OFFICE OF WASTEWATER MANAGEMENT

WASHINGTON, D.C. 20460

SOLICITATION OF PUBLIC COMMENT FOR PROJECT-SPECIFIC BUILD AMERICA, BUY AMERICA NONAVAILABILITY WAIVER PROPOSAL

SUBJECT: UNDER EVALUATION: Project-Specific Nonavailability Waiver of Build America, Buy America Act Manufactured Product Requirements to the City of Fond du Lac, Wisconsin, for a Biogas and Renewable Natural Gas Upgrading System

Intro: This solicitation of public comment by the U.S. Environmental Protection Agency (EPA) is to evaluate a Build America, Buy America (BABA) waiver request submitted by an assistance recipient based on nonavailability of a single product for a single project.

This solicitation of public comment does not represent a final agency decision. The purpose of this proposal is to inquire whether potential BABA-compliant products may be available that were not identified by the assistance recipient or through the EPA's product research efforts, and whether other factors should be considered in the evaluation of a waiver.

The EPA has completed its market research efforts and was unable to identify an alternative BABA-compliant product meeting the performance-based specifications in sufficient and reasonably available quantities and of a satisfactory quality. The EPA makes every effort to locate BABA-compliant products through its waiver process and the public comment period provides an additional meaningful opportunity to augment the Agency's research. In the EPA's experience, a viable BABA-compliant product may be identified through public comment. Through this public comment period, commenters may provide information that indicates a compliant item is available. In that circumstance, EPA would not issue a final waiver.

Public comments are requested for 15 days (specific dates noted on the EPA's website). Please submit comments to BABA-OW@epa.gov. Please include information in the subject of the email identifying it as a public comment on this waiver request, such as "Waiver Comment: Fond du Lac Biogas and RNG" or similar. The proposed waiver will also be posted to the Made in America website.

Background

The Buy America Preference set forth in section 70914 of the BABA included in the Infrastructure Investment and Jobs Act (Pub. L. No. 117-58), requires all iron, steel, manufactured products, and construction materials used for infrastructure projects under Federal financial assistance awards be produced in the U.S.

Under section 70914(b), the EPA may waive the application of the Buy America Preference, in any case in which it finds that: applying the domestic content procurement preference would be inconsistent with the public interest; types of iron, steel, manufactured products, or construction materials are not produced in the US in sufficient and reasonably available quantities or of a satisfactory quality; or the inclusion of iron, steel, manufactured products, or construction materials produced in the U.S. will increase the cost of the overall project by more than 25 percent. All waivers must have a written explanation for the proposed determination; provide a period of not less than fifteen (15) calendar days for public comment on the proposed waiver; and submit the proposed waiver to the Office of Management and Budget's (OMB) Made in America Office for review to determine if the waiver is consistent with policy.

Summary

Proposed Waiver: The EPA is soliciting comments regarding whether to issue a project waiver of the manufactured product requirements of section 70914 of the BABA included in the Infrastructure Investment and Jobs Act (Pub. L. No. 117-58), for a biogas and renewable natural gas (RNG) upgrading system used in an infrastructure project funded through the Clean Water State Revolving Fund.

Waiver Type: Nonavailability of a BABA-compliant product in sufficient and reasonably available quantities or of a satisfactory quality.

Waiver Level and Scope: Project level waiver for a single product for a single project. No other project will utilize the waiver.

Proposed Waiver Description: Project-specific nonavailability waiver of the BABA manufactured product requirements to the City of Fond du Lac (Applicant) in Wisconsin, for a biogas and RNG upgrading system (product) for the Biosolids Drying and RNG Addition Project (project).

Project Summary: This primary purpose of this project in Fond du Lac, Wisconsin is to install a biosolids drying system and storage silo. This work will include a building addition; heating, ventilation, and air conditioning (HVAC) updates; new interior plumbing connections; new electrical room and lighting; rerouting of utility lines; replacement of pavement; and related miscellaneous work to accommodate the installation of a biosolids drying system. The project will also include installation of gas conditioning membranes and high-pressure compression, including the replacement of existing gas conditioning equipment, replacement of existing digester gas pipe updated HVAC, a new RNG line to connect to the utility, and related miscellaneous work. This project will enable the Applicant to reduce the volume of biosolids in need of disposal and eliminate or greatly reduce the need to landfill biosolids. Regarding the biogas conditioning equipment, the Applicant currently has a combined heat and power system to manage the biogas generated onsite. However, this technology is now obsolete for this facility and is only capable of using about 50 percent of the biogas produced onsite. The replacement of the existing system with the biogas and RNG upgrading system included in its waiver request will allow the Applicant to inject energy into the grid and maintain sewer rates for residents.

Length of the waiver: From the effective date of the final waiver until project completion, estimated to be December 31, 2030.

Summary of Items Covered in the Proposed Waiver (including NAICS): The Applicant is seeking a waiver of the BABA manufactured product requirements for a biogas and RNG upgrading system (NAICS code 333248; PSC 4250), which includes process equipment for the removal of hydrogen sulfide, volatile organic compounds/siloxane, particulates, and carbon dioxide; as well as gas conditioning,

moisture removal, and heat exchange. No BABA-compliant alternative products meeting the technical specifications of the project were identified by the Applicant, or through the EPA's market research completed in July 2025. The required biogas and RNG upgrading system must be designed for the treatment of municipal anaerobic digester gas for the removal of particulates, moisture, volatile organic compounds, hydrogen sulfide, carbon dioxide, and siloxanes, and must include biogas conditioning equipment, gas conditioning membranes, and high-pressure compression.

For additional information on the project and waiver request, see the attached original waiver request from the Applicant and supporting documents.

Description of Efforts Made to Avoid the Need for a Waiver
The Applicant made a good faith effort to identify alternative compliant products that meet project specifications. No BABA-compliant alternatives meeting the technical specifications of the project were identified through those efforts.

The EPA also conducted market research in July 2025. The market research process included thorough review of the waiver request submission, examination of domestic manufacturer catalogs and other technical data and marketing materials, and communication with domestic manufacturers.

The EPA researched and contacted ten (10) biogas and RNG upgrading system manufacturers and suppliers. The manufacturers were asked whether they manufacture a BABA-compliant product that meets the project's specifications, and if so, what the estimated lead time would be. There were no (zero) manufacturers who indicated they could provide a BABA-compliant alternative meeting the technical specifications of the project. One (1) manufacturer indicated that they are able to produce a BABA-compliant oxygen generator, but this product is not required by the project. One (1) additional manufacturer indicated that they are able to provide a product that removes hydrogen sulfide but cannot manufacture a product that also removes volatile organic compounds and siloxane. Neither of these manufacturers could meet the technical specifications of the project.

Anticipated Impact if No Waiver is Issued
Absent a waiver, the Applicant would be unable to complete this project. Particulates, moisture, volatile organic compounds, hydrogen sulfide, carbon dioxide, and siloxanes are byproducts of wastewater treatment and biosolids digestion at this facility. Without this equipment, the Applicant would be unable to remove these contaminants, thereby rendering the biogas unable to have a beneficial use and contaminated biogas could be released to the environment. This treated biogas will be injected into the grid and positively impact local residents by maintaining low sewer rates. Redesigning to accommodate less-suitable alternatives would delay the project and likely require additional ancillary equipment and a new structure.

Description of Award
Recipient Name and/or Unique Entity Identifier (UEI): JLV4TBLDNM64

Federal Financial Assistance Identification Number (FAIN): N/A

Federal Financial Assistance Listing Name: Clean Water State Revolving Fund

Federal Financial Assistance Listing Number: 66.458

Agency CGAC: 068

Federal Financial Assistance Funding Amount: $16.9M

Total Project Cost: $30.5M

City of Fond du Lac
First on the Lake

Website: www.fdl.wi.gov
City-County Government Center
160 S. Macy Street~P.O. Box 150~Fond du Lac, WI 54936-0150

NOTE: Information in this waiver may have been redacted or removed due to issues of proprietary business information or incompatibility with Federal accessibility requirements. To request the information redacted for purposes of accessibility requirements, please email BABA-OW@epa.gov.

June 16, 2025

Office of Wastewater Management
United States Environmental Protection Agency
1200 Pennsylvania Avenue Northwest
Washington, DC 20460

Re: Project-Specific Nonavailability Waiver of Build America, Buy America Act (BABA) Requirements for the Biogas and Renewable Natural Gas (RNG) Upgrading System
City of Fond du Lac, Wisconsin (City)

To Whom It May Concern:

The City hereby applies for a waiver of BABA requirements for Biogas Conditioning and RNG Upgrading System as part of the Biosolids Drying and Renewable Natural Gas (RNG) Addition project.

1. Waiver Type–Nonavailability of a domestic product in sufficient and reasonably available quantities or of a satisfactory quality.

2. Waiver Level and Scope–Project-level waiver for a single product type for a single project.

3. Product–One biogas upgrading system that includes biogas conditioning equipment, gas conditioning membranes, and high-pressure compression. See Enclosure 1 for the Specifications.

4. Cost of Product Included in the Waiver: [redacted]

5. Project Summary–The Biosolids Drying and Renewable Natural Gas (RNG) Addition project includes installation of a biosolids drying system, including a building addition to Structure 75, heating, ventilation, and air conditioning (HVAC) updates, new interior plumbing connections, new electrical room and lighting, rerouting of utility lines, replacement of pavement, and related miscellaneous work. The project also includes installation of gas conditioning membranes and high-pressure compression, including the replacement of existing gas conditioning equipment, replacement of existing digester gas pipe, updated HVAC, a new RNG line to connect to the utility, and related miscellaneous work.

6. Comparable Projects–There are no known projects including this specific process in the state of Wisconsin, therefore, our understanding is that this is the first waiver request in the state. There have been alternative biogas upgrading technologies and membrane

technology processes submitted and approved as a nonavailability waiver nationwide included on the United States Environmental Protection Agency Web site.

7. Project Cost–The current construction cost is $30,500,000.

8. Project Schedule:

   a. Bid Opening–April 8, 2025.
   b. Contracts Executed and Notice to Proceed–May 19, 2025.
   c. Substantial Completion–November 16, 2026.
   d. Final Completion–December 31, 2026.

9. Review of BABA-Compliant Sources for Product–The following manufacturers meet the Specifications and are not BABA compliant. No other manufacturers were identified that are BABA compliant and meet the Specifications.

   a. [redacted]

   b. [redacted]

The statement from the product manufacturer regarding the non-availability of a BABA-compliant product is enclosed. The table below summarizes the financial assistance information associated with the project and product waiver.

Description	Value
Recipient Name and/or Unique Entity Identifier	City of Fond du Lac, Wisconsin JLV4TBLDNM64
Federal Financial Assistance Identification Number	Not Applicable
Federal Financial Assistance Listing Name	Clean Water Fund Program
Federal Financial Assistance Listing Number	66.458
Federal Financial Assistance Funding Amount	The applicant anticipates receiving a total of $16.9 million of funding from the Wisconsin Department of Natural Resources Clean Water Fund.
Total Cost of Infrastructure Expenditures of Product in the Waiver	[redacted]
Federal Financial Assistance Funding Amount and Total Estimated Infrastructure Funding Amount	$30.5 million

Please contact [redacted] with questions.

