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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2011
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CENTRAL STEAM GENERATING SYSTEM - COMBINATION GAS AND OIL FIRED

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CENTRAL STEAM GENERATING SYSTEM - COMBINATION GAS AND OIL FIRED
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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 items(s) or insert appropriate information.

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

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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% 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.

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1.1 REFERENCES

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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 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.

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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 15LR	(2001) Specification for Low Pressure Fiberglass Line Pipe and Fittings
API Spec 5L	(2007; Errata 2009; Addenda 1 2009; Addenda 2 2010; Addendum 2 2011; 44th Ed) Specification for Line Pipe

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C700	(2009) Standard for Cold Water Meters - Displacement Type, Bronze Main Case

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)

ASME B1.20.2M	(2006) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2001; R 2005) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2006) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(2010) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(2010) Power Piping
ASME B40.100	(2005) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2010) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2010) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2007; Addenda 2008; Addenda 2009) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2009) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 12.3	(1997; R 2009) Performance Test Code on Deaerators
ASME PTC 19.11	(2008) Steam and Water Sampling, Conditioning, and Analysis in the Power Cycle
ASME PTC 19.3	(1974; R 2004) Temperature Measurement

ASME PTC 25	(2008) Pressure Relief Devices
ASME PTC 4	(2008) Fired Steam Generators

ASTM INTERNATIONAL (ASTM)

ASTM A106/A106M	(2010) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2011a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A269	(2010) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276	(2010) Standard Specification for Stainless Steel Bars and Shapes
ASTM A278/A278M	(2001; R 2006) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A290/A290M	(2005; R 2010) Standard Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A395/A395M	(1999; R 2009) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A48/A48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A516/A516M	(2010) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A53/A53M	(2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A536	(1984; R 2009) Standard Specification for Ductile Iron Castings

ASTM A582/A582M	(2005) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A653/A653M	(2010) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2003; R 2009e1) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A743/A743M	(2006; R 2010) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2005) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C155	(1997; R 2007) Standard Specification for Insulating Firebrick
ASTM C34	(2010) Structural Clay Load-Bearing Wall Tile
ASTM C62	(2010) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C700	(2011) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D 3308	(2006) PTFE Resin Skived Tape
ASTM D 5543	(2009) Standard Test Methods for Low-Level Dissolved Oxygen in Water
ASTM D 888	(2009) Dissolved Oxygen in Water
ASTM F 1139	(1988; R 2010) Steam Traps and Drains

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2008) EJMA Standards

FM GLOBAL (FM)

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

ISA - 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	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2006) Enclosures
NEMA MG 1	(2009) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2011) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2009; TIA 10-3) National Fuel Gas Code
NFPA 70	(2011; TIA 11-1; Errata 2011) National Electrical Code
NFPA 85	(2011; Errata 2011) Boiler and Combustion Systems Hazards Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-232	(1997f; R 2002) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
TIA-485	(1998a; R 2003) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

THE 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

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2007; Change 1) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 296	(2003; Reprint Jun 2011) Oil Burners
UL 567	(2003; Reprint May 2010) Emergency Breakaway Fittings, Swivel Connectors and Pipe-Connection Fittings for Petroleum Products and LP-Gas
UL 574	(2003; Reprint Apr 2010) Standard for Electric Oil Heaters
UL 726	(1995; Reprint Apr 2011) Oil-Fired Boiler Assemblies
UL 795	(2011) Standard for Commercial-Industrial Gas Heating Equipment

1.2 DEFINITIONS

The definitions of the terms relating to process control instrumentation technology shall be those given in ISA 51.1. Logic symbols shall be in accordance with ISA 5.2. Graphic symbols for distributed control shall be 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. Instrumentation on equipment shall be mounted 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 shall not be adversely affected by interference voltages and fields from external sources, and that equipment provided shall not be a source of interference that might adversely affect the operation of other equipment. The basic design of equipment, components, and assemblies shall limit 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 to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation 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][; G, [_____]]
Variable Spring Hangers
Pipe Anchors
Setting Plans
Graphics Screen Format

SD-03 Product Data

Materials
Material Safety Data Sheets
Design Analysis and Calculations.
Welding[; G][; G, [_____]]
Water Treatment Plan
Cleaning of Boiler and Piping.
Testing of Piping Systems[; G][; G, [_____]]
Spare Parts
Framed Instructions[; G][; G, [_____]]

SD-06 Test Reports

Test Schedule
Proposed Test Procedure
Boiler Emissions Report
Adjusting, Inspecting, and Cleaning
Fuel oil analysis[; G][; G, [_____]]
Startup Test Hardcopy Printout[; G][; G, [_____]]

SD-07 Certificates

Environmental Permit Compliance[; G][; G, [_____]]
Experience[; G][; 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][; 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

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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. This information regarding welds, internal to packaged boilers, shall be furnished if requested by the Government.

a. Steam piping between the boiler [steam nozzle] [nonreturn valve] and the second stop valve shall be welded and stamped in accordance with ASME BPVC SEC I. [Other piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified 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. The Contracting Officer shall be notified 24 hours in advance of tests. The welder or welding operator shall apply the personally assigned symbol near each weld made as a permanent record.

c. Structural members shall be welded in accordance with Section 05 05 23 WELDING, STRUCTURAL] [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. Drawings shall indicate clearances required for maintenance and operation and shall 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. Equipment shall be supported by a service

organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured 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. High temperature equipment and piping exposed to contact by personnel or where they create a fire hazard shall be properly guarded or covered with insulation of the type specified. Items such as catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section [05 50 13 MISCELLANEOUS METAL FABRICATIONS][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. Performance charts shall provide information necessary to determine compliance to the specified and indicated requirements and shall 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. Materials shall comply 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. Draft gauges for the windbox, combustion chamber, and last boiler pass shall be mounted in the panel front. Operating range for the draft gauges shall be field-verified with normal reading in the middle of the scale range. Draft gauges shall 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 shall be larger than connecting pipe.

2.2.7 Expansion Joint

EJMA Stds Book of Standards and ASME B31.1. Expansion joint shall be packless, leak proof, externally pressurized bellows type. The expansion joint shall include integral guide rings, full thickness cover designed to contain full system pressure, and self-draining convolutions. The expansion joint shall be insensitive to flow direction. The expansion joint shall be provided with a drain connection for condensate removal. The expansion joint shall be 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, Schedule 80 pipe shall be used. Expansion joint shall be rated for 1.03 MPa 150 psig and 425 degrees C 800 degrees F and have 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

Low water cutoff shall be float actuated switch or electrically actuated probe type. Float chamber shall be provided with a blowdown connection. Low water cutoff shall 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 shall require manual reset before operation can be resumed and shall prevent recycling of the burner. Low water cutoff shall be 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. Underground fuel piping shall be 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. Convoluted flanges shall be cold-formed steel conforming to ASTM A516/A516M. Flanges shall mate with ASME B16.5, Class 150 flanges.

2.2.11.5 Flange Gasket

Gasket shall be nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, of self centering flat ring type. The gasket shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Metallic spiral wound nonasbestos gaskets shall be used 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.
****

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 shall conform to requirements of UL 567. Metal for hose and braided wire sheath shall be 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, union shall be ground joint cast steel or forged steel. Unions with appropriate pressure and temperature ratings shall be used.

2.2.12 Pipe Support

MSS SP-58 and MSS SP-69.

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, strainer shall have 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 WSP class forged steel or cast steel shall be used.

2.2.15.2 Screen

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

Screen shall be Type 304 stainless steel, with free area not less than 2.5 times inlet area. For water system, perforation shall be 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, the perforation shall be 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. Screen shall be reinforced wire gauge, 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

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

2.2.15.4 Tee Strainer

Tee strainer shall be provided as shown. Tee strainer shall be the full line size of the connecting piping with ends matching the piping system materials. Tee strainer shall have a swing bolt closure.

2.2.15.5 Basket Strainer, including Duplex Basket Strainer

Basket strainer shall be provided as shown. Basket strainer shall have bolted covers to allow removal of the basket for cleaning. Duplex basket strainer shall include 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 D 3308.

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 F 1139.

2.2.19 Thermometer

Unless otherwise specified, thermometer shall be dial type, 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. Well and temperature range shall be suitable for use encountered. Thermometer shall be installed so as to be easily read from the operating floor. Mercury shall not be used 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 shall 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, shall be [forged] [cast] steel, stainless steel trim, rising stem, Class [_____] with handwheels. Connections shall be [socket weld] [threaded] end connections.

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

2.2.20.3 Back Pressure Relief

ASME PTC 25 back pressure relief valve shall have stainless steel or cast steel body with valve internals and seats constructed of stainless steel. Back pressure relief valve shall have guides and shall be positive closing. Adjustment of the desired back pressure shall cover a range between 14 and 70 kPa 2 and 10 psig. The adjustment shall be effected externally and any shafts extending through the valve body shall be provided with adjustable stuffing boxes having renewable packing. Back pressure relief valve shall be self contained, internal pilot piston operated. An external positioner shall be provided on each valve.

2.2.20.4 Blowoff and Quick Opening

Blowoff and quick opening valves shall be as required in ASME BPVC SEC I. The valve shall be the balanced seatless type or the double seated rotating disk type. Quick opening valve shall be the straightway type. Blowoff and quick opening valves shall be designed for a working pressure of 2.06 MPa 300 psig and shall be 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.

****

Pressure reducing valve shall be designed for a working pressure of not less than 1.03 MPa 150 psig, and shall be quiet and nonsticking in operation. Pressure reducing valve shall be spring loaded, internal pilot piston operated type with an external position indicator. Pressure reducing valve body 65 mm 2-1/2 inches and larger shall be cast steel. Pressure reducing valve shall have raised face flanges to match the raised face flanges on connecting piping. Pressure reducing valve 38 mm 1-1/2 inches and smaller shall be bronze with screwed connections. Pressure reducing valve trim shall be stainless steel or monel metal. Parts subject to wear shall be renewable. Pressure reducing valve shall have seat and plug faced with cobalt tungsten carbide mixture, or made of heat treated stainless steel or high chromium steel. Seat and plug facing shall have a Brinell hardness of not less than 450. Pressure reducing valve shall be designed for dead-end service. Resulting noise level shall not exceed [_____] dBA.

2.2.20.6 Plug

Plug valve shall be tapered plug, lubricated type. Lubricant shall be suitable for the intended application. Body shall be cast steel. Plug shall be carbon steel. Pressure class shall be minimum ANSI Class 150. Plug valve 38 mm1-1/2 inches and smaller shall be screwed. Plug valve 50 mm 2 inches and larger shall be flanged.

2.2.20.7 Safety Relief

Safety relief valve shall be sized and constructed and shall fully comply with requirements set forth in ASME BPVC SEC I. Safety relief valve shall have a manual lifting device for testing.

2.2.20.8 Steam Nonreturn

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

2.2.20.9 Thermostatic Regulating

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

2.2.20.10 Ball

Ball valve shall be Teflon seated and packed. Ball valve shall provide bubble tight shutoff. Body shall be of [bronze] or [cast] [forged] steel or of stainless steel. Ball valve shall be two-piece full-port design.

2.2.20.11 Feedwater Control

Feedwater control valve shall be provided with the boiler. Feedwater control valve shall be supplied with filter, regulator, supply and control pressure gauges, [metric] converter and positioner with charactering cam. Control system shall provide 4 to 20 mAdc control signal.

2.2.21 Water Column

Water column valve shall be constructed in accordance with ASME BPVC SEC I, fitted with gauge glass and quick-closing gauge valves with chains and handles for operation from the boiler room floor. [Mirror and illuminating light shall be provided to allow water levels to be read from the boiler room floor] [Gauge glass with illuminating light shall be provided].

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.
****

Natural gas flow meter shall be of the positive displacement type, provided with a pressure correcting device that will correct flow readings to atmospheric pressure. Body shall be aluminum. Minimum meter design pressure shall be 690 kPa 100 psig. Accuracy shall be plus or minus 1 percent of calibrated span minimum. Turndown shall be [_____]. Connections shall be threaded for sizes 38 mm 1-1/2 inches and smaller. Connections shall be flanged for sizes 50 mm 2 inches and larger.

2.2.22.2 Water Flow

Water flow meter shall be disk type 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. Moving parts subject to wear shall be easily replaceable. Waterflow meters shall conform 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.

****

Fuel oil flow meter shall be nutating disc, positive displacement with direct mechanical shaft drive from meter to register. Construction materials shall be cast iron housing, bronze internals, aluminum ball and web disc, and Type 316 stainless steel diaphragm. Register shall be totalizing and shall be as specified. Flow oil meter shall be suitable for maximum oil temperature.

2.2.23 Natural Gas Pressure Regulator

Natural gas pressure regulator shall be pilot operated type. Diaphragms shall be nitrile. Natural gas pressure regulator valve body shall be steel. Minimum pressure rating shall be 1.03 MPa 150 psig. Vent connection shall be in accordance with NFPA. Natural gas pressure regulator shall be provided with an external position indicator.

2.2.24 Fractional and Integral Horsepower Motors

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

2.3 ELECTRICAL WORK

Electric motor driven equipment specified shall be provided complete with motor, motor starter, and controls. Electrical equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics shall be as specified or indicated. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and control wiring required for controls and devices specified, shall be provided.

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.

****

Boiler shall be provided as complete boiler-burner package, including integral forced draft burner, boiler trim, refractory, controls, fuel train and accessory components. Boiler-burner package shall be provided [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. Boiler shall have the capacity indicated. Equipment design and accessory installations shall permit accessibility for maintenance and service. Boiler shall comply with NFPA 85, including recommended procedures and advisory provisions. Boiler shall be designed for working pressure of [_____] kPa psig and operating pressure of [_____] kPa psig. Each boiler shall 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 shall be stable at a turndown ratio of [_____]. [Natural gas] [fuel oil] [combination natural gas fuel oil] burners shall be of type, size and so located and arranged that in no case shall the flame impinge on any surface in the boiler nor shall the flame extend beyond the limits of the furnace.

