UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION TABLE OF CONTENTS

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

SECTION 23 52 33.02 20

STEAM HEATING PLANT WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL

11/08, CHG 4: 08/18

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.3.1 Effective Radiant Heating Surface
1.3.2 Flue Gas Velocity
1.3.3 FRP
1.3.4 Furnace Volume
1.3.5 PVC
1.3.6 Standard Commercial Product
1.3.7 System Supplier
1.4 SYSTEM DESCRIPTION
1.4.1 Design Requirements
1.4.1.1 Boiler
1.4.1.2 Economizer
1.4.1.3 Forced Draft Fan
1.4.1.4 Induced Draft Fan
1.4.1.5 Screw Conveyors for Coal Handling Equipment
1.4.1.6 Screw Conveyors for Ash Handling Systems (Mechanical)
1.4.1.7 Stacks With Flue Gas Scrubbers
1.4.1.8 Fuel Oil Pumps
1.4.1.9 Fuel Oil Pump and Heater Set for Fuel Oil System
1.4.1.10 Ash Handling System (Mechanical)
1.4.1.11 Ash Handling System (Pneumatic)
1.4.1.12 Miscellaneous Equipment
1.4.2 Detail Drawings
1.4.2.1 Boiler Drawing
1.4.2.2 Boiler Room Auxiliary Equipment
1.4.2.3 Stokers
1.4.2.4 Ash Handling System
1.4.2.5 Burners
1.4.2.6 Dampers, Stacks and Breechings
1.4.2.7 Coal Handling Equipment
1.4.2.8 Fuel Oil Equipment

1.4.2.9 Piping and Specialty Items
1.4.2.10 Flexible Ball Expansion Joint Installation Details
1.4.2.11 Reinforced Concrete Foundation
1.4.2.12 Reproducible Drawings
1.4.3 Test Reports
1.4.3.1 Boiler Predicted Performance Data
1.4.3.2 Fan Performance Data
1.4.4 Performance Requirements
1.4.4.1 Boiler
1.4.4.2 Oil/Burner Windbox Package
1.4.4.3 Miscellaneous Equipment
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Standard Commercial Product
1.6.2 Equipment Furnished
1.6.3 Responsibility
1.6.4 Certification of Backflow Preventer
1.6.5 Modification of References
1.6.6 Certificates
1.6.6.1 List of Equipment Manufacturers
1.6.6.2 Proof of Experience
1.6.6.3 System and Equipment Installation
1.6.6.4 Vertical Fuel Oil Tank Calibration
1.6.6.5 Backflow Preventer
1.6.6.6 Ozone Depleting Substances Technician Certification
1.6.7 Posted Operating Instructions
1.6.8 Operation and Maintenance Data
1.7 DELIVERY, STORAGE AND HANDLING
1.7.1 Assembly of Components
1.7.2 Storing Tubes
1.8 ENVIRONMENTAL REQUIREMENTS
1.8.1 Air Permits
1.8.2 Boiler Emissions
1.8.3 Oil Burner/Windbox Package
1.9 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Identical Items
2.2 [COAL/OIL] [COAL] FIRED BOILER
2.2.1 Operational Requirements
2.2.1.1 Furnace Heat Input
2.2.2 Construction
2.2.2.1 Boiler Drums
2.2.2.2 Headers
2.2.2.3 Tubes
2.2.3 Boiler Setting and Insulation
2.2.3.1 Expansion Joints
2.2.3.2 Welded Wall
2.2.3.3 Tube and Tile Furnace Construction
2.2.3.4 Drum, Header and Miscellaneous Insulation
2.2.3.5 Baffles
2.2.3.6 Casing
2.2.3.7 Access and Observation Doors
2.2.3.8 Draft Connections
2.2.4 Support and Framing
2.2.5 Boiler Hoppers
2.2.5.1 Rear Pass Hoppers

2.2.5.2 Plenum Chamber
2.2.5.3 Ash Storage Hopper
2.2.6 Boiler Trim
2.2.6.1 Boiler Blowoff Valve
2.2.6.2 Steam Gage
2.2.6.3 Water Column
2.2.6.4 Safety Valves
2.2.6.5 Non-Return Valve
2.2.6.6 Blowoff Connections
2.2.6.7 Miscellaneous Stop Valves
2.2.6.8 Tube Cleaner
2.2.6.9 Wrenches
2.2.7 Boiler Limit Interlocks
2.2.8 Sootblowers
2.2.8.1 Fixed Position Soot Blowers (Steam)
2.2.8.2 Fixed Position Sootblowers (Air Puff)
2.2.8.3 Retractable Sootblowers
2.2.8.4 Elements
2.2.8.5 Control
2.2.8.6 Control for Sootblowing System
2.3 ECONOMIZER
2.3.1 Accessories
2.4 COAL GRATE STOKERS
2.4.1 Traveling Grate Coal Stoker
2.4.1.1 Stoker Grate Heat Release Rate
2.4.1.2 Construction
2.4.1.3 Grate Ash Discharge Enclosure
2.4.1.4 Stoker Grate Drive
2.4.1.5 Miscellaneous Equipment
2.4.1.6 Lubrication
2.4.1.7 Overfire Air System
2.4.2 Traveling Grate Spreader Coal Stoker
2.4.2.1 Stoker Grate Heat Release
2.4.2.2 Construction
2.4.2.3 Grate Ash Discharge Enclosure
2.4.2.4 Feeder Drives
2.4.2.5 Stoker Grate Drive
2.4.2.6 Overfire Air System
2.5 OIL BURNER/WINDBOX PACKAGE
2.5.1 Burner
2.5.1.1 Burner Characteristics
2.5.1.2 Atomization
2.5.1.3 Electric Ignition System
2.5.1.4 Windbox
2.5.1.5 Purge Connection
2.5.1.6 Aspirating System
2.5.1.7 Guide Pipe Purge
2.5.1.8 Metal Parts
2.5.1.9 Fuel Oil Control Valve
2.5.1.10 Fuel
2.5.1.11 Forced Draft Fan
2.5.1.12 Electric Motor
2.5.2 Flame Safeguard Controls
2.5.2.1 Fuel Oil Train
2.5.2.2 Control Sequencing
2.5.2.3 Light Off
2.5.2.4 Circuit Analyzer
2.5.2.5 Control Panel
2.6 FANS

2.6.1 Forced Draft Fan
2.6.1.1 Fan Size
2.6.1.2 Fan Construction
2.6.1.3 Fan Drive
2.6.1.4 Electric Motor
2.6.1.5 Steam Turbine
2.6.1.6 Noise Level
2.6.2 Induced Draft Fan
2.6.2.1 Fan Size
2.6.2.2 Fan Construction
2.6.2.3 Fan Drive
2.6.2.4 Electric Motor
2.6.2.5 Steam Turbine
2.6.2.6 Noise Level
2.7 COMPRESSED AIR SYSTEM
2.7.1 Plant Air Compressor
2.7.1.1 Air Compressor
2.7.1.2 Air Filter
2.7.1.3 Intercooler and Aftercooler
2.7.1.4 Air Receiver
2.7.1.5 Electric Motor
2.7.1.6 Controls
2.7.2 Instrument Compressed Air System
2.7.2.1 Air Compressor
2.7.2.2 Aftercooler
2.7.2.3 Air Receiver
2.7.2.4 Electric Motor
2.7.2.5 Accessories
2.7.2.6 Controls
2.7.3 Air Dryers
2.7.3.1 Compressed Air Desiccant Air Dryer
2.7.3.2 Compressed Air Refrigerated Air Dryer
2.8 BREECHING, EXPANSION JOINTS, STACKS AND DAMPERS
2.8.1 Breeching
2.8.1.1 Breeching Access Doors
2.8.1.2 Breeching Cleanout Doors
2.8.1.3 Breeching Connections and Joints
2.8.1.4 Breeching Structural Materials
2.8.1.5 Insulation
2.8.1.6 Breeching Paint
2.8.2 Expansion Joints
2.8.2.1 Metallic Breeching Expansion Joints
2.8.2.2 Non-metallic Expansion Joints
2.8.3 Stacks
2.8.3.1 Stacks With Flue Gas Scrubbers
2.8.4 Dampers
2.8.4.1 Multilouver Dampers
2.8.4.2 Guillotine Dampers
2.9 COAL HANDLING EQUIPMENT
2.9.1 Railroad Hopper Car Thawing System
2.9.1.1 Pit-type Railroad Hopper Car Thawing System
2.9.1.2 Surface Mounted Enclosed Railroad Hopper Car Thawing System
2.9.1.3 Shed
2.9.2 Top-Mounted Railroad Hopper Car Shaker
2.9.2.1 Shaker
2.9.2.2 Shaker Hoist
2.9.2.3 Controls
2.9.2.4 Frame [and Enclosure]
2.9.3 Car Pullers

2.9.3.1 Capstan Car Puller
2.9.3.2 Reversible Drum Type Car Puller
2.9.4 Track Hopper
2.9.4.1 Track Girders
2.9.4.2 Grating
2.9.4.3 Cover
2.9.4.4 Hopper Outlet
2.9.5 Truck Hopper
2.9.5.1 Grating
2.9.5.2 Hopper Outlet
2.9.5.3 Cover
2.9.6 Reclaim Hoppers
2.9.6.1 Grating
2.9.6.2 Hopper Outlet
2.9.6.3 Reclaim Hopper Cover
2.9.7 Belt Feeder
2.9.7.1 Head and Foot Shafts
2.9.7.2 Pulleys
2.9.7.3 Belt
2.9.7.4 Electric Motor
2.9.7.5 Reduction Gear
2.9.7.6 Backstop
2.9.7.7 Idlers
2.9.7.8 Load Skirts
2.9.7.9 Frame, Supports, and Enclosure
2.9.7.10 Loading Hopper
2.9.7.11 Vibrating Feeder
2.9.8 Shallow-In-Built Bar Flight Feeder and Receiving Hopper
2.9.8.1 Head and Foot Shafts
2.9.8.2 Terminal Sprockets
2.9.8.3 Chains and Flights
2.9.8.4 Frame and Enclosure
2.9.8.5 Trough
2.9.8.6 Hopper
2.9.8.7 Grating
2.9.8.8 Flight Feeder Drive
2.9.8.9 Electric Motor
2.9.9 Bucket Elevator
2.9.9.1 Head and Foot Shafts
2.9.9.2 Terminal Sprockets
2.9.9.3 Buckets and Chain
2.9.9.4 Backstop
2.9.9.5 Elevator Casing
2.9.9.6 Head Section
2.9.9.7 Boot Section
2.9.9.8 Electric Motor
2.9.9.9 Reduction Gear
2.9.9.10 Anchoring Brackets
2.9.10 Rotary Vane Feeder
2.9.10.1 Body
2.9.10.2 Feeder Vanes
2.9.10.3 Drive Sprocket
2.9.10.4 Electric Motor
2.9.11 Screw Conveyors
2.9.11.1 Inlet and Discharge Spouts
2.9.11.2 Screw Trough
2.9.11.3 Bearings and Hangers
2.9.11.4 Conveyor Screws and Couplings
2.9.11.5 Electric Motor

2.9.11.6 Service Platforms
2.9.12 Belt Conveyor
2.9.12.1 Head and Foot Shafts
2.9.12.2 Takeups
2.9.12.3 Pulleys
2.9.12.4 Magnetic Pulley
2.9.12.5 Belt
2.9.12.6 Electric Motor
2.9.12.7 Reduction Gear
2.9.12.8 Backstop
2.9.12.9 Emergency Stop Cord and Switch
2.9.12.10 Belt Alignment Switch
2.9.12.11 Idlers
2.9.12.12 Load Skirts
2.9.12.13 Frame, Supports, and Walkway
2.9.12.14 Discharge Hopper
2.9.13 Coal Scales
2.9.13.1 Body
2.9.13.2 Feeder
2.9.13.3 Feed Belt
2.9.13.4 Electric Motor And Drive
2.9.13.5 Coal Bypass
2.9.13.6 Weighing Mechanism
2.9.13.7 Scale Weigh Hopper
2.9.13.8 Controls
2.9.13.9 Counters
2.9.13.10 Scale Inlet
2.9.13.11 Scale Outlet Hopper
2.9.14 Stoker Hopper Extension
2.9.15 Coal Valve
2.9.15.1 Valve Body
2.9.15.2 Valve Gate
2.9.15.3 Operating Shaft
2.9.15.4 Electric Motor Operators
2.9.16 Track and Reclaim Hopper Valves
2.9.16.1 Valve Body
2.9.16.2 Valve Gate
2.9.16.3 Operating Shaft
2.9.17 Chutes
2.9.18 Coal Presence Indicators and Equipment Response Switches
2.9.18.1 Type A - Diaphragm Type Presence Indicator
2.9.18.2 Type B - Paddle Type Presence Indicator
2.9.18.3 Type C - Tilt Type Presence Indicator
2.9.18.4 Type D - Rotating Type Presence Indicator
2.9.18.5 Type E - Vibrating Type Presence Indicator
2.9.18.6 Equipment Speed Response Switch
2.9.18.7 Presence Indicators and Response Switches
2.9.19 Control Panel and Controls
2.9.19.1 Panel Devices
2.9.19.2 Switches and Pushbuttons
2.9.19.3 Annunciator Panel
2.9.19.4 Panel Size
2.9.19.5 Auxiliary Devices
2.9.19.6 Name Plates
2.9.19.7 Control Sequence
2.9.19.8 Additional Controls
2.9.20 Multiple Belt Scrapers
2.9.21 Steel Coal Bunker
2.9.21.1 Construction

2.9.21.2 Accessories
2.9.22 Stoker Surge Hoppers
2.9.23 Coal Meter
2.9.23.1 Vane
2.9.23.2 Counter
2.9.24 Stackout Tube
2.10 FUEL OIL SYSTEM
2.11 ASH HANDLING SYSTEM (MECHANICAL)
2.11.1 General
2.11.1.1 System Requirements
2.11.1.2 Routing
2.11.1.3 Discharge
2.11.1.4 Maximum Noise Level
2.11.2 System Valving
2.11.2.1 Rotary Valves
2.11.2.2 Manual Valve Intakes for Bottom Ash
2.11.2.3 Silo Discharge Valve
2.11.3 Conveyors
2.11.3.1 Chain Drag Conveyor
2.11.3.2 Screw Conveyors
2.11.3.3 Inlet and Discharge Spouts
2.11.3.4 Screw Trough
2.11.3.5 Bearings and Hangers
2.11.3.6 Conveyor Screws and Couplings
2.11.3.7 Electric Motor
2.11.3.8 Service Platforms
2.11.4 Bucket Elevator
2.11.4.1 Head and Foot Shafts
2.11.4.2 Terminal Sprockets
2.11.4.3 Buckets and Chain
2.11.4.4 Backstop
2.11.4.5 Casing
2.11.4.6 Head Section
2.11.4.7 Boot Section
2.11.4.8 Electric Motor
2.11.4.9 Anchoring Brackets
2.11.4.10 Discharge Chute
2.11.5 Ash Storage Silo
2.11.5.1 Construction
2.11.5.2 Concrete Stave Silo
2.11.6 Pulse Jet Bag Filter Vent
2.11.7 Rotary Ash Conditioner (Unloader)
2.11.8 Fluidizing System
2.11.9 Control Panel and Controls
2.11.9.1 Control Panel
2.11.9.2 Control Panel Devices
2.12 ASH HANDLING SYSTEM (PNEUMATIC)
2.12.1 System Requirements
2.12.2 System Type
2.12.3 Hoppers
2.12.4 Discharge
2.12.5 Maximum Noise Level
2.12.6 Ash Storage Hopper
2.12.6.1 Construction
2.12.6.2 Refractory Materials
2.12.6.3 Discharge Doors or Gates
2.12.6.4 Hopper Lift Door Enclosure
2.12.6.5 Hopper Access Door
2.12.7 Clinker Crusher

2.12.7.1 Construction
2.12.7.2 Fluid Gear Drive
2.12.8 System Valving
2.12.8.1 Side Intake Valve for Fly Ash
2.12.8.2 Rotary Valve Intakes for Bottom Ash
2.12.8.3 Air Intake
2.12.8.4 Isolating Valves (Line Valves)
2.12.8.5 Silo Discharge Valve
2.12.9 Ash Conveyor Pipe and Fittings
2.12.9.1 Conveyor Piping
2.12.9.2 Elbows and Fittings
2.12.9.3 Hangers and Supports
2.12.9.4 Contractor's Option
2.12.9.5 Expansion Joints
2.12.10 Vacuum Air Piping
2.12.11 Compressed Air Piping and Accessories
2.12.12 Primary Ash Receiver-Separator and Secondary Ash Separator
2.12.12.1 Primary Receiver-Separator
2.12.12.2 Secondary Separator
2.12.12.3 Dust Tight Enclosure
2.12.13 Mechanical Exhausters
2.12.13.1 Isolation Gates
2.12.13.2 Accessories
2.12.13.3 Electric Motor
2.12.13.4 Noise Level
2.12.14 Bag Filter
2.12.14.1 Cloth Area
2.12.14.2 Filter Construction
2.12.14.3 Discharge Gate
2.12.14.4 Bag Cleaning Mechanism
2.12.14.5 Bag Assemblies
2.12.14.6 Control Panel
2.12.14.7 Vacuum Breakers
2.12.15 Steam Exhauster
2.12.16 Steam Condenser, Air Washer and Silencer
2.12.17 Ash Storage Silo
2.12.17.1 Construction
2.12.17.2 Concrete Stave Silo
2.12.18 Pulse Jet Bag Filter Vent
2.12.19 Rotary Ash Conditioner (Unloader)
2.12.20 Fluidizing System
2.12.21 General Controls
2.12.21.1 Functions
2.12.21.2 Status Indicators
2.12.21.3 Alarms
2.12.21.4 Vacuum Transmitter
2.12.22 Controls Operation
2.12.22.1 Automatic
2.12.22.2 Switching
2.12.22.3 Valves
2.12.22.4 Bottom Ash Hopper Local Control Stations
2.13 AIR POLLUTION CONTROL EQUIPMENT
2.13.1 Mechanical Cyclone Collectors
2.13.2 Fabric Filter Baghouse
2.13.3 Electrostatic Precipitator Filters
2.13.4 Scrubbers
2.14 MISCELLANEOUS EQUIPMENT
2.14.1 Condensate Receiver
2.14.1.1 Coating

2.14.1.2 Accessories
2.14.2 Deaerating Heater
2.14.2.1 Heater Capacity
2.14.2.2 Inlet Water Characteristics
2.14.2.3 Storage Tank
2.14.2.4 Vent Condensing Arrangement
2.14.2.5 Materials
2.14.2.6 Accessories
2.14.2.7 Connections
2.14.2.8 Level Control
2.14.2.9 Low Pressure Steam Control
2.14.2.10 Gage Glasses
2.14.2.11 Alarms
2.14.2.12 Multiport Back Pressure Relief Valve
2.14.2.13 Exhaust Head
2.14.3 Boiler Feed Pumps
2.14.3.1 Construction
2.14.3.2 Drives
2.14.3.3 Minimum Flow Protection for Boiler Feed Water Pumps
2.14.3.4 Feedwater Stop and Check Valves
2.14.4 Condensate Pumps
2.14.4.1 Construction
2.14.4.2 Drives
2.14.5 Variable Speed Control for Motors
2.14.5.1 Housing
2.14.5.2 Variable Frequency Controllers
2.14.5.3 Controller Environmental Protection
2.14.5.4 Method of Control
2.14.6 Valve Actuators
2.14.7 Sump Pumps
2.14.8 Water Softening System
2.14.8.1 Softener Equipment
2.14.8.2 Brine Storage System
2.14.9 Chemical Feed Systems
2.14.9.1 Storage Tank
2.14.9.2 Exterior Gage Glass
2.14.9.3 Low Level Alarm
2.14.9.4 Dissolving Baskets
2.14.9.5 Tank Strainer
2.14.9.6 Supporting Steelwork
2.14.9.7 Agitator
2.14.9.8 Proportioning Pumps
2.14.9.9 Safety Relief Valve
2.14.10 Welded Blowdown Tank
2.14.10.1 Accessories
2.14.10.2 Controls
2.14.11 Continuous Boiler Blowdown System
2.14.11.1 Automatic Blowdown Controller
2.14.11.2 Flash Tank
2.14.11.3 Sample Cooler
2.14.11.4 Heat Exchanger
2.15 PIPING
2.15.1 Materials
2.15.1.1 Pipe Materials
2.15.1.2 Fittings
2.15.1.3 Flanges
2.15.1.4 Valves
2.15.1.5 Bolts and Nuts
2.15.1.6 Gaskets

2.15.1.7 Expansion Joints
2.15.1.8 Pipe Hangers and Supports
2.15.1.9 Instrumentation
2.15.1.10 Miscellaneous Pipeline Components
2.15.1.11 Backflow Preventers
2.15.1.12 Insulation
2.15.1.13 Pipe Sleeves
2.15.1.14 Piping Identification
2.16 FIRE PROTECTION SYSTEM
2.17 MARKING
2.18 TOOLS AND TESTING EQUIPMENT
2.19 WELDING MATERIALS
2.20 MOTORS AND DRIVES
2.21 SOURCE QUALITY CONTROL
2.21.1 Instrument Air Compressors
2.21.2 Variable Speed Motor Controller Factory Test

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Boiler
3.1.1.1 Installing Tubes In Headers
3.1.1.2 Installing Tubes In Drums
3.1.1.3 Inspecting Tubes
3.1.1.4 Installing Firebrick
3.1.1.5 Installing Plastic Refractory
3.1.1.6 Installing Casing Insulation
3.1.2 Equipment Installation
3.1.2.1 Equipment Foundations
3.1.2.2 Induced Draft Fan
3.1.2.3 Stack
3.1.2.4 Fuel Oil Tanks
3.1.3 Piping
3.1.3.1 Fittings
3.1.3.2 Grading of Pipe Lines
3.1.3.3 Anchoring, Guiding, and Supporting Piping
3.1.3.4 Copper Tubing
3.1.3.5 Sleeves
3.1.3.6 Flashing for Buildings
3.1.3.7 Outlets for Future Connections
3.1.3.8 Screwed Joints in Piping
3.1.3.9 Welded Joints
3.1.3.10 Cleaning of Piping
3.1.3.11 Reduction in Pipe Size
3.1.3.12 Expansion Control
3.1.3.13 Connection to Equipment
3.1.3.14 Valve Installation
3.1.3.15 Traps and Connections
3.1.3.16 Pressure Gage Installation
3.1.3.17 Thermometer and Sensing Element Installation
3.1.3.18 Strainer Locations
3.1.3.19 Dissimilar Piping Materials
3.1.3.20 Surface Treating, and Pipe Wrapping
3.1.4 Painting
3.1.4.1 Piping, Fittings, and Mechanical and Electrical Equipment
3.1.4.2 Boilers
3.1.4.3 Vertical Fuel Oil Tank
3.1.4.4 Surfaces Not to be Painted
3.1.5 Insulation

3.2 FIELD QUALITY CONTROL
3.2.1 Tests and Inspections (Piping)
3.2.1.1 Hydrostatic and Leak Tightness Tests
3.2.2 Preliminary Operation
3.2.3 General Startup Requirements
3.2.4 Plant Equipment Tests
3.2.4.1 Plant Air Compressors
3.2.4.2 Coal Handling System
3.2.4.3 Fuel Oil Tanks
3.2.4.4 Blowdown Valves and Try Cocks
3.2.4.5 Fans, Heaters, Pumps, and Motors
3.2.5 Boilers and Auxiliaries Tests and Inspections
3.2.5.1 Strength and Leak Tightness Tests
3.2.5.2 Boiler Inspection
3.2.5.3 Boiler Cleaning and Startup
3.2.5.4 Boiler Preliminary Operational Tests
3.2.6 General Operational Tests
3.2.6.1 General Controls
3.2.6.2 Steady State Combustion Tests
3.2.6.3 Varying Load Combustion Tests
3.2.6.4 Auxiliary Equipment and Accessory Tests
3.2.6.5 Feedwater Equipment Tests
3.2.6.6 Capacity and Efficiency Tests
3.2.6.7 Temporary Waste Steam Connection
3.2.6.8 Fire Safety for Oil-Fired Boilers
3.2.6.9 Plant Acceptance Operation
3.2.6.10 NAVFACENGCOM Acceptance
3.2.7 Manufacturer's Field Services
3.2.7.1 Erection/Installation Supervisors and Service Engineers
3.2.7.2 Boiler and System Representatives
3.2.7.3 Instruction to Government Personnel

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA	**UFGS-23 52 33.02 20 (November 2008)** **Change 4 - 08/18**
Preparing Activity: NAVFAC	**Superseding** **UFGS-23 52 33.02 20 (July 2007)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

SECTION 23 52 33.02 20

STEAM HEATING PLANT WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL
11/08, CHG 4: 08/18

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NOTE: This guide specification covers the requirements for steam heating plants from 7 1/2 to 60 1/2 kg/sec 60,000 to 480,000 lbs/hr steam capacity using a field erected watertube boiler.

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

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: This guide specification covers requirements for equipment for a steam heating plant which will generate from 7 1/2 to 60 1/2 kg of steam per second 60,000 to 480,000 pounds of steam per hour. This specification is intended to be used in the procurement and installation of heating plant equipment. Requirements for materials and procedures for special or unusual design shall be added to and modifications made to this specification as necessary to fit specific projects. This guide specification shall be used in conjunction with the following NAVFAC definitive drawings:

NAVFAC NO./DRAWING TITLE

1429345 - STEAM HEATING PLANT NO.5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN

1429346 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN

1429347 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL BASEMENT FLOOR PLAN

1429348 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL LONGITUDINAL SECTION

1429349 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL TRANSVERSE SECTION

1429350 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429351 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429352 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED)

1429353 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL CONTROL SCHEMATIC

1429354 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL HANDLING CONTROLS

1429355 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL DETAILS

1429357 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL UNLOADING

1429358 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL STORAGE

1429359 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE DETAILS-COAL HANDLING

1429360 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL RESERVE COAL STORAGE

1429361 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN - ELECTRICAL

1429362 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL BASEMENT FLOOR PLAN - ELECTRICAL

1429363 - STEAM HEATING PLANT NO. 5 7 12/ - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN - ELECTRICAL

1429364 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL ONE-LINE DIAGRAM - ELECTRICAL

1429366 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN

1429367 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN

1429368 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL BASEMENT FLOOR PLAN

1429369 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL LONGITUDINAL SECTION

1429370 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL TRANSVERSE SECTION

1429371 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429372 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429373 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL CONTROL SCHEMATIC

1429374 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL CONTROL SCHEMATIC

1429375 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL COAL HANDLING

CONTROLS

1429376 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL DETAILS

1429378 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL UNLOADING

1429379 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL STORAGE

1429380 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE DETAILS-COAL HANDLING

1429381 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL RESERVE COAL STORAGE

1429382 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN - ELECTRICAL

1429383 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL

1429384 - BASEMENT FLOOR PLAN - ELECTRICAL STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN - ELECTRICAL

1429385 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL ONE-LINE DIAGRAM - ELECTRICAL

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PART 1 GENERAL

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 Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

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

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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.

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

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

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

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
ANSI/AGMA 2009	(2001B; R 2008) Bevel Gear Classification, Tolerances, and Inspection Methods

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2016) Code of Standard Practice for Steel Buildings and Bridges
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN PETROLEUM INSTITUTE (API)

API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats
API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2017) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B29.100	(2011) Precision Power Transmission, Dbl-P-Power Transmission, Dbl-P-conveyor Roller Chains, Attachments and Sprockets
ASME B31.1	(2020) Power Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-A	(2017) BPVC Section II-Materials-Part A-Ferrous Materials Specifications
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC VII	(2017) BPVC Section VII-Recommended Guidelines for the Care of Power Boilers
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
ASME PTC 4	(2013) Fired Steam Generators

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C510	(2017) Double Check Valve Backflow

	Prevention Assembly
AWWA C511	(2017) Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C651	(2014) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

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

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2016) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2020a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A211	(1975; R 1985) Specification for Spiral-Welded Steel or Iron Pipe
ASTM A242/A242M	(2013; R 2018) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A312/A312M	(2019) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A1011/A1011M	(2018a) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube

ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2018) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM C27	(1998; R 2008) Fireclay and High-Alumina Refractory Brick
ASTM C155	(1997; R 2013) Standard Specification for Insulating Firebrick
ASTM C401	(2012) Alumina and Alumina-Silicate Castable Refractories
ASTM D396	(2019a) Standard Specification for Fuel Oils
ASTM D1047	(2016) Poly(Vinyl Chloride) Jacket for Wire and Cable
ASTM D1220	(1965; R 1990) Measurement and Calibration of Upright Cylindrical Tanks

FM GLOBAL (FM)

FM DS 12-17	(2001) Watertube Boilers

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

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment

	(1000 Volts Maximum)
NEMA MG 1	(2018) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2021) National Fuel Gas Code
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 85	(2019) Boiler and Combustion Systems Hazards Code

PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION (PHCC)

NAPHCC NSPC	(2015) National Standard Plumbing Code Illustrated

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 11.01	(1982; E 2004) Black (or Dark Red) Coal Tar Epoxy Polyamide Painting System
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-18480	(1982; Rev B; Notice 2 2009) Coating Compound, Bituminous, Solvent, Coal-Tar Base
MIL-DTL-17813	(2009; Rev H; Supp 1 2009; Notice 1 2013) Expansion Joints, Pipe, Metallic Bellows, General Specification for
MIL-DTL-18436	(2017; Rev G) Valves, Check, Bronze, Cast Iron, and Steel Body
MIL-E-17814	(1992; Rev F; CANC Notice 1) Expansion Joints, Pipe, Slip-Type, Packed
MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
MIL-T-19646	(1990; Rev A) Thermometer, Gas Actuated, Remote Reading

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

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

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50494	(Basic; Notice 1) Exhaust Head, Steam
CID A-A-50555	(Basic) Pumping Units, Sewage, Duplex, Centrifugal, Automatic Wet-Pit Type
CID A-A-50558	(Basic; Notice 1) Valves, Pressure Regulating, Steam
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-59222	(Basic; Notice 1) Fans, Centrifugal, Draft, Forced and Induced
CID A-A-59224	(Basic; Notice 2) Meters, Fluid Quantity Volumetric
CID A-A-60001	(Rev A) Traps, Steam
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam
FS XX-C-2816	(Rev A) Compressor, Air, Reciprocating or Rotary, Electric Motor Driven, Stationary, 10 HP and Larger

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

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910-SUBPART Q	Welding, Cutting, and Brazing
40 CFR 82	Protection of Stratospheric Ozone

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)

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

UNDERWRITERS LABORATORIES (UL)

UL 296	(2017; Reprint Sep 2020) UL Standard for

	Safety Oil Burners
UL 726	(1995; Reprint Oct 2013) Oil-Fired Boiler Assemblies

WATER QUALITY ASSOCIATION (WQA)

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

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with the additions and modifications specified herein.

1.3 DEFINITIONS

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NOTE: Information describing any specific project and site conditions which the Contractor would need to know in order to submit a firm price shall be specified in Division 1 of the project specifications. Such conditions include:

1. Allocated space for storage of materials.

2. Railway spurs and sidings available to the Contractor for delivery of materials.

3. Any restrictions on daily working hours.

4. Procedure for scheduling outages and tests.

5. Any noise or traffic restrictions.

6. Availability of utilities required for construction.

****

1.3.1 Effective Radiant Heating Surface

Heat exchange surface, exclusive of superheat elements, which is directly exposed to radiant heat of the flame on one side and to water or water-steam mixture being heated on the other. Effective radiant heating surface shall be calculated on the side receiving heat and shall consist of plain or finned tubes and headers which may be bare, metal covered, or metallic-ore covered. Refractory covered surfaces shall not be counted. Computations shall be made as follows:

a. Flat projected area of bare, metal covered, or metallic-ore covered tubes and headers shall be considered as effective radiant heating surface.

b. Metal and metallic surfaces extending from tubes or headers shall be considered to have an effective radiant heating surface equal to 60 percent of their flat projected area except that the following extended surfaces shall not be considered as effective radiant heating surface.

(1) Metal blocks not integral with tubes or headers.

(2) Extended surfaces less than 6 mm 1/4 inch thick.

(3) That portion of the extended surface more than one tube or header radius from the tube or header from which it extends.

(4) Extended surfaces larger than 32 mm 1 1/4 inches.

c. Flat projected areas of portions of first two rows of furnace exit tubes that receive radiant heat from the fire shall be considered as effective radiant heating surface.

1.3.2 Flue Gas Velocity

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NOTE: The maximum velocity to prevent erosion will vary according to whether boiler is multipass or single pass, the type of stoker and the type of fuel. See DM-3.6, Table 4, Maximum Velocities (MPS FPS) in Convection Sections for Coal, Wood or Solid Waste Boilers.

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Velocity of the gas entering the convection section shall not exceed [10] [15] [18] [23] meters per second (m/s) [35] [50] [60] [75] feet per second (fpm).

1.3.3 FRP

Fiberglass reinforced plastic.

1.3.4 Furnace Volume

The cubic volume of the space provided for combustion of the fuel between the top grate line and the first plane of entry into, or between the tubes, of the furnace face of the bridge wall. When screen or superheater tubes are utilized, they shall be considered as the first plane of entry. The manufacturer shall state the furnace volume of the boiler.

1.3.5 PVC

Poly-vinyl chloride.

1.3.6 Standard Commercial Product

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

1.3.7 System Supplier

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

1.4 SYSTEM DESCRIPTION

1.4.1 Design Requirements

1.4.1.1 Boiler

Design boiler in accordance with the ASME BPVC SEC I. Provide design data with computations and performance guarantees covering the full range of operation at full load, 75 percent load, 50 percent load and 30 percent load. Assemble tubes, drums, and headers so that the entire boiler can be drained dry. The furnace shall be water cooled on the side, top, front and back walls.

a. Boiler design and service conditions

(1) Steam capacity:
Continuous peak for 2 hours: [_____] kg/sec lb/hr
Maximum continuous: [_____] kg/sec lb/hr
Minimum (without smoking): [_____] kg/sec lb/hr

(2) Design pressure: [_____] kPa (gage) psig

(3) Operating pressure: [_____] kPa (gage) psig

(4) Steam temperature: [_____] degrees C F

(5) Feedwater temperature to economizer: [_____] degrees C F
Continuous blowdown: [_____] percent

(6) Maximum moisture content of steam leaving drum at peak rating:
[_____] percent

(7) Total solids concentration in drum: [_____] PPM

(8) Fuel:
Coal (see coal analysis):
[Oil (see oil analysis)]:

(9) Heating surface, minimum:
Radiant: [_____] sq. m ft.
Convective: [_____] sq. m ft.

(10) Furnace volume, minimum: [_____] cu. m ft.

