REC 18-066

The Narragansett Bay Commission
One Service Road
Providence, Rhode Island 02905

401 • 461 • 8848
401 • 461 • 6540 FAX
TTY (RI RELAY OPERATOR) 711

http://www.narrabay.com

March 31, 2018

Debra A. Howland
Executive Director
New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

Dear Ms. Howland,

Enclosed please find the completed Renewable Energy Source Eligibility Form for Class I Thermal Sources with Renewable Thermal Energy Capacity Greater Than 200,000 BTU/HR and applicable Appendices for the Narragansett Bay Commission's (NBC) new cogeneration project that is powered by anaerobic digester gas. The project is located at NBC's Bucklin Point Wastewater Treatment Facility in East Providence, RI. NBC collects the biogas and conveys it directly to the Generation Unit without use of facilities used as common carriers of natural gas.

NBC's completion date for the construction of the project is currently April 30, 2018. The project's status is currently listed by NEOOL GIS as pending (NON121998).

We look forward to hearing back from you soon with a favorable determination regarding the project's eligibility as a renewable thermal energy resource. Please contact us at (401) 461-8848 if you have any questions or need additional information.

Sincerely,

Thomas P. Uva
Director of Environmental Science & Compliance
Narragansett Bay Commission
One Service Road
Providence, RI 02905
Email: tuva@narrabay.com

State of New Hampshire
Public Utilities Commission

21 S. Fruit Street, Suite 10, Concord, NH 03301-2429

DRAFT REVISED 3-8-17

APPLICATION FORM FOR

RENEWABLE ENERGY SOURCE ELIGIBILITY FOR
CLASS I THERMAL SOURCES WITH RENEWABLE THERMAL ENERGY CAPACITY GREATER THAN
200,000 BTU/HR

Pursuant to New Hampshire Administrative Code PUC 2500 Rules

- Please submit one (1) original and two (2) paper copies of the completed application and cover letter* to:

Debra A. Howland
Executive Director
New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

- Send an electronic version of the completed application and the cover letter electronically to executive.director@puc.nh.gov.

* The cover letter must include complete contact information and identify the renewable energy class for which the applicant seeks eligibility. Pursuant to PUC 2505.01, the Commission is required to render a decision on an application within 45 days of receiving a completed application.

If you have any questions please contact Barbara Bernstein at (603) 271-6011 or Barbara.Bernstein@puc.nh.gov.

Only facilities that began operation after January 1, 2013 are eligible.

Is this facility part of a Commission approved aggregation?
Yes ____ No ✓
Aggregator's Company Name: _____
Aggregator Contact Information: _____

Contents

Attachment Labeling Instructions

Please label all attachments by Part and Question number to which they apply (e.g. Part 3-7). For electronic submission, name each attachment file using the Owner Name and Part and Question number (e.g. Pearson Part 3-7).

Part 1. General Application Information

Please provide the following information:

Applicant

Name: Narragansett Bay Commission

Mailing Address: One Service Road

Town/City: Providence State: RI Zip Code: 02905

Primary Contact: Thomas Uva

Telephone: (401) 461-8848 (x470) Cell: (401) 490 - 1215

Email Address: tuva@narrabay.com

Facility

Name: NBC Bucklin Point Wastewater Treatment Facility

Physical Address: 102 Campbell Avenue

Town/City: Rumford State: RI Zip Code: 02916

If the facility does not have a physical address, the Latitude: _____ & Longitude Provided Address

Installer

Name: BioSpark

Installer License Number: State of Rhode Island Electrical Corporation AC001320

Mailing Address: One Liberty Square, 11th Floor

Town/City: Boston State: MA Zip Code: 02109

Primary Contact: Thomas Moore

Telephone: 978-621-0421 Cell: _____

Email Address: tmoore@biosparkusa.com

If the equipment was installed by the facility owner, check here: ☑

Facility Operator

If the facility operator is different from the owner, please provide the following:

Name: NBC Bucklin Point Waste Water Treatment Facility

Facility Operator Telephone Number: (401) 461-8848 x190

Service to be provided by BioSpark

Independent Monitor

Name: Daymark Energy Advisors

Mailing Address: 370 Main Street, STE. 325

Town/City: Worcester State: MA Zip Code: 01608

Primary Contact: Dimitri Kordonis

Telephone: 617-778-5515 Cell:

Email Address: dkordonis@daymarkea.com

NEPOOL/GIS Asset ID and Facility Code

In order to qualify your facility's thermal energy production for RECs, you must register with the NEPOOL – GIS. Contact information for the GIS administrator follows:

James Webb
Registry Administrator, APX Environmental Markets
224 Airport Parkway, Suite 600, San Jose, CA 95110
Office: 408.517.2174
jwebb@apx.com

Mr. Webb will assist you in obtaining a GIS facility code and an ISO-New England asset ID number.

GIS Facility Code # Asset ID # NON121998

1. Has the facility been certified under another non-federal jurisdiction's renewable portfolio standards?

Yes ☐ No ☑

If you selected yes, *please provide proof of certification in the form of an attached document as Attachment 1-1.*

2. Attach any supplementary documentation that will help in classification of the facility as Attachment 1-9

Part 2. Technology Specific Data

All Technologies

Fuel type (solar, geothermal, or biomass): Anaerobic Disgester Biogas

Rated Thermal Capacity (Btu/hr): 2,742,081

Date of initial operation using renewable fuels: 04/30/2018 - Estimated

Biomass

If a thermal biomass facility, provide proof of New Hampshire Department of Environmental Services approval that the facility meets the emissions requirements set forth in Puc 2500, as Attachment 2-1.

see attached RIDEM Minor Source Air Permit Approval 2337

Solar Thermal

If a solar thermal facility, please provide the Solar Rating and Certification Corporation rating based on Mildly Cloudy C (kBtu/day): _____

Geothermal

If a geothermal facility, please provide the following:

The coefficient of performance (COP): _____

The energy efficiency ratio of the system: _____

Part 3. Metering and Measurement of Thermal Energy and REC Calculations

This section deals with the thermal metering system including methods for calculation and reporting useful thermal energy. **A copy of PUC 2506.04 of the RPS rules is included as Appendix A.**

Using the table below, identify the thermal metering system or custom components (e.g., heat meters, flow meters, pressure and temperature sensors) used to measure the useful thermal energy and enter the accuracy of measurement for the entire system:

System or Component	Product name	Product Manufacturer	Model No.	Accuracy
BTU Meter	Flow Meter	Onicon	F 3100	0.4% of rate
BTU Meter	Temp Sensors	Onicon	System 10	+/- 0.15%
BTU Meter	Calculator	Onicon	System 10	
Total System Accuracy (Percent)	Calculator utilizing above component meets ENI434/CSA C900.1 accuracy requirements			

Attach component specification sheets (Accuracy, Operating Ranges) as Attachment 3-1. ☑

Attach a simple schematic identifying the location of each sensor that is part of the metering system as Attachment 3-2. ☑

Check the applicable standard for meter accuracy prescribed in Puc 2506.04 among the six choices below (compliance with Puc 2506.04 shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing):

If the facility is a large thermal source using a liquid or air based system, check the method that applies:

A. Installation and use of heat meters capable of meeting the accuracy provisions of European Standard EN 1434 published by CEN, the European Committee for Standardization. The heat meter shall have the highest Class flow meter that will cover the design flow range at the point of measurement and a temperature sensor pair of Class 5K or lower. ☑

B. Installation and use of meters that do not comply with European Standard EN 1434, provided that the manufacturers' guaranteed accuracy of the meters is ±5.0% or better, ☐

C. Use of an alternative metering method approved pursuant to Puc 2506.06. ☐

If the facility is a large thermal source using a steam-based system, check the method that applies:

D. Installation and use of meters with accuracy of ±3.0% or better. ☐

E. Installation and use of meters with system accuracy that do not meet D but are ±5% or better. ☐

F. Use of an alternative metering method approved pursuant to Puc 2506.06. ☐

Please summarize the manufacturer's recommended methods and frequency for metering system calibration and provide reference for source document (e.g. owners/operators manual):

Frequency is not specified in the metering system manual , but a periodic check is recommended

REC Calculation Discount factor for meter accuracy (Enter 0 if no discount is required): 0 %

If the meters used to measure useful thermal energy comply with the accuracy of the European Standard EN 1434 for liquid systems or use of meters with accuracy of ±3.0% or better for steam systems enter zero, for all other systems enter the sum total of the manufacturer's guaranteed accuracy of the meters used or the accuracy of the alternative method approved pursuant to Puc 2506.06.

REC Calculation Discount factor for operating energy and thermal energy losses: 2.0 %

Check the method used for determining the operating energy and thermal loss factor among the choices below:

Default Factor ☑

- For sources using solar thermal technology, the discount factor shall be 3.0% of the useful thermal energy produced;
- For sources using geothermal technology, the discount factor shall be 3.6% of the useful thermal energy produced;
- For sources using thermal biomass renewable energy technology, the discount factor shall be

2.0% of the useful thermal energy produced.

Actual Metering ☐

- Include a simple schematic identifying the operating energy and thermal energy losses and placement of the meters.

Application Checklist

Please complete the following table to assist in the review of the application for REC eligibility.

Table 1: Description of the Equipment & Meters [Puc 2505.02 (d)(3)-(5),(10)-(14), 2506.04 (b)-(f), (m), & 2506.05]

C = Provided in compliance with Puc 2500 NC = Compliance with Puc 2500 not demonstrated N/A = Not Applicable

*if applicable	PUC 2500 Rule	Attachment #	Page #	Mass Flow Meter	Steam or Supply Water Temperature Sensor	Steam Pressure Sensor	Condensate or Return Water Temperature Sensor	Condensate Pressure Sensor	Thermal Energy Monitoring System
Product Name	2505.02(d)(3)	MeterData.pdf	29						
Product Manufacturer*	2505.02(d)(3)	MeterData.pdf	29						Onicon
Model #*	2505.02(d)(3)	MeterData.pdf	29						F3100
Total System Accuracy 99%	2506.04(e),(f)	Meter Data.pdf	29						
Placement of sensor*	2506.02(d)(3)	See attached diagram P-110							
Temperature operating range*	2506.02(d)(3)	MeterData.pdf	30						
Flow operating range*	2506.02(d)(3)	MeterData.pdf	29						General Specs
Pressure operating range*	2506.02(d)(3)	MeterData.pdf	29						Maximum op. press
Manufacturer's meter calibration recommendations	2506.02(d)(4)	Not Stated							
Manufacturer's guaranteed accuracy	2506.05(d)(10)	MeterData.pdf	29						
Useful thermal energy methodology & calculation	2506.04(m)	Heat and Mass Balance							
Meter accuracy discount factors*	2505.02(d)(13)	See page 6 - meter complies with EN 1434							
Discount factor for operating energy & thermal losses*	2505.02(d)(14)	see page 6							
Thermal energy data read hourly	2506.04(c)	see attached spreadhseet							
Thermal energy totaled every 24 hours	2506.04(c)	see attached spreadsheet							
Thermal energy totaled monthly	2506.04(c)	see attached spreadsheet							
Thermal energy totaled quarterly	2506.04(c)	see attached spreadsheet							
Manufacturer's specifications for heat meters followed	2506.04(d)	Attached attestation							

Rated thermal heating capacity	*Btu/hr*	*MW*	*calculation*
	~~2,000,000~~	~~0.586142~~	~~2,000,000/3,412.142 = 586.14207 kW~~

Rated Thermal Heating Capacity for Unit 2,742,081 Btu/hr 0.8036 MW

Part 4. Affidavits

Owners Affidavit

The following affidavit must be completed by the owner attesting to the accuracy of the contents of the application pursuant to PUC 2505.02 (b) (14).

AFFIDAVIT

I, Raymond Marshall have reviewed the contents of this application and attest that it is accurate and is signed under the pains and penalties of perjury.

Applicant's Signature Raymond Marshall Date 3/30/18

Applicant's Printed Name Raymond Marshall, P.E.