2.4.2 Performance

Boiler shall have the specified capacity at the operating pressure, feedwater temperature and boiler site elevation specified. Capacity shall be based 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]. [Fuel oil supply temperature and pressure shall be [_____] degrees C degrees F and [_____] kPa psig]. [Natural gas supply pressure shall be [_____] kPa psig]. Boiler shall be capable of continuous operation at full rated capacity. Minimum efficiency shall be not less than [_____] percent when fired continuously at full rated capacity with [natural gas] [fuel oil] [natural gas or fuel oil]. Stable firing and efficiency shall both be maintained over the entire firing range required by the turndown ratio. Output capacity of the boiler shall be based on tests of the boiler and burner as a unit. Moisture in the steam shall 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

Boiler shall be built and stamped in accordance with ASME BPVC SEC I and as specified.

2.4.4 Identification

Boiler shall be stamped 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

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

2.4.5.1 Drum

a. Drums shall extend beyond the entire length of furnace setting. Drum shall be fabricated of steel plate, welded in accordance with ASME BPVC SEC I, including stress relieving and X-raying of welded seams. Steam drum shall be provided with steam separators and drum internals required to maintain the specified steam moisture content, and provisions for maintenance. Necessary baffling shall be provided to separate steam from water in the drum and to maintain stable water level under a fluctuating load. Variations in normal water level shall 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 shall 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 shall not be less than 610 mm 24 inches in diameter.

c. Drum shall be provided with two 300 by 400 mm 12 by 16 inch elliptical manholes with double clamps, studs and gaskets.

d. Boiler shall be provided with connections as shown.

2.4.5.2 Tubes

a. Furnace and Boiler: Furnace and boiler tubes shall not be less than 50 mm 2 inches in diameter and the thickness shall conform to that given in ASME BPVC SEC I for the pressure specified. Tubes shall be bent to a true radius. Tubes that are distorted in bending, flattened or ridged are not acceptable. Tube holes in the drum shall be drilled,

reamed and serrated. Design of the tubes shall permit drums and tubes to drain by gravity.

b. Furnace Waterwall: Furnace waterwall shall extend the entire length of furnace setting and shall consist of 50 mm 2 inch tangential electric resistance welded steel tubes or welded furnace membrane wall. Tubes connected to the drums and/or lower headers shall be expanded into bored tube seats. If headers are provided,lower headers of sidewalls shall be round or square design. Lower header shall be provided with gasketed handhole covers for easy access to each wall tube. Tube bend radii shall be sized for standard turbine type cleaners for easy pass through for cleaning of the full length of the tubes.

c. Convection Tubes: Convection tubes shall be electric resistance welded construction in accordance with ASME BPVC SEC I. Convection tubes shall be arranged to ensure proper and effective soot blowing. Convection tubes in the boiler section shall be expanded into the upper and lower drums.

2.4.5.3 Baffles

Baffles shall be arranged to direct products of combustion into contact with heating surfaces without short circuit of flue gas at the outlet or excessive loss of draft. Baffles shall be either a refractory material, tangent tubes or a metal suitable for the temperature encountered.

2.4.5.4 Supports

Boiler and firing equipment shall be supported from the foundation with structural steel independent of brickwork. Boiler supports shall 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, lifting lugs shall be welded to the steam drum. Boiler skid shall be reinforced and provided with space beneath the end of the beam for jacking the unit during installation. Holes shall be provided 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 recommended by boiler manufacturer.

2.4.5.5 Boiler Casing and Insulation

Boiler shall be completely encased in a double casing and filled with blanket insulation. Casing shall be constructed of not lighter than 3.4 mm 10 gauge welded black steel sheets. Casing shall be gastight and shall be reinforced with structural steel to provide rigidity and prevent buckling. Refractory or insulation behind the waterwall tubes shall be not less than 65 mm 2 1/2 inches thick. Insulation shall be 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. Insulation material and installation shall be as recommended by the boiler manufacturer. Exposed portion of the boiler drum shall be insulated with mineral wool block and enclosed in a welded 3.4 mm 10 gauge steel casing, field installed. Refractory and insulation shall be factory installed.

2.4.5.6 Access Door and Observation Port

The boiler shall be provided with access doors in sufficient number, size and location for cleaning, inspection and repair. Access door shall be gastight and interior surfaces exposed to direct radiation and high temperature shall be lined with approved refractory material to prevent excessive heat loss. Access doors that are large or weigh more than 23 kg 50 pounds shall be hinged. In addition, at least two observation ports with cast iron covers shall be provided, 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.
****

Settling chamber for the removal of fly ash shall be provided 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.
****

Boiler shall be provided with soot blower for convection bank cleaning. Soot blower shall be steam operated, valve-in-head type and shall be furnished complete with wall sleeve, clamps, hangers, supports, manual operating chains and other appurtenances required for a complete installation. The blower elements shall be so arranged that all parts of the heating surfaces shall be cleaned of soot deposits when rotated by electric motor actuated by [automatic sequence from boiler control panel] [manual switch from boiler control panel]. Soot blower elements shall be of such length, diameter and total nozzle area 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. Soot blower shall be made of a material that will satisfactorily withstand the temperature in the zone where it is installed.

2.4.5.9 Economizer

a. Boiler shall be furnished with a rectangular, package extended surface economizer. Economizer shall be shop assembled and shipped complete with structural steel frame, inner casing, shop applied insulation and [_____] mm gauge box ribbed metal lagging. Economizer shall be designed and fabricated in accordance with ASME BPVC SEC I. Flue gas flow through economizer shall be vertical with orientation of economizer as shown.

b. Economizer shall be of continuous tube, loop tube design and shall be completely drainable by gravity after installation. Design and arrangement of economizer shall be such that there will be no steaming in the economizer under any load or operating condition. Minimum design temperature of the economizer shall be 370 degrees C 700 degrees F. Economizer shall be hydrostatically factory tested at 1.5 times the tube side design pressure or at least 2.07 MPa 300 psi in the presence

of a Code Inspector. The unit shall be ASME code stamped and shall include nameplate and code documentation.

c. Extended surface shall be of solid continuous, resistance welded carbon steel fins. Maximum fin spacing shall be [_____] fins per meter foot. Fins shall be not less than 1.9 mm 0.075 inches thick.

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

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

f. Pressure parts shall not be in contact with tube sheets.

g. Inner casing shall be a minimum of 3.4 mm 10 gauge carbon steel.

h. The economizer shall be designed for the maximum operating conditions of the boiler and shall be 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 shall not exceed 103 Pa 15 psi at maximum boiler load.

j. The economizer shall be insulated with a minimum 50 mm 2 inch thick blanket type mineral wool or approved equal.

k. Outer casing shall be weatherproof with a minimum 7.5 mm 22 gauge corrugated galvanized carbon steel lagging. Exposed surfaces not enclosed by outer casing shall be painted with high temperature aluminum paint.

l. Minimum 19 mm 3/4 inch vent and drain connections shall be provided on feedwater headers.

m. Economizer shall be provided with electrically operated soot blowers. The quantity of the soot blowers shall be as recommended by the manufacturer. Soot blowers shall be installed transversely to provide maximum cleaning capabilities.

n. Access door of carbon steel construction shall be provided in the economizer design. Access door shall be insulated.

o. The economizer shall be designed to accept piping reactions without distortion or creating overstressed conditions in the piping.

2.4.6 Firetube, Package Type Steam Boiler

Boiler pressure vessel shall be constructed and stamped in accordance with the rules of Section 1 of the ASME BPVC SEC I ASME manufacturer's data reports shall be executed 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. ASME manufacturer's data shall be furnished to the Contracting Officer, the inspection agency and the state and local authorities at the place of installation. Pressure vessel shall be stamped for 1030 kPa 150 psig design pressure.

2.4.6.1 Heating Surface

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

2.4.6.2 Boiler Firetubes

Boiler firetubes shall be not 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

Flue gas exhaust connection and stack thermometer shall be located on the top centerline. Boiler flue outlet shall be furnished with a manual cast iron locking damper.

2.4.6.4 Boiler Supports

Boiler and firing equipment shall be supported from the foundation. Boiler supports shall be heavy duty structural steel base with lifting lugs and rigging holes in the skid to facilitate installation. Two (2) or more lifting lugs shall be located on top of pressure vessel.

2.4.6.5 Refractory

Front boiler door shall be either hinged or davited, as required, to provide access to firetubes without disconnecting the burner or fuel train. Front boiler door shall be configured such that front tube sheets are fully accessible for inspection and cleaning when open. Rear door shall be davited. "Dry back" boilers having rear door refractory are not acceptable. Doors shall be sealed with ceramic fiber rope gaskets and fastened securely using lugs and nuts threaded onto studs welded into the vessel. Rear door shall be insulated with blanket insulation with a steel covering. The front door refractory and insulation shall be contained in the formed door which must swing open for inspection of brick work. Material Safety Data Sheets (MSDS) detailing refractory materials contained within the boiler shall be submitted.

2.4.6.6 Boiler Insulation

Boiler insulation shall be minimum 50 mm 2 inch fiberglass blanket covering entire circumference of pressure vessel and shall be protected by preformed sheet metal lagging. Insulation shall be covered with minimum 0.8 mm 22 gauge preformed sheet metal and factory painted before shipment using a hard finish enamel coating.

2.4.7 Boiler Trim

Boiler shall be provided 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 shall be factory wired into the burner control circuit to prevent burner operation if the boiler water level falls below the safe operating level.

c. An auxiliary low water cutoff shall be mounted below the primary unit, wired in series with the primary unit, and provided with a manual reset device.

d. Steam pressure gauge, range to suit operating pressure, shall be provided 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, surfaces of ferrous metal subject to corrosion shall be factory prime painted with a rust-inhibiting coating and subsequently factory finish painted in accordance with the manufacturer's standard practice. Equipment exposed to high temperature when in service shall be prime and finish painted with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil. Internal surfaces of tubes and piping that will not be in storage more than three months prior to being placed in service shall not be painted, but shall be coated with a water soluble pipe oil for rust protection. Surfaces which will be exposed directly to the flue gases (fireside furnace surfaces, OD surface of convection pass surfaces, inside of flues and ducts) need not be coated with a high temperature heat resistant paint, but shall be protected with a suitable coat of the manufacturer's standard primer. Surfaces that will be covered by insulation and lagging shall be painted with a high temperature heat resistant paint.

2.4.9 Factory Coating

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish unless otherwise specified.

2.5 FUEL BURNING EQUIPMENT

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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.

****

Fuel burning equipment shall be provided 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. Packaged burner shall be 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]. Provisions shall be incorporated for withdrawing, shielding or otherwise preventing the oil burner from cooking while firing gas. Emissions guarantees shall apply through specified turndown range. Flue gas recirculation shall be utilized to lower emissions, but shall be limited to 15 percent and shall be induced by the combustion air fan. Burner shall have a stable flame over the turndown range. Primary air spinner zone, zone divider and main burner shall be removable without removing the entire register or windbox. Register front plate shall have 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. Pilot burner shall be natural gas-electric type with the capacity required to reliably light off the boiler. A 6,000 volt secondary side ignition transformer shall be supplied and mounted backside of the windbox.

b. Pilot shall be liquefied petroleum gas (LPG) type. Two 18 kg 40 lb cylinders shall be located on concrete pads outside of the building as shown. Manifold and valves for cylinders to allow removal and filling of one tank without interrupting service to pilot shall be included. Regulators and gauges shall have adequate capacity to serve pilot.

c. Pilot shall be straight mechanical or atomizing type as specified for the burner. Pilot system shall be designed to fire No. 2 oil and shall be provided complete with fuel oil pump, safety shut-off valve, integral metallic screen strainers and a cartridge type filter. Ignition transformer shall be rated at not less than 10,000 volts on the secondary side.

d. Provision shall be made in the burner housing for inspection of the pilot flame.

e. Pilot shall be provided 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. Pilot and valving shall be in accordance with NFPA 85.

2.5.2 Burner Refractory Throat

Burner refractory throat shall be made of high quality castable refractory suitable for 1650 degrees C 3000 degrees F. The precast refractory in a steel retaining ring with stainless steel anchors shall be shipped separately for field mounting on the boiler. Burner refractory throat shall 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. Burner shall be so positioned 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 shall provide even airflow. Windbox shall not interfere with boiler smoke box door operation and shall have a flange bottom for easy firm mounting on a support structure. Windbox shall be provided with an induced flue gas recirculation (FGR) inlet adaptor assembly.

2.5.4 Combustion Air Fan

Combustion air fan shall be centrifugal type with backwardly inclined air foil bladed wheel. Combustion air-fan wheel shall be directly driven by a TEFC NEMA frame motor and shall be complete with inlet cone and screen and flange outlet. Combustion air fan shall be bottom flanged to be mounted on same structural member as windbox. Combustion air-fan shall be sized 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

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

2.5.6 Fuel Oil Burner

Fuel oil burner shall be [mechanical pressure atomizing] [steam atomizing][air atomizing] type conforming to UL 296, UL 726 and NFPA 85, capable of burning [heated] [unheated] [No. 6] [No. 4] [No. 2] fuel oil. Fuel oil burner shall be 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]. Fuel oil burner shall be 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. Fuel oil burner shall be easily moved out of firing position for cleaning, inspection, adjustment and maintenance.

2.5.7 Natural Gas Burner

Natural gas burner shall be a multi-spud burner with gas feed pipe in center of air register for easy removal. Natural gas burner shall be forced draft type and shall be 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. Natural gas shall be discharged in burner throat area. Natural gas-air premix or natural gas discharged outside of burner throat are not acceptable. Main natural gas burner shall 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 The flame safeguard system shall be manufactured by burner manufacturer and mounted in boiler control panel as a panel insert. Flame safeguard system components shall be UL listed. Complete and automatic flame safeguard system shall be provided in accordance with NFPA requirements safe start-up, on-line operation and shut-down of package burner.

