

ENCLOSED FLARE SYSTEM AND LANDFILL GAS BLOWER SYSTEM SPECIFICATIONS

EASTERN SANITARY LANDFILL

Summary of Work

The selected Vendor shall supply an enclosed flare, skid-mounted blower and control system, and appurtenances including but not limited to associated valves, actuators, flow meters, and sensors (the project) as detailed below. The purpose of this Summary of Work is to generally describe the proposed flare station configuration and the anticipated procurement and installation process.

Eastern Sanitary Landfill (ESL) is an active municipal solid waste (MSW) landfill located in White Marsh, Maryland, and owned and operated by the Baltimore County Bureau of Solid Waste Management (County). The County operates a comprehensive gas collection and control system (GCCS) that collects landfill gas (LFG) from disposal areas at ESL. Collected LFG is directed through a blower skid to an existing enclosed flare (rated at 2,500 scfm) and/or a utility flare (rated at 750 scfm). LFG is also directed to a separately-permitted third-party LFG-to-energy (LFGTE) plant owned and operated by Eastern Landfill Gas (ELG). The enclosed flare and utility flare typically operate as backup control devices to the LFGTE plant during partial or full downtime, or control LFG collected above the LFGTE plant capacity. Under this project, the existing enclosed flare will be replaced with a new, higher-capacity enclosed flare rated up to 4,500 cubic feet per minute (cfm).

The project includes the procurement and installation of an enclosed flare and three (3) skid-mounted blowers (with space for a fourth). An LFG inlet supply pipe will be connected to the skid inlet by others to provide LFG to the skid. The skid shall have a condensate knockout pot (KOP) to reduce moisture in the inlet LFG. Condensate drain lines will be connected to the existing condensate management system. The skid shall include a tee installed after the blowers to direct the LFG to either the new enclosed flare or the LFGTE plant. The system shall be designed to accommodate an anticipated flow rate range of up to 4,500 cfm based on a 50 percent methane (CH₄) content. The skid shall be equipped with temperature and flow monitoring equipment and a digital chart recorder.

All site work and installation activities will be performed by others and generally includes:

- Site preparation, concrete foundations, and demolition
- Removal of existing skid and flare and installing new skid and flare
- All connecting pipe and electrical connections to provide a functioning system that will provide vacuum to the GCCS and convey the collected gas to the LFGE plant and/or the Landfill flares.

SECTION 11170

ENCLOSED FLARE

PART 1 GENERAL

1.01. DESCRIPTION

- A. Scope of Work: The VENDOR shall supply all materials, equipment, and labor needed to fabricate, shop test, deliver, start-up, and field test a landfill gas flare and controls package, as specified herein, including necessary appurtenances to integrate the flare and controls package into the existing blower/flare station
- B. Related Work Described Elsewhere
 - a. Summary of Work
 - b. Section 15090 – Skid-Mounted Landfill Gas Blower System
 - c. Controls Discussion
 - d. Preliminary Landfill Gas Blower/Flare Station Schematic
- C. If necessary, modifications shall be made in the manufacturer's standard product to make it conform to the specific requirements of the Specifications and to requirements contained in regulations issued by public agencies.
- D. Equipment shall not have been in service except for shop tests, at any time prior to delivery. The equipment shall be furnished factory-assembled to the extent possible and ready for installation.

1.02. QUALIFICATIONS

- A. One (1) Enclosed Ground Flare, including all ancillary equipment shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished.
- B. The manufacturer shall have experience in supplying enclosed flares and related equipment for LFG service and shall have a minimum of five (5) years of experience in design and manufacture of this type of equipment.
- C. The manufacturer shall have a minimum of five (5) similar installations in successful operation in the United States.
- D. The Enclosed Ground Flare shall be manufactured by John Zink Company, Perennial Energy, Aptim-LFG Specialties, or approved equal.

1.03. SUBMITTALS

- A. Drawings:
 - 1. The VENDOR shall prepare and submit to the ENGINEER, for review and approval, manufacturer's drawings and other information pertaining to the assembly, operation, adjustments, and maintenance and repairs of equipment delivered under this Section, together with detailed parts lists and/or photographs.
 - 2. The VENDOR shall prepare and submit drawings showing the general arrangement, layout, orientation, elevations, and dimensions of the flare, pilot/ignition assembly, and other flare appurtenances.
 - 3. The VENDOR shall submit a piping and instrumentation diagram and Controls Discussion.