Subscribed and sworn before me this 30th Day of March (month) in the year 2018

County of Providence State of Rhode Island

John E. Rossi Karen K. Musumeci

Notary Public/Justice of the Peace Seal

My Commission Expires 03-04-2020

NH Professional Engineer Affidavit

AFFIDAVIT

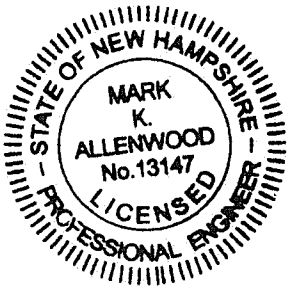
I, Mark Allenwood attest that this facility meets the requirements of the thermal REC eligibility requirements of Puc 2500, including the thermal metering and measurement methodologies and standards and REC calculation methodologies.

Professional Engineer's Signature Mark Allen Date February 16, 2018

Professional Engineer's Printed Name Mark Allenwood

NH Professional Engineer License Number 13147

PE Stamp



Application Checklist				
Application Section		Item Description	Attachment Required	Check box
Part 1-1		Applicant Information		☑
Part 1-2		Facility Location Information		☑
Part 1-3		Installer Contact Information		☑
Part 1-4		Equipment Seller Information		☑
Part 1-5		Facility Monitor Information		☑
Part 1-6		Regulatory Approvals for REC Requirements	Yes	☐
Part 1-7		Other REC Certifications		☐
Part 1-8		Facility Output Information		☑
Part 1-9		Facility Operator Information		☑
Part 1-10		Additional Facility Classification Information		☐
Part 1-11		Attestation that Building Codes are Met		☑
Part 2-1		Rated Thermal Capacity		☑
Part 2-2a		Thermal Biomass Facility, 3-99 MMBTu/hour Output		☐
Part 2-2b		Thermal Biomass Facility, 100+ MMBTu/hour Output		☐
Part 2-3		Solar Thermal Facility Solar Rating and Certification Corporation Rating		☐
Part 2-4a		Geothermal Facility Coefficient of Performance		☐
Part 2-4b		Geothermal Facility Energy Efficiency Ratio		☐
Part 3-1		Equipment and Meter Description		☑
Part 3-2		Recommended Methods for Meter Calibration Non specified by manufacturer		☐
Part 3-3		Attestation that Meters meet PUC 2506 Requirements	Certified on page8 of this doc	☐
Part 3-4		Guaranteed Accuracy of Meters	See attached mfr certificates	☑
Part 3-5a		Small Thermal Source- Calculating Useful Thermal Out		☐
Part 3-5b		Large Thermal Source- Calculating Useful Thermal Out	Heat and Mass Balance document attached	☑
Part 3-6		Meter Accuracy Discount Factor		☐
Part 3-7a		PUC 2506 Operating Energy and Thermal Loss Discount Factor		☐
Part 3-7b		Determining Operating Energy and Thermal Loss Discount Factor		☐
Part 4-1		Owner Affidavit		☑
Part 4-2		Professional Engineer Affidavit		☑

* see Fuel Source Plan Attachments

Appendix A. Excerpt from Puc 2500 – Certain Thermal Metering Provisions

For complete rules and requirements related to the RPS and REC eligibility, please refer to Puc 2500.

Puc 2506.04 Metering of Sources that Produce Useful Thermal Energy

(a) Sources producing useful thermal energy shall comply with this part in metering production of useful thermal energy.

(b) Sources shall retain an independent monitor to verify the useful thermal energy produced.

(c) Sources shall take data readings for the measurement of useful thermal energy at least every hour. The useful thermal energy produced shall be totaled for each 24 hour period, each monthly period, and each quarter.

(d) Sources shall install meters to measure thermal energy output in compliance with the manufacturer's recommendations and as noted in this part.

(e) Large thermal sources using a liquid or air based system shall measure the useful thermal energy produced using one of the following methods:

(1) Installation and use of heat meters with an accuracy that complies with European Standard EN 1434 published by CEN, the European Committee for Standardization, and that complies with paragraph (k), (l) or (m). The heat meter shall have the highest Class flow meter that will cover the design flow range at the point of measurement and a temperature sensor pair of Class 5K or lower. Compliance shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing;

(2) Installation and use of meters that do not comply with subparagraph (e) (1), provided that the manufacturers' guaranteed accuracy of the meters is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the meters were installed and operate according to the manufacturers' specifications and in accordance with paragraph (k), (l) or (m); or

(3) Use of an alternative metering method approved pursuant to Puc 2506.06, provided that the accuracy of any such method is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the source implemented the alternative method as approved by the commission and certifies that the alternative method achieves the stated accuracy of ±5.0% or better.

(f) Large thermal sources using a steam-based system shall measure the useful thermal energy produced using one of the following methods:

(1) Installation and use of meters with accuracy of ±3.0% or better, which compliance shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing and in accordance with paragraph (m);

(2) Installation and use of meters that do not comply with the accuracy of subparagraph (f) (1), provided that the manufacturer's guaranteed accuracy of the meters is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the meters were installed and operate according to the manufacturer's specifications and in accordance with paragraph (m); or

(3) Use of an alternative metering method approved pursuant to this section, provided that the accuracy of any such method is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the source implemented the alternative method as approved by the commission and certifies that the alternative method achieves the stated accuracy of ±5.0% or better.

(g) Small thermal sources shall measure useful thermal energy produced using one of the following methods:

(1) For any small thermal sources, the methods described in paragraphs (e) or (f);

(2) For small thermal sources using solar thermal technologies, the method described in paragraph (h);

(3) For small thermal sources using geothermal technologies, the method described in paragraph (i); or

(4) For small thermal sources using thermal biomass technologies, the method described in paragraph (j).

(h) Calculation of useful thermal energy produced by small thermal sources using solar technologies.

(1) "Q" means thermal energy generated, stated in Btu's.

(2) "R" means the Solar Rating and Certification Corporation (SRCC) OG100 rating on Mildly Cloudy C Conditions, stated in thousands of Btu's per day.

(3) "L" means the orientation and shading losses calculated based on solar models such as Solar Pathfinder, T-sol, Solmetric, or another model approved by the Commission, converted from a percentage to the equivalent number less than 1.

(4) "t" means the total operating run time of the circulating pump as metered, stated in hours.

(5) "h" means 11 hours per day to convert the SRCC OG100 rating to an hourly basis (conversion factor).

(6) To calculate Q, the useful thermal energy produced by small thermal sources using solar technologies, the source shall compute the product of R, t and the result of 1 minus L, and divide the result by the product of h and 1,000, as in the formula below:

$$Q = [R * t * (1 - L)] / (h * 1{,}000)$$

(i) Calculation of useful thermal energy produced by small thermal sources using geothermal technologies.

(1) "Q" means thermal energy generated, stated in Btu's.

(2) "HC" means the Air Conditioning, Heating and Refrigeration Institute (AHRI) certified heating capacity at part load, stated in Btu's per hour.

(3) "COP" means the AHRI Certified Coefficient of Performance.

(4) "t" means total operating run time of the pump when the entering water temperature is greater than the leaving water temperature, stated in hours.

(5) Small thermal sources using geothermal technologies may calculate Q, the useful thermal energy produced, by multiplying HC by the difference between COP and 1, multiplying the result by t, and dividing the result by COP, as in the formula below:

$$Q = [HC * (COP - 1) * t] / COP$$

(j) Calculation of useful thermal energy produced by small thermal sources using thermal biomass renewable energy technologies.

(1) "Q" means the thermal energy generated, stated in Btu's.

(2) "D" means the default pellet density, which shall be 0.0231 pounds per cubic inch.

(3) "R" means the auger revolutions per hour.

(4) "V" means auger feed volume, stated in cubic inches per auger revolution. Small thermal sources shall assume that V equals one of the following:

a. 5 cubic inches per revolution for augers with a 2" inside diameter;

b. 20 cubic inches per revolution for augers with a 3" inside diameter;

c. 50 cubic inches per revolution for augers with a 4" inside diameter;

d. 95 cubic inches per revolution for augers with a 5" inside diameter; or

e. 150 cubic inches per revolution for augers with a 6" inside diameter.

(5) "EC" means the default energy content of pellet fuel, which shall be 7870 Btu per pound.

(6) "ASE" means the default thermal efficiency expressed as a percentage based on the manufacturer's warranty of average seasonal thermal efficiency, or based on a default thermal efficiency of 65%.

(7) "t" means the total auger run time in hours as metered.

(8) The estimated amount of fuel burned (the product of D, R, V and t) shall be verified by the fuel purchase records and fuel inventory.

(9) Small thermal sources using thermal biomass renewable energy technologies with wood pellets as the fuel source may calculate Q, the useful thermal energy produced, by computing the product of D, R, V, EC, ASE and t, as in the formula below:

$$Q = (D * R * V * EC * ASE * t)$$

(k) Thermal sources using solar thermal technologies.

(1) "Q_g" means the heat generated in the collector loop, stated in Btu's.

(2) "dm/dt" means the mass flow of the collector working fluid measured near the inlet to the solar storage tank, stated in pounds per hour.

(3) "c_p" means the specific heat of the collector fluid, stated in Btu's per pound (mass), degrees Fahrenheit (BTU/lbm-°F).

(4) "Ti" means the collector loop inlet temperature measured near the outlet of the solar storage tank, stated in degrees Fahrenheit.

(5) "To" means the collector loop outlet temperature measured near the inlet to the solar storage tank, stated in degrees Fahrenheit.

(6) "t" means the frequency at which data readings are recorded, stated in hours.

(7) Meter sensors shall be installed on the collector loop as close to the water storage tank as practical and in accordance with the meter manufacturer's guidance.

(8) Thermal sources using solar thermal technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm/dt, c_p, the difference between To and Ti, and t, as stated in the formula below:

$$Q_g = (dm/dt)*c_p *(To - Ti) * t$$

(l) Thermal sources using geothermal technologies.

(1) "Q_g" means heat generated in the ground loop, stated in BTU's.

(2) "dm/dt" means mass flow measured near the outlet of the ground loop, stated in pounds per hour.

(3) "c_p" means specific heat of the working fluid, stated in BTU/lbm-°F.

(4) "t" means the frequency at which data readings are recorded, stated in hours.

(5) "Ti" means ground loop inlet temperature measured at the inlet to the ground loop, stated in degrees Fahrenheit.

(6) "To" means ground loop outlet temperature measured at the outlet from the ground loop, stated in degrees Fahrenheit.

(7) Bleed points, supplemental boilers and cooling towers shall be excluded from the calculation.

(8) Meter sensors shall be installed on the ground loop as close to the ground loop inlet and outlet as practical and in accordance with the manufacturer's recommendation.

(9) Thermal sources using geothermal technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm/dt, c_p, the difference between To and Ti, and t, as stated in the formula below:

$$Q_g = (dm/dt) * c_p * (To - Ti) * t$$

(m) Thermal sources using thermal biomass renewable energy technologies.

(1) "Q_g" means the thermal energy generated from biomass, stated in Btu.

(2) "dm_{out}/dt" means mass flow metered upstream of distribution and downstream of parasitic loads, stated in pounds per hour.

(3) "h_{out}" means the specific enthalpy at the metering point determined by temperature data and, for superheated steam, by pressure data, stated in Btu's per pound.

(4) "dm_{in}/dt" means mass flow of water into the feedwater or condensate pumps, stated in pounds per hour.

(5) "h_{in}" means the specific enthalpy at the metering point which will be a function of the enthalpy of incoming condensate and make-up water prior to the first condensate or feedwater pumps, stated in Btu's per pound.

(6) "t" means the frequency at which data readings are recorded, stated in hours.

(7) All metering systems shall measure boiler feedwater flow, pressure and temperature as close to the first feedwater pump inlet as possible, thereby excluding the deaerator.

(8) Metering for systems that produce hot water shall include sensors for temperature and hot water mass flow placed as close as possible to the boiler hot water distribution header inlet.

(9) Metering for systems that produce steam shall include sensors for temperature, pressure and steam flow placed as close as possible to the steam distribution header inlet and thereby prior to distribution to process loads.

(10) For saturated steam systems, pressure and temperature shall be measured to verify the absence of superheat at the measurement point.

(11) For superheated systems, both pressure and temperature measurements shall be required.