Sincerely,

CITY OF FOND DU LAC

[redacted]

Joseph Moore, City Manager

Enclosures

c: Tricia Davi, Director of Administration/CFO, City of Fond du Lac
Cameron Fails, Deputy Procurement Officer, City of Fond du Lac
Cody Schoepke, WTRRF Superintendent, City of Fond du Lac

[redacted]

Date:4/7/2025

[redacted]

[redacted], Request for BABA Waiver
400 - Fond du Lac BioCNG

The [redacted] Biogas Upgrading System is manufactured in the United States but is made from both foreign and domestic content. Given the complexity of the equipment, not all components are available from domestic sources. Per the excerpt below from BABA §70912, [redacted] is unable to source the domestic equivalent to meet the 55 percent requirement.

"All manufactured products used in the project are produced in the United States. This means the manufactured product was manufactured in the United States, and the cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product, unless another standard for determining the minimum amount of domestic content of the manufactured product has been established under applicable law or regulation."

While some domestic components are available, the bulk of the cost is associated with the non-domestic components required for the operation of our system.

Respectfully,

[redacted]

SECTION 11501

BIOGAS UPGRADING SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. The complete biogas upgrading system (BUS) shall be designed to provide reduction of sulfur compounds (H_2S), moisture, non-methane volatiles (VOCs), siloxanes, and carbon dioxide (CO_2) found in the digester gas.

B. The BUS design shall be based on digester gas composition specified. The BUS shall treat the digester gas to the quality specified.

C. All supplied components of the BUS shall be furnished and fully integrated by the Supplier, having Unit Responsibility, with specified piping, wiring and controls included:
   1. Supplier shall be responsible for furnishing and installing all wiring on the vendor supplied treatment skid(s) and on chiller and control panel skids.
   2. Provide equipment designed for the following power feeds. Provide transformer and distribution as required for any other secondary voltages required by the BUS.
      a. A single 480-volt connection to the gas compressor motor starter panel.
      b. A single 480-volt connection to the control panel skid provided by the Supplier.
         1) Provide distribution panel for additional power feeds for heating and ventilation.
         2) Provide 208/120V transformer and panel for distribution for lighting and other loads.
   3. The Contractor shall wire equipment provided by the Supplier and shipped loose including instrumentation as indicated herein.
   4. Vendor supplied control panel suitable for control of all equipment furnished under this Section is specified under Section 17055 - Packaged Control System.
   5. Supplier shall provide all piping, valves, and appurtenances located on the skid(s). Contractor shall be responsible for installation of all Vendor-furnished skids, vessels, and piping.
   6. Contractor shall furnish and install all piping outside the vendor supplied skid(s) that interconnects the Vendor-supplied equipment.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. H35.1 - Alloy and Temper Designation System for Aluminum.

B. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. American Gas Association (AGA).

D. American National Standards Institute (ANSI):
   1. S1.4 - Sound Level Meters.

E. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24-Inch Standard.
   2. Boiler and Pressure Vessel Code.

F. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

G. ASTM International (ASTM):
   1. A 36 - Standard Specification for Carbon Structural Steel.
   2. A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A 380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   5. A 967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
   6. B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
   7. F 37 - Standard Test Methods for Sealability of Gasket Materials.

H. FM Global (FM).

I. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. MG-1 - Motors and Generators.

J. National Fire Protection Association (NFPA):
   1. 54 - National Fuel Gas Code.
   2. 70 - National Electrical Code.
   3. 820 - Standard for Fire Protection in Wastewater Treatment Plants.

K. International Society of Automation (ISA).

L. Occupational Safety and Health Administration (OSHA).

M. Underwriters' Laboratories, Inc. (UL).
   1. UL 508A Industrial Control Panels
   2. UL 698A Industrial Control Panels Relating to Hazardous Locations

N. Section 17055 - Packaged Control System.

1.03 DEFINITIONS

A. Standard cubic feet per minute (scfm): The volumetric flow rate in cubic feet per minute at 68 degrees Fahrenheit, 14.70 pounds per square inch absolute pressure and 36 percent relative humidity.

B. Supplier: The BUS manufacturer that is supplying the equipment to the Contractor under the terms of the Contract Specifications.

C. Field Service Technician (FSE): The designated technical service representative of the Supplier.

1.04 SYSTEM DESCRIPTION

A. As a minimum the BUS shall consist of the following major components:
   1. Two (2) Hydrogen Sulfide Removal Vessels.
   2. Filter/separator.
   3. Booster blower (if required by Supplier).
   4. Pre-cooler.
   5. Compressor.
   6. Moisture removal heat exchangers:
      a. Gas to gas heat exchanger.
      b. Gas to glycol heat exchanger.
   7. Volatile organic compound/siloxane removal system.
   8. Particulate filter.
   9. Membrane system for carbon dioxide removal.
      a. Membranes shall be installed for 250 scfm capacity.
   10. Membrane system for tail gas treatment.
      a. Membranes shall be installed to treat tail gas from a system designed for 250 scfm raw biogas capacity.
   11. Piping, valves, controls, electrical equipment, and all accessories.
   12. Skid-mounted chiller and control panel.
   13. Initial media for hydrogen sulfide and VOC/siloxane removal vessels.
   14. Glycol mixture.
   15. Gas Treatment skid with control panels, VFDs and starters (if remote from control panel), and electrical distribution panels and transformers.
   16. Instruments shipped loose:
      a. Inlet gas pressure indicator transmitter.
      b. Product gas flow meter.
      c. Product gas analyzer.
   17. Tail gas vent system
      a. Flame arrester.
      b. LEL sensor.

B. Performance requirements:
   1. Performance of the system shall meet the limits specified under Part 2 Products of this Section.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
   1. Regularly engaged in manufacturer, assembly, start-up, and service of BUS for a minimum 5 years.
   2. Equivalent BUS systems provided by the manufacturer must have been successfully used in a minimum of 1 similar domestic wastewater application from anaerobic digester gas sized to treat a minimum of 100 scfm and designed for the removal of H_2S, moisture, siloxanes, VOCs, and CO_2.
      a. Provide a minimum of five (5) reference installations, including equipment size, date of commissioning, and owner's name, and information to contact owner's representative.

B. Regulatory requirements: Comply with:
   1. Regulations of the Fire Prevention Bureau of the fire department having jurisdiction.
   2. State of Wisconsin:
      a. Requirements of OSHA.
      b. Most recent versions of adopted Wisconsin Building Codes.
   3. International Building Code.
   4. International Mechanical Code.
   5. International Fire Code.
   6. National Electrical Code.
   7. Applicable state and local codes.
   8. ASME Boiler and Pressure Vessel Code.

C. Wiring:
   1. In accordance with NFPA 70 code for wiring of factory-wired equipment.

D. Pressure test BUS components during manufacture and prior to shipment.

1.06 SUBMITTALS

A. In accordance with this Section and Section 17055 - Packaged Control System.

B. Submit engineering drawings containing complete dimensions with sufficient detail to define the installation, anchor bolt layout, piping connections, wiring interconnections, and special requirements of all separately mounted equipment.

C. Submit complete shop drawings including control panel layout drawing, equipment data sheets, ISA instrument data sheets, process and instrumentation diagrams (P&IDs), control/communication block diagram(s), control descriptions and/or logic diagrams, complete on-skid conduit layout diagrams, and interconnection wiring diagrams.

D. The Supplier shall clearly identify instruments and equipment supplied by others as well as field wiring and terminations:
   1. In addition, the Supplier shall clearly identify any shipped loose instruments and/or equipment for the Contractor to install, including recommended placement location.

E. All equipment and appurtenances in this Section and Section 17055 - Packaged Control System shall be submitted in a complete initial submittal.

F. Submit certified treatment performance and pressure drop calculations for all system components. Consider full range of specified digester gas conditions and ambient conditions.

G. Submit sound data and estimated sound pressure level calculations for BUS equipment demonstrating conformance with specified requirements.

H. Submit compressor performance data including selections covering the full range of digester gas conditions and chemical compositions specified and pressure drops across system components (at clean and fouled conditions). Selections should demonstrate that the compressors and compressor motors are adequately sized and designed to meet the specified performances.

I. Submit hydrogen sulfide removal system details including expected life, performance, and sizing criteria.

J. Submit VOC/siloxane removal system details including expected life, performance, and sizing criteria.

K. Submit CO_2 removal system details including expected life, performance, and sizing criteria.

L. Submit drainage system details for gas conditioning equipment, piping, and treatment vessel low points including basis for sizing drains where applicable (i.e., basis for p-trap heights, etc.).

M. Submit chiller performance data and sizing criteria.

N. Submit wind calculation and anchor bolt sizing as specified for all equipment located outdoors. Calculations and anchorage details shall be stamped by a registered professional Engineer licensed to practice in the State of Wisconsin.

O. Submit calculations and drawings for the tank maintenance platforms stamped by a registered Professional Engineer licensed to practice in the State of Wisconsin showing conformance with performance criteria.

P. Submit material ASTM designations where specified.

Q. Furnish manufacturer's installation, operation and maintenance manuals in electronic and hardcopy format.
   1. Include information for recommended gas sampling equipment.
   2. Provide three (3) hardcopies of operation and maintenance manuals.

R. Submit for all subcomponents of the BUS: a list of all parts included; a list of recommended spare parts to stock on-site; and information for special tools needed to operate and maintain the equipment specified under this section. Part and tool lists shall include quantity, pricing, spare part identification numbers, and supplier with the shop drawing submittal.

S. Submit laboratory results in accordance with the requirements of this Section.

T. Submit information for each motor:
   1. Product data:
      a. Descriptive bulletins.
      b. Complete electrical data.
      c. Additional data for motors installed in classified areas:
         1) Temperature code.
         2) Hazardous area approval indicating Class, Division, and Group:
            a) For motors driven by variable frequency drives, provide manufacturer's certification that the motor is suitable for operation in the hazardous area when driven by a variable frequency drive.
      d. Accessories data:
         1) Motor winding heaters:
            a) Voltage.
            b) Watts.

2) Winding temperature detectors:
a) Type.
b) Rating.
e. Mechanical data:
1) Bearing design and bearing life calculations.
2) Resonant frequencies for all VFD-driven motors 50 hp or greater.
2. Shop drawings:
a. Motor weight.
b. Frame size.
c. Conduit box(es), size(s), and location(s).
d. Outline drawings with dimensions.
3. Test reports:
a. Factory test reports with test reference standard identified.
4. Certification:
a. When motors are driven by variable speed drive systems, submit certification that selected motor:
1) Is capable of satisfactory performance under the intended load.
2) Meets the requirements of the latest edition of NEMA MG-1 Part 31.
5. Calculations:
a. Where site conditions specified in Article 1.07 of this Section exceed manufacturer's ratings, provide derating calculations for each motor.

1.07 PROJECT CONDITIONS

A. All equipment and materials are to be suitable for performance in wastewater treatment plant environment and under following conditions:
1. Design temperatures are:
a. Outdoor temperatures: -20 to 110 degrees Fahrenheit.
b. Indoor temperatures:
c. Indoor electrical room temperatures:
2. Site elevation: Approximately 750 feet above mean sea level.
3. Relative humidity: 90 percent.
4. Low levels of hydrogen sulfide are present in the ambient air.

B. Design electrical enclosures (if provided) for the following:
1. Provide cooling to maintain maximum 80 degrees Fahrenheit.
2. Provide heating to maintain minimum 55 degrees Fahrenheit.