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

c Flame safeguard system cabinet shall house overcurrent protective devices, and motor starters for the combustion air fan motor, burner damper motor and electric oil heater. Control transformers and an RS-232C serial communication port shall also be included.

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

e. Logic provided with flame safeguard system shall:

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, operator intervention shall be

required to manually reset flame safeguard controller prior to restart.

f. First-out annunciation shall be provided by an expansion module. Alarms and flame-outs shall be individually annunciated at panel front and transmitted along with other process points monitored by the panel to [Central Monitoring System (CMS)] [Supervisory Computer Workstation[s]] for graphic display. Following points, at a minimum, shall be individually annunciated 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. Flame safeguard system cabinet shall be provided with [natural gas] [No. 6] [No. 4] [and] [No. 2] oil fuel selector. Selector shall be integrated 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. Indicating lights shall also be provided for 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. Indicating pilot lights shall be industrial, oil-tight construction 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.

****

Piping train shall be completely prepiped, wired and mounted on boiler. [Fuel oil and [steam] [Air] atomizing systems] [and] [natural gas] train shall be in accordance with NFPA and FM standards and requirements and shall include but not be limited to 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. Boiler controller and plant master controller systems, and other sub-control systems specified herein shall be provided by a single control manufacturer.

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

c. System components shall be electronic, solid state, microprocessor type. Control components shall operate on 120 VAC power.

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

2.6.1 Instrument System

Instrument systems shall be powered by 120 volts alternating current, 60

Hertz or 24 volts direct current 2-wire system. The 24 volts direct current powered systems shall receive power from the central control system. Instrument enclosures shall conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Transmitter output signals shall be 4 to 20 mADC.

2.6.2 Indicating Instruments

Indicating instruments shall have the normal operating point marked in green on instrument. Transmitters shall include output meters in integrally mounted housings. Calibration shall be set by manufacturer, and adjustment access shall be internal only.

2.6.3 Factory Tests

Instruments, units, and other accessories shall be inspected, calibrated, and tested. Calibration shall be 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 shall configure, program, stage, and burn-in the control system prior to shipment to construction site. Programming of configuration and constants data shall be performed at this time, and stored on disks. Burn-in shall be for a minimum of 10 days of continuous operation. The Government reserves right to witness factory tests. A thirty-day advance notice shall be given to the Government prior to commencing any factory tests.

2.6.4 Sequence of Operation

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

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

c. Steam pressure control shall include proportional plus reset control modes.

d. Combustion controls shall be fully integrated with flame safeguard system to assure low-fire startup and complete purge regardless of boiler master output signal.

e. Combustion control strategy shall be single point positioning with oxygen trim.

f. Boiler firing rate shall be controlled by actuating burner jackshaft drive motor to move jackshaft that mechanically links fuel and combustion airflow.

g. Boiler oxygen trim shall be accomplished by modulating combustion air damper to alter fuel-air ratio based on input from oxygen analyzer.

h. Control loops shall include manual-automatic stations to provide for control of system. Each manual-automatic station shall contain a built in indicator to graphically depict variable being controlled.

i. Control system shall be arranged so that failure of control system for one boiler does not affect automatic and manual operation of other boilers. Common electrical signals shall be electrically isolated in each boiler section.

2.6.5 Enclosures

a. 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 shall be provided for each boiler. For multiple boiler installations, the boiler No. 1 panel shall contain controls common to all boilers. Enclosure shall have locking doors and shall comply with NEMA ICS 6.

b. Enclosure shall be NEMA 12, 11 gage steel, all welded construction with minimum radius corners, stiffened as required and framed with angles. Door shall be constructed of 14 gage steel with key-locking vault handle and three (3)point latches. Doors shall be fully gasketed.

c. Metal surfaces shall be cleaned, phosphatized, primed and finished. Interior shall be glass white enamel. Exterior shall be gray texture polyurethane enamel to provide resistance to fuel oil, solvents and abrasion. Engraved plastic laminated nameplates shall be provided for devices on the front of the cabinet except where devices themselves are provided with a service engraving. Nameplates shall have white letters on a black background and be minimum 6.5 mm 0.25 inch height, mounted with screws or epoxy or secured by pilot light or switch. Equipment title and identification number shall be listed. Abbreviations are not acceptable.

d. Enclosure mounted devices shall be properly supported, front and rear and shall occupy the upper portion of the enclosure front.

e. Enclosure wiring shall comply with acceptable standard panel practice.

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

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

h. Signal common and power common buses shall be supplied. Signal common shall be connected 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. Controller shall be microprocessor-based and shall be of single loop design. Controller shall be flush-mounted in control cabinet and shall have splash-proof mylar faces. Operator pushbuttons shall be of the membrane type and have tactile feedback. A 4-1/2 digit numeric display shall be provided on front of controller.

b. Two bar graphs shall be provided on the front of controller to give an analog interpretation of process variables, setpoints or deviation. These shall be of the 100 segment LED type. A dedicated 20 segment LED bar graph shall be provided for the controller main output.

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

d. Controller output logic shall include proportional, plus integral, plus derivative (PID) modes.

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

f. Should the controller or memory fail, controller shall 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. Controller shall be capable of being configured in field without use of external computers, hand-held terminals, EPROM programmers or other devices.

i. Configuration changes and tuning adjustments shall be accomplished by means of key pad on controller front. Controller digital circuitry shall be protected from power surges and spikes by optical isolation or by uninterruptible power supply.

j. Configuration shall be maintained in (2) removable battery backed RAM chips. Failure in primary memory shall 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 shall be available: Manual, Automatic, and Adaptive. Provide tuning utility allowing collection of data and process tuning in real time.

2. The tuning utility shall 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. Above information shall be displayed 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. Program shall allow 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. Utility shall monitor the results and calculate new parameters for sample interval, Proportional band, Integral gain, and Derivative gain. Utility shall be 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. Adaptive tuning shall be initiated automatically whenever operator-defined change in the process input variable is detected. Utility shall monitor process (control loop) after natural disturbance, and automatically recalculate Proportional gain, Integral gain, and Derivative gain. This utility shall be used to keep a system tuned, as the equipment ages and occupancy and loads change, after commissioning.

l. The tuning utility shall 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. Controller shall be provided 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 [shall match individual boiler master controller[s] and] shall provide for proportional, integral, and derivative (PID) control of firing rate demand based on steam header pressure. [The plant master controller shall be located in the boiler No.1 cabinet.] The output of the plant master controller shall go to

the boiler master plant master controller. The controller shall provide for digital display of the following:

1. Controller output.

2. Steam pressure.

3. Steam pressure setpoint.

4. Outdoor temperature.

5. Total plant steam flow.

b. Inputs shall be 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. Outputs shall be as follows:

1. Boiler master signal (Analog).

2. Total plant steam flow.

3. Totalized steam flow pulse.

d. Controller shall be provided 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. Each boiler shall have a boiler master controller. This controller shall control jackshaft in response to plant master demand signal or in response to boiler pressure and local setpoint. Primary analog output shall 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 shall be the burner manufacturer's responsibility. Controller digital display shall 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 shall be:

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 shall be:

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

1. Controller output.

2. Water level.

4. Steam flow.

5. Feed water flow.

b. Controller inputs shall be:

1. Water level.

2. Steam flow.

3. Feed water flow.

4. Remote alarm silence (Contact).

c. Controller outputs shall be:

1. Feedwater control valve (Analog).

2. Remote audible alarm (Contact).

3. Steam flow (Analog).

d. Controllers shall be provided 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 shall match other controllers in system and shall have capability of PI control of furnace draft in response to changing furnace pressure and feed forward signal of boiler load.

b. Control system shall include 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. Controller shall have characterizable setpoint curves for feed forward signal based on load.

d. Controller digital displays shall be as follows in their respective engineering units:

1. Controller output.

2. Furnace draft.

3. Furnace draft setpoint.

e. Controller inputs shall be:

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 shall be:

1. Flue gas damper actuator (Analog).

2. Remote audible alarm (Contact).

g. Controller shall be provided 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 shall match other controllers in the system and shall have the capability of PID control of fuel/air ratio in response to flue gas oxygen content.

b. Controller shall be capable of calculating and displaying boiler efficiency using ASME "By Losses" method.

c. Control system shall include 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. Controller digital displays shall be 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 shall be:

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 shall be:

1. Oxygen trim actuator (Analog).

2. Boiler efficiency.

3. Remote audible alarm (Contact).

g. Controllers shall be provided 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. Each boiler master panel shall be provided with single horn and single alarm silencing pushbutton. First out alarm annunciation shall be provided for following alarm points and they shall 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 shall 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. Horn shall sound for every new alarm, even if previously silenced.

c. Controllers shall be provided 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. Opacity monitor shall be double pass system to provide continuous stack opacity indication.

b. System shall consist of transceiver and retro-reflector module mounted on opposite sides of the stack, and electronic monitor.

c. Bi-directional digital communications link shall connect electronics processor and transceiver module.

d. Transceiver shall be provided with backlit pushbutton for

calibration offline.

e. Light source and receiver shall be provided with air purge system for use with plant air.

f. Electronics shall withstand air failures and shall maintain on-line service without shutdown. Field-mounted device shall be in NEMA 4 enclosure.

g. System shall be suitable for operation on 120 volt single-phase power.

h. System shall be 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, each component of opacity system shall be checked including: light, source, receiver, optics on stack and associated electronics.

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

k. The output from the system shall include:

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 shall be 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

Vertical scale indicators shall be 150 mm 6 inches high for steam header pressure, outdoor air temperature and combustion air temperature.

2.6.15 Digital Indicators

Oversized digital indicators shall be provided 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

Draft gauges for wind box, combustion chamber and last boiler pass shall be mounted on panel front. Operating ranges for draft gauges shall be field verified with normal reading in middle of scale range. Draft gauge shall include piping between gauge and boiler with three (3) way cocks for shutoff and zero check.

2.6.17 Recorder

a. Recorder shall be circular chart type, direct reading having evenly divided graduation. Charts shall be driven by 120 volt, 60 Hz motors. Pens shall be provided with different color ink and arranged to pass each other without interference. Each chart shall show 24 hours.

b. Recorder shall be capable of recording up to four points. Recorder unit shall be fully programmable in order that each channel can be configured to accept 4-20 mA DC voltage, thermocouple and RTD inputs. Nonlinear inputs shall be linearized and provisions made for special linearizations.

c. In addition to recording, recorder shall have provisions for individual 16 character tags and messages per channel and up to four integrators which shall be selectable either as reset or non-reset type. Each channel shall be fitted with two alarms selectable as absolute, rate of change or deviation.

d. Recorder shall measure the following points:

1. Steam flow.

2. Percent oxygen.

3. Flue gas temperature.

4. Opacity.

e. Recorder shall be provided 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

Eight-digit, non-resettable totalizers shall be provided for: natural gas, fuel oil and steam flow flush-mounted in each boiler control panel. Totalizers shall display directly in engineering units. Only powers of ten (10) shall be allowable as scale factors. Power shall be backed up by a lithium battery with a life span of not less than 8 years. [Smart transmitters may be used to communicate to associated controllers on a device level network LAN. Smart transmitters shall not reside on controller LAN]

2.7 FIELD DEVICES

The following field devices shall be furnished and installed 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. Oxygen analyzer shall be provided for each boiler. Oxygen analyzer shall be stack-mounted and shall utilize zirconium sensing element. Sensing element shall be inserted directly in flue gas stream and shall be in direct contact with process gases. Sensing element shall be contained within a protective housing mounted to flue gas outlet by means of adapter plate, both furnished by manufacturer.

b. Oxygen analyzer shall be equipped 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, externally-mounted temperature controller shall be provided. Temperature controller output shall be isolated 4-20 mA DC representing 0-10 percent oxygen content as linear function.

e. Reference and calibration gas system shall be provided for each boiler consisting of gas supply, regulator with relief valve, gauge and necessary valving and piping. Electrical power connections and piping for distribution to calibration gas connection on each analyzer shall be provided.

2.7.2 Fuel Oil Flow Transmitter

a. Fuel oil flow transmitter shall be provided for each fuel oil flow meter. Transmitter output shall be isolated 4-20 mA dc.

b. Panel-mounted totalizer shall be connected to transmitter. Necessary signal conditioning devices shall be provided 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 shall not reside on controller LAN.

2.7.3 Natural Gas Flow Transmitter

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

2.7.4 Steam Flow Meter-Transmitter

a. Steam flow meter-transmitter shall be a Vortex-Bar meter probe designed for pipe insertion type installation by means of hot tap or other non-disruptive method. A steam flow transmitter shall measure media flow by means of a vortex shedding flow element located in flow

stream.

b. Steam flow meter-transmitter shall have 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. Steam flow meter shall be supplied with a two-wire preamplifier with analog 4 to 20 mA dc output signal.

c. Steam flow meter shall meet 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. Steam flow meter-transmitter shall meet 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. Both valve and pipe tap shall have a minimum [48 mm 1.875 inches] [_____] internal diameter clearance.

f. Electronics enclosure shall be NEMA [4] [4X].

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

2.7.5 Temperature Transmitter

a. Platinum resistance temperature detector (RTD) temperature transmitter shall be provided. Resistance shall be 100 ohms at [0 degrees C 32 degrees F] [_____] with tolerances in accordance with BS 101-4 and DIN 43760.

b. Connections to control cabinet shall be via three identical copper conductors of No. 14 AWG minimum.

c. RTD shall be inserted in protective sheath or well suitable for the environment.

d. Transmitter shall utilize platinum RTD input to provide 4-20 mA dc output to control cabinet. Transmitter shall be 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 shall not reside on controller LAN.]

f. The following temperatures shall be monitored.

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. Electric drive shall be provided for jackshaft and flue gas dampers. Electric drive shall accept signal input from control system and provide feedback of actuator position by means of integral potentiometer. Electric drive shall include four adjustable end switches.

b. Electric drive shall have 90 degree rotation in 15 seconds and be capable of [_____] Newton Meter ft-lbs of torque under continuous duty.

