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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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

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

SECTION 23 72 00.00 10

ENERGY RECOVERY SYSTEMS

01/08

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 WELDING PROCEDURES AND QUALIFICATIONS
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 EXTRA MATERIALS
1.5.1 Tube Cleaner
1.5.2 Tube Brush
1.5.3 Smoke Pipe Cleaner
1.5.4 Special Wrenches
1.5.5 Spare Parts
1.6 OPERATION AND MAINTENANCE MANUALS

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Standard Products
2.1.2 Nameplates
2.1.3 Prevention of Rust
2.1.4 Equipment Guards and Access
2.2 HEAT RECOVERY EQUIPMENT
2.2.1 Diesel Engine Cooling
2.2.1.1 Antifreeze
2.2.1.2 Water Jacket Temperature
2.2.1.3 Construction
2.2.2 Electrical Equipment
2.2.2.1 Motor Ratings
2.2.2.2 Motor Controls
2.2.3 Heat Recovery Silencer for Diesel Engine
2.2.4 Heat Recovery Section for Gas Turbine
2.2.5 Steam Separator Unit
2.2.6 Condensate Pumps and Receiver
2.2.7 Load Control Condenser

2.2.7.1 Air-Cooled Condenser
2.2.7.2 Water-Cooled Condenser
2.2.8 Pressure-Operated Control Valve
2.2.9 Auxiliary Boiler for Supplemental Firing
2.2.10 Forced Circulation Pump
2.2.11 Heat Exchangers
2.2.11.1 Lube Oil Cooling
2.2.11.2 Fuel Oil Preheating
2.2.11.3 Condensate Heat Exchanger
2.2.12 High Temperature Water Heat Recovery Systems
2.2.13 Pressure Gauges
2.2.14 Thermometers
2.3 WATER TREATMENT EQUIPMENT
2.4 INSULATION

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.3 CLEANING OF BOILERS AND PIPING
3.3.1 Boiler Cleaning
3.3.2 Boiler Water Conditioning
3.4 POSTED INSTRUCTIONS
3.5 FIELD TRAINING
3.6 TESTS
3.7 EFFICIENCY AND OPERATING TESTS
3.8 RETESTING
3.9 FIELD PAINTING

-- End of Section Table of Contents --

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 23 72 00.00 10

ENERGY RECOVERY SYSTEMS
01/08

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NOTE: This guide specification covers the requirements for energy recovery systems for power plant installations where a steady source of waste heat is available.

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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PART 1 GENERAL

1.1 REFERENCES

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

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

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

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

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2022) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes

ASTM INTERNATIONAL (ASTM)

ASTM D1066	(2018; E 2018) Standard Practice for Sampling Steam
ASTM D2186	(2005; R 2009) Deposit-Forming Impurities in Steam

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

1.2 SUBMITTALS

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

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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

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

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

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

Installation

SD-03 Product Data

Calculations

Welding Procedures and Qualifications

Spare Parts

Posted Instructions

Performance Tests; G[, [_____]]

SD-06 Test Reports

Tests

SD-10 Operation and Maintenance Data

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

1.3 WELDING PROCEDURES AND QUALIFICATIONS

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NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement.

****

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

1.4 DELIVERY, STORAGE, AND HANDLING

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

1.5 EXTRA MATERIALS

****

NOTE: If fire-tube boilers are specified, delete paragraph "Tube Cleaner;" if water-tube boilers are specified, delete paragraph "Tube Brush." If the boiler design utilizes bent tubes, both paragraphs "Tube Cleaner" and "Tube Brush" should be deleted.

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Furnish all special tools necessary for the operation and maintenance of boilers, pumps, fans, and other equipment. Furnish small hand tools with a suitable cabinet, mounted where directed.

1.5.1 Tube Cleaner

Provide water-driven type with three rotary cutters and rotary wire brush, complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation. Provide tube cleaner and rotary brush for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Provide necessary valves and fittings to permit quick connection of the raw water supply hose to one boiler feed pump for operation of the cleaner.

1.5.2 Tube Brush

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

1.5.3 Smoke Pipe Cleaner

Provide smoke pipe cleaner to clean the breeching and smoke connections.

Provide cleaner with a jointed handle long enough to clean breeching and smoke connections without dismantling the system.

1.5.4 Special Wrenches

Provide special wrenches as required for opening boiler manholes, handholes, and cleanouts.

