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USACE / NAVFAC / AFCESA **UFGS-11380 (August 2003)**

Preparing Activity: USACE **Superseding UFGS-11380 (December 1989)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags
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DIVISION 11 - EQUIPMENT

SECTION 11380

SLUDGE-DIGESTER GAS, HEATING, AND MIXING SYSTEM

08/03

-- End of Section Table of Contents --

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SECTION 11380

SLUDGE-DIGESTER GAS, HEATING, AND MIXING SYSTEM
08/03

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NOTE: This guide specification covers the requirements for sludge-digester gas, heating, and mixing system for sewage treatment plants.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.
****

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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.15	(1997; A 2001) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(2002) Specification for Pipeline Valves

AMERICAN WATER WORKS ASSOCIATION(AWWA)

AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1219 mm), for Water
AWWA C115	(1999) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

ASME INTERNATIONAL (ASME)

ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B31.1	(2001) Power Piping
ASME BPVC SEC IV	(2001) Boiler and Pressure Vessel Code; Section IV, Recommended Rules for the Care and Operation of Heating Boilers
ASME BPVC SEC IX	(2001) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2001) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 307	(2002) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 36/A 36M	(2003a) Carbon Structural Steel
ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2003) EJMA Standards

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

MSS SP-58	(2002) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(2002) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2000) Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC
NEMA ICS 3	(1993; R 2000) Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC
NEMA ICS 4	(2000) Industrial Control and Systems: Terminal Blocks
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures
NEMA MG 1	(2003) Motors and Generators
NEMA SG 3	(1995) Power Switching Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 58	(2004) Liquefied Petroleum Gas Code
NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 508	(1999; Rev thru Dec 2003) Industrial Control Equipment
UL 845	(1995; Rev thru Apr 2004) Motor Control Centers

1.2 SYSTEM DESCRIPTION

A complete gas, heating, and mixing system shall be provided for sludge digesters shown. The system shall consist of a digester gas handling system, digester heating system, auxiliary fuel system, sludge mixing system and appurtenances as required for a complete and operating system. The system shall be coordinated with the digester cover specified in Section 13234 FLOATING COVER FOR SLUDGE-DIGESTION TANKS.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Installation[; G][; G, [_____]]

Drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been

coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Materials and Equipment

A complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts

Spare parts data for each different item of material and equipment specified.

Framed Instructions

A copy of the instructions proposed to be framed and posted.

SD-06 Test Reports

Testing

Performance 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. Each test report shall indicate the final position of controls. Boiler and heat exchanger test reports shall include manometer readings at the main gas regulator, pilot gas regulator, burner inlet, burner and the furnace; amperes drawn by all motors; voltage of main flame and pilot controller signal; and flue gas readings including percent oxygen, percent carbon dioxide, temperature, efficiency, and smoke test results.

SD-10 Operation and Maintenance Data

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

[Six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set, prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the field training course.

1.4 QUALIFICATIONS

Procedures and welders shall be qualified in accordance with the code under which the welding is specified to be accomplished.

1.5 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.6 FIELD MEASUREMENTS

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

1.7 GENERAL PROJECT REQUIREMENTS

1.7.1 Standard Products

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

1.7.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

1.7.3 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

1.7.4 Spare Parts

The Contractor shall submit spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment shall conform to the following respective publications and other specified requirements.

2.1.1 Steel Shapes, Plates and Bars

Steel shapes, plates, and bars shall conform to ASTM A 36/A 36M.

2.1.2 Digester Gas Pipe and Fittings

2.1.2.1 Digester Gas Pipe Smaller Than 100 mm 4 Inch Diameter

Pipe shall be screwed joints galvanized steel in accordance with ASTM A 53/A 53M. Fittings shall be galvanized malleable iron in accordance with ASME B16.3. Couplings shall be in accordance with ASTM A 53/A 53M.

2.1.2.2 Digester Gas Pipe 100 mm 4 Inch Diameter and Larger

Pipe shall be ductile iron in accordance with AWWA C115. Joints shall be ASME B16.1, Class 125 flanged joints. Fittings shall be ductile iron in accordance with AWWA C110. Bolts and nuts shall be in accordance with ASTM A 307, Grade B.

