

a. Make welded joints as specified. Make changes in direction of piping with welding fittings only.

b. Branch connection may be made with either welding tees or branch outlet fittings. Provide forged branch outlet fittings, flared for improvement of flow where attached to the run, and reinforced against external strains.

c. Bevel, align, heat treat, and inspect weld conforming to ASME B31.1.

d. Remove weld defects and make repairs to the weld, or remove weld joints entirely and reweld.

e. Store and dry electrodes in accordance with AWS D1.1/D1.1M or as recommended by manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating.

3.2.2.3 Expansion Joints

Perform guiding of piping on both sides of expansion joint in accordance with published recommendations of manufacturer.

3.2.2.4 Flanges and Unions

Ensure flanges are faced true, provided with metallic spiral wound nonasbestos gaskets, and made square and tight. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.2.3 Supports

3.2.3.1 General

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions will contain notes indicating that hanger loads between panel points in excess of 22.7 kg 50 lbs steel joist must have the excess hanger loads suspended from panel points.

Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase in item a. if no seismic details are provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, will be included in the contract documents.

Support for steam piping from boiler nozzle to steam header and steam lines 150 mm 6 inches and larger will be detailed on the drawings as excessive stress and movement can occur in these piping systems due to thermal expansion. Each spring hanger location will be clearly indicated. They will be assigned a number in a schedule on the drawings that lists hanger details, load, and movement.

****

Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while supporting the load. Install pipe guides and anchors to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement when operating temperatures exceed ambient temperatures by variable spring hangers and supports or by constant support hangers. Submit detailed drawings of spring type pipe hangers, before installation. Ensure pipe hanger loads suspended from steel joists between panel points do not exceed 23 kg 50 pounds. Suspend loads exceeding 23 kg 50 pounds from panel points.

a. Seismic Requirements for Pipe Supports and Structural Bracing: Support and brace piping and attached valves to resist seismic loads as specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC. Provide structural steel required for reinforcement to properly support piping, headers, and equipment but not shown under this section. Use material for supports as specified under Section 05 12 00 STRUCTURAL STEEL.

b. Structural Attachments: Provide structural steel brackets required to support piping, headers, and equipment, but not shown, under this section. Provide material and installation as specified under Section 05 12 00 STRUCTURAL STEEL.

3.2.3.2 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts and supports conforming to MSS SP-58 except as otherwise specified.

a. Do not use Types 5, 12, and 26.

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

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

d. Torque Type 19 and 23 in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Do not construct C-clamp body from bent plate.

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

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

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

h. Space horizontal pipe supports as specified in the tables in MSS SP-58 and do not install a support over 300 m 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe support as required for specified hydrostatic tests. Do not space pipe supports over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Ensure spacing of the base support members does not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Connect clips or clamps rigidly to the common base member. Provide a clearance of 3.2 mm 1/8 inch between the pipe and clip or clamp for piping which may be subjected to thermal expansion.

i. Support vertical pipe at each floor, except at slab on grade, and at intervals of no more than 4.5 meters 15 feet, nor more than 2.4 m 8 feet from ends of risers, and at vent terminations.

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

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

(2) Where there are high system temperatures and welding to piping is not desirable, use type 35 guide including a pipe cradle, welded to the guide structure and strapped securely to the pipe.

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

(3) Insulated pipes: Except for type 3, use pipe hangers on horizontal insulated pipe that are the size of the outside diameter of the insulation.

3.2.3.3 Piping in Trenches

****

NOTE: Detail pipe in trenches on the drawings. Show exact locations of pipe supports. Include individual hanger identification. Provide schedule of data to include, but not be limited to identification number, detail references, load, and movement.

****

Support piping as indicated.

3.2.4 Pipe Anchors

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

3.2.5 Pipe Sleeves

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Provide rectangular and square openings as indicated. Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Unless otherwise indicated, use sleeves of a size that will provide a minimum of 6.35 mm 1/4 inch all around clearance between bare pipe or insulation jacket and sleeves. Ensure sleeves in bearing walls, waterproofing membrane floors, and wet areas are steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in non-fire rated walls and floors as indicated and specified in Section 07 92 00 JOINT SEALANTS, and in fire rated walls and floors seal as indicated and specified in Section 07 84 00 FIRESTOPPING. Sleeve pipes passing through wall waterproofing membrane as described above. In addition, install a waterproofing clamping flange as indicated.