(12) Regardless of phase, the enthalpy under the measured conditions shall either be calculated using International Association for the Properties of Water and Steam (IAPWS) Industrial Formulation 1997 (IF97) formulas or taken from IAPWS or derivative steam tables.

(13) Thermal sources using thermal biomass renewable energy technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm_{out}/dt, (h_{out}), and t, and subtract from that number the product of dm_{in}/dt, h_{in} and t, as stated in the formula below:

$$Q_g = [dm_{out}/dt * (h_{out}) * t] - [dm_{in}/dt * (h_{in}) * t]$$

Puc 2506.05 Calculation of Certificates for Production of Useful Thermal Energy

(a) Sources producing useful thermal energy, the independent monitor or the designated representative shall report to GIS the useful thermal energy produced and the amount of RECs calculated pursuant to this part, as verified by the source's independent monitor.

(b) Useful thermal energy shall be expressed and reported in megawatt-hours where each 3,412,000 Btu's of useful thermal energy is equivalent to one megawatt-hour.

(c) Small thermal sources shall receive certificates based on the useful thermal energy produced as metered pursuant to Puc 2506.04(e) or (f) and discounted, as applicable, by the discount for meter accuracy pursuant to paragraph (e) or as calculated pursuant to Puc 2506.04(h), (i), or (j).

(d) Large thermal sources shall receive certificates based on the useful thermal energy calculated pursuant to Puc 2506.04(e) or (f), discounted by the sum of the percentage discount for meter accuracy pursuant to paragraph (e) and the percentage discount for operating energy and thermal storage losses, or parasitic load, pursuant to paragraph (f).

(e) The discount factor for meter accuracy referenced in paragraphs (c) and (d) shall be one of the following:

(1) If the meters used to measure useful thermal energy output comply with the accuracy of the European Standard EN 1434 as provided in Puc 2506.04(e)(1) or the accuracy pursuant to Puc 2506.04(f)(1), there shall be no meter accuracy discount; or

(2) If the meters used to measure useful thermal energy output do not comply with the accuracy of the European Standard EN 1434 as provided in Puc 2506.04(e)(1) or the accuracy pursuant to Puc 2506.04(f)(1), the applicable meter discount shall be the manufacturer's guaranteed accuracy of the meters used or the accuracy of the alternative method approved pursuant to Puc 2506.06.

(f) The discount factor for large thermal sources for parasitic load referenced in paragraph (d) shall be one of the following:

(1) For sources using solar thermal technology, the discount factor shall be 3.0% of the useful thermal energy produced as measured pursuant to Puc 2506.04;

(2) For sources using geothermal technology, the discount factor shall be 3.6% of the useful thermal energy produced as measured pursuant to Puc 2506.04;

(3) For sources using thermal biomass renewable energy technology, the discount factor shall be 2.0% of the useful thermal energy produced as measured pursuant to Puc 2506.04; or

(4) The discount factor shall be the source's actual metering of the parasitic load.

Puc 2506.06 Request for Alternative Method for Measuring Thermal Energy

(a) A source shall not use an alternative metering method until that alternative method is approved by the commission.

(b) A source seeking approval of an alternative method shall submit an application to the commission that includes the following information:

(1) The name, mailing address, daytime telephone number, and e-mail address of the person requesting approval for the alternative method;

(2) The name and location of the source at which the alternative method will be implemented;

(3) A description of the metering method otherwise required by these rules and the reasons it cannot be used with the applicant's facility;

(4) A description of the proposed alternative method;

(5) Technical data and information demonstrating that the accuracy of the method otherwise required by these rules will be substantially achieved by the proposed alternative method (such data and information may include third party data such as product test results from independent test laboratories, performance data based on nationally recognized product test/certification programs, published resource data for use in calculations, and examples of the use of the method by other organizations for similar purposes); and

(6) Certification by a professional engineer licensed by the state of New Hampshire and in good standing of the meter accuracy rate that will be achieved by the alternative metering method and that the proposed alternative method is technologically sound.

(a) Electricity generation in megawatt-hours and useful thermal energy expressed in megawatt-hours shall be measured and verified in accordance with ISO-NE and GIS operating rules and this Part.

(c) The commission shall approve an alternative metering method that satisfies the requirements of paragraph (b).

Fuel Source Plan

Narragansett Bay Commission Fuel Source Plan

For

Bucklin Point WWTF Biogas Engine CHP System

This document and its attachments provides a detailed description of the type of eligible biomass fuel to be used at the generation unit commonly referred to as the NBC Bucklin Point Biogas Engine CHP System. It also includes a description of how the unit will at times be co-fired with natural gas, the relative amounts of eligible and ineligible fuel will be measured and how the eligible portion will be calculated. This Fuel Source Plan describes measures that will be taken to ensure that the amount of fuel used, measured and reported as eligible is truly eligible.

Type of eligible biomass fuel to be used at the generation unit

The eligible fuel to be used by this combined heat and power (CHP) system will be renewable digester gas commonly called biogas that is produced by the NBC's anaerobic digester. The digester was installed in the 1950s as part of the municipal wastewater treatment facility (WWTF) that was constructed at Bucklin Point in East Providence. The WWTF provides sewage collection and treatment to over 100,000 people in the Pawtucket, Central Falls, Lincoln and Cumberland and Rumford, RI. The sewage sludge that is continuously produced by the WWTF is fed into the mesophilic complete-mix digester. The digestion process reduces the amount of sewage solids that the WWTF needs to ship offsite.

Over several days in the digester, a portion of the sludge is biologically converted into biogas which is a mixture comprised mostly of methane (about 61% by volume) and carbon dioxide (about 39% by volume). The biogas will typically contain relatively low amounts of hydrogen sulfide, water and siloxane that can be removed to help improve CHP system performance. The composition of the raw biogas before its cleaned is shown in the attached summary table of results.

The biogas will be used to make renewable heat and electricity. The carbon dioxide emissions from combusting biogas are considered biogenic. At times it may be necessary to waste some of the biogas to the flare or radiator.

How the generation unit will be co-fired with biogas and natural gas

NBC's biogas engine CHP system will generate heat and electricity for the WWTF to use. The project is designed to utilize practically all of the biogas produced and to co-fire using natural gas (an ineligible fuel) only when needed. For example, when biogas production is less than the engine needs, some utility supplied natural gas will be automatically blended with the biogas (based on measured pressures) so that the engine can operate at the full capacity it was designed for.

The amount of eligible and ineligible fuels fed into the engine will be measured by revenue grade meters. The BTU content of the biogas will be measured at least monthly with a Lantec portable

methane content meter. The Btu content of natural gas will be determined from information provided by National Grid. The biogas flow meter will be an ultrasonic type meter. The natural gas flow meter will be a thermal mass type meter. The net power output from the engine will be measured by an ANSI approved meter. The useful heat produced by the system will be measured by an EN 1434 approved BTU meter. Specifications for these meters are attached.

The portion of the energy fed to the engine that came from eligible fuel will be calculated for each month. The calculation will be based on the flow and energy content of eligible and ineligible fuels used by the engine. The portion of the engine's output energy that is eligible will be considered equal to the portion of the engine's input that is eligible. An example spreadsheet showing calculations and data on a 15-minute, monthly, quarterly and annual basis is attached.

Measures to ensure the amount of eligible fuel measured is eligible

The sludge fed to the digester is largely made up of human waste and waste activated sludge (beneficial bacteria used to treat the wastewater). These materials are considered to originate from non-fossil (biogenic) sources and the energy they produced is considered eligible as a renewable energy resource. The digester feed is considered to be one of the WWTF's treatment streams.

Fossil based fuel materials are not allowed to enter the WWTF or digester. The NBC Pretreatment Program prevents fossil fuels from entering the sewer collection system and WWTF. Fossil fuel based materials also prohibited from entering treatment streams at the facility because these substances are strictly limited in the final effluent by the RI Department of Environmental Management. For these reasons, essentially all biogas leaving the digester and entering the engine can be considered to originate from non-fossil based sources.

Fuel Source Plan Attachments

Anaerobic Digester Gas Analytical Summary

Model SFGLD 360 Power Rating

Spreadsheet for Reporting Electricity and Heat Generation

Meter A – Biogas Meter

Meter B – Methane Content Meter

Meter C – Natural Gas Meter

Meter D – Net Power Meter

Meter E – BTU Meter

RIDEM Minor Air Source Permit Approval No. 2337

Heat & Mass Balance

Item From Checklist on Page 9	Satisfied by Fuel Source Plan Attachment Entitled:
1-6	Minor Air Source Approval No. 2337
1-11	Meter E - BTU Meter
3-1 and 3-4	Meter Specifdications A - E and SFGLD 360 Power Rating
3-5b	Heat and Mass Balance

Anaerobic Digester Biogas Analytical Summary

VOC	ppb
Per Method EPA TO-15 and ALS 102	
Acetic Acid	24.00
Propene	630.00
n-Pentane	1,863.92
Trimethylsilanol	134.19
2,4,4-Trimethyl-1-pentene	191.75
1-Decene	148.61
n-Decane	126.02
2,2,4,6,6-Pentamethylheptane	157.90
2,2,11,11-Tetramethyldodecane	58.40
2,7,10-Trimethyldodecane	105.52
2,2,5-Trimethylhexane	85.63
3-Methyldodecane	76.59
n-Tridecane	75.38
Decamethylcyclopentasiloxane	193.45
n-Dodecane	80.27
2,6-Dimethylundecane	110.63
cis-1,2-Dichloroethene	49.00
n-Hexane	320.00
Benzene	16.00
Trichloroethene	18.00
n-Heptane	580.00
Toluene	820.00
n-Octane	820.00
Tetrachloroethene	11.00
Ethylbenzene	50.00
m,p-Xylenes	29.00
o-Xylene	7.30
n-Nonane	71.00
Cumene	7.40
alpha-Pinene	180.00
1,2,4-Trimethylbenzene	6.60
d-Limonene	140.00
Sulfur Dioxide	1,084.56
Total	8,272.11

Analytical results reflect biogas production from two of the three primary digesters operating for the past several months while one is down for maintenance.

Siloxanes	ppm
Per Method ALS 112	
D4 (Octamethylcyclotetrasiloxane)	0.6
D5 (Decamthylcyclopentasiloxane)	1.44
D6 (Dodecamethylcyclohexasiloxane)	0.09
Trimethylsilanol	0.12
Hexamethyldisiloxane (L2)	0.01
Hexamethylcyclotrisiloxane (D3)	0.01
Octamethyltrisiloxane (L3)	0.02
Decamethyltetrasiloxane (L4)	0.01
Dodecamethylpentasiloxane (L5)	0.01
Total	2.31
Field Testing using Drager Tubes	
Hydrogen Sulfide	180
Ammomnia	<1
Amines	<0.5
Formaldehyde	<0.1
Hydrogen Sulfide	110
Per Method ASTM D 5504-12	
Composition	
Per Method ASTM D3588-98	
Methane	61.44%
Carbon Dioxide	37.90%
Nitrogen	0.54%
Oxygen	0.10%
BTU (LHV as Dry Gas)	560.6 BTU/SCF

Biogas samples were taken from Bucklin Point Wastewater Treatment Facility on 4/5/17 using a Silonite canister and sorbent tubes. Samples were sent to ALS for analysis by gas chromatography and mass spectrometry, methods are listed above. Analyses were processed to assess biogas content in anticipation of the installation of the CHP, (combined heat and power or cogeneration) . The CHP will utilize the biogas to fuel a recriprocating engine for the production of electricity and useful heat, at high efficiency. Biogas consists primarily of methane and carbon dioxide, but also contains contaminants including sulphur and siloxanes. Contaminants will need to be monitored as a preventative maintenance for the CHP. Parameters such as methane and LHV will need to be reported to the RIPUC on the Quarterly Fuel Eligibility Filing Form for eligibility of Renewable Energy Credits.