2.7.7 Pressure Transmitter

A pressure transmitter shall have 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. Pressure transmitter shall be provided with a calibration valve manifold. Pressure transmitter for steam service shall include an isolating siphon. Following transmitters shall be provided:

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. Boiler shall be provided with differential pressure type water level transmitter.

b. Differential pressure type water level transmitter shall have 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 shall not reside on the controller LAN.]

2.7.9 Pressure Switch

Pressure switch shall have repetitive accuracy of plus or minus 1 percent of the operating range. Pressure switch actuation shall be adjustable over the operating range. Pressure switch shall have snap-action Form C contacts rated for the application.

2.7.10 Temperature Switch

Temperature switch shall have repetitive accuracy of plus or minus 1 percent of the operating range. Temperature switch actuation shall be adjustable over operating temperature range. Temperature switch shall have a snap-action Form C contacts rated for the application.

2.7.11 Oxygen Trim Drive

Oxygen trim drive shall be in-line piston type actuator in linkage from jackshaft to combustion air damper. Oxygen trim drive shall act to position combustion air damper based on signal from oxygen trim controller.

2.7.12 Supervisory Computer Workstation

****
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. Dedicated monitoring and data collection system supervisory computer workstation, complete with custom software shall be provided as specified. Supervisory computer workstation computer shall collect and store data transmitted from system controllers and other sensing and monitoring devices, shall log alarms, and shall use software described to generate periodic reports. Data collection function shall take priority over report generation function and shall not be interrupted by generation of reports.

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

c. Supervisory computer workstation computer shall be designed such that a failure of the CPU, the storage disk, or any other device shall not result in the loss of any previously stored data.

d. Supervisory computer workstation shall include the computer, keyboard, printer, monitor, and other peripherals and shall be located 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. Authorized personnel shall be capable of editing and modifying programs with access code. Password protection shall be provided for all levels of access. The multiple level password protection system shall be acceptable to the Owner.

f. Supervisory computer workstation computer shall be microprocessor based personal computer. Computer shall be provided with eight expansion slots. Computer shall be Microsoft Windows (R) compatible, each with a floppy disk drive, 17 inch high resolution SVGA color monitor for graphic displays. The hard disk drive shall have 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.] Following minimum equipment shall be 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. The keyboard shall be equipped 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. The keyboard shall be provided with a high resolution track ball.

g. Following additional peripheral equipment shall be provided 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

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

a. Software required for efficient operation of automatic system functions required by this specification shall be provided. Software shall be modular in design.

b. Available supervisory computer workstation application and system software shall be provided with system, and shall reside 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. Licensing agreement from PC manufacturer shall be provided 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. Software in system shall consist of both firmware, resident in the controller, and software resident in the supervisory computer workstation computer. Architecture of system, application software and firmware shall be distributed, with no single system component responsible for a control function for entire LAN. Each controller shall contain the necessary firmware, control software and I/O capability to function independently in case of network failure. Controller shall be able to stage, rotate and fully control the equipment during a communication failure with network LAN. No active control sequences shall be resident in supervisory computer workstation or central control unit. Workstation and controllers shall be 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 shall 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. Necessary hardware, software and programming shall be provided 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. [Primary operator interface to system shall be through graphical, object oriented, and interactive presentation using mouse and cursor for object selection and commands. Plant management software shall be Microsoft Windows based.]

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

c. [System shall support pop-up windows for point editing. On selecting object with cursor, a window shall open up to present operator with a list of active point data base editors, if permitted by the operator's password level. Selecting one of these editors shall 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.]

d. [System shall be based on interactive prompts and choices, using dialogue boxes as opposed to memorization of commands, syntax or exact spellings. Interactive prompt and choices approach shall be used in monitoring, issuing commands, and editing. Command choices shall entail clicking cursor to select correct work choice prompts, for example: ON-OFF, without typing in letters. Editing mode choices shall prompt ranges or options, for example: 16 CHARACTERS for point name, or DIRECT-REVERSE for control action).]

e. [Zoom: It shall be 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. Operator shall be 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. System software shall be compiled for faster execution speeds and shall offer the following features and capabilities that follow.

1. Input/Output Capabilities: From the connected supervisory computer workstation, the system operator shall have ability to:

2. Request displays of current values or status using a tabular [or graphic format.] [A global data base sorting utility shall allow an expanded tabular display of only points on current graphic display.] This [expanded tabular] display shall 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. Development, editing and display work shall be 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 shall 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. Reports shall be initiated manually or automatically printed. System shall have capability to print reports on daily, weekly, monthly, yearly or scheduled basis. Report writer shall provide capability for statistical data manipulation and extraction. As a minimum, the custom report writer shall 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. Report function shall be on-line for both development and printout, and shall not require export to a third party spreadsheet program for execution.

11. [In addition to on-line function, historical database shall be capable of being converted to Data Interchange Format (DIF) for use in spreadsheet for off-line manipulation. Transmission to DIF files shall be 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 shall support appending new data to existing file data.

13. Printer shall print alarm annunciations and normal operator acknowledgments, action messages, system alarms, operator sign-on and sign-off. Operator control activities shall 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. Operator shall have the option of selecting daily, weekly or monthly scheduled frequency to synchronize time and data in controllers from the supervisory computer workstation. Synchronization shall be performed for dialup as well as direct connected locations. This program shall accommodate automatic daylight savings time adjustments.

15. Supervisory computer workstation shall have a feature to indicate audibly [and visually,] when Off-Normal conditions and messages exist.

16. [Operator shall be 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 shall:

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: System shall have following alarm processing features, all of which shall be definable through the input keyboard:

1. Each OFF-NORMAL condition shall cause an alarm and appropriate message, including time and date of alarm, system and point descriptor and alarm condition. Operator shall have the ability to select, at any time, which state or value shall be considered alarms and which alarms shall cause automatic dial-out to occur.

2. Each critical alarm or change-of-state message shall be displayed. Controller LAN network alarm messages shall be stored on disk and may be reviewed on the display printed on operator selected printer at any time. It shall be possible to sort this alarm and change-of-state database by date, time or item fields.

3. Automatic user defined time delay of alarms during equipment start-up or shut-down shall be provided.

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. Alarm notification shall consist 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 shall 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. Submittal shall 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, the following screens shall be 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

System shall be 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. The system shall be 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 shall 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 shall be able to log servicing or repair data in the supervisory computer. Plant maintenance shall also be capable of logging servicing or repair data for equipment monitored in the steam plant.

2.7.13 Centralized Monitoring System (CMS)

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

a. CMS shall be used for centralized monitoring and data acquisition

of various plant variables.

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

c. Equipment employed in CMS shall be industrial grade and 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. System controller shall monitor various plant variables, log data and generate summary reports as required by plant operations. System controller shall be capable of data reduction and backup data logging. Data and alarm interfaces between CMS equipment and Government equipment shall be performed at system controller.

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

c. System controller shall provide backup digital storage of CMS data. Backup data storage device shall have 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, data logged during communications failure period shall be automatically transferred to monitoring and data acquisition system computer. Battery backup shall be provided for backup data storage device if required to preserve data in event of a

power supply failure.

d. System controller shall consist 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. System controller shall consist of central processors, input-output interfaces, memory, power supplies, a programming device, and tape or disk drive for storing and rapidly loading programs. Provision for portable operator interface panel shall be provided 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. Central processing unit shall be 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. The system controller shall be 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. Inputs and outputs shall be electrically isolated from other input-output and from all cabinet wiring.

2.7.13.3 Alarm Interface

CMS shall be provided 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. One of these annunciator cabinets shall be located [_____] and the other shall be located in the plant control room. The Acknowledge and Test pushbuttons shall be momentary. Equipment in these cabinets shall be directly connected to the CMS input-output ports as shown. When alarm condition is detected, horn at both annunciator cabinets shall sound and the red indicating lights shall flash. When Acknowledge button is pressed in any one of the annunciator cabinets, or when the alarm is acknowledged at either of the work stations, horn shall be silenced, red flashing lights shall go off, and the white indicating light shall come on. At this point the system shall be ready to annunciate new alarm condition detected. The white indicating light shall stay on until the alarm condition is removed. If the Test pushbutton is pressed, the horn shall sound and the red indicating light shall flash. Pressing the Acknowledge button shall silence horn and reset alarm system. Lamptest pushbutton shall be provided 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 shall receive output signals from stand-alone boiler controller by means of data communication link. Other variables requiring monitoring shall be sent to CMS as analog or discrete contact closure signals. If existing boiler control system is utilized, provision shall be made to acquire data from these controllers, preferably by means of serial communication links. If it is not feasible to establish serial

communication links, variables to be monitored shall be sent to CMS as appropriate analog or discrete signals. CMS controller shall 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, data for the following variables shall be accessed from boiler control system:

a. Steam pressure in kPa psig.

b. Steam pressure setpoint s 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, following alarms shall be accessed 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. Status of equipment common to all boilers and any other plant variables not part of any boiler control system shall be monitored directly by the CMS controller via input-output interface modules. Input-output modules shall be analog, discrete or communication ports as required. Discrete inputs-outputs shall be isolated or nonisolated as required by prevailing conditions. System controller shall apply calibration factors to raw analog transmitter output as required.

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

2.7.15.1 BOP Variables to be Monitored:

Following balance of plant variables shall be accessed 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

Following alarms shall be accessed 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

Monitoring and communication cables, wiring, and associated raceways, including conduit, junction boxes, and fittings shall be provided 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. Cables shall be as required for connection between CMS equipment, boiler controllers and field devices.

2.7.18 Remote Communication Interface Modem

System shall have auto dial-auto answer modem suitable for use with voice grade telephone lines. Communications shall be in English language and limited to ASCII character codes. System shall be capable of automatically dialing up in both pulse and tone dial mode.

2.7.19 Instrument Power Supply

Instrument power supplies, as necessary, shall be provided to power panel and field mounted instruments, including instruments within instrument cabinets and back-of-panel components. Power supplies shall 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. Instrument power supply shall meet the following requirements:

a. Input power to the instrument power supply shall be 120 V ac, 60 Hz, single-phase. Power supply shall be wired as a tap circuit through

a separate pull-out type fusible block rated 300 V ac minimum at rated amperes, and shall be wired to the same branch circuit as CMS controller.

b. Power supply shall be provided with output current protection.

c. Power supply shall be supplied with brackets for installation on mounting panels within the CMS cabinet.

2.7.20 System Architecture

System shall be designed 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 shall be capable of accepting inputs as described below:

a. Analog Inputs (AI): Analog inputs originating from sensing elements shall be monitored and buffered as AI, except that automatic conversion to proper engineering units shall occur without any additional signal conditioning as follows:

1. Temperature inputs from thermistors or RTDs or temperature transmitters shall be converted to degree C,

2. Flow inputs from flow transmitters shall be converted to liter per minute, cubic meter per minute or as specified in process and instrumentation diagram.

3. Valve or damper position from potentiometer or similar device shall be converted to percent open.

4. Pressure input from pressure transmitter shall be converted to mm of water kPa as specified in process and instrumentation diagram.

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

2.7.20.2 Outputs

Controllers shall be capable of directing outputs as follows:

a. Analog Outputs (AO): Analog outputs as direct or reverse function of associated analog inputs shall modulate final elements in response

to controller algorithms. Final element actuators shall be industrial grade capable of accepting a modulated [electronic] [pneumatic] signal from the controller [via a signal converter, current to pneumatic]. Electronic signal shall be 4-20 mA dc with a minimum of 16 [_____] bit resolution. [The pneumatic signal shall be 21 to 34 kPa 3 to 15 psi. Each pneumatic output shall have feedback for monitoring of the actual pneumatic signal.]

b. Digital Outputs (DO): Digital outputs shall command equipment to the selected position via schedules and programs. Contact closure with contacts rated at a minimum of 1 ampere at 24 volts shall be provided. The output signals shall include, but not limited to:

1. Enable-Disable.

2. Start-Stop.

3. On-Off.

4. Open-Close.

5. Demand Limit

6. Temperature Reset.

7. Boiler Selection

8. Floating Control.

2.7.20.3 Program Storage

CMS controller shall 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

CMS controller program code shall be documented sufficiently that operator can modify controller logic and setpoints. Software provided shall include, but not be 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 shall be RAM resident. Bulk storage devices, such as magnetic disks, shall not be used in an interactive on-line mode, but may be added for extended data storage.

2.7.21.1 Trend Logging.

Operator shall be able to initiate a custom log for any variable value in the control program. Operator shall select type of log, number of values log shall contain, and time interval between values. Trend log activation period shall be assignable from keypad by day, month, year, and time span desired for each log.

2.7.21.2 Alarm Reporting.

Control system shall be capable of analyzing any variable in the program and evaluating for alarm condition. Alarm can be generated based on analog value out of limits or based on a programmed sequence of events. System

shall store alarms in log upon each occurrence and shall be capable of reporting them immediately.

2.7.21.3 Alarm Lockout Routine.

Alarm lockout routine shall be provided to inhibit nuisance alarms.

2.7.22 Documentation

Following documentation shall be provided:

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.

Operating and maintenance manuals providing functional description of proposed equipment, and descriptions of maintenance on system components. Operating and maintenance manuals shall cover inspection, periodic preventive maintenance, fault diagnosis, replacement and repair of defective components.

2.7.22.4 Equipment Installation Details.

Detail drawings shall be submitted showing installation requirements for each component of the CMS.

2.7.22.5 System Interconnection Block Diagram.

System interconnection block diagram shall show the interconnection of components in the CMS network.

2.7.22.6 Software Manual

Software manuals describing programming and testing for CMS controller and containing system overview with detailed description of software features. Software manuals shall 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. Software manual shall include:

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. Soft ware documentation providing easy reference from summary sheets which compare pertinent information about hardware, and wiring information in the field. Documentation shall include:

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

Internal equipment cabinet wiring shall be factory installed, color coded and bundled neatly or routed via wiring duct. Installation of cables and wiring shall be as specified.