2.1.3 Sludge Piping

Pipe shall be flanged ductile iron pipe in accordance with AWWA C115. Pipe 100 mm 4 inch diameter and smaller shall be thickness Class 51. Pipe 150 mm 6 inch through 600 mm 24 inch diameter shall be thickness Class 50. [Pipe 750 mm 30 inch diameter and larger shall be thickness Class 51]. Fittings shall be ductile iron in accordance with AWWA C110. Joints shall be ASME B16.1 Class 125 flanged joints. Bolts and nuts shall be in accordance with ASTM A 307, Grade B.

2.1.4 All Other Piping

Pipe shall be standard weight black steel pipe in accordance with ASTM A 53/A 53M. Pipe smaller than 100 mm 4 inch diameter shall have screwed joints and malleable iron fittings in accordance with ASME B16.3. Pipe 100 mm 4 inch diameter and larger shall have class 150 flanged joints and fittings in accordance with ASME B16.5.

2.1.5 Valves

2.1.5.1 Angle, Check and Globe Valves

Valves shall conform to MSS SP-80, Type 3, globe and angle.

2.1.5.2 Gate Valves

Valves shall conform to MSS SP-80, Type 1, Class 150 or MSS SP-70, Type I, Class 150 bronze trim.

2.1.5.3 Plug Valves

Bronze plug valves shall comply with MSS SP-78. Iron plug valves shall comply with API Spec 6D.

2.1.5.4 Gas Valves

Shut-off valves on gas lines shall be of the cast brass plug-cock type for sizes up to and including 50 mm 2 inch diameter and of the cast iron brass mounted or wholly brass plug-cock type for sizes 65 mm 2-1/2 inch diameter and larger. All gas line valves shall be in accordance with the applicable requirements of ANSI Z21.15. Gas valves shall be tested with air at 861.8 kPa 125 psiwithout developing leakage.

2.1.6 Expansion Joints

Expansion joints shall conform to EJMA Stds.

2.1.7 Pipe Hangers and Supports

Pipe hangers and supports shall conform to MSS SP-58 and MSS SP-69.

2.1.8 Electric Motors

Motors shall conform to NEMA MG 1.

2.1.9 Motor Controls and Motor Control Centers

Controls and motor control centers shall conform to NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6, UL 508, and UL 845.

2.2 DIGESTER GAS HANDLING SYSTEM

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NOTE: Coordinate with Section 13234A FLOATING COVER FOR SLUDGE-DIGESTION TANKS. Coordinate with paragraph COMPRESSED GAS SLUDGE MIXING SYSTEM.

****

A complete system shall be provided for distribution and disposal of gas produced in the digesters. The system shall include all necessary gas safety equipment to insure maximum protection against fire, explosion, and fume hazard at all times. Gas equipment shall be designed for digester gas having a calorific value of 22.3 MJ per cubic meter (600 Btu per cubic foot) 600 Btu per cubic foot, a specific gravity of 0.8, and a maximum pressure of [_____] Pa inches water column. The system shall provide distribution to the [compressed gas sludge mixing system,] and [gas storage tank,] sludge heating system and waste gas burner.

2.2.1 Waste Gas Burner

Waste gas burners, having a capacity for burning [_____] cubic meters cubic feet of gas per hour at a pressure loss not to exceed 127 Pa 1/2 inch of water column, shall be provided to dispose of excess digester gas. The burner shall be provided with a [_____] mm inch screwed inlet and a pilot-line connection not less than 20 mm 3/4 inch in diameter. The burner shall be provided with a readily adjustable pilot light, properly designed air inlet and mixing chamber, a burner bowl supported by a cast iron or steel pipe pedestal filled with insulating material, and a flanged base with anchor bolts for installation on a concrete foundation or concrete curb. The pilot light and burner shall be arranged to prevent the pilot light from being blown out by gas ignition, wind, or other accidental means. A shut-off valve shall be provided in the pilot gas line. The waste gas burner shall be located a minimum of 15 m 50 feet from the [gas storage tank] [and] [digester].