Model SFGLD 360 Power Rating

DRESSER-RAND.	GROUP	GAS	PRODUCT INFORMATION	INDEX
	IC		IC-G-B-36-161	B1
	POWER RATING		DATE	26/08/14
			DEP.	2

GENSET:	SFGLD 360	SPEED:	1800
JACKET WATER TEMPERATURE(°F):	194	FUEL TYPE:	SEWAGE GAS
INTERCOOLER WATER TEMP(°F):	131		

APPLICATION:		CONTINUOUS	COMPRESSION RATIO:		11,6:1
COOLING SYSTEM:		TWO CIRCUITS TWO STAGE IC	REGULATION:		Electronic
			IGNITION TIMING:		20º
EXHAUST MANIFOLD TYPE:		WATER COOLED	MAX. BACK PRESSURE:		18 "H2O (450 mmH2O)
EMISSIONS:			AMBIENT CONDITIONS ISO 3046/1:		
NOX	g/bHPh	0,5	Atmospheric pressure ("Hg (kPa))=		30 (100)
CO	g/bHPh	<1,8	Ambient temperature (°F (°C))=		77 (25)
NMHC	g/bHPh	<0,7	Relative humidity (%)=		30

POWER RATING (4)			NOMINAL	PARTIAL LOADS		
LOAD		%	100%	80%	60%	40%
MECHANICAL POWER	(3, 4, 5)	BHP (KWb)	893 (666)	713 (532)	536 (400)	357 (266)
BMEP		psi (bar)	178 (12.3)	144 (9.9)	107 (7.4)	71 (4.9)
ELECTRICAL POWER (cosϕ 1)		kWe	644	514	384	253
ELECTRICAL POWER (cosϕ 0,8)		kWe	637	509	381	251
FUEL CONSUMPTION	(1)	BTU/bHP-hr (KW)	6794 (1778)	7054 (1474)	7480 (1175)	8306 (869)
MECHANICAL EFFICIENCY		%	37.5	36.1	34.0	30.6
ELECTRICAL EFFICIENCY (cosϕ 1)		%	36.2	34.9	32.7	29.1
HEAT IN MAIN WATER CIRCUIT	(1)	BTU/min (KW)	27920 (491)	23660 (416)	19560 (344)	15980 (281)
HEAT IN SECONDARY WATER CIRCUIT	(1)	BTU/min (KW)	6711 (118)	6028 (106)	5403 (95)	4265 (75)
HEAT IN CHARGE COOLER	(1)	BTU/min (KW)	2559 (45)	2161 (38)	1820 (32)	853 (15)
HEAT IN OIL COOLER	(1)	BTU/min (KW)	4151 (73)	3867 (68)	3583 (63)	3412 (60)
HEAT IN EXHAUST GASES (25 ºC)	(1)	BTU/min (KW)	26780 (471)	22410 (394)	17970 (316)	13250 (233)
HEAT IN EXHAUST GASES (120ºC)	(1)	BTU/min (KW)	19930 (350)	16850 (296)	13630 (240)	10140 (178)
EXHAUST GAS TEMPERATURE	(1)	°F (°C)	747 (397)	765 (407)	784 (418)	802 (428)
HEAT TO RADIATION	(1)	BTU/min (KW)	1820 (32)	1479 (26)	1137 (20)	796 (14)
CARBURETION SETTINGS (2)						
O2 TO EXHAUST(DRY)(ONLY A REFERENCE)		%	8.5	8.3	8.1	7.8
MASS FLOWS						
INTAKE AIR FLOW	(1)	lb/h (Kg/h)	8000 (3630)	6520 (2960)	5070 (2300)	3640 (1650)
EXHAUST GAS FLOW (WET)	(1)	lb/h (Kg/h)	8720 (3960)	7110 (3230)	5540 (2520)	3990 (1810)

NOTES:

1. 100% LOAD TOLERANCES:
   FUEL CONSUMPTION +5%,
   COOLING CIRCUIT AND EXHAUST GASES ±8%, RADIATION ±25%
   EXHAUST TEMPERATURE ±36°F (20°C), MASS FLOWS ± 10%.
2. THE ENGINE PERFORMANCE DATA, TIMING ADVANCE AND CARBURETION SETTINGS ARE VALID FOR A GAS
   THAT FULFILS THE REQUIREMENTS DEFINED IN IC-G-D-30-001e AND IC-G-D-30-003e. HEAT BALANCE FOR A REFERENCE GAS: CH4 62.5%, CO2 36%, N2 1,5%
3. NET POWER, MECHANICAL PUMPS NOT INCLUDED.
4. POWERS ARE VALID FOR AMBIENT TEMP.=77 ºF (25 ºC) AND AN ALTITUDE OF =1640 ft (500 m). SEE OTHER CONDITIONS IN PI IC-G-B-00-001
5. OVERLOAD NOT ALLOWED
6. THE SPECIFICATIONS AND MATERIALS ARE SUBJECT TO CHANGE WITHOUT NOTIFICATION
7. A ENGINE WITH INLET OR OUTPUT RESTRICTION OVER PUBLISHED LIMITS, OR WITH INADEQUATE MAINTENANCE OR INSTALLATION
   CAN MODIFY POWER RATING DATA.
8. EMISSIONS
9. ALTERNATOR VOLTAGE 440 V
10. ONLY IN PARALLEL TO THE NET OPERATION

Spreadsheet for Reporting Electricity and Heat Generation

Annual, Quarterly and Monthy Reporting of Electricity and Heat Generation from Anaerobic Digester Gas Operations

Narragansett Bay Commission

Site: Bucklin Point Wastewater Treatment Facility, 102 Campbell Avenue, Rumford, RI 02916

2018	ADG* To Engine (1,000 scf)1	ADG LHV** (Btu/scf)2	Natural Gas To Engine (1,000 scf)3	Natrual Gas LLV (Btu/scf)4	Portion of Input Fuel Renewable	Net Electricity Generated (MWh)5	Net Renewable Electricity Generated (MWh)	Heat Recovered (MMBtu)6	Renewable Heat Recovered (MMBtu)	Comments
January-18										
February-18										
March-18										
April-18										
May-18	8.800	561	1.200	1,028	80.0%	423	339	1,861	1,489	Heat from cleaned biogas fed to boilers not metered
June-18										
July-18										
August-18										
September-18										
October-18										
November-18										
December-18										

* ADG = Anaerobic Digester Gas

** LLV = Lower Heating Value

Notes referenceing Fuel Source Plan Attachments:

1) From average 15-minute SCADA data from ADG meter "A"
2) From quarterly measurements from portable Landtec GA5000 meter "B"
3) From average of 15-minute SCADA data from Natural Gas meter "C"
4) From information provided National Grid
5) From average of 15-minute SCADA data for net electric meter "D"
6) From average 15-minute SCADA data from BTU meter "E"

Conversion Factors

1 Wh =	3.41496 Btu
1 MWh =	3.41496 MMBtu

Quarterly filing example for all potential and independent energy credits:

Quarter	Date Quarter Ends	Date RIPUC filings are due	RECs (MWh)	TRECs (MWh)
Quarter 1	31-Mar	30-May	0	0
Quarter 2	30-Jun	29-Aug	339	436
Quarter 3	30-Sep	29-Nov	0	0
Quarter 4	31-Dec	1-Mar	0	0

Meter A - Biogas Meter

Specifications & Diagram

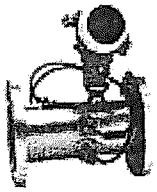
Data Sheet

Endress+Hauser
People for Process Automation

Applicator Sizing - Condensed (Flow)

Project

Project	NBC Bucklin Point
C.Project No.	
Customer:	BioSpark LLC
TAG	FT100.1
Timestamp	---
Review number	---
Sales order number	
Contact person	Tom Moore
eMail:	
Phone	9786210421
Fax	



General Parameters

Fluid	Bio Gas-60%CH4,40%CO2 (Gas)
State	Gas
Character	Clean
Abrasivity	Not abrasive
Fluid Group (PED)	Dangerous Fluid (Fluid group 1)
Fluid Type	Newtonian
Ref. Temperature	59 °F
Ref. Pressure	14.696 psi_a
Atmospheric Pressure	1.0132 bar_a
Standard	ASME/(ANSI)

Operating Conditions

	minimum	nominal	maximum	
Requested Flow	40	170	200	SCFM
Pressure		2.5		psi_g
Temperature		90		°F
Density		1.2752		kg/m3
Viscosity		0.01349		cP
Z-factor		0.9971		
Sound velocity		346.6		m/s
Pressure (min/max)	2.5		2.5	psi_g
Temp. (min/max)	90		90	°F

Flowmeter

Flowmeter	Prosonic Flow B 200
Flow Principle	Ultrasonic Flow (Prosonic Flow)
Extended order code	9B2B80-*******A14*+WA
Meter Size	3"
Operating range min.	3.973 SCFM
Operating range max.	397.277 SCFM
Material (sensor) *	SS 1.4404 / 316L
Process connection*	Cl 150 ASME B16.5, 316L lap joint flange
PED category ** :	Application is Cat. I

Operating Conditions

	minimum	nominal	maximum	
Requested Flow	40	170	200	SCFM
Velocity	3.021	12.84	15.1	m/s
Pressure loss	0	0	0	in.H2O@68°F
Measured error Vol.***	1.5	1.5	1.5	%
Measured error Spec. Volume***	1.5	1.5	1.5	%
Reynolds No.	24 243	103 032	121 215	

*The user is responsible for the selection of process-wetted materials in view of their corrosion resistance. Endress+Hauser makes no guarantees and assumes no liability for the corrosion resistance of the materials selected here for the application described above.

** The PED category is an Endress+Hauser recommendation and depends on the fluid category, process data as well from the max. permissible pressure of the selected pressure rating.The fluids of the Applicator data base are classified to 67/548/EWG.

***For error calculation, the specified reference conditions for the calibration of the flowmeter according to ISO/IEC 17025 apply. Further information in technical documentation.

Applicator Sizing - Flow

Project : NBC Bucklin Point

Customer:	BioSpark LLC			C.Project No.:	
Contact person:	Tom Moore	Phone:	9786210421	Fax:	
		eMail:			

TAG : FT100.1

Timestamp:	—	Review number:	—
Sales order number:			

Fluid properties sheet

Fluid

Fluid name	Bio Gas-60%CH4,40%CO2 (Gas)	State	Gas
Chemical formula	60%CH4, 40%CO2	Calculation standard	NEL

Fluid description

Medium character	Clean
Fluid group (PED)	Dangerous Fluid (Fluid group 1)
Fluid Type	Newtonian
Fluid stability	Stable

Gas mixture			Fraction	
Component				
1	Carbon dioxide (Gas)	40 Mole%	64.76	Mass%
2	Methane (Gas)	60 Mole%	35.24	Mass%
3		0 Mole%	0	Mass%
4		0 Mole%	0	Mass%
5		0 Mole%	0	Mass%
6		0 Mole%	0	Mass%
7		0 Mole%	0	Mass%
8		0 Mole%	0	Mass%

Basic fluid parameters

Tc (Critical temperature)	-42.26 °F	Tm (Melting point)	n.a. °F
Pc (Critical pressure)	813.209 psi	Tb (Boiling point)	n.a. °F
Rho_c (Critical density)	280.4 kg/m3		

Calculated results

Density nom.	1.2752 kg/m3	Pressure nom.	2.5 psi_g
Molar mass	27.23 kg/kmol	Temperature nom.	90 °F
Z-factor nom.	0.9971		
Viscosity nom.	0.01349 cP		
Sound velocity nom.	346.6 m/s		
Thermal capacity nom.	1.351 kJ/(kg*K)		
Heat conductivity nom.	0.028 W/(m K)		
Rel. humidity nom.	0 %		

Reference values:	Normal conditions (SI):	Standard conditions (US):	
Atmospheric pressure	1.0132 bar_a	Atmospheric pressure	1.0132 bar_a
Density normal	1.2193 kg/m3	Density standard	1.1551 kg/m3
Temperature	0 °C	Temperature	59 °F
Pressure	1.0132 bar_a	Pressure	14.696 psi_a

Applicator Sizing - Flow

Project : NBC Bucklin Point

Customer:	BioSpark LLC			C.Project No.:	
Contact person:	Tom Moore	Phone:	9786210421	Fax:	
		eMail:			

TAG : FT100.1

Timestamp:	---	Review number:	---
Sales order number:			