2.7.23.1 Termination

Terminations shall be made with pressure type connectors or lugs. Stranded conductors shall not be wrapped around screw type terminals. Incoming cables shall be connected to CMS controller via terminal blocks. Internal wiring shall be terminated at one side of the terminal blocks.

2.7.23.2 Nameplate for Device Inside Equipment Cabinets.

Nameplate for device mounted inside equipment cabinet shall be stamped with the device number only. Nameplate shall be 10 mm 3/8 inches wide stainless steel tape, attached 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 shall 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, the Contracting Officer shall be furnished a written test report which provides documentation that the CEMS equipment has passed factory and field certification tests required by federal, state and local regulations. The investigation will determine if the reported values may be calculated or should be direct measurements. 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. Continuous emissions monitoring system (CEMS) equipment shall be provided as a system by a single manufacturer. CEMS, meeting requirements of applicable federal regulations, State of [_____] and local regulations, shall be provided for boiler in accordance with manufacturer's recommendations and under direct supervision of CEMS equipment manufacturer.

b. Reported data shall include [sulfur dioxide (SO_2)] [oxides of nitrogen (NO_x)] [carbon monoxide (CO)] [carbon dioxide (CO_2)] [particulate matter (PM)] and other information required by federal, state, and local regulations. SO_2 reporting shall be based on [analyzer measurement] [fuel flow and percent sulfur calculation] [daily heat input calculation]. Nitrous oxides, carbon oxides and particulate matter reporting shall be based on analyzers.

c. The CEMS equipment shall include central processing unit, printer, hard disk drive, and floppy disk drive. Floppy disk drive shall function as recorder. Manufacturer shall provide software to generate required reports in format acceptable to federal, state and local regulatory agencies. Operator interface to CEMS equipment shall be by means of CRT display.

2.7.24.1 Gaseous Emissions Monitor

Extractive or in-situ gaseous emissions monitors shall be provided. Combination of extractive and in-situ monitors is not acceptable. Gaseous emissions monitors shall include automatic calibration checks. Alarm horn and annunciator shall be provided to alarm when any monitored parameter is out of range or gaseous emissions monitor malfunctions. Surfaces exposed to corrosive gas of boiler shall be constructed of noncorrosive materials such as 316 SS, Teflon or Hastelloy.

Extractive systems shall be [wet][dry][diluted]. Analyzing equipment for extractive system shall be [rack-mounted][located in a walk-in cabinet].

2.7.24.2 Flue Gas Flow Monitor

Flue gas flow monitor shall utilize the pitot tube principle to measure flue gas flow. Flue gas flow monitor base shall be across-the-duct average pitot tube and shall be properly designed and located to obtain representative measurement. Differential pressure transmitters shall be used to sense the difference between the static and total pressure of the flowing flue gas stream. Calibrations shall be stable.

2.7.24.3 Particulate Matter Opacity Monitor

Particulate matter opacity monitor shall be based on principle of transmissometry. Transmissometer shall include automatic simulation of zero opacity and up scale check of calibration while boiler is in service

without dismounting monitor. Calibration check shall include analyzer internal circuitry and electronic circuitry. Alarm horn and annunciator shall be provided to annunciate excess opacity and system malfunction. Monitor shall be provided with fans to keep sending and receiving lenses pressurized and blown clean at all times.

2.7.24.4 Wiring

CEMS equipment shall be provided with plug in prefabricated cable for interconnection between components. Power supply to the equipment shall be 2 wire, 120 volt nominal or less, 60 Hz, with one side grounded. Electrical devices shall be connected 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

Deaerator shall be complete package by one manufacturer including receiver with deaerating section, pumps, electrical control and accessories. Deaerator components shall include but not be 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

Deaerator water storage tank shall be [_____] mm inches diameter, [_____] mm inches long.

a. Storage tank section shall have [_____] minutes of storage and have a capacity of [_____] liters gallons measured to overflow. An 280 by 380 mm 11 by 15 inch elliptical manhole shall be provided for access. Deaerator shall be rated at [_____] kg pounds of steam per hour.

b. Deaerator shall be designed 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. Tank shall be 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. Internal surfaces which come in contact with underaerated water shall be constructed of Type 316 stainless steel.

d. Deaerator shall be provided with manual and automatic vent valves. Automatic vent valve shall be thermostatically controlled to provide

fast venting of sudden buildup of gases. Manual vent valve shall have an orifice for continuous minimum venting. Manual minimum venting rate shall not exceed 0.1 percent of rated deaerator capacity. Deaerator shall be suitable to operate from 13.6 to 102 kPa 2 to 15 psig.

e. Deaerator stand shall be steel fabricated of appropriate height for the feed pump-motor set, and mounted on a solid base. The base shall be reinforced to prevent vibration.

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

g. Pump-motor set shall be mounted on individual base before mounting on the stand base. Individual suction piping, including strainer, shutoff valve and flexible connector, shall be provided for pump. Pump suction nozzle shall be provided with vortex breakers to eliminate loss in NPSH and cavitation. Connections shall be as shown.

h. Interior of the tank shall be factory-lined with high quality baked epoxy lining. Lining shall be applied to white metal surface in accordance SSPC SP 5/NACE No. 1. Four to six coats shall be applied 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. Lining shall be holiday spark tested using low voltage and a wet sponge to ensure uniform coating free of pin holes.

i. Exterior shall be primed with a high heat silicone acrylic primer, 0.05 mm 2 mil minimum DFT.

2.8.1.3 Deaerator, Atomizing Spray-Type

Deaerator shall be atomizing spray-type, pressurized horizontal type. Heads shall be ASME torispherical type constructed of ASTM A516/A516M GR 70 carbon steel with a minimum thickness of 6.35 mm 0.25 inch. Shell plate shall be fabricated of ASTM A36/A36M carbon steel with minimum thickness of 6.35 mm 0.25 inch. Main deaerating portion, located internally, shall consist of water collector and steam atomizing valve. Spring loaded water spray nozzle which includes automatic and manual vent valves shall be built into a flange on top of the tank.

2.8.1.4 Deaerator, Tray-Type

Deaerator shall be tray-type with spray manifold in a 300 Series stainless steel deaeration dome with integral cascade trays, pressurized horizontal type. Deaeration dome with integral cascade trays containing a spray manifold with stainless steel spray nozzles shall be flange mounted to the boiler feed receiver. Spray manifold shall be flange mounted to the dome. Flange opening shall be large enough to permit the manifold to be easily withdrawn for servicing. Direct injection steam heating assembly shall be installed in the receiver. Heating assembly shall consist 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. Deaerator shall be atomizing spray-type two-tank, divided into two separate sections. Deaerator water storage and condensate surge sections shall be divided by a double inner head. Air space between 2

inner spaces shall be packed with fiberglass insulation and shall have a breather and drain connections. Shell plate shall be fabricated of ASTM A36/A36M carbon steel with minimum thickness of 6.35 mm 0.25 inch. Heads shall be ASME torospherical type constructed of ASTM A516/A516M GR 70 carbon steel with a minimum thickness of 6.35 mm 0.25 inch.

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

c. Surge tank shall receive returning condensate and be supplemented by makeup by water to maintain desired operating level. Surge tank shall be vented to the atmosphere. Collected water shall be transferred to deaerator. Main deaerating portion shall be located in deaerator storage tank and shall consist of water collector and steam atomizing valve. Built into a flange on top of deaerator storage tank is a spring loaded water spray nozzle which includes an automatic and manual vent valve.

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

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

2.8.1.6 Chemical Feed Quill

Chemical feed quill shall be located beneath the normal tank water level. Chemical feed quill material shall be stainless steel. Chemical feed quill shall 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 shall 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

a. Number of pumps [_____]

b. Rated capacity of each pump, L gpm 1/hr [_____]

c. Total dynamic head at rated capacity, m Feet [_____]

d. Net positive suction head available, m Feet [_____]

e. Maximum allowable shutoff head, m Feet [_____]

f. Minimum allowable shutoff head, m Feet [_____]

g. Type of fluid pumped Boiler Feedwater

h. Max. expected temp. of fluid [_____] degrees C degrees F

i. Maximum speed of pump, rpm 3600

2.8.2.2 Construction Materials

Pump shall have [_____] Class [_____] suction flange and [_____]Class [_____] discharge flange. Shaft, impeller, and internals including sleeves and wearing rings shall be stainless steel containing not less than 11 percent chromium. [Horizontal pump impellers shall be closed type, cast in one piece.] Casing shall be 11 to 13 percent chromium steel. [Suction and discharge chamber shall be cast iron.] [Horizontal pump shall be designed to pump water at any temperature from 10 to [_____] degrees C 50 to [_____] degrees F without undue temperature strains within pump. Rotating parts shall be properly balanced. Assembled rotor shall be dynamically balanced. Casing volutes shall be staggered to ensure radial balance of the assembled rotor under operating conditions. On volute pumps, impeller shall be mounted 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

Pump shall be furnished with complete cooling water system which connects jacket cooler to common header. Piping shall be factory assembled as completely as possible on the pump. Seal flush piping shall be Type 316 stainless steel. Seal flush cooler tubing shall be Type 304 stainless steel. Flow regulating valve and 6.35 mm 1/4 inch bypass needle-valve shall be provided on each supply branch.

2.8.2.4 Bearings

[Horizontal pump shall include a double row ball type thrust bearing on the outboard end and a single row deep groove radial bearing on the inboard end. Splash type bearing lubrication shall be provided.]

[Vertical type pump bearings shall be water lubricated sleeve type constructed of babbitted graph alloy with Type 304 stainless steel shaft sleeves.] The bearings shall be designed for L-10 bearing life of [_____].

2.8.2.5 Shaft Sealing System

[Vertical pump shall be equipped with an effective mechanical shaft seal to

seal.] [Horizontal pump shall be fitted with balanced mechanical seals, pressurized type, tungsten carbide and carbon sealing faces especially designed for high temperature, high pressure boiler feed pump service. Mechanical seals shall be provided with pumping rings. Complete field flush piping from each mechanical seal to its respective seal cooler shall be provided 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

[Shaft coupling between vertical pump and drive shall be direct coupled type.] [Horizontal pump shall be direct connected to its motor by means of a spacer disc type coupling. Spacer piece provided between motor and pump shall facilitate removal of coupling flanges and mechanical seals without disturbing the pump or motor hold-down bolts. Disc coupling shall be limited and float. Disc shall be stainless steel. Suitable coupling guards shall be furnished.]

2.8.2.7 Special Tools

Complete set of special tools shall be furnished as required for assembly, disassembly or maintenance of pumps.

2.8.2.8 Pump Characteristics

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

b. Pump shall have shutoff head of not greater than 150 percent and not less than 115 percent of design head. Design point capacity on the selected pump curve shall be within 25 percent of the capacity at the best efficiency point for the impeller selected. Minimum flow required for continuous pump operation shall not be greater than 30 percent of the specified design flow for each pump.

c. Pump shall have efficiency of 60 percent or greater at rated capacity.

2.8.2.9 Horizontal Pump Accessory Equipment

Following shall be provided 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. Tee type strainer shall have fine mesh screen fitted over it for use during startup period. Fine mesh screen shall be removed 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

Deaerator manufacturer shall furnish completely wired control cabinet, mounted on pump unit or free-standing. Cabinet shall have 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: Deaerator control panel shall be properly sized to contain control devices, instrument gauges and meters. Deaerator control panel shall be unit mounted or free-standing with face-plate of not less than 4.7 mm 3/16 inch reinforced steel plate. Control cabinet shall be factory-assembled steel enclosure with locking door. Panel shall be NEMA 4 construction, 12 gauge steel all welded construction with minimum radius corners, stiffened as required and framed with angles. The door shall be constructed of 12 gauge steel with door clamps and continuous hinge. Door shall be fully gasketed.

2. Wiring:Deaerator control panel shall be wired in accordance with NFPA 70 and shall have individual motor starter with 120 volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. Switches and light shall be NEMA 4 rated and have nameplate identification. Paralleling of individual control power transformers will not be permitted. Panel shall be provided with main disconnect device, consisting of nonfused disconnect or nonautomatic circuit breaker. Disconnect shall be equipped with mechanical door interlock preventing door opening the disconnect in closed position. Fusing shall be cartridge type. Dual element, current limiting, time delay safety switches shall be multiple horsepower rated, heavy duty type. Magnetic motor starter for motor assembly shall be NEMA type, full voltage, non-reversing, overload protected for each phase, with auxiliary contacts. Overload relay shall be trip-free, thermal bimetallic, manual reset with trip heaters based on actual full load current of motor. Spare NO and NC auxiliary contacts wired to the terminal block shall be provided. Control power transformer with primary fuse disconnect and secondary fusing shall be provided. Factory mounted and wired control shall be provided, arranged to receive a signal from the boiler plant

master controller and water regulating valve assembly. Quantity of deaerator feedwater pumps shall match quantity of boilers. Panel mounted Lead-Lag-Off-Continuous switch for each feedwater pump shall be provided.

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

2.9 CONDENSATE RETURN SYSTEM

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

Condensate return system shall be factory assembled package system including condensate surge tank, transfer pumps, controls, auxiliary equipment and piping as shown.

2.9.1 Condensate Surge Tank

The condensate surge tank shall be [_____] mm inch diameter by [_____] mm inch long with 280 by 380 mm 11 by 15 inch elliptical manhole. Condensate surge tank shall have [_____] minutes of storage and capacity of [_____] liters gallons flooded. Condensate surge tank, base, piping nozzle construction shall be as specified. The condensate surge tank shall 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

Surge tank shall have gauge glass assembly that covers entire tank diameter. Gauge glass shall be quartz 16 mm 5/8 inch diameter by 610 mm 24 inch maximum length. Gauge glass shall be furnished with bronze gauge cock set and protector rods.