(11) Maximum boiler flue gas exit
Temperature: [_____] degrees C F
Continuous rating: [_____] degrees C F

(12) Maximum economizer flue gas exit
Temperature: [_____] degrees C F
Continuous rating: [_____] degrees C F

(13) Efficiency at maximum continuous rating [includes economizer]
Coal: [_____] percent
[Oil]: [_____] percent

(14) Elevation above sea level: [_____] meters feet

(15) Boiler room & combustion air ambient: [_____] degrees C F

(16) Maximum allowable total draft loss furnace, boiler, exit damper, and economizer outlet at continuous rating: [_____] Pa inches of Water

(17) Steam drum, minimum diameter: [_____] mm inches

(18) Mud drum, minimum diameter: [_____] mm inches

(19) Seismic zone: [_____]

1.4.1.2 Economizer

****
NOTE: Feedwater temperatures should be 110 degrees C 230 degrees F when sulfur (S) content of fuel is 0.5 percent to 1.5 percent; 116 degrees C 240 degrees F, S = 1.5 percent to 2 percent; 121 degrees C 250 degrees F, S = 2.0 percent to 2.7 percent. Where fuels having more than 1.5 percent sulfur content are to be fired, finned tubes shall not be used unless the steel tubes are covered with cast iron fin casing.
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a. Flue gas quantity: [_____] kg/s lbs/hr

b. Flue velocity: [_____] m/s ft/min

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

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

e. Feedwater Temperature entering economizer: [_____] degrees C F

f. Feedwater Temperature leaving economizer: [_____] degrees C F

g. Fouling factor on feedwater side: [_____]

h. Fouling factor on gas side: [_____]

i. Boiler operating pressure: [_____] kPa (gage) psig

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

k. Steam loads shall be as specified under boiler[s]

l. Performance: The efficiency due to the economizer shall be included with and stated as part of the overall boiler efficiency.

1.4.1.3 Forced Draft Fan

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

1.4.1.4 Induced Draft Fan

Design fan of materials which will withstand flue gas temperatures up to 316 degrees C 600 degrees F without damage. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counter clockwise] rotation when viewed from [motor] [turbine] end. Provide outboard pedestal bearings with sole plates [and dual extension shaft].

1.4.1.5 Screw Conveyors for Coal Handling Equipment

Each screw conveyor shall meet the following minimum design and performance specifications when handling [_____] size coal:

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

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

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

1.4.1.6 Screw Conveyors for Ash Handling Systems (Mechanical)

Each screw conveyor shall meet the following minimum design and performance specifications when handling dry fly ash of density not greater than [_____] kg per cubic meter pounds per cubic foot:

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

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

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

1.4.1.7 Stacks With Flue Gas Scrubbers

Stacks with flue gas scrubbers, boilers 5 kg/sec 40,000 lb/hour and over:

a. Temperature

(1) Maximum ambient: [_____] degrees C F

(2) Minimum ambient: [_____] degrees C F

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

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

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

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

b. Gas Flow at Inlet

(1) Maximum: [_____] kg/s lbs/hr

(2) Minimum: [_____] kg/s lbs/hr

c. Required net available draft at stack inlet

Maximum gas flow: [_____] Pa inches water

d. Gas exit velocity (cone exit)

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

e. Flue gas dew point

(1) Fuel oil: [_____] degrees C F

(2) Fuel-coal: [_____] degrees C F

f. Test pressures

Shop test: [_____] Pa inches water

g. Thermal efficiency of stack: 96 to 98 percent

h. Stack friction

Maximum at design conditions: [_____] Pa inches water

i. Stack height

(1) Ground elevation: [_____] m ft

(2) Roof elevation: [_____] m ft

(3) Stack height: [_____] m ft

(4) Foundation or footing elevation: [_____] m ft

j. Wind pressure: [_____] kg/m2 psf

Elevation Above Ground Level (m)	Wind Pressure (kg/m2)
0 - 9	[_____]
15	[_____]
23	[_____]
30	[_____]
38	[_____]
46	[_____]
53	[_____]
61	[_____]

Elevation Above Ground Level (ft)	Wind Pressure (psf)
0 - 30	[_____]
50	[_____]
75	[_____]
100	[_____]
125	[_____]
150	[_____]
175	[_____]
200	[_____]

k. Wind velocity, gusting: [_____] km/hr mph

l. Stack inside diameter, minimum (below velocity cone): [_____] mm inches

m. Maximum stack deflection (from vertical center line): [_____] mm inches

n. Soil bearing stress, maximum: [_____] kg/m2 psf

o. Seismic zone: [_____]

1.4.1.8 Fuel Oil Pumps

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

****
NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.
****

(1) Number of assemblies: [_____]

(2) Tag numbers: [_____]

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

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

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

(6) Operating temp.: [27 to 54 80 to 130] [_____to_____] degrees C F

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

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

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

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, Low Sulfur] [_____]

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

****
NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.
****

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

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

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

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

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

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

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

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

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

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

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

****
NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.
****

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

(3) Capacity: 1.58 L/s 25 gpm at 450 ssu

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

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

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

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

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

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

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

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

1.4.1.9 Fuel Oil Pump and Heater Set for Fuel Oil System

****
NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.
****

a. Pump/heater set

(1) Capacity each pump and each steam heater: [_____] L/s gpm

(2) Suction lift: [_____] kPa ft water

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

(4) Maximum pump speed: 1750 rpm

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

(6) Viscosity at brake power point: 5000 ssu

(7) Viscosity range: [500 to 5000] [_____] to [_____] ssu

(8) Oil temperature at inlet of heater: [_____] degrees C F

(9) Oil temperature at outlet of heater: [_____] degrees C F

(10) Maximum oil pressure drop through heater: [_____] kPa psi

(11) Heating medium: Steam

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

(13) Steam temperature: [_____] degrees C F

(14) Heater type: [Extended surface][Bare tube]

b. Electric startup heater

(1) Oil temperature at heater inlet: [_____] degrees C F

(2) Oil temperature at heater outlet: [_____] degrees C F

(3) Maximum oil pressure drop through heater: [_____] kPa psi

(4) Capacity of heater: [_____] L/s gpm

(5) Heating power supply at three phase, 60 Hz [_____] volts

(6) Control power supply 120 volts, single phase, 60 Hz

1.4.1.10 Ash Handling System (Mechanical)

a. Capacity:

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

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

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

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

b. General data

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

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

(3) Seismic zone: [_____]

(4) Wind velocity (gusts): [_____] km/hr mph

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

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

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

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

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

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

] (7) Coal analysis

(a) Ash [_____] percent

(b) Carbon [_____] percent

(c) Hydrogen [_____] percent

(d) Sulfur [_____] percent

(e) Moisture [_____] percent

(f) Nitrogen [_____] percent

(g) Oxygen [_____] percent

(8) Ash Analysis

(a) Carbon [_____] percent

(b) Calcium [_____] percent

1.4.1.11 Ash Handling System (Pneumatic)

a. Capacity:

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

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

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

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

b. General Data

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

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

(3) Seismic zone: [_____]

(4) Wind velocity (gusts): [_____] km/hr mph

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

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

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

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

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

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

] (7) Coal analysis

(a) Ash: [_____] percent

(b) Carbon: [_____] percent

(c) Hydrogen: [_____] percent

(d) Sulfur: [_____] percent

(e) Moisture: [_____] percent

(f) Nitrogen: [_____] percent

(g) Oxygen: [_____] percent

(8) Ash analysis

(a) Carbon: [_____] percent

(b) Calcium: [_____] percent

(9) Minimum velocities required for materials

(a) Fly ash: 19.30 m/s 3800 ft./min.

(b) Bottom ash (traveling grate stoker): 28.44 m/s 5600 ft./min.

(c) Bottom ash (spreader stoker): 26 m/s 5100 ft./min..

1.4.1.12 Miscellaneous Equipment

a. Deaerating heater: Design the deaerating heater for the following conditions:

(1) Design pressure: 207 kPa (gage) 30 psig

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

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

(4) Capacity (minimum): [_____] kg/s lb/hr of feedwater

(5) Inlet Conditions at Heater:

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

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

(6) Outlet temperature of feedwater from heater at design capacity: [_____] degrees C F

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

(8) Heating steam enthalpy: [_____] kJ/kg Btu/lb

(9) Storage capacity to overflow of storage tank: [_____] liters gallons.

****

NOTE: At the text below, analysis of the water available for makeup shall govern the water treatment system selected. A competent water treating consultant shall be obtained to formulate specific system recommendations when the makeup water analysis indicates any of the following:

1. Iron in excess of 0.1 ppm as Fe.

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

3. Silica in excess of 6 ppm as SiO2.

****

b. Water softening system: Base the water softening system on the following:

(1) Raw water analysis: Source of raw water is [_____]. It is available at pressures of [_____] to [_____] kPa (gage) psig. The analysis of the water available for makeup is approximately as follows:

TABLE 1: MAKEUP WATER ANALYSIS			
	Constituent	Analysis	Parts Per Million (PPM)
Cations	Calcium (Ca++)	as CaCO3	[_____]
	Magnesium (Mg++)	as CaCO3	[_____]
	Sodium (Na+)	as CaCO3	[_____]
	Hydrogen (H+)	as CaCO3	[_____]
TOTAL CATIONS		as CaCO3	[_____]
Anions	Bicarbonate (HCO3 -)	as CaCO3	[_____]
	Carbonate (CO3 --)	as CaCO3	[_____]
	Hydroxide (OH -)	as CaCO3	[_____]
	Sulfate (SO4 --)	as CaCO3	[_____]
	Chloride (Cl -)	as CaCO3	[_____]
	Phosphate PO4 ---)	as CaCO3	[_____]
	Nitrate (NO3 -)	as CaCO3	[_____]
TOTAL ANIONS		as CaCO3	[_____]

TABLE 1: MAKEUP WATER ANALYSIS			
	Total hardness	as CaCO3	[_____]
	Methyl orange alkalinity	as CaCO3	[_____]
	Phenolphthalein alkalinity	as CaCO3	[_____]
	Iron, total	as Fe	[_____]
	Carbon dioxide	as Free CO2	[_____]
	Silica	as SiO2	[_____]
	Suspended solids (Turbidity)		[_____]
	Total dissolved solids (TDS)		[_____]
	Free acids		[_____]
	Color		[_____]
	pH		[_____]
	Specific Conductance Microhms/cm		[_____]

(2) Softener effluent analysis:

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

****
NOTE: At the text below, total solids of 175 ppm in the feedwater concentrated 20 times give 3,500 ppm in the boiler water.
****

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

1.4.2 Detail Drawings

1.4.2.1 Boiler Drawing

Submit safety valve calculation sheets or Manufacturer's standard sheets) and detail drawings for the following:

a. Refractory details, expansion joints

b. Certified outline, general arrangement (setting plan), and anchor bolt

detail drawings including foundation loading diagrams

c. Plans and elevations detailing piping connections

d. Detailed dimensional drawings of auxiliaries furnished with the unit

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

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

g. Wiring diagrams for subsystems

h. Economizers and economizer inlet breeching

i. Soot blowers

j. Auxiliaries furnished with the boilers

k. Forced draft fan, drives and duct work

l. Induced draft fan, drives and duct work

m. Structural steel and loading diagrams

n. Overfire air fan system

1.4.2.2 Boiler Room Auxiliary Equipment

Submit descriptive information for the following items on the drawings including arrangements, wiring diagrams, piping diagrams, and details of valves and piping.

a. Water softening equipment

b. Brine storage tank

c. Condensate receiver

d. Condensate transfer pumps including certified performance curves

e. Deaerator

f. Boiler feed pumps including certified performance curves

g. Steam turbines and their drives

h. Continuous blowdown system

i. Chemical feed units

j. Air compressors

k. Air dryers

l. Cranes and hoists

m. Plant heating and ventilation equipment showing related ductwork

1.4.2.3 Stokers

Include the following:

a. General arrangement

b. Foundation drawings

c. Front plates

d. Ash hoppers

e. Fuel gate mechanism

f. Grate details

g. Zone dampers

h. Air seal details

i. Overfire air nozzle arrangement, overfire air fan and drives

j. Coal feeder details

k. Fuel feeder drives

l. Piping schematics

m. Wiring schematics

n. Access doors

1.4.2.4 Ash Handling System

Include the following:

a. General arrangement

b. Construction details ash storage silo complete with loading diagrams

c. Control panel arrangement and schematics

d. Wiring and control diagrams

e. Ash piping arrangement drawings and schematic drawings

f. Wear back fitting details

g. Piping and fittings

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

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

j. Silo fluidizing system and rotary ash conditioner

k. Bottom ash hopper and vertical lift doors

l. Ash crusher

1.4.2.5 Burners

Include the following:

a. General arrangement

b. Piping details

c. Burner control schematics

d. Flame safety schematics

e. Component details

f. Throat tile details

1.4.2.6 Dampers, Stacks and Breechings

Include the following:

a. General arrangement

b. Breeching, reinforcing details

c. Breeching hangers and support details

d. Dampers and operators

e. Access doors and frames

f. Expansion joints

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

[Submit drawings stamped by a registered professional engineer for stacks with flue gas scrubbers, boilers 5 kg/sec 40,000 lb/hour and over.

]1.4.2.7 Coal Handling Equipment

Include the following:

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

b. Dimensional equipment and fabrication drawings, including all equipment weights, equipment locations, support details, and anchor bolt arrangements for items and equipment specified under the coal handling section

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

d. Control schematic diagrams and complete wiring diagrams

1.4.2.8 Fuel Oil Equipment

Drawings may be manufacturer's standard size for pumps, pump curves, valves, strainers and pump wiring.

a. Certified outline and general arrangement drawings

b. Certified pump and performance curves and tabulations

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

d. Electrical wiring diagrams

e. Oil tanks, foundations, tank heaters, appurtenances, water draw-off and level indication.

1.4.2.9 Piping and Specialty Items

Drawings may be manufacturer's standard size.

a. Details of valves and special fittings

b. Feedwater regulator details and schematics

c. Details and schematics of feedwater automatic recirculation

1.4.2.10 Flexible Ball Expansion Joint Installation Details

Include allowable angular flex and minimum offset dimensions for approval.

1.4.2.11 Reinforced Concrete Foundation

Concrete and reinforcing for the foundation shall be detailed on the Contractor's submitted shop drawings as specified under Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.4.2.12 Reproducible Drawings

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

a. Boiler layout, foundations, construction and details including [preheaters,] [economizers,] auxiliaries and details

b. Breeching layout, construction and details

c. Burner construction, control and flame safety schematics, and details

d. Burner details

e. Wiring diagrams

f. Fuel tanks, foundations and appurtenances

g. Feedwater automatic recirculation system

h. Piping schematics

i. Control diagrams schematics including panel construction and layout

j. Coal handling equipment

k. Stoker drawings and details

l. Ash handling system, including panels, schematics and details

1.4.3 Test Reports

1.4.3.1 Boiler Predicted Performance Data

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

1.4.3.2 Fan Performance Data

Submit to the Contracting Officer manufacturer's fan performance data based on performance tests made in accordance with the requirements of AMCA 210. AMCA certified test data from prototype fan designs is acceptable.

1.4.4 Performance Requirements

1.4.4.1 Boiler

****

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

****

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

a. Coal analysis

(1) Ultimate analysis (percent by weight)

Carbon	[_____]
Hydrogen	[_____]
Oxygen	[_____]

Nitrogen	[_____]
Sulfur	[_____]
Ash	[_____]
Moisture	[_____]
TOTAL	[_____]

(2) Proximate analysis (percent by weight)

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

(3) Coal characteristics:

Heating value: [_____] kJ/kg Btu/lb

Ash softening temperature reducing: [_____] degrees C F

Oxidizing: [_____] degrees C F

Free swelling index (coke button): [_____]

Size: 32 by 19 mm: [_____] percent; 19 by 6.35 mm: [_____] percent; 6.35 by 0 mm: [_____] percentSize: 1 1/4 by 3/4 inch: [_____] percent; 3/4 by 1/4 inch: [_____] percent; 1/4 by 0 inch: [_____] percent

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

	Minimum	Maximum
Ash	[_____]	[_____]
Sulfur	[_____]	[_____]
Hydrogen	[_____]	[_____]

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

b. Fuel oil analysis

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

Grade of fuel oil ultimate analysis (percent by weight)

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

Heating value: [_____] kJ/kg Btu/lb
Specific gravity: [_____] degrees API
Viscosity at burner: [_____] SSF at 50 degrees C 122 degrees F
Water and sediment (by volume): [_____] percent
Flash point: [_____] degrees C F.

1.4.4.2 Oil/Burner Windbox Package

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

1.4.4.3 Miscellaneous Equipment

a. Boiler feed pump service requirements:

(1) Capacity: [_____] L/s gpm

(2) Pumping temperature: [_____] degrees C F

(3) Liquid pH: [_____]

(4) Discharge head: [_____] kPa feet

(5) Available NPSH: [_____] kPa feet

(6) In addition to the operating point established above, the pump curve shall also run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

b. Condensate pump service requirements

(1) Capacity: [_____] L/s gpm

(2) Pumping temperature range: [_____] to [_____] degrees C F

(3) Liquid pH: [_____]

(4) Discharge head: [_____] kPa feet

(5) Available NPSH: [_____] kPa feet

(6) In addition to the operating point established above, the pump curve shall run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

1.5 SUBMITTALS

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

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

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

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

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

SD-02 Shop Drawings

Boiler Drawing

Boiler Room Auxiliary Equipment

Stokers

Ash Handling System

Burners

Dampers, Stacks and Breechings

Coal Handling Equipment

Fuel Oil Equipment

Piping and Specialty Items

Flexible Ball Expansion Joint Installation Details

Reinforced Concrete Foundation

Reproducible Drawings

Submit for approval within [60] [75] [90] days after award of contract. Drawing size shall be A1 (841 by 594 mm) 34 by 22 inches.

SD-03 Product Data

Boiler

Boiler Room Auxiliary Equipment

Stacks

Coal Handling Equipment

****
NOTE: Include refrigerant submittal when a compressed air refrigerated air dryer is included.
****

[Refrigerant (compressed air refrigerated air dryers) - Provide SDS sheets for all refrigerants

] Insulation

Submit for approval within [60] [75] [90] days after award of contract.

SD-04 Samples

Each Type of Insulation

Include the intended application for each type of insulation and attach manufacturer's stamp or label giving name of manufacturer, brand and description of material.

[SD-05 Design Data

****
NOTE: Choose this paragraph only if the paragraph STACKS WITH FLUE GAS SCRUBBERS, BOILERS 5 kg/sec

40,000 lb/hour AND OVER and its subparagraphs are chosen. Delete this paragraph if the paragraph STACKS WITH NO FLUE GAS SCRUBBERS, BOILERS 5 kg/sec 40,000 lb/hour & UNDER and its subparagraphs are chosen.

****

Stacks with Flue Gas Scrubbers, boilers 5 kg/sec 40,000 lb/hour and over

Submit design calculations for static and dynamic analysis and damping. Submit manufacturer's foundation and stack calculations. Submit as specified under the paragraph STACKS WITH FLUE GAS SCRUBBERS, BOILERS 5 kg/sec 40,000 lb/hour AND OVER.

] SD-06 Test Reports

Boiler Predicted Performance Data

Fan Performance Data

Instrument Air Compressors

Variable Speed Motor Controller

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

Steam Heating Plant

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

SD-07 Certificates

List of Equipment Manufacturers

Proof of Experience

Submit the required information and experience certificates prior to commencing work on the site.

System and Equipment Installation

Vertical Fuel Oil Tank Calibration

Backflow Preventer

Ozone Depleting Substances Technician Certification

SD-10 Operation and Maintenance Data

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

Equipment, Data Package 3

Control Components, Data Package 4

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

SD-11 Closeout Submittals

Posted Operating Instructions

1.6 QUALITY ASSURANCE

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

1.6.1 Standard Commercial Product

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

1.6.2 Equipment Furnished

Equipment furnished by the Contractor shall be furnished by the manufacturers listed.

1.6.3 Responsibility

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

a. Boiler system, including but not limited to the boiler, stoker, oil burners, [economizer,] [air preheater,] refractories, insulation, induced draft fan, sootblowers, steam separator, forced draft fan, overfire air fan, reinjection system, boiler trim, blowdown valves, safety valves and trim, and breeching. System manufacturer shall coordinate required instrumentation and control logic with controls and instrumentation supplier. Controls and instrumentation are specified in VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

b. Coal handling system, including but not limited to the track and reclaim hoppers, belt feeders, belt conveyors and tube galleries, telescoping chute, flight conveyor, coal bunker, under bunker conveyor with triple valves, coal scale and non-segregating distributor.

c. Ash handling system including clinker crusher, ash intakes, ash silo with baghouse filter, vacuum pump and rotary dustless filter.

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

e. Emission equipment including precipitator, scrubber and baghouse.

1.6.4 Certification of Backflow Preventer

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

1.6.5 Modification of References

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

1.6.6 Certificates

1.6.6.1 List of Equipment Manufacturers

Submit a letter which names the equipment manufacturers for the following equipment. When the Contracting Officer determines that a manufacturer does not meet the qualification or experience requirements of the specifications, the Contractor shall submit, to the Contracting Officer, the name of another manufacturer within fifteen days of notification.

a. Boilers and stokers

b. Boiler feedwater pumps

c. Coal car handling equipment

d. Induced draft fans

e. Coal handling equipment

f. Ash handling equipment

1.6.6.2 Proof of Experience

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

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

****

NOTE: Verify number of manufacturers' installations operating and years of operation for coal handling systems, ash handling systems and control systems to avoid an unnecessarily restrictive experience requirement.

****

b. Experience Requirements: Boilers and equipment installed within or as a part of the heating plant shall be of proven designs. Each manufacturer or system supplier shall be regularly engaged in designing, fabricating, erecting or erection supervision, testing and starting up of the equipment or system. Within 30 days after award or at any time during performance of the contract, when the Contractor is required to use another manufacturer or system supplier is required through no fault of the Contractor, the Contractor shall submit a certificate and other evidence from each manufacturer or each system supplier to show that equipment and systems, made or furnished by the manufacturers or system suppliers, have substantially comparable operating requirements to the equipment or systems specified under this section and that they have been successfully installed and reliably operated in at least [one] [two] [three] installations under substantially comparable operating conditions for a period of not less than two years.

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

(1) List of installations meeting the aforementioned requirements including detailed description of equipment furnished for each one.

(2) Owner and location of each installation.

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

(4) Date of Owner acceptance of such installation.

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

1.6.6.3 System and Equipment Installation

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

1.6.6.4 Vertical Fuel Oil Tank Calibration

Submit four copies of the certified record.

1.6.6.5 Backflow Preventer

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

1.6.6.6 Ozone Depleting Substances Technician Certification

****

NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.6.7 Posted Operating Instructions

Provide posted operating instructions for each piece of equipment installed.

1.6.8 Operation and Maintenance Data

Submit operation and maintenance data for each equipment, including control components. Include the following supplemental information in addition to requirements of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

a. Illustrations, catalog information, shop drawings, and certified drawings of each item of equipment and control components

b. Tests and test results

c. Adjustments

d. Fan and blower characteristics curves

e. Pump characteristic curves superimposed on system curves at various pumping rates (20, 40, 60, 80, 100 percent capacity)

f. Boiler predicted performance data

g. List of special tools required

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Assembly of Components

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

1.7.2 Storing Tubes

Grind tube ends before shipment and properly coat against elements that may cause rusting or decomposition prior to erection. Store tubes used in erection of boiler with full protection from elements and at no time shall tubes be stored upon the ground. Maintain sufficient space between bottom row of tubes and ground to give good circulation of air at all times. Before installing tubes, remove mill scale and other foreign matter.

1.8 ENVIRONMENTAL REQUIREMENTS

1.8.1 Air Permits

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

1.8.2 Boiler Emissions

Comply with local, state, and federal emission regulations for the fuel to be fired.

1.8.3 Oil Burner/Windbox Package

The emission requirements shall be met at the maximum required continuous output. The burner shall meet environmental rules and regulations. Emission requirements to be considered are oxides of nitrogen (NOx), opacity, particulates, sulfur dioxide, and carbon monoxide. Compliance with NOx emission regulations shall be met using one [a combination] of the following:

a. Low NOx burners

b. Flue gas recirculation

c. Other NOx reduction methods

1.9 EXTRA MATERIALS

a. Furnish two extra sets of air filters for each compressor.

****
NOTE: At the text below, choose one of the two following items in coordination with the option chosen in Part 2 "Compressed Air Desiccant Air Dryer" or "Compressed Air Refrigerated Air Dryer."
****

[b. Furnish 4 spare prefilters and 4 spare afterfilters for compressed air desiccant air dryer.

][c. Furnish 4 spare disposable cartridge type prefilters and afterfilters each, for compressed air refrigerated air dryer.

] d. Furnish a spare set of refractory bricks for each thawing unit.

PART 2 PRODUCTS

2.1 MATERIALS

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

2.1.1 Identical Items

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

2.2 [COAL/OIL] [COAL] FIRED BOILER

Multiple-drum, bent tube, field erected, cross drum, high static head, and vertical combustion chamber type designed for stoker [and oil] firing. Stoker [and oil burner] shall be as specified elsewhere in this section. Utilize shop assembled components to the maximum extent to facilitate erection and minimize field labor. Materials shall be as specified herein. Materials and piping shall meet requirements of ASME BPVC SEC I. Boiler shall be a fully erected water tube boiler, including engineering, labor, supervision, tools, materials, and testing required for a complete operational unit. Equipment shall include boiler, waterwalls, refractories, insulation, supporting structural steel, steel casing and lagging, windbox, ductwork, sootblowers, stoker, [oil burners], ASME required safety valves, valves and trim, forced draft fan, induced draft fan and overfire air fan. Boiler design shall be fully integrated with and coordinated with stoker, [fuel oil burner,] economizer, and forced draft fan, induced draft fan, and controls specified elsewhere in this section. Boilers with [welded wall,] [or] [tube and tile] are acceptable.

2.2.1 Operational Requirements

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

2.2.1.1 Furnace Heat Input

****

NOTE: See NAVFAC Design Manual DM-3.6, Table 12 Stoker Selection Criteria.

****

When boiler is operating at a maximum continuous rating, heat input to furnace shall not exceed either of the following limits:

a. [310] [362] kW [30,000] [35,000] Btu per hour per cubic meter foot of furnace volume.

b. 315 kW 100,000 Btu per hour per square meter foot of effective radiant heating surface.

Combustion gas temperature at furnace exit shall not exceed [1149 degrees C 2100 degrees F when firing oil and] 93 degrees C 200 degrees F below ash fusion temperature when firing coal.

2.2.2 Construction

2.2.2.1 Boiler Drums

****

NOTE: Boilers 11 1/4 kg of steam per second 90,000 pounds of steam per hour or more should have a steam drum of not less than 1372 mm 54 inches in diameter and a lower drum of not less than 1067 mm 42 inches in diameter.

****

Drums shall be steel plate, fusion welded in conformance with the ASME BPVC SEC I. The manufacturer shall determine the inside diameter and overall length of each drum except that the steam drum shall be sized sufficiently large to contain the steam-water separating equipment, to prevent excessive rise of water due to sudden change in steam demand, and to allow for ready access into the drum. The steam drum shall be at least [_____] mm inches internal diameter. The lower drum shall be at least [_____] mm inches internal diameter. Provide each drum with an elliptical manhole at each end not less than 300 by 400 mm 12 by 16 inches, with hinged manhole cover, yoke and gaskets and machined to fit manhole flange of head. Provide flat bar ring of not less than 10 gage steel plate welded to the exterior of the drum heads around the manholes for protection of the drum head insulation. Rings shall be continuous and shape shall conform to the general outline of the manhole opening. Groove the tube holes in the drums for maximum holding power. Fusion weld the longitudinal seams in drums and the circumferential joints between heads and shells. Remove excess welding material and clean drum surface. Relieve stresses caused by welding by heat treatment in annealing furnaces, and X-ray the seams to ensure complete and proper welding. Drum variation shall not exceed one percent between maximum and minimum diameters at any section and when necessary, reheat, reroll or reform drums to meet this requirement.

a. No part of the boiler drum or header surface shall be directly exposed to furnace radiation unless it is adequately protected by a water screen in such a manner that no part of the exposed drum or header surface shall be more than 50 mm 2 inches from the nearest water tube.

b. Fit the steam outlet drum of the boiler with easily removable efficient dry pipe, special baffle, or other separating device so that the steam delivered to the boiler header shall have not more than 1.0 ppm of total solids at maximum continuous load, and during change of load from 50 percent to 100 percent of continuous rated capacity within a three minute period, provided that the total solids concentration in the boiler water does not exceed 3500 parts per million, the total alkalinity concentration does not exceed 700 parts per million, and no organic matter is present.

c. Nozzles for safety valves, main steam outlet, feed and blowdown lines,

shall be forged steel, straight neck type, flanged and fusion welded to drums. Weld threaded connections in the steam drum for the feed water regulator, continuous blowdown, vent gage, and chemical feed lines.

d. Provide steam drum with internals for continuous blowdown, running the length of the steam drum at the point of highest concentration of dissolved solids, and an internal distribution pipe for chemical feed. Continuous blowdown and chemical feed pipe inside of drum shall be stainless steel.

2.2.2.2 Headers

Horizontal lower and upper side wall headers shall preferably be square. However, round headers are acceptable, provided approved stoker seals are provided. Provide rear wall and front wall headers. Protect the front wall header by studs and pack with insulating cement. Provide headers with key caps or gasketed type handhole fittings.

2.2.2.3 Tubes

Boiler design pressure shall not be less than 1724 kPa (gage) 250 psig. Water tube rows and first two rows of main boiler bank shall be one gage heavier than other tubes. Tubes shall be resistance welded or seamless, ASME BPVC SEC II-A SA-178/SA-178M, Grade A carbon steel not less than 63.50 mm 2 1/2 inches O.D.; tubes shall not be reduced in size at the boiler drums. Manufacturer shall indicate the size, weight, and kind of tubes on the submittal drawings. Furnace walls and roof shall be water cooled. Radii of bends in tubes shall be such that standard turbine type cleaners can easily pass through the full length of the tubes.

a. When a boiler is provided with welded wall construction, the tube side walls, front wall, and furnace roof shall be of gastight construction, tubes shall be skin cased for gastight construction.

b. The width of the water wall tubes, as determined by the outside diameter of the tubes, shall cover at least 50 percent of each of the front, rear furnace, side walls, and roof of the boiler.

c. Tube connections to upper drum shall be so arranged that the ends of downcomer tubes shall be covered with water when the water level in the steam drum is 50 mm 2 inches below the bottom of the gage glass with the gage glass being centered at the normal water level in the drum. Tube bends shall be free of wrinkles and at no point of the bend shall the diameter of the tube be more than 3 mm 1/8 inch less than the minimum allowable diameter of the tubes.

d. Space boiler and water wall tubes so that tubes may be removed and replaced without disturbing another tube.

2.2.3 Boiler Setting and Insulation

Provide a complete setting including firebrick, refractory tile, insulation, tile supports, supporting steel, steel casing, material for expansion joints, and necessary work and materials to provide a complete gas envelope for the convector and water walls.

2.2.3.1 Expansion Joints

Provide expansion joints where required to permit brickwork to expand freely without interference with the boiler. Joints shall be of adequate width, tightly sealed against leakage, and free from mortar, with the outer 100 mm 4 inches sealed with resilient material suitable for 927 to 1093 degrees C 1,700 to 2,000 degrees F. In addition, to allow for expansion of the inner face, a series of 3 mm 1/8 inch wide vertical openings spaced 1.83 meters 6 feet apart shall be provided on the furnace side of the wall. Proper provision shall be made for expansion and contraction between boiler foundation and floor.

2.2.3.2 Welded Wall

a. Inner Casing: Provide No. 10 gage inner casing for tangent tube construction.

b. Insulation and Firebrick: Back up the walls and roof of the furnace with not less than 63.50 mm 2 1/2 inches of block insulation (816 degrees C 1500 degrees F class) or ASTM C155 insulating firebrick. Provide standard welded casing or lagging to cover and protect insulation.

c. Furnace Roof Tube Openings: Where necessary, such as where the furnace roof tubes are separated to enter the drum, the opening shall be completely inner cased and filled with ASTM C401 castable refractory.

2.2.3.3 Tube and Tile Furnace Construction

Sides, front and rear walls, and the roof of the boiler, as far as is practical, shall include water wall tubes backed up with not less than a thickness of 63.50 mm 2 1/2 inches of super duty Class, regular type, ASTM C27 fire brick followed by high temperature block insulation 816 degrees C 1500 degrees F Class or ASTM C155 insulating firebrick. Insulation shall not be less than 127 mm 5 inches thick on the furnace walls and roof, 100 mm 4 inches thick on the side walls beyond the furnace, and 76 mm 3 inches thick on the rear wall, consisting of two layers with staggered joints. Plaster the entire exterior of the setting with a thin coating of plastic high temperature cement before the casing is applied.

2.2.3.4 Drum, Header and Miscellaneous Insulation

a. Drum Heads: Insulate drum heads with a minimum thickness of 51 mm 2 inches of calcium silicate blocks applied in two 25 mm one inch layers with 25 mm one inch mesh wire fabric embedded between layers. Entire surface shall be neatly finished with 13 mm 1/2 inch coat of smooth, hard finish hydraulic setting insulating cement with one inch chicken wire mesh embedded therein. Neatly finish drum heads with a field applied 0.47 kg 14 ounce per square meter yard glass cloth.

b. Drum Top and Header: Insulate the top half of the steam drum as previously specified for drum heads, but finish with 16 gage welded steel casing. Provide insulation to the flange on smoke outlet of the boiler. Insulate headers and downcomer tubes with not less than 38 mm 1 1/2 inch thick calcium silicate blocks banded in place, covered with 13 mm 1/2 inch thick coat of hydraulic setting insulating cement and enclosed in an 18 gage metal lagging with openings for access to

handhole fittings, as required.

c. Miscellaneous: Provide special firebrick and tile required in connection with fitting of doors and seals, and around stoker and headers. Build arches of wedge brick where arches are required for door openings. Line doors exposed to furnace radiation for full depth of door with plastic refractory properly fastened to door. Caulk expansion joints with temperature resisting caulking material at points where setting joins parts of boiler. Provide air passages in insulated walls or brick work required for the stoker.

2.2.3.5 Baffles

When provided, baffles shall be properly located and practically gastight. Maximum velocity at end of baffle where gas turns shall be 17 meter 55 feet per second, except at baffle above rear pass hopper where maximum velocity shall not exceed 12 meter 40 feet per second.

2.2.3.6 Casing

****

NOTE: Designer shall fill in this blank depending on type of air pollution equipment and maximum pressure possible to be exerted on boiler casing by induced draft fan. Do no use less than 4980 Pa 20 inches of water gage.