1.5.5 Spare Parts

Submit spare parts data for each different item of equipment specified, after approval of the detail drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies with current unit prices and source of supply.

1.6 OPERATION AND MAINTENANCE MANUALS

****

NOTE: The designer should require the Contractor to prepare (in addition to providing O&M manuals for each piece of equipment) O&M manuals for the completed work which consists of diverse equipment integrated into a system not covered by instructions from a single manufacturer; in that case retain the first bracketed statement. Remove the first bracketed statement when the manufacturer's instructions are sufficient to operate and maintain the completed work.

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The manuals will be approved by [the Contracting Officer] [_____] before acceptance of the installed system. Submit [6] [_____] complete copies of operation manual for energy recovery system outlining the step-by-step procedures required for system startup, operation, and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment items and their basic operating features. Submit [6] [_____] copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and provide troubleshooting guide. Include in the manuals piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

PART 2 PRODUCTS

****

NOTE: In order to comply with Executive Order 13423 and Public Law 109-58 (Energy Policy Act of 2005), designs must achieve energy consumption levels that are at least 30 percent below the level required by ASHRAE 90.1 - 2004. In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and Federal Acquisition Regulation (FAR) 23.203 Energy-efficient Products must meet or exceed the performance criteria for ENERGY STAR®-qualified or FEMP-designated products as long as these requirements are nonproprietary. The FEMP and ENERGY STAR product requirements are available on the web at www.eere.energy.gov/femp/procurement and

www.energystar.gov/products. **Where ENERGY STAR or FEMP products are not applicable, energy consuming products and systems must meet or exceed the requirements of ASHRAE 90.1.**

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2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

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

2.1.2 Nameplates

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

2.1.3 Prevention of Rust

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

2.1.4 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located where personnel contact is possible. Guard or cover high temperature equipment and piping located within personnel contact or where a potential fire hazard exists with insulation of a type specified. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown and construct them in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 HEAT RECOVERY EQUIPMENT

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NOTE: Heat recovery equipment is closely associated with the prime mover and it will frequently be more advantageous to specify this equipment in the same section in which the prime mover is specified. The designer must insure that drawings defining the interrelationship between all components and design data such as flows, pressures, temperatures, and heat transfer rate are included.

Specify 2, 3, 4, or 8 degrees C 3, 5, 8, or 15 degrees F for the maximum temperature differential for coolant in and out of engine. Differential selected must be in accordance with engine

manufacturer's recommendations. The 2 degree C 3 degree F) range is for conventional ebullient cooling where the heat of evaporation is used to remove the rejected heat from the engine. A 8 degrees C 15 degree F differential across the engine is desirable for all other systems but may be limited by engine manufacturer's recommendations.
****

Provide a heat recovery system that is an integrated design package compatible with the prime mover [cooling] [and] [exhaust] system in accordance with the drawings and data sheets. Provide a [diesel engine exhaust waste heat boiler only to generate [saturated steam at [_____] Pa psig pressure] [hot water at [_____] degrees C degrees F and [_____] Pa psig pressure].] [diesel engine [jacket water cooling and heat reclaim system] [and] [lube oil cooling and heat reclaim facilities].] [diesel engine ebullient cooling system combining jacket water heat reclaim and exhaust waste heat boiler to generate up to 105 kPa 15 psig steam.] [gas turbine exhaust heat reclaim unit to generate [steam at [_____] Pa psig] [hot water at [_____] degrees C degrees F and [_____] Pa psig pressure].]

2.2.1 Diesel Engine Cooling

2.2.1.1 Antifreeze

[For ebullient cooling, provide a cooling system suitable for a combination of water and an azeotropic antifreeze compatible with the equipment (methoxy propanol) as a cooling medium, hereafter called the coolant.] [For cooling systems where steam is not required, utilize an ethylene glycol permanent type antifreeze. Base size of cooling system upon the use of an antifreeze solution which will protect the system down to minus 45 degrees C minus 50 degrees F.] Provide a permanent type antifreeze for cooling the lube oil and auxiliaries suitable for use with water, or use the antifreeze solution specified above and connect to a separate section of the waste heat condenser from the engine coolant. Provide valve trim and materials that are compatible for use with the antifreeze solution. Operation of the cooling system must be fully automatic while the prime mover is running.