3.2.5.1 Pipes Passing Through Roof or Floor Waterproofing Membrane

Install pipes through a 1.8 kg 4 pound lead flashing sleeve, a 0.450 kg 16 ounce copper sleeve, or a 0.8 mm 0.032 inch thick aluminum sleeve, each having an integral skirt or flange. Form flashing sleeve suitably, and

extend the skirt or flange no less than 200 mm 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend flashing sleeve up the pipe a minimum of 50 mm 2 inches above the highest flood level of the roof or a minimum of 250 mm 10 inches above the roof, whichever is greater, or 250 mm 10 inches above the floor. Seal the annular space between the flashing sleeve and the bare pipe or metal jacket covered insulation as indicated. Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.5.2 Counterflashing

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

3.2.5.3 Sealing Uninsulated Pipes or Conduits

A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing, as specified, of annular space between pipe and sleeve or conduit and sleeve. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Assemble links loosely with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.2.6 Escutcheons

Povide escutcheons at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep type escutcheons. Fasten chromium plated iron or chromium plated brass, either one piece or split pattern, escutcheons securely to pipe or pipe covering and hold in place by internal spring tension or setscrew.

3.2.7 Clay Sewer Pipe

Install pipe where indicated for housing steam supply and condensate return lines. Install sewer pipe on properly graded and well tamped earth or gravel base. Pack joints with twisted jute packing and seal with bituminous sealing compound or portland cement mortar.

3.2.8 Pipe Expansion

****

NOTE: Detail expansion loops on the drawings.
****

Install expansion loops and pipe guides where indicated.

3.2.9 Valves

Install valves at locations indicated and where specified. Use gate valves for isolation service unless otherwise indicated or specified. Use globe valves for throttling service unless otherwise specified. Install valves with stems horizontal or vertical, except install steam nonreturn valves as specified. Use chain operated type gate valves as shutoff valves in the boiler lines to and from steam headers, and elsewhere as indicated, if walkways are not provided for their operation. Ensure chain operated valves have sufficient chain for easy reach of the operating personnel from the operating floor or walkway. Provide gate valves 200 mm 8 inches and larger used on high pressure steam lines, and elsewhere as indicated, with a valve bypass integral with the valve body.

3.2.9.1 Back Pressure Relief

Set backpressure valve to exhaust at the pressure indicated.

3.2.9.2 Steam Pressure Reducing

Adjust steam pressure reducing valve to maintain desired terminal pressure, regardless of fluctuations in the inlet steam pressure. Steam pressure reducing valves must fail closed. Provide pilot, or auxiliary operated valves using steam for operating medium, or sliding gate and plate valves. Install steam pressure reducing valve with strainer, 3 valve bypass, and safety valve as indicated. Where steam pressure reducing valves is used for reducing steam pressure to deaerating heater, provide pneumatic pilot operated type valve. Connect sensing line to the steam space in the deaerator.

3.2.9.3 Thermostatic Regulating

Provide thermostatic regulating valve to control temperature of water within hot water generator, by regulating steam supplied to the heating coil, in the steam supply line to each generator.

3.2.10 Flow Meter

****
NOTE: Specify which meters should receive 3-way bypass to maintain service during a meter service or replacement (suggest that fuel oil flow meters have a 3-way valve bypass if service is critical.)
****

Install flow meter in straight line pipe of at least [_____] pipe diameters to maintain accuracy. [Provide a 3-way valve bypass for [_____] flow meters.]

3.3 FUEL OIL SYSTEM INSTALLATION

3.3.1 Fuel Storage Tank Installation

Install fuel storage tank in accordance with Section 33 56 10

FACTORY-FABRICATED FUEL STORAGE TANKS.

3.3.2 Underground Ferrous Metallic Piping

Provide underground ferrous metallic piping in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.4 FIELD PAINTING AND FINISHING

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 ELECTRICAL

3.5.1 General

Perform field run conduit, wiring and terminations in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.5.2 Splice

Splice stranded conductors by solder or pressure type connectors. Do not use wirenut connectors on stranded conductors. Cover splices with electrical insulation equivalent to, or of higher rating than, insulation of conductors being spliced. Splices will not be allowed in control or signal wiring, except where sensors or controlled devices are provided with pigtails for connecting to incoming cable

3.5.3 Identification

Label both ends of wires.