2.2.2 Flame Checks

Flame checks shall be provided in the pilot line to the waste gas burner. Flame checks shall block flame return and shall have threaded end connections of the same size as the pilot line.

2.2.3 Flame Traps

Flame traps shall be provided in the gas piping system between each source of ignition and the digesters. Flame traps shall be located as close as possible to the source of ignition, the distance not to exceed 7.5 m 25 feet. Each flame trap shall have a capacity to pass at least [_____] cubic meters cubic feet of gas per hour at a pressure loss not to exceed [_____] 127 Pa 1/2 inch of water column. The flame trap element shall prevent the passage of flame and shall permit convenient replacement of the entire element. The unit shall also include a spring actuated thermal shut-off valve, held open by a fusible element, to automatically close in the presence of burning mixtures.

2.2.4 Sediment Traps

Sediment traps shall be provided in the gas piping system prior to all other equipment. Traps shall be baffled and provided with a sealed, safe means of determining the liquid level without closing the gas supply line. Sediment traps shall be of cast iron, ductile iron, or galvanized steel construction with a minimum capacity of 38 liters 10 gallons of accumulated sediment and condensate. Supply line connections shall be equal to the supply line size. A manual drip trap shall be provided to drain accumulated condensate from the sediment trap.

2.2.5 Drip Traps

Drip traps shall be provided in the gas piping network at the low points and on the upstream side of each gas meter. Drip traps shall be manually operated, shall be constructed of cast iron, ductile iron, or galvanized steel, and shall have a minimum capacity of 2 liters two quarts. Trap construction shall effectively prevent leakage of gas from the system when the trap is being drained.

2.2.6 Gas Meters

Gas meters shall be provided to measure the gas production of each digester and the volume of gas delivered to the waste gas burner and the sludge heating system. Gas meters shall be rated at [_____] cubic meters per second cubic feet per minute at [_____] Pa inches water column pressure drop with a capacity of 200 percent rated flow. Meters shall be constructed of materials resistant to the corrosive effects of digester gas. A valved bypass shall be provided around each gas meter.

2.2.7 Pressure Indicating Gauges

Pressure indicating gauges shall be provided in the gas piping system to enable monitoring of digester pressure and to enable the pressure balancing at the waste gas burner and the digester heating system. Gauges shall be direct reading in Pa inches of water and shall be [assembled as one unit, wall mounted,] [individually mounted on the pipe,] with shut-off cocks. Shut-off cocks shall be pinned and sealed to prevent gas leakage.

2.2.8 Pressure Relief Valves

A pressure relief valve shall be provided in the gas line to the waste gas burner and connected to the upstream side of the flame trap. Pressure relief valves shall maintain a predetermined back pressure throughout the system at settings from 1.25 to 2.49 kPa 5 to 10 inches of water column and shall release surplus gas to the waste gas burner. The relief valve shall

be actuated by a protected diaphragm. The diaphragm shall be a readily adjustable weighted type or compression spring type of ample area to allow sensitive control of the gas pressure. The valve shall be capable of passing [_____] cubic meters cubic feet of gas at a pressure loss not to exceed [_____] Pa inches water column.

2.2.9 Pressure Controls

Pressure controls shall be provided to maintain proper distribution of gas flow on a priority basis to the [compressed gas sludge mixing system,] [gas storage tank,] digester heater, and the waste gas burners, respectively.

2.2.10 Digester Gas Piping

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NOTE: If removal of hydrogen sulfide gas, present in some anaerobic sludges, is desired, then iron oxide impregnated wood chip filters should be added to the gas piping system.
****

Pipe shall be installed with a minimum slope of 20 mm per meter 1/4 inch per foot toward drip traps and sediment traps.

2.2.11 Digester Gas Storage

A digester gas storage tank, gas compressor, controls, and appurtenances shall be provided as required for the storage of digester gas.