2.2.1.2 Water Jacket Temperature

For diesel engine ebullient cooling, provide jacket water temperature no lower than 110 degrees C 230 degrees F, nor higher than 120 degrees C 250 degrees F in the steam separator at all loads with a maximum differential of [_____] degrees C degrees F for coolant in and out of the engine.

2.2.1.3 Construction

Where cooling system design is part of prime mover installation, components other than the wasteheat condenser and condensate receiver or pump units may be mounted on the engine skid extension. For any antifreeze cooling system, provide a PVC makeup tank with an electric motor-driven pump unit as indicated. Manifold pump to allow using it as a mixing unit by shunting the flow back to the tank. System fill must be [manual] [automatic] with feed into the piping system steel expansion tank connection line as indicated.

2.2.2 Electrical Equipment

Provide electric motor-driven equipment specified complete with motors and necessary motor control devices. Provide motors and motor control devices conforming to the applicable requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM including requirements for hazardous area locations. Provide premium efficiency integral size motors in accordance with NEMA MG 1.

2.2.2.1 Motor Ratings

Furnish motors that are suitable for the voltage and frequency provided. Motors 373 watt 1/2 horsepower and larger must be three-phase, unless otherwise indicated. Ratings must be adequate for the duty imposed, but not less than indicated.

2.2.2.2 Motor Controls

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

2.2.3 Heat Recovery Silencer for Diesel Engine

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NOTE: The degree of silencing will match the environmental requirement. In a retrofit installation, the unit should match the original silencer installation. As a general guide the attenuation will be approximately as follows:

Type of Silencer	Attenuation in dB	Measured at Octave Band Frequency (Hz)
Industrial	25	250
Semi-Residential	30	250
Residential, Critical Area	35	250
Quiet Residential	37.5	250

Indicate pressure required. For most low-pressure installations this will be 345 kPa 50 psig.

****

For each combination boiler silencer or supplementary silencer, reduce the generated sound spectrum to standard commercial level permitted for [industrial] [semi-residential] [residential, critical] area. Provide exhaust gas boiler that is a combination boiler silencer or a boiler with a supplementary silencer to meet the noise limits, and construct heat

recovery unit in accordance with ASME BPVC SEC VIII D1 for [_____] Pa psig steam working pressure. Design the boiler for maximum efficient heat recovery under any load condition up to 110 percent of full load with an exit exhaust gas temperature not less than 165 degrees C 330 degrees F. Design each boiler for continuous wet operation or for periods of dry operation without interruption of the diesel engine operation when located and connected as indicated. Make provisions for expansion and contraction to prevent overstressed conditions in the pressure vessel during continuous wet or dry operation. Gas side pressure drop through the boiler exceeding the recommendations of the engine manufacturer is not permitted. Provide each boiler with standard boiler trim including, but not limited to, pressure gauge, water gauge with try cocks, water level control, ASME-rated safety relief valve, surface blowoff valve, bottom blowdown valves, and bottom dump valves. Insulate the shell as required by the paragraph "INSULATION" and cover the insulation by lagging.

2.2.4 Heat Recovery Section for Gas Turbine

Furnish unit consisting of a [fire tube] [water tube or water wall] exhaust boiler equipped with an exhaust gas bypass. Design unit for the specified installation and provide a complete package with thermal insulation, controls, accessories, and base. The insulation must be in accordance with the paragraph "INSULATION." If heat recovery section does not meet the turbine exhaust sound levels specified, supply a supplementary exhaust silencer to meet specification requirements for both on-stream and bypass conditions.

2.2.5 Steam Separator Unit

Provide unit consisting of a combination flash tank and steam separator unit of sufficient size for the engine cooling and waste heat recovery system when engine is operated at 110 percent load in an ambient temperature of [40] [_____] degrees C [105] [_____] degrees F at [_____] m feet altitude. The unit must be complete with low-water alarm switch, low-level cutout switch (set at a level lower than the low-water alarm switch), pressure gauge, safety valve, gauge glass and cocks, vent valve, water-level control, high-water-level alarm, condensate-motor control, and blowdown connection. Position controls so that coolant level is visible in gauge glass at all times. Construct and certify the vessel in accordance with the ASME requirements and hydrostatically test conforming to ASME requirements. Use steam at 105 kPa 15 psig from this separator for [space heating] [and] [absorption cooling] [_____]. Insulate the unit as required by paragraph "INSULATION."