Tri-Size Sheet

General Parameters

Fluid	Bio Gas-60%CH4,40%CO2 (Gas)	Ref. Temperature	59 °F
State	Gas	Ref. Pressure	14.696 psi_a
Character	Clean	Atmospheric Pressure	1.0132 bar_a
Abrasivity	Not abrasive	Standard	ASME/(ANSI)
Fluid Group (PED)	Dangerous Fluid (Fluid group 1)		
Fluid Type	Newtonian		

Sizing and Calculated Results

	Next Smaller Size	Current Size	Next Bigger Size	
Flow meter	Prosonic Flow B 200	Prosonic Flow B 200	Prosonic Flow B 200	
Flow Principle	Ultrasonic Flow (Prosonic Flow)	Ultrasonic Flow (Prosonic Flow)	Ultrasonic Flow (Prosonic Flow)	
Meter Size	2"	3"	4"	
Process connection*	Cl 150 ASME B16.5, 316L	Cl 150 ASME B16.5, 316L	Cl 150 ASME B16.5, 316L	
Operating range min.	1.747	3.973	6.705	SCFM
Operating range max.	174.701	397.277	670.546	SCFM
Velocity at req. Flow min.	6.869	3.021	1.79	m/s
Velocity at req. Flow nom.	29.19	12.84	7.606	m/s
Velocity at req. Flow max.	34.34	15.1	8.948	m/s
Pressure loss at req. Flow min.	0	0	0	in.H2O@68°F
Pressure loss at req. Flow nom.	0	0	0	in.H2O@68°F
Pressure loss at req. Flow max.	0	0	0	in.H2O@68°F
Meas. error Vol. at req. Flow min.***	1.5	1.5	3	%
Meas. error Vol. at req. Flow nom.***	1.5	1.5	1.5	%
Meas. error Vol. at req. Flow max.***	n.a.	1.5	1.5	%
Meas. error Spec. Vol. at req. Flow min.***	1.5	1.5	1.5	%
Meas. error Spec. Vol. at req. Flow nom.***	1.5	1.5	1.5	%
Meas. error Spec. Vol. at req. Flow max.***	n.a.	1.5	1.5	%
Reynolds No.	155 372	103 032	79 306	
Warnings	1. Requested max. flow too big for flowmeter range. Please adapt the max. flow or select a bigger size (if available) or select another flowmeter.			

*The user is responsible for the selection of process-wetted materials in view of their corrosion resistance. Endress+Hauser makes no guarantees and assumes no liability for the corrosion resistance of the materials selected here for the application described above.

***For error calculation, the specified reference conditions for the calibration of the flowmeter according to ISO/IEC 17025 apply. Further information in technical documentation.

Applicator Sizing - Flow

Project : NBC Bucklin Point

Customer:	BioSpark LLC			C.Project No.:	
Contact person:	Tom Moore	Phone:	9786210421	Fax:	
		eMail:			

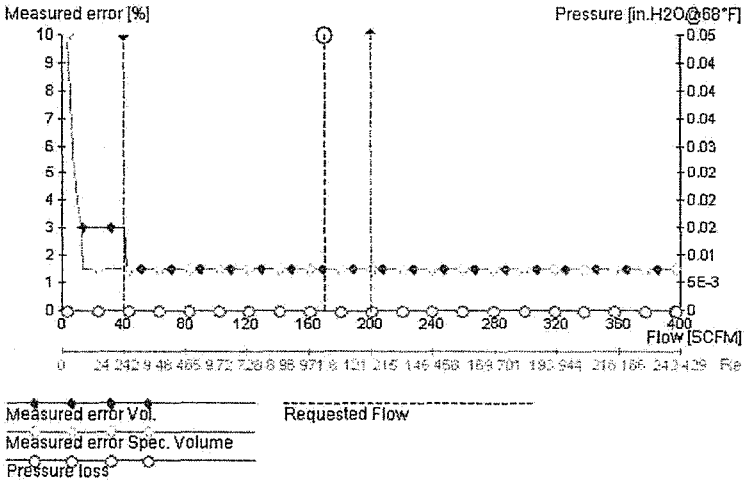
TAG : FT100.1

Timestamp:	—	Review number:	—
Sales order number:			

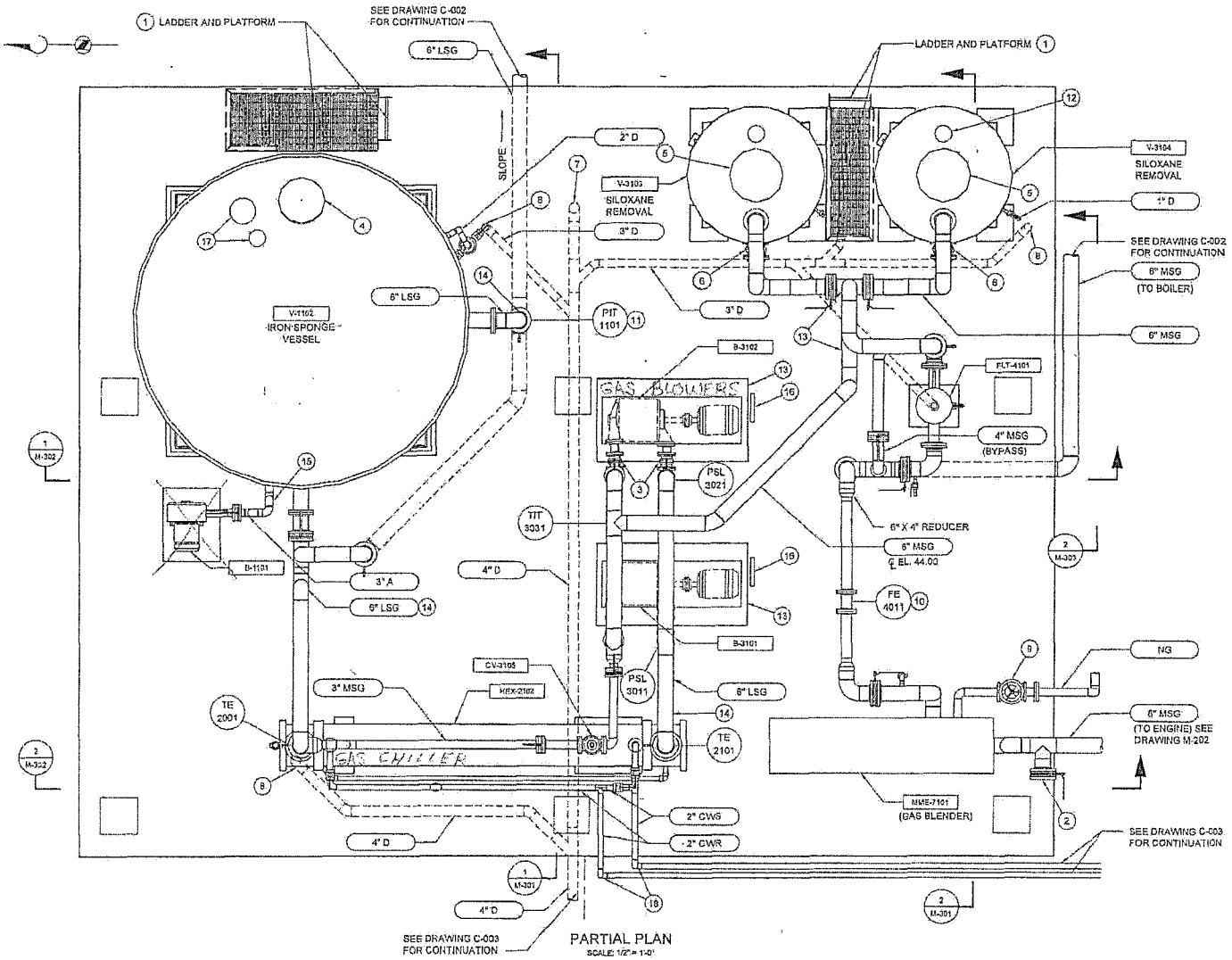
Chart Sheet

Flowmeter: Prosonic Flow B 200

Flow Principle	Ultrasonic Flow (Prosonic Flow)	Fluid	Bio Gas-60%CH4,40%CO2 (Gas)
Meter Size	3"	Pressure	2.5 psi_g
Operating range min.	3.973 SCFM	Temperature	90 °F
Operating range max.	397.277 SCFM	Density	1.2752 kg/m3
		Viscosity	0.01349 cP



***For error calculation, the specified reference conditions for the calibration of the flowmeter according to ISO/IEC 17025 apply. Further information in technical documentation.



GENERAL NOTES:

A. V3103 AND V3104 LAYOUT BASED ON ONE MANUFACTURERS EQUIPMENT. MODIFY LAYOUT BUT PROVIDE CONNECTIVITY SHOWN AS APPLICABLE TO SELECTED MANUFACTURER.

B. CONTRACTOR'S DESIGN PROFESSIONAL SHALL DESIGN PIPE SUPPORTS AND EXPANSION COMPENSATION PER SECTIONS 15050, 15090 AND 15099.

C. B-3101 AND B-3102 HERMETICALLY ENCLOSED PER SECTION 11465.

D. GAS BLENDER PIPING CONNECTIONS MAY VARY BY MANUFACTURER. MODIFY LAYOUT BUT PROVIDE CONNECTIVITY SHOWN AS APPLICABLE TO MANUFACTURER.

KEY NOTES:

1. ACCESS LADDER, RAILING AND PLATFORM PROVIDED BY TANK MANUFACTURER.
2. 6" CONNECTION WITH BLIND FLANGE FOR FUTURE ENGINE.
3. 3" FLEXIBLE CONNECTOR, (TYP.) SUCTION AND DISCHARGE.
4. 12" INSPECTION HATCH.
5. 20" ACCESS MANWAY.
6. 6" FLEXIBLE CONNECTOR.
7. CLEANOUT DETAIL C/M-102.
8. TYPE 1 EQUIPMENT DRAIN. SEE M-102.
9. NG PIPING, REGULATOR AND METER BY UTILITY. FINAL CONNECTION TO MME-7101 BY CONTRACTOR.
10. 40" MINIMUM STRAIGHT RUN UPSTREAM AND 20" DOWNSTREAM OF FLOW METER.
11. LOCATE 4' AFF.
12. PRESSURE RELIEF VALVE PROVIDED BY SILOXANE REMOVAL SYSTEM MANUFACTURER. SEE SECTION 11561.
13. REFER TO A/M102 FOR EQUIPMENT MOUNTING.
14. 1/2" SAMPLE TAP ON TOP OR SIDE OF PIPE.
15. BAROMETRIC LOOP TO PREVENT WATER BACKFLOW.
16. BLOWER E-STOP.
17. PRESSURE RELIEF VALVE AND HOSE CONNECTION PROVIDED BY IRON SPONGE MANUFACTURER. SEE SECTION 13578.
18. TRANSITION TO INSULATED UNDERGROUND PIPING PER SECTION 15255.

Brown AND Caldwell
ANDOVER, MASSACHUSETTS

SUBMITTED: _____ DATE: _____
APPROVED: _____ DATE: _____

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" LEGALE ACCORDINGLY)
DESIGNED: —
DRAWN: —
CHECKED: —
CHECKED: —
APPROVED: —

EXTERNAL REFERENCE FILES

REVISIONS					
ZONE	REV.	DESCRIPTION	BY	DATE	APP.

Narragansett Bay Commission

BIOGAS COGENERATION SYSTEM BUCKLIN POINT WWTF

MECHANICAL

GAS CONDITIONING PLAN

FILENAME 140033-M-201.dwg
DC PROJECT NUMBER 140033
CLIENT PROJECT NUMBER 13-120.000
DRAWING NUMBER M-201
SHEET NUMBER 18 OF 72

Meter B - Methane Content Meter

Specifications

LANDTEC
QED

GA5000

PORTABLE GAS ANALYZER INSTRUMENTATION

WWW.LANDTECNA.COM

- EASY TO USE AND CALIBRATE
- CAPABLE OF MONITORING UP TO SIX GASES
- MEASURES AND STORES FLOW READINGS, RELATIVE PRESSURE, TEMPERATURE AND MORE
- UPGRADABLE WITH INTERNAL, LOW-FLOW OPTION

PORTABLE GAS ANALYZER FOR LANDFILLS AND CONTAMINATED LAND

The GA5000 is our landfill and contaminated land portable gas analyzer, with available gas measurements of CH_4, CO_2, O_2, H_2S and CO. It's easy to use and calibrate and will help standardize your monitoring routines while supporting environmental compliance.