2.2.11.1 Storage Tank

****
NOTE: Design of supports should be according to TI 809-01 for windload and snowload design. Specific site information on wind and snow loadings must be included in the design. Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase, in the penultimate sentence, if seismic details are not provided. Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT or 15070N MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL, properly edited, must be included in the contract documents.Other types of storage, other than the expensive relatively high pressure spherical gas storage tank and supports, should be considered. Digesters with gas holder covers or cylindrical steel tanks with adjusting covers, which supply gas at constant pressure at variable volume, generally supply digester gas at low pressures but at pressure sufficient to operate many boiler burners. A small auxiliary compressor may be added, if required, to boost gas pressure.
****

The gas storage tank shall be capable of storing [_____] cubic meters cubic feet of gas operating between [_____] kPa maximum and [_____] kPa minimum

[_____] psig maximum and [_____] psig minimum pressure. The tank shall be cylindrical above ground tank with supports designed to withstand dead shell load plus a [_____] km/hour mph wind load and a [_____] kPa psi snowload. Seismic details shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and [15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT] [15070N MECHANICAL SOUND VIBRATION, AND SEISMIC CONTROL] [as shown on the drawings]. The tank shall be air tested in accordance with ASME BPVC SEC VIII D1 to 125 percent of the design maximum pressure.

2.2.11.2 Compressor

A reciprocating type electric motor driven gas compressor, capable of compressing [_____] cubic meters cubic feet of digester gas per minute at [_____] kPa psig to a maximum operating pressure of [_____] kPa psig, shall be provided. Compressor components shall be stainless steel or equally noncorrosive materials. Motor shall conform to NEMA MG 1. Controls shall conform to NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6, UL 845, and UL 508. Electric controls shall be provided as required for automatic operation of the compressor. Control panel shall include circuit breaker, magnetic starter, and manual-off-automatic selector switch. Power supply to the control panel shall be [_____] volts ac, [_____] phase, 60 Hz and shall be equipped with thermal overload protector with manual reset. All electrical wiring and motors shall be explosion-proof and be installed according to NFPA 70. Panel shall be NEMA 250, Type 7.

2.2.11.3 Pressure Relief Valve

A pressure relief valve shall be provided on the gas storage tank. A stop valve, locked open except for maintenance shall be provided between the gas storage tank and the pressure relief valve. Sediment traps and drip traps shall be provided in gas lines at the base of the tank. Pressure controls for gas distribution shall be provided. A remote pressure indicator shall be provided in the compressor building to indicate tank pressure [in kPa psi gauge].

2.3 DIGESTER HEATING SYSTEM

****
NOTE: Boilers providing building radiation and digester heating operate at 71 to 82 degrees C (160 to 180 degrees F). Hot water to heat exchanger is mixed to maximum 66 degrees C (150 degrees F) to prevent caking on sludge tubes.
****

2.3.1 System Performance Requirements

A complete system shall be provided for automatic control of the digester operating temperature at 35 degrees C 95 degrees F, within plus or minus 0.3 degrees C 0.5 degrees F, by means of an external sludge heating system. The digester heating system shall have a minimum sludge heating capacity of [_____] kW Btu/hr based on heating [_____] L/second gpm of sludge from digesters operating at 35 degrees C 95 degrees F. Boiler shall be fire tube hot water boiler with maximum operating pressure of 207 kPa 30 psig, with boiler, burners, draft fans, combustion safety controls and equipment, breeching and stacks, fuel system, and fittings and accessories in accordance with Section 15561A CENTRAL STEAM GENERATING SYSTEM-COMBINATION GAS AND OIL FIRED. Draft fan shall be designed for corrosive application.

2.3.2 Heat Exchanger

The heat exchanger shall be of the water bath or concentric tube type and shall be provided with an integral factory-fabricated insulation jacket. Heat exchanger insulated jacket shall be insulated with a minimum of 40 mm 1-1/2 inches of fiberglass having a density of 12.0 kg per cubic meter 0.75 pcf and a K-factor of 2.15 at 38 degrees C 0.38 at 100 degrees F. The jacket shall have minimum 16 gauge sides and 5 mm 3/16 inch plate top and bottom.

2.3.2.1 Sludge Tubes

Sludge tubes shall be standard weight ductile iron pipe with cast iron return bends with flanged, gasketed connections. Return bends shall be readily removable for inspection, cleaning, or replacement. Sludge tubes and return bends shall be large enough to pass a [_____] mm inch diameter sphere. Sludge tube connections shall be arranged to prevent sludge contamination of the heating water due to a gasket or connection failure.