2.2.6 Condensate Pumps and Receiver

Furnish condensate unit with duplex pumps and receiver and skid-mount. Provide pump that is capable of full capacity at 120 percent full steam rate when all of the heat is wasted under 110 percent engine load in an ambient temperature of [40] [_____] degrees C [105] [_____] degrees F. Provide an alternator for automatically switching the pumps under response from the liquid level control of the steam generator units each time an ON-OFF cycle is completed. Provide electric motor-driven pumps with stainless steel shafts and bronze impellers for operation with condensate at 95 degrees C 200 degrees F. Control pump operation to maintain condensate level between high and low visible levels indicated on the glass gauge of the receiver. Provide receiver sized to hold at least enough condensate for 15 minutes of operation without raw water makeup and complete with skid mounting, gauge glass, float-type makeup water valve

with emergency manual valve, air vent, high-and low-level controlled pump switch, low-level alarm, and drain connection. Provide air vent suitable for use with coolant selected.

2.2.7 Load Control Condenser

Furnish condenser unit with a capacity to dissipate the heat rejected by the engine and its components at 110 percent full-rated load under temperature of [_____] degrees C degrees F and at [_____] m feet elevation from above sea level. The maximum coolant temperatures leaving the engine must not be in excess of that recommended by the engine manufacturer; however, temperature differential must not be greater than [_____] degrees C degrees F for coolant in and out of the engine.

2.2.7.1 Air-Cooled Condenser

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NOTE: Designer will select proper speed, based on air requirements. The larger units will generally require the slowest speed motor but the type of fan drive must also be considered. The fan speed and pitch of the blades are determined from manufacturer's rating data.

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Provide main core unit suitable for condensing the vapor generated during engine operation from zero to 110 percent of full load when there is no utilization of the steam for useful purposes. Use a secondary core for cooling the auxiliary system coolant. The condenser must be the [vertical] [horizontal] air discharge type with round tubes. Construct fins and tubes of nonferrous materials; provide carbon steel headers of the plug type. Firmly bond fins to tubes; construct tanks and supporting framework of steel; and construct adjustable-pitch fan of aluminum. Make inlet and outlet coolant connections on one side. Install a drain cock at the low point of each core. Provide a welded structural frame for entire unit, drilld and arrange for mounting on a concrete base, and design to withstand winds up to [80] [_____] km/hour [50] [_____] mph. [Provide hail screens in areas where hails storms are prevalent.] Provide reliefs to protect against excessive pressures and temperatures developed in the system.

a. Furnish condenser complete with motor-driven fan or fans and with face dampers controlled by the condensate temperature. [Provide two fans per bay.] Avoid excessive subcooling of the condensate by overexposure to the air stream. Provide freeze protection for all modes of operation. Do not exceed fan tip speed of 60 meters/second 12,000 feet/minute.

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

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b. Direct-connect or belt connect rhe fan motor to the fan and seal bearings. Provide motor that is three-phase, squirrel cage induction type, [208] [460] volts at 60 Hz, synchronous speed not to exceed [1,200] [1,800] rpm. Provide motor size such that seasonal adjustments of the fan blade pitch are not necessary to prevent motor

overloads when ambient air temperature drops to lowest value or rises to highest value specified for the prime mover operating conditions. Provide a 60 Hz, across-the-line, enclosed type, magnetic motor starter having thermal overload protection in each ungrounded phase. If the condenser fan motor is large enough to cause a transient voltage dip of 20 percent or more during starting inrush, use a reduced-voltage type magnetic motor starter. Make connections such that the fan motor will start automatically as its respective engines are started.

c. The distance between condenser and engine must be [[_____] m feet] [as shown]. Furnish complete unit with a matched float and thermostatic trap installation. Provide air flow from the fan motor [upward] [downward] [inward] [outward] through the condenser. Furnish 300 mm twelve-inch lengths of flexible hose or pipe for all inlet and outlet pipe connections. Provide a valved vent for release of noncondensible gases. Provide condenser sized by the engine manufacturer for this application. Auxiliary system coolant temperature must not exceed 80 degrees C 180 degrees F, with a maximum differential of 8 degrees C 15 degrees F. Maintain temperature for the system by regulating the steam pressure.

2.2.7.2 Water-Cooled Condenser

Provide a shell-and-tube type unit rated for 30 degrees C 85 degrees F entering water and 40 degrees C 105 degrees F leaving water. Furnish a complete unit with a matched float and thermostatic trap installation as well as a subcooler unit to reduce flashing of condensate. Provide a valved vent for release of noncondensible gases.