INFO@QEDENV.COM

800-LANDTEC

QED ENVIRONMENTAL
2355 Bishop Circle West
Dexter, MI 48130, USA

LANDTEC
QED

GA5000

PORTABLE GAS ANALYZER INSTRUMENTATION

FEATURES

- Measures % CH4, CO2 and O2
- Measures barometric pressure, relative pressure and temperature
- Modular and upgradeable
- Up to six gases monitored
- Simultaneous display of all gases
- Peak and previous readings shown
- Adaptable to low flow measurement

APPLICATIONS

- Landfill Gas Monitoring
- Waste to Energy
- Site Investigation
- Contaminated Land

KEY BENEFITS

- Easy to use and calibrate
- Industry leading reliability
- Standardizes monitoring routines
- Supports environmental compliance
- Easy transfer of data

TECHNICAL SPECIFICATION

GAS RANGES

Gases Measured	CH_4	By dual wavelength infrared cell with reference channel	Standard
	CO_2	By dual wavelength infrared cell with reference channel	Standard
	O_2	By internal electrochemical sensor	Standard
	CO	By internal electrochemical sensor	Optional
	H_2S	By internal electrochemical sensor	Optional
	NH3	By internal electrochemical sensor	Optional
	H2	By internal electrochemical sensor	Optional
	CO (H_2 Comp)**	By internal electrochemical sensor	Optional

Ranges	CH_4	0-100% (vol)	
	CO_2	0-100% (vol)	
	O_2	0-25% (vol)	
	CO	0-2,000ppm***	
	CO (H_2 Comp)**	0-2,000ppm***	
	H_2S	0-10,000ppm***	
	NH3	0-1000ppm	
	H2	0-1000ppm	
Gas Accuracy*	CO_2	0-60%: +/-0.5% (vol)	60-100%: +/- 1.5% (vol)
	CH_4	0-70%: +/-0.5% (vol)	70-100%: +/-1.5% (vol)
	O_2	0-25%: +/-1.0% (vol)	
	CO	+/- 2.0% FS	
	CO(H_2)**	+/- 1.0% FS	
	H_2S	+/- 5.0% FS	
	NH3	+/- 10.0% FS	
	H2	+/- 2.5% FS	

*All typical accuracies quoted are after calibration
**Hydrogen cross gas effect on carbon monoxide approximately 1% Do not use where hydrogen is in excess of 10,000ppm
***Additional ranges available. Contact LANDTEC for more information

POWER SUPPLY

Battery Life	Typical use 8 hours from fully charged
Charge Time	Approximately 4 hours from complete discharge

PUMP

Flow	Typically 550cc/min
Flow with 80 in. H2O vacuum	Approximately 80cc/min
Low Flow Range	0-0.0117cfm
Accuracy	+/- .0001cfm

SWANA MEMBER ISWA International Solid Waste Association

BSI Ex IECEx SIRA C US

WWW.LANDTECNA.COM

#2386 REV 1 4-17

INFO@QEDENV.COM
800-LANDTEC
QED ENVIRONMENTAL
2355 Bishop Circle West
Dexter, MI 48130, USA

Meter C - Natural Gas Meter

Specifications & Diagrams

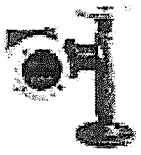
Data Sheet

Endress+Hauser
People for Process Automation

Applicator Sizing - Condensed (Flow)

Project

Project	NBC Bucklin Point
C.Project No.	
Customer:	BioSpark LLC
TAG	FT101.1
Timestamp	---
Review number	---
Sales order number	
Contact person	Tom Moore
eMail:	
Phone	9786210421
Fax	



General Parameters

Fluid	Natural Gas (Gas)
State	Gas
Character	Clean
Abrasivity	Not abrasive
Fluid Group (PED)	Dangerous Fluid (Fluid group 1)
Fluid Type	Newtonian
Ref. Temperature	59 °F
Ref. Pressure	14.696 psi_a
Atmospheric Pressure	1.0132 bar_a
Standard	ASME/(ANSI)

Operating Conditions

	minimum	nominal	maximum	
Requested Flow	10	100	160	SCFM
Pressure		5		psi_g
Temperature		60		°F
Density		0.9795		kg/m3
Viscosity		0.01088		cP
Z-factor		0.9971		
Sound velocity		423.3		m/s
Pressure (min/max)	5		5	psi_g
Temp. (min/max)	60		60	°F

Flowmeter

Flowmeter	t-mass 65F
Flow Principle	Thermal (t-mass)
Extended order code	65F50-AK**G1
Meter Size	2"
Operating range min.	2.779 SCFM
Calibrated Flow	277.932 SCFM

Operating Conditions

	minimum	nominal	maximum	
Requested Flow	10	100	160	SCFM
Velocity	1.854	18.54	29.67	m/s
Pressure loss	0	0.01	0.01	psi
Measured error	4.17	1.5	1.5	%
Mass***				
Reynolds No.	8 218	82 178	131 485	

Operating range max.	555.864 SCFM
Material (sensor) *	SS 1.4404 / 316L
Process connection*	Cl 150 ASME, 316L/1.4404 ASME B16.5 flange
PED category ** :	Application is Cat. I

*The user is responsible for the selection of process-wetted materials in view of their corrosion resistance. Endress+Hauser makes no guarantees and assumes no liability for the corrosion resistance of the materials selected here for the application described above.

** The PED category is an Endress+Hauser recommendation and depends on the fluid category, process data as well from the max. permissible pressure of the selected pressure rating.The fluids of the Applicator data base are classified to 67/548/EWG.

***For error calculation, the specified reference conditions for the calibration of the flowmeter according to ISO/IEC 17025 apply. Further information in technical documentation.

Applicator Sizing - Flow

Project : NBC Bucklin Point

Customer:	BioSpark LLC			C.Project No.:	
Contact person:	Tom Moore	Phone:	9786210421	Fax:	
		eMail:			

TAG : FT101.1

Timestamp:	—	Review number:	—
Sales order number:			

Fluid properties sheet

Fluid

Fluid name	Natural Gas (Gas)	State	Gas
Chemical formula	93%CH4, 3%C2H6, 2%C3H8, 2%N2	Calculation standard	NEL

Fluid description

Medium character	Clean
Fluid group (PED)	Dangerous Fluid (Fluid group 1)
Fluid Type	Newtonian
Fluid stability	Stable

Gas mixture		Fraction
Component		
1 Nitrogen (Gas)	2 Mole%	3.23 Mass%
2 Methane (Gas)	93 Mole%	86.3 Mass%
3 Propane (Gas)	2 Mole%	5.21 Mass%
4 Ethane (Gas)	3 Mole%	5.26 Mass%
5	0 Mole%	0 Mass%
6	0 Mole%	0 Mass%
7	0 Mole%	0 Mass%
8	0 Mole%	0 Mass%

Basic fluid parameters

Tc (Critical temperature)	-104.7 °F	Tm (Melting point)	n.a. °F
Pc (Critical pressure)	669.112 psi	Tb (Boiling point)	n.a. °F
Rho_c (Critical density)	168.01 kg/m3		

Calculated results

Density nom.	0.9795 kg/m3	Pressure nom.	5 psi_g
Molar mass	17.264 kg/kmol	Temperature nom.	60 °F
Z-factor nom.	0.9971		
Viscosity nom.	0.01088 cP		
Sound velocity nom.	423.3 m/s		
Thermal capacity nom.	2.128 kJ/(kg*K)		
Heat conductivity nom.	0.032 W/(m K)		
Rel. humidity nom.	0 %		

Reference values: Normal conditions (SI):		Standard conditions (US):	
Atmospheric pressure	1.0132 bar_a	Atmospheric pressure	1.0132 bar_a
Density normal	0.7723 kg/m3	Density standard	0.7317 kg/m3
Temperature	0 °C	Temperature	59 °F
Pressure	1.0132 bar_a	Pressure	14.696 psi_a

Applicator Sizing - Flow

Project : NBC Bucklin Point

Customer:	BioSpark LLC			C.Project No.:	
Contact person:	Tom Moore	Phone:	9786210421	Fax:	
		eMail:			

TAG : FT101.1

Timestamp:	—	Review number:	—
Sales order number:			

Tri-Size Sheet

General Parameters

Fluid	Natural Gas (Gas)	Ref. Temperature	59 °F
State	Gas	Ref. Pressure	14.696 psi_a
Character	Clean	Atmospheric Pressure	1.0132 bar_a
Abrasivity	Not abrasive	Standard	ASME/(ANSI)
Fluid Group (PED)	Dangerous Fluid (Fluid group 1)		
Fluid Type	Newtonian		

Sizing and Calculated Results

	Next Smaller Size	Current Size	Next Bigger Size	
Flow meter	t-mass 65F	t-mass 65F	t-mass 65F	
Flow Principle	Thermal (t-mass)	Thermal (t-mass)	Thermal (t-mass)	
Meter Size	1 1/2"	2"	3"	
Process connection*	Cl 150 ASME, 316L/1.4404	Cl 150 ASME, 316L/1.4404	Cl 150 ASME, 316L/1.4404	
Operating range min.	1.695	2.779	6.534	SCFM
Calibrated Flow	169.508	277.932	653.375	SCFM
Operating range max.	339.016	555.864	1 306.75	SCFM
Velocity at req. Flow min.	3.092	1.854	0.751	m/s
Velocity at req. Flow nom.	30.92	18.54	7.513	m/s
Velocity at req. Flow max.	49.48	29.67	12.02	m/s
Pressure loss at req. Flow min.	0	0	0	psi
Pressure loss at req. Flow nom.	0.01	0.01	0	psi
Pressure loss at req. Flow max.	0.04	0.01	0	psi
Meas. error Mass at req. Flow min.***	2.54	4.17	9.8	%
Meas. error Mass at req. Flow nom.***	1.5	1.5	1.5	%
Meas. error Mass at req. Flow max.***	1.5	1.5	1.5	%
Reynolds No.	106 120	82 178	52 305	
Warnings				

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***For error calculation, the specified reference conditions for the calibration of the flowmeter according to ISO/IEC 17025 apply. Further information in technical documentation.

Applicator Sizing - Flow

Project : NBC Bucklin Point

Customer:	BioSpark LLC			C.Project No.:	
Contact person:	Tom Moore	Phone:	9786210421	Fax:	
		eMail:			

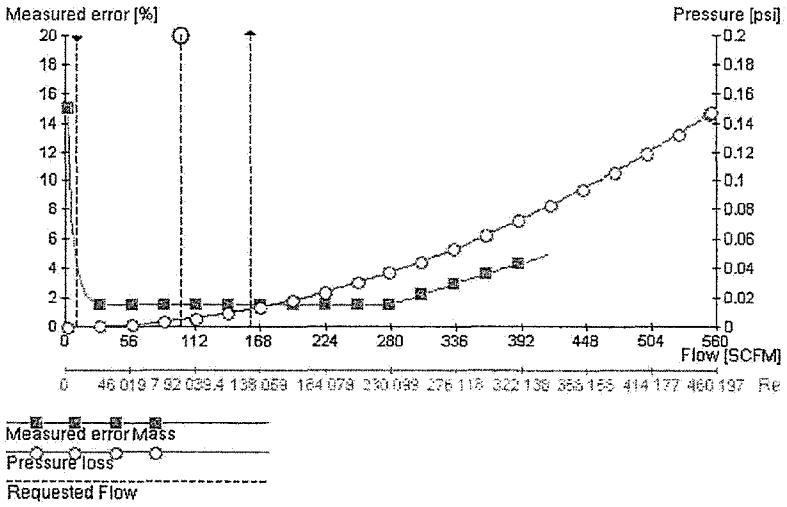
TAG : FT101.1

Timestamp:	—	Review number:	—
Sales order number:			

Chart Sheet

Flowmeter: t-mass 65F

Flow Principle	Thermal (t-mass)	Fluid	Natural Gas (Gas)
Meter Size	2"	Pressure	5 psi_g
Operating range min.	2.779 SCFM	Temperature	60 °F
Calibrated Flow	277.932 SCFM		
Operating range max.	555.864 SCFM	Density	0.9795 kg/m3
		Viscosity	0.01088 cP



***For error calculation, the specified reference conditions for the calibration of the flowmeter according to ISO/IEC 17025 apply. Further information in technical documentation.