2.3.2.2 Pressure Relief Valve

A pressure relief valve, constructed and installed in accordance with ASME BPVC SEC IV shall be provided. The valve discharge shall be piped to within 150 mm 6 inches of the floor in full line size.

2.3.3 Burning Equipment

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NOTE: Delete type of burner and fuel train for inapplicable fuels.
****

The burning equipment shall be of the capacity to develop the specified boiler capacity and shall have dual fuel, combination or separate, burners. The burning equipment shall include equipment for burning either digester gas, with heat content of approximately 22.3 MJ per cubic meter 600 Btu per cubic foot and a specific gravity of 0.8, or [No. 2 fuel oil, with heat content of 39,000 MJ per cubic meter 140,000 Btu per gallon] [natural gas, with heat content of 37.3 MJ per cubic meter 1,000 Btu per cubic foot or a mixture of the two gases] [LP gas with heat content of [_____] MJ per cubic meter Btu per cubic foot]. Gas piping and equipment for LP gas shall conform to NFPA 58.

2.3.4 Electric Control Panel

A single electric control panel, containing the digester temperature controller, the burner controller, and the branch circuit breakers and magnetic starters for the sludge circulating pump, induced or forced draft fan motor, and heat exchanger water circulating pump shall be provided. Induced or forced draft fans, motor, and associated boiler and burner controls shall be in accordance with Section 15561A CENTRAL STEAM GENERATING SYSTEM COMBINATION GAS AND OIL FIRED. Controllers shall be in accordance with NEMA ICS 1, circuit breakers shall be in accordance with NEMA SG 3, and motor controls and motor control centers shall be in accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6, UL 508, and UL 845. [The control panel shall include provision for integrating the control function of the building radiation hot water circulating pump into the control package.] The control panel shall be

NEMA 250, Type 12 construction and shall have [dual swing-out doors.] [a single swing out door.] All equipment shall be mounted and wired with rigid steel conduit and flexible water-tight connectors, all in accordance with NFPA 70. Main power to the control panel shall be [480] [_____] volts ac, [3] [_____] phase, 60 Hz, and control power at 120 volts ac, single phase, 60 Hz. Interlocks shall be provided as required for sludge heater operation with raw sludge pumps. The following selector switches and indicating lamps, clearly labeled, shall be provided on the control panel doors:

- Digester heater switch (manual/automatic/off).
- Fuel selection switch (digester gas/[oil] [natural gas] [LP gas]/automatic).
- Constant water bath switch (on/off).
- Induced draft fan (automatic/continuous).
- Sludge recirculation pump (continuous/intermittent).
- Low boiler water lamp with alarm horn and silencer.
- Induced draft [or forced draft] fan failure lamp with alarm horn and silencer.
- Flame failure lamp with alarm horn and silencer.
- Boiler high temperature lamp with alarm horn and silencer.

2.3.5 Digester Temperature Control

Digester temperature control shall be permitted by the manual/automatic off switch mounted on the control panel. Automatic control of the digester temperature shall be by means of a thermostat located at the inlet to the sludge tubes of the heat exchanger. The water circulation pump for sludge heating and the burner equipment shall be automatically controlled by the temperature of the sludge passing the thermostat. A repeating cycle time switch shall be provided for periodic starting of the digester recirculation pump, with controls arranged such that the recirculation pump will continue to operate until the digester heating requirements are satisfied or shall stop after a short cycle if heat is not required by the digester. Indicating thermometers, with a range from minus 18 to 66 degrees C 0 to 150 degrees F, shall be provided in the sludge inlet and outlet of the heat exchanger. Each thermometer shall be provided with a mounting socket that will enable the removal of the thermometers without draining the sludge tubes.

2.3.6 Sludge Circulating Pump

Pump shall be as specified in Section 11310 PUMPS; SEWAGE AND SLUDGE.

2.3.7 Sludge Piping

Sludge piping shall be arranged to permit heating of the digester contents by pumping the digester sludge through the heat exchanger and back to the digester. The piping arrangement shall also include provision for heating of raw sludge before it enters the digester or for heating a mixture of raw sludge and recirculating sludge.