C. Design systems to meet NFPA 820 requirements for Class 1 Division 1 and 2 areas. Unclassified equipment shall be located outside the Class 1 Division 1 and 2 boundaries. NFPA boundaries will be indicated on the Contract Drawings.

D. Design for wind and seismic in accordance with the most recently adopted International Building Code.

E. Mechanical and electrical equipment provided by the BUS manufacturer, including equipment supports and anchorage to structures or foundations, and including associated distribution systems such as piping, ductwork, conduits, cable trays, bus ducts, etc.:
1. Design in accordance with the provisions of ASCE 7-10, Chapter 13, except as modified herein.
2. Seismic design category B exemptions:

a. Exemptions in ASCE 7, paragraph 13.1.4 for anchoring and bracing of mechanical, and electrical components in Seismic Design Category B are permitted for this Work.

3. Component amplification factor (a_p) and component response modification factor (R_p): In accordance with ASCE 7, Table 13.6-1.
4. Overstrength factor for anchorage to concrete (Ω_o): In accordance with ASCE 7, Table 13.6-1.
5. Component importance factor, I_p: In accordance with the provisions of ASCE 7, Chapter 13 unless otherwise specified in Table 2 of this Section:

Table 2: Mechanical and electrical equipment, Component importance factor, Ip		
Component	**Description**	**Ip**
Electrical	Equipment and appurtenances provided and installed under Divisions 26 and 28.	1.5
Mechanical (HVAC)	Equipment and appurtenances provided and installed under Division 23.	1.0
Process	Equipment and appurtenances provided and installed under Divisions 40, 41, 43 and 46.	1.0

F. Tanks, including pre-fabricated tank structures, tank supports, and anchorage to structures or foundations:
1. Consider impulsive and convective “sloshing” effects.
2. Component response modification factor for impulsive effects, R_i: In accordance with ASCE 7, Table 15.4-2.
3. Component response modification factor for convective effects, $R_c = 1.0$.
4. Component importance factor, I_e: Determine in accordance with ASCE 7, Section 15.4.1.1.

1.08 SEQUENCE AND SCHEDULING

A. Conduit seals shall be filled during start-up and commissioning after verification of field wiring by Manufacturer’s start-up technician. Conduit seals are to be filled prior to the introduction of gas to the equipment.

1.09 WARRANTY

A. Special warranty:
1. Duration: Provide 2-year warranty. Warranty shall begin in accordance with the Request for Proposal.
2. The manufacturer shall furnish an equipment warranty certificate assuring that the BUS system provided for this Project will meet the service conditions specified herein.
3. The manufacturer warrants satisfactory performance of the BUS to achieve equipment performance objectives (e.g., design flows, gas quality, and delivery pressure).

B. Performance warranty:
1. The equipment furnished under this section, when operated within the conditions specified in the Contract Documents, will meet or exceed the

performance requirements specified herein for a period of 2 years which shall commence upon Substantial Completion.

2. If the equipment fails to meet design and performance criteria within performance warranty period, the equipment Supplier shall modify, change, or add equipment as necessary to meet performance criteria. Supplier shall be responsible for any additional costs to Contractor or Owner due to changes (including but not limited to piping, mechanical, structural, or electrical changes) or additional equipment as necessary to meet performance requirements. This includes design, engineering, construction, as well as equipment.
    a. Replacement of components will restart 2-year warranty period for those components that have been replaced.
3. The Owner shall make available the BUS electronic data records of historical performance for Supplier's review. The automation system shall log all relevant performance data and store it in the historical database.
4. If the system fails to meet specified performance criteria during the warranty period and the Supplier is unable to modify the system through the addition of equipment or other elements, then the Supplier shall be responsible for complete removal of nonconforming system and subsequent installation of products that are capable of meeting specified performance conditions.

C. End of warranty inspection:
    1. Inspection:
        a. Supplier's representative shall perform a minimum of one-day (8 hours) inspection of Supplier's BUS, within 30 days prior to the 2-year anniversary date of the equipment warranty.
        b. Supplier shall ascertain or appraise the following:
            1) Status of equipment and installation after normal usage.
            2) All electrical connections.
            3) Calibration of sensors.
            4) Operation of alarms.
        c. Supplier shall make adjustments as necessary to restore equipment within original tolerances.
        d. Supplier shall submit a written letter report to the Owner covering the inspection items and including recommendations where applicable.

1.10 SPARE PARTS AND SPECIAL TOOLS

A. If special tools are required for the service and maintenance of the equipment, provide 1 complete set of tools.

B. Reference Section 17055 - Packaged Control System.

1.11 PERFORMANCE

A. A written guarantee shall be provided with the Supplier's bid stating that the BUS shall produce fuel that meets the gas outlet condition specifications for H_2S, VOC/organosilicons/siloxane, and CO_2 contaminant levels required by this Specification. The written guarantee shall clearly state these limits, which shall be consistent with this Specification. In addition, the guarantee shall state that the gas shall meet the maximum allowed moisture/relative humidity levels and minimum outlet pressures required per this Specification.

B. Noise level:
   1. BUS, including the gas conditioning system skid and the chillers, shall be provided with a maximum installed, field-measured sound pressure level at rated flow not to exceed 79 DBA measured at any point 10 feet from skid edge using a ANSI S1.4 precision, Type 1, sound meter set for slow response when all units are operating.

C. The Supplier shall be responsible for ensuring that the BUS will function as part of a complete integrated system. A general overview of the systems is as follows:
   1. The BUS must respond to changes in digester gas production by operating to vary the intake of digester gas dependent on the either the pressure present in the digester gas feed piping to the BUS or the gas holder cover elevation.
   2. The BUS must respond to changes in digester gas flow and temperature by operating to maintain a maximum dewpoint setpoint, as well as BUS skid gas outlet temperature and relative humidity as indicated in this Section.
   3. The BUS shall maintain a minimum gas flow through the BUS at all times while maintaining the discharge gas conditions at the system outlet as indicated in this Section to allow for proper gas distribution within the system and to accommodate the BUS turndown throughout the full range of digester gas flow into and out of the system. Turndown shall be provided via a backpressure regulator to allow excess gas to flow from the discharge of the system back to the inlet of the gas compressor.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. One of the following:
   1. [redacted]
   2. [redacted]
   3. [redacted]
   4. [redacted]

2.02 MATERIALS

A. Components and materials:
   1. Suitable for use with digester gas containing hydrogen sulfide in a Wastewater Treatment Plant environment.
   2. All wetted components shall be Type 304L or 316L stainless steel except as noted otherwise.
   3. All drain piping and appurtenances shall be Type 316L stainless steel.
   4. All wetted stainless steel piping and tanks shall be cleaned (pickled) and passivated.
   5. Following shop fabrication of tanks, pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.
   6. Clean (pickle) and passivate in accordance with ASTM A380 or A967:
      a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible:
         1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.
      b. Passivation treatments with citric acid are not allowed.

7. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.
8. Bases, supports, and grating shall be ASTM A36 steel, aluminum, type 304L stainless steel, or fiberglass. ASTM A36 steel components shall be hot-dip galvanized or powder coated after fabrication.
9. Gaskets:
    a. Digester Gas:
        1) Microcellular [redacted] outer layers with rigid center layer.
        2) Sealability in accordance with ASTM F37, less than 0.55 millimeters per hour leakage of iso-octane at 1,000 pounds per square inch gasket load and 9.8 pounds per square inch fluid pressure.
        3) Manufacturers:
            a) One of the following or equal:
                (1) [redacted]
                (2) [redacted]
10. Other fluids:
    a. Provide gaskets suitable for the specific fluids and pressure and temperature conditions.

B. Stainless steel, ASTM A276, Type 304 or 316 as noted:
    1. Components, piping or structural shapes which are welded:
        a. Materials: Type 304L or 316L stainless steel, as noted.
        b. Manufacturer's shop welds, welding procedures, and welders:
            1) Qualified and certified in accordance with the requirements of AWS D1.6.

2.03 PERFORMANCE

A. Equipment shall be designed for the treatment of municipal anaerobic digester gas for the removal of particulates, moisture, VOCs, hydrogen sulfide, carbon dioxide, and siloxanes.

B. The BUS system shall be designed to treat digester gas:
    1. System shall be designed to automatically accommodate flow variations between these flow rates without impacting BUS digester gas treatment effectiveness.
    2. The BUS shall include provisions to accommodate the flow rates noted below by recycling a portion of the flow back to the BUS inlet in a controlled manner to maintain a minimum of 125 scfm, or as recommended by the Manufacturer, through the BUS at all times.

C. Digester gas characteristics:

Gas Conditioning System Inlet Conditions	
Flow Rate	125 - 250 scfm
Methane	65%; ± 5% (by volume)
Carbon Dioxide	35%; ± 5% (by volume)
Oxygen	Less than 0.75%
Nitrogen	1.5 ± 0.5%
Lower Heating Value (LHV)	630 ± 25 Btu/scf

Gas Conditioning System Inlet Conditions	
Sulfur	
H_2S	750 ppmv average
Volatile Organic Compounds	See VOC Testing Results (Attachment A)
Siloxanes and Organosilicons	See Siloxane Testing Results (Attachment B)
Temperature	Range: 40 to 100 degrees Fahrenheit, Typical value: 95 degrees Fahrenheit
Moisture	Saturated at temperatures to 100 degrees Fahrenheit
System Inlet Pressure	Varying between 6 inches and 14 inches of water

D. Minimum Renewable Natural Gas Characteristics: as specified below and in Attachment C.

Gas Conditioning System Outlet Conditions	
Flow Rate	75 to 175 scfm
Carbon Dioxide	Less than 2.0% (by volume)
Oxygen	Less than 0.20% (by volume)
H_2S	0.25 grains/100 cu ft
Nitrogen	Less than 3.0% (by volume)
Sulfur	0.5 grains/100 cu ft
Moisture	Less than 5 lbs/mmscf
Hydrocarbon dewpoint	-40 ^oF
Liquids	None
Temperature	35 – 80 ^oF (73 ^oF maximum annual average)
Higher Heating Value (HHV)	967 - 1,050 BTU/scf
Wobbe Index	1,274 – 1,380
Alkyl mercaptans/thiols	120 ppm
Siloxanes and Organosilicons	Less than 1 ppmv total
Biologicals	4 x 10^4/scf and free of <0.2 micron filter
Hydrogen	400 ppm
Heavy hydrocarbons	1.5% (by mole) of butane plus, including isobutane, normal butane, and all heavier hydrocarbons (C_4+)
Toluene	2,400 ppm
Ammonia	10 ppm
Ethylbenzene	60 ppm
Total Inert Gases	Less than 4% (by mole)
p-Dichlorobenzene	9.5 ppm
Vinyl chloride	3.3 ppm
Mercury	0.00008 ppm
System Outlet Pressure	160 – 260 psi

E. Tail Gas Requirements:

Third Stage Membrane (Tail Gas) Minimum Requirements	
Tail Gas Flow	40 to 100 scfm
Tail Gas Temperature	40 to 120 degrees Fahrenheit
Tail Gas Pressure	<24 in W.C.
Tail Gas Methane	<1.5%

F. Media life in (combined) H_2S removal vessels shall be at least 180 days at an average of 1,500 ppm H_2S and 205 scfm (2045 projected average raw biogas flow rate) and media life through the VOC/Siloxane removal vessels (combined) shall be at least 180 days based on loading rated in the digester gas characteristics specified in this Section and 205 scfm.

