UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 48 16 00

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05/17

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Preparing Activity: USACE

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SECTION 48 16 00

LANDFILL GAS SYSTEMS
05/17

NOTE: This guide specification covers the requirements for landfill gas systems as utility grade renewable power generation source.

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).

NOTE: Use this UFGS in conjunction with UFC 3-460-01 "Design: Petroleum Fuel Facilities". Include in this specification any additional equipment/devices necessary to meet state and local regulations.

The specification is written around ASME's standard Class 150 rating. For applications requiring higher pressure ratings (e.g., Class 300, etc.), the designer will have to modify this specification appropriately.

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.

****

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

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3	(2016) Process Piping
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment

	(1000 Volts Maximum)
NEMA MG 1	(2018) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2021) Flammable and Combustible Liquids Code
NFPA 58	(2020; TIA 20-1; TIA 20-2; TIA 20-3) Liquefied Petroleum 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 77	(2014) Recommended Practice on Static Electricity
NFPA 407	(2017) Standard for Aircraft Fuel Servicing
NFPA 780	(2017) Standard for the Installation of Lightning Protection Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

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

40 CFR 60.18	General Control Device and Work Practice Requirements
40 CFR 60.752	Standards for Air Emissions from Municipal Solid Waste Landfills

UNDERWRITERS LABORATORIES (UL)

UL 913	(2013; Reprint Mar 2019) UL Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations

1.2 RELATED REQUIREMENTS

****

NOTE: To apply this guide specification to other divisions of the project specification, insert the appropriate division number and title. Ensure that the appropriate sections having electrical equipment include the following paragraph:

Delete sections in the paragraph that are not in the

job. The requirements of this specification section are being incorporated into the other specification sections that reference it with the intent of phasing out this section. As the requirements of this section are incorporated into each specification section, that section should be added to the list in the paragraph below. Do not use this section, and delete reference to it, if the only sections used in the job are listed below.
****

This section applies to certain sections of Division 13, SPECIAL CONSTRUCTION, and Divisions 22, PLUMBING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections.

1.3 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:

****
NOTE: Permits are assumed to be obtained by firm holding design responsibility. Ensure this is clarified in contract bid package.
****

SD-02 Shop Drawings

Grounding and Bonding; G[, [_____]]

SD-03 Product Data

Condensate pump stations; G[, [_____]]

Condensate knockouts; G[, [_____]]

Blowers; G[, [_____]]

Propane stations and components; G[, [_____]]

Skid mounted flare systems and components; G[, [_____]]

Gas condensers; G[, [_____]]

Gas dryer systems and components; G[, [_____]]

Aftercoolers; G[, [_____]]

Gas turbines; G[, [_____]]

Microturbines; G[, [_____]]

Internal combustion engines; G[, [_____]]

Filtration systems and components; G[, [_____]]

Landfill gas analyzers and components; G[, [_____]]

Control Systems; G[, [_____]]

Gas Collection and Control System; G[, [_____]]

Generator; G[, [_____]]

SD-07 Certificates

Emissions Compliance; G[, [_____]]

Warranty; G[, [_____]]

SD-10 Operation and Maintenance Data

Condensate pump stations; G[, [_____]]

Condensate knockouts ; G[, [_____]]

Blowers; G[, [_____]]

Propane stations and components; G[, [_____]]

Skid mounted flare systems and components; G[, [_____]]

Gas condensers ; G[, [_____]]

Gas dryer systems and components; G[, [_____]]

Aftercoolers ; G[, [_____]]

Gas turbines ; G[, [_____]]

Microturbines ; G[, [_____]]

Internal combustion engines ; G[, [_____]]

Filtration systems and components; G[, [_____]]

Landfill gas analyzers and components; G[, [_____]]

Control Systems ; G[, [_____]]

Gas Collection and Control System; G[, [_____]]

Generator; G[, [_____]]

SD-11 Closeout Submittals

Demonstrations; G[, [_____]]

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Materials and equipment must have been in satisfactory commercial or industrial use for a minimum two years prior to bid opening. The two year period must include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two year period.