2.2.8 Pressure-Operated Control Valve

Provide butterfly control valve with maximum 60 percent full open operating position for good control characteristics. Nominal rating must be 7 kPa 1 psig with pressure drop at 60 percent of full open position. For use as a back pressure valve when there is no auxiliary fired boiler, provide metal-to-metal seats which do not provide 100 percent shutoff to condenser. For use with an auxiliary fired boiler, provide high temperature butyl or silicone rubber or EPDM seats for bubble-tight shutoff to the condenser. Provide valve operator that is [electric proportional operator with pressure control mounted internally] [pneumatic with controller with proportional band, reset and filter regulator mounted on operator]. Valve must open on loss of air supply pressure.

2.2.9 Auxiliary Boiler for Supplemental Firing

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NOTE: Delete this paragraph if auxiliary fired boiler is not required. Auxiliary boiler is required when a constant source of heat must be maintained during maintenance or overhaul of prime movers or to supplement heating requirements during peak demands which are beyond the capacity of the heat recovery installation.

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Provide boiler and related equipment as specified in Section 23 52 30.00 10 HEAT RECOVERY BOILERS .

2.2.10 Forced Circulation Pump

Where an engine-driven pump is not provided for jacket water circulation, provide a separate electric motor-driven pump interlocked with engine operation as required by the engine manufacturer.

2.2.11 Heat Exchangers

Provide heat exchangers as shown. Provide heat exchangers that are the shell-and-tube design, either U-tube type or helical coil type. Other types of construction are not acceptable unless prior written approval is received. Design, fabricate, test, and stamp heat exchangers in accordance with ASME BPVC SEC VIII D1.

a. Furnish construction materials suitable for the intended service except do not use cast material. The manufacturer's drawing submittal must indicate the grade of material that has been used, giving the full ASME specification number designation for each component. Furnish U-tube materials as light drawn temper; furnish fully annealed helical coils. Provide carbon construction materials on the shell side [casing]. Provide tube side materials that are 90-10 Copper-Nickel for the tubes, tubesheets, and channel bonnets for U-tube designs. Provide tubing and headers for the helical coil designsthat are 90-10 Copper-Nickel.

b. Provide either rolled or welded tube-to-tube sheet connections and tube-to-header connections for helical coils for the condensate cooler and lube oil cooler, and welded for lube oil preheater.

2.2.11.1 Lube Oil Cooling

Furnish lube oil cooling and heat reclamation exchangers as part of the engine. The designs must provide for the oil to be on the outside of the tubes and the cooling water on the inside. Provide a thermal sensing unit in the oil outlet piping where it can sense the mixed average temperature of the oil leaving the cooler and actuate the control valve on the cooling water flow to prevent overcooling the lube oil.

2.2.11.2 Fuel Oil Preheating

If fuel oil preheating is required, provide this heat exchanger as part of the boiler package. The designs must provide for the oil to be on the outside of the tubes and the steam or high temperature water on the inside. Provide a thermal sensing unit in the oil outlet piping where it can sense the mixed average temperature of the oil leaving the preheater and actuate the control valve on the high temperature hot water/steam to ensure that oil temperature is in the proper range for the prime mover.

2.2.11.3 Condensate Heat Exchanger

High pressure condensate heat exchanger must provide heating of domestic or boiler feedwater while reducing the condensate temperature to minimize flashing in the condensate surge tank. The designs must provide for the condensate to be on the outside of the tubes and the cooling water (domestic or boiler feedwater) to be on the inside.

2.2.12 High Temperature Water Heat Recovery Systems

****

NOTE: Delete this paragraph if high temperature water heat recovery is not utilized.
****

Where high temperature water is utilized as a heat recovery system medium, provide system with proper expansion tank, dump tank, pressurization system, circulation pumps, makeup water facilities, controls, unit heaters, and piping as specified in Section 23 50 52.00 10 CENTRAL HIGH TEMPERATURE WATER (HTW) GENERATING PLANT AND AUXILIARIES.