11467 Natural Gas Blending System P&ID

Drawing	Function	Location	Revision	Date	Created by	Description	Folder designation
1	F1	L1	0	10/8/2015	G Marks	Title Page	
2	F1	L1	0	10/8/2015	G Marks	Drawing list	
3	F1	L1	0	10/8/2015	G Marks	LEGEND	
4	F1	L5	0	10/8/2015	G Marks	NATURAL GAS BLENDING SYSTEM P&ID	

DESIGN OFFICE
BIOSPARK LLC
1 LIBERTY SQ - 11TH FLOOR
BOSTON, MA 02109
WWW.BIOSPARKUSA.COM

Drawing list

REVISION	DATE	NAME	CHANGES
0	10/8/2015	G Marks	

REVISION 0

LOCATION
L1
NBC - BUCKLIN POINT WWTP

CONTRACT N° : 150204

DRAWING No. 150204 P011

SHEET 2 / 4

INSTRUMENT IDENTIFICATION GENERAL REFERENCE (ISA - S5.1)

FIRST LETTER		SUCCEEDING LETTERS	PRIMARY ELEMENT	INDICATOR	RECORDER	CONTROLLER			TRANS-MITTER	CONTROL SWITCH	CONTROL VALVE OR REGULATOR	ALARM	SELF-ACTUATED VALVE	RELAY OR CONVERTER
						BLIND	INDICATING	RECORDING						
A	ANALYSIS	ALARM	AE	AI	AR	AC	AIC	ARC	AT	AS( )	AA( )	AV		AY
B	BURNER FLAME	USER'S CHOICE	BE	BI	BR	BC			BT	BS( )	BA( )	BV		BY
C	CONDUCTIVITY	CONTROL (CLOSE)	CE	CI	CR	CC	CIC	CRC	CT	CS( )	CA( )	CV		CY
D	DENSITY OR MASS		DE	DI	DR	DC	DIC	DRC	DT	DS( )	DA( )	DV		DY
E	VOLTAGE	PRIMARY ELEMENT	EE	EI	ER	EC	EIC	ERC	ET	ES( )	EA)	EV		EY
F	FLOW (RATIO OR FRACTION)	SHUTDOWN FIRST OUT	FE	FI	FR	FC	FIC	FRC	FT	FS( )	FA)	FV	FCV	FY
G	GAUGING	GLASS	GE	GI	GR	GC	GIC	GRC	GT	GS( )	GA)	GV		
H	HAND	(HIGH)				HC	HIC		HT	HS( )		HV	HCV	HY
I	CURRENT	INDICATE	IE	II	IR	IC	IIC	IRC	IT	IS( )	IA( )			IY
J	POWER (SCAN)		JE	JI	JR	JC	JIC	JRC	JT	JS( )	JA( )			JY
K	TIME	CONTROL STATION		KI	KR	KC	KIC	KRC	KT	KS( )	KA( )			KY
L	LEVEL	LIGHT (LOW)	LE	LI	LR	LC	LIC	LRC	LT	LS( )	LA( )	LV	LCV	LY
M	MOISTURE, HUMIDITY	MIDDLE (INTERMEDIATE)	ME	MI	MR	MC	MIC	MRC	MT	MS( )	MA( )	MV		MY
N	USER'S CHOICE													
O	POINT	ORIFICE (OPEN)		OI	OR	OC	OIC	ORC	OT	OS( )	OA( )			
P	PRESSURE OR VACUUM	POINT	PE	PI	PR	PC	PIC	PRC	PT	PS( )	PA( )	PV	PCV	PY
Q	QUANTITY OR EVENT											QV		QY
R	RADIOACTIVITY	RECORD OR PRINT	RE	RI	RR	RC	RIC	RRC	RT	RS( )	RA( )			RY
S	SPEED OR FREQUENCY	SWITCH	TE	SI	SR	SC	SIC	SRC	ST	SS( )	SA)			SY
T	TEMPERATURE	TRANSMIT		TI	TR	TC	TIC	TRC	TT	TS( )	TA( )	TV	TCV	TY
U	MULTI-VARIABLE	MULTI-FUNCTION		UI	UR	UC	UIC	URC				UV		
V	VISCOSITY OR VIBRATION	VALVE OR DAMPER	VE	VI	VR	VC	VIC	VRC	VT	VS( )		VV		VY
W	WEIGHT OR FORCE	WELL	WE	WI	WR	WC	WIC	WRC	WT	WS( )		WV		WY
X	UNCLASSIFIED	UNCLASSIFIED	XE	XI	XR	XC	XIC	XRC	XT	XS( )		XV		XY
Y	USER'S CHOICE	RELAY OR COMPUTE												YY
Z	POSITION OR SPEED	DRIVE OR ACTUATE	ZE	ZI	ZR	ZC	ZIC	ZRC	ZT	ZS( )	ZA( )			ZY

Note- TM designation for the flow meters means "Thermal Mass"

(C) -CLOSE
(H) -HIGH ALARM
(HH)-HIGH SHUTDOWN

(O) -OPEN
(L) -LOW ALARM
(LL)-LOW SHUTDOWN

(XX) -DIAGNOSTIC SHUTDOWN (USED TO INDICATE THE DIAGNOSTIC CHECK REQ'D ON THE ANALOG INPUT)

PIPE REFERENCE

AA-BB-CC-DD-EEEE

AA: NOMINAL PIPE SIZE

BB: FLUID

NG	NATURAL GAS	DG	DIGESTER GAS	LFG	LANDFILL GAS
SG	SYNTHETIC GAS	EX	COMBUSTION EXHAUST	BC	BIOGAS CONDENSATE
IA	INSTRUMENT AIR	AA	ATMOSPHERIC AIR	CA	COMPRESSED AIR
RW	RAW WATER	TW	TREATED WATER	PW	POTABLE WATER
SW	SEA WATER	PG	PROPELYNE GLYCOL	EG	ETHYLENE GLYCOL
SS	SATURATED STEAM	SH	SUPERHEATED STEAM	SC	STEAM CONDENSATE
FW	FEED WATER	DA	DEAERATED WATER	RO	RO WATER
LO	LUBRICATION OIL	RA	REDUCING AGENT		
LM	OIL MIST				

CC: PIPE MATERIAL

316	316 STAINLESS STEEL	314	314 STAINLESS STEEL	A53	A53 CARNON STEEM
106	A106 CARBON STEEL	CU	COPPER	PVC	PVC (< 120 DEG F)
CPV	CPVC (120F TO 180F)				

DD: PIPE SCHEDULE

EE: PIPE SEQUENCE NUMBER

EXAMPLE > 04-DG-304-10-0000

DIGESTER GAS IN A 4" SCHEDULE 10 PIPE MADE FROM 304 SS

COMMON INSTRUMENT SYMBOLS

GENERIC VALVE
LUG / WAFER BUTTERFLY VALVE
FLANGED BUTTERFLY VALVE
NEEDLE VALVE (THREADED)
BALL VALVE (FLANGED)
BALL VALVE (THREADED)
FLOAT VALVE (THREADED)
WYE STRAINER (THREADED)
RELIEF VALVE
3-WAY BALL VALVE (THREADED)
CIRCUIT SETTER (FLANGED)

REDUCER / INCREASER
FLEX CONNECTOR (FLANGED)
FLEX CONNECTOR (THREADED)
FLEX CONNECTOR (CLAMPED)
CHECK VALVE (THREADED SPRING LOADED BALL)
CHECK VALVE (FLANGED SWING GATE)
THERMAL INSULATION WITH U VALUE
THERMAL INSULATION WITH U VALUE & HEAT TRACE
MOTOR OPERATOR / MOTOR
SOLENOID OPERATOR
DOUBLE SOLENOID OPERATOR
GEAR OPERATOR / GEARBOX

OPEN DRAIN
P-TRAP

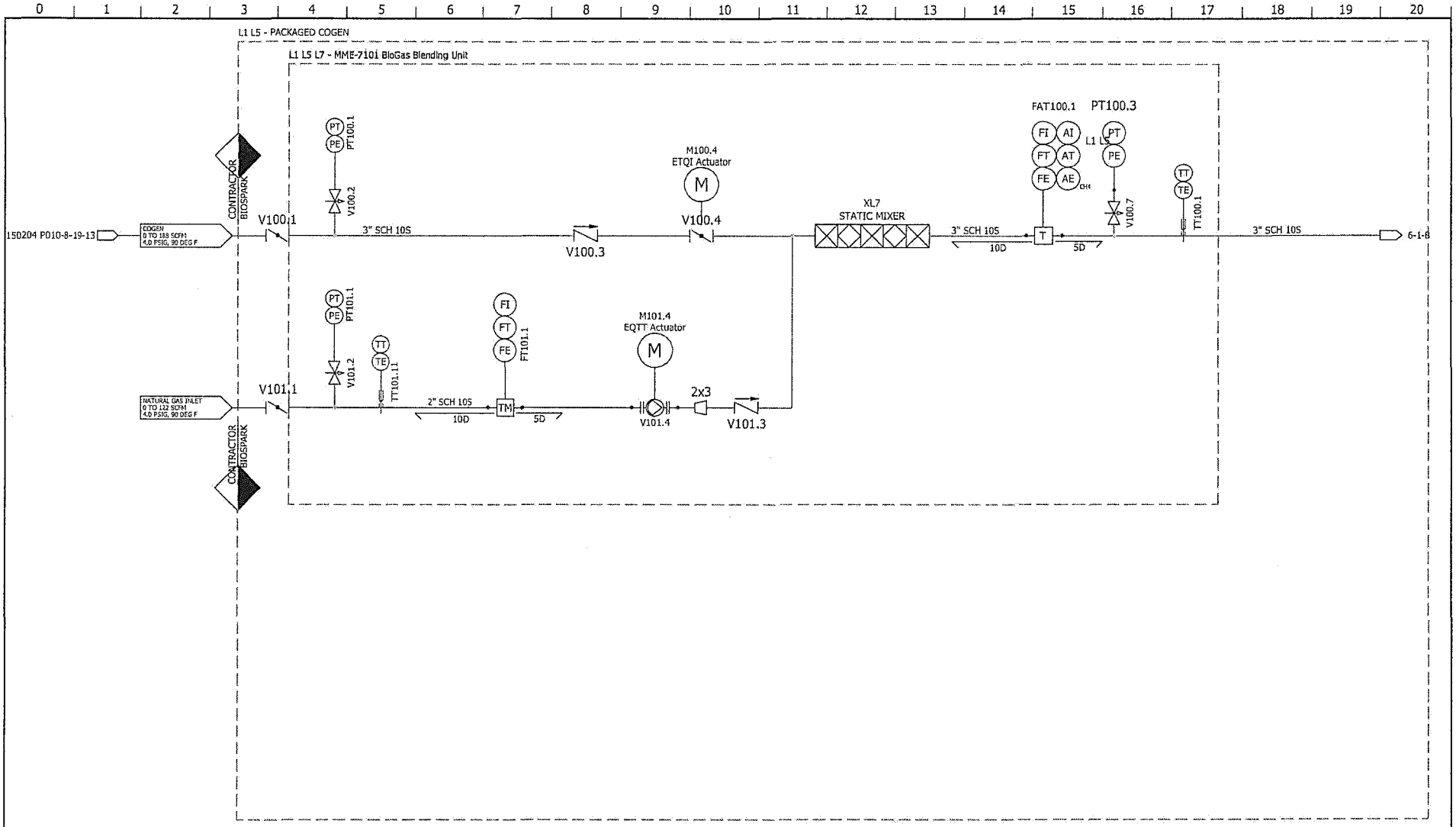
DIFFERENTIAL PRESSURE GAUGE
SINGLE PRESSURE GAUGE
TEMPERATURE SENSOR WITH INTEGRAL THERMOWELL
TEMPERATURE TRANSMITTER WITH INTEGRAL THERMOWELL
TEMPERATURE TRANSMITTER WITH INTEGRAL THERMOWELL AND DISPLAY
PRESSURE TRANSMITTER WITH NO DISPLAY
PRESSURE TRANSMITTER WITH DISPLAY
DIFFERENTIAL PRESSURE TRANSMITTER
FLOW TRANSMITTER WITH INDICATION & VORTEX FLOW ELEMENT
FLOW TRANSMITTER WITH INDICATION & THERMAL MASS FLOW ELEMENT