1.4.2 Nameplates

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Require melamine plastic nameplates for all NAVFAC projects. Also for NAVFAC projects, require nameplates to be associated or keyed to system

charts and schedules.
****

Attach nameplates to all specified equipment, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, contract number, acceptance date, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 25 by 65 mm/1 by 2-1/2 inches. Lettering must be the normal block style with a minimum 6 mm/1/4 inch height. Accurately align all lettering on nameplates.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 WARRANTY

Warranty overall landfill gas collection, processing, control, and generation system to be free from material, workmanship, and manufacturing defects (excluding normal maintenance), for a period of [5] years.

a. Gas Collection and Control System. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

b. Skid Mounted Flare Systems. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

c. Blowers. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

d. Gas Treatment System. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

e. Generator. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The landfill gas system includes the following:

a. Landfill gas and condensate piping and accessories;

b. Condensate pump stations;

c. Condensate knockouts;

d. Blowers;

e. Propane stations;

f. Skid mounted flare systems;

g. Gas condensers;

h. Gas dryer systems;

i. Aftercoolers;

j. Gas turbines;

k. Microturbines;

l. Internal combustion engines;

m. Filtration systems;

n. Landfill gas analyzers; and

o. Control systems.

2.2 Design Conditions

Equipment specified herein must be designed to for:

a. Elevation [_____] meters/[_____] feet.

b. Minimum/maximum ambient temperature [_____] / [_____] degrees C/[_____] / [_____] degrees F.

c. Landfill gas and condensate to be handled.

d. Maintaining a [75] percent collection efficiency.

e. Raw gas inlet conditions of:

LFG flow: [_____] liters/minute/[_____] SCFM.

LFG temperature: [_____] / [_____] degrees C/[_____] / [_____] degrees F.

Relative humidity: [100] percent.

Raw gas composition:

[_____] percent methane

[_____] percent carbon dioxide

[_____] percent nitrogen

[_____] percent oxygen

f. Treated gas conditions of:

****

NOTE: Specify for end use. I.e. on site power generation equipment requirements, direct use, or distribution.

****

Sulfur (hydrogen sulfide, sulfur dioxide) less than [57] mg/MJ/[60]

microgram/BTU.

Halides (chlorine/fluorine) less than [19] mg/MJ/[20] microgram/BTU.

Ammonia less than [2.81] mg/MJ/[2.96] microgram/BTU.

Particulates less than [10] microns.

Siloxanes less than [0.56] mg/MJ/[60] microgram/BTU.

Moisture less than [80] percent relative humidity at lowest temperature.

2.3 MATERIALS

Internal parts and components of equipment, piping, piping components, and valves that could be exposed to landfill gas and/or condensate during system operation must not be constructed of zinc coated (galvanized) metal. Do not install cast iron bodied valves in piping systems that could be exposed to landfill gas and/or condensate during system operation.

2.3.1 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

2.3.2 Acrylonitrile Butadiene Rubber (NBR)

Provide NBR material that conforms to SAE AMS3275.

2.4 ELECTRICAL WORK

****

NOTE: Show electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 DESIGN: INTERIOR ELECTRICAL SYSTEMS.

Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497M. Fuel ignition temperatures will dictate the maximum allowable temperature rating of the electrical equipment. Coordinate the area classification and the electrical design with UFC 03-460-01.

****

2.4.1 General

Provide motors, motor starters, controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of equipment, except controllers indicated as part of motor control centers.[Provide electrical equipment, including motors and wiring, as specified in [Section 26 05 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS] [Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL].] Provide switches and devices necessary for controlling and protecting electrical equipment. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Comply with API RP 540 and API RP 2003.

2.4.2 Motors

Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure. Comply with IEEE 112.

2.4.3 Motor Controllers

Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW/10 hp or less and adjustable frequency drives for larger motors. Controllers and contactor must have a maximum of 120-volt control circuits and must have auxiliary contacts for use with the controls provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

2.4.4 Underground Wiring

Provide underground electrical wiring in PVC conduit, as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.4.5 Grounding and Bonding

Grounding and bonding must be in accordance with NFPA 70, NFPA 77, NFPA 780, IEEE 1100, IEEE 142. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.5 GAS COLLECTION AND CONTROL SYSTEM

Landfill gas collection and control system (GCCS) to comply with 40 CFR 60.752.