2.2.13 Pressure Gauges

Provide heavy-duty industrial type gauges conforming to ASME B40.100, style as required, suitable for pressure or vacuum specified, with minimum 152 mm 6 inch diameter dial, except as otherwise specified. Install pressure gauges on each boiler, on the low-pressure side of each pressure reducing valve, on the discharge side of each pump, and where shown or where required for proper operation. Provide gauges that are readily accessible and easily read from the operating floor. Equip gauges with integral or separate siphons and connect by brass pipe and fittings with shutoff cocks. Where pressure-reducing valves are used, place gauges close to the pressure-reducing assembly, both downstream and upstream, but connect approximately 3 m 10 feet therefrom. Provide operating ranges of the gauges be as follows:

Gauges	Operating Pressure, kPapsig	Pressure Range, kPapsig
Boiler	690-860100-125	0-13800-200
Medium-Pressure Steam	34550	0-6900-100
Low-Pressure Steam	14-352-5	0-2100-30
Boiler Feed Pump	10342-5	0-13800-200
Other Pumps	140-34520-50	0-6900-100

2.2.14 Thermometers

Furnish thermometers conforming to ASME PTC 19.3 TW, Type I, Class 3, with wells. Do not use Mercury in thermometers. Temperature ranges must be suitable for the intended use. Install thermometers in the feedwater pipeline between the feedwater heater and boiler feed pump in the main condensate return line before entering the surge tank, and elsewhere as indicated or specified. Thermometers must have straight or angle stems as required and must be easily read from the operating floor.

2.3 WATER TREATMENT EQUIPMENT

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NOTE: The proper condition of feedwater and boiler water is of major importance in assuring long life and minimum maintenance of any heat recovery system. Due to varying conditions in different locations, it is impossible to set forth specific control

standards. If water treatment is covered in another section, the requirements should be reviewed for compatibility with the requirements of waste heat recovery systems. A study should be made as follows:

a. Internal Treatment: Conventional internal water treatment should be used along with regular boiler blowdown. Water treatment should consist of alkalinity adjustments and chemical additions for the removal of dissolved oxygen and treatment of residual hard-scale-forming materials. Treatment may also be required for sludge dispersal and to prevent foaming.

The following values can be used as a guide:

pH	**10.5 - 11.2**
02	**0 ppm**
PO4	**20-40 ppm**
TDS	**3500 ppm, max**

b. External Treatment: Makeup water must be treated to remove calcium, magnesium, and total iron. Special attention should be given to water which contains suspended solids, a high residual of iron and sodium chloride, and dissolved oxygen.

c. Condensate Return Line Corrosion: Corrosion in the return line will allow harmful iron oxide to enter the boiler system where it can adhere to the internal surfaces and reduce the heat transfer. It is recommended that steps be taken to protect the condensate return system from the corrosive effects of oxygen and carbon dioxide.

For additional information concerning control of internal chemical conditions, refer to ASME Boiler and Pressure Vessel Code, Section VII (Recommended Rules for Care of Power Boilers), Subsection C7.

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Water treatment equipment is required and must be as specified in Section 23 25 00 CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS.

2.4 INSULATION

Apply insulation in sufficient thickness to limit the surface temperature of the lagging to not more than [50] [65] degrees C [120] [150] degrees F when in still air at site maximum dry bulb temperature. Submit Heat transfer calculations to the Contracting Officer to substantiate insulation material and thickness selection. Provide insulation with waterproof lagging when installed outdoors. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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NOTE: All pertinent piping and related equipment supports are to be designed and indicated in accordance with UFC 3-301-01 for seismic design.

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Install equipment in accordance with manufacturer's instructions and recommendation. Bolt all pieces of equipment in place on foundations unless they are skid-mounted on the prime mover base skid. Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, drawings, and installation instructions. Include in the drawings complete piping and wiring drawings, schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Also show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances required for maintenance and operation. Use flexible connectors to connect any piping to the prime mover. Provide piping for interconnecting various components of the heat recovery equipment conforming to the requirements of ASME B31.1. Submit calculations, manufacturer's design data and structural computations for walls, roof, foundations, and other features for specialty type of construction, with design data for lateral forces that may be encountered due to wind loads and seismic zone forces.

3.3 CLEANING OF BOILERS AND PIPING

3.3.1 Boiler Cleaning

After the hydrostatic tests have been made and before starting the operating tests, thoroughly and effectively clean the boiler of foreign materials, including mill scale, grease, and oil deposits. The Contractor may use the following described procedure or may submit his own standard procedure for review and approval by the Contracting Officer. Wherever possible, wire-brush surfaces in contact with water to remove loose material before filling the boiler with a solution containing:

caustic soda	11 kg24 pounds
sodium nitrate	4 kg8 pounds
disodium phosphate, anhydrous	11 kg24 pounds
approved wetting agent, 3785 L1000 gallons water	230 g1/2 pound

Dissolve chemicals thoroughly in the water before placing in the boilers. Operate the boiler at 210 to 345 kPa 30 to 50 psig and minimum rating for 24 to 48 hours, exhausting the steam to atmosphere. After the boiling period, allow the boiler to cool before being drained and thoroughly flushed out. Clean piping by operating the boilers for a period of approximately 48 hours, wasting the condensate.