2.3.8 Water Circulation Pumps

Water circulation pumps shall be single stage, centrifugal, enclosed impeller, electrically driven, non-overloading type with integrally mounted motor. The pump shall be connected to the motor with a flexible coupling. Motor shall conform to NEMA MG 1 for operation on [_____] volts ac, [_____] phase, 60 Hz and shall be equipped with thermal overload protector with manual reset. Motor frame shall be [open] [dripproof] [totally enclosed] [explosion-proof] type.

2.3.8.1 Heat Exchanger Water Circulation Pump

The heat exchanger water circulation pump shall be mounted in line with the heat exchanger package. Pump rating shall be determined by the heat exchanger manufacturer as required to provide turbulent flow across the sludge tubes.

2.3.8.2 Building Heat Water Circulation

****
NOTE: Delete paragraph Building Heat Water Circulation if system is not used for building heat. Coordinate criteria with building heating system specification.
****

The building heat water circulation pump shall be rated at [_____] L/second gpm and [_____] mm feet TDH.

2.4 MECHANICAL SLUDGE MIXING SYSTEM

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NOTE: For projects with single-stage sludge-digestion, delete "primary" and include reference to bottom 1/10 of contents. For projects with two-stage sludge digestion, include "primary" and delete reference to bottom 1/10 of contents.
****

Electric motor driven mechanical mixers shall be provided in each [primary] [_____] digester, each capable of producing a flow of [____] L/second gpm of sludge. The combined action of all the mixers shall effectively circulate all [except the bottom 1/10] of the digester contents. Mixers shall be suitable for mixing sludge on a continuous basis.

2.4.1 Motor

The electric drive motor shall be mounted on the outside of the digester on the [gear reduction unit] [or] [mixer bearing support.] Motors shall be in accordance with NEMA MG 1 and shall be of explosion-proof design for operation near digester gas. Motor shall be sized for and shall not overload under the intended conditions. Motor shall operate on [_____] volts ac, [3] [_____] phase, 60 Hz and shall be provided with thermal overload protection.

2.4.2 Speed Reducer

A unit shall be provided for the mechanical reduction of speed while

transmitting power from the motor to the mixer shaft. The reducer shall be either V-belt drive or gear drive type. Reduction ratio shall be as required for proper mixer operation.

2.4.2.1 V-Belt Speed Reducer

The unit shall consist of sheaves and V-belts, properly sized for the required horsepower transmission. Belts shall be of the static-conducting type for operation near digester gas. A means of adjusting belt tension shall be provided. An enclosure shall be provided to protect the unit from weather and to protect personnel from injury.

2.4.2.2 Gear Reducer

The unit shall consist of gears, shafts, and bearings, mounted in a cast metal housing. Unit shall be sized to transmit the intended horsepower. Lubrication shall be by oil bath and the unit shall have provision for filling, draining, and checking the oil level. Seals shall be provided on all shaft penetrations to prevent the escape of oil and the entry of contaminants. A vent shall be provided to allow the entry and escape of air. The vent shall be designed to minimize contaminant entry.

2.4.3 Shaft

A cold-rolled steel shaft, [_____] mm feet long, shall be provided for support and rotation of the [impeller] [or] [propeller]. The shaft shall be designed to prevent excessive deflection under normal load conditions. The shaft shall extend from the speed reducer unit through the bearing and support assembly to the [impeller] [or] [propeller].

2.4.4 Bearing and Support Assembly

A cast metal unit, complete with bearings, shall be provided for the support of all other mixer components. The assembly shall mount directly on the digester [cover] [wall] and shall provide a gas tight seal. The unit shall contain two bearings, mounted sufficiently apart from each other to give stable support to the shaft. Bearings shall be self-aligning roller or ball bearings designed for axial loading and sized to support the shaft and [impeller] [or] [propeller] under all load conditions. The assembly shall have grease fittings, passages, and relief ports as required for proper bearing lubrication.

2.4.5 Seals

****

NOTE: Coordinate with Section 13234A FLOATING COVER FOR SLUDGE-DIGESTION TANKS. Coordinate with paragraph COMPRESSED GAS SLUDGE MIXING SYSTEM.