- B. Catalog Cuts and Specification Sheets: The VENDOR shall submit information describing the make and model number for all components and physical dimensions for the following: flame arrester, valves, actuators.
- C. The VENDOR shall submit information showing the total weight of the equipment, including the weight of the single largest item.
- D. O&M Manual: An electronic copy of the draft O & M manual shall be submitted for review 3 weeks prior to flare delivery. The draft manual must include a detailed check list specifying how all controls, safeties, etc. will be tested during start-up. The VENDOR shall submit to the ENGINEER four (4) copies of a final operations and maintenance manual two weeks after startup of the flare that incorporate the ENGINEER's comments on the draft manual. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, specification sheets, record drawings, equipment list, descriptions, health and safety issues, and information necessary to instruct operating personnel unfamiliar with such equipment.
- E. The VENDOR shall submit detailed instructions on the proper handling, unloading, storage, and installation of all equipment in an outside environment.

1.04. DESIGN CRITERIA

A. Landfill Gas

- 1. Equipment specified herein is intended to be standard equipment for use in a landfill gas handling system.
- 2. The flare system shall be designed for continuous operation in an outdoor environment at the following service conditions.

Parameter	Value
Number of flares required	1
Maximum LFG Flow	4,500 scfm
Minimum LFG Flow	650 scfm
Turndown (min)	7:1
Maximum BTU Rate (LHV)	135 MMBTU/hr
Minimum BTU Rate (LHV)	20 MMBTU/hr
Flare Inlet Pressure (in-WC)	5
Hydrogen sulfide	Up to 500 ppm
Moisture Content	Saturated
Site Elevation	50 ft M.S.L.
Pilot Gas	Propane
Methane Content Range	30-60%
Carbon Dioxide Content	25-40%
Oxygen Content	<5%
Maximum Stack Emissions at 1600 °F	
NOx (HHV)	0.08 lb/MMBTU
CO (HHV)	0.20 lb/MMBTU
NMOC Destruction Efficiency	98% min
Methane Destruction Efficiency	99% min
Operating Temperature	1400 to 1800 °F
Minimum Residence Time	0.7 seconds @ 1,500 deg F

1.05. PERFORMANCE REQUIREMENTS

- A. The following performance requirements shall be guaranteed by the VENDOR:
 - 1. The flare shall provide a minimum 98 percent by weight, destruction and removal efficiency of nonmethane organic compounds (NMOC) as measured by US Environmental Protection Agency (EPA) Method 25 or an outlet NMOC concentration that shall not exceed 20 ppmvd measured as hexane and corrected to 3 percent oxygen, per 40 CFR 62 Subpart OOO and 40 CFR 63 Subpart AAAA.
 - 2. The flare shall provide a minimum 99 percent by weight, destruction and removal efficiency of methane per the Code of Maryland Regulations (COMAR) Title 26, Subtitle 11, Chapter 42 (26.11.42), Control of Methane Emissions from Municipal Solid Waste Landfills.
 - 3. Exhaust from the flare stack shall have no visible flame and no visible emissions.
 - 4. The burner shall be designed so the flame lift-off from the burner does not occur and shall be an anti-flash back design.

1.06. APPLICABLE CODES AND STANDARDS

- A. All equipment shall be manufactured in accordance with codes and guidelines as specifically detailed herein and in accordance with applicable portions of the following (latest edition):
 - 1. Local laws and ordinances.
 - 2. State and Federal laws.
 - 3. National Electrical Code (NEC).
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. Underwriters Laboratories (UL).
 - 6. State Building Code.
 - 7. American National Standards Institute (ANSI).
 - 8. American Society of Mechanical Engineers (ASME).
 - 9. American Gas Association (AGA).
 - 10. Institute of Electrical and Electronic Engineers (IEEE).
 - 11. Instrument Society of America (ISA).
 - 12. Industrial Risk Insurance (IRI).
 - 13. Factory Mutual (FM).
 - 14. National Fire Protection Agency (NFPA).
 - 15. Environmental Protection Agency (EPA).
- B. Whenever drawings or specifications require materials, workmanship, arrangement or construction of higher standard or larger size than is required by Codes and Regulations, then drawings and specifications shall take precedence. Likewise, whenever drawings or specifications require materials, workmanship, arrangement or construction of lower standard or lower size than is required by Codes and Regulations, then the Codes and Regulations shall take precedence.
- C. All electrical materials and equipment shall bear the label of UL, listed by them in their list of electrical fittings; and approved by them for the purpose for which they are intended to be used, unless material and equipment is of a type for which UL do not list or provide a label. Panels shall bear UL labels, as of the bid submittal date.

PART 2 EQUIPMENT

2.01. EQUIPMENT

- A. The landfill gas flare system shall have the following items as a minimum:
 - 1. Stack and burners for landfill gas.
 - 2. Flame arrester.
 - 3. Control system.
 - 4. Auxiliary equipment and piping.
 - 5. Ignition by propane pilot system with electric igniter and pressure regulator.
 - 6. Spare parts.