****

Provide the entire setting, other than the top half of the steam drum with a continuously welded tight skin steel casing of not less than 10 gage, or an integral wall construction with outer casing of not less than 12 gage construction. Weld other steel casing joints where practicable, and reduce the number of bolted joints to a minimum. In places where sections of the casing are subject to removal periodically for inspection and maintenance, the casing shall be bolted using 18 mm 5/8 inch bolts on not more than 76 mm 3 inch centers with joints gasketed. Design the steel cased settings to withstand an internal negative or positive pressure of not less than the maximum static pressure generated by the boiler fans at shutoff and test block, plus a 25 percent safety factor without objectionable deflection of sides, or damage to side walls, casing, or refractory materials, or other parts of the unit. The minimum design pressure shall be a [_____] Pa inch water column. Make proper provisions for expansion and contraction of the casing without creating breakage or air leaks. With a surface wind velocity of 0.07 meter 2 feet per second, the average surface temperature of the casing shall not exceed 66 degrees C 150 degrees F while the boiler is operated at full rated load in an ambient temperature of 38 degrees C 100 degrees F. Finish the top half of the steam drum with 16 gage welded steel casing, as previously specified for the setting.

2.2.3.7 Access and Observation Doors

a. General: Provide boiler with a sufficient number of access and observation doors, to give free and easy access and observation to parts of the interior of the boiler.

b. Access and Cleaning Doors: Provide a minimum of [_____] by 450 mm 18 inch access and cleaning doors to give free and easy access to parts of the interior of the setting and the convection section of boiler.

Brick up the furnace access door openings with No. 1 firebrick or firebrick tile properly held in place, between door and furnace.

****

NOTE: At the text below, consider that access is essential to all spaces between boiler tube banks, the convection section, and on both sides of baffles within these spaces. Consider access door under burner box when oil fired.

****

c. Observation Doors: Provide boiler with not less than [_____] by 250 mm 10 inch observation doors and [_____] 100 by 100 mm 4 by 4 inch peep doors.

****

NOTE: At the text below, do not specify less than 8 observation doors and consider using more when it is desired. On traveling grate stokers an observation door should be located above each air zone on both sides of the boiler which will probably result in using a greater number of observation doors.

****

d. Door and Opening Frames: Frames and front plates for openings for doors, soot blowers, overfire air openings, and other such items, in the pressure parts shall be completely gastight and airtight. Doors shall close against planed seats or the equivalent and shall be provided with heavy latches. Anchor door frames securely. There shall be no air leaks between door frames and setting.

2.2.3.8 Draft Connections

Provide draft connections through setting and steel casing for draft and airflow connections for combustion control and metering. Provide draft connections for measuring furnace draft, boiler outlet gas pressure, [and] economizer outlet gas pressure, [and fly ash collector outlet gas pressure]. Provide other openings as required for temperature elements and other combustion control and metering items in accordance with ABMA Boiler 103, recommended standard instrument connections unless otherwise specified.

Connection	Minimum Size
Thru setting	50 mm
Flue gas	25 mm
Air ducts (windbox)	25 mm

Connection	Minimum Size
Thru setting	2 inches

Connection	Minimum Size
Flue gas	1 inch
Air ducts (windbox)	1 inch

2.2.4 Support and Framing

a. Support the boiler entirely independent of the casing and tile work, in a manner that will allow for expansion and contraction without straining part of boiler or affecting the setting. Support boiler and stoker entirely on structural steel work extending down to foundations as indicated.

****
NOTE: At the text below, provisions must be made for adequate boiler foundations based on soil conditions at each plant location. Foundations should be typically detailed on the drawings.
****

b. Provide structural steel columns and beams to support the boiler [_____], [_____] [and] [stoker] [and the boiler operating floor adjacent to the boiler,] [walkways, and platforms] [as indicated]. Size steel to support the equipment dead loads imposed, plus a minimum live load of 976 kg 200 pounds per square meter foot.

****
NOTE: Designer should include here any provisions where boiler steel is to serve as support for portions of building, or equipment.
****

[c. Boiler manufacturer shall furnish a drawing showing the magnitude and location of the loads imposed by the equipment and structural steel on the building structural steel.

] d. Provide anchor bolt setting plans along with anchor bolts with nuts and sleeves that shall be set in concrete for attachment in support of boiler and allied equipment. Provide bolts and nuts as required for items furnished.

2.2.5 Boiler Hoppers

2.2.5.1 Rear Pass Hoppers

****
NOTE: Delete bracketed portions with cinder return (fly ash reinjection) when a cinder return system will not be incorporated into the project.
****

Provide rear pass hoppers at the rear of the stoker or boiler setting. Construct hoppers of 6 mm 1/4 inch thick welded steel plate as approved. Hoppers shall have minimum storage capacity based on 8 hours of operation at full load with no cinder return (fly ash reinjection) and shall have 200 mm 8 inch diameter outlets with standard flanges on the bottom of the hoppers. [Coordinate hoppers and hopper outlet flanges with overfire

air-cinder return reinjection system furnished by the stoker manufacturer.] Provide insulation and lagging for the hoppers as specified for the boiler.

2.2.5.2 Plenum Chamber

Enclose the underside of the grates so as to form a plenum chamber and not permit any leakage of siftings onto the floor. Provide this chamber with a single hopper complete with access door and supporting steel. Provide manually operated double leaf stoker blast gates at duct connection to plenum chamber. Provide an 200 mm 8 inch diameter outlet with standard flange on bottom of the hopper.

2.2.5.3 Ash Storage Hopper

Hopper is specified under the paragraph ASH HANDLING EQUIPMENT in this section.

2.2.6 Boiler Trim

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

2.2.6.1 Boiler Blowoff Valve

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

a. Steel gate, globe and angle valves: ASME B16.34.

b. Safety, relief, and safety relief valves: MIL-DTL-18436.

2.2.6.2 Steam Gage

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

Provide a 300 mm 12 inch diameter indicating steam gage with chromium plated trim and zero to [_____] kPa (gage) psig scale. Gage shall be complete with siphon, valve, piping, and fittings to properly connect same. Gage shall be flush mounted on a 368 mm 14 1/2 inch square by 5 mm 3/16 inch thick steel plate. Provide plugged tee connection for connection to remote steam gage.

2.2.6.3 Water Column

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

and water column gage glass with plug-in type valves accessible from operating floor. Provide plugged, screw-in type connections in water column piping to accommodate a remote level indicator. Provide gate valves immediately below water column and gage glass. Provide a suitable lamp fixture to illuminate water column.

2.2.6.4 Safety Valves

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

2.2.6.5 Non-Return Valve

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

2.2.6.6 Blowoff Connections

Bottom drum blowoff connection on boiler shall be [_____] mm inch diameter and extended to outside of setting terminating with Class 250, tandem iron body, flanged blowoff valves, and shall be in accordance with ASME BPVC SEC I, Art. PG-59. Boiler water wall blowoff connections and economizer inlet pipe blowoff shall be 40 mm 1 1/2 inch diameter and extended to outside of setting and equipped with same type valves. Provide stop valves for water column blowoff connections.

2.2.6.7 Miscellaneous Stop Valves

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

2.2.6.8 Tube Cleaner

Provide one tube cleaner suitable for cleaning tubes of the boiler. Tube cleaner shall operate on water at 1034 kPa (gage) 150 psig pressure. Tube cleaner shall be complete with one motor, one wrench, one cutter head assembled, one universal coupling for cutter head, two sets of cutters, two sets of cutter pins, one set of arm pins, one set of keeper pins, one brush with a set of refills, one tool box, and two 15 meter 50 foot lengths of heavy duty hose with 20 mm 3/4 inch diameter pipe connections.

2.2.6.9 Wrenches

Provide special wrenches required for proper maintenance of equipment.

2.2.7 Boiler Limit Interlocks

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

2.2.8 Sootblowers

Provide the boiler [and] [economizer] [and air preheaters] with a sootblowing system using [steam] [compressed air] for removing the deposits of soot and fly ash from the heat transfer surfaces. Sufficient number of blower elements shall be provided to adequately clean the heat transfer surfaces. Fixed position, multi-nozzle rotating elements may be provided in applications where flue gas temperatures do not exceed 982 degrees C 1800 degrees F. Retractable soot blowers shall be provided where flue gas temperatures exceed 982 degrees C 1800 degrees F.

2.2.8.1 Fixed Position Soot Blowers (Steam)

Soot blowers shall be steam, fixed position, multi-nozzled, rotating, valve-in-head type with electric motor operation to permit the proper cleaning of the heat transfer surfaces with cam operated valves arranged to automatically open the steam valve through the proper arc of rotation. Cams shall be adjustable to give the proper operating arc or shall be specifically designed for each location. Furnish and install soot blowers complete, including valve-in-head blower heads, wall sleeve bushings, high temperature elements, low temperature elements, [_____] volt, [_____] Hz., [_____] kW hp motor operators, hand operated drain valve, with drilled orifice and disc to prevent tight shutoff, element supports, clamps, bolts, and other such items. Furnish necessary piping and valves including drainlines, shut-off valves, piping supports and insulation. Weld soot blower piping and fittings. No screwed piping or fittings will be permitted. Blower elements shall be carefully installed to avoid rubbing on tubes which would cause eventual tube failure. Scavenging air connections from forced draft fan shall be provided where required to protect blowers in non-blowing position. Provide a single control station containing start and stop pushbuttons and necessary relays to control the motor operators.

2.2.8.2 Fixed Position Sootblowers (Air Puff)

Sootblowers shall be air puff type, fixed position, multi-nozzled rotating element type complete with air master controller for each boiler, entirely air-operated and designed for controlled automatic sequential operation. Units shall be operated in such a manner that air issues from the element in a series of sustained high pressure puffs of approximately one second duration each. During each puff, the element shall be rotated through a predetermined and measured short arc (17 1/2 degrees) by means of a ratchet mechanism in the sootblower head. Between each puff, no air shall flow through the blowers and there shall be sufficient time for the system to be restored to full pressure. When the blowing cycle has been completed, the controller shall automatically stop the sequence. Provide sootblowers complete with wall sleeve bushings, element supports, clamps bolts and other required components. Provide necessary piping and valves, including shutoff valves, piping and supports. Weld sootblower piping and fittings. No screwed piping or fittings will be permitted. Carefully install blower elements to avoid rubbing on tubes which would cause eventual tube failure.

2.2.8.3 Retractable Sootblowers

Provide in lieu of fixed position type and where flue gas temperatures exceed 982 degrees C 1800 degrees F. Sootblowers shall be [air] [electric] motor operated. Rotation of the blower shall be continuous

from the moment the lance begins to extend. Rotating and traversing speeds shall be independently adjustable by changing sprockets. Blowers shall be complete with heavy steel housing, outside adjustment of nozzle pressure, alloy lance, wall sleeve, supports, and other necessary appurtenances required for a completely workable system.

2.2.8.4 Elements

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

2.2.8.5 Control

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

2.2.8.6 Control for Sootblowing System

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

2.3 ECONOMIZER

Provide economizer [separate from the boiler] [integral to and within the boiler setting]. Economizer shall be of the [bare tube] [cast iron fin covered steel tube] design complete with feedwater piping between economizer and boiler drum. Economizer shall be constructed in accordance with the requirements of ASME BPVC SEC I meeting the design and operating conditions as specified for the boiler and bearing the ASME Code symbol stamp. Economizer shall be suitable for the operating conditions and the fuels specified. Materials provided shall withstand temperatures and pressures prevailing under maximum load conditions. Economizer casing, insulation, and lagging shall be specified for the boiler.

2.3.1 Accessories

Provide the following accessories and equipment for each economizer.

a. Sootblowers of the same manufacturer and construction as sootblowers to be provided for boilers;

b. Stack temperature control with sensor and motorized feedwater temperature control valves to function to limit flue gas temperature to a minimum of [_____] degrees C F by modulating feedwater to the bypass;

c. Temperature and pressure indicators on feedwater outlet;

d. Temperature and pressure indicator on feedwater inlet;

e. Temperature and pressure indicator on flue gas outlet;

f. Temperature and pressure indicator on flue gas inlet;

g. Manual shutoff and bypass piping and valving;

h. Low point drain pipe complete with two blowoff valves as specified for the boiler; and

i. Audible alarm with silencing switch and indicating lights for high feedwater exit temperature, low feedwater exit temperatures, low or high flue gas exit temperature, low feedwater entrance temperature or pressure.

2.4 COAL GRATE STOKERS

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NOTE: Choose from either the paragraphs and subparagraphs below TRAVELING GRATE COAL STOKER or the paragraphs and subparagraphs TRAVELING GRATE SPREADER COAL STOKER that follow it.

****

[2.4.1 Traveling Grate Coal Stoker

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NOTE: Designer shall select type of stoker most suited for each project. Stoker Selection Criteria is shown in NAVFAC Design Manual DM-3.6, Table 12.

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NOTE: When the boiler is not part of this project insert Coal Analysis at end of this paragraph.

****

Stoker shall be of the bar and key traveling grate type arranged for rear ash discharge. Stoker shall be capable of continuous operation at such rate as required for the continuous output of not less than that specified for the boiler and shall satisfactorily provide for automatic operation, by means of combustion control system, within the range given when burning the specified coal and operated in accordance with instructions supplied by the manufacturer. Obtain satisfactory operating conditions throughout the full operating range of the stoker. The stoker shall be considered as an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service conditions together with requirements of tests, performance guarantees and other warranties specified for the boiler. Coal analysis shall be as specified in the Coal Analysis Schedule for the boiler. The gate moving mechanism shall be positive, up and down, and equipped with suitable operating mechanism for manual control. Provide an indicator to show the vertical position of the gate and the thickness of the fuel bed.

2.4.1.1 Stoker Grate Heat Release Rate

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NOTE: Normally the stoker grate heat release will be 1417 kW per square meter 450,000 Btu per square foot per hour when coal meeting the criteria set out

in the Stoker Selection Criteria shown in NAVFAC Design Manual DM-3.6, Table 12 is used. When coal is specified which does not meet this criteria then the grate heat release will have to be lowered accordingly.

****

Not greater than [_____] kW per square meter Btu per square foot per hour at the specified maximum continuous rating for the boiler. The square meter feet of projected grate area shall be the product of the length measured between the inside of the coal gate and the centerline of the rear shaft or return bend and the width of the grate.

2.4.1.2 Construction

a. Fuel Feed Control: Control fuel feed to the stoker by the stoker speed and the vertical position of the coal regulating gate. Coal gate to vary the thickness of the fuel bed shall be of heavy cast iron with refractory facing to protect it from the furnace heat. The gate moving mechanism shall be positive, up and down, and equipped with suitable operating position of the gate and the thickness of the fuel bed.

b. Coal Hopper: Provide a coal hopper of 6 mm 1/4 inch thick Type 304 or 316 stainless steel plate at the front of each stoker. The capacity of the hoppers shall not be less than [_____] cubic meters feet.

c. Stoker Front Enclosure: Provide stoker fronts with dust tight enclosures of not less than 10 gage plate to eliminate dust from the boiler room and prevent air infiltration to the grate. Fit these fronts with access doors.

d. Air Plenum (Siftings Hopper) and Ducts: Provide an undergrate air plenum and air ducts for the stoker which will receive air from the forced draft fan. Plenum and air ducts shall be not less than 10 gage steel plate. Provide concrete ducts or airways along the sides of the setting when adaptable to use by the stoker submitted. Provide ducts in accordance with drawings and requirements furnished by the stoker manufacturer. Provide unit with necessary observation doors or ports of the self-closing glass-covered type for side walls, including a minimum of four for observing the underside of the grate.

e. Stoker Air Zones: The stokers shall have not less than [_____] air zones with individual control to each zone in order to provide optimum control of combustion conditions for loads within the specified range and shall be so arranged that a positive air seal will be formed between each zone. Design the zones to provide removal of siftings. To ensure proper air distribution to each zone, provide an air control valve or damper for each zone. Control valves or dampers shall be hand controlled and shall be accessible for instant adjustment by the operator from the side of the stoker. Provide each zone with a pipe opening for a draft gage connection and provide connection in the overfire air duct for the same purpose.

f. Stoker Grate: Mount the traveling grate stoker grate keys (clips) on carrier bars supported from an endless heat treated type steel chain. Provide wearing shoes on the carrier bars to carry the grate weight on skid rails extending the length of the furnace. The chain links shall mesh with the shaft sprockets transmitting the driving force to

the endless chain. Grate keys (clips) shall be chrome alloyed cast iron to resist growth. Links shall be uniform. Grates shall be made of the best quality, heavy duty, heat resisting, cast iron or cast alloy carefully cast to minimize initial strain. The sifting hoppers and removal system shall be so arranged that siftings may be removed from zones.

g. Grate Thermocouples: Provide two grate temperature sensing thermocouple arrangements on each grate to indicate and record grate temperatures on the operator's [interface console] [control panel].

h. Tension Adjustment: Provide a conveniently located adjustment accessible from outside of the boiler or through access plates in the stoker front cover for regulating the tension of the grate. Provide adequate adjustment for the chain length.

i. Stoker Seals: Provide the stoker with seals between the bottom of the sidewall header and the frame. Provide restraints in the boiler setting to prevent seals at rear of stoker from opening up.

j. Stoker Support: Stoker and drive shall be complete with supporting structural steel framework. Locate and protect structural supports so that they will not be overheated or damaged by heat from either the furnace or ash pit.

k. Grate Return Run Support: Adequately support the lower return run of the grate on a system of cross members and longitudinal members or skids. Provide an air seal between this lower drag frame and ash pit and siftings hopper.

2.4.1.3 Grate Ash Discharge Enclosure

Enclose rear end of grate, where ash is discharged into the hopper below the floor line, with a dust tight enclosure made of heavy steel plates properly protected with fire brick where exposed to the furnace. Fit vertical ends of this enclosure with cast iron, refractory lined inspection and access doors, one for each feeder. Seal off roof of this enclosure with refractory, protecting metal parts from the furnace temperature with refractory. Exposed metal parts in the enclosure are not acceptable. Enclosure shall be compatible with the ash storage hopper as specified under the paragraph ASH HANDLING SYSTEM in this section.

2.4.1.4 Stoker Grate Drive

Drive the grate of the stoker through hydraulic drive, or with electrical motor and transmission equipment as specified below. Drive shall have a variable speed ratio of not less than six to one with the speed changing device, controlled automatically by the combustion control system. Provide a manual and reversing adjustment so the grate speed can be operated independent of the combustion control system. Provide adequate safety release to prevent damage to the drive or grates due to foreign material or jamming of the grates. Provide the front and rear shafts of the grates with an adequate lubrication system with fittings located on the outside of the setting.

a. Electric Motor: Motor shall be [_____] volt, [_____] phase, [_____] rpm, 60 Hz, totally enclosed, fan cooled, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

b. Mechanical Drive: Mechanical drive shall include variable speed transmission with gears and chains, enclosed in an oil tight case, and running in a bath of oil. Bearings shall be of the anti-friction type, with hardened inner and outer races and fitted with forced lubrication fittings.

c. Hydraulic Drive: Hydraulic drive shall include a complete hydraulic system with adequately sized reservoir, dual pumps, oil piping to and from drive, control and isolating valves, oil cooler, when required, with self-operated cooling water control valve, oil temperature indicator, and other accessories for a complete, satisfactory operating system.

2.4.1.5 Miscellaneous Equipment

Provide shafting, couplings, bearings, drives with guards, linkages, rods, and other miscellaneous equipment from the stoker manufacturer required or necessary for interconnecting of the stoker units and drives necessary for a complete operating system. Provide equipment even though it is not specifically mentioned herein. Gears, chains, belts, couplings, and other moving parts shall be properly enclosed or guarded.

2.4.1.6 Lubrication

The entire stoker mechanism shall have adequate provisions for proper lubrication where required and shall be equipped with conveniently located fittings for this purpose.

2.4.1.7 Overfire Air System

Provide an overfire air system from the stoker manufacturer to ensure good ignition at the stoker front and adequate control of smoking. System shall include necessary nozzles, ducts, and overfire air fan with motor drive. When more than one row of nozzles is supplied, provide individual air volume control for each row or set as required. Locate nozzles or protect them with shields so as to prevent plugging of the nozzles in service. Nozzles shall be constructed of materials suitable for service at maximum temperatures anticipated. Provide necessary arrangements to the water wall tubes, arch construction, refractory, insulation, and casing from the boiler manufacturer, to permit installation of an adequate overfire air system. Overfire system shall be capable of providing a minimum of 15 percent of total combustion air at the required static pressure.

][2.4.2 Traveling Grate Spreader Coal Stoker

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NOTE: Choose this paragraph and its subparagraphs or the paragraphs and subparagraphs above, TRAVELING GRATE COAL STOKER.

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NOTE: When the boiler is not part of this project insert Coal Analysis at end of this paragraph.

****

Stoker shall be of the overfeed, synchronized, self-feeding, spreader stoker type with continuous cleaning forward moving bar and key grates

suitable for burning a portion of the coal in suspension and burning the balance on the grates. Stoker shall be capable of continuous operation at such rate as required for the continuous output of not less than that specified for the boiler, and shall satisfactorily provide for automatic operation by means of the combustion control system, within the range given when burning the specified coal and operated in accordance with instructions supplied by the manufacturer. Stoker shall be considered an integral part of the steam generator and shall be subject to all applicable provisions of the boiler design and service conditions together with requirements of tests, performance guarantees and other warranties specified for the boiler. Coal analysis shall be [as specified in the Coal Analysis Schedule for the boiler] [as listed below].

2.4.2.1 Stoker Grate Heat Release

****

NOTE: Normally the stoker grate heat release will be 2205 kW per square meter 700,000 Btu per square foot per hour when coal meeting the criteria set out in the Stoker Selection Criteria shown in NAVFAC Design Manual DM-3.6, Table 12 is used. When coal is specified which does not meet this criteria then the grate heat release will have to be lowered accordingly.

****

The active grate area shall be such that the heat release at the maximum continuous rating shall not exceed [_____] kW per square meter Btu per hour per square foot. At minimum boiler rating the stoker grate heat release shall be a minimum of [2280] [2850] MJ per square meter [200,000] [250,000] Btu per square foot; this results in a guaranteed turndown ratio of [_____] to 1. Grate area shall be the product of the width between the inside faces of the sidewall heaters at the grate line and the length of the air-supplied grate area. The grate shape shall be designed so that the heat release per front meter foot of stoker width does not exceed 2930 kW 10,000,000 Btu/hour at the maximum continuous boiler rating.

2.4.2.2 Construction

a. Fuel Feed Control: Coal shall be fed to and distributed in the furnace by not less than three overfeed type spreader stoker feeders for each boiler. Feeders shall be operated simultaneously and at synchronized speeds so that any one feeder may be taken out of service without affecting the operation of the others. Each feeder shall be readily adjustable to ensure proper fuel distribution within the furnace. Design and size the total combined width of the feeder openings for proper distribution of the fuel over the width of the stoker grate. Design shall be such that the combined width of the feeders shall not be less than 40 percent of the width of the stoker grate. The feeders shall be capable of handling and uniformly distributing coal varying in size from 6 to 32 mm 1/4 to 1 1/4 inches with no more than 40 percent passing a 6 mm 1/4 inch round mesh over the entire grate area. The feeder shall be capable of properly performing with moisture in the fuel as high as 15 percent by weight. Materials of construction shall be such that coal with high sulfur content can be satisfactorily used without extensive corrosion over the lifetime of the parts. Provide moving parts of the feeders with anti-friction type bearings and with a forced system of lubrication. Bearings subject to high temperatures shall be water

cooled. Gear teeth shall be machine cut.

b. Coal Hopper: Provide a metal hopper for each spreader stoker feeder. Hoppers shall be not less than 6 mm 1/4 inch thick 304 stainless steel plate, rigidly reinforced and connected to the coal grates. Support hoppers from the floor or boiler columns to eliminate weight on the feeders. Provide hoppers with suitable cleanout doors located in the front.

c. Air Plenum (Siftings Hopper) and Ducts: The traveling grate/stoker shall be complete with under grate air plenum, manually operated blast gates and operating handles, and siftings hopper. Plenum and air ducts shall be not less than 10 gage steel plate. Locate and protect structural supports so that they will not be overheated or damaged by heat from either the furnace or ash pit. Provide unit with necessary observation doors or ports of the self-closing glass-covered type for side walls, including a minimum of four for observing the underside of the grate.

d. Stoker Grate: Grates shall be made of the best quality, heavy duty, heat resisting, cast iron or cast alloy carefully cast to minimize initial strain. Specially design the grates for spreader stoker firing. Grates shall be of high resistance, air metering type with closely and uniformly spaced self-cleaning air openings. The grates shall have close fitting, overlapping edges to prevent air leakage at the joints. Provide undergrate air seals at both the front and rear ends fabricated of cast iron and counterweighted so that they will always be in close contact with the under sides of the grates. Construct the rear seal to proportion the air flow through the rear end of the grate to expedite coking and ignition of the coal, thereby properly conditioning it for efficient combustion when the fuel bed reaches the active air admitting area. Side seals between edge of stoker grate and boiler shall be approved bellows type.

e. Grate Thermocouples: Provide two grate temperature sensing thermocouple arrangements on each grate to indicate and record grate temperatures on the operator's [interface console] [control panel].

f. Tension Adjustment: Provide a conveniently located adjustment accessible from outside of the boiler or through access plates in the stoker front cover for regulating the tension of the grate. Provide adequate adjustment for the chain length.

g. Stoker Support: Stoker and drive shall be complete with supporting structural steel framework. Locate and protect structural supports so that they will not be overheated or damaged by heat from either the furnace or ash pit.

2.4.2.3 Grate Ash Discharge Enclosure

Enclose front end of grate, where ash is discharged into the hopper below the floor line, with a dust tight enclosure made of heavy steel plates properly protected with fire brick where exposed to the furnace. Fit vertical fronts of this enclosure with cast iron, refractory lined inspection and access doors, one for each feeder. Seal off roof of this enclosure with refractory, protecting the metal parts from the furnace temperature with refractory. Exposed metal parts in the enclosure are not acceptable. Enclosure shall be compatible with the ash storage hopper as specified under "Ash Handling System" this section.

2.4.2.4 Feeder Drives

At the option of the Contractor, the drives shall be either individually driven and controlled feeders or feeders driven by a line shaft with individual clutch arrangements.

a. Controlled Feeders: The individually driven and controlled feeders shall have a variable speed drive on each distributor and a silicon controlled rectifier (SCR) D.C. motor drive for each drum or feed box. A master controller shall receive a fuel demand signal from the combustion control system and control the individual slave controllers of the individual SCR units to satisfy the particular fuel demand. Control arrangement shall provide for simple adjustments between feeders for equal fuel delivery and also for single feeder biasing.

b. Line Shaft Feeder: The feeders driven by a line shaft shall be driven through a variable speed drive having a ratio of not less than three to one. Feeder drive shall be so arranged that each feeder is independently driven from a lineshaft so that any feeder can be engaged or disengaged without disturbing the operation of the remaining feeders. Fuel delivery shall be governed by the combustion control system.

c. For either stoker drive system, provide a complete operating unit with necessary shafting, couplings, bearings, drives with guards, linkages, rods, and other equipment, as required or necessary for any interconnecting of the stoker units and drives. This equipment shall be provided even though it is not specifically mentioned. Provide safety release to prevent damage to the units due to foreign materials in the coal or other causes of overload.

d. Distributor: The distributor shall be driven by a variable speed electric drive which is manually adjusted to achieve optimum distribution.

2.4.2.5 Stoker Grate Drive

Drive the grate the stoker by [hydraulic package] [electrical motor] [a steam turbine] through a variable speed device with a speed ratio of at least six to one, with the speed changing device, controlled automatically by the combustion control system. Provide a manual adjustment to regulate grate speed ratio to fuel feed in order to compensate for variations in the ash content. Provide a suitable safety release device to prevent damage to the drive or grates due to foreign material or other obstruction interfering with the grate operation.

****

NOTE: Make heat balance to determine whether it is more economical to use turbine drives rather than electric motors.

****

a. Electric Motor: Motor shall be [_____] volt, [_____] phase, [_____] rpm, 60 Hz, totally enclosed, fan cooled, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

b. Steam Turbines: Drive shall be by steam turbine conforming to NEMA SM 23 as modified below. Turbine shall be noncondensing capable

of producing braking power [_____] kW horsepower at [_____] rpm at a steam rate of not more than [_____] kg pounds per brake power hour. Inlet steam condition, upstream of built-in governor, shall be [_____] kPa (gage) psig and [_____] degrees C F. Exhaust steam conditions at exhaust nozzle shall be [_____] kPa (gage) psig. Turbine rotation shall be [clockwise] [counterclockwise] and shall be [direct connected] [geared] to the driven piece of equipment which shall operate at [_____] rpm. Piping connections 50 mm 2 inches and smaller shall be screwed. Connections 65 mm 2 1/2 inches and larger shall be flanged. Inlet flanges shall be raised face suitable for the inlet pressure specified. Exhaust flanges shall be Class 125 or Class 150 flat-faced flanges. Turbine shall be complete with insulation and lagging. Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Turbine governor shall be of direct oil relay type with 10 percent adjustable speed range. Lubrication shall be of the manufacturer's standard non-pressure type.

[c. Mechanical Drive: Mechanical drive shall include variable speed transmission with gears, worm drives and bearings, enclosed in an oil tight case, and running in a bath of oil. Bearings shall be of the anti-friction type, with hardened inner and outer races and fitted with forced lubrication fittings.

][d. Hydraulic Drive: Hydraulic drive when required shall include a complete hydraulic system with adequately sized reservoir, dual pumps, oil piping to and from drive, control and isolating valves, oil cooler, when required, with self-operated cooling water control valve, oil temperature indicator, and other accessories for a complete, operating system. Hydraulic drive system motor, shall be [_____] volt, [_____] phase, 1200 rpm, 60 Hz totally enclosed, fan cooled, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

] e. Miscellaneous Equipment: For a stoker drive system, provide a complete operating unit with necessary shafting, couplings, bearings, drives with guards, linkages, rods, and other equipment, as required or necessary for any interconnecting of the stoker units and drives. This equipment shall be provided even though it is not specifically mentioned herein. The front and rear shafts of the grate are to be fitted with a forced system of lubrication with fittings located on the outside of the setting. The devices for changing the speed ratio of the grate drives shall be connected to the fuel feed regulation system, so both fuel feed and grate speed can be synchronized and controlled automatically by the combustion control system. A manual adjustment shall be provided to regulate grate speed ratio to fuel feed in order to compensate for variations in ash content of the fuel. A suitable safety release device shall be provided to prevent damage to the drives or grates, due to foreign material or other obstruction interfering with the grate operation. Gears, chains, belts, couplings, and other moving parts shall be properly enclosed or guarded.

2.4.2.6 Overfire Air System

****

NOTE: Designer should include bracketed sentence when cinder return (fly ash reinjection) will not be incorporated in the project.

****

Provide a high pressure overfire air system for each stoker, including fan, [motor drive,] ductwork, dampers and nozzles. The fan shall have a capacity of not less than 15 percent of the total air required at maximum steaming capacity when operating at the predicted amount of excess air in the furnace. Static pressure of the fan shall be sufficient to ensure full penetration of the furnace by the air jets, but not less than 6225 Pa 25 inches of water. Overfire air distribution nozzles shall be fabricated from heat resistant alloy. Locate air jets properly and in sufficient numbers to create proper furnace turbulence for complete combustion at all ratings. Make modifications and additions to the system to ensure penetration and turbulence of areas of the furnace as required after startup. [There will be no cinder return system incorporated in the overfire air system.]

****

NOTE: At the text below, delete the following paragraph on pneumatic cinder return (fly ash reinjection) system when this system will not be incorporated in the project.

****

[a. Cinder Return System (Fly Ash Reinjection): Provide a pneumatic cinder return system to reinject collected fly ash and unburned combustibles into the furnace. The system shall operate in conjunction with the overfire air system and shall be complete with necessary air lines, nozzles, ducts, and dampers for returning the cinders from the rear convection pass hopper of the boiler and the economizer soot hopper or air heater hopper. Cinder return lines, shall be constructed of abrasion-resistant iron having a Brinnell hardness of not less than 350, with the exception that the straight conveyor lines, starting at a point not less than 600 mm 2 feet downstream from each cinder pickup nozzle or elbow extending to within not less than 600 mm 2 feet of the furnace, may be constructed of extra strong Schedule 80 steel pipe. Provide glass viewing ports at the end of each cinder return line so that interior of lines are visible all the way through to furnace.

]]2.5 OIL BURNER/WINDBOX PACKAGE

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NOTE: Choose this paragraph and its subparagraphs when oil is used.

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

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

2.5.1 Burner

2.5.1.1 Burner Characteristics

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

2.5.1.2 Atomization

****

NOTE: Burners may be air atomizing or steam atomizing. When a separate compressed air system is used the designer shall fill in blanks with the quantity and pressure of compressed air that will be available for fuel oil atomization. The designer should allow for an adequate amount of atomizing air. Atomizing air requirements will vary depending on many factors including burner design, fuel oil characteristics, fuel oil pressure, air pressure and even furnace conditions. See NAVFAC Design Manual DM-3.6 for empirical information.

****

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

2.5.1.3 Electric Ignition System

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

2.5.1.4 Windbox

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

2.5.1.5 Purge Connection

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

2.5.1.6 Aspirating System

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

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

2.5.1.7 Guide Pipe Purge

Provide piping and flexible hoses for the guide pipe purge and aspirating systems. Air from the forced draft fan shall be provided for guide pipe purging during normal operation.

2.5.1.8 Metal Parts

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

2.5.1.9 Fuel Oil Control Valve

Fuel oil will be supplied at [_____] kPa (gage) psig and [_____] degrees C F at the inlet of the fuel piping train. Size fuel oil automatic control valve for 103 kPa 15 psi differential pressure as specified in VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.5.1.10 Fuel

ASTM D396, Grade no. [_____].

2.5.1.11 Forced Draft Fan

****
NOTE: The designer shall make a technical evaluation to determine when the forced draft fan should be integrated with or mounted separately from the windbox on the floor next to the boiler. When the forced draft fan is to be mounted separately, delete this paragraph and specify the fan in the paragraph FANS.
****

Fan shall be fully integrated with and mounted on the windbox. Provide an inlet silencer, when required, to ensure operation at noise level below 85 dBA as specified in Section 22 05 48.00 20 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL.