2.9.1.2 Makeup Valve and Controller

a. Makeup valve shall be motorized with steel body and threaded connections. Makeup valve actuator shall be gear type directly coupled to the valve stem and shall be electronically controlled by solid state controller with internally mounted capacitance probes. Controller shall maintain water level setpoint. Controller shall be provided with hand selector for automatic and manual operation. Makeup valve shall not exceed 69 kPa 10 psig pressure drop and shall be rated for 150 degrees C 300 degrees F.

b. Makeup valve shall be rated for [_____] kPa psi 1/hr. inlet pressure and valve C_v shall not exceed [_____]. Controller shall include two additional probes for high and low water level alarms.

2.9.1.3 Sparge Tube

Sparge tube shall be located beneath normal tank water level. Sparge tube shall be constructed of 50 mm 2 inch pipe. Sparge tube shall 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 shall 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/hr	[_____]
Total dynamic head at rated capacity m	[_____]
Net positive suction head (NPSH) available m	[_____]
Maximum allowable shut-off head, m	[_____]
Type of fluid pumped	Condensate
Maximum expected temperature of fluid, degrees C	[_____]
Maximum speed of pump, rpm	1800

2.9.2.2 Construction and Materials

Pump shall be [centrifugal, horizontal end suction, top discharge type] [vertical, multistage, self contained type with suction barrel]. The pumps shall include [_____] Class [_____] suction flange and [_____] Class [_____] discharge.

2.9.2.3 Casing and Casing Bowls

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

2.9.2.4 Impeller

[Impeller for horizontal type pump shall 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. Impeller shall be dynamically balanced to the maximum rated speed.] [Impeller for vertical can type pumps shall be enclosed, split ring, key mounted type and shall be constructed of 11 to 13 percent chrome steel in accordance with ASTM A743/A743M or 316 SS ASTM A290/A290M GR CF-8M. Impeller shall have replaceable wearing rings

constructed of 11 to 13 percent chrome hardened to 300 BHN. Impeller shall be statically and dynamically balanced to maximum rated speed. Impeller shall be 95 percent of maximum allowable impeller diameter.]

2.9.2.5 Pump Shaft

[Pump shaft and shaft sleeve for horizontal pumps shall be constructed of Type 316 stainless steel. Shaft diameter and design shall be sufficient to transmit at least 2.5 times rated motor power of the pump.] [The pump shaft for vertical type pumps shall be one piece and constructed of ASTM A582/A582M Type 416 stainless steel. Largest diameter shaft available for use with selected impeller shall be supplied and shall be able to transmit at least 2.5 times rated motor power.]

2.9.2.6 Pump Construction

[Pump and bearing frame and housing shall be constructed of cast iron, ASTM A48/A48M.] [Discharge head and suction barrel with mounting flange shall be constructed of carbon steel, designed in accordance with ASME BPVC SEC VIII D1 with a 7.6 mm 300 mil corrosion allowance. Sole plate shall also be provided 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. Welds on the pressure containing section of the pump shall be the full penetration type with welders and welding procedures in accordance with ASME BPVC SEC IX. Suction barrel shall be sized 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 shall be the "T" type configuration so that discharge and suction are above baseplate. Suction barrel shall be of sufficient length to accommodate installation of 2 additional turbine stages.]

2.9.2.7 Pump Column

Pump column shall be flanged and constructed of carbon steel. Pump column assembly shall be designed to withstand 4.1 MPa 600 psig and incorporate 7.6 mm 300 mil corrosion allowance. Bearing retainers located in the pump column shall be constructed in a manner that will assure concentric alignment of the shaft within 0.13 mm 0.005 inches.

2.9.2.8 Miscellaneous Hardware

Bolts, lock washers, nuts and miscellaneous hardware used with casing, pump frame and gland shall be Type 316 stainless steel.

2.9.2.9 Shaft Sealing System

Pump shall be equipped with effective mechanical shaft seal to seal against discharge pressure when pump is operating. Seals shall be cartridge type with Hastalloy "C" bellows mounted on Type 316 stainless steel shaft sleeve. Seal faces shall be tungsten carbide versus silicon carbide. One spare mechanical seal shall be provided. Gland shall be flush vent and drain type constructed of ASTM A276 Type 316 stainless steel. Bypass line, constructed of ASTM A269 Type 316 stainless steel, from the stuffing box to the suction side of the pump shall also be provided.

2.9.2.10 Pump Bearings

[Horizontal end suction pump bearings shall be anti-friction type and shall operate in oil bath. Pump bearings shall be designed for radial and

unbalanced axial loads imposed by the pump.] [Vertical type pump bearings shall be water lubricated sleeve type constructed of babbitted graph alloy with Type 304 stainless steel shaft sleeves.] The bearings shall be designed for L-10 bearing life of [_____] hours.

2.9.2.11 Shaft Coupling

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

2.9.2.12 Painting and Corrosion Protection

Pumps, motors and accessories shall be protected prior to initial startup. Exposed unfinished work shall be thoroughly cleaned and smoothed. Surfaces which will not be in contact with the pumping fluid shall be factory painted with a finish coat. Internal surfaces shall be coated with a water soluble rust preventative material.

2.9.2.13 Special Tools

Complete set of special tools shall be provided, if required for assembly, disassembly or maintenance of pump.

2.9.2.14 Bedplate

Horizontal type pump shall include single bedplate long enough to accommodate pump, motor drive and cooler. Bedplate shall be in accordance with API and shall be of heavy rigid construction, made of suitably structural steel members and plate to provide a stable platform for pump, drive and accessories. Bedplate shall be suitably reinforced and braced to minimize deflection or bending during shipment and erection. Sufficient grout holes, minimum 75 mm 3 inch diameter, and grouting area vent holes in each corner of each grout space shall be provided. Bedplate shall include horizontal jacking screws and vertical leveling screws along the length and width. Provisions shall be made on the bedplate to collect drainage from the unit at one point. The hold down bolts and dowel holes shall be located and drilled in field. Pump shall be mounted on bedplate at factory and shipped as unit with bedplate mounted on a suitable skid to prevent deformation of the bedplate during shipment and erection.

2.9.2.15 Alignment

Pump unit shall be precision aligned. Pump coupling, mechanical seal and motor shall be mounted and matchmarked prior to shipment. Maximum allowable shaft runout shall be 0.05 mm 0.002 inch as measured at impeller end.

2.9.2.16 Pump Characteristics

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

b. Pump shall 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 shall 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 shall not be greater than 30 percent of specified design flow for each pump.

c. Pump shall have efficiency of 50 percent or greater at rated capacity.

2.9.3 Sump Pump

Sump pump shall be provided for sump pit shown. Sump pump shall be heavy duty, upright type, 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 of [_____] 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. Upright column shall be brass. Discharge connection shall be ISO NPT. High efficiency non-clogging impeller shall be furnished with stainless steel shaft journal and bearing suitably designed for intended service.

2.9.3.3 Backwater Valve

A backwater valve shall be provided in the pump discharge.

2.9.3.4 Float Switch

Float switch shall be actuated 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

Steam turbine drive shall be rated for the specified operating conditions and designed in accordance with NEMA SM 23. Turbine shall be of the single or multiple valve design and utilize impulse type blading. Flexible support for thermal expansion shall be provided at governor end of turbine. Turbine shall be horizontally or vertically split case with metal to metal joints without the use of gaskets. Journal bearings shall be properly

lubricated as recommended by turbine manufacturer for operating conditions. Anti-friction bearings shall have L-10 bearing life of [_____] hours. Thrust bearings shall be of [ball] [tilting pad] design. Turbine blading shall not be welded, shall be securely anchored, and shall be renewable. Blading material shall be minimum stainless steel and shall be suitable for steam quality and purity. Steam glands [interstage diaphragms] shall be sealed with carbon rings or labyrinths. Turbine shaft shall be finished with hard chrome in gland sealing zones. Turbine shall be provided with single governor to control valve(s). Governor shall be NEMA SM 23 Class [_____]. Hand valves shall be furnished in cases where operating conditions will be substantially different than design or where future operating conditions will change. Overspeed trip set at 110 percent of the normal operating speed shall be provided. Overspeed trip shall be NEMA SM 23 Class [_____]. Manual trip lever shall be included. Turbine shall be factory tested to check operation.

2.9.4.2 Electric Drive

Motor shall 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 shall 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

The condensate return system manufacturer shall furnish completely wired control cabinet, mounted on condensate return equipment or free-standing. Cabinet shall have 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: The condensate return surge tank control panel shall be properly sized to contain all control devices, instrument gauges and meters. Control cabinet shall be factory assembled steel enclosure with locking door. Panel shall be NEMA 12 construction, 11 gauge steel with key-locking vault handle, three (3) point latches, and continuous hinge. The door shall be fully gasketed.

2. Wiring: Control panel shall be wired in accordance with NFPA 70 and shall have individual motor starter with 120 volt holding coil and fuse protection. Individual green oil-tight pump run lights shall be provided. Switches and lights shall have nameplate identification. Paralleling of individual control power transformers shall not be permitted. Panel shall be provided with

a non-fuse disconnect or non-automatic circuit breaker main disconnect device . Disconnect shall be equipped with mechanical door interlock preventing door opening with the disconnect in the closed position. Fusing shall be cartridge type. Dual element, current limiting, time delay safety switches shall be multiple horsepower rated, heavy duty type. Magnetic motor starter for each motor assembly shall be NEMA type, full voltage, non reversing, overload protected for each phase, with auxiliary contacts. Overload relay shall be trip-free, thermal bimetallic, manual reset with trip heaters based on actual full load current of motor. Spare NO and NC auxiliary contacts wired to the terminal block shall be provided. Control power transformer with primary fuse disconnect and secondary fusing shall be provided. Factory mounted and wired control shall be provided, arranged to receive a signal from the deaerator water level assembly. A panel mounted Lead-Lag-Off-Continuous switch for feedwater pump shall be provided.

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

2.10 BOILER BOTTOM BLOWDOWN TANK

Blowdown tank shall be [_____] mm inches diameter by [_____] mm inches high. Supports, associated accessories and appurtenances shall be as specified and shown. Blowdown tank shall be of welded steel construction built in accordance with ASME BPVC SEC VIII D1 and stamped for a 1.03 MPa 150 psig rating. Blowdown shall 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. Materials used in fabrication of boiler blowdown tank equipment shall comply with ASME BPVC SEC II-C. Inspection openings on tank shall be as required in paragraphs UG-45 and 46 of ASME BPVC SEC VIII D1 and as shown. Connections shall be as shown. Interior surface preparation shall be in accordance with SSPC SP 5/NACE No. 1 and the coating manufacturer's recommendations. Interior shall be coated with a suitable baked epoxy phenolic coating, minimum 0.13 mm 5 mil DFT. Exterior surface preparation shall be in accordance with SSPC SP 6/NACE No.3 and the coating manufacturer's recommendations. Exterior shall be primed with a high heat silicone acrylic primer, minimum 0.05 mm 2.0 mil DFT. The blowdown tank shall be supplied with drain aftercooler and temperature regulating valve. Aftercooler shall be provided with cold water inlet, flanged body for easy removal, 6.35 mm 1/4 inch NPTF connection for temperature regulating valve sensing bulb. Valve adjustable range shall be 43 to 65 degrees C 110 to 150 degrees F. A thermostatic regulating valve shall inject potable water to maintain acceptable discharge temperature to the sewer.

2.11 BOILER SURFACE BLOWDOWN HEAT RECOVERY SYSTEM

2.11.1 General Requirements

Blowdown flush separator shall be [_____] mm inches in diameter by [_____] mm inches high. Supports, associated accessories and appurtenances shall be in accordance with these specifications and as shown. Steel tank shall

be of welded construction in accordance with ASME BPVC SEC VIII D1 and stamped for a 1.0 MPa 150 psig rating. Tank shall be provided 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. Thermostatic regulating valve shall inject potable water to maintain acceptable discharge temperature to sewer.

2.11.2 Materials

Materials used in fabrication of boiler blowdown equipment shall comply with ASME BPVC SEC II-C. Inspection openings on tank shall be as required in Paragraphs UG-45 and 46 of ASME BPVC SEC VIII D1 and as shown. Connections shall be as shown. Interior surface preparation shall be in accordance with SSPC SP 5/NACE No. 1 and the coating manufacturer's recommendation. Interior shall be coated with a suitable baked epoxy phenolic coating, minimum 0.13 mm 5 mil DFT. Exterior surface shall be in accordance with SSPC SP 6/NACE No.3 and coating manufacturer's recommendations Exterior shall be primed with high heat silicone acrylic primer, minimum 0.05 mm 2.0 mil DPT. Flash separator shall be piped to heat exchanger. Heat exchanger shall be horizontal U-tube with removable tube bundle and shall be of self-draining type. Blowdown water shall pass through shell and cooling water shall pass through tubes. Tubes shall be stainless steel with rear supporting baffle. Steel side welded shell shall be provided 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. Heat exchanger shall be supplied with drain aftercooler and temperature regulating valve. Aftercooler shall be provided 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. Valve adjustable range shall be 43 to 65 degrees C 110 to 150 degrees F.

2.11.3 Monitor-Controller

One electronic monitor-controller for use in boiler surface blowdown line shall be provided for each boiler, consisting of:

a. Monitor-controller shall control concentration of total dissolved solids (TDS). Monitor-controller shall be housed in a painted steel NEMA 12 enclosure. Boiler surface blowdown control shall be interlocked with boiler operation.

b. Panel display shall include:

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. One prepiped blowdown piping assembly installed in each boiler surface blowdown line shall be provided. Assembly shall consist 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

Chemical feed system shall be provided for steam and condensate chemical treatment consisting of introduction of chemical solutions into deaerator, boiler and boiler feedwater lines. Chemical feed system shall be automatic proportioning pump type for single or multiple boiler installation and shall consist of pumps, tank, piping, control and accessories. Chemical feed system shall be completely preassembled package, factory tested, hydraulically and electrically, and shall be furnished with required special tools, lubricants, and installation instructions. Chemical feeding and control equipment shall be provided 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.

Chemical treatment manufacturer shall provide a 1 year supply of chemicals. Chemical products shall be compatible with system materials of construction and operating conditions and shall comply with all applicable regulatory agencies. The chemical feeder shall be interlocked with boiler and deaerator operation.