2.02. FLARE SYSTEM

- A. The VENDOR shall provide one (1) enclosed flare, with a minimum turndown ratio of 7:1 (based on Btu rate). The stack shall be constructed of ASTM A-36 carbon steel, at a minimum, with a minimum thickness of 1/4-inch. BOCA Code and local Building Code requirements shall be met, including structural loading for 110 mph winds in Seismic Zone 4. Welds shall be full penetration. LFG burners shall be made from 304L series stainless steel, at a minimum, with a minimum thickness of 16 gauge. The manifold shall be of a sectional header arrangement to accommodate the removal and repair of individual flanged headers.
- B. The refractory shall be a lightweight ceramic insulating blanket, manufactured by A.P. Green or equal, installed at the factory. The flare shall not require warm-up or cool-down procedures to avoid refractory damage. The shell skin temperature shall not exceed 250 degrees F under maximum Btu loading conditions. A minimum of two (2) layers of ceramic fiber insulation blanket shall be provided. One 1-inch thick layer of ceramic fiber blanket of 9 lbs/ft³ density shall be installed, using overlap outer face construction methods, over one 1-inch-thick layer of ceramic fiber blanket of 6 lbs/ft³ density. Insulation shall be attached to stack wall and floor with Inconel 601 series, or as approved by the ENGINEER as equal, anchors, pins, and keepers. A 304 S.S. rain guard shall be provided at top of the flare stack to prevent water seeping into the insulation. A 2-inch heat- and flame-resistant sight port shall be provided.
- C. The exposed carbon steel surfaces of the flare shall be sand blasted (SSPC – SP6) and have one (1) finish coat of rust-resistant, heat-resistant primer and one (1) finish coat applied at the shop/factory. The primer shall have a high zinc content (minimum 50 percent by weight) suitable for the operating temperatures, such as Sherwin Williams Zinc Clad II or approved equal, suitable for a corrosive environment with high hydrogen sulfide LFG. Primer coat shall be 2 to 3 mils DFT and finish coat shall be minimum 1.5 dry mils. The VENDOR shall remove rust and repaint equipment that experiences blistering, cracking, peeling, rusting, or other failure during the first year of operation under normal flare temperature conditions (< 2000°F). The color of the finish coat shall be consistent with the existing on-site flares, if applicable, and shall be approved by the OWNER.
- D. At all levels of performance, the sound pressure shall not exceed 85 dbA over a frequency range of 37.8 to 9,600 cycles per second. Measurement shall be made a distance of three (3) feet from the outer face of the flare.
- E. All factory-finished equipment shall be protected from damage during shipment, thoroughly cleaned after shipment, and touched up as directed by the ENGINEER. If the factor finish had, in the opinion of the ENGINEER, been damaged, the equipment shall be given one (1) finish field coat.

- F. The flare stack shall have a galvanized ladder mounted to it to allow servicing of the thermocouples. The ladder shall comply with OSHA requirements and include a hood shield at the top of the ladder and safety harness attachment lugs. Include one OSHA-approved harness. Protective screening shall be provided behind the ladder.
- G. A brass or stainless steel nameplate shall be attached to the flare in a conspicuous place. The following information shall be plainly marked on the nameplate: name and address of the manufacturer, serial number, model number, and any other information necessary for complete identification.
- H. An access manway shall be provided on the unit for inspection and maintenance of the burners. Access may be provided by hinging one set of louvers, or by a separate bolted or locked manway.
- I. A set of four sampling ports shall be spread horizontally and located at least 1/2 stack diameter below the top of the flare shroud. Sampling ports shall be installed 90 degrees apart, and shall consist of 4-inch NPT ports with insulated plugs.
- J. Eye bolts shall be provided above each sampling port to properly support sampling probe and trains.
- K. The flare stack shall be provided with lifting lugs near the top of the flare to permit the lifting and upright suspension of the flare at these points. The flare shall arrive on the site with internal supports necessary to permit the lifting of the flare by the lifting lugs without damage to the refractory or other flare components and all necessary covering and weather protection to enable outside storage prior to installation.
- L. The flare stack shall be assembled at the factory to the extent possible. Instructions for any unavoidable on-site assembly shall be provided per submittal requirements.
- M. The flare stack shall be installed on the concrete slab. All necessary support angles to install the flare on the concrete slab shall be furnished by the VENDOR. A base ring template made of 1/4" carbon steel shall be used to assist in setting the anchor bolts. The landfill gas inlet flange and pilot gas pipe connection furnished with the flare shall extend a minimum of 6 inches beyond the outermost dimension of the flare.
- N. The flare shall be configured to operate on LFG only and maintain operating temperature, provided the methane content is greater than 25 percent.