2.5.1.12 Electric Motor

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

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

2.5.2 Flame Safeguard Controls

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

2.5.2.1 Fuel Oil Train

Provide fuel oil train consisting of [steam] [air] atomizing oil gun, auxiliary [steam] [air] atomizing oil gun for changing guns without a shutdown, fuel oil control valve, two safety shutoff valves recirculation valve, strainer, and flexible hose connections to oil burner package the following gages. Gages shall be 150 mm 6 inch with white coated dials and black figures:

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

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

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

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

]2.5.2.2 Control Sequencing

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

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

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

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

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

(1) Flame failure

(2) High boiler outlet pressure

(3) Low fuel oil pressure

(4) Low water level cutout

(5) Low combustion air flow

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

(7) Any additional devices as required by FM or NFPA

[(8) Low fuel oil temperature

] e. Safety system limits specified above shall be displayed on a first out annunciator mounted in the burner panel. [Provide a common alarm contact to be wired to the operator control console, specified under VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.5.2.3 Light Off

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

2.5.2.4 Circuit Analyzer

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

2.5.2.5 Control Panel

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

2.6 FANS

2.6.1 Forced Draft Fan

****
NOTE: The fan type shall be specified in accordance with CID A-A-59222.
****

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

2.6.1.1 Fan Size

Size fans for complete combustion of fuel at maximum firing rate. Maximum fan speed shall not exceed 1800 rpm at test block rating with [10] [20] [40] percent excess air, taking into account design allowances, corrections for burner or stoker pressure drop, furnace pressure,

combustion air temperature, plant elevation, and other design factors. Minimum static efficiency at maximum continuous rating shall be [_____] percent. Add the following allowances for momentary overloads and normal deterioration of fans, firing equipment, and boilers after sizing fans in accordance with the above to obtain the test block rating:

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

2.6.1.2 Fan Construction

Fan shall be arrangement [_____] in accordance with AMCA 801. Fan shall have backward inclined or backward curved single thickness blades. Fan shall have stable characteristics with self-limiting power curve. Construct fan wheel of steel. Balance fan wheel both statically and dynamically at factory. Provide fan with air cooled roller bearings mounted in horizontally split pillow blocks. Fan housing shall be welded constructed of a minimum of 12 gage steel. Provide flanged inlet and outlet connections, 50 mm 2 inch plugged opening in low point of scroll and hinged, quick opening access door in scroll. Provide a multi-blade vortex ball bearing damper in fan inlet with an extended, ball bearing mounted control lever for field connections to control actuator. Interior of fan, including wheel, shall be painted with two coats of red primer and one coat of rust resistant enamel with a total dry film thickness of 0.152 mm 6 mils. Exterior surface of the fan shall have two coats of red primer with a total dry film thickness of 0.10 mm 4 mils. Cleaning and painting shall be in accordance with the manufacturer's standards.

2.6.1.3 Fan Drive

Equip fans with [both] [a motor] [and] [steam turbine] drive. The [motor] [and] [turbine] shall be direct connected to the fan [with a gear type flexible coupling] [with a roller type, hardened steel clutch coupling consisting of an over-running clutch and double flexing coupling to permit instantaneous change-over from one drive to the other. One clutch coupling shall be provided between the fan and each driver. Clutch couplings shall be selected for the maximum torque requirement of the fan, with a 1.5 service factor. Provide a removable guard over each clutch coupling].

2.6.1.4 Electric Motor

Motor for driving the forced draft fan shall be [_____] volt, three phase, 60 Hz, [open drip-proof] [totally enclosed fan cooled] [two speed] [variable speed] not less than [_____] kW hp, as specified under MOTORS AND DRIVES in this section, and shall not overload at the specified capacity with unheated cold air. [Fan motor shall be suitable for installation in a hazardous location as defined by NFPA 70.] Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be

common for four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.1.5 Steam Turbine

Steam turbine shall drive the fan through a reduction gear shall be single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig, [_____] degrees C F total temperature and a normal exhaust back pressure of [_____] kPa (gage) psig or a maximum back pressure of [_____] kPa (gage) psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power hour. Maximum turbine speed shall not exceed [_____] rpm.

a. Turbine Construction: Turbine casing split on the horizontal centerline constructed of ASTM A48/A48M cast iron, with design pressure rating of 1724 kPa (gage) 250 psig at 232 degrees C 450 degrees F at the inlet, and 379 kPa (gage) 55 psig at 232 degrees C 450 degrees F at the outlet. Turbine shall also include a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and two hand valves.

b. Turbine Bearings and Shaft: Bearings horizontally split, ring-oiled, sleeve type water-cooled. Shaft shall be stainless steel sprayed or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

c. Speed Governor: Variable speed oil relay NEMA Class [A] [D] governor for speed limiting [and pneumatic operator to maintain an adjustable turbine speed]. [Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal.] [Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller specified in VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.] [Turbine shall go to maximum rated speed on air failure.]

d. Emergency Overspeed Governor: Completely independent of the speed governor and shall operate a separate trip valve.

e. Insulation: Turbine shall be insulated and lagged by the manufacturer as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

f. Reduction Gear: High speed, heavy duty, double helical, full pressure lubricated, horizontal offset type with a service factor not less than 2 provided in a horizontally split casing. The gear and pinion shall be spray lubricated from a pressure lubricating system. The pressure lubricating system shall include a shaft driven oil pump, strainer, cooler, pressure gage, low oil pressure switch, relief valve, reservoir and piping. Provide a high speed, gear type, forge steel coupling between the turbine and the gear. Reduction gear and turbine shall be mounted on a common baseplate.

g. Turbine Trip: Provide solenoid valve to trip turbine on failure of induced draft fan.

2.6.1.6 Noise Level

Noise level shall not exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above the floor and 1 1/2 meters 5 feet from the fan in any direction. [Provide heavy duty sound attenuator with screen on fan inlet

to meet the sound pressure level requirements.]

2.6.2 Induced Draft Fan

****
NOTE: The fan type shall be specified in accordance with CID A-A-59222.
****

CID A-A-59222, Type [_____], Class 2.

2.6.2.1 Fan Size

Size fans to handle combustion gases at maximum firing rate. Maximum fan speed shall not exceed 1200 rpm at test block rating. Design allowances and corrections for furnace, economizer, [scrubber,] [baghouse,] dust collector, breeching pressure drop when operating at [10] [20] [40] percent excess air, flue gas temperature, plant elevation, and other design factors shall be made. Add the following allowances for momentary overloads and normal deterioration of fans, firing equipment and boilers after sizing fans in accordance with the above, to obtain the required test block rating:

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

2.6.2.2 Fan Construction

Fan shall be arrangement [_____] in accordance with AMCA 801. Fan wheel shall be radial tip design (forward curved-backward inclined) or straight radial blade with shrouds for high efficiency design. Blading shall be 8 gage minimum thickness steel [with the addition of 6 mm 1/4 inch thick steel partial blade wear strips, 125 mm 5 inch minimum width each side of centerplate]. A minimum number of blades is preferred; a maximum of twenty-four is acceptable. Balance fan wheels both statically and dynamically at factory. Minimum static efficiency at maximum rating including allowances shall be 67 percent.

****
NOTE: At the text below, heat slingers may not be necessary on low temperature flue gas applications.
****

a. Bearings and Pedestals: Provide fan with water-cooled self-aligning sleeve type bearings mounted in suitable pillow blocks. Bearings shall be independent high temperature, oil lubricated, pedestal type with dust seals. [Provide fan shaft heat slingers.] Cast iron or fabricated steel pedestals mounted on fabricated steel soleplates shall be provided. Provide a self-contained temperature control valve, with water piping to control temperature of bearings.

b. Housing: Fan shall have 5 mm 3/16 inch thick welded steel housing and inlet boxes which shall be split with flanged and gasketed joints. Construction shall permit one piece removal of rotor from rear of fan without disturbing duct connections. Provide hinged, quick opening access door in scroll and inlet boxes and 50 mm 2 inch plugged openings in low points of scroll and inlet boxes.

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

d. Welding: Welding of fan components shall be in accordance with current production standards. High stress fan wheels shall be continuously welded. Low stress exterior housing bracing, dampers, and other similar components shall be intermittently, plug or continuously welded.

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

2.6.2.3 Fan Drive

Fans shall be equipped with [both] [a motor] [and] [steam turbine] drive. The [motor] [and] [turbine] shall be directly connected to the fan [with a gear type flexible coupling] [with a roller type, hardened steel clutch coupling consisting of an over-running clutch and double flexing coupling to permit instantaneous change-over from one drive to the other. One clutch coupling shall be provided between the fan and each driver. Clutch couplings shall be selected for the maximum torque requirement of the fan, with a 1.5 service factor. Provide a removable guard over each clutch coupling].

2.6.2.4 Electric Motor

Motor for driving the induce draft fan shall be [_____] volt, three phase, 60 Hz, [open drip-proof,] [totally enclosed fan cooled,] variable speed not less than [_____] kW hp, as specified under the paragraph MOTORS AND DRIVES in this section, and shall not overload over the range of the fan with unheated air. [Fan motor shall be suitable for installation in a hazardous location as defined by NFPA 70.] Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be common for each of the four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.2.5 Steam Turbine

Steam turbine shall drive the fan through a reduction gear and shall be single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig, [_____] degrees C F total temperature and a normal exhaust back pressure of [_____] kPa (gage) psig or a maximum back pressure of [_____] kPa (gage) psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power

hour. Maximum turbine speed shall not exceed [_____] rpm.

a. Turbine Construction. Turbine casing shall be split on the horizontal centerline constructed of ASTM A48/A48M, cast iron, with design pressure rating of 1724 kPa (gage) 250 psig at 232 degrees C 450 degrees F at the inlet, and 379 kPa (gage) 55 psig at 232 degrees C 450 degrees F at the outlet. Turbine shall include a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and two hand valves.

b. Turbine Bearings and Shaft. Turbine bearings shall be horizontally split, ring-oiled, sleeve type water-cooled. Shaft shall be stainless steel sprayed or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

c. Speed governor variable speed oil relay NEMA Class D governor for speed limiting and pneumatic operator to maintain an adjustable, preset draft pressure in boiler by variation of turbine speed. Input to the operator shall be a 30 to 103 kPa (gage) 3 to 15 psig pneumatic signal. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller specified in VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. [Turbine shall go to maximum rated speed on air failure.]

d. Emergency Overspeed Governor. Completely independent of the speed governor and shall operate a separate trip valve.

e. Insulation. Turbine shall be insulated and lagged by the manufacturer as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

f. Reduction Gear. High speed, heavy duty, double helical, full pressure lubricated, horizontal offset type with a service factor not less than 2 provided in a horizontally split casing. The gear and pinion shall be spray lubricated from a pressure lubricating system. The pressure lubricating system shall include a shaft driven oil pump, strainer, cooler, pressure gage, low oil pressure switch, relief valve, reservoir and piping. Provide a high speed, gear type, forged steel coupling between the turbine and the gear. Reduction gear and turbine shall [each] be provided with a [common] [_____] mm inch thick steel baseplate[s].

2.6.2.6 Noise Level

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

2.7 COMPRESSED AIR SYSTEM

2.7.1 Plant Air Compressor

Provide two plant air compressor systems, each with a compressor, filters, intercooler, aftercooler, accessories, control panel and controls. Provide a receiver for each of the two compressor systems.

2.7.1.1 Air Compressor

****
NOTE: Select standard L/s SCFM of air to compensate for plant elevation.
****

Packaged unit, FS XX-C-2816, as modified below. Each compressor capacity shall be not less than [94] [118] [142] [165] standard L/s [200] [250] [300] [350] scfm of air, at 20 degrees C 68 degrees F and [862] [1379] kPa (gage) [125] [200] psig at the discharge. Compressor speed shall not exceed [_____] rpm. Compressor shall be [belt drive] [direct drive] double acting, two stage, with flange mounted water cooled cylinders and heads. Provide a safety valve between each compressor discharge and its shutoff valve which is required on the discharge piping of the compressor. Provide a full flow type oil filter for positive forced feed lubrication and an electric thermostatically controlled immersion heater. Provide lifting lugs and tie downs.

2.7.1.2 Air Filter

Provide a dry type air filter constructed of pleated filter paper with protective stainless steel cloth on each side. Filter shall also act as a muffler and shall be readily removed for cleaning.

2.7.1.3 Intercooler and Aftercooler

Compressed air intercooler and aftercooler heat exchangers shall each be water cooled, with counter current flow, and shall be integrally mounted with no external air piping between compressor cylinders and cooler. Design heat exchangers to cool the total output air flow of the compressor to within 9 degrees C 15 degrees F of the inlet cooling water temperature. The tube bundles shall be removable for cleaning and inspection.

2.7.1.4 Air Receiver

Vertical tank with a minimum volume of [1585] [1840] [2717] liters [56] [65] [96] cubic feet. Design unit for [1034] [1724] kPa (gage) [150] [250] psig working pressure in accordance with the ASME BPVC SEC VIII. A receiver bearing the ASME Code Symbol stamp will be accepted as meeting these requirements. Provide an automatic condensate trap, safety valve, outlet connection, and a 114 mm 4 1/2 inch pressure gage ([1379] [2068] kPa (gage) [200] [300] psig range).

2.7.1.5 Electric Motor

Motor shall be [totally enclosed fan cooled], [open-drip proof], [_____] kW hp, [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section. Control circuits for motor shall be nominal 120 volts. [Provide removable totally enclosed belt guard.]

2.7.1.6 Controls

Provide controls and shutdowns necessary for automatic operation of the compressor package. House controls in NEMA 12 control cabinet. Controls shall consist of alarm and running lights, push buttons and selection switches for automatic dual control, 120 volt control transformer connected to power circuit serving the compressor, along with necessary

time delay and control relays, and indicators. Provide automatic solenoid-operating cooling

a. Start-and-Stop Control: When set for start and stop control, motor shall stop automatically when discharge pressure reaches maximum pressure setting and start automatically when discharge pressure falls to minimum setting. Cylinders shall unload during periods of motor shutdown.

b. Constant Speed Control: Compressor shall operate continuously at constant speed. Provide means to automatically load and unload compressor at preset minimum and maximum pressure settings respectively. Provide means for automatic release of pressure within cylinders when the unit is operating without load. Also provide means for manual or automatic unloading of cylinders during starting of unit. Equip each compressor with a timed control to stop compressor after a 10 minute unloaded period when air is not used. Compressor shall re-start automatically at a preset minimum pressure.

c. A lead-lag system shall be provided to alternate compressor start-ups and to operate both compressors when discharge pressure cannot be met with one operational compressor. The operator selector switch shall have the following positions:

(1) Both compressors alternating as specified above;

(2) Compressor "A" operation only;

(3) Compressor "B" operation only;

(4) Off.

Total elapsed time shall be recorded for operation time of each compressor.

d. Compressor Safety Controls and Management Panel:

(1) Provide light in panel, alarm and shutdown of compressor for the following functions:

(a) High Main Bearing Temperature

(b) High Discharge-air Temperature

(c) High Discharge-air Pressure

(d) High Water Temperature for [Water Supply,] [Intercooler,] [Aftercooler,] [Lubrication Oil Cooler]

(e) Excessively High Motor Temperature

(f) Excessive Vibration

(g) Low Crankcase Oil Level

(h) Low Oil Pressure

1. Provide light in panel and alarm for the following functions:

a. High Lubrication Oil Temperature
b. Low Suction Pressure (Dirty Filter)

2.7.2 Instrument Compressed Air System

Provide two instrument air compressor systems each with a compressor, filters, aftercooler, accessories control panel, controls and receiver, [mounted on one supporting steel base with skids] [mounted separately].

2.7.2.1 Air Compressor

Each compressor shall deliver a minimum of [_____] std. L/s scfm of air at 20 degrees C 68 degrees F at a discharge pressure of 862 kPa (gage) 125 psig. Compressor speed shall not exceed [_____] rpm. Air compressor shall be belt drive, single stage, crosshead type, vertical, double acting, water cooled, non-lubricated head type. Compressor shall be specially designed for non-lubricated service, with a honed cylinder, piston rod packing, piston rings, and piston wearing rings. Valve guide inserts and wear rings shall be TFE. Valves shall be reversible and hardened, with stainless steel seat plates for nonlubricated service. Provide necessary sleeves, baffles, and collars to prevent oil carryover. Provide air-operated, piston type, free air unloaders for capacity reduction and starting. Mount inlet filter-silencer directly on the air inlet to the cylinder.

2.7.2.2 Aftercooler

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

2.7.2.3 Air Receiver

Horizontal tank with a minimum volume of [_____] liters cubic feet. Design unit for 1034 kPa (gage) 150 psig working pressure in accordance with ASME BPVC SEC VIII receiver bearing the ASME Code Symbol stamp will be accepted as meeting these requirements. Provide an automatic condensate trap, safety valve, and outlet connection.

2.7.2.4 Electric Motor

Motor shall be [totally enclosed, fan controlled], [open drip proof], [_____] kW hp, [_____] volt, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section. Provide a removable, totally enclosed belt guard.

2.7.2.5 Accessories

Factory assemble air compressors, drives, controls, air receiver, aftercoolers, and miscellaneous hardware and mount on a steel supporting base. Provide lifting lugs and tie down attachments. Air, water, and condensate piping shall be provided and terminated at the edge of the supporting base.

2.7.2.6 Controls

Provide controls and shutdowns necessary for automatic operation of the

compressor package. House controls in NEMA 12 control cabinet. Controls shall include alternator control to switch compressors from lead to lag and run both compressors when needed; 120 volt control transformer connected to power circuit of compressor; air discharge pressure gage; selection switches for constant speed for automatic dual control, along with necessary time delay and control relays. Provide automatic solenoid-operated cooling water valve in the cooling water line to the compressors and aftercoolers. Factory wire control cabinet and mount as a part of the package. Compressor safety controls and management panel shall be provided as specified in the paragraph PLANT AIR COMPRESSOR, located in this section.

2.7.3 Air Dryers

****
NOTE: Choose the following subparagraph or the subparagraph COMPRESSED AIR REFRIGERATED AIR DRYER.
****

2.7.3.1 Compressed Air Desiccant Air Dryer

****
NOTE: The refrigerated air dryer is limited with an atmospheric dew point of approximately minus 23 degrees C 10 degrees F equivalent to minus 12 degrees C plus 10 degrees F at 172 kPa (gage) 25 psig and 2 degrees C 35 degrees F at 690 kPa (gage) 100 psig, and where this may be a problem the desiccant air dryer should be used as a much lower dew point can be attained.
****

Provide for systems exposed to freezing temperatures [one] [two] compressed air dual chamber type desiccant dryer[s] each of sufficient capacity for each system listed below. Each dryer shall be equipped with an automatic regeneration system which uses [steam heated dry air] [unheated dry air] for the regenerative media. The capacity of each dryer shall be such that compressed air, in the quantities listed below will be dried from a saturated condition at [_____] degrees C F to a pressure dew point of minus 40 degrees C F.

Service	Capacity (Each Tower)
Baghouses	[_____] L/s at 862 kPa (gage)
Ash Handling	[_____] L/s at 862 kPa (gage)
Instrumentation	[_____] L/s at 862 kPa (gage)

Service	Capacity (Each Tower)
Baghouses	[_____] cfm at 125 psig
Ash Handling	[_____] cfm at 125 psig

Service	Capacity (Each Tower)
Instrumentation	[_____] cfm at 125 psig

The contact time of the air in the chambers shall not be less than 4.5 seconds. Velocity of the air shall be less than that which will fluidize the desiccant bed. Pressure drop through the unit when operating at rated flow shall not exceed 27 kPa 4 psi. Units shall be field adjustable to maintain the pressure dew point of the dried air at any preselected value below operating temperature, to minus 40 degrees C F. Units shall have as an integral part of the construction an indicator showing the water content of the dry air and a calibrated adjustment control to change the water content to any preselected level. Desiccant dryers shall provide a continuous supply of dry air by automatically cycling operation of the desiccant beds.

a. Chambers: Designed for 1034 kPa (gage) 150 psig working pressure in accordance with the ASME BPVC SEC VIII, and so stamped. Each chamber shall be fitted with separate fill and drain ports so that inlet and outlet piping manifolds need not be removed to fill or drain the chambers. Each chamber shall be provided with stainless steel screens at the inlet and the outlet to contain the desiccant bed, pressure gage, and safety valve. Normal air flow during drying shall be upward through the desiccant chamber. Desiccant shall be spherical activated alumina.

b. Regeneration: Accomplish by depressurizing the chamber on reactivation and purging with a portion of the dry outlet air from the chamber on stream. Purge air flow shall be downward. Maximum allowable purge flow rate at design conditions shall be 10 percent of design capacity of dryer. Purge system shall be controlled by a cam timer such that each desiccant bed is regenerated as required. Provide a flow control valve, flow indicator, and exhaust muffler for the purge system.

c. Controls: Cam timer, switches and relays shall be housed in a NEMA 12 control panel, mounted as part of the dryer. Provide interconnecting wiring in accordance with Division 16. In the case of electrical power failure, automatic valves shall fail in the open position to allow the wet gas to pass through the chambers. Provide gages to indicate pressure in each chamber.

d. Accessories: Dryer shall be complete with necessary solenoid operated control valves, check valves, and interconnecting piping. Mount equipment on a steel base plate suitable for floor mounting. [Provide pressure reducing valve to reduce pressure to suit desiccant dryer.]

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

f. Afterfilter: Provide an additional afterfilter for instrument air.

Filter shall combine three filter mechanisms - mechanical separation, coalescence and absorption in a single, cartridge type unit. Filtration efficiency shall be greater than 99.99 percent at 0.5 micron particle size for oil and other contaminants. A visible color change shall indicate when element should be replaced.

[2.7.3.2 Compressed Air Refrigerated Air Dryer

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

****
NOTE: The refrigerated air dryer is limited with an atmospheric dew point of approximately minus 23 degrees C 10 degrees F equivalent to minus 12 degrees C plus 10 degrees F at 172 kPa (gage) 25 psig and 2 degrees C 35 degrees F at 690 kPa (gage) 100 psig, and where this may be a problem the desiccant air dryer should be used as a much lower dew point can be attained.
****

Provide for systems not exposed to freezing temperatures a self-contained refrigerated type compressed air dryer capable of drying [_____] std. L/s scfm of air to an atmospheric dew point of not less than minus 23 degrees C 10 degrees F with entering air at 38 degrees C 100 degrees F, saturated. Dryer shall be complete with heat exchanger, a commercial quality refrigeration system, a moisture separator and condensate trap. Maximum operating pressure of the dryer shall be [_____] kPa (gage) psig. Install dryer between the receiver and distribution line.

Provide internal tubing, wiring, and piping complete, such that only connections to air inlet and outlet, to refrigerant compressor contractor, and to condensate drain are necessary.

a. Heat Exchanger: Heat exchanger shall consist of air and refrigerant coils surrounded by aluminum granules of sufficient mass to ensure adequate cooling capacity for varying air flow loads without causing excessive refrigeration cycling. Moisture separator shall be of centrifuge type and shall be located within the heat exchanger to provide for moisture separation at point of minimum air temperature. Suitably control heat exchanger temperature and provide an automatic control system, whose sensing element is located in the aluminum granules, to shut down the refrigeration system on low or no load conditions. Provide means to ascertain exchanger temperature.

b. Refrigeration Unit: Hermetically sealed type and shall operate intermittently at all but maximum load conditions. House entire unit in a steel cabinet. Provide cabinet with access door and panel for easy access to each part for maintenance and inspection.

c. Refrigerant: CFC-based refrigerants are prohibited. Refrigerant must have an Ozone Depletion Potential (ODP) no greater than 0.0, with exception to R-123.

d. Instrumentation and Control: Include control panel in dryer cabinet containing:

(1) Indicators for the following services: Inlet air pressure gage, discharge air pressure gage, inlet air temperature gage, refrigeration compressor suction pressure gage, refrigeration compressor discharge pressure gage, power interruption light, and high temperature light.

(2) Electrical relays located in an enclosed portion of panel, accessible for ease of servicing.

(3) Green "POWER ON" indicating light.

(4) Controls and interlocks to maintain required compressed air dew point and to cycle air-cooled condenser with refrigeration compressor.

(5) Dryer capable of automatic zero to 100 percent capacity control. Dryer shall use an automatic control expansion valve with sensing bulb to control capacity; dryer to have automatic shutdown switch sensor located at point of lowest temperature to prevent freezing.

e. Filters: Provide a disposable cartridge type prefilter and afterfilter at the air dryer. Filter cartridges shall have a 517 kPa 75 psi differential pressure rating, and the design flow clean pressure drop shall not exceed 1.40 kPa 0.2 psi. Filter shall be designed to remove liquid water and oil particles 5 microns and larger. Provide an additional afterfilter for instrument air. Filter shall combine three filter mechanisms - mechanical separation, coalescence and absorption - in a single, cartridge type unit. Filtration efficiency shall be greater than 99.99 percent at 0.5 micron particle size for oil and other contaminants. A visible color change shall indicate when element should be replaced.

f. Pressure Reducing Regulator: Self-operating type designed for not less than a 1724 kPa (gage) 250 psig operating pressure, a normal operating temperature range of minus 29 degrees C 20 degrees F to plus 66 degrees C 150 degrees F, and shall deliver constant reduced pressure compressed air. Regulator shall have an adjustable outlet pressure range of at least 34 to 690 kPa (gage) 5 to 100 psig with not less than 4 ranges. Provide external adjusting screw for adjustment throughout each spring range. Provide internal pressure tap for outlet pressure registration.

]2.8 BREECHING, EXPANSION JOINTS, STACKS AND DAMPERS

2.8.1 Breeching

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

2.8.1.1 Breeching Access Doors

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NOTE: Specify locations for breeching access and cleanout doors. Where practical show locations on project drawings. Show access and cleanout door details on project drawings.
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Construct access doors with frame and hinged door of cast iron or reinforced steel plate. Frame shall be not less than 686 by 787 mm 27 by 31 inches with access opening of not less than 508 by 610 mm 20 by 24 inches. Connection to breeching shall be gasketed and made with minimum 15 mm 1/2 inch diameter hot-dipped galvanized bolts, lockwashers, and nuts spaced not more than 125 mm 5 inches on center. Sides of the access door shall have not less than two quick clamp positive closing latches, with the long side opposite the hinges containing three clamps to give a gastight seal. Side of access door opposite the hinges shall contain a minimum 80 by 125 mm 3 by 5 inch size handle. Provide a gasket consisting of 10 mm 3/8 inch diameter fire proof resilient rope seal and mastic compound between the hinged access door and the access door frame. Provide breeching access doors at the following locations [and where indicated]:

[a. [_____]

][b. [_____].

]2.8.1.2 Breeching Cleanout Doors

****
NOTE: Specify locations for breeching access and cleanout doors. Where practical show locations on project drawings. Show access and cleanout door details on project drawings.
****

Construct cleanout doors of not less than 5 mm 3/16 inch thick steel plate. Secure cleanout doors to a 32 by 32 by 5 mm 1 1/4 by 1 1/4 by 3/16 inch thick angle frame with 10 mm 3/8 inch hot-dipped galvanized mounting bolts welded to the angle frame and spaced not over 150 mm 6 inches on center. Weld frame to breeching and provide a 3 mm 1/8 inch gasket between frame and cleanout door. Cleanout doors shall be not less than 610 by 610 mm 24 by 24 inches except where breeching dimensions are smaller, in which case the cleanout door shall be full height of the breeching and not less than 610 mm 24 inches in width. Provide breeching cleanout doors at the following locations [and where indicated]:

[a. [_____]

][b. [_____].

]2.8.1.3 Breeching Connections and Joints

Weld breeching joints [unless indicated or specified otherwise]. Welding shall conform to AWS D1.1/D1.1M and AWS D1.3/D1.3M. Bolts for bolted connections shall be hot-dipped galvanized bolts not less than 15 mm 1/2 inch diameter and spaced not more than 80 mm 3 inches apart, with hot-dipped galvanized lockwashers, and nuts. Provide bolted joints with a minimum of 3 mm 1/8 inch thick gaskets. Bolt flanged breeching connections to boilers, equipment items, dampers, expansion joints, and breeching accessories. Flanged breeching connections to equipment shall

be drilled to match flanges on equipment. Flanged joints shall be sealed welded to make connection gas-tight.

2.8.1.4 Breeching Structural Materials

****

NOTE: Designer shall detail breeching supports and breeching stiffening. Breeching hangers shall be designed to carry not less than 5 times the breeching weight, or the breeching weight plus weight of fly ash when breeching is half full plus 136 kg 300 pounds whichever is greater. Hangers for rectangular breeching shall be of the trapeze type with angle or channel support members and hanger rods. Breeching shall be stiffened with angle or channel members as required to withstand internal breeching static pressure. Designer shall verify that expansion joint flexure for axial travel is suitable. Expansion joints shall be detailed on the drawings.

****

Structural and support materials shall be steel and comply with the applicable sections of the AISC 303 or AISC 360. [Support and stiffen breeching as indicated].

2.8.1.5 Insulation

Provide insulation on breeching as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8.1.6 Breeching Paint

When breeching is shop fabricated, wire brush and clean interior and exterior with a nonflammable solvent and paint with FS TT-P-28 heat resistant paint, immediately after fabrication. When breeching is to be fabricated on the job, prime paint steel sheets, one coat each side, prior to delivery to job site.

2.8.2 Expansion Joints

2.8.2.1 Metallic Breeching Expansion Joints

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

2.8.2.2 Non-metallic Expansion Joints

Provide factory fabricated non-metallic breeching expansion joints 3 mm 1/8 inch minimum thickness [where indicated]. Expansion joints shall be constructed of fluoroelastomer vulcanized to two plies of knitted wire mesh capable of a minimum of [_____] mm inches of axial compression, [_____] mm inches of axial extension and [_____] mm inches of lateral offset [unless indicated otherwise]. Joints shall have a continuous operating temperature rating of 204 degrees C 400 degrees F, with

excursion design standards up to 400 degrees C 750 degrees F. Operating pressure range shall be minus 34 kPa (gage) 5 psig to plus 34 kPa (gage) 5 psig. Expansion joints shall be pre-formed with integrally molded corners, suitable for mounting against a 150 mm 6 inch flange. Provide carbon steel backup bars with slotted holes, bolts, and nuts.

2.8.3 Stacks

2.8.3.1 Stacks With Flue Gas Scrubbers

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NOTE: Use stack with acid resistant lining if temperatures below dew point of flue gas are expected in stack. Designer has to consider down drafts in stack at low firing rate.

****

Stacks shall be free standing, self-supporting, steel construction with an acid resistant lining system. Provide each stack complete with all accessories and appurtenances, including test ports, sampling platforms, ladders, safety climb devices, anchors, sleeves, insulation, stainless steel base and chair rings, and clean-out door.

a. Construction: Acid resistant lined steel stacks shall be fabricated of [ASTM A242/A242M, Type 1] [ASTM A36/A36M] structural steel plate with a 1.60 mm 1/16 inch corrosion allowance. Design shall include a static analysis of stack of wind loadings and critical wind velocity and dynamic analysis of stack including damping of vortex shedding and seismic response. Minimum steel plate thickness of stack shall not be less than 6 mm 1/4 inch. Stack sections shall be of welded construction and fabricated in sections not to exceed normal shipping limitations. Longitudinal seams shall have full penetration, continuous butt-welded joints. The section or horizontal joints of the stack shall also be full penetration continuous buttwelds. Welding shall be done by certified welders. Secure the stack to the foundation by a base plate with gussets, counterforts or steel beams provided as required. A reinforced concrete foundation, the design of which shall be approved by the stack manufacturer, shall be provided. Base construction of the stack shall transmit forces and moments in the shell to the [foundation] [supporting steel] without local stresses of appreciable magnitude being induced in the shell or exceeding the allowable stresses of the supporting [concrete] [steel].

b. Stack-Breeching Connection: A lined breeching connection of the same wall thickness as the stack shall be welded to the stack and the steel jacket of the stack reinforced as required to compensate for the structural strength of steel removed. A flange for bolting breeching to the connection shall be provided. A hinged cast iron or steel cleanout door with refractory lining and heavy duty steel frame shall be provided at the bottom of the stack. Frame and door shall be fitted gastight. Door shall be a minimum of 457 by 610 mm 18 by 24 inches in size.

c. Block Lining: Provide a lining consisting of inorganic borosilicate glass blocks bonded to the steel. Entire inside of each stack shall be sandblasted to a white metal blast finish. Block shall be 40 mm 1 1/2 inches thick, constructed of totally organic-free closed cell borosilicate glass. Blocks shall be shaped to reasonably match the inside of the stack and beveled to match adjacent blocks such that no

gaps between surfaces shall be greater than 3 mm 1/8 inch. Blocks shall be bonded to the steel and adjacent blocks with a two compound, urethane adhesive membrane. Adhesive membrane shall be trowelled to both the steel and block. Blocks shall be pressed into place in accordance with the manufacturer's instructions to provide a bond free of voids.

d. Optional Stack Lining: In lieu of the borosilicate glass block lining specified above an acid resistant cast insulating refractory lining with an acid resistant membrane liner over an anchoring system may be provided. Lining system shall be suitable for use in the pH range of 1.6 to 8. Liners composed of calcium aluminate or calcium silicate will not satisfy service requirements of the stack system.

(1) Membrane Liner: Urethane-Asphalt, or suitable similar material, which has been used successfully in similar installations to protect stacks from acid attack when flue gas temperatures are below their dew point. Service temperature range of the liner shall be minus 40 to plus 82 degrees C 180 degrees F, when applied to a thickness of 3 mm 1/8 inch.

(2) Refractory Lining: Potassium silicate single component chemically hardened cement or two component potassium silicate bonded cement with an inert filler material such as silica, or suitable similar material, gunite applied or cast monolithic insulating refractory, suitable for use on flue gas from 66 degrees C 150 degrees F and up to 232 degrees C 450 degrees F and resistant to continuous exposure of sulfuric acid, nitric and nitrous acid, carbonic acid and other liquids, in the pH range of 1.6 to 8 and formed when the surface of the stack is at a temperature at and below the flue gas dewpoint.

(3) Membrane/Refractory Lining Certification: Manufacturers of the membrane liner and the refractory lining shall certify that the lining system to be provided in the stack shall be suitable for the specific application, considering the flue gas temperature, velocities, moisture content and corrosive qualities of the fuel being burned.

(4) Refractory Lining Anchor System: Tinned metal anchors welded to the stack wall, or wire mesh fabric welded to anchors welded to stack wall, shall support the refractory lining of the stack. Tinned anchor system shall have anchors welded to stack shell on vertical spacing not greater than 200 mm 8 inches on center and horizontal spacing not greater than 100 mm 4 inches on center, in staggered rows to provide a minimum of 48 4.5 anchors per square meter foot. Wire mesh fabric shall be No. 10 or 12 wire gage made into a welded fabric approximately 50 by 50 mm 2 by 2 inches mesh size. Mesh shall be welded to anchors o.c. not to exceed [250] [300] mm [10] [12] inches. Mesh and anchors shall be of the same alloys.

(5) After anchor system is welded in place, blast clean entire inside surface of stack including stack base, and anchor system to a white metal blast finish and then coat with two coats of membrane liner to a total minimum thickness of 3 mm 1/8 inch. The stack base shall be included in the coating system. Prior to the installation of the refractory, spark test coated surfaces with a holiday detector to ensure membrane is free of voids. Refractory

lining shall be trowelled on or pneumatically applied to a minimum thickness of 76 mm 3 inches.