1. H_2S removal vessels shall also be sized to accommodate iron sponge or [redacted] media should economics and performance favor the use of iron sponge or [redacted] media in the future.

2.04 EQUIPMENT

A. The subsystems shall be arranged to fit within the available space as indicated on the Drawing in Attachment D:
   1. Each subsystem shall be completely factory wired, piped, installed, and tested with the exception of piping and electrical connections between the separately shipped components.
   2. See Article 3.04 of this Section for start-up and field-testing requirements.
   3. Each subsystem shall be complete with all equipment, panels, accessories, and appurtenances pre-piped and pre-wired as common systems.
   4. All piping and wiring connections and terminations shall be brought to edge of skid locations, any deviations from this shall be clearly identified in the Supplier's bid proposal.
   5. All external electrical connections shall be made at termination blocks within junction boxes at edge of equipment skids.
   6. Contractor shall be responsible to ensure a complete and functional system.

B. Biogas blowers and appurtenances (if required) shall include the following items:
   1. The digester gas will be delivered at the pressure indicated above for inlet conditions. The Supplier shall provide pressure boosting and flow control as required for their system to fully accommodate the gas treatment system inlet and discharge pressure and flow requirements specified in this Section.
   2. Blowers shall be either:
      a. Rotary positive displacement blowers and motors as manufactured by one of the following or equal:
         1) [redacted]
         2) [redacted].
      b. Regenerative blowers as manufactured by one of the following or equal:
         1) [redacted]
   3. Blowers shall include at a minimum the following appurtenances:
      a. Intake filters. Inlet filter shall have front access for filter element access. Filter shall provide 99 percent removed efficiency of 5-micron particle size and larger.
      b. Instrumentation including pressure and temperature gauges.
      c. High vibration switch
      d. High discharge temperature switch
      e. Provide blower controls in accordance with Section 17055 – Packaged Control System.

C. H_2S and VOC/siloxane removal system shall consist of the following:
   1. Scrubber assembly design shall be stamped and sealed by a registered professional engineer licensed in Wisconsin.
   2. Systems that combine H_2S and siloxane/VOC removal in a single vessel are acceptable. Provide multiple media-filled vessels for redundancy.
   3. Iron hydroxide H_2S removal system:
      a. Provide a minimum of two (2) tanks sized, with a total media quantity as necessary to meet the specified capacity.
      b. Vessels are to be installed outdoors.

4. Siloxane removal tanks:
    a. To be mounted downstream of the moisture removal system
    b. Provide tanks sized as necessary to meet the specified capacity.
    c. Tanks shall be piped in series and shall have all piping and valving for bypass operation of any individual vessel while other vessels remain in service.
    d. Vessel installation condition to be determined by overall space requirements of required biogas upgrading equipment.
5. Tank Construction
    a. Tank shall be designed for minimum and maximum internal pressure as required by system supplier.
    b. Tank shall be Type 304L stainless steel, with internal surfaces pickled and passivated.
    c. Tank heads shall be flanged and dished.
    d. Inlet and outlet flanges:
        1) ASME B16.5, Class 150 or 300, as required for system design pressure.
        2) Side-inlet, side outlet or top outlet.
    e. Tank shall be designed for accommodating varying flow rates as specified in this Section.
    f. Low pressure tank shall be provided with 30-inch top and 30-inch side manways, inlet and outlet gas connections, tank drain connections, pressure relief/vacuum relief valves, and manual air vents for venting system pressure during media replacement.
    g. High pressure tanks shall be provided with 11-inch by 15-inch elliptical top manway, inlet and outlet gas connections, tank drain connections and rupture disk or similar pressure relief devices to prevent overpressurization of the tank in the event of a mechanical or operational failure.
    h. Tank height to top manway shall accommodate vactor truck access as needed. Ensure no obstructions such as handrails interfere with access within the specified height limitations.
    i. System shall be supplied with initial fill of Supplier-selected media, shipped loose suitable for shelf storage for installation by Contractor prior to startup.
    j. Tank shall have internal supports and baffling as appropriate to ensure proper gas distribution at all times in order to treat the varying gas flows as specified in this Section.
    k. Tank shall be supported on hot-dip galvanized steel or welded stainless steel supports:
        1) Tank and supports shall be designed for seismic loading as specified in this Section.
        2) Supports shall be designed so that manway elevation is suitable for a dumpster to be positioned under the manway. Additional height should be provided as required to accommodate drainage methods.
    l. Tank legs may be shipped loose, however Supplier shall provide all the necessary connecting hardware.
    m. Provide capped sample ports with ball valves on inlet and outlet of H_2S removal tank and on inlet to the moisture-removal skid:
        1) Provide capped sample port with ball valve on the condensate line to enable periodic monitoring of condensate pH.
    n. Drain system/drain piping:

1) Supplier shall be responsible for providing automatic drainage systems for draining low points of tank. Drainage method shall be suitably sized and configured to accommodate digester gas saturated with water vapor under the design conditions specified without the condensate plugging the drain system. Drainage method shall also accommodate all worst-case (end-of-media life) pressure and vacuum conditions. Supplier shall ensure that adequate height is provided underneath the tanks to accommodate drainage method. Provide inlet piping drains as needed to prevent media channeling.
2) Drainage equipment and piping shall be designed to prevent leakage of digester gas from the system and to prevent the introduction of ambient air into the system.
3) All drain piping shall be Schedule 40S Type 316L stainless steel. Supplier shall be responsible for providing drains piped to the edge of the skid and sloped at 1/4 in/ft. Provide two Type 316L stainless steel ball valves in series on each drain line – one near the tank drain connection and one shipped loose for installation by the Contractor near the outlet of the drain pipe. The two ball valves shall allow the collected condensate to be isolated from the tank for sampling and pH monitoring. Manufacturer shall route drain piping to the edge of the skid or inside the equipment footprint.
4) Supplier shall preassemble all piping and pressure test as a complete system prior to shipment.
5) Piping shall be shipped in as large of preassembled segments as practical to facilitate field assembly.
6) Contractor shall be responsible for field fabrication as necessary of all included piping.
7) Isolation valves shall be provided at each fitting at each tank; in addition to the piping and valving required to be provided to allow series selection/isolation of the tanks:
8) Valving shall be provided as necessary to ensure accommodating varying flow rates as specified in this Section.

6. Maintenance platforms:
   a. The H_2S removal tanks and siloxane/VOC vessels shall be provided with an access platform with ladder.
   b. The maintenance platforms and ladders shall be constructed of fiberglass, aluminum, powder coated carbon steel, or hot-dipped galvanized steel and shall be OSHA compliant.
   c. The maintenance platforms shall be a minimum of 3 feet wide and shall provide access to all man ways, ports, valves, and appurtenances located on the top of the tanks requiring periodic inspection. The maintenance platforms shall be designed to meet at least the minimum clearance requirements recommended by component manufacturers and as specified within this section.
   d. The maintenance platforms shall be provided with safety tie-off points and removable handrails on all sides with swing gate openings for locations requiring personnel access.
   e. The maintenance platforms and ladders shall be shipped in as large of preassembled segments as practical to facilitate field assembly. Field assembly shall be by the Contractor.
7. Outlet particulate filters (for filtering gas downstream of the H_2S and siloxane removal systems) prior to the CO_2 removal system:

a. Provide filter with isolation ball valves on the inlet and discharge of the filtration system.
b. Performance: 99% removal of particulate 1 micron and larger.
c. Filter housing:
    1) Materials: Materials of construction shall be as follows:
        a) Body: ASTM A276, Type 304L stainless steel.
        b) Internals: ASTM A276, Type 304L stainless steel.
        c) Mounting hardware/fasteners: ASTM A276, Type 304L stainless steel.
        d) Supports: Hot-dip galvanized steel, ASTM A36.
    2) Supports: Provide housing support legs of sufficient length to permit access to filter drain trap with at least 6 inches additional clear space available; pipe-mounted filter is acceptable if pipe support is adequate for filter plus piping weight.
    3) Inlet and outlet flanges:
        a) ASME B16.5, Class 300.
        b) Side-inlet; side outlet.
    4) Drain, vent, and gauge connections: National Pipe Thread, class 300 fittings.
    5) Filter removal: Provide hinged bolt top cover or C-clamp for filter removal from the top without disturbing the piping connections.
    6) Drain sump: Provide minimum 1/2 inch drain connection and stainless steel ball valve.
d. Filter components:
    1) Replaceable filter element:
    2) Accessories:
        a) Differential pressure gauge.
        b) Level switch for alarm of high level.
e. Manufacturers: The following or equal:
    1) [redacted]

D. Gas conditioning system skid shall consist of the following:
1. Inlet/moisture particulate filter:
    a. Mesh pad separator upstream of compressor system:
    b. Performance:
        1) Remove 99 percent of all solids 3-micron and larger, 99 percent of all liquid droplets 5 microns and larger.
        2) Mesh pad separator shall be selected and arranged to automatically accommodate varying flow rates as specified in this Section.
    c. Construction:
        1) Materials: All stainless steel construction, Type 304L.
        2) Inlet and outlet flanges:
            a) ASME B16.5, Class 150.
            b) Side-inlet, side outlet.
        3) Drain, vent, and gage connections: suitable for National Pipe Thread fittings rated for minimum 150 psig.
        4) Mesh pad removal: Provide dished top or standard blind flange cover for mesh pad removal from the top without disturbing the piping connections.
        5) Drain: Provide minimum 1-1/2 inch drain connection with ball valve, Type 316L stainless steel, redundant drain pump, and check valves

on pump discharges, to suit installation requirements assuring positive continuous drainage of condensate.

6) Drain piping shall be piped to edge of skid and sloped at 1/4 inch per foot away from the condensate source. Drain piping shall be located minimum 6 in above the top of skid base. Contractor shall supply drain piping external to skid.

d. Mesh pad components:
   1) Mesh pad:
      a) Cleanable polypropylene steel mesh with Type 316L stainless steel metal parts.
e. Accessories:
   1) Differential pressure gauge.

2. Pre-cooler:
   a. Performance:
      1) Gas to glycol finned tube core design.
      2) Cool the inlet gas to 50 degrees Fahrenheit to remove any entrained moisture from the gas.
   b. Construction:
      1) 304SS housing.
      2) Heat Exchanger to be aluminum fins on 304SS tubes.
      3) Flanges to be ASME B16.5 Class 150.