2.03. FLAME ARRESTER

- A. Flame arrestor (1) shall be suitable for installation on lines containing saturated LFG.
- B. The VENDOR shall supply an eccentric flame arrester compatible to the required flow rates. Flame arrester shall be sized to match the LFG header pipe with 125-pound, ANSI flanged connections. All LFG piping and fittings downstream of the flame arrester shall be provided by the VENDOR. The housing construction shall be cast aluminum and shall have a drain connection with manual valve. Maximum head loss through the flame arrester shall not exceed 5 in.-w.c. at the maximum flow rate. The flame arrester shall be manufactured by Varec, Enardo, or approved equal.
- C. The bank assembly shall be all aluminum and shall be so arranged for removal from the housing to facilitate inspection and cleaning, without removal of the housing from the pipe. The net free area through the bank assembly shall not be less than four times that of the corresponding size pipe. All grids of the bank shall be arranged for individual removal.
- D. A differential pressure (Dwyer Capsuhelic or approved equal) indicator shall be provided across the flame arrester, including connecting piping, mount, and isolation valves.

2.04. CONTROL SYSTEM

- A. Control panel(s) for the system shall be compliant with NEMA 4 specifications at a minimum and shall house all control functions for the new flare, existing flare, and LFG handling system (3 blowers). The system shall be controlled by a programmable logic controller (PLC) and human machine interface (HMI). The PLC and HMI shall have ethernet communications and be capable of being accessed remotely. The HMI shall be capable of being viewed and operated remotely over the internet. HMI design should be equivalent to AutomationDirect Cmore model EA9-T8CL. The HMI shall have a NEMA 4 cover around it to prevent water infiltration; Saginaw SCE-HA1212 or equal.
- B. The control system shall include a data recorder to record gas flows and stack temperatures for both the existing and new flare. The data recorder shall be Yokogawa DX1000 data recorder with Ethernet and math capabilities. Provide sufficient channels to accommodate the required data plus 30 percent additional channels for future expandability. Alarms for flare temperatures or system failures shall be communicated via text message and email per the instructions of the OWNER.

2.05. AUXILIARY EQUIPMENT

- A. Auxiliary equipment shall include the following:
 - 1. Temperature Indication – Three (3) thermocouples installed at various stack heights to appropriately monitor anticipated minimum, maximum, and intermediate flow temperatures. The PLC will calculate the correct thermocouple to monitor based on the input flow rate and user specified gas content.
 - 2. Automatic temperature control via makeup air dampers.
 - 3. Ultraviolet scanner (self-checking) flame monitoring with NFPA-approved flame safeguard controller as manufactured by Honeywell, or approved equal.
 - 4. Purge blower.

2.06. IGNITION PROCEDURE

- A. The pilot and main flame shall be controlled by ultraviolet (UV) scanner(s), thermocouples and timers to perform the following functions:
 - 1. System startup shall begin with a 5 –minute purge cycle, using a purge blower, to evacuate any fugitive hydrocarbons from the flare. Limit switch on flare shut-off valve must indicate closure. After purge is completed, spark ignition of propane creates pilot flame. Prove the pilot flame by a self-checking flame scanner.
 - 2. When pilot is successfully ignited, main valve on flare inlet is activated. Open limit switch on main valve and closed limited switch on vent valve must be made before blower turns on.
 - 3. When main flame is successfully ignited (as detected by a UV scanner), pilot gas is shut off.
 - 4. If pilot is not ignited after three attempts within the pre-selected time interval (as set on the timer), the pilot is shut off, a trouble light is illuminated, and the auto dialer signal is initiated.
 - 5. If main flame is not ignited within the pre-selected time interval, the pilot is shut off, and the trouble light is illuminated.
 - 6. If the main flame fails (either loss of flame or high or low temperature condition), a contact closure shall signal the inlet valve to close, the blower(s) to turn off and an alarm to activate.

2.07. SPARE PARTS

A. The Vendor shall provide the following spare parts:

1. One Flame scanner
2. One Flame scanner amplifier
3. Four Thermocouple assemblies
4. One spark plug
5. Two ignition rods
6. One Sight Port Assembly
7. Six panel lights
8. One Pressure gauge
9. One Regulator
10. One Solenoid valve
11. One damper actuator
12. One Pressure Switch
13. One Flame arrester element

PART 3 – EXECUTION

- 3.01. Prior to shipment, the VENDOR shall test all interlocks, relays, blowers, valves, instrumentation and controls. Testing of proper start-up, operating and shutdown sequences is required, together with and required adjustment or corrections. The main flare burners do not need to be operated.
- 3.02. The VENDOR's representative shall be on site for a minimum of 3 days (defined as 8-hour days at the site) during flare system start-up to provide start-up troubleshooting, to perform QA/QC check of the installation work, to identify any defects requiring corrective action, to confirm all controls and safeties, to demonstrate equipment operation, health and safety issues, and to train on-site personnel using the draft O&M manual. Successful demonstration of all equipment, controls, and field testing, supplies and other necessary items to perform the blower/flare start-up shall be provided by the VENDOR.