3.5.4 Grounding of Drain Wire of Shielded Cable.

Ground shield cable drain wire at the source end, terminate at a copper bus ground bar 3.175, 12.7, by 100 mm 1/8, 1/2, by 4 inches minimum.

3.5.5 Analog Signal Cable Connections

Connect analog signal cables to controller by means of terminal blocks with knife isolation switches with test plugs to enable isolation of each instrument without disconnecting common instrument power supply. Ensure these terminal blocks are double level terminal blocks with knife disconnect point with test plugs at the upper level and feed through terminal at lower level. Provide minimum of thirty percent (30 percent) spare terminal points.

3.5.6 Digital Input-Output

Connect digital input-output cables to controller by means of terminal blocks. Provide minimum of thirty percent (30 percent) spare terminal points.

3.6 INSULATION

Use thickness of insulation materials for piping and equipment and application in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.7 BOILERS AND AUXILIARY EQUIPMENT

****

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

****

3.7.1 Inspection

Inspect areas and conditions under which boiler and auxiliary equipment are to be installed. Field verify location of connections to piping, equipment and supports and make connection to said items utilizing field-verified dimensions. Notify Contracting Officer of discrepancies and ensure that unsatisfactory conditions have been corrected in an acceptable manner.

3.7.2 Preparation

a. Coordinate the installation of equipment and appurtenances prior to installation with other work.

b. Provide work required to correct situations resulting from the Contractor's failure to coordinate with the work of other trades, at no additional cost.

c. Take into consideration priority needs for location and space of work of all trades. Failure to do so will require the Contractor to remove and relocate the work at no additional cost.

3.7.3 Installation

****

NOTE: Delete reference to local city and state codes if not applicable.

****

3.7.3.1 Boiler

Install boiler in accordance with the manufacturer's written instructions, [in accordance with boiler installation requirements of local, city, state codes] and in accordance with applicable provisions of NFPA and ASME code standards. Locate boiler and associated components where indicated. Install boiler level to a tolerance of 3 mm in 3 m 1/8 inch in 10 feet in all directions. Make electrical connections in accordance with Section [_____].

3.7.3.2 Protection

It is the Contractor's responsibility to protect boiler and components from damage after installation, until Government takes custody. After installation, provide touchup paint to damaged areas on shop and finish-coated surfaces of the equipment. Ensure surfaces are free of rust, scale and foreign substances before application of touchup paint. Use touchup paint that is equivalent to the shop and/or finish paint.

3.7.3.3 Adjusting, Inspecting, and Cleaning

Submit test reports, in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completing and testing the installed system. Indicate the final position of controls in each test report. A written statement from the manufacturer's representative certifying that combustion control equipment has been properly installed and is in proper operating condition, upon completion of the installation. Include action settings for automatic controls in the form of a typed, tabulated list indicating the type of control, location, setting, and function.

a. Thoroughly clean inside of boiler by performing boil-out, flushing and cleaning in accordance with manufacturer's instruction prior to startup.

b. Make final adjustment to boiler in accordance with manufacturer's recommendations, but no less than following:

(1) Verify lubrication of moving parts.

(2) Verify fan rotation direction.

(3) Adjust water level control for proper operating level.

(4) Adjust firing rate control.

(5) Confirm operation of safety devices.

(6) Adjust controls and verify operation.

3.7.3.4 Field Quality Control.

a. Provide trained field representative to supervise installation of boiler and its components. Inspect alignment and balancing of rotating and moving parts. After completion of installation, provide services of factory-trained field representative to start and adjust boiler.

b. Provide trained field representative for final inspection of boiler for proper installation, alignment and leveling prior to boiler startup.

c. Coordinate with other representatives on startup of other items and building services as required.

d. Contractor's representative must be available to instruct and train Government personnel for not less than two (2)days after boilers are operational.