****

Shaft seals shall be provided at the top and bottom of the bearing and support assembly. The upper seal shall both retain grease and prevent the entrance of contaminants. The lower seal shall be designed to retain grease and to prevent the passage of digester gas under [_____] kPa psi pressure.

2.4.6 Impeller or Propeller

An [impeller] [or] [propeller] shall be provided on the end of the shaft to

impart motion to the sludge. The unit shall effectively transmit the mixer's mechanical energy to the sludge without producing unbalanced forces on the shaft. The unit shall be constructed of a material capable of withstanding rapid motion through sludge without undue wear or corrosion. [The unit may operate unenclosed or enclosed in a draft tube. The draft tube shall be flared at the bottom and shall be constructed of at least 6 mm 1/4 inch thick steel plate.] [The propeller shall be designed to avoid fouling and also to pump sludge in either direction.]

2.4.7 Controls

Each mixer shall be provided with a magnetic starter; forward, stop, and reverse pushbuttons; and a circuit breaker with manual reset. Controls shall be [120] [_____] volts ac, single phase, 60 Hz, and shall be housed in explosion-proof NEMA 250, Type 7 enclosure Reverse operation shall be provided for periodic dislodging of sludge from the [impeller] [or] [propeller].

2.5 COMPRESSED GAS SLUDGE MIXING SYSTEM

****

NOTE: Include only the applicable system. Consult with various manufacturers to determine correct system for the project and to obtain criteria to be specified.

For projects with single-stage sludge-digestion, delete "primary" and include reference to bottom 1/10 of contents. For projects with two-stage sludge digestion, include "primary" and delete reference to bottom 1/10 of contents.

****

A system shall be provided for mixing [all except the bottom 1/10] of the [primary] [_____] digester contents by the circulation of digester gas. The system shall be designed for safe handling of digester gas. [The system for each digester shall consist of a compressor, piping system, and [_____] diffusers located within each digester as indicated. The system shall provide [_____] cubic meters per second cfm of digester gas at [_____] kPa psi sequentially to each of the diffusers to provide thorough mixing of the digester contents.] [The system for each digester shall consist of a compressor, piping system, and [_____] diffusers within a centrally mounted draft tube, forming a confined gas lift for circulation and mixing of the digester contents. The system shall provide a total of [_____] cubic meters per second cfm of digester gas at [_____] kPa psi to the diffusers.] [The system for each digester shall consist of a compressor, piping system, and [_____] diffusers located [on] [near] the bottom at the center of each digester as indicated, forming an unconfined gas lift for circulation and mixing of the digester contents. The system shall provide a total of [_____] cubic meters per second cfm of digester gas at [_____] kPa psi to the diffusers.]

2.5.1 Compressor

****

NOTE: For gas recirculation and low pressure gas handling, rotary displacement, sliding vane, or liquid ring compressors may be used.

****

A positive displacement, electric motor driven, air cooled compressor shall be provided for circulating the digester gas. The compressor shall be capable of providing [_____] cubic meters per second cfm of gas at [_____] kPa psi and shall be driven by a [_____] kW horsepower explosion-proof electric motor. The motor shall operate on [_____] volts ac, [3] [_____] phase, 60 Hz. Motor shall conform to NEMA MG 1. Controls shall conform to NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6, UL 845, and UL 508. Panel shall be NEMA 250, Type 7. Motor power shall be transmitted to the compressor through a static-conducting V-belt drive.

2.5.2 Diffusers

Diffusers capable of diffusing the specified quantity of gas into the sludge shall be provided. The diffusers shall be constructed of a material resistant to corrosion caused by digester sludge and shall be of a nonclogging design which prevents the backflow of sludge into the gas piping upon loss of gas pressure. [Draft tubes shall be constructed of at least 6 mm 1/4 inch thick steel plate and shall have flared bottoms.]

2.5.3 Piping System

****
NOTE: Certain gas recirculation piping systems provide discharge wells which allow removal of the discharge tubes within the wells for inspection or change of depth of discharge without interrupting digester operation and provide sealing in of gas during removal and replacement of discharge tubes.
****

2.5.3.1 Piping

Piping shall comply with paragraph DIGESTER GAS HANDLING SYSTEM.