PART 4 WARRANTY

- 4.01. The supplied flare assembly shall meet the design and performance criteria specified herein including the emissions limits for a minimum period of 1 year beginning at completion of the start-up phase and acceptance.

END OF SECTION

SECTION 15090

SKID-MOUNTED LANDFILL GAS BLOWER SYSTEM

PART 1 GENERAL

1.01. DESCRIPTION

A. Scope of Work

1. The work described in this section consists of furnishing all labor, materials, equipment, and incidentals necessary to furnish and field test a SKID-MOUNTED LANDFILL GAS BLOWER SYSTEM as specified herein, including all appurtenances to provide a complete system ready for operation.
2. The Skid-Mounted Landfill Gas Blower/Flare System shall include the following sub-systems
 - a. Gas Handling System
 - b. Knockout Pot
 - c. Interconnecting Piping System
 - d. Control System

B. Related Work Described Elsewhere:

- a. Summary of Work
- b. Section 11170 – Enclosed Flare

1.02. SUBMITTALS

A. All Equipment and accessories shall have manufacturer's Shop drawings approved by the ENGINEER prior to shipment and shall be tested for conformance with these Specifications prior to acceptance and final payment by the OWNER. The following materials and shop drawing information shall be submitted:

1. Certified Shop Drawings showing all important details of construction and dimensions.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. A complete bill of materials for all equipment.
4. The total weight of the equipment, including the weight of the single largest item.
5. Complete performance data that will indicate full compliance with the Specifications; performance curves for flow and pressure/vacuum capacity; calculations showing the equipment gas flow and motor corrections required for operation at the elevation of the job site.
6. Complete control panel diagrams and elevations showing all components wires, connections, and external devices
7. Complete electrical interconnect diagram showing all wires and terminals between the control panel and external devices.
8. Exceptions to the applicable requirements, Specifications, and applicable codes and standards.

B. An operation and maintenance manual shall be furnished per the Enclosed flare Specifications.

C. Spare Parts: In addition to the spare parts required by this specification, a list of manufacturer's recommended spare parts shall be submitted.

1.03. APPLICABLE CODES AND STANDARDS

- A. All equipment shall be manufactured in accordance with codes and guidelines as specifically detailed herein and in accordance with applicable portions of the following (latest edition):
 - 1. Local laws and ordinances.
 - 2. State and Federal laws.
 - 3. National Electrical Code.
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. Underwriters Laboratories (UL).
 - 6. Uniform Building Code (UBC).
 - 7. American National Standards Institute (ANSI).
 - 8. American Society of Mechanical Engineers (ASME).
 - 9. American Gas Association (AGA).
 - 10. Institute of Electrical and Electronic Engineers (IEEE).
 - 11. Instrument Society of America (ISA).
 - 12. Industrial Risk Insurance (IRI).
 - 13. Factory Mutual (FM).
 - 14. National Fire Protection Agency (NFPA).
 - 15. Environmental Protection Agency (EPA).

1.04. PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- B. The equipment shall be delivered on site as fully assembled as transportation will allow. Factory-assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the ENGINEER.
- C. Finished surfaces of all exposed openings shall be protected by wooden blanks, strongly built, and securely bolted thereto.
- D. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.05. WARRANTY AND GUARANTEES

- A. The VENDOR shall warrant the units being supplied to the OWNER against defects in workmanship and material for a period of one (1) year from the date of equipment acceptance by the OWNER. In the event that the equipment fails to perform as specified, the equipment manufacturer shall promptly repair or replace the defective equipment without any cost to the OWNER (including handling and shipment costs).

PART 2 MATERIALS

2.01. GENERAL

- A. Equipment shall not have been in service, except for shop tests, at any time prior to delivery. The equipment shall be furnished factory-assembled to the extent possible and ready for installation.
- B. Equipment shall be designed and proportioned to have liberal strength, stability, and stiffness and shall be especially adapted for the intended service. Ample room and facilities shall be provided for inspection, repairs, and adjustments.
- C. Parts of equipment shall be amply proportioned for all stresses which may occur during operation and for any additional stresses which may occur during fabrication, transportation, handling, and erection.
- D. These Specifications are intended to give a general description of what is required, but do not cover all requirements of the equipment as offered. They are, however, intended to cover the furnishing, delivery, and field testing of all materials, equipment, and apparatus as required.
- E. A brass or stainless steel nameplate shall be attached to each piece of equipment in a conspicuous place. The following information shall be plainly marked on the nameplate: name and address of the manufacturer, serial number, model number, and any other information necessary for complete identification.
- F. If necessary, modifications shall be made in the manufacturer's standard product to make it conform to the specific requirements of the Specifications and to requirements contained in regulations issued by public agencies. Such modifications shall be noted in Shop Drawing submittals.