3.7.4 Gaseous Emissions Monitor

Provide extractive or in-situ gaseous emissions monitor. Combination of extractive and in-situ monitors is not acceptable. Include automatic calibration checks. Alarm horn and provide annunciator to alarm when any monitored parameter is out of range or gaseous emission monitor malfunctions. Construct surfaces exposed to corrosive gas of boiler of noncorrosive materials such as 316 SS, Teflon or Hastalloy.

a. Mount in-situ gaseous emissions monitor on ductwork at location [shown on plans] [recommended by the manufacturer]. Do not affect in-situ system by presence of particulate matter in flue gas.

b. Provide [wet] [dry] [diluted] extractive systems. [Provide rack-mounted analyzing equipment for extractive system.] [Locate analyzing equipment for extractive system in a walk-in cabinet.]

c. Arrange equipment to provide access for maintenance. Heat trace extractive system sampling between probes and analyzers to maintain temperature recommended by manufacturer when ambient temperature is [_____]. Mount probes on ductwork at the location [shown on the plans] [recommended by manufacturer].

d. Submit a Boiler Emissions Report of air pollutants showing compliance with the limits established in the environmental permit.

3.7.5 Flue Gas Flow Monitor

Utilize pitot tube principle to measure flow. Ensure flue gas flow monitor probe is across-the-duct average pitot tube and properly designed and located to obtain representative measurement. Use differential pressure transmitters to sense the difference between the static and total pressure of the flowing flue gas stream. Arrange lines to prevent collection of condensate. Provide purge system to keep pitot pressure taps clear.

3.7.6 Testing

ASME PTC 19.3 TW.

3.7.6.1 Factory Testing

Provide boilers guaranteed to perform in accordance with stated operating conditions. Complete packaged boiler must be hydrostatically and fire tested at boiler manufacturer's factory to check construction, operation and function of all controls. Submit certification of factory tests. Tests may be witnessed by Contracting Officer or Representative of Contracting Officer. Notify Contracting Officer two weeks prior to factory testing.

3.7.6.2 Field Testing

a. Furnish personnel, equipment, instrumentation, and supplies necessary to perform field testing. Upon completion, and prior to acceptance of the work, subject boiler plant to such operating tests as may be required to demonstrate satisfactory functional operation of the plant, including safety devices. Conduct operating tests at such times as the Contracting Officer may direct.

b. Submit proposed test procedure to Contracting Officer, 30 days prior to the proposed test date, for approval. Include a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not commence test until the procedure has been approved. The Government will witness the field tests. Obtain written permission from the Contracting Officer before proceeding with testing. Tests

must be supervised by respective manufacturers.

c. Turn over original copies of data produced, including results of each test procedure during field testing, to the Government at the conclusion of testing prior to Government approval of the test.

d. Do not schedule testing during seasonal off-periods of heating systems. Perform testing in accordance with approved test procedures. Cover actual equipment and functions specified for the project.

3.7.6.3 Hydrostatic Test

****
NOTE: Delete boiler isolation valve test for single-boiler plants. This test is critical for multiple-boiler plants as it verifies that individual boilers can be isolated for maintenance or replacement while the steam system is in operation.
****

a. General: Submit a written field hydrostatic test schedule [7] [_____] days in advance to Contracting Officer for approval. Schedule will be approved by the Contracting Officer.

b. After installation is completed and prior to startup, furnish the services of local boiler and pressure vessel inspector to observe field hydrostatic test, inspect installation and piping and certify that installation is in accordance with ASME code.

c. Following installation of piping and boiler plant equipment, but before application of piping and boiler insulation, complete a hydrostatic test, including boiler and associated piping within boiler plant. Prove system tight for at least two hours under gauge pressure of 1.5 times the working pressure specified and no less than the following:

[(1) Low pressure lines up to 448 kPa 65 psig working - Test pressure 590 kPa 100 psig.]

[(2) Medium pressure from 448 to 690 kPa 65 to 100 psig, working - test pressure 1.03 MPa 150 psig.]

[(3) High pressure 1.03 MPa 150 psig working - Test pressure 1.55 MPa 225 psig.]

d. Test boiler isolation valves individually to isolate against the specified hydrostatic test pressure. At the conclusion of the system hydrostatic test, close each boiler's isolation valves (steam discharge, boiler feedwater, etc.); drain down the boiler; and monitor pressure on both sides of each isolation valve for a minimum of two hours to verify that the valves isolate each boiler.

e Test boilers and inspect piping connections by a certified boiler inspector for compliance with ASME BPVC SEC I.

f. Submit certificate of compliance with ASME BPVC SEC I for each boiler to Contracting Officer.