(6) Design of anchor system and application of refractory lining shall permit expansion and prevent cracking of the refractory.

e. Manufacturer's Calculations Required for Foundation and Stack:

(1) Foundation (including bearing and moment forces) reinforcement and anchor bolts

(2) Stack

- Stresses due to various loading conditions including wind and seismic loads

- Vibration and damping

- Heat transfer at various design and ambient conditions

- Expansion profiles

- Shipping and erection stress analysis

f. Finish: Stacks shall be shop coated prior to shipping from the factory. After erection, touch-up damaged shop coated surfaces and apply a prime coat and two coats of finish paint suitable for the temperatures and environmental exposure as specified in Section 09 90 00 PAINTS AND COATINGS.

g. Platforms and Ladders: Stacks shall be provided with platforms for sampling tests, monitoring equipment maintenance and obstruction-lighting maintenance. Access to lower platform shall be by ASTM A242/A242M, Type 1, steel [stairway] [catwalk or platform] [ladder] from the [heating plant] [pollution control building] [ground level]. Design for a minimum live load on platforms to be 488 kg 100 pounds per square meter foot. Platforms shall be not less than 1220 mm 48 inches wide and the sampling platform shall be a minimum width of 610 mm 2 feet plus the stack diameter, but not more than 3 meters 10 feet in width. Toe plates shall be not less than 150 mm 6 inches high around the platform perimeter. Platform railings shall have two intermediate railings. Ladders shall be [caged] corrosion resistant steel, 406 mm 16 inches wide with 305 mm 12 inch rung spacing. Ladders shall be provided from the lower platform to the top of each stack and shall be provided with a full length stainless steel safety climb device. The climb device shall consist of a notched rail attached to the rings' centerline with a sleeve which rides on the rail and locks into position on a sudden downward pull. Two belts for attaching the device to the climber shall be furnished.

h. Anchor Bolts: Provide anchor bolts, nuts, washers and sleeves to properly anchor the stacks. Stack manufacturer shall furnish certified dimensional drawings showing location for setting bolts in concrete.

i. Miscellaneous:

(1) Sample Ports: Provide two sample ports at 90 degree orientation to each other about 1220 mm 4 feet above platform. Each sample

port shall consist of a 100 mm 4 inch diameter pipe welded to the steel jacket and provided with a flange and mating blind flange. Provide openings required for installation of opacity monitor and SO2 analyzer specified in VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. [Locations of sample ports and instrumentation openings shall be as detailed on drawings].

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

(a) Hazard Beacons: Federal Aviation Administration FAA AC 150/5345-43, Type L-866.

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

(3) Painter's Trolley: Provide a ring of Type 304 stainless steel to support an inspection or painter's trolley. Provide a three wheel standard steel flat rail trolley of 227 kg 500 pounds capacity. Guide trolley to prevent it from leaving the track.

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NOTE: Velocity cones decrease cold air down drafts and increase velocity of discharged flue gas but increase flow resistance of stack; they may be used when justified.

****

(4) Velocity Cone: Provide stack with an acid resistant lined truncated velocity cone. Velocity cone shall be lined with the same insulating refractory as applied to the stack with a 80 mm 3 inch minimum thickness. Cone shall be 1220 mm 4 feet long, bolted to top of stack, and shall taper to a diameter of [_____] mm inches inside.

2.8.4 Dampers

2.8.4.1 Multilouver Dampers

Provide factory fabricated parallel multilouver dampers for two position service (open-closed) and opposed blade damper for modulating control. Construct damper frame of distortion resistant welded steel channels with raised seat to ensure free nonbinding operation of blades and to keep blades square in the frame. Construct blades of [_____] mm inch thick steel plate in a stressed skin airfoil-shape with fully welded seams containing no external ribs. Blade deflection in mm inches shall not exceed the length in mm inches divided by 360, consistent with AISC 360 beam deflection criteria. Blade shafts shall be stainless steel. Blades shall be pinned to blade shafts. Louver shaft bearings shall be outboard type and shall be self-lubricating and self-cleaning. Bearing seals shall be gastight.

a. Multilouver Damper Linkage: Damper linkage shall be adjustable and of pinned construction for easy removal and shall be designed to handle full operation torque. Linkage on dampers in clean flue gas areas shall operate from a single connection point.

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

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

2.8.4.2 Guillotine Dampers

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

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

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

b. Guillotine Damper Bonnet Seal: Provide bonnet seal to effectively seal against atmospheric leakage under normal operating conditions.

c. Double-bladed Guillotine Dampers: Provide where indicated. Damper frame, blades, and bonnet seals shall be as specified for single-bladed guillotine dampers, except frame shall be thicker and two blades shall be provided instead of one. Double-bladed guillotine damper shall provide absolute zero leakage across damper blades. This shall be accomplished by utilizing a blower to introduce air into the space between the damper blades. Blower shall be mounted on damper frame complete with isolation valve. Blower shall have sufficient capacity to maintain a pressure of at least 498 Pa 2 inch water column over breeching pressure.

d. Guillotine Damper Drive: A positive dual endless chain drive capable of driving damper in both directions. Chain-drive head shaft shall have sufficient torsional rigidity to prevent binding of blade when the blade is stalled. Damper shall be motor-operated with manual override. Design drive mechanism to prevent back driving of motor. Entire drive mechanism shall be of a simple design and require no

routine maintenance other than inspection. Chain shall be capable of operating up to the stall torque of the damper drive motor.

e. Electric Motor: Motor shall be [totally enclosed fan cooled] [open drip-proof], [_____] kW hp, [_____] volt, [_____] phase, 60 Hz, as specified under the paragraph MOTORS AND DRIVES in this section. Provide removable, totally enclosed chain guard.

2.9 COAL HANDLING EQUIPMENT

2.9.1 Railroad Hopper Car Thawing System

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

****

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

2.9.1.1 Pit-type Railroad Hopper Car Thawing System

a. Pit-type Thawing Unit: Pit-type hopper car thawing unit shall be complete with a refractory lined steel box, burner assemblies, steel burner enclosure with cover, valves, piping, and hinged main pit protective covers. Each pit shall have the capacity to generate 366 kW 1,250,000 Btu/hr when burning [No. 2 fuel oil] [natural gas] [liquified petroleum gas]. Burners shall fire horizontally and tangentially into the pit from opposite sides to heat the refractory lined pit up to radiant temperature. Heat shall be transferred to the hopper car by radiation from hot refractory surfaces and by convection from exhaust gases and evaporated moisture to rail car bottom and sides. Construct pit outer shell of not less than 6 mm 1/4 inch thick corrosion resistant steel plate, with the end plates of 10 gage (3.42 mm 0.1345 inch) steel. Provide supporting flanges and handling loops on both ends and provide cap strips on top of both sides. Place cast iron heat deflecting plates with overlapping edges on pit sides and bottom supported off the ledge on the outer shell. Provide a minimum 25 mm one inch air space between plates and outer shell. Pit side

walls and bottom shall have a minimum 65 mm 2 1/2 inch thickness of standard firebrick with one course of standard end skew brick along the top of the side walls. Firebrick shall be easily replaceable. End section shall have not less than 114 mm 4 1/2 inch thick precast high temperature refractory panels. Provide burner refractory ignition tiles with steel jacket casings having mounting lugs for bolting to end plates of pit. Provide concrete railroad ties adjacent to each thawing pit. Deliver combustion air to burners by means of pressure blowers which take fresh air from outside thawing area. Factory wire and assemble heaters, control panels, blowers, and zone controls. Shop fabricate burner piping and control valve assemblies.

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NOTE: Designer shall make selection here based on fuel to be used in thawing system.

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

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

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

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

2.9.1.2 Surface Mounted Enclosed Railroad Hopper Car Thawing System

a. Surface Mounted Enclosed Thawing Unit: Burner shall be of multiport cast iron construction and provide for even heating of radiant elements. Heater design shall be essentially the same for undercar and sidecar heaters, with heat transmitted to hopper car by both radiation and convection. Design burner and radiant element for radiation being the primary mode of heat transfer. Make radiant element over the burner of a heavy corrosion-resistant metal material. Design burner to operate on [No. 2 fuel oil] [natural gas] [liquified petroleum gas], and such that open flame from combustion will not extend beyond the emitter surface either during normal operation or in the event of emitter deterioration or burnout. Provide shields where necessary to direct radiation and hot exhaust gases to hopper car surface. Provide means for shielding car air hoses, air brake equipment, and bearings from excessive heat. Provide each heater with individual heater control boxes constructed as to provide positive air pressure inside control box. Control boxes shall contain mixing valve for maintaining proper gas-air ratio for satisfactory combustion. Locate gas and air piping connections for easy removal of individual burners. Deliver combustion air to heaters by means of pressure blowers which take fresh air from outside thawing area to ensure continued satisfactory combustion of gaseous fuels. Factory wire and assemble thawing units, control panels, blowers, and zone controls. Fuel system and burner control for oil fired units shall be as specified under the paragraph PIT-TYPE RAILROAD HOPPER CAR THAWING SYSTEM above.

b. Burner Controls (for gas fired units): Burners shall be electrically ignited with controls meeting I.R.I. requirements. Provide a gas pressure regulator for serving not more than eight individual burners. Regulator shall reduce gas pressure in supply line to pressure required for burners. Provide each burner with an air regulating valve for fuel-air ratio adjustment. Regulating valve shall contain positive vibration-proof locking device for maintaining critical adjustment.

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

[d. Thawing unit may be an electric radiant heat thawing unit which includes self-contained heater banks such as under-car outside the rail heater sections, lower side car heater sections and vertical side

car heater sections, with reflectors, hinged cover, waterproof and weatherproof wired terminal blocks and zone controls for flexibility of operation.

]2.9.1.3 Shed

****
NOTE: Shed should be used in the severe climate areas. Consult appropriate DM-2 series design manuals for design criteria for the shed.
****

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

2.9.2 Top-Mounted Railroad Hopper Car Shaker

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

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

2.9.2.1 Shaker

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

Shaker Electric Motor and Drive: Motor shall be totally enclosed, fan cooled, 1,800 rpm, [_____] volt, three phase, 60 Hz, not less than 15 kW 20 hp, as specified under the paragraph MOTORS AND DRIVES in this section. Motor shall be mounted on heavy spring isolated supporting frame with adjustable motor base. Shaker shall be belt driven with special deep groove sheaves, taper locking type hubs, and constant belt tensioning spring.

2.9.2.2 Shaker Hoist

Hoist shall be twin hook type having a rated capacity exceeding the weight of the shaker unit. Hoist shall have a lift of not less than 7 1/2 meters 25 feet with a hoist speed of not less than 0.08 meter per second (m/s) 16 feet per minute (fpm). Hoist shall have not less than 460 mm 18 inch long sling chains for connecting hoist to shaker lifting eyes, and hooks shall have U-bolt safety latches. Hoist shall be mounted on an electrified trolley as specified in Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING.

Shaker Hoist Electric Motor: Motor shall be totally enclosed, [fan cooled], [non ventilated], 1,800 rpm, [_____] volt, three phase, 60 Hz, not less than 5 1/2 kW 7 1/2 hp as specified under the paragraph MOTORS AND DRIVES in this section. Motors shall be high slip type and shall with thermal overload protection embedded in the windings.

2.9.2.3 Controls

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

2.9.2.4 Frame [and Enclosure]

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

2.9.3 Car Pullers

2.9.3.1 Capstan Car Puller

****
NOTE: Choose this subparagraph or the subparagraph REVERSIBLE DRUM TYPE CAR PULLER.
****

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

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

b. Rope: Capstan rope shall be not less than 25 mm one inch outside diameter marlin clad wire rope with a breaking strength of not less than 13,620 kg 30,000 pounds.

c. Rope Storage Reel: Construct rope storage reel of metal, hand operated with the drum not less than 300 mm 12 inches in diameter and the reel faces not less than one meter 3 feet in diameter. Drum shall have not less than [_____] mm inches face width and store not less than [_____] meters feet of 25 mm 1 inch diameter marlin clad wire rope.

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

2.9.3.2 Reversible Drum Type Car Puller

****
NOTE: Choose this subparagraph or the above subparagraph CAPSTAN CAR PULLER.
****

****
NOTE: Designer shall detail required footings and foundations based on the selected puller and soil conditions at each plant site.
****

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

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

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

   (2) Reduction Gear: ANSI/AGMA 2009 or AGMA 2011, "AGMA Gear Handbook," sized for the motor horsepower with motor base and coupling. Motor shall include motor mounted disc brake in dust and watertight enclosure. Provide rope overwind switch assembly and rotary type limit assembly.

b. Accessories:

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

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

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

(4) Miscellaneous: Provide reversing controls, car hooks, snatch blocks, and anchors.

2.9.4 Track Hopper

****

NOTE: Determine when a track hopper will be required.

****

Welded construction of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate not less than 4 1/4 meters 14 feet wide and 8 1/2 meters 28 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.4.1 Track Girders

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

2.9.4.2 Grating

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

2.9.4.3 Cover

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

2.9.4.4 Hopper Outlet

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

2.9.5 Truck Hopper

****

NOTE: Determine when a truck hopper will be required.
****

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

2.9.5.1 Grating

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

2.9.5.2 Hopper Outlet

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

2.9.5.3 Cover

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

2.9.6 Reclaim Hoppers

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

2.9.6.1 Grating

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

2.9.6.2 Hopper Outlet

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

2.9.6.3 Reclaim Hopper Cover

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

2.9.7 Belt Feeder

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

2.9.7.1 Head and Foot Shafts

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

2.9.7.2 Pulleys

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

2.9.7.3 Belt

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

2.9.7.4 Electric Motor

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

2.9.7.5 Reduction Gear

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

2.9.7.6 Backstop

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

2.9.7.7 Idlers

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

2.9.7.8 Load Skirts

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

2.9.7.9 Frame, Supports, and Enclosure

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

2.9.7.10 Loading Hopper

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

2.9.7.11 Vibrating Feeder

Flat pan type vibrating feeder to convey coal from the day hopper to the belt conveyor. Pan shall be [_____] mm inches wide by [_____] mm inches long, with 150 mm 6 inch sides, constructed of 6.35 mm 1/4 inch thick stainless steel. Provide feeder with integral electromechanical drive and a remote controller. Controller shall contain operating switches and rate of flow adjustment and the power source for the feeder drive. Controller shall be designed for 460 volt, 60 Hz supply voltage. Support feeder from the hopper.

2.9.8 Shallow-In-Built Bar Flight Feeder and Receiving Hopper

Bar flight feeder shall be totally enclosed, dusttight type with shallow-in-built [track] [truck] hopper. Bar flight feeder shall have a horizontal length of [_____] meter feet [_____] mm inches between sprocket centers, operate at not greater than [_____] m/s fpm, and have a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide feeder complete with continuous chains and attached bars, terminal

sprockets, gears, shafts, bearings, troughs, enclosure, frames, [truck] [track] hopper, grating, regulating gate, hinged inspection doors, discharge chute, electric motor, reduction gear, and supports.

2.9.8.1 Head and Foot Shafts

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

2.9.8.2 Terminal Sprockets

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

2.9.8.3 Chains and Flights

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

2.9.8.4 Frame and Enclosure

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

2.9.8.5 Trough

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

2.9.8.6 Hopper

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

2.9.8.7 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches.

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

2.9.8.8 Flight Feeder Drive

Flight feeder shall be driven by an electric motor direct connected by means of flexible coupling to a reduction gear unit having alloy steel helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and gear. Drive from output speed shaft of the reduction gear to the conveyor head shaft shall be by means of standard finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100.

2.9.8.9 Electric Motor

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

2.9.9 Bucket Elevator

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

2.9.9.1 Head and Foot Shafts

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

2.9.9.2 Terminal Sprockets

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

2.9.9.3 Buckets and Chain

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

2.9.9.4 Backstop

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

2.9.9.5 Elevator Casing

Not less than [_____] by [_____] mm inches inside of not less than [_____][gage] [mm inch thick] commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator casing. Construct casing in standard sections from 3 to 3.66 meters 10 to 12 feet high with 50 by 50 by 6 mm 2 by 2 by 1/4 inch angle flanges at the end of each section. Provide a hinged inspection door not less than 610 by 760 mm 24 by 30 inches in the section immediately above the boot section [and where indicated]. Casing and inspection doors shall be of dust-tight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Casing interior shall be given a 1.60 mm 1/16 inch thick coating of coal tar primer and enamel in accordance with SSPC PS 11.01.

2.9.9.6 Head Section

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

2.9.9.7 Boot Section

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

2.9.9.8 Electric Motor

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

2.9.9.9 Reduction Gear

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

2.9.9.10 Anchoring Brackets

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

2.9.10 Rotary Vane Feeder

Provide a fully enclosed, dusttight, rotary vane feeder designed to feed [_____] size coal at a constant rate of not less than [_____] Mg tons per hour. Provide feeder complete with housing, feeder vanes, removable panels and inspection doors.

2.9.10.1 Body

Construct feeder body dusttight of not less than 12.7 mm 1/2 inch thick formed carbon steel plate with 19.05 mm 3/4 inch thick flanges. Continuously weld joints both inside and out. Top cover of feeder between inlet and outlet flanges shall be removable to allow access to interior of feeder. Provide hinged inspection doors in both sides of the outlet section.

2.9.10.2 Feeder Vanes

Feeder section shall consist of not less than four vanes, equally spaced, extending radially from drive shaft. Feeder section shall be not less than 457 mm 18 inches long and 457 mm 18 inches in diameter. Construct shaft of turned and polished cold rolled steel mounted in externally flanged babbitted type bearing blocks with forced lubrication type fittings. Protect bearings with felt seal between bearing blocks and feeder body.

2.9.10.3 Drive Sprocket

Provide cast iron drive sprocket with chilled rims. Coordinate diameter with drive motor and reduction gear for required feeder speed.

2.9.10.4 Electric Motor

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

2.9.11 Screw Conveyors

Provide each dusttight and furnished complete, with trough, screw, inlet and discharge spouts, discharge gates, bearings, bearing hangers, dust cover, electric motor, reduction gear, [service platform,] and supports.

2.9.11.1 Inlet and Discharge Spouts

Arrange as indicated. Spouts shall be flanged and square with opening

dimensions equal to inside diameter of trough.

2.9.11.2 Screw Trough

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

2.9.11.3 Bearings and Hangers

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

2.9.11.4 Conveyor Screws and Couplings

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

2.9.11.5 Electric Motor

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

2.9.11.6 Service Platforms

Provide service platform conforming to OSHA regulations as indicated to properly maintain and service conveyor drive unit.

2.9.12 Belt Conveyor

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

2.9.12.1 Head and Foot Shafts

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

2.9.12.2 Takeups

[Three pulley guided vertical counter weighted type] [Screw type] to maintain proper belt tension. Shafts shall be as specified above and not less than [_____] mm inches in diameter. Provide a safety device to prevent free fall of take-up pulley. Takeups shall provide a minimum adjustment of 1.5 percent of total belt length.

2.9.12.3 Pulleys

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

2.9.12.4 Magnetic Pulley

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

2.9.12.5 Belt

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

2.9.12.6 Electric Motor

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

2.9.12.7 Reduction Gear

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

2.9.12.8 Backstop

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

2.9.12.9 Emergency Stop Cord and Switch

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

2.9.12.10 Belt Alignment Switch

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

2.9.12.11 Idlers

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

2.9.12.12 Load Skirts

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

2.9.12.13 Frame, Supports, and Walkway

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NOTE: Designer shall detail footings based on load and soil conditions at each plant site. Walkway shall be detailed.

****

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

2.9.12.14 Discharge Hopper

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

2.9.13 Coal Scales

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

2.9.13.1 Body

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

2.9.13.2 Feeder

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

2.9.13.3 Feed Belt

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

2.9.13.4 Electric Motor And Drive

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

2.9.13.5 Coal Bypass

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

2.9.13.6 Weighing Mechanism

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

2.9.13.7 Scale Weigh Hopper

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

2.9.13.8 Controls

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

2.9.13.9 Counters

Mount a mechanical type coal counter on the scale body. Counter shall be rugged, reliable, with heavy duty register and designed so that double counting is impossible. [A remote motor operated counter shall be furnished located on the coal handling control panel in the control room. Counter shall be designed so that double counting is impossible.] [Provide a contact closure for sending a pulse signal of each weigh hopper discharge to the operator control console, specified under VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.9.13.10 Scale Inlet

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

be provided to make the slip joint completely dusttight.

2.9.13.11 Scale Outlet Hopper

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

2.9.14 Stoker Hopper Extension

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

2.9.15 Coal Valve

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

2.9.15.1 Valve Body

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

2.9.15.2 Valve Gate

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

2.9.15.3 Operating Shaft

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

2.9.15.4 Electric Motor Operators

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

2.9.16 Track and Reclaim Hopper Valves

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

2.9.16.1 Valve Body

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

2.9.16.2 Valve Gate

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

2.9.16.3 Operating Shaft

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

2.9.17 Chutes

Construct coal chutes dusttight as indicated of not less than 6 mm 1/4 inch

thick 410 stainless steel plate. Weld chutes with flanges located as indicated to facilitate equipment and chute section removal. Flanges shall be not less than 10 mm 3/8 inch thick steel and gasketed to maintain dust-tight seal. Poke holes and access panels shall be provided where indicated.

2.9.18 Coal Presence Indicators and Equipment Response Switches

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

2.9.18.1 Type A - Diaphragm Type Presence Indicator

Pressure-sensitive to presence of coal consisting of housing, diaphragm, limit switches, wiring, and mounting bracket flanges. Housing shall be either cast iron, stainless steel, or protected cast aluminum, with synthetic diaphragm as recommended for coarse slightly abrasive materials. Diaphragm deflection shall actuate a limit switch to indicate coal presence. Design unit so that maintenance, diaphragm replacement and sensitivity adjustment can be made from outside the bin. Type and number of contacts and voltages shall be as indicated on the control diagrams.

2.9.18.2 Type B - Paddle Type Presence Indicator

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

2.9.18.3 Type C - Tilt Type Presence Indicator

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

2.9.18.4 Type D - Rotating Type Presence Indicator

Rotating paddle where presence of coal stalls motor and actuates a limit switch. Unit shall have either cast iron or cast aluminum housing, stainless steel paddle, couplings, and flexible shaft. Shaft seal shall be spring loaded and shall prevent the buildup of fines between shaft and hub. Operation shall be such that when paddle stalls, motor continues to

operate until the limit switch is actuated, which in turn shuts off the current to the motor. Vane and baffle arrangements shall be according to manufacturer's recommendations for each indicator location. Type and number of contacts and voltages shall be as indicated on the control diagrams.

2.9.18.5 Type E - Vibrating Type Presence Indicator

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

2.9.18.6 Equipment Speed Response Switch

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

2.9.18.7 Presence Indicators and Response Switches

Provide at hoppers and conveyor discharges located and protected according to manufacturer's recommendations to ensure safe and reliable operation. Mount presence indicators in such a manner that they will not be injured by occasional large lumps nor falsely operated by stray lumps or collected amounts of coal.

2.9.19 Control Panel and Controls

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

2.9.19.1 Panel Devices

Control panel shall include the following indicating lights and color:

a. Power - ON	red
b. System Run (3 required)	
Rail unloading hopper to boiler plant	green
Rail unloading hopper to storage yard	green
Reclaim hopper to boiler plant	green
c. Rail unloading hopper surfactant sprays - ON	green
d. Reclaim hopper surfactant sprays - ON	green
e. Stackout tube belt conveyor - ON	green
f. Reclaim belt conveyor - ON	green
g. Bunker rotary vane feeder - ON	green
h. Bunker reclaim belt feeder - ON	green
i. Bucket elevator - ON	green
j. Bunker - HIGH LEVEL	green
k. Bunker - LOW LEVEL	red
l. Screw conveyor no. 1 - ON	green
m. Screw conveyor no. 2 - ON	green
[n. Stoker surge hopper no. 1 inlet valve - OPEN]	[green]
[o. Stoker surge hopper no. 2 inlet valve - OPEN]	[green]
p. Emergency discharge chute - OPEN	green
q. Stoker hopper - HIGH LEVEL (one required for each hopper)	
r. Stoker hopper - LOW LEVEL (one required for each hopper)	
s. Stoker hopper - LOW LOW LEVEL (one required for each hopper)	
[t. Coal scale - ON]	[green]

2.9.19.2 Switches and Pushbuttons

Provide momentary contact pushbuttons or selector switches for the following:

a. System- START (3 required)
Rail unloading hopper to storage yard

Reclaim hopper to boiler plant
Bunker to boiler plant

b. System - STOP (red head)

c. Rail unloading hopper surfactant spray - START/STOP

d. Reclaim hopper surfactant spray - START/STOP

e. Alarm - ACKNOWLEDGE

2.9.19.3 Annunciator Panel

Annunciator panel shall include the following:

a. Bunker - HIGH LEVEL

b. Bunker - LOW LEVEL

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

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

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

f. EMERGENCY SHUTDOWN (Auxiliary contacts for remote alarm)

g. Blank (3 required)

2.9.19.4 Panel Size

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

2.9.19.5 Auxiliary Devices

Provide auxiliary devices required for the control functions indicated above.

2.9.19.6 Name Plates

Provide laminated plastic name plates for devices on panel face.

2.9.19.7 Control Sequence

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

2.9.19.8 Additional Controls

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

a. Belt feeders

b. Rotary vane feeder

c. Belt conveyor (at head pulley)

d. Screw conveyors

[e. Coal scale

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

2.9.20 Multiple Belt Scrapers

Equip conveyor belts at the head pulley, with multiple belt scrapers. Adequate room and service access shall be provided in the head chute design for multiple cleaners. Provide a doctor blade on the face of the head pulley to remove most of the carryback material and a torsion arm type multiple blade cleaner to scrape and remove material that bypasses the primary cleaner. Tail pulley takeups shall be provided with a plow to protect against material being carried back between the belt and the pulleys. Both cleaners and plows shall have features that enable the operator to safely inspect and adjust blades. Dribble chutes shall be designed to resist material buildup and shall be plastic lined. A convenient dust tight door for clean out and inspection purposes shall be provided on each side of the dribble chute.

2.9.21 Steel Coal Bunker

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

2.9.21.1 Construction

Welded construction, not less than [_____] meters feet in diameter with a vertical cylindrical section [_____] meters feet [_____] mm inches high. Construct vertical cylindrical section of not less than 7.94 mm 5/16 inch thick steel plate. Slope bottom cone shaped hopper section at not less than 55 degrees and fabricate from not less than 10 mm 3/8 inch thick 410 stainless steel plate. Top of bunker shall be conical 35 degree sloped structurally reinforced 6 mm 1/4 inch thick steel plate. Provide ladder inside bunker and immediately above ladder the bunker top shall contain dusttight, weather tight access hatch of not less than 610 by 610 mm 24 by 24 inches. Shell and bottom plates shall be beveled for full butt weld on inside of bunker and a finish weld on outside of bunker. Provide bunker with flanged outlet drilled to match inlet of gate.

a. Responsibility: Contractor with whom contract is drawn shall assume full responsibility for the design and final details of construction of the steel coal bunker.

b. Supports: Bunker shall be self supporting from four steel columns which shall be supported from on top of a concrete foundation. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

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

2.9.21.2 Accessories

a. Alarm Switches: Provide bunker with two automatic bin level indicators with neoprene rubber diaphragm and a single pole, double throw switch mounted in explosion proof aluminum housing to signal high and low level alarms. Provide mounting plates on bunker shell and holes for installation of indicator housing on outside of bunker. Wiring shall be as specified in 26 11 16 SECONDARY UNIT SUBSTATIONS.

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

2.9.22 Stoker Surge Hoppers

Construct stoker surge hoppers dusttight approximately as indicated of 6 mm 1/4 inch, 410 stainless steel plate with structural stiffeners, to hold not less than [_____] Mg tons of coal at a density of 800 kg per cubic meter 50 pounds per cubic foot. Connection transition between surge hopper discharge chute and stoker hopper extension shall have bolted emergency firing door of not less than 610 by 457 mm 24 by 18 inches which shall contain a 150 by 150 mm 6 by 6 inch glass observation window. Connections shall be dusttight.

2.9.23 Coal Meter

Vane type, where a direct readout counter is directly connected by a flexible shaft to a vane projected into center of coal downspout.

2.9.23.1 Vane

Construct vane of stainless steel design so that each foot of coal travel in the downspout causes the vane to turn a definite amount.

2.9.23.2 Counter

Counter shall have not less than four 25 mm one inch high figures on translucent material, illuminated from within the counter. Counter shall record directly the number of pounds of coal passing through the downspout.

2.9.24 Stackout Tube

Provide a stackout type discharge tube not less than 10 mm 3/8 inch thick, reinforced, stainless steel plate for discharging coal from the stackout conveyor to the coal storage yard. Tube shall be 1220 mm 4 feet 0 inches in diameter, and shall be designed as the structural support for a portion of the stackout conveyor and support steel as indicated on the drawings. Tube shall be a window chute designed to discharge coal at not more than 1.83 meters 6 feet above coal pile.

2.10 FUEL OIL SYSTEM

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NOTE: In reference to the following text, choose Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS if specifying below grade level fuel oil

tanks. The rest of the system (including above ground tanks) shall be constructed to Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).
****

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

2.11 ASH HANDLING SYSTEM (MECHANICAL)

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NOTE: Choose this article and its paragraphs and subparagraphs or the following article ASH HANDLING SYSTEM (PNEUMATIC) and its paragraphs and subparagraphs.
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2.11.1 General

2.11.1.1 System Requirements

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

2.11.1.2 Routing

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

2.11.1.3 Discharge

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

2.11.1.4 Maximum Noise Level

Noise level of the operation shall not exceed 85 decibels sound pressure level 1.52 meters 5 feet from the equipment in any direction.

2.11.2 System Valving

2.11.2.1 Rotary Valves

Provide rotary valve feeders of carbon steel construction complete with drive, guard, motor mount and gaskets, carbon steel adjustable blade tips, adjustable shoe type air seal and right angle gearhead drive motor. Rotor blade tips and shoes shall have a minimum Brinnell hardness of 500. Valves requiring part of the housing to form an airlock seal are not acceptable.

Electric Motor: Totally enclosed, fan cooled, [_____] volt, [_____] phase, 60 Hz not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

2.11.2.2 Manual Valve Intakes for Bottom Ash

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

2.11.2.3 Silo Discharge Valve

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

2.11.3 Conveyors

2.11.3.1 Chain Drag Conveyor

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

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

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

c. Chain: Combination drag type of riveted construction. Design chain symmetrically so that it can be turned over after one side is worn. Chain shall be [_____] mm inches wide with a pitch not greater than 200 mm 8 inches and an ultimate strength of not less than [187] [249] kN [42,000] [56,000] pounds. Construct chain of promal, a pearlitic malleable iron, center links not less than [_____] mm inches high, and

heavy [_____] mm inch thick heat treated carbon steel side bars. Steel pins shall be cold rolled steel not less than [_____] mm inch in diameter, press-fitted into sidebars, and machined flat on one side to prevent rotation. Center section shall be rugged block type forming a rigid rectangle for maximum resistance to distortion with broad wearing shoes contoured to prevent snagging and damage to chain or trough. Barrels of center section shall be chambered to provide lubricant reservoir and still provide maximum bearing area for pins. Shape barrel with pushing surface on one side and for contact with sprocket on the other side.

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

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

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

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

2.11.3.2 Screw Conveyors

Provide each screw conveyor dusttight and furnished complete, with trough, screw, inlet and discharge spouts, discharge gates, bearings, bearing hangers, dust cover, electric motor, reduction gear, [service platform,] and supports.

2.11.3.3 Inlet and Discharge Spouts

Arrange as indicated. Spouts shall be flanged and square with opening dimensions equal to the inside diameter of the trough.

2.11.3.4 Screw Trough

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

2.11.3.5 Bearings and Hangers

Provide thrust bearings and trough end dust seals for both drive and tail bearings. Thrust bearings shall be bronze in antifriction pillow

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

2.11.3.6 Conveyor Screws and Couplings

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

2.11.3.7 Electric Motor

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

2.11.3.8 Service Platforms

Provide service platform conforming to OSHA regulations as indicated to properly maintain and service conveyor drive unit.

2.11.4 Bucket Elevator

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

2.11.4.1 Head and Foot Shafts

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

2.11.4.2 Terminal Sprockets

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

diameter.

2.11.4.3 Buckets and Chain

Construct buckets of malleable iron not less than 200 mm long, 127 mm wide, 140 mm deep 8 inches long, 5 inches wide, and 12 inches deep. Buckets shall be mounted by not less than four bolt attachments to a single strand of steel bushed chain having an ultimate strength of not less than 178 kN 40,000 pounds and pitch of 100 mm 4 inches. Bucket spacing shall be not greater than 406 mm 16 inches.

2.11.4.4 Backstop

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

2.11.4.5 Casing

Elevator casing shall be not less than 298 by 991 mm 11 3/4 by 39 inches inside and constructed of not less than 5 mm 3/16 inch thick commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator casing. Fabricate casing in standard sections from 250 to 300 meter high with 50 by 50 by 6 mm 10 to 12 feet high with 2 by 2 by 1/4 inch angles at both flanges for each section. Provide a hinged inspection door not less than 610 by 762 mm 24 by 30 inches in the section immediately above the boot section and at other indicated points. Casing and inspection doors shall be of dusttight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Give casing interior a 1.60 mm 1/16 inch thick coating of coal tar primer and enamel conforming to SSPC PS 11.01.

2.11.4.6 Head Section

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

2.11.4.7 Boot Section

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

2.11.4.8 Electric Motor

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

AND DRIVES in this section, direct connected by means of flexible coupling to a reduction gear unit having alloy steel herringbone or helical gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive from the output speed shaft of the reduction gear to the elevator head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100.

2.11.4.9 Anchoring Brackets

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

2.11.4.10 Discharge Chute

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

2.11.5 Ash Storage Silo

[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. Design of support steel shall be approved by the ash system supplier. Design silo in accordance with the Uniform Building Code. The design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and shall be of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access to the stair tower with intermediate platforms at 3.66 meters 12 feet intervals which access the ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms must be additionally provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo. [Provide silo roof enclosure and unloader room enclosure each with a single one by 2 meters 3 by 7 foot access door, [_____] by [_____] meter foot double door, two windows, ventilator, [heater], insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.11.5.1 Construction

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

2.11.5.2 Concrete Stave Silo

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

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

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

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

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

2.11.6 Pulse Jet Bag Filter Vent

Provide for the silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter

9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s per square meter at 249 Pa 15 to 20 cfm per square foot at one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.11.7 Rotary Ash Conditioner (Unloader)

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

2.11.8 Fluidizing System

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

2.11.9 Control Panel and Controls

Provide a semi-automatic control system for the ash handling system [as indicated]. Provide a centrally controlled operation, with auxiliary local operation, and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start pushbuttons and indication stations for chain drag conveyor, screw conveyors, bucket elevator, and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid valves, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system. [Ash handling system manufacturer shall provide detailed control logic diagrams to the manufacturer of the digital process control and data acquisition system specified under VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.11.9.1 Control Panel

Provide a [separate control panel] [subpanel mounted in the main plant control panel] of NEMA 12 construction, centrally located in the main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an

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

2.11.9.2 Control Panel Devices

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

(1) Power - ON	red
(2) System Run (3 required)	
Chain drag conveyor to elevator	green
Screw conveyors to drag conveyor	green
Bucket elevator to silo	green
(3) Ash Silo - HI LEVEL	red
(4) Ash Silo - LOW LEVEL	red
(5) Silo Vent Filter - ON	green

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

(1) System - START (3 required)
Bucket elevator
Chain drag conveyor
Screw conveyors

(2) System - STOP (red head)

c. Provide sensors such that the following items can be alarmed on an ash handling system control panel annunciator.