3. Compressor system:
   a. Manufacturers: One of the following or equal, modified as necessary to meet the specified requirements:
      1) [redacted]
      2) [redacted]
   b. The compressor shall be of the oil flooded twin helical screw type with a history of usage on wastewater treatment plant digester gas or landfill gas applications and rated for the full range of conditions and flow rates specified.
   c. Provided with explosion-proof electric motor as specified in this Section.
   d. Motor speed shall be controlled by a VFD.
   e. Casing Material: Cast iron.
   f. Provided with:
      1) Inlet and discharge flexible connectors.
      2) Inlet check valve.
      3) Discharge pressure safety valve.
      4) Inlet and discharge isolation valves.
         a) Discharge isolation valve located downstream of oil recovery system.
      5) Oil recovery system:
         a) Oil separator, stamped per ASME Section VIII, DIV 1.
         b) Oil filter.
         c) Forced air oil cooler.
            (1) Designed for outdoor installation.
         d) All components in the oil recovery system should be fabricated from 304SS.
      6) Initial fill of lubrication oil.
   g. Compressor shall be designed to deliver digester gas at any volume and pressure within the capacity range specified in this Section.
   h. Compressors shall be designed to maximize operating efficiency and to withstand the full range of internal losses through clean and fouled filters,

tank media, or other components in the system while still meeting discharge gas pressure requirements specified. Motors shall be sized to accommodate all conditions specified while not operating within their service factor.

i. Compressors shall be operated with variable speed controls and shall be operated without encountering any surge characteristics during its full range of turndown.

j. As part of the submittal, the Supplier shall submit multiple performance selection operating points covering the full range of extreme condition requirements of inlet and discharge digester gas to demonstrate that compressor selections are appropriate to accommodate them.

k. Switches, valves, and gauges:
   1) Pressure gauges shall be installed on the compressor suction and discharge to measure suction pressure and discharge pressure and temperature.
   2) Provide compressor with high gas temperature RTD, and suction pressure and discharge pressure analog sensors.
   3) High discharge temperature and low suction and high discharge pressure alarms shall automatically shut down the compressor.

l. Equipment guards shall meet OSHA requirements and shall be fabricated from non-sparking material.

4. Pipe and fittings:
   a. Welding shall comply with the requirements of AWS D1.1 and D1.6.
   b. Pipe in contact with digester gas shall be Type 304L stainless steel.
   c. Chilled Water/Glycol piping on the skid: Type 304 stainless steel.
   d. Oil piping shall be Type 304L stainless steel.
   e. All drain piping shall be Schedule 40S Type 316L stainless steel and shall be piped to the edge of the skid with a Type 316 stainless steel ball valve on each drain line.
   f. Provide warning signs on piping and equipment with an operating temperature greater than 120 degrees Fahrenheit.

5. Valves:
   a. Check valves:
      1) Provide check valve on compressor.
      2) Suitable for digester gas service and pressures and temperatures required at compressor discharge.
      3) Flapper type with spring return.
      4) Type 316 stainless steel body and Type 316 stainless steel internals.
      5) Manufacturers: One of the following or equal:
         a) [redacted]
         b) [redacted]
         c) [redacted]
   b. Safety-relief valve:
      1) Provide to limit discharge pressure to 15 percent above the rated discharge pressure.
      2) Meet requirements of ASME Section VIII of boiler and pressure vessel code.
      3) Direct spring loaded type.
      4) Body, bonnet, and cap: carbon steel.
      5) Disc and seat: Type 316 stainless steel.
      6) Size to protect compressor if discharge valve is closed.
      7) Manufacturers: One of the following or equal:

a) [redacted]
b) [redacted]

6. Moisture removal heat exchanger system:
   a. The digester gas downstream of the compressor system shall be cooled with a heat exchanger package to remove all of the heat of compression and reduce the dew point of the digester gas as specified under Article 2.03D Outlet Conditions Minimum Requirements.
   b. The system shall actively monitor the compressor system discharge temperature conditions and include required controls to automatically adjust ensure meeting the specified dewpoint requirements at all times.
   c. After cooling to remove moisture, the digester gas shall be reheated as necessary to ensure that the discharge gas relative humidity is as specified in Outlet Conditions in this Section. The system shall be designed to achieve this during all ambient conditions and considering heat losses from all equipment supplied during low ambient conditions including piping and tanks. The Supplier shall demonstrate adequate sizing of the system to accommodate all ambient conditions during the submittal.
   d. The heat exchanger system shall be complete including all required chilled glycol/water system components and controls.
   e. Two heat exchangers shall be provided; a gas to gas heat exchanger for the reheat, and a gas to glycol for the cooling heat exchanger.
   f. The heat exchangers shall be plate and frame type.
      1) Inlet and outlet flanges:
         a) Glycol Loop: ASME B16.5, Class 300.
         b) Process: ASME B16.5, Class 300.
      2) Drainage system shall be provided and designed such that all condensation generated and accumulated during cooling shall be automatically removed from the inside of the heat exchanger housing:
         a) Provide appropriately sized trap to ensure there is no gas loss at any operating compressor pressure.
         b) Provide drain with manual bypass, strainer, and piped to edge of skid with 1/4 in/ft slope. Contractor shall supply drain piping external to skid.
      3) An RTD shall be mounted within the housing to measure minimum gas temperature. Minimum gas temperature shall be indicated at the main system control panel.
7. Moisture separator shall be centrifugal type.
   a. Material of construction to be 304SS.
   b. ASME Section VIII, DIV 1 stamped.
   c. Gas connections to be B16.5 Class 150.
   d. Condensate removal sump:
      1) Level switch for alarm of high level.
      2) Drain, vent, and gage connections: National Pipe Thread, Class 300 fittings.
8. CO_2 removal system:
   a. Consisting of membrane elements, membrane vessels, piping and appurtenances plus required pressure control valve(s) and product carbon dioxide (CO_2) analyzer.

b. Membrane racks shall be designed for the full system capacity as indicated in Article 2.03 of this Section. Supply membranes for system capacity of 250 scfm.
c. Provide third pass of membranes for tail gas treatment as indicated in Article 2.03 of this Section.
    1) Membrane racks for tail gas treatment shall be designed for the full system capacity as indicated in Article 2.03 of this Section. Supply membranes to treat tail gas from the system designed for a raw biogas capacity of 250 scfm.
d. Gas analysis:
    1) Product Gas Analyzer:
        a) IR Infared Industries (IR-8400D).
            (1) 90-100% VOL CH_4.
            (2) 0-10% VOL CO_2.
        b) Siemens Ultramat 23.
            (1) 90-100% VOL CH_4.
            (2) 0-10% VOL CO_2.
    2) Stage 1 Permeate Gas Analyzer:
        a) 0-20% VOL CH_4.
    3) Stage 3 - Off Gas Analyzer:
        a) 0-10% VOL CH_4.
e. Membrane vessels:
    1) Vessels shall be designed for a maximum internal pressure of 290 psig.
    2) Vessels shall be Type 316L stainless steel for surfaces in contact with biogas, and 304SS for non-contact surfaces.
    3) Inlet and outlet connections: ASME B16.5, Class 300 flanges or Victaulic grooves, with G-Type connections.
    4) Vessels shall have all piping and valving for 3-pass operations capable of meeting the gas quality requirements specified herein.
    5) Rupture disks or similar pressure relief devices to prevent overpressurization are required at membrane vessels or before and after the CO_2 removal system.
    6) Vessels shall be supported on hot-dip galvanized steel or stainless steel supports. Anchorage shall be designed as required in Article 1.07 of this Section.
    7) Supports may be shipped loose, however Supplier shall provide all the necessary connecting hardware.
f. Membranes:
    1) The membrane elements shall be hollow fiber type cartridges typical for CO_2 removal.
g. Piping and appurtenances:
    1) Gas piping shall be Type 304 stainless steel. Drain piping shall be Type 316L stainless steel.
    2) Supplier shall preassemble all piping and pressure test as a complete system prior to shipment.
    3) Piping shall be shipped in as large of preassembled segments as practical to facilitate field assembly.
    4) Isolation valves shall be provided at each fitting at each vessel; in addition to the piping and valving required to be provided to allow 3-pass gas treatment:

a) Valving shall be provided as necessary to ensure accommodating varying flow rates as specified in this Section.

5) Drain system/drain piping:
   a) Supplier shall provide condensate drains with manual valves for each vessel. Supplier shall ensure that adequate height is provided underneath the vessels to accommodate drainage method.
   b) Drain valves shall be Type 316L stainless steel ball valves.

9. Base:
   a. Structural steel, ASTM A36, hot-dip galvanized or powder coated after fabrication, aluminum, or fiberglass.
   b. Fabricated from "H" beams, channels, angles, and plates.
   c. Designed to support compressors, motors, drives, piping, inlet filter, after cooler, moisture separator, valving, and any specified skid-mounted instrumentation and control panels.
   d. Decking shall be inset with no edges exposed.
   e. Base plate shall be drilled for anchor bolts.
   f. Base shall have hot dipped galvanized or powder coated steel, aluminum, or fiberglass decking as appropriate for base material. Base shall include curbs for drainage with ball valves for oil leaks over any area that requires access for routine maintenance of operation; i.e., under the compressor bearing area.
   g. All piping shall terminate at the edge of the skid base.
10. Recirculation valve:
   a. Pilot operated back pressure regulator type.
   b. Recirculation valve shall be sized by the Supplier and shall be automatically controlled.
   c. Valve shall be as specified under Article 2.04E of this Section.

E. Chilled water system:
1. The chilled water/chiller package shall be located a minimum of 10 feet from digester gas piping, equipment, and appurtenances and shall be powered independently from the compressor system control panel. Provide disconnect to the input power of the chiller.
2. Chilled water/chiller package shall be designed for continuous operation within ambient conditions as specified. Chiller shall be designed to accommodate the full range of varying ambient conditions and digester gas flow rates and inlet conditions while still meeting specified digester gas outlet conditions (of overall system). Supplier shall demonstrate this with multiple performance selections covering extreme conditions as part of the submittals.
3. Chilled water/chiller package shall be of the air-cooled type and shall be sized large enough to provide the required cooling capacities to meet the specified performances with no cooler than 35 degrees Fahrenheit glycol/water mixture being added to the heat exchanger.
4. Chilled glycol water/chiller packages shall be designed and arranged to automatically accommodate varying digester gas flow rates as specified in this Section.
5. Glycol chiller refrigeration systems:
   a. Chiller capacity 25 percent to 100 percent of rated capacity as required to meet requirements specified in this Section.
   b. Dual independent refrigeration circuits sized for 50 percent capacity each.
   c. Dual independent compressors sized for 50 percent capacity each.

d. Electronically controlled motor driven condenser fans with die cast aluminum fan blades.
e. Aluminum micro-channel air-cooled condensers.
f. Type 316L stainless steel evaporators.
g. R-410A refrigerant.
h. Refrigeration circuits shall each be equipped with a sealed core filter drier, liquid line solenoid valve, liquid line shut-off valve, sight glass/moisture indicator and unload solenoid valve.
i. One electronic expansion valve per refrigeration circuit.
j. Glycol chillers shall be shipped with complete refrigerant charge.
k. Glycol chillers shall be [redacted] or equal.

6. Glycol/water circulation:
   a. Provide chiller mounted water/glycol dual circulation pump system.
   b. Pumps shall be stainless steel end suction centrifugal type.
   c. Pump motors shall be TEFC.
   d. Pumps shall be equipped with a suction and discharge isolation valve and discharge check valves.
   e. Type 304 stainless steel closed glycol reservoir.
   f. Glycol piping shall be ASTM B88 Type L copper pipe with wrought copper fittings and anti-corrosion PVC coating.
   g. Glycol pipe outside the chiller housing shall be insulated per manufacturer's standard, with a minimum of 0.020 inch aluminum cover with stainless steel banding.
   h. Provide initial fill of propylene glycol.
7. Glycol chiller support package:
   a. Chiller housings shall be constructed of G90 mil galvanized sheet steel or powder-coated steel that is formed and reinforced to provide a rigid assembly.
   b. All components mounted, piped, and wired on the skid.
   c. Coating:
      1) The interior and exterior of the units shall be completely cleaned prior to application of paint.
      2) A prime coat shall be applied to a minimum thickness 1.5 mils.
      3) A finish coat of low gloss, low VOC acrylic alkyd enamel shall then be applied to a minimum thickness of 2.5 mils:
         a) When tested in accordance with ASTM B117 the finished unit shall withstand 125-hour salt spray solution (5 percent) without any sign of red rust.
8. Chiller control panel:
   a. NEMA 4X 316 stainless steel enclosure.
   b. UL508A listed.
   c. Rated for 480 Volt/3-phase/60 hz power.
   d. Flange-mounted disconnect handle mechanically interlocked with door.
   e. Microprocessor based controller with full text LCD display.
   f. 480V primary control power transformer.
   g. Phase monitor to protect against phase loss, unbalance or reversal.