3.7.6.4 Inner Casing Air Tests for Packaged Force Draft Boilers

Following installation, air test each packaged forced draft boiler up to 2.5 kPa 10 inches water gauge. Apply soap foam to seams to detect leaks. Ensure boiler does not lose more than 1.3 kPa 5 inches water gauge in 10 minutes. Perform this test prior to installing insulation.

3.7.6.5 Efficiency and Capacity Test

a. Run efficiency and capacity test on one boiler of each size installed, conduct in strict accordance with ASME PTC 4, abbreviated efficiency test.

b. Properly calibrate measuring devices used for measuring feedwater evaporated and amount of fuel burned prior to test. Use water flow meter suitable for hot water. Furnish instruments, test equipment, test personnel, and fuel oil required to properly conduct tests. Submit a fuel oil analysis report of Independent Agency for fuel oil used during efficiency testing.

c. Calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and furnish thermometer to be used in the efficiency and capacity test prior to test.

d. Obtain necessary natural gas, water and electricity as specified in the [SPECIAL CONTRACT REQUIREMENTS][Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS] Provide necessary quantities of propane gas or No. [_____] fuel oil when propane gas or fuel oil is require for testing.

e. Conduct efficiency and general performance tests on boiler by a qualified test engineer furnished by Contractor.

TESTING AND PERFORMANCE		
Percent of Capacity		
Time	Waterwall Watertube Boilers	Cylindrical Furnace Firetube Goilers
First 1 hour	50	50
Next 2 hours	75	75
Next 4 hours	100	100

f. Efficiency tests may be conducted concurrently with operating tests, or separately. Ensure thermal efficiency is no less than specified. Ensure maximum moisture content of saturated steam leaving boiler is as specified.

g. Submit Performance Test report including logs, heat balance calculations, and tabulated results together with conclusions to Contracting Officer in quadruplicate.

h. Submit an analysis by an independent testing laboratory of fuel being burned during test to the Contracting Officer. Include pertinent data

tabulated in ASME PTC 4, abbreviated efficiency test.

i. Contracting Officer will observe and approve tests.

3.7.6.6 Control System Operational Testing

****

NOTE: For operational functional testing, consider adding project specific equipment and sequences of operation, alarms and other critical interface points between contracts (such as mechanical and instrumentation) for field operational tests. Consider integrating these tests into a larger project commissioning plan and specification.

****

a. Conduct full operational test of boiler plant control system to demonstrate compliance with sequences of operation, safety interlocks and control functions of the specification.

b. Field Installation Test: Following the installation of the control system, align and adjust all hardware, and record all test readings in accordance with the manufacturer and installer recommended tests and maintenance procedures. Include in the associated test report a list of all hardware or components replaced or changed between the completion of factory tests and the start of field installation test. Demonstrate all hardware to be operational by running off-line diagnostics. Include electrical continuity, complete exercising of each Input and Output point, and simulation of each control loop. Consider field installation test complete only after all variances generated during installation are resolved and tested.

c. Startup Test and Punchout: Prior to on-line operation, conduct a complete demonstration and readout of the control system scope of surveillance and control. Include simulation of analog inputs and observation of the action of system final control elements. Generate a hardcopy printout and perform punchout of all Input and Output points. Submit startup test hardcopy printout to Contracting Officer two (2) weeks prior to demonstrating the control system. Conduct full functional test in accordance with the control system sequences of operation. Conduct startup test and punchout in the presence of the Contracting Officer. Notify the Contracting Officer no later than ten days prior to scheduled startup testing.

d. Operational Acceptance Test: After all previous testing has been successfully completed, operate control system for thirty (30) days to the complete satisfaction of the Contracting Officer. Submit to Contracting Officer a bound log reporting all control system failures that occur red during operational acceptance test. Show the point name and number, time and date of failure, and time and date of return to service. During the 30-day acceptance test, any operational failures due to malfunction of the control panels, wiring, or Control Room Equipment must require that the 30 day test begin again when repairs are completed. Correct any failures between field-sensing equipment and the control panels, and continue the testing from the day of failure. During the last seven calendar days of testing, no failures of any kind will be accepted or repeat the last seven days. If the season of the year prevents complete testing of any individual component of the control system, acceptance will be conditional upon

the successful demonstration of the specific component at the appropriate season.

e. Final Acceptance: The control system will not be considered accepted by the Government until all tests are successfully completed. Beneficial use of the system by the Government will not be considered as acceptance. The Government will deem the control system to be fully accepted when:

(1) Structured, unstructured and availability tests have been successfully completed, and all incidents and variances have been resolved to the Government's satisfaction.