Provide piping, accessories, and valving in accordance with in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES.

2.6 CONDENSATE PUMP STATIONS

****

NOTE: Refer to NAVFAC Standard Design 140-40-05 TRUCK UNLOADING SYSTEM and UFC 3-460-01 for detailed information of an off-loading assembly.

****

Assembly must be a complete, packaged, factory fabricated for use in the landfill, transferring condensate or leachate from landfill gas header and subheader piping. Assembly must include automatic level control of condensate or leachate and must pump to a point of disposal.

2.6.1 Condensate Pump Station and Enclosure

Provide pump station that is fully enclosed, weatherproof, polyethylene or PVC construction with an intermediate storage reservoir. Provide with quick connect/disconnect fittings and corrosion resistant components. Assembly must have a vault for access and maintenance. Comply with NEMA 250.

2.6.2 Condensate Pumps

Provide electric centrifugal or submersible type condensate pump sized and designed for condensate service.

2.6.3 Service Nameplate

In addition to the equipment identification nameplate, provide pump station service nameplate, of type 18-8 stainless steel or monel, securely attached by stainless steel pins at an accessible and conspicuous point on the pump station. Tagging in letters 6 mm/1/4-inch high must bear the equipment number as shown on the drawings. The pump station service nameplate must be stamped with the following information:

a. Manufacturer's name;

b. Pump serial number;

c. Capacity, [_____] L/s/[_____]gpm;

d. Pumping head, [_____] m/[_____] ft;

e. Pumped fluid maximum specific gravity;

f. Revolutions per minute; and

g. Driver horsepower.

2.7 CONDENSATE KNOCKOUTS

Provide complete packaged assembly, factory fabricated, for use in-line with the landfill gas pipelines to remove condensate from the landfill gas stream. Assembly must include automatic condensate level control and must pump to a point of disposal. Provide cleanout and monitoring ports.

2.7.1 Condensate Knockout Enclosure

The knockout must have a fully enclosed, weatherproof, polyethylene or PVC construction with an intermediate storage reservoir. Provide with quick connect/disconnect fittings and corrosion resistant components.

2.7.2 Condensate Pumps

Pumps must be an electric centrifugal or submersible type. Comply with API STD 610.

2.7.3 Service Nameplate

Provide a knockout service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the knockout, must be furnished in addition to the identification nameplate. The knockout service nameplate must be stamped with the following information:

a. Manufacturer's name;

b. Pump serial number;

c. Capacity, [_____] L/s/[_____]gpm;

d. Pumping head, [_____] m/[_____] ft;

e. Maximum specific gravity of fluid to be pumped;

f. Revolutions per minute; and

g. Driver horsepower.

2.7.4 Identification Nameplate

Provide a knockout identification nameplate of Type 18-8 stainless steel or monel and securely attached by stainless steel pins to a conspicuous place on the knockout. Tagging in letters 6 mm/1/4-inch high must bear the equipment number as shown on the drawings.

2.8 BLOWERS

Provide positive displacement blowers, completely assembled with strainer, silencers, check valves, pressure relief valves, shaft seals, and intake and discharge pressure gauges. Provide with variable frequency drive for LFG flow control. Provide actuated fail-safe valve on intake and discharge side for blower isolation during normal and emergency shutdown operations.

2.9 PROPANE STATIONS

Provide propane station compatible with flare pilot system requirements and integrated into the main station control panel. Size propane storage for 6 [_____] months of operation. Comply with ASME BPVC SEC VIII D1, ASME Boiler and Pressure Vessel Code, NFPA 58, and piping as specified in 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES.

2.10 SKID MOUNTED FLARE SYSTEMS

****

NOTE: Check local air quality board for more stringent emissions requirements.
****

Provide a skid mounted flare system for use in landfill gas destruction. Assembly must include burners, louvers, weather protection, insulation, access ladder and platform, heat shields, purge blower, flame arrester/thermal valve, wind shields, pilot light system, flame sensor, modulation control valves, and controls. The flare control system shall be completely assembled and tested prior to shipment by the flare supplier at the supplier's own fabrication facility.