(1) Ash silo - HIGH LEVEL

(2) Bucket elevator - EMERGENCY SHUTDOWN

(3) Screw conveyor - EMERGENCY SHUTDOWN

(4) Chain drag conveyor - EMERGENCY SHUTDOWN

(5) Silo vent filter - OFF

(6) Plugged Hopper

d. Provide auxiliary devices required for the control functions above and laminated plastic name plates for devices on the panel front.

e. Provide local control panel for operating and indication of the rotary ash conditioner with the following functions:

(1) Power - ON (red)

(2) Water - ON/OFF

(3) Ash feeder - ON/OFF

(4) Rotary ash conditioner - START/STOP/JOG

(5) Normal Stop

(6) Wash out - START/STOP

(7) Emergency Stop

f. Provide control panel mounted at grade level for remote operation of the rotary ash conditioner with the following functions:

(1) Rotary ash conditioner - START/STOP

(2) Normal stop

(3) Emergency stop

2.12 ASH HANDLING SYSTEM (PNEUMATIC)

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

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2.12.1 System Requirements

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

2.12.2 System Type

System shall be of the intermittent vacuum type, whereby the vacuum is

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

2.12.3 Hoppers

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

2.12.4 Discharge

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

2.12.5 Maximum Noise Level

The noise level of the operation shall not exceed 85 decibels sound pressure level 1.52 meters 5 feet from the equipment in any direction.

2.12.6 Ash Storage Hopper

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

2.12.6.1 Construction

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

2.12.6.2 Refractory Materials

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

2.12.6.3 Discharge Doors or Gates

Provide each hopper with refractory lined, dust tight, water cooled, vertical lift doors, of an opening size not less than 560 by 560 mm 22 by 22 inches. Each door shall be [air-cylinder operated] [chain wheel operated]. [Provide intermediate positioning capability with air cylinder operators.] Provide each door with guide rollers and support arms to ensure smooth operation without binding. When doors are vertical the minimum number of rollers shall be 4; for a sloping surface, the minimum number of rollers shall be 6.

2.12.6.4 Hopper Lift Door Enclosure

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

2.12.6.5 Hopper Access Door

Provide hinged access door on one side wall of each hopper. Door shall be cast iron, air tight swing-away locking type with refractory lining. Install door so that it is convenient and easy to use.

2.12.7 Clinker Crusher

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

2.12.7.1 Construction

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

2.12.7.2 Fluid Gear Drive

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

2.12.8 System Valving

2.12.8.1 Side Intake Valve for Fly Ash

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

prevent overloading of the conveyor system.

2.12.8.2 Rotary Valve Intakes for Bottom Ash

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

2.12.8.3 Air Intake

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

2.12.8.4 Isolating Valves (Line Valves)

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

2.12.8.5 Silo Discharge Valve

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

2.12.9 Ash Conveyor Pipe and Fittings

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

2.12.9.1 Conveyor Piping

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

2.12.9.2 Elbows and Fittings

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

2.12.9.3 Hangers and Supports

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

2.12.9.4 Contractor's Option

At the Contractor's option, conveyor pipe handling only fly ash may be Schedule 80 black steel pipe in lieu of the iron alloy pipe; however outlet fitting, elbows, tees and laterals shall be cast iron alloy with wearbacks and the pipe for a distance of one meter 3 feet after the cast iron alloy fittings shall be cast iron alloy pipe. Provide pipe with couplings or split flanges, bolts and gaskets, rated not less the 530 degrees C 1000 degrees F.

2.12.9.5 Expansion Joints

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

2.12.10 Vacuum Air Piping

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

2.12.11 Compressed Air Piping and Accessories

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

2.12.12 Primary Ash Receiver-Separator and Secondary Ash Separator

Provide on top of ash silo two stages of receiving and separating, with each stage a complete self-contained unit with efficient dust and air separation and gravity dump bottom gates to open with interruption of vacuum and discharge into a silo. Design system so that suction is positively shut off from the receiver during its dumping period, so that no dust can be sucked out through the exhaust while the discharge of the receiver is open or opening. Air from the primary receiver shall enter the external secondary separator which shall remove approximately 85 percent of the dust not collected by the primary receiver. Combined efficiency of the primary and external secondary separators shall be not less than 95 percent. Provide completely contained gate assemblies in a dust-tight enclosure fitted with access doors large enough to remove entire gate assembly. Provide receivers of hard, abrasion-resistant, cast alloy iron with a Brinell hardness of not less than 500 constructed as described below:

2.12.12.1 Primary Receiver-Separator

Not less than [914] [1219] mm [36] [48] inches inside diameter with cast

sections 19 mm 3/4 inch thick and 50 mm 2 inch thick impingement section. Cylinder, along with the discharge hopper shall be of segmental bolted construction. Construct receiver to ensure dropping of the maximum quantity of solids from the transporting air. Provide carbon steel outlet pipe and discharge gate. Receiver-separator shall have an internal baffle assembly to prevent re-entrainment of ash.

2.12.12.2 Secondary Separator

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

2.12.12.3 Dust Tight Enclosure

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

2.12.13 Mechanical Exhausters

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

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

2.12.13.1 Isolation Gates

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

2.12.13.2 Accessories

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

2.12.13.3 Electric Motor

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

2.12.13.4 Noise Level

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

2.12.14 Bag Filter

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

2.12.14.1 Cloth Area

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

2.12.14.2 Filter Construction

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

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

b. Bag Compartment: Of sufficient height to allow internal access by maintenance personnel. Base of this compartment shall include a metal platform supported by steel angle cross bracing. Platform shall extend over the entire base area of the compartment. Sidewall of this compartment shall include a hinged access door with locking handle. Door shall be gasketed and the opening shall be a minimum of 762 mm high by 406 mm wide 30 inches high by 16 inches wide.

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

d. Access Platform: With [stairs] [ladder] and safety handrail for

external mounting to the filter housing. Mount platform at a height to allow convenient access through the hinged door located on the bag compartment sidewall. Platform floor area shall be not less than 1.40 square meter 15 square feet.

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

2.12.14.3 Discharge Gate

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

2.12.14.4 Bag Cleaning Mechanism

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

2.12.14.5 Bag Assemblies

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

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

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

2.12.14.6 Control Panel

Provide NEMA 4, wall mounted control panel to sequentially control the bag cleaning and dump operations of the filter unit. Locate panel near the filter unit to permit easy field adjustment of sequence timers. Panel overall dimensions shall be not less than 610 mm wide by 762 mm high by 200 mm deep 24 inches wide by 30 inches high by 8 inches deep. As a minimum, the panel instrumentation shall include a dump cycle timer, pulse valve sequence timer, two high differential pressure delay relays, alarm relay, time delay relay, manual/auto selector switch, pulse valve "ON"

indicating light, high differential indicating light, terminal blocks and internal wiring. Welds and scratches of panel enclosure shall be free from blemishes. Paint panel exterior with manufacturer's standard enamel. Interior of panel shall be white enamel. Shop inspect panel and test prior to shipment.

2.12.14.7 Vacuum Breakers

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

2.12.15 Steam Exhauster

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NOTE: The steam exhauster system requires 0.32 kg 2500 pounds of steam per second hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg 3500 pounds of steam per second hour for an 200 mm 8 inch system (13.6 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a steam jet exhauster of cast iron construction with venturi throat of the high efficiency type for producing the vacuum necessary for handling ashes through the system. Make inlet air connection on the steam jet exhauster through a special spiral fitting so that the air enters the exhauster unit tangentially, avoiding direct impingement on the nozzle. Provide a unit capable of producing a vacuum of at least 40.56 kPa 12 inches of mercury column at shutoff and not requiring more than [0.32] [0.44] kg of steam per second at 690 kPa (gage) [2500] [3500] pounds of steam per hour at 100 psig.

2.12.16 Steam Condenser, Air Washer and Silencer

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NOTE: The steam exhauster system requires 0.32 kg 2500 pounds of steam per second hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg 3500 pounds of steam per second hour for an 200 mm 8 inch system (13.6 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a double stage cyclone type steam condenser, which also extracts the remaining solids from the steam-air system. Construct steam condenser body of hard metal castings not less than 16 mm 5/8 inch thick suitable for this special service except that the inlet connector shall be not less

than 19 mm 3/4 inch thick. Castings shall have a Brinell hardness of not less than 250. Other metal used in the condenser shall be at least 6 mm 1/4 inch thick steel with the top not less than 13 mm 1/2 inch thick steel plate. Provide drain connection not less than 76 mm 3 inches and water connection not less than 38 mm 1 1/2 inches. Provide silencer as required for quiet operation.

2.12.17 Ash Storage Silo

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

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[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. The design of the support steel shall be approved by the ash system supplier. Design silo in accordance with the Uniform Building Code. The design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and shall be of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access stair tower with intermediate platforms at 3.66 meters 12 foot intervals for access to ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms must be additionally provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo. [Provide silo roof enclosure and unloader room enclosure each with single one by 2 meter 3 by 7 foot access door, [_____] by [_____] meter foot double door, two windows, ventilator, [heater], insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.12.17.1 Construction

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

2.12.17.2 Concrete Stave Silo

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

cure.

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

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

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

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

2.12.18 Pulse Jet Bag Filter Vent

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NOTE: Consult the manufacturer of ash handling equipment for venting requirements.

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Provide for the silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter 9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s per square meter

15 to 20 cfm per square foot at 249 Pa one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.12.19 Rotary Ash Conditioner (Unloader)

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

[2.12.20 Fluidizing System

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NOTE: Delete fluidizing system when not necessary.
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Provide a fluidizing system on the silo floor to ensure a constant and uniform feed of ash through the silo discharge outlet. System shall consist of a series of diffuser modules, a conical diffuser hood, designed to support the total weight of ash when the silo is full, and compressed air piping. Each diffuser module shall be mounted on the silo floor using sloped concrete pads. System shall operate from the plant air system. Provide pressure reducing valves, safety valves, and controls for a complete system.

]2.12.21 General Controls

Provide a centrally controlled operation, with auxiliary local operation, and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start push buttons and indication stations for chain drag conveyor, screw conveyors, bucket elevator, and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid valves, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system. [Ash handling system manufacturer shall provide detailed control logic diagrams to the digital process control and data acquisition system manufacturer specified under VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.12.21.1 Functions

Provide capability to perform any of the following functions from the operator interface console specified under VAMS Section 23 09 53.00 20

SPACE TEMPERATURE CONTROL SYSTEMS.

a. System Start

b. System Stop

c. Auto/Manual/Index Mode of Operation Selection

d. Selection of Bypass of any Boiler

e. Manual Index to any Intake

f. Selection of Ash Silo for Baghouse Ash

2.12.21.2 Status Indicators

Provide sensors or contact closures for status indication on the operator interface console specified under VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS[, or on the annunciator over the central control panel] for the following:

a. Conveyor On

b. Unit On (one required for each unit)

c. Final Line Purge On/Complete

d. Baghouse Ash to Ash Silo

2.12.21.3 Alarms

Provide sensors such that the following items can be alarmed on the operator interface console specified under VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS[or on the annunciator over the central control panel]:

a. Blower Failure

b. Blower High Temperature

c. Bag Filter Failure

d. Bag Filter High Differential

e. Bag Filter Off

f. Plugged Hopper

g. Conveying Complete

h. Clinker Crusher Abnormal Shutdown (1 required for each boiler)

i. Low Conveying Air

j. High Conveying Vacuum

2.12.21.4 Vacuum Transmitter

To measure conveying system vacuum. Range shall be zero to 101 kPa 30

inches mercury with 4 to 20 mA dc linear transmitter output. Display vacuum on the operator interface console specified under VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.12.22 Controls Operation

2.12.22.1 Automatic

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

2.12.22.2 Switching

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

2.12.22.3 Valves

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

2.12.22.4 Bottom Ash Hopper Local Control Stations

Provide a wall mounted, NEMA 250, control station at each bottom ash hopper with front access door, lock, circuit breakers, selector switches, lights and push buttons.

a. Selector Switches:

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

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

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

b. Emergency "Stop" Pushbutton, For clinker crusher, with manual reset.

(1) "On-Manual"

(2) "Crusher Stalled"

2.13 AIR POLLUTION CONTROL EQUIPMENT

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NOTE: Mechanical cyclone collectors should be used for soot blowing and as a prefilter on baghouse

fabric filters or electrostatic precipitators. The fabric filter should be used where necessary to meet local, state or federal regulations or statutes for particulate emissions, when sulfur emissions are within regional limits through the burning of low sulfur "compliance coal." When coal containing more than 2 percent sulfur is burned, an electrostatic precipitator is generally more economical for control of particulates than the fabric filters, when sulfur emissions will meet regional limitations. When sulfur emissions are not within the regional limits, a scrubber with a prefilter mechanical cyclone and possibly a baghouse filter may be required to meet the emission limitations.
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2.13.1 Mechanical Cyclone Collectors

As specified in Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.2 Fabric Filter Baghouse

As specified in Section 23 51 43.03 20 FABRIC FILTER DUST COLLECTOR OF FLYASH PARTICULATES IN FLUE GAS.

2.13.3 Electrostatic Precipitator Filters

As specified in Section 23 51 43.02 20 ELECTROSTATIC DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.4 Scrubbers

As specified in Section [23 51 43.00 20 DUST AND GAS COLLECTOR DRY SCRUBBER AND FABRIC FILTER TYPE.]

2.14 MISCELLANEOUS EQUIPMENT

2.14.1 Condensate Receiver

Provide a [horizontal] [vertical] type tank not less than [_____] meter feet [_____] mm inches in diameter by [_____] meter feet [_____] mm inches [long] [high] overall with a storage capacity of not less than [_____] liters gallons. Tank shall be constructed of welded steel plate not less than 10 mm 3/8 inch thick. Provide condensate tank with a 610 mm 24 inch diameter manway, dual gage glasses with protective guards, saddles, and other connections as indicated.

2.14.1.1 Coating

Surface blast interior of tank to bare metal and coat with a bake-on phenolic lining or corrosion resistant liner consisting of a resin and hardener suitable for immersion in water at not less than 121 degrees C 250 degrees F. Coat the exterior of the tank with one shop coat of manufacturer's standard primer rated for service of not less than 121 degrees C 250 degrees F.

2.14.1.2 Accessories

Provide the condensate receiver with the following:

a. Connections for condensate pumped return, vent, water outlet, drain, sampling outlet, level transmitter and controls.

b. [_____] mm inch vent.

c. Reflex type water gage glasses with shutoff valves and guards.

d. One, 125 mm 5 inch dial, thermometer, 10 to 149 degrees C 50 to 300 degree F range, with lagging extension type wells, for steam and water space.

e. [_____] mm inch overflow trap.

f. One high water alarm switch with stainless steel float and trim. Circuit shall close as liquid level rises. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of receiver.

g. One low water alarm switch with stainless steel float and trim. Close circuit as liquid level falls. Locate switch to close circuit when water level drops to 25 percent of the storage capacity of the storage tank.

h. Switches on a single column with valved connections to tank. Provide unions in pipe on each side of each float switch.

i. Pipe, fittings, controls, specialties, bolts, gaskets, drains, and valves, necessary for a complete unit.

j. Provide automatic control system to control level in condensate tank by modulating discharge from condensate pumps.

2.14.2 Deaerating Heater

Provide a deaerating feedwater heater with storage tank conforming to FS W-H-2904, except as modified below and to ASME BPVC SEC VIII. Tank shall be ASME Code stamped. Provide stainless steel trays. No test model will be required.

Model A - Pressurized operation.
Type I - Tray-type heating and deaerating element.
Class 3 - 10 minute water storage capacity (minimum).
Grade A - Guaranteed removal from water of dissolved oxygen in excess of .005 cubic centimeters (cc) per liter, over a ten to one load swing.

2.14.2.1 Heater Capacity

Provide deaerating heater capable of heating and deaerating makeup water consisting of [_____] kilograms per second (kg/sec) pounds per hour of softened makeup water from [_____] to [_____] degrees C F (outlet temperature).

2.14.2.2 Inlet Water Characteristics

Softened makeup water:

Ph: [_____]
Total hardness (as CaC03): [_____]

2.14.2.3 Storage Tank

Horizontal design with steel supports [drilled for bolting] of approved design. Provide storage tank with not less than a 410 by 510 mm 16 by 20 inch minimum size manhole and cover and provide heater section with not less than a 300 by 460 mm 12 by 18 inch minimum size tray access handhole and door.

2.14.2.4 Vent Condensing Arrangement

Provide the deaerating heater with a vent condenser which shall condense the vented steam when the heater is operating at full capacity with the inlet water mixture at a temperature not exceeding 82 degrees C 180 degrees F. Construct the vent condenser, when of the direct contact type, with stainless steel baffling.

2.14.2.5 Materials

Construct trays, tray supports, water distributors, and other parts coming in contact with underaerated water or air laden steam of 430 stainless steel.

2.14.2.6 Accessories

Provide the deaerating heater unit with the following accessories:

a. Pressure relief valve: Sized in accordance with FS W-H-2904.

b. Thermometers: Two, 125 mm 5 inch dial thermometers, 10 to 149 degrees C 50 to 300 degrees F, with lagging extension type wells for the storage tank and the heater section. Provide a thermometer similar to above but with range of minus [_____] degrees C F to plus [_____] degrees C F for the makeup water connection.

c. Lifting attachments for the deaerator unit and the storage tank.

d. Water gage glasses: Reflex type with shutoff valve and guards.

e. Pressure gages: One 150 mm 6 inch dial compound pressure gage for the heater section with range from [_____] kPa inches of mercury (vacuum) to [_____] kPa (gage) psig.

f. Float controllers:

(1) Inlet condensate controller

(2) Makeup water controller

(3) Overflow controller

g. Overflow control valve: With pneumatic controller arranged for local automatic operation.

h. Storage tank gage glass: Full height, shielded, for storage tank including shutoff valve and drain cocks.

i. Makeup water inlet control valve: With pneumatic controller.

j. Switches: For low water level alarm in the storage tank, high water level alarm, condensate pump shut-down in the storage tank, and low steam pressure alarm. Install switches on a single column with connections valved and unions provided in pipe on each side of each float switch.

k. Special tools: One set for maintenance.

l. Condensate pump reset: With stainless steel float and trim to reset pump shutdown switch on fall of liquid level in tank to [_____] mm inches below level of overflow level of storage tank.

m. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, and valves, necessary for proper attachment of accessories and trimmings and install.

[n. Oil separator

]2.14.2.7 Connections

Provide necessary connections for condensate, steam, makeup water, removal of vented gases, vacuum breakers, discharge of deaerated water, and as required for instruments and controls.

a. Provide heater connections as follows:

(1) [_____] mm inch steam inlet

(2) [_____] mm inch makeup water inlet

(3) [_____] mm inch condensate

(4) [_____] mm inch high pressure trap return

(5) [_____] relief valves sized as required

(6) [_____] mm inch vent

(7) [_____] mm inch for thermometer well

(8) [_____] mm inch for pressure gage

(9) Vacuum breakers: As required

(10) [_____] mm inch heater drain

(11) [_____] mm inch spare [capped] [flanged]

(12) [_____] mm inch spare [capped] [flanged]

(13) Handholes And manhole: With covers

b. Tank connections shall include:

(1) [_____] mm inch drain

(2) [_____] mm inch boiler feed recirculation ([_____] required)

(3) 25 mm one inch sampling

(4) 25 mm one inch chemical feed

(5) [_____] mm inch for sight glass ([_____] sets required)

(6) [_____] mm inch for high and low alarm switches

(7) [_____] mm inch thermometer well

(8) Vacuum breakers: As required

(9) [_____] mm inch spare (capped)

(10) [_____] mm inch spare (flanged)

(11) [_____] mm inch level transmitter and controller ([_____] sets required)

(12) Downcomer and equalizer: As required

(13) [_____] mm inch feedwater outlet

(14) [_____] mm inch overflow outlet with internal water seal

2.14.2.8 Level Control

Provide an automatic control system to control the water level in the storage tank, by modulating valves in the makeup water lines. Output of the condensate pump shall be controlled by level in condensate storage tank.

a. Controllers: Provide external cage type air operated level controllers for both the condensate and makeup water lines complete with 40 mm 1 1/2 inch screwed connections, external cage, and controller. Cage body shall be Class 125 cast iron construction. Internal components including displacer, torque tube, displacer rod, displacer rod driver and bearings shall be 316 stainless steel. Displacer shall be 356 mm 14 inches long. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band adjustment. Locate controller to maintain an operating level at 2/3 full point of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

b. Air operated regulating valves: Provide air operated control valves for both the condensate and makeup water lines. Valves shall have Class 125 or Class 150 rating with iron or semi-steel bodies and 316 stainless steel internals. Provide open on air failure condensate valve and provide makeup water valve with an air lock mounted on valve diaphragm and piped to hold valve in last position on air failure. Design valves for the following conditions:

	Condensate	Makeup Water
Valve size	[_____]	[_____]
Capacity (L/s)	[_____]	[_____]
Maximum pressure drop at above capacity (kPa (gage))	[_____]	[_____]
Available pressure (kPA (gage))	[_____]	[_____]
Minimum Cv at 100 percent open	[_____]	[_____]
	Condensate	Makeup Water
Valve size	[_____]	[_____]
Capacity (gpm)	[_____]	[_____]
Maximum pressure drop at above capacity (psig)	[_____]	[_____]
Available pressure (psid)	[_____]	[_____]
Minimum Cv at 100 percent open	[_____]	[_____]

2.14.2.9 Low Pressure Steam Control

Provide an automatic control system to control the steam to the deaerating feedwater heater. Maintain steam pressure in the heater by modulating a pressure reducing valve in the steam supply line. Control shall be local and remote from the control panel.

a. Controller: Adjustable proportional band, 0 to 103 kPa (gage) 0 to 15 psig brass bellows for input signal, and 20 to 103 kPa (gage) 3 to 15 psig output air pressure range, pilot controller complete with air set (valve, filter, drier and pressure regulator) mounted on control valve yoke.

b. Pressure reducing station control valve: Provide a [_____] mm inch air operated pressure reducing valve with proper internals to pass a flow of [_____] kg per second pounds per hour of steam. Steam at the valve inlet shall be [_____] kPa (gage) psig saturated, and the outlet shall be controlled at [_____] kPa (gage) psig. Minimum steam flow shall be approximately [_____] kg per second pounds per hour. Minimum valve Cv shall be [_____] at 100 percent open. Valve shall be Class 250 or Class 300 flanged, iron or semi-steel body with stainless steel internals equal percentage flow characteristics and a full size port. Provide valve actuator including travel indicator, hand jack, valve positioner, and air supply filter-reducer set. Valve shall move to open position in case of failure.

2.14.2.10 Gage Glasses

Provide to cover the entire range of water level in the storage section. Gage glasses shall not be greater than 610 mm 24 inches center-to-center. Provide gage glasses complete with [chain operated] ball check shutoff and drain cock valves and safety shield.

2.14.2.11 Alarms

Provide high and low water level alarms for storage tank as follows:

a. High water level alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of storage tank.

b. Low water level alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level falls to [_____] meters feet [_____] mm inches above bottom of storage tank.

c. Coordinate alarms with annunciator panel as indicated.

2.14.2.12 Multiport Back Pressure Relief Valve

Capable of relieving not less than [_____] kg per second pounds per hour of steam with not more than a [_____] kPa (gage) psig pressure rise when set at [_____] kPa (gage) psig initial operating pressure and fully adjustable by means of an external handwheel or chain operator for an initial set pressure of 0 to 172 kPa (gage) 0 to 25 psig. Locate on low pressure steam header manifold for the deaerating heater. Valve shall be multiport vapor cushion type rated for operating temperatures up to but not greater than 149 degrees C 300 degrees F with Class 125 cast iron body, bronze trim and carbon steel springs.

2.14.2.13 Exhaust Head

CID A-A-50494, Type [I (cast iron)] [II (fabricated steel plate)] of [_____] mm inch size with [_____] mm inch diameter drain, and a capacity of [_____] kg/sec pounds per hour of steam at [_____] kPa (gage) psig.

2.14.3 Boiler Feed Pumps

****

NOTE: Use this paragraph for centrifugal boiler feed pumps. Use Style 1, horizontal split case pumps in all sizes. Pump service requirements shall include pump capacity of a minimum of 125 percent of boiler requirements at maximum load. Discharge head must be sufficient to deliver water to the boiler at a pressure 3 percent higher than the setting of the highest setting of the boiler safety valves and up to 6 percent over the maximum operating pressure of the boiler in accordance with ASME BPVC.

****

CID A-A-50562, Type II (boiler feed pump), Style 1 (horizontally split case), Class 2 (multi-stage) except as modified below. Each pump shall be two stage with horizontal split casing, enclosed single suction opposed type impellers, renewable casing and impeller wearing rings, stuffing box with quenching gland and flooded oil lubricated, water cooled bearings.

2.14.3.1 Construction

Bronze fitted including bronze impeller and impeller wear rings, and ASTM A48/A48M, Class 30, cast iron casing. Provide casing with suction and discharge gages in tapped openings. Mount each pump and prime mover on a fabricated steel bed plate having a drip collection chamber with

tapped drain openings. Provide lifting attachments to enable equipment to be set into its normal position and to enable split case pumps to be easily dismantled in place.

2.14.3.2 Drives

Variable speed motors and turbines direct connected to respective pumps with a gear type, forged steel, flexible coupling. Provide a shaft and coupling guard.

a. Electric motors: Variable speed, [open drip proof], [totally enclosed], [fan cooled], [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified under the paragraphs MOTORS AND DRIVES and VARIABLE SPEED CONTROL FOR MOTORS in this section.

b. Steam turbine: Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F and normal exhaust back pressure of 34 kPa (gage) 5 psig or a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

(1) Turbine construction: Turbine casing split on the horizontal centerline constructed of ASTM A48/A48M, cast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

(2) Turbine bearings and shaft: Horizontal split, ring oiled, sleeve type, water cooled. Shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

(3) Speed governor: Variable speed oil relay, NEMA Class D, governor for speed control and pneumatic operator to maintain an adjustable, preset pump discharge header pressure by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the control system controller specified in VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

(4) Emergency overspeed governor: Completely independent of the speed governor and shall operate a separate trip valve.

(5) Insulation: Turbine shall be insulated and lagged by the manufacturer as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14.3.3 Minimum Flow Protection for Boiler Feed Water Pumps

a. Automatic flow control valve: Provide with each pump an automatic bypass valve. Valve shall automatically program the recirculation flow, the detection of low flow, the cycling of control valve and pressure letdown for high pressure boiler feedwater return to the feedwater heater. Bypass valve shall be cast steel with stainless steel internals, and shall have a rating of not less than 2068 kpa

(gage) at 204 degrees C 300 psig at 400 degrees F. Valve shall have a line size body with a one inch recirculation connection. Provide pumps and turbine with all trimmings which the manufacturer considers essential for proper operation of units.

b. Boiler feedwater automatic recirculation system: (Option to Automatic Valve). Provide a boiler feedwater automatic recirculation system to protect the feedwater pumps at low flow conditions. System shall be capable of recirculating the minimum flow recommended by the pump manufacturer. System shall be an engineered system consisting of the various functional components specified or shall be a self-contained and self-powered mechanical system. Components of the engineered system shall include a flow transmitter with orifice in feedwater line, bypass flow controller with bypass flow control valve, and a bypass pressure reducing orifice.

(1) System bypass flow controller: Include detection of low flow and modulation of a control valve in a bypass line returning to a low pressure sink. Incorporate a pressure let-down feature or device to reduce the pressure from the boiler feedwater pump discharge pressure to that of the low pressure sink.

(2) System bypass control valve: Modulate to provide minimum flow recommended by the pump manufacturer and to provide shutoff or recirculation flow when feedwater flow to boilers exceeds the minimum flow required for pump protection.

2.14.3.4 Feedwater Stop and Check Valves

Provide a Class 300, flanged, cast steel feedwater stop gate valve and check valve on the feedwater outlet of each pump. Provide piping from the valves to the economizer inlet, and from the economizer to the flanged connection on the boiler drum. Provide connection on pipe at economizer outlet for remote recording thermometer.

2.14.4 Condensate Pumps

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NOTE: Use this paragraph for centrifugal condensate pumps. Pump service requirements shall include pump capacity at a minimum of 125 percent of full load boiler requirements. Discharge into deaerator heater shall be modulated.
****

CID A-A-50562, Type I, Style [1 (horizontally split cast)] [2 (end suction)], Class 1 (single stage) unless modified below.

2.14.4.1 Construction

Bronze impellers and impeller wear rings. [Cast iron] [ductile iron] pump casing designed for the specified conditions. Bearings shall be oil lubricated. Equip casing with tapped openings for suction and discharge gages. Provide gages in openings. Mount pump and driver on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments for installation and maintenance.

2.14.4.2 Drives

Variable speed motors and turbines direct connected to the respective pumps with a gear type flexible coupling. Provide shaft and coupling guards.

a. Electric motors: Variable speed, [open drip proof], [totally enclosed], [fan cooled], [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified under the paragraphs MOTORS AND DRIVES and VARIABLE SPEED CONTROL FOR MOTORS in this section.

b. Steam turbine: Single stage, rated at not less than [_____] with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F, normal exhaust back pressure of 34 kPa (gage) 5 psig and a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

(1) Turbine construction: Turbine casing split on the horizontal or vertical centerline constructed of ASTM A48/A48M cast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

(2) Turbine bearings shaft: Ring oiled, anti-friction type. The shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

(3) Speed governor: Variable speed governor for speed limiting and pneumatic operator to maintain an adjustable preset level in [deaerator tank] [condensate receiver] by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal and vary the turbine speed from minimum to full speed in a linear response. Maximum and minimum speed shall be adjustable. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller specified in VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

(4) Emergency overspeed governor: Completely independent of the speed governor and shall operate a separate trip valve.

(5) Insulation: Turbine shall insulated and lagged as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14.5 Variable Speed Control for Motors

Remotely installed cabinet housed units with solid state rectification and inverter equipment to vary frequency of electrical power to drive motors.

2.14.5.1 Housing

a. House controller in a [wall] [floor] mounted, NEMA 250 enclosure finished with manufacturers standard painted finish. Provide control panel complete with fused disconnect switches, magnetic [across the line] [part winding] starters with thermal overload protection, transformer, hand-off-automatic selector switches, hand potentiometer for manual speed control, fuses and running lights.

b. Provide manual switch within control panel so that in the event of failure of a component, the motor can be put across the line at full voltage to maintain air or pump pressure. Provide a mechanical door interlock that will allow the panel to open only when the fused disconnect is in the off position.

2.14.5.2 Variable Frequency Controllers

Variable frequency controllers shall use solid-state semiconductor power conversion equipment. Provide controllers as integrated and assembled products. Provide controllers by the same manufacturer.

a. Each controller shall be rated for a supply of [_____] volts, three phase, 60 Hz. The output shall be [_____] volts, three phase with frequency variable between zero and 60 Hz. Controllers shall be rated to operate the motors continuously at their rated horsepower and frequency. Speed regulation shall be three percent or better without tachometer feedback. The electrical supply system has an available short circuit rating of [_____] amperes symmetrical.

b. Each controller shall be capable of driving the motor continuously at a lower speed no greater than 20 percent of full rated motor speed with stable operation and without overheating the motor under rated ambient conditions. Provide estimate of minimum speed at which motor can be operated continuously without overheating or problems of instability due to overhauling of the load.

c. Provide controller fault protection so that a single or three phase short circuit at the controller terminals or inverter commutation failure will not result in damage to power circuit components. Provide overload protection so that motor and controller are protected against operating overloads.

d. Provide adjustable time delay undervoltage protection so that motors will continue to operate during momentary voltage fluctuation or loss of voltage. Time adjustment shall be zero to 5 seconds. Provide for orderly shutdown on undervoltage conditions exceeding the time delay interval.

e. Provide adjustable timed linear acceleration and deceleration.

f. Provide volts/hertz control to prevent motor overheating throughout the speed range.

g. Provide door interlocks to prevent opening of enclosure doors unless power is disconnected.

h. Controllers shall be self protecting and shall provide orderly shutdown for, but not limited to, the following conditions:

(1) Loss of input power

(2) Undervoltage

(3) Sustained gradual overload

(4) Fault or large instantaneous overload

(5) Overtemperature

(6) Failure of ventilating system

(7) Overvoltage

(8) Control circuit failure

i. Provide contacts for remote annunciation of shutdown or abnormal condition.

j. Electrical bypass: Provide each controller with manual isolation and bypass switching. The switch shall be manually operated with controller deenergized. Switch shall be two position with provisions for locking the switch in either position.

(1) Normal position: Bypass shall be open and the controller shall be connected to the supply circuit and the load.

(2) Bypass position: Bypass shall be closed and controller shall be electronically isolated from the supply and the load. Isolating contacts shall be located so that it is possible to verify by visual inspection that the contacts are open and the controller is electrically isolated. In the bypass position the motor shall be operated at constant speed and controlled from the air circuit breaker. Provide auxiliary contacts that close in the bypass position. The auxiliary contacts shall be used to activate the damper control to provide fan load control in the bypass position.

2.14.5.3 Controller Environmental Protection

a. Ventilation: Design controllers enclosed and ventilated for installation in a moderately dusty area. Provide forced filtered ventilation including fans, filters, controls and accessories required for operation. Enclosures shall be operated under positive pressure at all times. Provide filtered ventilating openings and gasketed doors to prevent infiltration of dust.

b. Heating: Provide electric heaters to prevent condensation in the enclosure and to prevent low in going air temperatures that exceed the equipment rating. Provide a low temperature alarm to sound when enclosure temperature falls below required minimum temperature. Provide contacts for remote annunciation of alarm condition.

2.14.5.4 Method of Control

Supply each controller from an electrically operated air circuit breaker or motor starter. Controller ventilation and heating shall be from another circuit.

a. Start signal: Closes the electrically operated air circuit breaker or motor starter to energize the controller. Controller shall accelerate fan to operating speed. Fan speed shall be controlled from the load control signal.

b. Stop signal: Opens the electrically operated air circuit breaker or motor starter to de-energize the controller. Upon deenergization, the controller control system shall revert to the stop condition.

c. Boiler feedwater pump speed control system: Matches pump discharge to system demand and maintains a system header pressure controlled to the set point values. Provide Manual/Automatic control stations for master pressure and for each boiler feed pump. Provide indicators for feedwater header pressure and individual boiler feedwater pump flow. See VAMS Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.14.6 Valve Actuators

[Electrically] [or] [pneumatically] operated designed so that valve may be manually operated by removing the drive pins. Actuators shall be operated by push button control. Locate one push button at a position adjacent to the valve. Locate a second push button within the boiler control room. Provide a valve position indicator utilizing indicating lights. A green light shall indicate the valve is fully open and an amber light shall indicate the valve is fully closed. Both lights on shall indicate when the valve is partially open. [Provide torque limit controls to protect the valve during opening and closing for electrically operated valves.] Actuator electric motor shall be totally enclosed, [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section. Provide NEMA 4 control enclosures.