(2) Documentation and training requirements have been completed and are satisfactory to the Government.

(3) Maintenance and related contracts and releases of subcontractors have been duly executed and submitted to the Government.

(4) Identified defects have been corrected to the Government's satisfaction.

3.7.6.7 Boiler Room Panels and Instruments

After inspections of installation and calibration of instruments, and after boiler test, provide a certificate of compliance to Contracting Officer stating that controls and instrumentation operate satisfactorily and within the operating parameters as specified for each fuel. If units fail to operate satisfactorily or fail to achieve specified performance, make adjustments, modifications, repairs, or replacements as necessary at no additional cost until specified performance has been achieved and certified by Contracting Officer.

3.7.6.8 Temporary Piping for Testing

Furnish necessary temporary piping, of no less than 100 mm 4 inches in diameter, and provide a muffler to exhaust excess steam to atmosphere in event boiler load is insufficient to meet capacity specified. Provide control valve for exhausting excess steam to atmosphere in a convenient location inside the boiler room. Provide instruments required for conducting boiler tests as described in ASME PTC 4 and ASME PTC 19.11. Provide temporary piping, valves, pipe hangers, mufflers and test equipment at no additional cost. Muffler must have level of noise of exhaust steam within requirements as set forth by Occupational Safety and Health Act.

3.7.6.9 Fuel Burning Equipment Testing

a. Test fuel burning equipment to demonstrate that equipment installed will meet requirements of specifications, and that overall efficiency is as specified, with not over 15 percent excess air, can be obtained with boiler operating at 100 percent capacity without flame impingement on any combustion chamber wall, floor, baffle or watertube.

b. Include all boiler and burner interlocks, safety interlocks, combustion controls, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. prior to combustion testing. Replace all malfunctioning components. Submit an itemized data record sheet of this component testing.

c. Calibrate each boiler control system and all boiler appurtenances and set to ensure the specified performance. Ensure the fuel burner, forced-draft fan, controls, and other such items are fully coordinated, manually capable, and automatically controllable to hold the required settings. Ensure boiler fuel burning system is continuously variable throughout the specified operating range without manual adjustment of burner, register or nozzle, and achieve turndown without manual adjustment. Ensure testing apparatus is set up, calibrated, tested and ready for use prior to final combustion testing. Furnish calibration certificates for all test instruments with test data.

3.7.6.10 Deaerating Feedwater Heater Testing

Test deaerating feedwater heater to demonstrate that equipment installed meets specified requirements as to performance, capacity, and quality of effluent. During operating test of boiler, conduct tests to determine oxygen content in accordance with ASTM D888, Method B or C, or ASTM D5543. Operate boilers at varying loads, up to maximum heater capacity, while oxygen tests are being made. Furnish means and equipment to perform this test.

3.7.6.11 Water Treatment Testing

Test water treatment equipment meeting requirements specified as to capacity and quality of effluent. Tests for ion exchange units must cover at least 2 complete regenerations and capacity runs. Test for hot process or other precipitation type softeners must cover a minimum continuous period of 48 hours with samples being taken at 2 hour intervals.

3.7.6.12 Steam Quality Testing

Test for steam quality and water level stability must be simultaneous under operating conditions specified.

3.7.6.13 Water Level Stability Testing

Boiler water level stability must be specified by boiler manufacturer in writing to Contracting Officer prior to test. Conduct test first by use of manual bypass around feedwater regulator. Repeat test using automatic feedwater regulator. To be acceptable, boiler must maintain specified water level stability as specified by boiler manufacturer under both conditions.