3.3.2 Boiler Water Conditioning

Provide chemical treatment and blowdown of boiler water during periods of boiler operation to prevent scale and corrosion in boilers and in steam and return distribution systems from initial startup of the system, through the testing period, and to final acceptance by the Government. Chemicals used and method of treatment must be approved by the Contracting Officer.

3.4 POSTED INSTRUCTIONS

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

3.5 FIELD TRAINING

Provide a field training course for designated operating staff members. Training must be provided for a total of [_____] hours of normal working time and must start after the system is functionally complete, but prior to final acceptance tests. Cover all of the items contained in the approved operation and maintenance instructions.

3.6 TESTS

Following installation, test each boiler hydrostatically and prove that the system is tight under a gauge pressure of 1.5 times the working pressure specified and in accordance with applicable ASME requirements. Following the installation of piping and heat recovery equipment, but before the application of any insulation, perform hydrostatic tests and prove that the system is tight under gauge pressures of 1.5 times the working pressure specified, but no less than the following:

Low-pressure lines	275 kPa40 psi
Medium-pressure lines	415 kPa60 psi
High-pressure-steam lines	1035 kPa150 psi
Boiler feed lines	1550 kPa225 psi

The boilers and the piping must be inspected by a boiler inspector qualified as required by ASME BPVC SEC VIII D1, ASME BPVC SEC I, or

ASME BPVC SEC IV, as applicable. Supply a certificate of approval for each boiler. Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

3.7 EFFICIENCY AND OPERATING TESTS

Upon completion, and before acceptance of the work, subject the heat recovery plant to such operating tests as may be required to demonstrate satisfactory functional operation. Conduct each operating test at such times as directed by the Contracting Officer. Use water meter in the test that is suitable for hot water. Provide instruments, test equipment, and test personnel required to properly conduct all tests; the necessary fuel, water, and electricity will be furnished by the [Government] [_____]. Conduct boiler operating tests, as a minimum, continuously at the following capacities for the following time:

Test Percentage of Operating Capacity		
Testing Time	Water Wall or Water Tube Boilers	Firebox Boilers
First 2 hours	50	50
Next 2 hours	75	75
Next 6 hours	100	100*
Next 2 hours	110	--

a. Do not operate firebox boiler above 100 percent of capacity.

b. Conduct general performance tests on the heating plant by an experienced test engineer and tests will be observed by the Contracting Officer. Submit a proposed performance test procedure, 30 days prior to the proposed test date. Include in the procedure a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not start the test until the procedure has been approved. Deliver test report including logs, heat balance calculations, tabulated results, and conclusions to the Contracting Officer as stated in the paragraph "PERFORMANCE TEST REPORTS." [Submit an analysis of the fuel being burned on the test to the Contracting Officer.]

c. Test of capacity of water treatment equipment and quality of the effluent must meet the requirements specified. Perform tests for ion-exchange units covering at least two complete regenerations and capacity runs. Conduct tests for hot process or other precipitation type softeners continuously for a period of at least 48 hours, with samples taken at 2-hour intervals.

d. Conduct tests for steam quality in accordance with ASTM D1066 under the operating conditions specified.

e. Test quality of steam used for air conditioning equipment in accordance with the conductivity method in ASTM D2186 with the conductivity of the steam corrected for carbon dioxide and ammonia content not to exceed 4.0 microsiemens 4.0 micromhos at 18 degrees C 65 degrees F.

3.8 RETESTING

If any deficiencies are revealed during test, correct such deficiencies and reconduct the tests at no additional costs to the Government.

3.9 FIELD PAINTING

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NOTE: Where identification of piping is required by the using service, this paragraph will be amplified to include appropriate requirements, either directly or by reference to a separate section.

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Clean, prepare, and paint ferrous metal surfaces not specified to be coated at the factory as specified in Section 09 90 00 PAINTS AND COATINGS. Paint exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum lagging over insulation.

-- End of Section --