2.02. BLOWER SYSTEM

- A. Shop Assembly and Testing:
 - 1. The blower system shall be fully assembled and tested prior to shipment.
- B. Equipment Parameters:
 - 1. A total of three (3) blowers, sized for the following conditions:
 - a. Maximum LFG flow rate: at least 3,000 scfm
 - b. Minimum LFG flow rate: 1,000 scfm
 - c. Inlet vacuum: 60 in-WC
 - d. Discharge pressure: 5 in-WC
 - e. LFG inlet temperature: 60F to 140F
 - f. Site elevation: 50 ft M.S.L.
 - g. Methane content range: 30-60%
 - h. Carbon dioxide content: 25-40%
 - i. Oxygen content: <5%
 - j. Noise: <90 dbA at 3 feet
 - 2. Additional space shall be provided on the skid for a future fourth blower.
 - 3. VFDs shall be provided for the blowers, and include the following:
 - a. VFD should allow control of blowers based on inlet pressure, blower discharge pressure, percent full output, and flow.
 - b. Operator selectable for system to maintain constant vacuum, flow, or constant blower speed.
 - c. VFD shall be housed in a NEMA 3R enclosure.

C. Blower and Motor:

1. The blower unit(s) shall be multi-stage centrifugal type.
2. Centrifugal Blower:
 - a. The blower construction shall consist of impeller(s), mounted directly on the motor shaft. The impeller(s) shall be precision cast aluminum with multiple radial blades at its periphery. The impeller(s) shall be the only moving part and shall not require any lubrication. The impeller(s) shall be dynamically balanced to provide vibration-free operation without the need for vibration isolators.
 - b. The blower impeller(s) shall be supported by outboard-mounted, anti-friction bearings. No overhung loads will be permitted. The bearings shall be located outside the compression chamber to maximize efficiency and bearing life. No lubrication of bearings shall be required.
 - c. Internal coating. The blowers shall be supplied with a factory-applied Bisonite, Kynar, phenolic coating, or approved equal, to protect all internal parts (excluding aluminum impellers) that will be in contact with extracted gas to provide resistance to corrosion.
 - d. Where the motor shaft passes through the blower housing, a seal shall be provided to minimize gas leakage.
3. Casing Drains. Each blower stage drain shall be connected to a manifold to form a single blower casing drain and connected to a manual shut-off ball valve.
4. Motor. Each blower shall be direct-coupled to a horizontal 480V, 3-phase, 60-hertz motor rated for service with a VFD. The blower manufacturer shall be responsible for selecting the proper motor size to suit this equipment, the performance requirements noted herein, and the site conditions. The motor shall be totally-enclosed fan-cooled (TEFC), UL-approved and suitable for Class 1, Division II, Group D locations. Motor shall be inverter-duty rated. Motor shall be rated at 104 degrees F ambient with not more than 131 degrees F rise. Motor bearings shall be of the antifriction type with an AFBMA L-10 life rating of not less than 25,000 hours. Provide a manufacturers' certificate confirming all motor ratings.
5. Flexible Coupling and Drive. The blower shall be connected to the drive with a suitable flexible coupling. The alignment of the coupling and drive shall have a tolerance of plus or minus 2 mils. Couplings shall be covered with base-mounted aluminum or non-sparking metallic guard.
6. Bases. Stainless steel or epoxy-coated steel bedplates of suitable size for mounting the blower and motor shall be furnished by the blower manufacturer. The blower and motor shall be carefully aligned and then bolted in place. Suitable vibration isolation pads shall be provided under the steel bedplates of the units.
7. The blower-motor assembly shall be installed on the base and delivered as a complete unit.
8. The blower controls shall include a thermal protection package to monitor the blower inlet and outlet bearing temperatures.
9. Experience:
 - a. Blowers shall be manufactured in the United States. Blower manufacturers shall have a minimum of 5 years of experience in the design and manufacture of this type of equipment and have a minimum of 25 operating installations on landfills in the U.S.

- b. Acceptable Manufacturers:
 - 1) Lone Star Turbo
Houston, Texas
(832) 532-3112
 - 2) Houston Service Industries (subsidiary of Atlas-Copco)
Houston, Texas
(800) 725-2291
 - 3) Gardner Denver, Inc.
Quincy, Illinois
(217) 228-8247
 - 4) Continental Blower LLC
East Syracuse, New York
(315) 451-5410
 - 5) Approved equal.