3.7.6.14 Testing of Piping Systems

a. General: Submit a written schedule 7 days in advance of test to Contracting Officer for approval, and a detailed manufacturer's acceptance testing plan, for approval, for each item of instrumentation; including procedures for pressure testing and repair of piping and tubing materials failing pressure tests.

b. Hydrostatically test piping before piping insulation is applied. Ensure hydrostatic test pressure at any point in piping system is no less than 1.5 times the design pressure, but does not exceed the maximum allowable test pressure of nonisolated components.

c. Test underground lines in pressure service prior to backfilling, as

specified, with pressure to be maintained for 12 hours without drop. Furnish accessories required for test.

d. When particular circumstances prohibit hydrostatic tests, Contracting Officer may exercise option to have Contractor perform air pressure and soap solution test. If this type of test is approved by Contracting Officer, perform air pressure and soap solution test at weld and flange joints. Ensure pneumatic test pressure is no less than 1.2 nor more than 1.5 times the design pressure of piping system. Do not exceed maximum allowable test pressure of non-isolated components. Correct leaks discovered during test and perform successive tests. Repeat test until leaks are sealed. Conduct test before insulation is applied. Use a portable sprayer to spray soap solution on joints to detect leaks. Provide temporary pumps and air compressors required to pressurize system prior to and during tests. Perform tests in accordance with ASME B31.1.

3.7.7 Cleaning of Boiler and Piping

After hydrostatic tests have been made, and prior to performance of operating tests, thoroughly and effectively clean boiler of foreign materials by mechanical cleaning, initial chemical cleaning, a chemical boiling period and finally by operating steam system at 100 percent (100 percent) makeup water and wasting the condensate. Submit procedure for cleaning, prior to connecting tubing and piping to instruments and prior to pressure testing, test equipment use, and cleaning after completion of testing and installation. Wherever possible, wire brush water contacted surfaces to remove loose material, then fill boiler with solution consisting of following proportional ingredients and circulate at approximately 207 to 344 kPa 30 to 50 psig for period of 24 to 48 hours:

Caustic soda	10.9 kg 24 lbs
Disodium phosphate, anhydrous	10.9 kg 24 lbs
Sodium nitrate	3.6 kg 8 lbs
Approved wetting agent	0.23 kg 1/2 lb
Water	3,785 liters 1,000 gallons

Dissolve chemicals in proportions above, or as approved by Contracting Officer, thoroughly in water before placing in boiler. After this initial chemical cleaning, drain boiler and refill with the above chemical solution and boil in accordance with the manufacturer's instructions. After specified boiling period, allow boiler to cool, after which drain boiler and thoroughly flush. Finally, clean piping by operating boiler for period of approximately 48 hours with 100 percent (100 percent) makeup water, wasting the steam and condensate.

3.7.8 Boiler Water Conditioning

Provide boiler water conditioning by chemical treatment and blowdown during periods of boiler operation from the initial starting of system, through testing period, and to final acceptance of completed work by the Government. Use chemicals and treatment method approved by Contracting

Officer.

3.7.9 Fuel Oil Leak Test

Conduct fuel oil leak tests for the underground portion of the system in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.8 MANUFACTURER'S SERVICES

Provide services of a manufacturer's representative who is experienced in installation, adjustment, and operation of equipment specified. Supervise installing, adjusting, and testing of equipment. Contractor personnel will not be allowed to render specified services. Manufacturer's test representatives must be on manufacturer's payroll on a continuing eight hour pay basis, especially trained, and regularly rendering such services.

3.9 FIELD TRAINING

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NOTE: Consult equipment manufacturer for hours required to train plant personnel for equipment operation and then insert the hours.

****

a. Provide field training course for designated operating staff members. Provide training for a total period of [_____] hours of normal working time and start after system is functionally complete, but prior to final acceptance tests. Cover items contained in approved operation and maintenance instructions as well as demonstrations of routine maintenance operations. Notify Contractiin writing at least 14 days prior to start of training.

b. Submit [6] [_____] complete copies of operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, service manual and a brief description of equipment and their basic operating features.

c. Submit [6] [_____] complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, preventative maintenance schedule, and troubleshooting guides. Include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. Also include equipment lubrication requirements and schedules, recommended spare parts list, index, instruction book binders with hard back covers and printing to identify the name of the facility, Government entity operating the facility, Contractor, shop order, equipment, and volume number if required. Obtain approval of operation and maintenance manuals prior to the training course.

d. Provide a minimum of [_____] days of training for [_____] of Government's representatives at [plant site] [factory]. Training includes, but is not limited by the following:

(1) Use of operating console display; their interface with process; their aid in system diagnostics; all with hands on experience with equipment for trainees.