2.12.1 Chemical Feed Pump and Tank

Chemical feed pump and tank shall be provided as indicated. Chemical feed pump and tank shall be a package with pump mounted and piping connected to the tank. Chemical feed pump capacity shall be as indicated. Chemical feed pump shall be positive displacement metering type. Chemical feed pump shall have micrometer capacity adjustment from 0-100 percent while the chemical feed pump is running and metering accuracy within plus or minus

one (1) percent. Chemical feed pump components shall be constructed of materials suitable for the chemicals being pumped. Drive motors shall be 120 volts ac, 60 Hz, single phase, with general purpose dripproof enclosure. Chemical feed tank shall be fabricated of materials suitable for chemicals used and shall be provided with fill and chemical feed drain connections and gauge glass. Chemical feed tank shall be furnished with one chemical feed pump, mounted and piped with piping and fittings constructed of materials suitable for the chemicals being pumped, and shall include a suction strainer and 13 mm 1/2 inch relief valve. Chemical feed tank shall have hinged cover. Chemical feed tank bottom shall be dished concave to radius equal to diameter of tank.

2.12.2 Agitator

Chemical feed tank shall be equipped with agitator. Agitator shall be motor driven with Type 316 stainless steel impeller and drive shaft. Maximum speed shall be 1750 rpm. Agitator and support shall be mounted on of 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.
****

The following shall be provided for each boiler:

a. Three (3) chemical feed pumps. Each pump shall be provided with a pressure relief valve piped on discharge side of the pump to divert overpressurized chemical solution back to the storage tank. Chemical feed pumps shall have capability of accepting 4 to 20 mA dc signal.

b. [One (1) 800 liter 200 gallon bulk storage tank.]

c. [Three (3) 200 liter 50 gallon drums.]

d. One connecting head water meter. Maximum operating pressure shall be 1650 kPa 225 psig and maximum temperature shall be 120 degrees C 250 degrees F. Water meters shall be turbine type with cast iron Maine cases.

e. Proportional chemical feed controller and electronic pulse timer. Pulse timer shall control proportional feed of treatment chemicals based on feedwater as measured by a contacting head water meter. Controller shall have 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 liter (50 gallon) drum for boiler plant up to 22,650 kg/hr
****

One feedwater chemical treatment system for deaerator shall be provided including the following:

a. One chemical feed pump. Chemical feed pump shall be provided with pressure relief valve piped on discharge side of chemical feed pump to divert overpressurized chemical solution back to the storage tank. Chemical feed pump shall have capability of accepting 4 to 20 mA dc signal.

b. [One 8000 liter 200 gallon tank.]

OR

c. [One 200 liter 50 gallon tank.]

d. One contacting head water meter shall be provided. Maximum operating pressure shall be 1650 kPa 225 psigand maximum temperature shall be 120 degrees C 250 degrees F. Meter shall be turbine type with cast iron Maine case.

e. Proportional chemical feed controller and electronic pulse timer. Electronic pulse timer shall control proportional feed of treatment chemicals based on makeup water as measured by contacting head water meter. Controller shall have 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

Testing equipment, including carrying case and spare reagent, for maintaining control of a program of water treatment standards in steam boiler system shall be provided 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. Testing equipment shall consist 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. Cabinet shall have one shelf, keylock door and fluorescent light. Cabinet shall be constructed 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. Assembly shall 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. A [single] [double] unit automatic water softener system shall be provided as indicated. Water softener system shall be designed for working pressure of [_____] MPa psi. Water softener system shall be 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. Test sets shall be provided for pH comparator for range [_____] to [_____], sulfide comparator, and phosphate comparator.

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

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

2.14 MAINTENANCE EQUIPMENT

2.14.1 Tube Cleaner

Water turbine driven tube cleaner shall include three rotary cutters, complete with necessary length of armored water hose, valves, and other appurtenances necessary for operation. Tube cleaner shall be provided for each size of watertube in boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings shall be provided to permit convenient connection of tube cleaner hose boiler feed pump to supply cold raw water for operation of tube cleaner. Piping arrangement shall be 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.
****

Brush with steel bristles and jointed handle of sufficient length to clean full length of fire tubes shall be provided.

2.15 FACTORY COATING

Equipment and component items, when fabricated from ferrous metal, shall be factory finished 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

Work shall be installed 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, pipe and fittings shall conform to requirements of ASME B31.1. Pipe shall be cut to measurements established at the jobsite and worked into place without springing or forcing, completely clearing windows, doors, and other openings.

b. Pipes shall be minimum 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. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Filings, dust, or dirt shall be wiped from interior of pipe or tubing before connections are made.

e. Changes in direction shall be made 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. Centerline radius of bends shall not be less than 6 diameters of pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be carried through the roof as directed and shall be flashed.

f. Unless otherwise indicated, horizontal supply mains shall pitch down in direction of flow with a grade of not less than 25 mm in 12 meters 1 inch in 40 feet.

g. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system.

h. Pipe not otherwise specified shall be uncoated. Unions for copper pipe or tubing shall be brass or bronze.

i. Connections between ferrous piping and copper piping shall be electrically isolated from each other with dielectric couplings or

other approved methods.

j. Pipe and fittings shall be of the types indicated in TABLES I and II for the applicable service and pressure.

3.2.2 Joints

Joints between sections of pipe and between pipe and fittings shall be threaded, flanged, or welded as specified. Except as otherwise specified, fittings 38 mm 1-1/2 inches and smaller shall be either threaded or socket welded, and fittings 50 mm 2 inches and larger shall be either flanged or butt welded. Pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Unless otherwise specified or indicated, connections to equipment shall be made 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

Threaded joints shall be made with tapered threads properly cut, and shall be made tight with PTFE tape, or equivalent joint compound material applied to the male threads only. Joint compound shall not be applied to fittings.

3.2.2.2 Welded Joints

a. Welded joints shall be made as specified. Changes in direction of piping shall be made with welding fittings only.

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

c. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1.

d. Weld defects shall be removed and repairs made to the weld, or weld joints shall be entirely removed and rewelded.

e. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.2.2.3 Expansion Joints

Guiding of piping on both sides of expansion joint shall be in accordance with published recommendations of manufacturer.

3.2.2.4 Flanges and Unions

Flanges shall be faced true, provided with metallic spiral wound nonasbestos gaskets, and made square and tight. Union or flange joints shall be provided 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 shall 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 3-310-04 and Sections 13 48 00 and 13 48 00.00 10, 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.

****

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

a. Seismic Requirements for Pipe Supports and Structural Bracing: Piping and attached valves shall be supported and braced to resist seismic loads as specified in UFC 3-310-04 and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for supports shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

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

3.2.3.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as otherwise specified.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used 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. Type 18 inserts shall be secured 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. Type 19 and 23 shall be torqued in accordance with MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. The C-clamp body shall not be constructed from bent plate.

e. Type 20 attachments used on angles and channels shall be furnished 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, the type 39 saddle shall be used on pipe 100 mm 4 inches and larger.

h. Horizontal pipe supports shall be spaced as specified in the tables in MSS SP-69 and a support shall be installed not over 300 m 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe support spacing shall be as required for specified hydrostatic tests. Pipe supports shall be spaced not over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 3.2 mm 1/8 inch shall be provided between the pipe and clip or clamp for piping which may be subjected to thermal expansion.

i. Vertical pipe shall be supported at each floor, except at slab on grade, and at intervals of not 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, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be 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, type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated 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, pipe hangers on horizontal insulated pipe shall be 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.
****

Piping shall be supported as indicated.

3.2.4 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results, using turnbuckles where required. Supports, anchors, or stays shall not be attached 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

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as indicated. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Unless otherwise indicated, sleeves shall be 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. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be 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, the annular space between pipe and sleeve or between jacket over insulation and sleeve in non-fire rated walls and floors shall be sealed as indicated and specified in Section 07 92 00 JOINT SEALANTS and in fire rated walls and floors shall be sealed as indicated and specified in Section 07 84 00 FIRESTOPPING. Pipes passing through wall waterproofing membrane shall be sleeved as described above. In addition, a waterproofing clamping flange shall be installed as indicated.

3.2.5.1 Pipes Passing Through Roof or Floor Waterproofing Membrane

Pipes shall be installed 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. Flashing sleeve shall be suitably formed, and the skirt or flange shall extend not less than 200 mm 8 inches from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. Flashing sleeve shall extend 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. The annular space between the flashing sleeve and the bare pipe or metal jacket covered insulation shall be sealed 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. Waterproofing membrane shall be clamped into place and sealant shall be placed 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. The seals shall consist 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. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.2.6 Escutcheons

Escutcheons shall be provided 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, special deep type escutcheons shall be used. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium plated iron or chromium plated brass, either one piece or split pattern, held in place by internal spring tension or setscrew.

3.2.7 Clay Sewer Pipe

Pipe shall be installed where indicated for housing steam supply and condensate return lines. The sewer pipe shall be installed on properly

graded and well tamped earth or gravel base. Joints shall be packed with twisted jute packing and sealed with bituminous sealing compound or portland cement mortar.

3.2.8 Pipe Expansion

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

Expansion loops and pipe guides shall be installed where indicated.

3.2.9 Valves

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

3.2.9.1 Back Pressure Relief

Backpressure valve shall be set to exhaust at the pressure indicated.

3.2.9.2 Steam Pressure Reducing

Steam pressure reducing valve shall be adjusted to maintain desired terminal pressure, regardless of fluctuations in the inlet steam pressure. Steam pressure reducing valves shall fail closed. Pilot, or auxiliary operated valves using steam for operating medium, or sliding gate and plate valves shall be provided. Steam pressure reducing valve shall be installed with strainer, 3 valve bypass, and safety valve as indicated. Where steam pressure reducing valves is used for reducing steam pressure to deaerating heater, the valve shall be of pneumatic pilot operated type. Sensing line shall be connected to the steam space in the deaerator.

3.2.9.3 Thermostatic Regulating

Thermostatic regulating valve to control temperature of water within hot water generator, by regulating steam supplied to the heating coil, shall be provided 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.)
****

Flow meter shall be installed in straight line pipe of at least [_____]

pipe diameters to maintain accuracy. [A 3-way valve bypass shall be provided for [_____] flow meters.]

3.3 FUEL OIL SYSTEM INSTALLATION

3.3.1 Fuel Storage Tank Installation

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

3.3.2 Underground Ferrous Metallic Piping

Underground ferrous metallic piping shall be 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

Field run conduit, wiring and terminations shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.5.2 Splice

Stranded conductors shall be spliced by solder or pressure type connectors. Wirenut connectors shall not be used on stranded conductors. Splices shall be covered 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

Both ends of wires shall be labeled.

3.5.4 Grounding of Drain Wire of Shielded Cable.

Shield cable drain wire shall be grounded at the source end, terminated 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

Analog signal cables shall be connected 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. These terminal blocks shall be double level terminal blocks with knife disconnect point with test plugs at the upper level and feed through terminal at lower level. Minimum of thirty percent (30%) spare terminal points shall be provided.

3.5.6 Digital Input-Output

Digital input-output cables shall be connected to controller by means of terminal blocks. Minimum of thirty percent (30 percent) spare terminal points shall be provided.

3.6 INSULATION

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

3.7 BOILERS AND AUXILIARY EQUIPMENT

****
NOTE: Before occupancy of a facility the boilers shall be inspected 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

Boiler shall be installed 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. Boiler and associated components shall be located where indicated. Boiler shall be installed level to a tolerance of 3 mm in 3 m 1/8 inch in 10 feet in all directions. Electrical connections

shall be made 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, touchup paint shall be provided to damaged areas on shop and finish-coated surfaces of the equipment. Surfaces shall be free of rust, scale and foreign substances before application of touchup paint. The touchup paint shall be 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. Each test report shall indicate the final position of controls. 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. The action settings for automatic controls in the form of a typed, tabulated list indicating the type of control, location, setting, and function shall be included.

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

b. Final adjustment to boiler shall be in accordance with manufacturer's recommendations, but not 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. Field representative shall 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. Manufacturer shall 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 shall 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

Extractive or in-situ gaseous emissions monitor shall be provided. Combination of extractive and in-situ monitors is not acceptable. Gas monitors shall include automatic calibration checks. Alarm horn and annunciator shall be provided to alarm when any monitored parameter is out of range or gaseous emission monitor malfunctions. Surfaces exposed to corrosive gas of boiler shall be constructed of noncorrosive materials such as 316 SS, Teflon or Hastalloy.

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

b. Extractive systems shall be [wet] [dry] [diluted]. Analyzing equipment for extractive system shall be [rack-mounted] [located in a walk-in cabinet].

c. Equipment shall be arranged to provide access for maintenance. Extractive system sampling between probes and analyzers shall be heat traced to maintain temperature recommended by manufacturer when ambient temperature is [_____]. Probes shall be mounted 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

Flue gas monitor shall utilize pitot tube principle to measure flow. Flue gas flow monitor probe shall be across-the-duct average pitot tube and shall be properly designed and located to obtain representative measurement. Differential pressure transmitters shall be used to sense the difference between the static and total pressure of the flowing flue gas stream. Lines shall be arranged to prevent collection of condensate. Purge system shall be provided to keep pitot pressure taps clear.

3.7.6 Testing

ASME PTC 19.3.