2.03. CONDENSATE KNOCKOUT POT

- A. The condensate knockout pot shall be fabricated from high density polyethylene (HDPE) and sized for a maximum 4,500 scfm flow rate. It shall be of a vertical, cylindrical design with element removal from the top. An 8-inch flanged, covered, inspection port shall be provided in the side near the bottom for manual clean out of accumulated debris. Nozzle flanges shall meet ANSI 150-pound specifications. A support ring shall be extrusion-welded along the inside diameter of the moisture separator for support of the demister pad.
- B. The demister pad shall be made from non-corrosive mesh and shall be supported on and held down by high open area, stainless steel grid, or equivalent. The moisture separator shall be able to remove 100 percent of droplets greater than 6 μ m at maximum flow capacity and shall also remove particulate matter having a density equal to or greater than water which are greater than 6 μ m in size.
- C. The moisture separator shall have a flow capacity of at least 4,500 scfm. At the design flow rates, temperatures and pressures, the moisture separator (including demister pad) shall not have a pressure drop greater than 3 in-w.c. and shall be capable of withstanding no less than 3 pounds per square inch (psi) gauge vacuum.
- D. Condensate Removal. There shall be a 2-inch IPS pipe coupling near the bottom of the assembly for condensate removal.
- E. Pressure Drop Monitoring. There shall be two (2) 1/2-inch pipe couplings in the side of the unit, one upstream and one downstream of the demister element material, for the purpose of connecting a differential pressure gauge. Pressure differential gauge shall be furnished and mounted on the face of the moisture separator. Inlet and outlet shall be flanged.
- F. Transparent Liquid Level Gauge. The moisture separator shall include a transparent liquid level gauge installed along the side of the unit, from the bottom to the invert elevation of the inlet landfill gas pipe, to allow visual determination of liquid level within the unit. The transparent material in the gauge shall be glass, and shall be easily removed for cleaning. The liquid level gauge shall be connected to the moisture separator at the top and bottom of the gauge, to allow the gauge to properly respond to changes in liquid level.
- G. Davit Arm. A davit arm shall be provided to support the top lid of the knockout pot when removing lid to service the demister pad.

2.04. INTERCONNECTING PIPING SYSTEM

- A. All landfill gas and condensate piping on the Skid-Mounted Blower and Flare System shall be SDR 17 HDPE pipe. Blower inlet and outlet piping manifolds shall be sized to accommodate up to 3,000 scfm per blower with up to 4,500 scfm maximum combined flow.
- B. All piping, fittings and flanges shall be free of loose particles or other foreign material.
- C. Pipe Supports:
 - 1. Pipe supports shall be installed as necessary to properly support the pipe during normal service and upon disconnection of any pipe or equipment at flanged connections.
 - 2. Pipe supports shall be galvanized, adjustable with an elastomeric insert.
- D. Flexible expansion joints: Provide for inlet and outlet of blower.
- E. The gaskets shall be full face rubber, 1/16 inch to 1/8 inch in thickness, and shall meet the requirements of ANSI Specification A21.11.
- F. As required, pipes and fittings shall be drilled and tapped to receive drainage or other piping or plugs. All holes shall be drilled at right angles to the axis of pipes and fittings.
- G. Piping and fittings shall be supported so as to prevent any strain being transmitted between sections and connected equipment and appurtenances. Release of any joint shall result in no transverse piping movement and shall allow easy removal and replacement of any piping component.

2.05. VALVES

- A. Blower Butterfly Valves: The butterfly valves, for low pressure/vacuum landfill gas services, shall have cast iron wafer style valve body with contoured 316 stainless steel disc, Type 316 stainless steel stem, Acetal stem bushing, and viton replaceable resilient seat. Valves shall be bubble tight at 150 pounds per square inch differential pressure and shall be suitable for installation between ANSI 125 pound flanges.
- B. Flexible Expansion Joints: provide for inlet and outlet of blower.
- C. Check valves: Provide aluminum body check valve on blower outlet.
- D. All valves shall be complete with all necessary operators, actuators, handwheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, wrenches, and other accessories or appurtenances which are required for the proper completion of the work. Manual operators and other accessories shall be sized and furnished by the valve supplier and factory mounted.
- E. Valves shall be suitable for the intended service. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service, but not of a lower quality than specified herein.
- F. Valves and operators shall be suitable for the exposure they are subject to: interior or exterior, as applicable. Valves shall have all safety features required by OSHA.
- G. Unless approved by ENGINEER, valves shall be the same size as the adjoining pipe.