Flare system must be capable of continuous stable combustion operation with [30] to [50] percent methane at the maximum required flow rate. Flare must have a minimum exhaust gas retention time of [0.5] [1.0] [_____] seconds at a minimum temperature of [760] to [980] degrees C/ [1400] to [1800] degrees F.

The flare shall be capable of achieving a minimum destruction efficiency of >98 percent of total non-methane organic compounds (NMOCs)by weight and 99 percent destruction of hydrogen sulfide. Flare shall be designed to comply with and operate in compliance of 40 CFR 60.18.

2.10.1 Skid Mounted Flare Construction

Flare construction must be carbon steel with a stainless steel weather and heat protection at the top of the flare.

2.10.2 Flare Insulation

Insulate flare with 100 mm/4 inch ceramic fiber blanket insulation to achieve a not to exceed skin temperature of 121 degrees C/250 degrees F.

2.10.3 Burner and Propane Pilot

Burner must be stainless steel construction. Propane pilot must be stainless steel construction. Provide thermocouple flame recognition system and purge system.

2.10.4 Manifold

Provide low pressure type manifold with flame arrestor and safety shutdown valve.

2.11 GAS DRYER SYSTEMS

Provide a complete packaged gas dryer system for use in landfill gas piping to remove water vapor and condition the landfill gas to a quality acceptable for use specified microturbines and combustion engines.

2.11.1 Gas Dryer Construction

Provide modular construction gas dryer with stainless steel wetted parts, heat exchanger tubes, and moisture separator. Gas dryer system must be mounted on a structural solid steel base.

2.11.2 Refrigeration System

The refrigerant used must not contain CFC. The refrigeration system must

include:

a. Liquid line dryer;

b. Suction line dryer;

c. Site glass;

d. Crank case heater;

e. Isolation valves for compressor and evaporator;

f. Condenser and liquid receiver;

g. Condenser pressure relief valve;

h. Compressor discharge check valve;

i. Separator/filter; and

j. Dew point sensor and readout.

2.12 AFTERCOOLERS

****

NOTE: Piston type differential pressure gauges do not require calibration. Suggest showing on the drawings a pressure gauge installed on the high pressure side of the differential pressure gauge. The pressure gauge should have a scale range from 0 to 2068 kPa (300 psi).

****

Provide an aftercooler after the blower. Aftercooler cores must be made of stainless steel to resist attacks from acids of sulfur, chlorine and fluorine. Provide condensate collection and piping.

2.13 GAS TURBINES

****

NOTE: Indicate the location and approximate configuration of each station. Mount all the control equipment on a single equipment rack next to the corresponding receiving/dispensing equipment. Include the sequence of operation for each station on the drawings.

****

Provide a gas turbine based [grid parallel] [dual mode] [grid isolated] generator system designed for landfill gas fuel meeting the following criteria:

a. Electrical efficiency [30] percent LHV;

b. Nominal heat (HHV) [_____] BTU/kWh;

c. Nominal heat (LHV) [_____] BTU/kWh;

d. Nominal electrical power [_____] kWh;

e. Voltage [_____] VAC;

f. Frequency [_____] Hz;

g. Service 3 phase, wye, 4 wire;

h. Grid isolation +- [0.50] percent nominal voltages and +- [0.50] percent nominal frequency;

i. Transient handling +- [10] percent nominal voltages maximum and +- [5] percent frequency max; and

j. Meets or exceeds [CARB] emissions standards.

k. Sound level not to exceed [_____] dB at [1] meter/[3] feet.

l. Minimum design life of [80,000] hours with overhauls.

2.14 MICROTURBINES

Provide microturbine based generator [grid parallel] [dual mode] [grid isolated] system designed for landfill gas fuel. Microturbine shall have recuperator and integrated heat recovery.

a. Electrical efficiency [30] percent LHV;

b. Nominal heat (HHV) [_____] BTU/kWh;

c. Nominal heat (LHV) [_____] BTU/kWh;

d. Nominal electrical power [_____] kWh;

e. Voltage [_____] VAC;

f. Frequency [_____] Hz;

g. Service 3 phase, wye, 4 wire;

h. Grid isolation +- [0.50] percent nominal voltages and +- [0.50] percent nominal frequency;

i. Transient handling +- [10] percent nominal voltages maximum and +- [5]percent frequency max; and

j. Meets or exceeds [CARB] emissions standards.

k. Sound level not to exceed [1] meter/[3] feet.

l. Minimum design life of [80,000] hours with overhauls.