2.5.3.2 Motor Operated Multiport Rotary Valve

****
NOTE: Include this paragraph only if paragraph COMPRESSED GAS SLUDGE MIXING SYSTEM is specified.
****

A single motor operated multiport rotary valve or multiple motor operated valves shall be provided for control of gas supply to the individual diffusers.

2.5.4 Supernatant Removal

****
NOTE: Include this paragraph if supernatant removal is included in project.
****

[Overflow box with weir or supernatant piping] [Rotatable draw-off supernatant pipe to pull supernatant at varying levels] shall be provided. Digester sight glass or depth indicator shall be provided.

2.5.5 Controls

2.5.5.1 Compressor Controls

A magnetic starter, start-stop pushbuttons, and a circuit breaker with manual reset shall be provided for the compressor. Circuit breaker shall be in accordance with NEMA SG 3 and motor controls shall be in accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6, UL 508, and UL 845. A relief regulator system consistent with the system operational pressures shall be provided. A flame arrestor, moisture separator, and sediment trap shall be provided on the suction piping to the compressor. All controls shall be 120 volts ac, single phase, 60 Hz, and shall be housed in an explosion-proof NEMA 250, Type 7 enclosure.

2.5.5.2 Automatic Programming

****

NOTE: Include this paragraph only if paragraph COMPRESSED GAS SLUDGE MIXING SYSTEM is specified.

****

Equipment shall be provided to automatically program a predetermined discharge period through the diffusers in sequence. The time period shall be adjustable. A selector switch shall be provided to allow discharge to any desired diffuser.

2.5.6 Compressor Housing

A weatherproof enclosure shall be provided for the compressor and motor assembly. The enclosure shall have lockable access doors and shall be louvered for ventilation. [The enclosure shall be insulated and equipped with a thermostatically controlled electric heater.] The enclosure shall be mounted on the digester cover.

PART 3 EXECUTION

3.1 WELDING

****

NOTE: If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

[Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05090A WELDING STRUCTURAL.] [Welding and nondestructive testing procedures for piping shall be as specified in Section 05093 or 15216N WELDING PRESSURE PIPING.]

3.2 PAINTING

All ferrous metal equipment shall be cleaned, primed, and given two coats of machinery enamel at the factory. Fiberglass, stainless steel, and galvanized components need not be painted. Field painting shall be in accordance with Section 09900 PAINTS AND COATINGS.

3.3 EQUIPMENT INSTALLATION

****
NOTE: Coordinate with Section 13234A FLOATING COVER FOR SLUDGE-DIGESTION TANKS.
****

Equipment shall be installed where indicated and in accordance with the manufacturer's written instructions and under the supervision of the manufacturer's representative. Sufficient clearances shall be provided around all equipment to allow for proper operation and maintenance. Connections with or protrusions through the digester cover or walls shall be gastight. Special attention shall be given to the proper installation of gas and fuel systems to insure safe operation. [Equipment installed on floating digester covers shall be counterbalanced to insure proper operation of the cover.]

3.4 TESTING

3.4.1 Gas Piping Test

Gas piping shall be tested by subjecting it to pneumatic pressure of not less than 105 kPa 15 psi for 6 hours. During the test the system shall be disconnected from the source of pressure and, with corrections made for barometric and temperature changes, the pressure shall remain constant for the test period, as indicated by a test gauge.

3.4.2 Piping System and Heat Exchanger Test

The piping system and heat exchanger shall be isolated and shall be tested for a period of at least 6 hours at a hydrostatic pressure of 310 kPa 45 psi.

3.4.3 Operational Test

The entire gas, heating, and mixing system shall be subjected to an operational test to demonstrate satisfactory functional efficiency.

3.4.4 Boiler and Heat Exchanger Test

Boiler and heat exchanger shall be tested as specified in Section [15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS] [15950N HVAC TESTING/ADJUSTING/BALANCING].

3.5 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. The framed instructions shall be posted before acceptance testing of the system. The instructions shall show wiring and control diagrams and complete layout of the entire system. The instructions shall also include, in typed form, 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.

3.7 FIELD TRAINING

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

-- End of Section --