(2) Training to emphasize process control techniques, with

demonstrations to show variations that can be implemented with algorithms and system configuration instructions.

(3) Training to acquaint the operators with specifics of this process, and how system operates.

(4) Training to include theory of operation, maintenance, and troubleshooting techniques, using flow charts and diagnostics with equipment in operation, and framed instructions containing wiring and control diagrams under glass or in laminated plastic, to be posted where directed. Frame condensed operating instructions, prepared in typed form, as specified above and post beside the diagrams. Post framed instructions before acceptance testing of the systems.

e. Video tape field training. Provide reproducible copies of each training session video tape, printed training materials for each designated operating staff member, and two spare copies for file.

TABLE I. PIPE				
Service	Pressure, kPa psig	Material	Specification	Type
Steam	0-10300-150	Std. wt. black steel	ASTM A53/A53M	Type E or S, Grade A
Condensate return	0-17000-250	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Boiler feed & blowoff lines	0-10300-150	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Feedwater piping	0-10300-150	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Water column (a)	0-10300-150	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Vent & pipe	0-1700-25	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Compressed air	0-8600-125	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Gauge piping	0-1700-25	Copper tubing	ASTM B88MASTM B88	Type K or L
Draft gauge & Oxygen recorder	0-1700-25	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Aboveground Fuel oil (No. 2)	0-10300-150	Copper tubing	ASTM B88MASTM B88	Type K or L
		Fiberglass (b)	API Spec 15LR or UL approved	[_____]
		Std weight black steel	ASTM A53/A53M	Type E or S Grade A or B
		Sched 40 seamless or Elec. welded steel	API Spec 5L	Grade A or B
Aboveground Fuel oil (Nos. 4, 5 & 6)	0-10300-150	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Control air	0-10300-150	Copper tubing	ASTM B68/B68M	[_____]
		Std weight black steel	ASTM A53/A53M	Type E, Grade A
Natural gas	0-1050-75	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Note a: No bending of pipe will be permitted.				
Note b: For buried service only.				

TABLE II. FITTINGS				
Service	Size	Title	Materials	Specification
Steam	38 mm 1.5 inches and under	Screwed or Socket welded	Steel	ASME B16.11
	50 mm 2 inches and larger	Flanged or Butt welded	Steel	ASME B16.5, ASME B16.9
Condensate return	38 mm 1.5 inches and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	50 mm 2 inches and larger	Butt welded	Steel	ASME B16.9 extra strong
Vent pipe	38 mm 1.5 inches and under	Screwed	Steel	ASME B16.9
	50 mm 2 inches and larger	Butt welded	Steel	ASME B16.9
Compressed air	38 mm 1.5 inches and under	Screwed	Zinc-coated malleable iron	ASME B16.3
	50 mm 2 inches and larger	Butt welded	Steel	ASME B16.9
Boiler feed	38 mm 1.5 inches and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	38 mm 1.5 inches and under	Butt welded	Steel	ASME B16.9 extra strong
Feedwater pipe	38 mm 1.5 inches and under	Screwed	Steel	ASME B16.9
	50 mm 2 inches and larger	Butt welded	Steel	ASME B16.9
Blowoff lines	38 mm 1.5 inches and under	Butt welded	Steel	ASME B16.9 extra strong
	50 mm 2 inches and larger	Socket welded	Steel	ASME B16.11 extra strong
		Flanged with long radius elbows	Steel	ASME B16.5
Water column piping	38 mm 1.5 inches and under	Screwed		extra strong
Draft gauge and O^2 recorder	All	Screwed		
Fuel oil (a)	All	Screwed, Flared or brazed	Cast or wrought bronze	ASME B16.18 ASME B16.26
Gauge pipe	All	Flared or soldered	Cast or wrought bronze	ASME B16.18 ASME B16.26

TABLE II. FITTINGS				
Service	Size	Title	Materials	Specification
Natural gas	38 mm 1.5 inches and under	Socket welded		ASME B16.11
	50 mm 2 inches and larger	Butt welded		ASME B16.9
Note a: Conform to ASME B31.1 for wall thickness. Match requirements for steam piping.				

-- End of Section --