F. System enclosure:
1. Provide an enclosure custom designed and built for the gas conditioning system skid.
   a. LEL monitor with transmitter.
   b. Steel exterior with insulated panels.

c. Multiple access doors.
d. Designed for wind and seismic loading.
e. Provide acoustical ventilation louver and exhaust fan for internal cooling size for site conditions specified in this Section.
f. Provide unit heater with integrated thermostat sized for the site conditions specified in this Section.
g. Provide pipe penetration factory prefit.
h. LED Light fixtures and on/off switch.
i. Shall achieve at a minimum sound attenuation specified in this Section.
j. BUS shall be sized large enough such that the enclosure does not interfere with or reduce specified component and manufacturer recommended access requirements.

2. On skid electrical room:
   a. All on Skid electrical Devices shall be wired to terminal blocks in termination boxes or control panels located in the electrical room.
   b. A single 480 VAC power circuit will be provided to the skid/control room.
   c. All power distribution shall be from the BUS vendor supplied equipment.
   d. BUS shall be designed such that electrical room is an unclassified space.
   e. Penetrations between the electrical room and the exterior or to process areas must prevent passage of corrosive or explosive gases.
   f. Heated and cooled:
      1) To meet the rating of the internal equipment.
      2) Heating and Cooling System to be closed loop.
      3) Corrosion coating to withstand wastewater environment.
   g. Lighting:
      1) LED lighting.
      2) Indoor:
         a) Manual switch.
      3) Outdoor:
         a) Monted on outer walls of the enclosure.
         b) Photo eye controlled.
         c) Over doorways and openings.
   h. Receptacles:
      1) Gas conditioning room:
         a) Rated for hazardous environment.
         b) At least one on each wall.
      2) Outdoors:
         a) Mounted on exterior wall, near chiller as indicated on the Drawings.
         b) In use weatherproof cover, GFCI.
   i. Distribution panel:
      1) One of the following or equal:
         a) [redacted]
         b) [redacted]
         c) [redacted]
      2) Fully rated.
      3) Minimum width: 20 inches.
      4) Gutter space in accordance with the NEC:
         a) Minimum of 4 inches of gutter space.
      5) Dead-front, no live parts when the panelboard is in service.
      6) Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.

7) NEMA Rating suitable for the environment in which the panel will be installed.
8) Bus:
    a) General:
        (1) Tin-plated copper.
    b) Phase bus:
        (1) Full size and height without reduction.
        (2) Dimensions and temperature rise in accordance with UL 67:
            (a) Limit current density to less than 1,000 amps per square inch.
        (3) Insulate all current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
    c) Ground bus:
        (1) Copper, solidly bonded.
9) Lugs:
    a) UL listed for copper and aluminum wire:
        (1) Provide lugs rated for 75-degree Celsius terminations.
        (2) Provide bolted or compression main lug terminations as required for the incoming cable size.
10) Circuit breakers:
    a) Provide all circuit breakers with bolt-on connections:
        (1) Plug-in circuit breakers and branch-mounted main circuit breakers are not allowed.
11) UL 3rd Edition Surge Protective Device.

j. Step down transformer:
1) One of the following or equal:
    a) [redacted].
    b) [redacted]
    c) [redacted]
    d) [redacted]
    e) [redacted]
2) Cores:
    a) Non-aging, grain-oriented silicon steel.
    b) Magnetic flux densities below the saturation point.
3) Windings:
    a) High-grade magnet wire.
    b) Impregnated assembly with non-hydroscopic, thermo-setting varnish:
        (1) Cured to reduce hot-spots and seal out moisture.
    c) Material electrical grade:
        (1) Copper.
4) General:
    a) 10 kilovolts BIL for 600-volt class windings.
5) Taps:
    a) 15 kilovolt-amperes and less:
        (1) Two 5 percent full capacity primary taps below rated voltage.
    b) 25 kilovolt-amperes and larger:
        (1) Four 2.5 percent full capacity primary taps below rated voltage.

(2) Two 2.5 percent full capacity primary taps above rated voltage.

c) Operated by a tap changer handle or tap jumpers accessible through a panel.

6) Terminals:
   a) UL listed for either copper or aluminum conductors.
   b) Rated for 75 degrees Celsius.
7) Daily overload capacities, at rated voltage and without reduction in life, in accordance with IEEE C57.96.
8) Energy efficient transformers 15 kilovolt-amperes and larger:
   a) Insulation class: 220 degrees Celsius.
   b) Temperature rise: 115 degrees Celsius, except as noted below:
      (1) 150-degree Celsius rise for dry-type transformers located in motor control centers.
   c) Efficiency:
      (1) In accordance with DOE 10 CFR Part 431.
9) Enclosures:
   a) Heavy gauge steel:
      (1) Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.
      (2) Indoor: NEMA Type 2.
   b) Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
   c) Built-in vibration dampeners to isolate the core and coils from the enclosure:
      (1) Neoprene vibration pads and sleeves.

k. Motor Starters:
   1) As specified in Section 17055 - Packaged Control System.

G. BUS accessories:
1. All valves, sample ports, and devices shall be accessible in locations out from underneath the H_2S and siloxane removal tanks.
2. Pressure transmitters:
   a. Pressure transmitters shall be located in the follow locations:
      1) Inlet to the H_2S Removal System.
      2) Precooler discharge.
      3) Compressor inlet.
      4) Compressor discharge.
      5) VOC/siloxane removal discharge.
      6) Off gas discharge.
      7) Product gas discharge.
   b. General:
      1) Pressure transmitter assembly shall include a diaphragm type pressure transducer and microprocessor-based transmitter for measurement of gauge, vacuum, or absolute pressure.
   c. Performance requirements:
      1) Maximum ratio of total instrument range to calibrated span: 10 to 1.
      2) Accuracy:
         a) Reference accuracy: Plus or minus 0.075 percent of calibrated span, including effects of hysteresis, nonlinearity, and repeatability.

b) Total performance accuracy: Plus or minus 0.30 percent of calibrated span, including reference accuracy effects, static pressure and ambient temperature effects.
c) Stability: Plus or minus 0.15 percent of upper range limit over 5 years.

d. Element:
1) Diaphragm type transducer integral to pressure transmitter.
2) Diaphragm material: Stainless steel or ceramic.
3) Process material compatibility:
a) Verify all material compatibilities with the instrument manufacturer.
4) Process connection: As specified in the Instrument Data Sheets.

e. Transmitter:
1) Power supply:
a) 24 VDC - 2 wire loop powered.
b) Power consumption: 3 VA maximum.
2) Outputs:
a) Analog 4-20 mA.

f. Manufacturer:
1) The following or equal:
a) [redacted]
2) Adjustments: Adjustable electronic zero and span, with elevated or suppressed zero as required by application. Adjustment shall be possible without mechanical fulcrum points or a handheld configurator.
3) Local display:
a) 5-digit LCD.
b) Scaled in engineering units.
4) Enclosure:
a) Rated for use in Class I Division 1 locations.
5) Over range protection: To maximum process line pressure.
6) Conduit: 1/2-inch male NPT.

g. Components:
1) Transmitter mounting:
a) Provide all necessary hardware for transmitter mounting.

3. Pressure gauges:
a. Pressure gauges shall be located at the following locations:
1) Inlet and outlet of compressor.
2) Inlet and outlet of the chilled water and digester gas piping to each heat exchanger.
3) At each pressure change point.
b. Digester gas pressure gauges shall have pressure and/or vacuum ranges as appropriate to indicate the full range of possible operating pressures with the normal/typical pressures near the midpoint of the scales. Chilled water pressure gauges shall have 0- to 150-psig scale.
c. 316 stainless steel wetted parts.
d. [redacted] diaphragm.
e. Attach gauge with stainless steel tubing.
f. Manufacturers: The following or equal:
1) [redacted]
2) [redacted]

4. Differential pressure gauge (less than 35 psig):

a. Differential pressure gauges shall be located at the following locations:
    1) Each filter/separator.
b. [redacted] diaphragm.
c. Attach gauge with stainless steel tubing.
d. Mount gauge on mesh pad separator.
e. Manufacturers: The following or equal:
    1) [redacted]

5. Temperature transmitters:
    a. Temperature transmitters shall be located at the following locations:
        1) Inlet of the mesh pad separator.
        2) At each temperature change point.
        3) Glycol supply line to the BUS.
    b. General:
        1) Temperature measuring instrument shall include an RTD temperature element and transmitter.
    c. Performance requirements:
        1) Accuracy:
            a) Within 0.25 percent of calibrated span.
        2) Repeatability:
            a) 0.25 percent of full scale.
        3) Sensor lead wire compensation: Maximum zero shift of 0.2 percent of the temperature range.
    d. Element:
        1) 100-Ohm platinum thin film resistance temperature detector (RTD).
        2) 3-wire.
        3) Hermetically sealed and enclosed in Type 316 stainless steel outer sheath.
        4) Single element temperature sensor shall be spring-loaded.
    e. Transmitter:
        1) Microprocessor based.
        2) Compatible with 3-wire and 4-wire RTD inputs.
        3) Local display:
            a) 5-digit LCD.
            b) Scaled in engineering units.
        4) Power supply:
        5) 24 VDC - loop powered.
        6) Outputs:
            a) Analog 4-20 mA.
    f. Manufacturer:
        1) The following, or equal:
            a) [redacted].
        2) Transmitter enclosure:
            a) Rated for use in Class I Division 1 locations.
        3) Transmitter mounting:
            a) As specified on the Instrument Data Sheets or Instrument Index.
            b) Connection to thermowell: 1/2-inch NPT.
            c) Provide all necessary hardware for transmitter mounting.

6. Temperature gauges:
    a. Temperature gauges shall be located at the following locations:
        1) Inlet of the inlet filter/separator upstream of compressor system.
        2) Inlet and outlet of the cooling water piping and digester gas piping to each heat exchanger.

3) Inlet of the outlet particulate filters.

b. Temperature gauges shall have 30- to 150-degree Fahrenheit scales.