2.14.7 Sump Pumps

CID A-A-50555 with automatic float switch and disconnect switch in NEMA 6 enclosure.

2.14.8 Water Softening System

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NOTE: Size the system for 125 percent of the maximum expected steam load to 100 percent of plant capacity. Include losses from blowdown. Size with one tower regenerating. Frequency of regeneration should be between 12 and 24 hours at peak loading.

****

Ion exchange resin type, conforming to WQA S-100 except as modified below. [Manual] [Push button automatic] [Fully automatic] in operation with operating controls housed in a NEMA 12 enclosure having a total capacity between regenerations of not less than [_____] liters gallons of water of [_____] grams grains hardness when operated at a sustained softening rate of [_____] L/s gpm. Maximum effluent water temperature shall be [_____] degrees C F.

2.14.8.1 Softener Equipment

Including but not limited to the following:

a. Water hardness monitor: Provide a water hardness monitor with an alarm point at 1.0 ppm to assure compliance for boilers rated above 3150 grams/sec 25,000 lbs./hr.

b. Total solids monitor/controller: Provide a continuous monitor and controller when required to control the concentration of dissolved solids and treatment chemicals in the water for boilers rated above 3150 grams/sec 25,000 lbs./hr.

c. Water meter: Provide a [_____] mm inch cold water meter on each

softener unit.

d. Ion exchange resin: High capacity, polystyrene base, sulfonated synthetic type except that the exchange capacity shall be not less than 68.70 kg per cubic meter 30 kilograins per cubic foot at a salt dosage of 240 kg per cubic meter 15 pounds per cubic foot.

e. Tank sizing: Minimum acceptable bed depth of 762 mm 30 inches; maximum acceptable bed depth of 1829 mm 72 inches. Base reactor tank sizes on allowing a freeboard above the resin bed of not less than 75 percent of the resin bed depth, and flow rate between 1.11 and 7.13 L/s per cubic meter 0.5 and 3.2 gpm per cubic foot of resin.

2.14.8.2 Brine Storage System

Provide a complete brine storage system including fiberglass storage tank, sight level gage, bulk salt delivery tube, internal distribution system, level control system, tank vent with dust collection system, top and side manholes, access ladder, and other required appurtenances.

a. Storage tank: Filament wound fiberglass with flat bottom and domed top as recommended by the manufacturer for brine storage. The tank shall be [_____] meters feet [_____] mm inches in diameter by [_____] meters feet [_____] mm inches wall height with a nominal capacity of [_____] liters gallons and a dry salt storage capacity of [_____] Mg tons. Design the water distribution system, internal piping distributors, and brine collection system so that system shall be capable of dissolving [_____] kg pounds of rock salt per second minute to produce [_____] L/s gpm of brine. System shall be able to dissolve [_____] Mg tons of salt before cleanout.

b. Accessories: Provide the following accessories:

(1) Steel holddown lugs securely bonded to the tank in adequate number to properly anchor tank to concrete base

(2) Side bottom flanged drain not less than 100 mm 4 inches in diameter

(3) Side and top manholes not less than 559 mm 22 inches in diameter

(4) Flanged top connections for delivery pipe and vent

(5) Ladder for access to top manhole

(6) Water inlet connection

(7) Brine outlet connection

(8) Level control system

(9) Sight level gage

c. Pneumatic delivery pipe: Not less than 100 mm 4 inches in diameter.

d. Dust collection vent system and safety relief valve: Provide storage tank with dust collection vent system and safety relief valve.

e. Access ladder: Of steel construction to be bolted to tank by means of FRP mounting lugs complete with safety cage. Platform shall connect

ladder to tank for safe access to manhole.

f. Tank internals: Construct tank internals including water distribution piping and brine collectors of FRP or polyvinyl chloride (PVC).

g. Tank nozzles: ASME B16.5, Class 150, reinforced FRP or PVC flanges.

h. Level control system: Electrode holder and electrodes mounted in a standpipe exterior to the tank. Position electrodes so that a solenoid operated water makeup valve will be opened or closed to maintain the liquid level to within plus or minus 25 mm one inch of the set level. Provide tank with a high water alarm. Electrodes shall be easily removable for cleaning and constructed of materials, that will allow continual immersion in brine.

2.14.9 Chemical Feed Systems

Provide systems complete with storage tank, supporting framework, hinged cover, mixer, strainers, level indicators, proportioning pumps, relief valves and interconnecting piping for a complete chemical feed packaged unit.

2.14.9.1 Storage Tank

190 liters50 gallon capacity constructed of FRP. Provide removable, hinged cover.

2.14.9.2 Exterior Gage Glass

Protected, full height of the tank complete with gage cocks.

2.14.9.3 Low Level Alarm

Provide tank with a low level switch to sound alarm and shut down pumps should level drop to preset minimum.

2.14.9.4 Dissolving Baskets

Construct baskets of a corrosion resistant material suitable for continuous immersion in a [_____] solution.

****

NOTE: The chemical feed solution to be used shall be inserted here.

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2.14.9.5 Tank Strainer

In suction line to pump.

2.14.9.6 Supporting Steelwork

Provide supporting steelwork to adequately support tank, mixer, and the number of proportioning pumps specified.

2.14.9.7 Agitator

Provide an agitator with mounting bracket to mount to storage tank. Agitator shaft and propeller shall be of stainless steel.

2.14.9.8 Proportioning Pumps

Provide [two] [three] [_____] proportioning pumps of the [simplex] [duplex] type. Each pump shall have a minimum capacity of [_____] L/s gph at a [_____] kPa (gage) psig discharge pressure. Capacity shall be adjustable from zero to 100 percent by a convenient screw adjustment of stroke length. Provide pump with integral check valves. Electric motors shall be [totally enclosed], [fan cooled], [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section.

2.14.9.9 Safety Relief Valve

Provide for each pump to discharge back into the tank in event of excessive line pressure.

2.14.10 Welded Blowdown Tank

Provide in accordance with the Recommended Rules for the Design and Arrangement of Boiler Blowoff Equipment supplemental to the National Board Inspection Code latest edition published by the National Board of Boiler and Pressure Vessel Inspectors, Columbus, Ohio.

a. Construction: Construct equipment and accessories in accordance with the requirements of the ASME BPVC SEC VIII for a working pressure of at least the maximum allowable working pressure of the boiler but in no case shall the plate thickness be less than 10 mm 3/8 inch. Provide corrosion allowance of [2.55 mm] [0.1 inch] [_____]. Tank dimensions shall be [_____] meters feet [_____] mm inches O.D. by [_____] meters feet [_____] mm inches long over the heads (overall). Provide tank with wear plate not less than 10 mm 3/8 inch thick and [279 by 381 mm 11 by 15 inch] [457 by 508 mm 18 by 20 inch] manhole.

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NOTE: The volume of the blowdown tank shall be calculated to be twice the volume of water removed from one boiler when the normal water level is reduced not less than 100 mm 4 inches.

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b. Tank connections: Provide the following connections:

(1) Blowdown inlet for bottom blowdown [20] [25] mm [3/4] [1] inch

(2) Tangential blowdown inlet [_____] mm inch

(3) Steam vent, flanged [_____] mm inch

(4) Discharge water outlet, flanged [_____] mm inch with internal water seal and 20 mm 3/4 inch siphon breaker

(5) Drain 50 mm 2 inch

(6) Thermometer connection 20 mm 3/4 inch

(7) Pressure gage connection 6 mm 1/4 inch

(8) Cold water inlet [_____] mm inch with temperature regulating valve and backflow preventer

(9) Two gage glass connections 15 mm 1/2 inch

c. Angle supports and coating: Provide the tank with steel angle support legs extending [_____] meter feet below the bottom of the tank. Coat the tank with one coat of manufacturer's standard high temperature primer.

2.14.10.1 Accessories

a. Gage glass: 300 mm 12 inch reflex type with shutoff valves and guard.

b. Thermometer: Bi-metal dial type with separable socket, 125 mm 5 inch dial, 10 to 149 degrees C 50 to 300 degrees F range.

c. Pressure gage: Zero to 172 kPa (gage) Zero to 25 psig range.

d. Internal baffles and pipes: As detailed.

2.14.10.2 Controls

Provide a self operating regulator to control the flow of cooling water to the tank. Regulator shall include a 20 mm 3/4 inch screwed bronze body with stainless steel trim, reverse acting actuator for cooling, capillary tubing and a union connection bulb with a stainless steel well. Control setting shall be 60 degrees C 140 degrees F with a minimum Cv of [_____].

2.14.11 Continuous Boiler Blowdown System

Provide a complete automatic continuous boiler blowdown system, in accordance with NBBI NB-27, which shall include a controller/programmer unit and flow assembly for each boiler, plus a continuous blowoff heat exchanger, flash tank and boiler water sample cooler.

2.14.11.1 Automatic Blowdown Controller

Intermittent type boiler blowdown system rated for not less than 1724 kPa (gage) 250 psig steam pressure.

a. Flow assembly: Include a 25 mm one inch ball valve with 316 stainless steel ball and stem and stainless steel electrode assembly.

b. Controller/programmer: Include a conductivity meter with zero to 6000 microhms range, valve open/closed indicators and manual/auto control switch. Cycle interval and sample duration shall both be adjustable over a wide range. Mount units at the operating floor near the boiler front.

c. Accessories and connections:

(1) Continuous blowdown connection: At each boiler, provide a gate valve and extend piping to header at flash tank.

(2) Header connections: Provide with a tee with valved sampling connection. Provide a 20 mm 3/4 inch, three globe valve bypass around each flow assembly.

(3) Common header: Provide from valved outlet connections on flow assembly units, to connection on flash tank.

2.14.11.2 Flash Tank

ASME code stamped and constructed in accordance with the ASME BPVC SEC VIII designed for [_____] kPa (gage) psig. Tank shall be [_____] mm inches in diameter by [_____] mm inches long including heads.

a. Provide tank with blowdown inlet, steam outlet, gage glass, float operated outlet valve, relief valve, and inspection openings. Tank shall have steel angle legs with plate feet for bolting to floor and legs shall be of sufficient length so that bottom of lower head of tank will be not less than 457 mm 18 inches above floor.

b. Automatic control system: Control level in the flash tank, by modulating a valve in the water outlet line.

(1) Level controller: External cage type air operated level controller, complete with 40 mm 1 1/2 inch screwed connection, 350 mm 14 inch stainless steel float and Class 125 cast iron body. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band. Locate controller to maintain an operating level at center line of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

(2) Outlet water valve: [_____] air operated control valve with a capacity to pass [_____] L/s gpm at a pressure drop of [_____] kPa (gage) psig. Cv shall not be less than [_____] at 100 percent open. Valve shall be Class [_____], flanged, iron or semi-steel body with stainless steel internals. Valve shall have equal percentage flow characteristics with a full size port. Provide an air lock mounted on valve diaphragm and piped to hold valve in last position on air failure.

2.14.11.3 Sample Cooler

Water cooled shell and tube type with valves and accessories required to safely withdraw a water sample from the boiler drum. Provide drain under sampling valve terminating with a 20 mm 3/4 inch splash proof funnel, 229 mm 9 inches below outlet of valve.

2.14.11.4 Heat Exchanger

Provide an ASME code stamp continuous blowoff heat exchanger designed and constructed in accordance with the ASME BPVC SEC VIII, to transfer heat from the continuous blowoff water leaving the existing continuous blowoff flash tank to the treated makeup water entering the feedwater heater. Heat exchanger shall be a bare tube, helical coiled bundle, installed in a one piece casing with removable front plate. Bundle shall be removable. Tube diameter shall not be less than 20 mm 3/4 inch. Tubes shall be ASTM B111/B111M copper alloy, with cast iron shell. Design tube side for not less than [_____] kpa (gage) psig pressure at [_____] degrees C F. Design shell side for not less than [_____] kpa (gage) psig pressure at [_____] degrees C F.

2.15 PIPING

Piping work shall include the provision, of piping systems, including

valving and specialty items, for the steam plant and related external auxiliary equipment.

a. Piping materials, design, and fabrication shall be in accordance with ASME B31.1 except as modified otherwise below or indicated otherwise.

b. Compute expansion of pipe with operating temperatures above minus 19 degrees C zero degrees F in lieu of 21 degrees C 70 degrees F specified in ASME B31.1.

c. Requirements of ASME B31.1 apply to the building steam heating and steam distribution piping designed for 103 kpa (gage) 15 psig or lower and hot water heating systems 207 kpa (gage) 30 psig or lower.

2.15.1 Materials

Suitable for the maximum pressure at the maximum temperature at which the equipment must operate.

2.15.1.1 Pipe Materials

a. Steel pipe

(1) Steam pipe, boiler feedwater pipe, relief pipe and steam tracer pipe: Black, ASTM A53/A53M or ASTM A106/A106M seamless steel pipe, Grade A or B. Wall thickness not less than Schedule 40. Steam tracer pipe, with steam up to 103 kPa (gage) 15 psig, may be ASTM B88M ASTM B88, type K copper tubing.

(2) Condensate pipe and boiler blowdown pipe: Black, welded or seamless ASTM A53/A53M or ASTM A106/A106M, steel pipe, Grade A or B. Wall thickness not less than extra strong (XS or Schedule 80).

(3) Chemical feed pipe and coal pile-runoff water sump pump discharge piping: ASTM A312/A312M austenitic stainless steel.

(4) Fuel oil pipe: ASTM A53/A53M or ASTM A106/A106M, seamless black steel pipe, Grade A or B.

(5) Treated water, hot water heating, high temperature water, drains (other than sanitary), and overflow pipe: black, welded or seamless steel up to a maximum pressure of 1724 kPa (gage) 250 psig or ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

(6) Gas pipe and compressed air pipe: Welded or seamless pipe up to a maximum pressure of 1724 kpa (gage) 250 psig or ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

b. Copper tubing

(1) Instrument air pipe: ASTM B88M ASTM B88 hard copper tubing, Type K or L; except in a corrosive atmosphere or outside pipe shall be copper tubing, Type K or L, with ASTM D1047 PVC jacketing.

(2) Steam tracer pipe: Contractor may at the Contractor's option provide ASTM B88M ASTM B88, Type K, copper tubing for steam up 103 kPa (gage) 15 psig.

(3) Potable water, sanitary drains and storm drains: As specified in

Section 22 00 00 PLUMBING, GENERAL PURPOSE, unless otherwise specified. Chlorinated polyvinyl chloride (CPVC) and other plastic tubing and fittings shall not be used in the steam heating plant.

2.15.1.2 Fittings

a. Fittings for steel pipe:

(1) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.3 malleable iron, screwed end fittings, for working pressures not greater than 2068 kpa (gage) 300 psig at temperatures not greater than 232 degrees C 450 degrees F or ASME B16.11 forged steel.

(2) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.11 steel, socket welded end fittings.

(3) Sizes 6 to 65 mm 1/8 to 2 1/2 inches: ASME B16.9 steel, butt welding fittings.

(4) Sizes 65 to 600 mm 2 1/2 to 24 inches: ASME B16.5 forged steel, flanged fittings.

b. Welded outlets and welding saddles: Make branch connections of 45 and 90 degrees either with ASME B16.9 forged steel welded outlet fittings or welding saddles. Welding outlets and saddles shall not be smaller than two pipe sizes less than the main pipe sizes.

c. Fittings for copper tubing: ASME B16.18 cast bronze solder joint or ASME B16.22 wrought copper solder joint. For instrument air, fittings may be ASME B16.26 compression joint type.

d. Unions:

(1) Unions for steel pipe: ASME B16.11, ASME B16.39 threaded. Unions for zinc coated pipe shall be zinc coated.

(2) Unions for copper tubing: ASME B16.22. For instrument air, unions may be compression joint type.

2.15.1.3 Flanges

ASME B16.5, forged steel, welding type. Remove the raised faces on flanges when used with flanges having a flat face. Except as specified otherwise, pressure and temperature limitations shall be as specified in ASME B16.5 for the proper class and service, and the type face specified.

2.15.1.4 Valves

a. Valves for maximum working pressure of 1034 kpa (gage) 150 psig saturated steam or 1550 kPa (gage) 225 psig W.O.G. (Water, Oil, Gas) at 93 degrees C 200 degrees F (non-shock service). (For working pressures not exceeding 862 kPa (gage) 125 psig saturated steam or 1379 kpa (gage) 200 psig water at 93 degrees C 200 degrees F non shock service, Class 125 may be used in lieu of Class 150 or Class 250).

(1) Valve sizes 50 mm 2 inches and smaller:

(a) Non throttling valves: Gate valves, bronze, wedge disc,

rising stem, Class 150, MSS SP-80 or ball valves, bronze, double stem seals, stainless steel ball and shaft, tight shutoff.

(b) Globe valves and angle valves: Bronze, Class 150, MSS SP-80.

(c) Check valves: Bronze, Type [IV, swing check] [III, lift check], Class 150, MSS SP-80.

(2) Valve sizes 65 mm 2 1/2 inches and larger.

(a) Gate valves: Flanged, cast iron, Class 250, MSS SP-70 or steel, Class 150, ASME B16.34. Valves shall have wedge disc, outside screw and yoke (OS&Y), rising stem; valves 200 mm 8 inches and larger shall have globe valved bypass.

(b) Globe valves and angle valves: Flanged, cast iron, Class 250, MSS SP-85 or steel, Class 150, ASME B16.34.

(c) Check valves: Flanged, cast iron, Class 250 or steel, Class 150, Type [_____], [lift] [swing] check, style [_____], MIL-DTL-18436.

b. Valves for maximum working pressure of 1724 kPa (gage) 250 psig steam at a maximum temperature of 232 degrees C 450 degrees F or 3447 kPa (gage) 500 psig W.O.G. at 93 degrees C 200 degrees F (non-shock).

(1) Valve sizes 65 mm 2 1/2 inches and larger.

(a) Gate valves: Flanged or butt welded, cast iron, Class 250, MSS SP-70 (maximum size 300 mm 12 inches) or steel, Class 300, ASME B16.34. Valves shall have wedge disc, OS&Y, rising stem; each valve 200 mm 8 inches and larger shall have globe valved bypass.

(b) Globe valves and angle valves: Flanged or butt welded, cast iron, Class 250, MSS SP-85 or steel, Class 300, ASME B16.34.

(c) Check valves: Flanged or butt welded, iron body, Class 250 or steel, Class 300, Type [_____] [lift] [swing] check, style [_____], MIL-DTL-18436.

c. Valves for maximum working pressure of 2068 kPa (gage) 300 psig steam at a maximum temperature of 454 degrees C 850 degrees F or a maximum W.O.G. pressure of 4653 kPa (gage) 675 psig at 149 degrees C 300 degrees F (non shock).

(1) Valve sizes 65 mm 2 1/2 inches and larger:

(a) Gate valves, Globe Valves, and Angle Valves: Flanged or butt welded, ASME B16.34, steel, Class 300, rising stem, OS&Y. Gate valves 200 mm 8 inches and larger shall have globe valved bypass.

(b) Check valves: Flanged or butt welded, steel, Class 300, Type [_____], [lift] [swing] check, style [_____], MIL-DTL-18436.

d. Ball valves: ASME B16.5 and API Std 607 double stem seal type for bubble tight shutoff. Seats and seals shall be TFE material. Ball and shaft shall be stainless steel. Provide mechanical stops to prevent cycling valve in wrong direction and self-aligning stem seal.

e. Valve accessories: ASME B16.34 valve operating mechanisms including chain wheels, gear operators, floor stands, electric motors, air motors and cylinder-type actuating devices. Provide the accessories as follows and as indicated.

(1) Provide power operators with remote position indicators on the following valves: soot blowers, [_____], [_____].

(2) Provide floor stands and valve extensions on platforms and floors for the following valves: deaerator drain valves, [_____].

(3) Provide motorized actuators or chain wheels with chain and guides on valves with handwheel centerline higher than 2 meters 7 feet above the floor or platform except where specified otherwise. Chains shall extend from the valve to within one meter 3 feet above the floor. Provide impact chain wheels on steam headers and other locations where the valve has a tendency to stick. When a valve is motorized, provide hand operation for emergency.

(4) Provide gear operators on ball valves larger than 80 mm 3 inches and on gate valves 200 mm 8 inches and larger.

f. Steam pressure regulating valves: CID A-A-50558, minimum of Class [125] [150] [250] [300], except as specified otherwise. [Cast iron], [cast steel] valve body with valve seats and disc of replaceable heat treated stainless steel. Valves shall be single seated, shall seat tight under dead end conditions, and shall go to the closed position in the event of pressure failure of the operating medium. Valves shall be spring loaded diaphragm operated type, except valves exposed to ambient temperature of less than 2 degrees C 35 degrees F or exposed to the weather shall be piston operated type. Capacity of valves shall be not less than that indicated. Pilot valves shall have strainer at inlet from external feeder piping.

(1) Spring loaded diaphragm operated valves: Fabricate main spring of stainless steel, and it shall not be in the path of steam flow through the valve. Control valves by pilot valve through external feeder piping.

(2) Piston operated valves: Control valves by integral pilot valve through external feeder piping.

g. Safety relief valves: MIL-DTL-18436, Style D or E, with Class [150] [300] inlet flange, with test lever, designed for the intended service.

2.15.1.5 Bolts and Nuts

a. Bolts: ASTM A193/A193M, Grade B8. Lengths of bolts shall be such that not less than two full threads will extend beyond the nut with bolts tightened to required tensions and washers seated.

b. Nuts: ASTM A194/A194M, Grade 8.

2.15.1.6 Gaskets

ASME B31.1 and as specified below, except provide spiral wound metal covered non-asbestos gaskets in lieu of compressed sheet non-asbestos. Gaskets shall be as thin as the finish of surfaces will permit. Do not

use paper, vegetable fiber, rubber, or rubber inserted gaskets for temperatures greater than 121 degrees C 250 degrees F. Provide metal or metal jacketed non-asbestos gaskets with small male and female and small tongue-and-groove flanges and flanged fittings; they may be used with steel flanges with lapped, large male and female, large tongue-and-groove, and raised facings. Provide full face gaskets with flat-faced flanges. Raised face cast iron flanges, lapped steel flanges, and raised faced steel flanges shall have ring gaskets with an outside diameter extending to the inside of the bolt holes. Widths of gaskets for small male and female and for tongue-and-groove joints shall be equal to the widths of the male face and tongue. Gaskets shall have an inside diameter equal to or larger than the port opening. Dimensions for nonmetallic gaskets shall be in accordance with ASME B16.21. Materials for flanged gaskets shall be as listed below for service specified:

a. Steam, boiler blowdown, exhaust steam: Spiral wound metal composition or copper

b. Boiler feed water: Metal jacketed non-asbestos, copper or monel

c. Hot water, above 38 degrees C 100 degrees F: Spiral wound metal non-asbestos

d. Cold water: Red rubber or neoprene rubber

e. Heavy fuel oil (No. 6): Spiral wound metal non-asbestos, soft steel, or monel

f. Diesel fuel (No. 2): ASME B16.21 metallic

g. Compressed air: Spiral wound metal non-asbestos

2.15.1.7 Expansion Joints

a. Slip tube expansion joints: MIL-E-17814, Type IV, single or double slip tube as indicated, designed for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Expansion joints shall be of the type which permits the injection of semi plastic type packing while the joint is in service under full line pressure. Slip tube shall be of chromium plated, wrought steel construction, guided by internal and external guides integral with joint body. Fit slip tube ends with forged steel pipe flanges or bevel for welding into pipe line where indicated. Deliver joints complete with packing and ready for installation.

b. Flexible ball expansion joint: Capable of 360 degrees rotation plus 15 degrees angular flex movement and shall be installed in strict accordance with recommendations of the manufacturer. Ball joints shall have steel bodies and polished steel balls. Provide end connections to suit class of piping herein before specified. Seals shall be of pressure molded composition designed for the working pressure. Design joints for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Cold set joints as necessary to compensate for temperature at time of installation. Do not use ball joints on superheated steam or on joints subject to frequent flexure.

c. Bellows expansion joints: MIL-DTL-17813 flexible guided type with stainless steel expansion element, internal sleeves and external covers. Joints shall be designed for a working pressure of [_____]

kPa (gage) psig and a temperature of [_____] degrees C F.

2.15.1.8 Pipe Hangers and Supports

MSS SP-58 and MSS SP-69, Type [_____] or Type [_____] of the adjustable type, except as specified or indicated otherwise. Suspended steam and condensate piping shall have pipe hangers Type [_____] with insulation protection saddles Type [_____]. Provide insulated piping, except steam and condensate piping, with insulation protection shields Type 40. Provide bronze or copper plated collars on uninsulated copper piping. Support rods shall be steel. Rods, hangers and supports shall be zinc plated, except for uninsulated copper piping which shall be copper plated; cast iron rollers, bases and saddles may be painted with two coats of heat resisting aluminum paint in lieu of zinc plating. Axles for cast iron rollers shall be stainless steel. Size hanger rods with a 150 percent safety factor for a seismic design.

2.15.1.9 Instrumentation

a. Pressure and vacuum gages: Conform to applicable requirements of ASME B40.100.

b. Indicating thermometers: MIL-T-19646 dial type. Thermometer shall include a separable immersion well.

2.15.1.10 Miscellaneous Pipeline Components

a. Cold and hot water meters: CID A-A-59224 for maximum flow of [_____] L/s at 38 degrees C gpm at 100 degrees F and reduced flow of up to [_____] L/s at 121 degrees C gpm at 250 degrees F.

b. Air traps: Float controlled valves arranged to close properly when water enters the traps. Air traps shall conform to requirements for float operated steam traps (non-thermostatic), CID A-A-60001, except that the valve mechanism shall be inverted so as to be closed, not opened, by rising water.

c. Steam traps: CID A-A-60001. Inverted bucket high pressure steam traps designed for use at [_____] kPa (gage) psig at [_____] degrees C F. Low pressure steam traps shall be float and thermostatic type for pressures up to 103 kPa (gage) 15 psig. Provide traps with separate strainers unless specified otherwise.

d. Strainers: FS WW-S-2739 for Class [125] [250] with blow off outlet. Construct strainers for Class 300 of cast carbon steel in accordance with ASME B16.5 for minimum of 2068 kPa (gage) 300 psig saturated steam pressure. Provide blow off outlet with pipe nipple and gate valve.

e. Steam exhaust heads: CID A-A-50494 for atmospheric discharge of exhaust steam.

2.15.1.11 Backflow Preventers

Reduced pressure principle type conforming to the applicable requirements of [AWWA C510 and AWWA C511.] [Section 22 00 00 PLUMBING, GENERAL PURPOSE.]

2.15.1.12 Insulation

Materials and application shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.1.13 Pipe Sleeves

a. Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade: Galvanized steel pipe having an inside diameter at least 15 mm 1/2 inch larger than the o.d. diameter of the pipe passing through it. Provide sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs shall extend 13 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction shall include flange and clamping ring.

b. Partitions: Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

2.15.1.14 Piping Identification

Piping Identification shall conform to MIL-STD-101 and shall be placed in clearly visible locations; except that piping in the boiler room shall be painted the primary color of the color code. Labels and tapes conforming to ASME A13.1 shall be used in lieu of band painting or stenciling. Labels shall be outdoor grade acrylic plastic. Markings on labels shall indicate the direction of flow, flowing media, and media design pressure and temperature. Spacing of identification marking shall not exceed 3 meters 10 feet. Provide two copies of the complete color and stencil codes used. Frame codes under glass and install where directed.

2.16 FIRE PROTECTION SYSTEM

Provide the fuel oil room with a wet sprinkler system as specified in Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION.

2.17 MARKING

Identify equipment, valves, switches, motor controllers, and controls or indicating elements, by printed, stamped or manufactured identification plates or tags of rigid plastic or non-ferrous material. Lettering for identification plates or tags shall be not less than 5 mm 3/16 inch high. Nomenclature and identification symbols used on the identification plates or tags shall correspond to those used in the maintenance manuals, operating instructions, and schematic diagrams. Identification plates or tags shall be rigidly affixed to the equipment or devices without impairing functions or, when this is not possible, shall be attached using a non-ferrous wire or chain. In addition to the identification plate or tag, each major component of equipment shall have a nameplate listing the manufacturer's name, model number, and when applicable, electrical rating and other information required by pertinent standards or codes.

2.18 TOOLS AND TESTING EQUIPMENT

Provide special tools and wrenches required for the installation, maintenance, and operation of the equipment. Testing equipment to be provided shall include necessary equipment to perform routine tests:

a. On lubricating oil for acidity (pH-potentiometer), viscosity (saybolt test), and dirt (gravimetric).

b. On softened water for hardness (soap test or colorimetric test), and boiler blowdown water for pH (colorimetric) and conductivity (potentiometer).

c. For water (distillation) and sediment (gravimetric) in fuel oil.

2.19 WELDING MATERIALS

Welding materials shall comply with Section 2, ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

2.20 MOTORS AND DRIVES

A.C. electric motors shall meet the requirements of NEMA MG 1. Motors shall be designed for continuous operation at rated load under usual service conditions as defined by NEMA. Unless specifically noted otherwise, motors less than 3/8 kW 1/2 hp shall be 115 volt, 60 Hz, single phase, capacitor-start, or permanent split capacitor, with Class B insulation for 40 degrees C 104 degrees F ambient. Unless specifically noted otherwise, motors 3/8 kW 1/2 hp and larger shall be 460 volt, 60 Hz, three phase, Design B, squirrel cage induction with a minimum insulation of Class F for 40 degrees C 104 degrees F ambient. Size motors to meet power requirements of the driven unit at design conditions, including drive and coupling losses which are incurred, without loading the motor beyond its nameplate horsepower rating. Minimum service factor for open drip-proof motors shall be 1.15 and for totally enclosed, fan cooled motors 1.0. Motor shall be quiet operating. Bearings shall be heavy duty, grease lubricated, anti-friction, single shielded, regreasable type and shall have approved lubricating fittings extended to an easily accessible location for field servicing. Provide sole plates for motors installed on concrete pads. Motors shall have copper windings.

2.21 SOURCE QUALITY CONTROL

2.21.1 Instrument Air Compressors

Factory test air compressor package at full load for not less than 2 hours. Check capacity, smoothness of operation, alternation of units, and proper operation of the air unloaders during the test.

2.21.2 Variable Speed Motor Controller Factory Test

Burn-in tests shall be conducted for at least 50 hours at rated conditions. Replace each component that fails during the burn-in test, and the test shall be run on the entire assembly for the complete 50 hours. Burn-in test shall not be complete until the entire assembly has operated for 50 hours without failure.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with manufacturer's recommendations.

3.1.1 Boiler

3.1.1.1 Installing Tubes In Headers

Tubes may be rolled into the headers provided the holes used for rolling will not be blocked for access in the future by any item of equipment or piping, provided under this contract. Otherwise, weld tubes into the headers by use of stubs or socket welds. Stub end tubes may be welded into headers in shop and tubes welded to same in field.

3.1.1.2 Installing Tubes In Drums

Before installing tubes, polish tube ends and tube seats in the drums to bright metal using a No. 60 grit cloth grinding band driven on a pneumatic or electric polishing motor. Do not polish these tubes until ready for immediate installation. Install the tubes and hold in place with proper width, hard maple wood spacers and by lapping the tubes in the tube sheet. Lap tubes only enough to hold them in place for rolling. Check tube stock on each end of the tube before rolling. Furnish 10 mm 3/8 inch stock on each tube end with no deviation. When, after the tubes are rolled in place, there remains more than 10 mm 3/8 inch stock due to extra length of tube, excess shall be milled off to 10 mm 3/8 inch using a milling wheel driven by a pneumatic or electric motor. At no time shall there be less than 10 mm 3/8 inch stock between end of tube and nearest surface of header. Tubes shall then be rolled with a bell roll of the proper size and tension. Tubes shall not be rolled to excess. Drive bell roll by a pneumatic or electric motor using a proper size mandrel pin. At no time will a manual operation of tube rolling be permitted. Lubricant for the expanding operation shall be a water soluble compound.

3.1.1.3 Inspecting Tubes

After tubes are rolled in place, provide, under manufacturer's supervision, one person in steam drum and one in mud drum. The person in the steam drum shall drop a ping pong ball through every tube to be sure that no foreign matter or misalignment obstructs the tube. After boiler tubes have been tested, follow the same procedure on the water wall tubes. Remove each tube that is not in alignment after being installed and install a new tube in its place.

3.1.1.4 Installing Firebrick

Lay up in air-setting mortar. Dip each brick in mortar, rub, shove into its final place, and then tap with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel will not be permitted. Maximum mortar joint thickness shall not exceed 3 mm 1/8 inch and average joint thickness shall not exceed 1.60 mm 1/16 inch.

3.1.1.5 Installing Plastic Refractory

Install in accordance with the manufacturer's recommendations and by workmen skilled in its application.

3.1.1.6 Installing Casing Insulation

Before application of the insulations, clean exterior surfaces of the boiler not covered by brick work by commercial blast and finish with one coat of FS TT-P-28 aluminum heat-resisting paint. Apply paint directly to

cleaned metal surfaces to a minimum dry film thickness of 0.0254 mm one mil.

3.1.2 Equipment Installation

Install equipment in strict accordance with this specification, and with manufacturer's installation instructions. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place strain on equipment. Flanged joints shall not be bolted to final torque settings until the flanges are aligned, gasketed and mated properly. Expansion bends shall be adequately extended before installation. Grade, anchor, guide and support piping, without low pockets.

3.1.2.1 Equipment Foundations

Provide foundations of sufficient size and weight, and proper design to preclude shifting of equipment under operating conditions, or under abnormal conditions which could be imposed upon the equipment. Equipment vibration shall be limited within acceptable limits, and shall be isolated. Foundations shall be adequate for soil conditions of the site and shall meet requirements of the equipment manufacturer. Trowel exposed foundation surfaces smooth except surfaces which are to receive grout, which shall be properly roughened.

3.1.2.2 Induced Draft Fan

Provide each driver and reduction gear with a 38 mm 1 1/2 inch thick steel base plate. Shim base plate level, using steel shim stock which is at least as large as the equipment foot and is slotted for installation around studs or bolts. Anchor and grout into place prior to setting driver. An approved millwright shall align and shim the drive unit. Millwright shall drill and ream foot and base plate and install taper pins with nut on top for pullout removal. One front foot and diagonally opposite rear foot shall be pinned to base plate. Bolt equipment in place in a manner approved by the manufacturer. Level and grout fan and bearing pedestal sole plates in place.

3.1.2.3 Stack

Stack shall be leveled and plumb during installation. Erected stack shall be no more than 25 mm one inch out of plumb per 15 meters 50 feet in height. Remove roughness, marks, and lifting lugs from stack. Grind surfaces smooth and flush with surrounding surfaces.