2.06. GAUGES

- A. Pressure/Vacuum/Differential Pressure Gauges:
 - 1. The system shall be equipped with pressure, vacuum, and differential pressure gauges. Gauges shall be Capsuhelic gauges as manufactured by Dwyer Instruments, Inc. or approved equal. Gauges shall read "Inches of Water" and gradations shall be at intervals of 1 inch of water column (in-w.c.). Gauges shall include the following:

- a. Flare arrester pressure drop indicator. Gauge shall be capable of measuring 0 to 15 in-w.c., differential pressure.
 - b. Moisture separator pressure drop indicator. Gauge shall be capable of measuring 0 to 15 in-w.c., differential pressure.
 - c. Blower vacuum indicators. Vacuum gauges shall be capable of measuring -100 to 0 in-w.c.
 - d. Blower pressure indicators. Pressure gauges shall be capable of measuring 0 to 100 in-w.c.
 - e. System vacuum indicator. A vacuum gauge shall be mounted upstream of the knockout pot. It shall be capable of measuring 0 to 100 in-w.c.
- B. Blower inlet and outlet Temperature Gauges:
 - 1. Dial-type temperature gauges shall be provided at the inlet and outlet of each blower. The gauges shall range from 0 to 200 °F.

2.07. CONTROL SYSTEM

- A. The control panel for the Skid-Mounted Landfill Gas Blower System shall be compliant with NEMA 4 specifications at a minimum. The main control panel shall be sized to accommodate the required controls, and shall be provided with a swing out panel, and with a NEMA 4 compliant window in the door through which status annunciators, recorder, controller, etc. may be viewed. The control panel shall be mounted, installed and prewired by the manufacturer. The panel shall include, but not be limited to, the following components:
 - 1. A load center for the motors, outlets, fixtures, controls, devices, lights, etc.
 - 2. A control center to receive all the signals from the various safeties, controls and monitoring equipment, and to automatically control all the components of the system.
 - 3. An operator control panel to allow either manual or automatic selection for the control of the operating components of the system.
 - 4. A weather/heat shield shall be provided to protect the control panel against radiated heat (solar and/or flare) and rain. The control system shall be designed and manufactured as an outdoor system.
 - 5. Safeties. The system shall be equipped with the following safeties as a minimum:
 - a. Blower-motor overcurrent shall cause system shutdown.
 - b. Blower-motor undercurrent (surge) shall cause system shutdown.
 - c. Flame failure shall cause system shutdown.
- B. Variable Frequency Drive
 - 1. VFDs shall be installed in control panels to provide and control power to blower system.
 - 2. VFD shall include input for 4-20 mA vacuum transmitter signal, and include integrated PID controller to adjust blower operation to maintain constant inlet vacuum. VFD shall also allow output of vacuum signal to Programmable Logic Control (PLC), and allow PLC to modify VFD PID controller setpoint.
 - 3. Variable frequency drive shall be specific for selected blower system inlet power.

C. Communications

1. See the attached Controls Discussion.

2.08. AUXILIARY EQUIPMENT

A. Flow Meter:

Quantity:1
Type:Thermal mass
Probe material: 304 stainless steel
Manufacturer: Thermal Instruments (or equal)

B. Automatic Block Valve:

Quantity: 1
Diameter: sized for 4,500 scfm
Style:wafer
Actuator: pneumatic, fail closed
Body material: carbon steel
Disk:316 stainless steel
Seat: PTFE
Manufacturer: Xomox (or equal)

C. Pressure Transmitter: 3 total (1 to new enclosed flare, 1 to LFGTE plant, 1 to utility flare – see attached Controls Discussion)

2.09. ELECTRICAL

A. Per National Electrical Code (NEC) and National Electrical Manufacturers' Association (NEMA) codes and standards.

B. Per National Fire Protection Association (NFPA) 70E standards for construction.

C. Area Classifications:

1. Per NEC standards, minimum area classification to be Class I, Div. 2, Group D within three (3) feet of any gas (LFG or propane) containing pipe or device.
2. Conduit seals at transitions between classified and unclassified areas. Conduit seals to be packed and poured by vendor after successful commissioning of system.
3. Control panel shall be located a minimum of five (5) feet away from any gas (LFG or propane) source or pipe.
4. All wiring within threaded rigid galvanized steel conduit.
5. Conduit and thermocouple wires shall be installed to junction box on base of flare with sufficient extra thermocouple wire to complete installation coiled at end of conduit. Local electrician to install stack thermocouple conduit and wires.

2.10 SPARE PARTS

A. The VENDOR shall provide the following spare parts:

1. 20 ounces of bearing grease.
2. One each vacuum, pressure and temperature gauge.
3. One shaft coupling

PART 3 EXECUTION

3.01. INSTALLATION

A. The VENDOR shall install the following items on the main skid:

- i. Blower-Motor Assemblies
- ii. Moisture Separator Assembly (knock-out pot).
- iii. Piping and fittings
- iv. Valves
- v. Control Panels

B. All skid-mounted equipment shall be installed plumb and perpendicular to piping.

3.02. FACTORY TESTING – The controls for the landfill gas blower/flare system shall be tested at the supplier's plant before shipment. Complete test reports shall be provided to the ENGINEER which show that all system controls operated correctly prior to shipment

END OF SECTION