7. Level switch:
   a. Vibronic type.
   b. Point level switch that detects change in vibrating frequency when immersed:
      1) Mercury switches are not acceptable.
   c. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.
   d. Manufacturer:
      1) The following, or equal:
      2) [redacted]
8. Discharge flow:
   a. Locations
      1) Product gas.
      2) Off gas.
   b. Thermal mass measurement principle.
   c. General:
      1) Thermal mass flowmeters measure airflow, industrial, and process gas mass flows by detecting the heat transfer from a heated RTD sensor referenced to the temperature of the ambient gas stream sensor.
      2) The electronic circuitry shall either maintain a constant differential temperature between the gas temperature and the heated element or a constant power.
      3) The electronic circuitry shall deliver a linear signal 4 to 20 mA DC output proportional to the process fluid flow.
      4) Shall be certified for use in digester gas applications with negligible affect from moisture in the process air.
   d. Performance requirements:
      1) Accuracy:
         a) 1.5 percent of full scale for velocities over 2 feet per second.
      2) Repeatability:
         a) 0.5 percent of full scale.
   e. Element:
      1) Inline sensor with terminal enclosure.
      2) Flange process connection.
      3) No overheat at zero flow.
   f. Transmitter:
      1) Microprocessor-based.
      2) Enclosure:
         a) Rated for use in Class I Division 1 locations.
      3) Power supply:
         a) 120 VAC.
         b) Power consumption: 50 VA maximum.
      4) Outputs:
         a) Analog 4-20 mA.
   g. Manufacturer:
      1) The following, or equal:
         a) [redacted]
      2) Outputs:
         a) Analog 4-20 mA.

3) Alphanumeric display for flow rate.
4) Ambient operating temperature limits: 0 to 150 degrees Fahrenheit.

9. Automatic condensate removal (drip traps/pumps):
   a. Automatic condensate removal systems shall automatically remove water and all contained contaminants from all system components. Where possible, automatic condensate removal systems shall be by non-electro/mechanical means.
   b. Independent condensate removal systems shall be installed at all equipment/piping low spots where moisture can be trapped upstream of the reheat/drying stage at the gas-to-gas heat exchanger. This shall include but not be limited to systems provided at drains on the inlet and discharge filter/separators, the H_2S scrubber vessels, the compressor compartments, and the moisture separators.
   c. Automatic condensate removal systems and associated water removal system shall be provided with redundant pumps with lead/follow controls to ensure continuous automatic removal of all water from the gas conditioning system.
   d. All automatic condensate removal systems shall be provided with manual bypass.
10. Miscellaneous valves:
   a. Valves in copper lines shall have bronze bodies and valves in stainless steel lines shall have stainless steel bodies unless otherwise noted.
   b. Ball valves:
      1) Manufacturers: One of the following, or equal:
         a) [redacted]
         b) [redacted]
         c) [redacted]
         d) [redacted]
      2) General:
         a) Type: Non-lubricated, full port and capable of sealing in either direction.
         b) Low pressure end connections:
            (1) Class 150 threaded or solder ends for sizes 3-inch and smaller.
            (2) Class 150 flanged for sizes larger than 3 inch:
               (a) Flanges: In accordance with ASME B16.1 standards.
         c) High pressure end connections:
            (1) Class 300 threaded or solder ends for sizes 3-inch and smaller.
            (2) Class 300 flanged for sizes larger than 3 inch:
               (a) Flanges: In accordance with ASME B16.1 standards.
         d) Stem packing: Manually adjustable while valve is under pressure.
         e) Shafts: Rigidly connected to the ball by a positive means. Design connection to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
         f) Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
         g) Temperature limits: Suitable for operation between -20 to 350 degrees Fahrenheit.
   c. Butterfly valves (Class 150):

1) Manufacturers: One of the following or equal:
   a) [redacted]
2) Valve body:
   a) Pressure rating: 150 pounds per square inch, minimum.
   b) Material: Cast iron, ASTM A126, Class B or Ductile Iron, ASTM A395, Grade 60/40/18.
   c) Body design: Lugged style body with drilled and tapped bolt holes in accordance with ASME B16.1, Class 150 flange drilling dimensions.
3) Disc:
   a) Type 316 stainless steel, ASTM A351, Grade CF8M.
4) Shaft and bearings:
   a) Shaft: Type 316 stainless steel, ASTM A276.
   b) Shaft bearings: Self-lubricating sleeve type, Teflon with stainless steel or fiberglass backing.
5) Disc pins: Secure valve disc to shaft by means of solid, smooth-sided, taper or dowel pins, Type 316 stainless steel:
   a) Extend pins through shaft and mechanically secure in place.
6) Seats:
   a) PTFE.
7) Valve shaft packing:
   a) PTFE.

d. Butterfly valves (Class 300):
1) Manufacturers: One of the following or equal:
   a) [redacted]
2) Valve body:
   a) Pressure rating: 300 pounds per square inch, minimum.
   b) Material: carbon steel, ASTM A216, Grade WBC.
   c) Body design: Lugged style body with drilled and tapped bolt holes in accordance with ASME B16.1, Class 300 flange drilling dimensions.
3) Disc:
   a) Type 316 stainless steel, ASTM A351, Grade CF8M.
4) Shaft and bearings:
   a) Shaft: Type 316 stainless steel, ASTM A276.
   b) Shaft bearings: Self-lubricating sleeve type, Teflon with stainless steel or fiberglass backing.
5) Disc pins: Secure valve disc to shaft by means of solid, smooth-sided, taper or dowel pins, Type 316 stainless steel:
   a) Extend pins through shaft and mechanically secure in place.
6) Seats:
   a) PTFE.
7) Valve shaft packing:
   a) PTFE.

H. 3-phase induction motors:
1. Manufacturers: One of the following or equal:
   a. [redacted]
   b. [redacted]
   c. [redacted]

d. [redacted]

2. Voltage:
   a. All motors 1/2 hp and larger shall be rated 460 V, 3-phase unless otherwise indicated on the Drawings.
3. All motors greater than 1 hp and up to 500 hp shall meet the "NEMA Premium Efficiency" percent listed in NEMA MG-1.
4. Service factor:
   a. 1.15 service factor on sine wave power.
   b. 1.0 when driven by VFD.
5. Torque:
   a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
   b. When started using reduced voltage starters:
      1) Provide motors that develop sufficient torque for acceleration to full speed.
   c. NEMA Design B except where driven load characteristics require other than normal starting torque:
      1) In no case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
6. Enclosures:
   a. Totally enclosed fan cooled:
      1) Cast iron conduit box.
      2) Tapped drain holes with Type 316 stainless steel plugs for frames 286 and smaller, and automatic breather and drain devices for frames 324 and larger.
   b. Explosion-proof:
      1) Tapped drain holes with corrosion resistant plugs for frames 286 and smaller and automatic breather and drain devices for frames 324 and larger.
   c. Lifting devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
7. Manufactured with cast iron frames in accordance with NEMA MG-1 or manufacturer's standard material for the specified rating.
8. Nameplates:
   a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
      1) NEMA standard motor data.
         a) Indicate compliance with NEMA MG-1 Part 31 for inverter duty motors.
      2) AFBMA bearing numbers and lubrication instructions.
9. Hardware:
   a. Type 304 or 316 stainless steel.
10. Conduit boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
       1) Frames and conduit boxes.
       2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90-degree increments.
       1) Where available based on the size of the conduit box.
    e. Exceeding the dimensions defined in NEMA MG-1.

f. Provide grounding lugs inside conduit boxes for motor frame grounding.

11. Motor bearings:
    a. Antifriction.
    b. Regreasable and initially filled with grease for horizontal motors and vertical motors per manufacturer's standard design.
    c. Bearings and lubrication suitable for ambient temperature and temperature rise.
    d. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
    e. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
    f. Where specified in the equipment Specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.
12. Insulation systems:
    a. Motors installed in ambient temperatures 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius at the altitude where the motor will be installed.
    b. Motors installed in ambient temperatures between 40 degrees Celsius and 50 degrees Celsius:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 50 degrees Celsius at the altitude where the motor will be installed.
2. Motor leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
3. Noise:
    a. Maximum operating noise level in accordance with NEMA MG-1.

4. Vertical motors:
    a. Enclosures:
        1) Totally enclosed fan cooled (TEFC) for motors 200 hp and less installed outdoors.
        2) Weather protected Type II (WPII) for motors greater than 200 hp installed outdoors.
        3) Weather protected Type I (WPI) where installed indoors.
    b. Thrust bearings:
        1) Selected for combined rotor and driven equipment loads.
        2) Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.
    a. Anti-reverse ratchet.
13. Motors driven by variable frequency drives:
    a. Compatible with the variable frequency drives specified.
    b. Inverter duty rated and labeled.
    c. Meet the requirements of NEMA MG-1 Part 31.
    d. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
    e. Capable of running continuously at 1/2 of full speed, with no harmful effects or overheating.
    f. All motors except explosion proof motors:

1) Shaft grounding ring:
a) Provide a shaft grounding ring for each VFD-driven motor.
b) Aluminum frame and internal components.
c) Conductive microfiber brushes.
d) Maintenance free design.
e) Aegis Bearing Protection ring as manufactured by [redacted] or equal.

g. Explosion proof motors:
1) On motors less than or equal to 100 hp, provide insulated bearings on one end of the motor.
2) On motors over 100 hp, provide insulated bearings on both ends of the motor.
3) Shaft grounding ring:
a) Installed inside the explosion proof enclosure in accordance with IEEE standard 303.
b) Provide a shaft grounding ring for each VFD-driven motor.
c) Aluminum frame and internal components.
d) Conductive microfiber brushes.
e) Maintenance free design.
f) Aegis bearing protection ring:
(1) Manufacturers, The following or equal:
(a) [redacted]

h. On motors over 100 hp, provide insulated bearings on both ends of the motor or on the end opposite of the shaft ground ring as recommended by the motor manufacturer.

14. Motors installed in hazardous locations:
a. Class I, Division 1 areas:
1) Enclosures:
a) Explosion proof for 3-phase motors.
b) UL listed in conformance with UL-674.
c) UL approval with nameplate and serial number.
b. Other hazardous areas:
1) Enclosures:
a) TEFC for motors in Class I, Division 2 areas.
c. Hazardous area and temperature code approval stamped on nameplate.

15. Single-phase motors:
a. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified.
b. Totally enclosed fan cooled (TEFC) motors manufactured in accordance with NEMA MG 1.
c. Ball bearings: Sealed.
d. 1/2 hp or less fan motors:
1) Split-phase or shaded pole type when standard for the equipment.
2) Open type when suitably protected from moisture, dripping water, and lint accumulation.
e. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the Engineer.
f. Integral overload protection.

16. Motor winding heaters:
a. Provide all 3-phase motors with belted or cartridge space heaters mounted within the motor enclosure.

1) Suitable for the area classification in which the motor is located.
b. Space heater rating shall be 120 volts, single-phase, unless otherwise indicated on the Drawings.
c. Power leads for heaters wired into conduit box.
d. Installed within motor enclosure adjacent to core iron.

17. Winding temperature detectors:
a. Provide factory installed winding temperature detector with leads terminating in the conduit box:
b. Temperature switches with normally closed contacts.
1) Suitable for the area classification in which the motor is located.

18. Provide completed Motor Data Sheet (Attachment E) for every motor furnished as part of the associated equipment submittal.
a. Conform to data sheet in Attachment of this Section.
b. Manufacturer's or other data sheets are not acceptable.

I. Conduits:
1. RAC (Rigid aluminum conduit - for Class I Division 2 locations):
a. Material:
1) Extruded from 6063 Alloy in Temper Designation T-1.
2) Maximum 1/10-percent copper content.
3) Containing lubricating inside liners.
b. NPT standard threads with a 3/4-inch taper per foot:
1) Running conduit threads are not acceptable.
c. Provide aluminum fittings and conduit bodies.