2.15 INTERNAL COMBUSTION ENGINE

Provide a internal combustion engine based [grid parallel] [dual mode] [grid isolated] generator system designed for landfill gas fuel.

a. Electrical efficiency [30] percent LHV;

b. Nominal heat (HHV) [_____] BTU/kWh;

c. Nominal heat (LHV) [_____] BTU/kWh;

d. Nominal electrical power [_____] kWh;

e. Voltage [_____] VAC;

f. Frequency [_____] Hz;

g. Service 3 phase, wye, 4 wire;

h. Grid isolation +- [0.50] percent nominal voltages and +- [0.50] percent nominal frequency;

i. Transient handling +- [10] percent nominal voltages maximum and +- [5] percent frequency max; and

j. Meets or exceeds [CARB] emissions standards.

k. Sound level not to exceed [_____] dB at [1] meter/[3] feet.

l. Minimum design life of [80,000] hours with overhauls.

2.16 FILTRATION SYSTEMS

Provide filtration system to remove particulates and other contaminants as required to comply with specified generation system specifications.

2.17 LANDFILL GAS ANALYZERS

Provide continuous gas analyzer for methane, carbon dioxide, [_____] and oxygen. Provide warning alarm at [2] percent oxygen and shutdown alarm at [4] percent oxygen. Provide output to main control panel and generator control system to allow automatic system shutdown.

****
NOTE: Methane may seep into buiding structures/enclosed spaces.
****

Provide methane sensor/alarm within enclosed structures.

2.18 CONTROL SYSTEMS

Control systems must have all necessary sensors, interlocks, relays, alarms, and user interfaces to allow for continuous monitoring and [grid parallel][dual mode][grid isolated]operations. Use gas analyzer output to adjust generator speed and air/fuel ratio set point for emissions compliance and power output optimization.

Provide critical shutdown alarms for:

a. Shutdown oxygen level - [4] percent or greater, by volume;

b. Low methane level - less than [30] percent by volume;

c. Flare failure;

d. Blower fault;

e. Blower inlet and exit bearing temperatures greater than [100] degrees C/[212] degrees F;

f. Emergency stop;

g. Power loss;

h. Condensate tank high level;

g. Gas dryer failure; and

h. Enclosed structure methane level greater than [4] percent by volume.

Provide non-critical alarms for:

a. High oxygen levels - greater than [2] percent by volume;

b. Low propane supply pressure;

c. Low flare temperature;

d. Landfill gas temperature at wellhead - greater than [60] degrees C/[140] degrees F; and

e. Methane detection within enclosed structures.

[Provide automated trouble notification system for critical shutdown [and non-critical] alarms.]

PART 3 EXECUTION

3.1 SITE PREPARATION

Evaluate and ensure site is accessible for the size and weight of planning equipment and facilities. Prepare site and lay down areas in accordance with approved contract documents.

3.2 INSTALLATION

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.3 and NFPA 30, NFPA 70 except as modified herein. Safety rules as specified in NFPA 30 and NFPA 407 must be strictly observed. When work is not in progress, securely close open ends of pipe and fittings with expansion plugs so that water, earth, or other substances cannot enter the pipe or fittings. Comply with UL 913.

3.2.1 Equipment

Properly level, align, and secure equipment in place in accordance with manufacturer's instructions. Provide supports for equipment, appurtenances, and pipe as required. Provide floor-mounted pumps and other floor mounted equipment with mechanical vibration isolators or a vibration isolation foundation. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified must be as required for proper installation.

3.3 SYSTEM COMMISSIONING

System commissioning must conform to Section [01 91 00.15 10][01 91 00.15 20] TOTAL BUILDING COMMISSIONING.

3.4 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 8 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the on-site training.

-- End of Section --