3.1.2.4 Fuel Oil Tanks

****
NOTE: At the text below, choose one of the following fuel oil tanks found below.
****

[a. Horizontal Fuel Oil Tanks (Below Ground). Provide concrete ballast slabs for tanks and concrete protective ground level slabs for FRP tanks. Ballast slabs shall be full length and width of tanks and protective slabs shall extend 610 mm 2 feet beyond the tanks. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

(1) Install backfill fiberglass reinforced tanks as recommended by the

manufacturer; backfill adjacent to the tanks shall be pea gravel unless otherwise recommended by the manufacturer. Backfill for steel tanks shall be sand.

(2) Set steel tanks on a bed of sand not less than 152 mm 6 inches deep over the concrete slab and strap in place with stainless steel hold-down straps with stainless steel turnbuckles. Set FRP tanks on a bed of pea gravel not less than 305 mm 12 inches thick and pre-shape for the tank contours for FRP tanks. Fabricate straps for FRP tanks from FRP resins reinforced with stainless steel to prevent breaking of straps and floating of empty tanks.

(3) Slope tank toward sump not less than 25 mm in each 1.50 meters one inch in each 5 feet.

][b. Horizontal Fuel Oil Tanks (Above Ground). Continuously support steel tank saddles along the full length of the base and level and grout to ensure full bearing.

][c. Vertical Fuel Oil Tank. Provide [sand, crushed stone or fine gravel cushion] [concrete base].
]

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NOTE: Choose for a base material either sand/ crushed stone/fine gravel or a concrete base.

****

(1) Sand, Crushed Stone or Fine Gravel Cushion: Area beneath tank shall be covered with a fuel resistant plastic membrane with a thickness of not less than 0.50 mm 20 mils. Carefully fuse or cement plastic membrane seams. Lay plastic over a thoroughly compacted select subgrade free from rocks that could puncture the plastic. Over the plastic provide a bed of sand, crushed stone or fine gravel not less than 152 mm 6 inches thick. Stabilize the bed with an approved material and shape to the tank bottom. Slope bed down to the center sump approximately 152 mm 6 inches for each 3 meters 10 feet of tank radius. When in place, tank shell shall be plumb.

(2) Concrete base shall be as indicated and in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

(3) Mastic Seal: Place the mastic seal between the tank and the concrete ring to the cross section indicated. Compact the mastic thoroughly. Immediately before placing the mastic, coat the tank surfaces to be in contact with the concrete ring with a coat of MIL-C-18480 bituminous material.

3.1.3 Piping

Unless specified otherwise, erection, welding, brazing, testing and inspection of piping shall be in accordance with ASME B31.1 and Section 40 17 26.00 20 WELDING PRESSURE PIPING. Piping shall follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings shall be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until piping has

been inspected, tested, and approved. Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected and building structure shall not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, vertical piping shall run plumb and straight and parallel to walls. Piping connected to equipment shall be installed to provide flexibility for vibration. Support and anchor piping so that weight of the piping is not putting equipment under a load.

3.1.3.1 Fittings

Provide long radius elbows on welded piping to reduce pressure drops due to bends in the piping runs. Do not miter pipe to form elbows or notch straight runs to form full sized tees, or similar construction. Make branch connections with welding tees or factory made forged welding branch outlets and nozzles having integral reinforcements conforming to ASME B31.1.

3.1.3.2 Grading of Pipe Lines

Unless indicated otherwise, install horizontal lines of steam and return piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where flow may be either direction. Pitch air lines to the source of supply, and make provisions for draining off condensate. Install water lines to drain to a shutoff valve.

3.1.3.3 Anchoring, Guiding, and Supporting Piping

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NOTE: Pipe hangers and supports shall be spaced and designed to support steam piping filled with water for hydrostatic tests.

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Anchor and support piping in a manner such that expansion and contraction will take place in the direction desired, prevent vibration by use of vibration dampeners, and prevent undue strains on boilers and equipment served. Fabricate hangers used for the support of piping of 50 mm 2 inch nominal pipe size and larger to permit adequate adjustment after erection while still supporting the load. Provide wall brackets where pipes are adjacent to walls or other vertical surfaces which may be used for supports. Provide supports to carry the weight of the lines and maintain proper alignment. Provide inserts and sleeves for the supports in concrete where necessary and place in new construction before pouring concrete. Provide insulated piping with a pipe covering protection saddle at each support. Provide pipe guides and anchors of approved type at points where necessary to keep pipes in accurate alignment, to direct expansion movement, and to prevent buckling and swaying and undue strain. Provide pipe guides for alignment of pipe connecting the free unanchored ends of each expansion joint. Support pipe rollers in concrete conduits and trenches by extra strong steel pipe with ends inserted in slots provided in concrete walls. Set pipe supports for rollers at correct elevations either by metal shims or by cutting away of concrete and after placing pipe lines in alignment, grout ends of pipe supports and fix in place. Space pipe supports to provide adequate support for pipes. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports, caused by the weight of the pipe, medium in the pipe, insulation, valves, and fittings. Maximum spacing for pipe supports for

steel pipe shall be in accordance with ASME B31.1; maximum spacing for supports for copper tubing shall be in accordance with NAPHCC NSPC.

3.1.3.4 Copper Tubing

Copper tubing shall have solder joints with solder suitable for the pressure-temperature ratings of the piping system. Tubing 20 mm 3/4 inch and smaller for instrument air may be compression joint in lieu of soldered joint. Tin-antimony (95/5) solder is suitable for saturated steam up to 103 kPa (gage) 15 psig but tin lead (50/50) solder is not acceptable for steam service. Flux shall be non corrosive. Wipe excess solder from the joints.

3.1.3.5 Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry and concrete walls, floors, and partitions. Space between pipe, tubing, or insulation and the sleeve shall be not less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, and slabs. Sleeves in floor slabs shall extend 13 mm 1/2 inch above the finished floor. Firmly pack space between pipe or tubing and the sleeve with oakum and caulk on both ends of the sleeve with elastic cement.

3.1.3.6 Flashing for Buildings

Where pipes pass through building roofs and outside walls, provide proper flashing and counter flashing and make tight and waterproof.

3.1.3.7 Outlets for Future Connections

Locate as directed capped or plugged outlets for connections to future equipment, when not located exactly by the project drawings.

3.1.3.8 Screwed Joints in Piping

Provide teflon tape or suitable pipe joint compound applied to male threads only for making up screwed joints. Piping shall be free from fins and burrs. Ream or file out pipe ends to size of bore, and remove chips.

3.1.3.9 Welded Joints

Weld joints in piping by the metal-arc or gas welding processes in accordance with ASME B31.1 and as specified in Section 40 17 26.00 20 WELDING PRESSURE PIPING. Number or mark each weld to identify the work done by each welder on welds on which stress relieving or radiographic inspection is required.

a. Contracting Officer reserves the right to require the Contractor to provide re-examination and re-certification of welders.

b. Radiographic testing of circumferential butt welded joints of pipe with operating temperature of 177 degrees C 350 degrees F and above shall be required on ten percent of the joints, the location of which will be determined by the Contracting Officer; when more than ten percent of the radiographically tested joints show unacceptable defects radiographically test joints of this type piping.

c. Equipment and Protection: Items of equipment for welding shall be so designed and manufactured, and shall be in such condition as to enable qualified operators to follow procedures and to attain the results specified. Protect welders and gas cutters from the light of the arc and flame by approved goggles, shields, helmets, and gloves. Replace cover glasses in helmets and shields when they become sufficiently marred to impair the operator's vision. Take care to avoid risk of explosion and fire when welding and gas cutting near explosive or flammable materials. Ventilate welding and gas cutting operations in accordance with paragraph 29 CFR 1910-SUBPART Q (f) of Title 29 of the Code of Federal Regulations).

d. Surface Conditions: Do not weld when atmospheric temperature is less than minus 18 degrees C zero degrees F, when surfaces are wet, when rain or snow is falling or moisture is condensing on surfaces to be welded, nor during periods of high wind, unless welder and work are protected properly. At temperatures between zero and minus 18 degrees C 32 and zero degrees F heat with a torch the surface for an area within 80 mm 3 inches of the joint to be welded to a temperature warm to the hand before welding. Free surfaces to be welded from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth, uniform and free from fins, tears, and other defects which might affect proper welding. Remove slag from flame-cut edges to be welded by grinding, but temper color need not be removed. Thoroughly clean each layer of weld metal by wire brushing prior to inspection or deposition of additional weld metal.

3.1.3.10 Cleaning of Piping

Before installing pipe, thoroughly clean it of sand, mill scale and other foreign material. After erection but before final connections are made to apparatus thoroughly clean interior of piping. Flush with water piping except air and fuel lines, in addition, blow out steam lines with intermittent high pressure steam blows to promote shedding of internal scale; blow compressed air and fuel oil lines clean with 552 to 690 kPa (gage) 80 to 100 psig air dried to a 2 degrees C 35 degree F dew point at 552 kPa (gage) 80 psig. Sterilize potable water piping by means of liquid chlorine or hypochlorite in accordance with AWWA C651 before placing water system in service. Take care during fabrication and installation, to keep piping, valves, fittings and specialties free of loose welding metal chips of metal or slag, welding rods and other foreign matter. Blowing or flushing shall in no case be channeled through equipment, pump, control valve, regulating valve, instrument gage or specialty in the system. Provide temporary screens, strainers, connections, spool pieces and bypasses consisting of piping or hoses, pumps and other required equipment temporarily installed for the purpose of cleaning and flushing piping. Drain flushing water and test water to the sanitary sewer system.

3.1.3.11 Reduction in Pipe Size

Provide reducing fittings for changes in pipe size; the use of bushings will not be permitted. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain the bottom of the lines in the same plane. In horizontal water mains, reducers shall be set to maintain top of lines in the same plane.

3.1.3.12 Expansion Control

Provide bends, loops, and offsets wherever practical to relieve

overstressed piping systems due to thermal expansion and to provide adequate flexibility. Cold spring piping system as indicated but not more than an amount greater than 50 percent of the total linear expansion.

3.1.3.13 Connection to Equipment

Provide unions or flanges where necessary to permit easy disconnection of piping and apparatus. Provide unions and gate valves at each connection to threaded end control valves, strainers and equipment.

3.1.3.14 Valve Installation

Install valves in positions accessible for operation and repair. Install stems in a vertical position with handwheels or operators on top or in a horizontal position. Do not install handwheels on stop valves below the valve. When the centerline of any valve is more than 2 meters 7 feet above the floor or platform, provide the valve with a chain-operated handwheel. When the valve is motorized, provide hand operation for emergency use.

a. Gate Valves: Arrange back outlet gate valves for turbine exhaust for hand operation and provide with a floor stand.

b. Globe Valves: Pressure shall be below the disc. Install globe valves with stems horizontal on steam and exhaust lines, when better drainage is required or desired.

c. Steam Pressure-Reducing Valves: Provide the steam line entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two shutoff valves and with a globe or angle bypass valve and bypass pipe. A bypass around a reducing valve shall be of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure-reducing valve unit with indicating steam gages to show the reduced pressure and the upstream pressure and an adequately sized safety valve on the low pressure side.

d. Valve Tags and Charts: Permanently tag each valve with a black and white engraved laminated plastic tag showing valve number, valve function and piping system and whether another valve must be opened or closed in conjunction with this valve. Provide a typed chart which will show the required valve tagging plus the location of each valve; frame valve charts under glass and install as directed.

3.1.3.15 Traps and Connections

Traps shall be of the type and capacity for the service required, and shall be properly supported and connected. Except for thermostatic traps in pipe coils, radiators, and convectors, install traps with a dirt pocket and strainer between it and the piping or apparatus it drains. Whenever it is necessary to maintain in continuous service apparatus or piping which is to be drained, provide a three valve bypass so that the trap may be removed and repaired and condensate drained through the throttled bypass valve. Provide a check valve on the discharge side of the trap whenever the trap is installed for lift or operating against a back pressure, or it discharges into a common return line. Provide test connections on the discharge side of the high and medium pressure traps when they are specifically required. Test connection shall include a 15 mm 1/2 inch globe valve with open blow.

3.1.3.16 Pressure Gage Installation

Pressure gages shall have a shutoff valve or petcock installed between the gage and the line, and gage on steam lines shall have a siphon installed ahead of the gage.

3.1.3.17 Thermometer and Sensing Element Installation

Provide thermometers and thermal sensing elements of control valves, with a separable socket. Install separable sockets in pipe lines in such a manner to sense flowing fluid temperature and minimize obstruction to flow.

3.1.3.18 Strainer Locations

Provide strainers with meshes suitable for the services upstream of each control valve and where dirt might interfere with proper operation of valve parts, orifices, or moving parts of equipment.

3.1.3.19 Dissimilar Piping Materials

Provide dielectric unions or flanges between ferrous and nonferrous piping, equipment, and fittings, except that bronze valves and fittings may be provided without dielectric couplings for ferrous-to-ferrous or nonferrous-to-nonferrous connections. Dielectric fittings shall utilize a nonmetallic filler which will prevent current flow from exceeding one percent of the short circuit current. Spacer shall be suitable for the pressure and temperature of the service. Fittings shall otherwise be as specified in this section.

3.1.3.20 Surface Treating, and Pipe Wrapping

Uninsulated steel piping buried in the ground shall have exterior surfaces protected with a tape wrapping system or a continuously extruded polyethylene coating system as specified in Section 09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS.

3.1.4 Painting

Unless specified otherwise, pipe hangers, structural supports, pipe and pipe fittings, conduit and conduit fittings, air grilles, pipe coverings, insulation, and metal surfaces associated with mechanical and electrical equipment including zinc-coated steel ducts shall be painted utilizing the painting systems as specified in Section 09 90 00 PAINTS AND COATINGS. Zinc-coated steel duct in unpainted areas shall not be painted. Piping to be insulated, except zinc-coated and copper pipe, shall be given a protective coating prior to installing the insulation.

3.1.4.1 Piping, Fittings, and Mechanical and Electrical Equipment

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for particular end item. Factory finished equipment on which the finish has been damaged shall have damaged areas retouched and then be given a complete finish coat to restore the finish to its original condition. Finish coat shall be suitable for exposure in the intended end use environment.

3.1.4.2 Boilers

After erecting and testing boilers, clean as necessary exposed surfaces of boiler normally painted in commercial practice to remove grease, coal dust, flyash and other foreign matter and finish with one coat of aluminum heat resisting paint applied to minimum dry film thickness of 0.025 mm one mil.

3.1.4.3 Vertical Fuel Oil Tank

Clean interior surfaces to bare metal in accordance with SSPC SP 10/NACE No. 2. Clean to bare metal by powered wire brushing or other mechanical means surfaces that cannot be cleaned satisfactorily by blasting. Wash members which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Remove weld backing plates prior to blast cleaning; when left in place, round off corners prior to blast cleaning and coating. Internally coat tanks in accordance with Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS.

3.1.4.4 Surfaces Not to be Painted

Unless specified otherwise, do not paint equipment having factory applied permanent finish, switchplates and nameplates, motor starters, and concrete foundations.

3.1.5 Insulation

Insulate mechanical equipment, systems and piping as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2 FIELD QUALITY CONTROL

Furnish labor, equipment, test apparatus required and materials for preparation and performance of tests and inspections specified to demonstrate that the steam heating plant as installed, are in compliance with contract requirements. During start-up and during tests, ensure the presence of factory trained engineers or technicians employed by the boiler manufacturer and system suppliers of such components as the boiler, stoker, burner, combustion controls, ash handling system, air pollution control system, feedwater treatment equipment, and other auxiliary equipment, to ensure proper functioning, adjustment, and testing of the individual components and systems. Furnish a detailed written record of test conditions, test procedures, field data, and the start-up and operational performance of the entire heating plant to the Contracting Officer before the Contractor's operational and test personnel leave the site. The Government will furnish, when available, water, electricity and fuel for the tests, except fuel required for retesting. The Contractor shall rectify defects disclosed by the tests and retest the equipment. The Contractor's boiler plant personnel shall be experienced in starting up and operating boiler plants.

3.2.1 Tests and Inspections (Piping)

Examine, inspect, and test piping in accordance with ASME B31.1 except as modified below. The Contractor shall rectify defects disclosed by the tests. Necessary subsequent tests required to prove system tightness after additional work by the Contractor shall be furnished by the Contractor. Make tests under the direction of and subject to the prior

approval of the Contracting Officer.

3.2.1.1 Hydrostatic and Leak Tightness Tests

a. Test piping systems attached to the boilers and included under the jurisdiction of ASME BPVC SEC I in accordance with the requirement of that Code. Piping bearing ASME Code symbol stamp will be accepted only as indicating compliance with the design and material requirements of the code.

b. Test piping which is a part of the steam generation or auxiliary systems, including piping within the boiler room and external to the boiler room, by the following methods:

(1) Perform hydrostatic test at 150 percent of design pressure for welded and screwed steel piping systems except those for air, oil, and gas. Hold hydrostatic tests for a period of one hour with no pressure loss. Temperature of testing fluid shall not exceed 38 degrees C 100 degrees F.

(2) Test air and oil lines in accordance with the requirements of ASME B31.1 for pneumatic tests with the exception that the test pressure must be held for one hour. Examine for leaks by a soap or other foaming agent test.

(3) Inspection and test of gas piping shall conform to the requirements of NFPA 54.

c. For each test, install a calibrated test pressure gage in the system to observe loss in pressure.

3.2.2 Preliminary Operation

The Contractor under the direction of the respective manufacturer's representative shall perform the work of placing in operation equipment provided by the Contractor, except as specifically noted otherwise. Make adjustments to equipment that are necessary to ensure proper operation as instructed by the manufacturer of the equipment.

a. Lubricate equipment prior to operation in accordance with the manufacturer's instructions. Lubricants shall be provided by the Contractor. Contractor shall furnish lubrication gun with spare cartridges of lubricant to operating personnel.

b. Dry out motors before operation as required to develop and maintain proper and constant insulation resistance.

c. Check drive equipment couplings for proper alignment at both ambient and operating temperature conditions.

3.2.3 General Startup Requirements

Prior to initial operation of complete system, check each component as follows:

a. Inspect bearings for cleanliness and alignment and remove foreign materials found. Lubricate as necessary and in accordance with the manufacturer's recommendations. Replace bearings that run roughly or noisily.

b. Adjust direct drives for proper alignment of flexible couplings. Provide lubrication when a particular coupling so requires. Check security of couplings to driver shafts. Set drive components to ensure free rotation with no undesirable stresses present on the coupling of attached equipment.

c. Check motors for amperage comparison to nameplate value. Correct conditions that produce excessive current flow and that exist due to equipment malfunction.

d. Check speeds of each motor and driven apparatus to ensure that they are operating at the desired point.

e. Check the actual suction and discharge pressure of each pump against the desired performance curves.

f. Check pump packing glands or seals for cleanliness and adjustment before running each pump. Inspect shaft sleeves for scoring and proper placement of packing; replace when necessary. Ensure piping system is free of dirt and scale before circulating liquid through pumps.

g. Inspect both hand and automatic control valves. Clean bonnets and stems, tighten glands to ensure no leakage, but permit valve stems to operate without galling. Replace packing in valves that require same to retain maximum adjustment after system is judged complete. Replace entire packing in valves that continue to leak after adjustment. Remove and repair bonnets that leak. Coat packing gland threads and valve stems with a suitable surface preparation after cleaning.

h. Inspect and make certain that control valve seats are free from foreign material and are properly positioned for the intended service.

i. Check flanges and packing glands after the system has been placed in operation. Replace gaskets in flanges that show signs of leakage after tightening.

j. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.

k. Strainers installed shall be thoroughly blown out through individual valved blow-off connection on each strainer prior to placing in operation.

l. Thoroughly blow out or dismantle and clean strainers after systems have been in operation one week. Thoroughly clean, repair, and place back in service traps or other specialties in which foreign matter has accumulated, causing malfunction or damage.

m. Adjust pipe hangers and supports for correct pitch and alignment.

n. Remove rust, scale and foreign materials from equipment and renew defaced surfaces. When equipment is marred, the Contracting Officer shall have the authority to request that new materials be provided.

o. Adjust and calibrate temperature, pressure and other automatic control

systems.

p. Inspect each pressure gage and thermometer for calibration, and replace those that are defaced, broken or read incorrectly.

q. Vertical Fuel Oil Tank Calibration: After completing installation of tank, prepare a calibration table for the tank showing volume of fuel in liters gallons in tank to any height of liquid in meters and mm feet, inches, and eighths of an inch when measured by a steel tape lowered through the roof. Calibrate tank in accordance with ASTM D1220 for "critical measurement" "operating control." Correct the data obtained for use with the product to be stored.

3.2.4 Plant Equipment Tests

3.2.4.1 Plant Air Compressors

Test plant air compressors in service to determine compliance with contract requirements and warranty. During the tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.2.4.2 Coal Handling System

Test coal handling system under operating conditions and demonstrate that the work is in conformance with the specified requirements. Conduct this test in the presence of the Contracting Officer.

3.2.4.3 Fuel Oil Tanks

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NOTE: Choose one of following subparagraphs.
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[a. Horizontal Fuel Oil Tanks (Below Ground)

(1) Test tanks before placing in service, in accordance with the applicable paragraphs of the code under which they were built. A UL label, ASME Code Stamp, or API monogram on a tank shall be evidence of compliance with code requirements.

(2) Holiday Detection Test: Inspect coal tar epoxy coating system for film imperfections using a low voltage (75 volt) holiday tester. Inspect FRP coated tanks with a 10,000 volt spark test for imperfections or holidays. Repair holidays or pinholes in the coatings.

][b. Vertical Fuel Oil Tank: Inspect and test as specified in API Std 650. Use the radiographic method of inspection of butt welds as required by API Std 650; sectioning method will not be acceptable as an alternative to radiographic inspection.

]3.2.4.4 Blowdown Valves and Try Cocks

Test blowdown valves and try cocks for proper operation.

3.2.4.5 Fans, Heaters, Pumps, and Motors

Test draft fans, fuel oil heaters, fuel pumps, and electric motors to determine compliance with the referenced standards. Standard symbols and certifications from the referenced organization may be accepted at the discretion of the Contracting Officer. Closely observe the operation of fans, fuel oil heaters, fuel pumps, and electric motors for possible defects or nonconformance.

3.2.5 Boilers and Auxiliaries Tests and Inspections

The Contractor, with qualified personnel provided by the Contractor, shall make tests and inspections at the site under the direction of and subject to the approval of the Contracting Officer. Furnish direction of the Contractor's boiler plant personnel in the operation of each boiler and appurtenances through the entire testing period, from the respective manufacturer's representatives and consultants and ensure that necessary adjustments have been made. The Contractor shall notify the Contracting Officer in writing at least 7 days in advance that equipment is ready for testing. The Contractor shall furnish testing equipment, including gages, thermometers, calorimeter, Orsat apparatus, thermocouple pyrometers, fuel flow meters, water meters and other test apparatus and calibrate instruments prior to the test. Draft, fuel pressure and steam flow may be measured by permanent gages and meters installed under the contract. The Contractor is responsible for providing an analysis of the fuel being used for the tests. Control of noise levels developed by exhaust steam shall be as directed by the Contracting Officer to satisfy the environmental conditions of the surrounding area. The Contractor shall perform the following tests when feasible in the sequence as listed:

a. Strength and tightness tests

b. Standards compliance tests

c. Preliminary operational tests (steady state combustion test and variable load combustion test)

d. Tests of auxiliary equipment

e. Feedwater equipment test

f. Capacity and efficiency tests

3.2.5.1 Strength and Leak Tightness Tests

Subject boilers to the following strength and tightness tests:

a. Watersides Including Fitting and Accessories: Hydrostatically test watersides in accordance with the requirements of ASME BPVC SEC I The ASME label will be accepted as evidence of this test.

b. Boiler Casing, Air Casing, and Ducts: Test air casing and ducts exterior to the furnace pneumatically at the maximum working pressure. Use the soap bubble method to verify tightness. Test gas sides of boilers normally operated under pressure for tightness at one and one half times the predicted operating pressure in the furnace at maximum continuous output. For this test, tightly seal the boiler with a suitable means to blank off openings. Admit air to the boiler until the test pressure is reached, and then hold. When, in a 10

minute period the pressure drop does not exceed 1245 Pa 5 inches water gage, the casing shall be regarded as tight and accepted. Use air pressure and soap bubble tests or comparative carbon dioxide readings for induced draft boilers.

3.2.5.2 Boiler Inspection

The Boiler Inspector shall be present to witness the appropriate tests which need to be observed in order to certify the safety of the boiler. The inspection shall include the requirements of NAVFAC MO 324. The Boiler Inspector shall complete NAVFAC form 9-11014/40, Data Record Sheet; NAVFAC form 9-11014/41, Inspection Report; NAVFAC 9-11014/32 Inspection Certificate for each boiler after inspecting the boiler and finding it to be safe. No boiler may be fired until it has passed the inspection of the Boiler Inspector. The boiler inspection forms shall be submitted through the Contractor to the Contracting Officer. The Inspection Certificate shall be placed under framed glass, mounted on or near the boiler in a conspicuous location.

3.2.5.3 Boiler Cleaning and Startup

Dry out, boil out, and operate the firing rate of the new boiler(s) under direct responsibility and supervision of the manufacturer[, and in the presence of the boiler room operating personnel]. Provide chemicals that are required. Allow sufficient time for the boiling out process to ensure interior surfaces are clean. This time shall be at least 24 continuous hours and generally not more than 36 hours; boil out shall continue until water is clear. Boil out, cleaning and starting procedures shall be in accordance with requirements of ASME BPVC SEC VII, and FM DS 12-17.

3.2.5.4 Boiler Preliminary Operational Tests

Conduct a boiler operational test on each unit continuously for two weeks. Operate one boiler at a time to demonstrate control and operational conformance to specified requirements including ability to respond to load swings from the specified capacity to minimum turndown. Operational test shall be conducted under the supervision of a registered professional engineer or a licensed power plant operator and shall serve to prove safeties, controls, maintenance of stable combustion at low loads[, proper coal distribution and combustion, and ability to operate without furnace slagging][, proper flame lengths and patterns to avoid flame impingement on the tubes for oil firing], and proper mechanical and electrical functioning of systems. This test shall include each item mentioned in this specification as well as each item mentioned in the specification of the particular pieces of equipment. Conduct tests with factory trained combustion equipment engineers, as previously specified. Test and record steam quality rates of steam flow, flue gas temperature, percentages of carbon dioxide, carbon monoxide, oxygen and nitrogen in the flue gas and percent excess air for each boiler at tested load and graphically present test data.

3.2.6 General Operational Tests

3.2.6.1 General Controls

Operational tests, performance tests, and demonstration tests shall be conducted with boiler controls functional and on line. No bypassing, use of jumpers, or other disablement of control systems will be allowed unless specified elsewhere.

3.2.6.2 Steady State Combustion Tests

Test fuel burning and combustion control equipment with each of the specific fuels at the minimum limit of the turndown range and at increments of 50, 75 and 100 percent of full rated load. Each test run shall be at least two hours on each fuel and until stack temperatures are constant and capacity and efficiency requirements of this specification have been verified and recorded. Verify proper operation of instrumentation and gages during the tests.

3.2.6.3 Varying Load Combustion Tests

Test boilers continuously under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control and safety interlocks. Conduct these tests after adjustment of combustion controls has been completed under the steady state combustion tests. Continue variable load operational tests for a period of at least 8 hours.

a. Sequencing: Boiler shall start, operate and stop in strict accordance with the specified operating sequence.

b. Flame Safeguard: Verify operation of flame safeguard controls by simulated flame and ignition failures. Verify trial-for-pilot ignition, trial-for-main flame ignition, combustion control reaction and valve closing times by stop watch.

c. Immunity to Hot Refractory: Operate burner at high fire until combustion chamber refractory reaches maximum temperature. Main fuel valve shall then be closed manually. Combustion safeguard shall drop out immediately causing safety shutoff valves to close within the specified control reaction and valve closing times.

d. Pilot Intensity Required: Gradually reduce fuel supply to the pilot flame to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. When the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, the boiler shall be rejected.

e. Boiler Limit and Fuel Safety Interlocks: Safety shutdown shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

f. Combustion Controls: Demonstrate accuracy, range and smoothness of operation of the combustion controls by varying steam demand through entire firing range required by turndown ratio specified for the burner. Control accuracy shall be as specified.

g. Safety Valves: High pressure limit switch shall be locked out or otherwise made inoperative and the boiler safety valves shall be lifted by steam. Determine the relieving capacity, popping pressure, blowdown and reseating pressure by observation and measurement in accordance with the ASME BPVC SEC I. The ASME standard symbol will be accepted only as indicating compliance with the design and material requirements of the code.

3.2.6.4 Auxiliary Equipment and Accessory Tests

Observe and test blowdown valves, stop valves, try cocks, draft fans, fuel oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctions, defects, and for compliance with referenced standards.

3.2.6.5 Feedwater Equipment Tests

Perform the test of the feedwater treatment equipment in two steps. Conduct one test concurrently with the combustion tests. The Government will perform a second test during the first period of heavy loading after the plant has been accepted and put in service. Correct deficiencies revealed during the Government tests under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with the limits for chemical concentrations of this specification. Supply equipment for taking samples and test kit for analyzing samples. Sampling equipment and test kit shall become the property of the Government when tests are completed.

3.2.6.6 Capacity and Efficiency Tests

Perform capacity and efficiency tests after operating tests have been satisfactorily completed and boiler has been operated continuously for at least 14 days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. Perform these tests on each boiler. Conduct tests using [the] [each] specified fuel. Test procedures shall be in accordance with the heat loss method [and the input-output method] of ASME PTC 4. Before performing tests, the Contracting Officer and the Contractor shall reach agreement on those items identified in ASME PTC 4 Section 3, paragraph 3.0l "Items on Which Agreement Shall be Reached." A test run shall not start until the boiler and accessories have reached an equilibrium and stabilization condition for at least one hour in duration. Duration of tests shall be sufficient to record necessary data but in no case shall each run be less than [4] [10] [24] hours.

a. Accomplish maximum output testing by means of a single 2 hour run at 110 percent load on the boiler under test. Calculate boiler efficiency, both input-output and heat loss, from the consistent readings taken during the runs. Runs shall be made at four different loads 30, 50, 70, and 100 percent of boiler rating during which both heat loss and input-output data shall be taken. Predict unmeasured losses used in conjunction with heat loss calculations and include with equipment data when submitted for approval. Subsequent tests required because of failure of the equipment to perform adequately during specified capacity and efficiency tests shall be the financial responsibility of the Contractor, including the cost of fuel.

b. Should analysis of the coal being burned during performance tests vary from that specified as the performance coal, the guarantees shall be adjusted in accordance with accepted engineering practice to determine compliance. Carbon loss shall be determined in accordance with American Boiler Manufacturers Association curves for carbon loss.

3.2.6.7 Temporary Waste Steam Connection

When necessary to obtain sufficient load for these tests, provide a temporary steam line at a point outside of building. Provide necessary

pipe, fittings, supports, anchors and appurtenances including a field fabricated silencer as directed by the Contracting Officer. Remove temporary piping and silencer after tests have been satisfactorily completed.

3.2.6.8 Fire Safety for Oil-Fired Boilers

Conduct tests as necessary to determine compliance with the applicable UL Safety Standards. The presence of the applicable Underwriters' label may be accepted as evidence of compliance in this respect when equipment is manufacturer's standard commercial product.

a. Oil-Fired Boilers: Meet test requirements of UL 726.

b. Oil Burners: Meet test requirements of UL 296.

3.2.6.9 Plant Acceptance Operation

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NOTE: Include bracketed portion when project is for coal fired installation with flue gas desulfurization system.

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After satisfactory completion of tests specified, operate complete plant including each boiler [and its related flue gas cleaning equipment] and subsystems for a period of 30 continuous 24 hour operational days prior to final acceptance by the Government. Furnish labor, chemicals, test equipment and apparatus; the Government will furnish fuel, electricity and water. During this 30 day period, furnish readily available, services of qualified representatives from manufacturers of each plant component and system for the purpose of additional operational assistance, component and system adjustment and repairs. Government personnel will observe Contractor's operational procedures. The Contractor's representatives shall be prepared to answer pertinent questions from the Government about the plant operation.

3.2.6.10 NAVFACENGCOM Acceptance

Operational, piping systems, auxiliary equipment and accessory testing shall be completed prior to requesting an acceptance inspection by a Naval Facilities Engineering Command (NAVFACENGCOM) Boiler Inspector. The Contracting Officer, upon receipt of 14 calendar days advance notice from the Contractor, shall request that the boiler plant by a qualified NAVFACENGCOM Boiler Inspector. Contractor shall perform final operational performance testing of all plant systems in the presence of the NAVFACENGCOM Boiler Inspector, at the inspector's discretion. The NAVFACENGCOM Boiler inspector shall receive copies, and review the results, of all pertinent operational test reports before approving acceptance of the boiler plant by the Government.

3.2.7 Manufacturer's Field Services

3.2.7.1 Erection/Installation Supervisors and Service Engineers

a. Boiler: Furnish the services of a competent supervisor who is in the direct employ of the boiler manufacturer. This supervisor shall remain on the construction site the full 8 hours per day, 5 days per week, or the same hours as the boiler erectors are on the job. This

supervisor shall be responsible for the complete steam generating unit, including the steam generator, stoker, fans and related work, such as refractory, or insulation regardless of whether the stoker, fans or other related items of work are furnished by manufacturers other than the boiler manufacturer.

b. Stoker: Furnish a competent erection supervisor for the equipment furnished by the stoker manufacturer.

c. Fans: Furnish a company service engineer to advise on the erection or installation of fans and related equipment.

d. Service Engineers: Furnish services of the manufacturing companies' service engineers and the system suppliers' service engineers to advise during erection and installation of other systems and equipment such as control system, ash handling system, coal handling system, air compressors, air dryers, boiler feedwater pumps, fuel oil pumps, condensate pumps, water treatment equipment, chemical feed pumps, deaerating feedwater heater and stacks.

3.2.7.2 Boiler and System Representatives

Furnish factory trained engineers or technicians who are representatives of the boiler manufacturer and system supplier to supervise testing of the boilers and auxiliary equipment.

Furnish the services of a Boiler Inspector who is qualified and certified as such by the National Board of Boiler and Pressure Vessel Inspectors and who is presently employed full time by a firm, such as Hartford Steam Boiler Inspection and Insurance Company, which has a business of inspecting boilers.

3.2.7.3 Instruction to Government Personnel

Supervisors and service engineers shall provide instruction for the Government's operators in the operation and maintenance of the equipment furnished under this section. The minimum number of hours provided shall

be as follows:

Equipment	Operation Instruction	Maintenance Instruction
Boiler and auxiliaries	40 hours	16 hours
Stoker	40 hours	16 hours
FD and ID fans	16 hours	16 hours
Coal handling system	16 hours	32 hours
Ash handling system	24 hours	8 hours
Air compressors and dryers	8 hours	16 hours
Boiler feedwater pumps	8 hours	8 hours
Miscellaneous equipment	16 hours	16 hours

-- End of Section --