2. PCS (PVC-coated steel - for Class I Division 1 locations):
a. Steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, in accordance with the requirements for Type GRC.
b. Coated conduit NEMA Standard RN-1:
1) Galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
c. Factory-bonded PVC jacket:
1) Exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
2) Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.
3) PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
4) PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
a) Confirm bond with certified test results.
d. Urethane coating shall be uniformly and consistently applied to the interior of conduits and fittings:
1) Nominal thickness of 0.002 inch.
2) Conduits having areas with thin or no coating are not acceptable.
3) Threads shall be coated with urethane.
e. PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).

f. PCS conduit bodies and fittings:
    1) Malleable iron.
    2) Conduit body, before PVC coating, shall be new, unused material and shall be in accordance with appropriate UL standards.
    3) PVC coating on the outside of conduit bodies shall be 0.040-inch thick and have a series of ribs to protect the coating from tool damage during installation.
    4) 0.002-inch interior urethane coating.
    5) Utilize PVC coating as an integral part of the gasket design.
    6) Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.
    7) PVC sleeves extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
        a) Inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
        b) Sleeves shall provide a vapor- and moisture resistant seal at every connection.
        c) Fittings shall be Form 8 and supplied with plastic encapsulated stainless steel cover screws. Fittings shall be UL Type 4X. Fittings shall be from the same manufacturer as the conduit in order to maintain system continuity and warranty.

3. SLT (Sealtight-liquidtight flexible conduit):
    a. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
        1) General purpose:
            a) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
        2) Oil-resistant:
            a) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
    b. Sunlight-resistant, weatherproof, and watertight.
    c. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
    d. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
    e. Overall PVC jacket.
    f. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.
4. EFLX (Explosion proof flexible conduit):
    a. Suitable for the hazardous Class and Group where installed.
    b. Metallic braid shall provide continuous electrical path.
    c. Stainless steel construction.
    d. Provide fittings and unions as required for the installation.

J. Sealing fittings:
1. Construction:
    a. 40-percent wire fill capacity.
    b. PVC-coated when used in corrosive areas.
    c. PVC Coated Hazardous (Classified) Location fittings must be UL 1203 listed after the coating is applied and have a red metal tag attached to the fitting to signify compliance.

d. Aluminum with aluminum conduit.
e. Crouse-Hinds Type EYD where drains are required.
f. Crouse-Hinds Type EYS where drains are not required.
g. UL listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.

2. Sealing compound:
   a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
   b. Approved for the conditions and use.
      1) Not affected by surrounding atmosphere or liquids.
   c. Melting point shall be 200 degrees Fahrenheit minimum.

2.05 CONTROLS

A. Major components of the BUS control panel and process instrumentation shall be in accordance with Section 17055 - Packaged Control System.
   1. Enclosure:
      a. Outdoor areas: NEMA 4X type 316 Stainless Steel, with quarter turn latches on doors.
      b. Interior, unclassified areas: NEMA 12
      c. VCP shall be rated and listed for the available fault current level as calculated by the Contractor. Supplier shall coordinate with Contractor to ensure VCP is adequately rated for available fault current.
   2. Provide and identify 4-20 mA analog PLC inputs for the following signals. The field hardware and wiring will be provided by the contractor.
      a. Digester gas holder cover level.

B. The following control strategies for the BUS shall be programmed in the BUS PLC:
   1. Permissives
      a. BUS shall operate only when all permissive signals pertaining to the selected control mode (Gas Holder Level Mode) are received.
      b. If any instrument falls outside the permitted range BUS shall shut down.
      c. Common Permissives (Gas Holder Level Mode selected)
         1) Plant Relay CR 53-100: FLARE PILOT (ON).
         2) INTERCONNECT-PLC: INTERCONNECT CALL FOR FUEL (ON).
         3) INTERCONNECT-PLC: ESTOP (OFF).
      d. Pressure control mode permissives:
         1) To be completed during design.
            a) Setpoints shall be adjustable locally at the BUS VCP.
         2) All controlling instruments (NOT FAILED).
   2. Gas Treatment System Operation – Gas Holder Level Control:
      a. When permitted per article A.1. above the BUS shall be controlled by inputs from the level instrument.
      b. The BUS PLC shall be programmed to vary the output of the Gas Treatment System based on the membrane gas holder level.
         1) The operator will input a GH_{LVL} Setpoint and the BUS capacity shall modulate to maintain the setpoint.
            a) If GH_{LVL} is higher than the setpoint then BUS capacity will decrease to re-establish the setpoint.
            b) If GH_{LVL} is lower than the setpoint then BUS capacity will increase to re-establish the setpoint.

2) The GH_{LVL} Setpoint and the GH_{LVL} Normal Range shall be operator adjustable in the BUS PLC.
3) Operator GH_{LVL} Setpoint input shall be constrained to the GH_{LVL} Normal Range, input values outside the allowable range will not be accepted.

2.06 FINISHES

A. All components shall be factory coated prior to shipment.

2.07 SOURCE QUALITY CONTROL

A. Minimum testing requirements: Where not otherwise specified, the manufacturer's standard testing procedures shall be followed, and in the event the system does not satisfy the criteria or the requirements of this Section, it shall be repaired, modified, or replaced before shipment to the Site.

B. Factory testing: The BUS components shall receive the following minimum testing at the factory:
   1. System operation shall be simulated to ensure system function as specified, throughout the required operating range of varying flows, temperatures, and pressures.
   2. Equipment performance test: Provide CAGI data sheets per ISO 1217.
   3. Vibration Test: Run test compressor after skid installation, vibration shall not exceed 0.6 inches per second (ips). Modifications to reduce vibration below 0.6 ips shall be made at no cost to Owner.
   4. Noise Test: Assembled components shall meet noise testing per Article 1.12 of this Section.
   5. Motor factory tests:
      a. Perform manufacturer's standard production tests including but not limited to:
         1) No load current.
         2) High potential test.
         3) Winding resistance.
      b. Furnish copies of standard test reports on prototype or identical units.

C. Supplier's shop testing: The BUS shall receive the following additional testing at the Supplier's shop:
   1. Leak Test: Skids, vessels and Vendor provided piping shall be leak tested as a package by hydrostatic pressure testing at the design pressure. Leakage allowance for the skid is zero.
   2. Operation Test: Skid shall be tested as a package to demonstrate proper operation of all components.
   3. Noise Test: Assembled components shall meet noise testing per Article 1.12 of this Section.

D. Control panel testing as specified in Section 17055 - Packaged Control System.

E. Labeling
   1. All components shall be labeled with a 2-inch tag corresponding to P&ID number.
   2. Tag shall be manufactured from a UV resistant material.
   3. Tag shall be affixed to the component with a meter seal.

4. Tagging shall be per manufacturer’s standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Supplier shall clearly label all loose components and shall provide complete detailed instructions showing installation requirements for all components to be installed by the Contractor.

B. All steel components not stainless steel shall be factory primed and coated by the Supplier. Field coatings and touch-up shall be by the Contractor.

C. Install in accordance with manufacturer’s recommendations and as indicated on the Drawings.

D. All components of the BUS shall be installed within the limited space indicated on the Drawings.

E. Install motors in accordance with manufacturer's instructions.

F. Install shaft grounding ring on VFD-driven motors in accordance with the manufacturer’s instructions.

3.02 PREPARATION FOR SHIPMENT

A. Insofar as is practical, the equipment specified in this Section shall be factory assembled.

B. The assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field.

C. Generally, machined and unpainted parts shall be protected from damage by elements with the application of strippable protective coatings.

D. On skid equipment shall be properly anchored to the skid prior to delivery to the site.

3.03 FIELD QUALITY CONTROL

A. Contractor shall conduct a performance test to determine that gas treatment is to the specified levels. Sampling shall be as specified in Article 3.04E of this Section. Sampling shall confirm compliance with specified performance requirements.

B. System operation shall be simulated to ensure system function as specified, throughout the required operating range of varying flows, temperatures, and pressures.

C. Test procedure shall be provided by the Supplier and approved by the Engineer.

D. All chemical analysis shall be provided by the Supplier. Supplier can assume EPA method TO-15 is acceptable to end user for determination of VOCs.

E. Failure to meet performance requirements is cause for replacement or repair by the Supplier at no cost to the Owner.

3.04 MANUFACTURER SERVICES

A. The Supplier shall provide the services of a FSE for inspecting the unloading, loading, packaging, placement, installation, and adjustments of the BUS. This will include one (1) trip for two (2) consecutive 8-hour days.

B. The Supplier shall furnish and supervise installation of the first fill of all consumables including H_2S and siloxane removal media, oil, coolant, and other materials necessary to result in a complete operating system.

C. The Supplier shall be on-site a total of ten (10) days divided over two (2) trips for commissioning/start-up and training services.
   1. Training shall be provided covering maintenance and operation requirements of all individual components as well as for the complete overall system operation and maintenance.
   2. Supplier shall provide two (2) trainings to ensure all of Owner's staff can attend around normal shift schedules.
   3. Training shall include a mixture of classroom sessions and equipment walkthroughs.
   4. Training shall include how to take gas samples and preparation of chain of custody for sample taking.

D. Upon completion of system start-up at the site, the Supplier shall collect samples of the digester gas and treated gas as noted below and submit it for laboratory analysis:
   1. Laboratory results shall be provided to the Owner within 10 days for review and approval as a condition of the final equipment acceptance.
   2. The Contractor and BUS Supplier shall coordinate with Alliant Energy to ensure that samples are tested for the constituents noted below to be tested by the end user. Should this not be coordinated, the BUS supplier will be required to take additional samples for testing the required constituents at no additional cost to the Owner.
   3. The method used for analyzing the samples shall be of appropriate sensitivity to detect the levels of treatment required per the specified treatment levels. Should the results indicate sampling reporting limits higher than the treatment level required for the constituent, the BUS supplier will be required to take additional samples for testing using a more appropriate method at no additional cost to the Owner.
   4. The Supplier shall take one round of samples as outlined in the following table. Supplier shall repeat sampling effort in the event that product gas does not meet the quality requirements specified herein.

Test Location	Major Gas Constituents Total Btu	Hydrogen Sulfide	VOCs	Siloxane Series
Upstream H_2S Vessels	✔	✔	✔	✔

Test Location	Major Gas Constituents Total Btu	Hydrogen Sulfide	VOCs	Siloxane Series
Downstream of Siloxane Vessels		✔	✔	✔
Downstream of Membranes	✔	✔	✔	✔
Tail Gas	✔			

E. Long-term operations assistance
   1. BUS supplier shall include costs for assistance to Owner with operation and maintenance questions and optimization of the BUS. The BUS supplier shall include for 5 years after substantial completion, two trips to the Owner's site (one 8-hour day on site per trip) per year with qualified BUS supplier certified service technician with understanding of the BUS.
   2. BUS supplier shall provide telephone assistance at no additional cost to Owner for 5 years after substantial completion. A preferred call list indicating BUS supplier contact information that may be contacted 24 hours a day, 7 days per week shall be provided and updated as changes occur. Engineer may contact BUS supplier as designated Owner representative for technical and engineering assistance.
   3. Owner shall provide internet access to connection through a secure computer network to allow BUS supplier with pre-authorized viewing or modification of provided control system.

END OF SECTION