3.7.6.1 Factory Testing

Boilers shall be guaranteed to perform in accordance with stated operating conditions. Complete packaged boiler shall 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. Contracting Officer shall be notified two (2) 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, boiler plant shall be subjected to such operating tests as may be required to demonstrate satisfactory functional operation of the plant, including safety devices. Operating tests shall be conducted 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. The submittal shall contain 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. The test shall not commence until the procedure has been approved. The Government will witness the field tests. Written permission shall be obtained from the Contracting Officer before proceeding with testing. Tests shall be supervised by respective manufacturers.

c. Original copies of data produced, including results of each test procedure during field testing, shall be turned over to the Government at the conclusion of testing prior to Government approval of the test.

d. Testing shall not be scheduled during seasonal off-periods of heating systems. Testing shall be performed in accordance with approved test procedures. The Test Procedures shall 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, a hydrostatic test shall be completed, including boiler and associated piping within boiler plant. System shall be proved tight for at least two hours under gauge pressure of 1.5 times the working pressure specified and not 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. Boiler isolation valves shall be individually tested to isolate against the specified hydrostatic test pressure. At the conclusion of the system hydrostatic test, each boiler's isolation valves (steam discharge, boiler feedwater, etc.) shall be closed; the boiler drained down; and pressure monitored on both sides of each isolation valve for a minimum of two hours to verify that the valves isolate each boiler.

e Boilers shall be tested and piping connections inspected 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, each packaged forced draft boiler shall be air tested up to 2.5 kPa 10 inches water gauge. Soap foam shall be applied to seams to detect leaks. The boiler shall not lose more than 1.3 kPa 5 inches water gauge in 10 minutes. This test shall be performed prior to installing insulation.

3.7.6.5 Efficiency and Capacity Test

a. Efficiency and capacity test shall be run on one boiler of each size installed, conducted in strict accordance with ASME PTC 4, abbreviated efficiency test.

b. Measuring devices used for measuring feedwater evaporated and amount of fuel burned shall be properly calibrated prior to test. Water flow meter used in the test shall be 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 thermometer to be used in the efficiency and capacity test shall be furnished 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. Efficiency and general performance tests on boiler shall be conducted by a qualified test engineer furnished by Contractor.

TESTING AND PERFORMANCE
Percent of Capacity

Time	Waterwall Watertube Boilers	Cylindrical Furnace Firetube Boilers
First 1 hour	50	50
Next 2 hours	75	75

TESTING AND PERFORMANCE
Percent of Capacity

Time	Waterwall Watertube Boilers	Cylindrical Furnace Firetube Boilers
Next 4 hours	100	100

f. Efficiency tests may be conducted concurrently with operating tests, or separately. Thermal efficiency shall be not less than specified. Maximum moisture content of saturated steam leaving boiler shall be as specified.

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

h. An analysis by an independent testing laboratory of fuel being burned during test shall be submitted to the Contracting Officer. Analysis shall 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. Full operational test of boiler plant control system shall be conducted 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, all hardware shall be aligned and adjusted, and all test readings recorded in accordance with the manufacturer and installer recommended tests and maintenance procedures. Manufacturer and installer shall 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. All hardware shall be demonstrated to be operational by running off-line diagnostics. Field installation test shall include electrical continuity, complete exercising of each Input and Output point, and simulation of each control loop. The field installation test shall be considered 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. Demonstration of controls shall 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. Full functional test shall be conducted in accordance with the control system sequences of operation. Conduct startup test and punchout in the presence of the Contracting Officer. The Contracting Officer shall be notified no later than ten (10) 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. Log shall 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 shall require that the 30 day test begin again when repairs are completed. Any failures between field-sensing equipment and the control panels shall be corrected, and the testing shall continue from the day of failure. During the last seven (7) calendar days of testing, no failures of any kind will be accepted or the last seven (7) days shall be repeated. 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

Necessary temporary piping, of not less than 100 mm 4 inches in diameter, shall be furnished and a muffler shall be provided to exhaust excess steam to atmosphere in event boiler load is insufficient to meet capacity specified. Control valve for exhausting excess steam to atmosphere shall be provided in a convenient location inside the boiler room. Instruments required for conducting boiler tests shall be 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 shall 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 of fuel burning equipment shall 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. Test shall include all boiler and burner interlocks, safety interlocks, combustion controls, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. prior to combustion testing. All malfunctioning components shall be replaced. Submit an itemized data record sheet of this component testing.

c. Each boiler control system and all boiler appurtenances shall be calibrated and set to ensure the specified performance. The fuel burner, forced-draft fan, controls, etc. shall be fully coordinated, manually capable, and automatically controllable to hold the required settings. The boiler fuel burning system shall be continuously variable throughout the specified operating range without manual adjustment of burner, register or nozzle, and turndown shall be achieved without manual adjustment. Testing apparatus shall be set up, calibrated, tested and ready for use prior to final combustion testing. Calibration certificates for all test instruments shall be furnished with test data.

3.7.6.10 Deaerating Feedwater Heater Testing

Test of deaerating feedwater heater shall demonstrate that equipment installed meets specified requirements as to performance, capacity, and quality of effluent. During operating test of boiler, tests shall be conducted to determine oxygen content in accordance with ASTM D 888, Method B or C, or ASTM D 5543. Boilers shall be operated at varying loads, up to maximum heater capacity, while oxygen tests are being made. Means and equipment shall be furnished to perform this test.

3.7.6.11 Water Treatment Testing

Test of water treatment equipment shall meet requirements specified as to capacity and quality of effluent. Tests for ion exchange units shall cover at least 2 complete regenerations and capacity runs. Test for hot process or other precipitation type softeners shall 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 shall be simultaneous under operating conditions specified.

3.7.6.13 Water Level Stability Testing

Boiler water level stability shall be specified by boiler manufacturer in writing to Contracting Officer prior to test. Test shall first be conducted by use of manual bypass around feedwater regulator. Test shall be repeated using automatic feedwater regulator. To be acceptable, boiler shall 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. Piping shall be hydrostatically tested before piping insulation is applied. Hydrostatic test pressure at any point in piping system shall not be less than 1.5 times the design pressure, but shall not exceed the maximum allowable test pressure of nonisolated components.

c. Underground lines in pressure service shall be tested 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, Contractor shall perform air pressure and soap solution test at weld and flange joints. Pneumatic test pressure shall not be less than 1.2 nor more than 1.5 times the design pressure of piping system. The test pressure shall not exceed maximum allowable test pressure of non-isolated components. Leaks discovered during test shall be corrected and successive tests performed. Test shall be repeated until leaks are sealed. Test shall be conducted before insulation is applied. A portable sprayer shall be used to spray soap solution on joints to detect leaks. Temporary pumps and air compressors shall be provided as required to pressurize system prior to and during tests. Tests shall be 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, boiler shall be thoroughly and effectively cleaned of foreign materials by mechanical cleaning, initial chemical cleaning, a chemical boiling period and finally by operating steam system at 100 percent (100%) 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, water contacted surfaces shall be wire brushed to remove loose material, following which, boiler shall be filled with solution consisting of following proportional ingredients and circulated at approximately 207 to 344 kPa 30 to 50 psig

for period of 24 to 48 hours:

1.10.9 kg 24 lbs caustic soda.

2.10.9 kg 24 lbs disodium phosphate, anhydrous.

3.3.6 kg 8 lbs sodium nitrate.

4.0.23 kg 1/2 lb approved wetting agent.

5.3,785 liters 1,000 gallons water.

Chemicals in proportions above, or as approved by Contracting Officer, shall be thoroughly dissolved in water before being placed in boiler. After this initial chemical cleaning, boiler shall be drained and refilled with the above chemical solution and boiled in accordance with the manufacturer's instructions. After specified boiling period, boiler shall be allowed to cool, after which boiler shall be drained and thoroughly flushed. Finally, piping shall be cleaned by operating boiler for period of approximately 48 hours with 100 percent (100%) makeup water, wasting the steam and condensate.

3.7.8 Boiler Water Conditioning

Boiler water conditioning by chemical treatment and blowdown shall be provided during periods of boiler operation from the initial starting of system, through testing period, and to final acceptance of completed work by the Government. Chemicals used and method of treatment shall be approved by Contracting Officer.

3.7.9 Fuel Oil Leak Test

Fuel oil leak tests for the underground portion of the system shall be conducted in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.8 MANUFACTURER'S SERVICES

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

3.9 FIELD TRAINING

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

a. Field training course shall be provided for designated operating staff members. Training shall be provided for a total period of [_____] hours of normal working time and shall start after system is functionally complete, but prior to final acceptance tests. Field training shall cover items contained in approved operation and

maintenance instructions as well as demonstrations of routine maintenance operations. Contracting Officer shall be notified in 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. The manuals shall 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. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall 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. Operation and maintenance manuals shall be approved prior to the training course.

d. Distributed control system manufacturer shall provide a minimum of [_____] days of training for [_____] of Government's representatives at [plant site] [factory]. Training shall include, but not be limited by 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. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

e. Field training shall be video taped. 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	Material	Specification	Type
Steam	0-1030	Std. wt. black steel	ASTM A53/A53M	Type E or Type S, Grade A
Condensate return	0-1700	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Boiler feed and blowoff lines	0-1030	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Feedwater piping	0-1030	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Water column (a)	0-1030	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Vent and pipe	0-170	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Compressed air	0-860	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Gauge	0-170	Copper tubing	ASTM B88 ASTM B88M	Type K or L
Draft gauge & Oxygen recorder	0-170	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Aboveground Fuel oil	0-1030	Copper tubing	ASTM B88 ASTM B88M	Type K or L
(No. 2)	0-1030	Std. wt. black steel	ASTM A53/A53M	Type E or S, Grade A or B
	0-1030	Sched. 40 seamless or Elec. welded steel	API Spec 5L	Grade A or B
	0-1030	Fiberglass (b)	API Spec 15LR or UL approved	
Aboveground Fuel oil (No. 4, 5 and 6)	0-1030	Std. wt. black steel	ASTM A53/A53M	Type E or S, Grade A or B
	0-1030	Sched. 40 seamless or Elec. welded steel	API Spec 5L	Grade A or B
		Fiberglass (b)	API Spec 15LR	

TABLE I PIPE

Service	Pressure	Material	Specification or UL approved	Type
Control air	0-1030	Copper tubing	ASTM B88, ASTM B88M	
		Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Natural gas	0-105	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A

TABLE I PIPE

Service	Pressure psi	Material	Specification	Type
Steam	0-150	Std. wt. black steel	ASTM A53/A53M	Type E or Type S, Grade A
Condensate return	0-250	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Boiler feed and blowoff lines	0-150	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Feedwater piping	0-150	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Water column (a)	0-150	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Vent and pipe	0-25	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Compressed air	0-125	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Gauge	0-25	Copper tubing	ASTM B88, ASTM B88M	Type K or L
Draft gauge & Oxygen recorder	0-25	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Aboveground Fuel oil	0-150	Copper tubing	ASTM B88, ASTM B88M	Type K or L
(No.2))	0-150	Std. wt. black steel	ASTM A53/A53M	Type E or S Grade A or B
	0-150	Sched. 40 seamless or Elec. welded steel	API Spec 5L	Grade A or B

TABLE I PIPE

Service	Pressure psi	Material	Specification	Type
		Fiberglass (b)	API Spec 15LR or UL approved	
Aboveground Fuel oil (No. 4, 5 and 6)	0-150	Std. wt. black steel	ASTM A53/A53M	Type E or S Grade A or B
	0-150	Sched. 40 seamless or Elec. welded steel	API Spec 5L	Grade A or B
		Fiberglass (b)	API Spec 15LR or UL approved	
Control air	0-150	Copper tubing	ASTM B88, ASTM B88M	
		Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Natural gas	0-75	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A

(a) No bending of pipe will be permitted.

(b) For buried service only.

TABLE II FITTINGS

Service	Size	Type	Material	Specifications
Steam	38 mm and under	Screwed or Socket welded	Steel	ASME B16.11,
	50 mm and larger	Flanged or	Steel	ASME B16.5
		Butt welded	Steel	ASME B16.9
Condensate return	38 mm and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	50 mm and larger	Butt welded	Steel	ASME B16.9 extra strong
Vent pipe	38 mm and under	Screwed		
	50 mm and larger	Butt welded	Steel	ASME B16.9
Compressed air	38 mm and under	Screwed	Zinc-coated malleable iron	ASME B16.3
	50 mm and larger	Butt welded	Steel	ASME B16.9
Boiler feed	38 mm and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	50 mm and larger	Butt welded	Steel	ASME B16.9, extra strong

TABLE II FITTINGS

Service	Size	Type	Material	Specifications
Feedwater pipe	38 mm and under	Screwed		
	50 mm and larger	Butt welded	Steel	ASME B16.9
Blowoff lines	38 mm and under	Butt welded	Steel	ASME B16.9, extra strong
	50 mm and larger	Socket welded	Steel	ASME B16.11 extra strong
		Flanged with long radius elbows	Steel	ASME B16.5
Water column piping	38 mm 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
Natural Gas	38 mm and under 50 mm and larger	Socket welded Butt welded		ASME B16.11 ASME B16.9

TABLE II FITTINGS

Service	Size	Type	Material	Specifications
Steam	1-1/2" and under	Screwed or Socket welded	Steel	ASME B16.11,
	2" and larger	Flanged or	Steel	ASME B16.5
		Butt welded	Steel	ASME B16.9
Condensate return	1-1/2" and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	2" and larger	Butt welded	Steel	ASME B16.9 extra strong
Vent pipe	1-1/2" and under	Screwed		
	2" and larger	Butt welded	Steel	ASME B16.9
Compressed air	1-1/2"and under	Screwed	Zinc-coated malleable iron	ASME B16.3
	2" and larger	Butt welded	Steel	ASME B16.9
Boiler feed	1-1/2" and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	2" and larger	Butt welded	Steel	ASME B16.9,

TABLE II FITTINGS

Service	Size	Type	Material	Specifications
Feedwater pipe	1-1/2" and under	Screwed		extra strong
	2" and larger	Butt welded	Steel	ASME B16.9
Blowoff lines	1-1/2" and under	Butt welded	Steel	ASME B16.9, extra strong
	2" and larger	Socket welded	Steel	ASME B16.11, extra strong
		Flanged with long radius elbows	Steel	ASME B16.5
Water column piping	1-1/2" 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
Natural Gas	1-1/2" and under	Socket welded		ASME B16.11
	2" and larger	Butt Welded		ASME B16.9

(a) Fittings for fiberglass pipe shall be of the same material as the pipe and shall be compatible with the adhesives used for joining the pipe.

-- End of Section --