FLOW TRANSMITTER WITH INDICATION & THERMAL MASS FLOW AND CH4 ELEMENT
ANALYTIC TRANSMITTER WITH INDICATION & ANALYTIC ELEMENT
MOTOR OPERATOR
SOLENOID OPERATOR
DOUBLE SOLENOID OPERATOR
PROCESS START / END POINT WITH CONDITIONS
ORIGIN / DESTINATION ARROW WITH REFERENCE
RESPONSIBILITY LIMIT

DESIGN OFFICE	BIOSPARK LLC 1 LIBERTY SQ - 11TH FLOOR BOSTON, MA 02109 WWW.BIOSPARKUSA.COM	LEGEND	REVISION 0

REVISION	DATE	NAME	CHANGES
0	10/8/2015	G Marks	

LOCATION	CONTRACT N° :	DRAWING No.	SHEET
L1 NBC - BUCKLIN POINT WWTP	150204	150204 P011	3 / 4

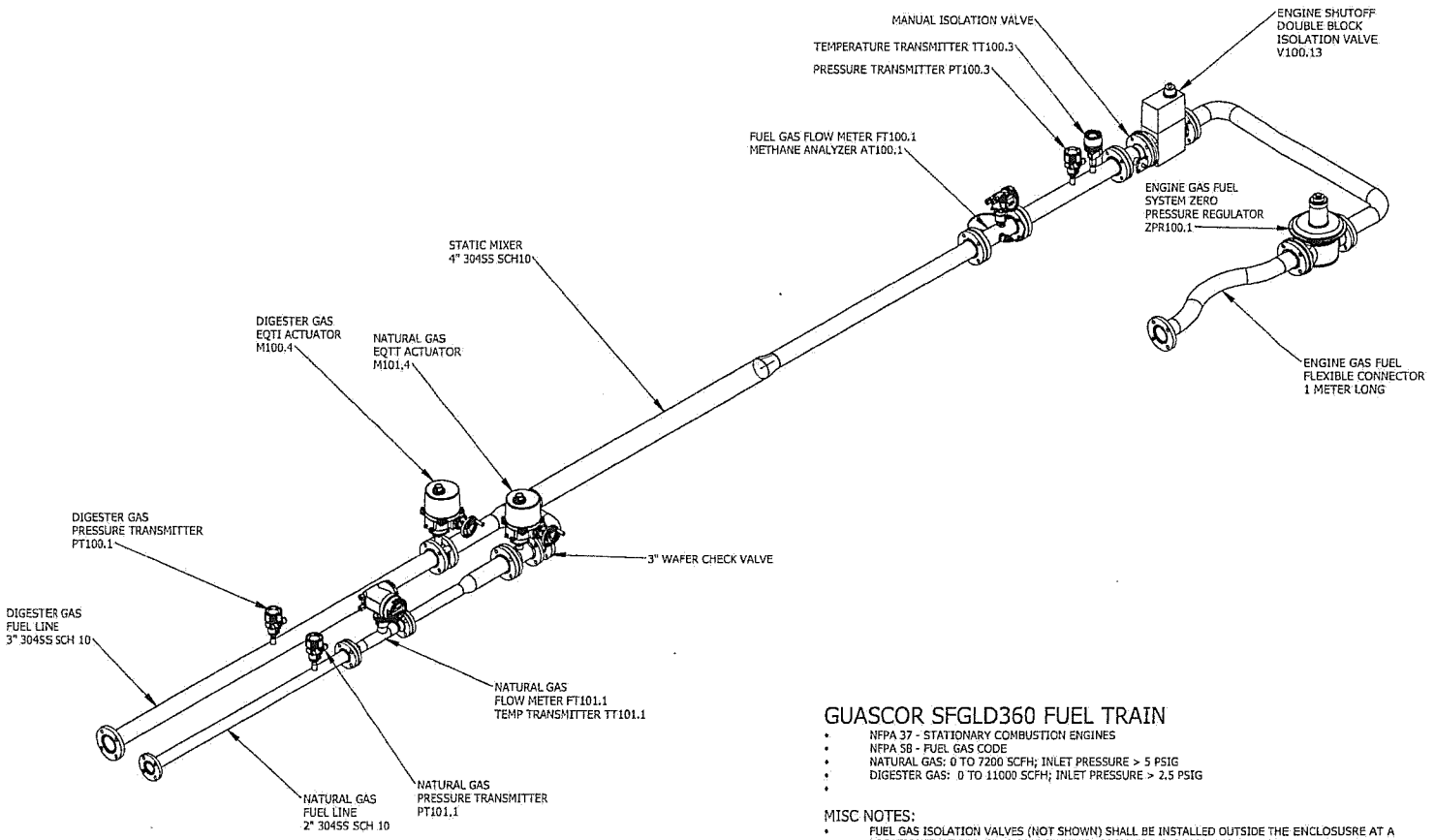


DESIGN OFFICE: BIOSPARK LLC 1 LIBERTY SQ - 11TH FLOOR BOSTON, MA 02109 WWW.BIOSPARKUSA.COM	DIGESTER GAS BLENDING SYSTEM SPECIFICATION SECTION 11467				REVISION 0
		0	10/8/2015	G Marks	
		REVISION	DATE	NAME	CHANGES

LOCATION	CONTRACT Nº :	DRAWING No.	SHEET
L1 L5 L1 DIGESTER / NATURAL GAS MIXING SYSTEM	150204	150204 P011	5 / 8

SOLIDWORKS Electrical 2016.0.3.12

GUASCOR SFGLD360 DUAL FUEL GAS BLENDING/MIXING TRAIN



GUASCOR SFGLD360 FUEL TRAIN

- NFPA 37 - STATIONARY COMBUSTION ENGINES
- NFPA 58 - FUEL GAS CODE
- NATURAL GAS: 0 TO 7200 SCFH; INLET PRESSURE > 5 PSIG
- DIGESTER GAS: 0 TO 11000 SCFH; INLET PRESSURE > 2.5 PSIG

MISC NOTES:

- FUEL GAS ISOLATION VALVES (NOT SHOWN) SHALL BE INSTALLED OUTSIDE THE ENCLOSUSRE AT A LOCATION THAT PROVIDES CONVIENIENT ACCESS FOR GAS ISOLATION
- DIGESTER GAS LINE SHALL BE FITTED WITH A FLAME ARRESTOR LOCATED OUTSIDE THE ENCLOSURE. FLAME ARRESTOR SHALL BE INSTALLED BY THE CONTRACTOR SO AS TO ELIMINATE THE POSSIBIBLITY OF MOISTURE COLLECTING IN THE FLAME ARRESTOR.

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CLIENT NAME

NARRAGANSETT BAY COMMISSION
102 CAMPBELL AVENUE
EAST PROVIDENCE, RI 02914

PROJECT NAME

BIOGAS COGENERATION SYSTEM - BUCKLIN POINT WWTP

DRAWING DESCRIPTION

SECTION 11467 - GAS BLENDING SYSTEM

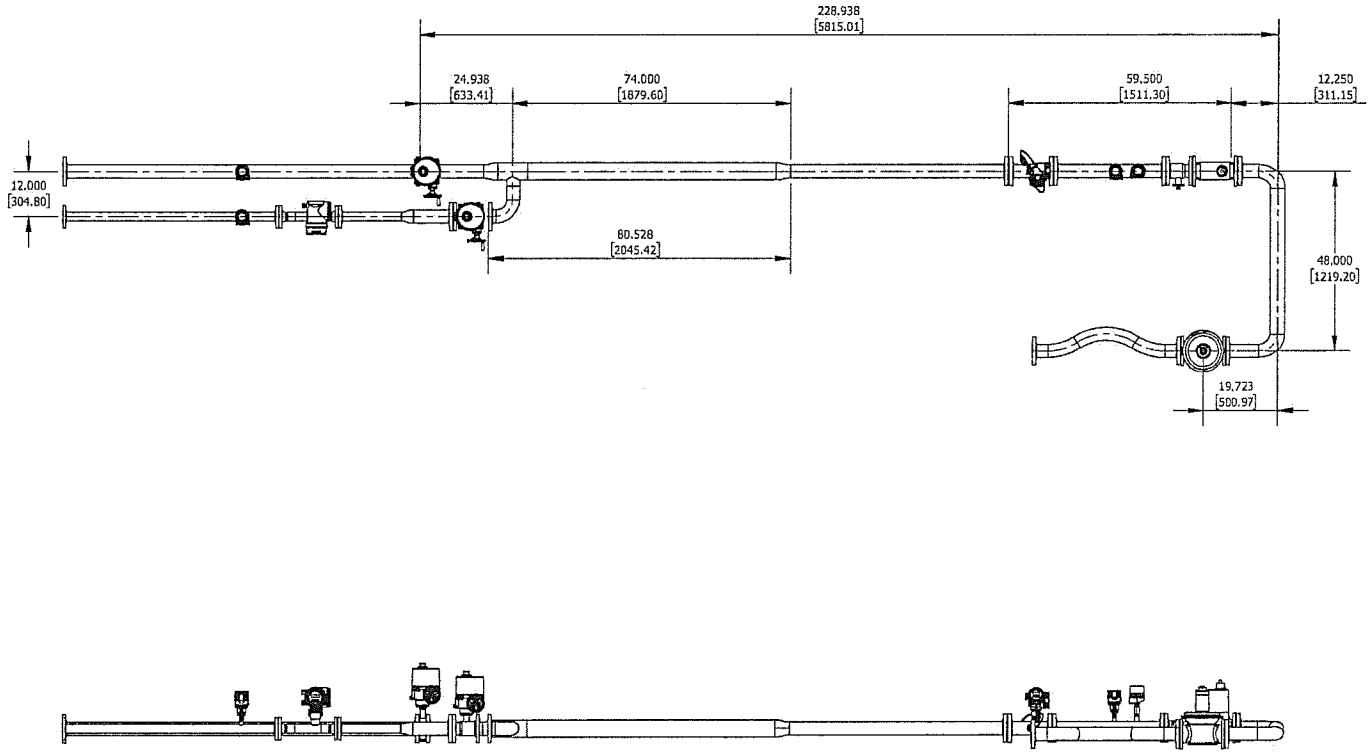
DATE	
6/24/2016	
SCALE	WEIGHT
1:24	

ENGINEER / DESIGNER

SHEETS	SIZE
SHEET 1 OF 2	B

DRAWING NUMBER

150204 P102



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CLIENT NAME

NARRAGANSETT BAY COMMISSION
102 CAMPBELL AVENUE
EAST PROVIDENCE, RI 02914

PROJECT NAME

BIOGAS COGENERATION SYSTEM - BUCKLIN POINT WWTP

DRAWING DESCRIPTION

SECTION 11467 - GAS BLENDING SYSTEM

DATE
6/24/2016

SCALE
1:32

WEIGHT

ENGINEER / DESIGNER

SHEETS
SHEET 2 OF 2

SIZE
B

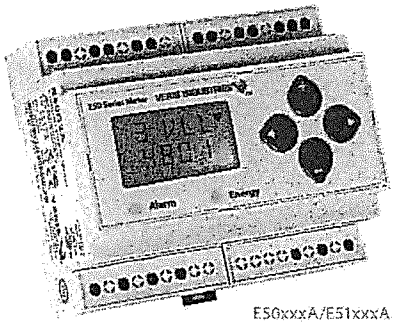
DRAWING NUMBER
150204 P102

Meter D - Net Power Meter

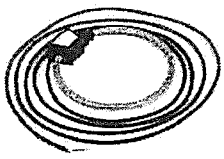
Specifications, Diagrams & Installation Attestation

E5XXXA SERIES

Cost-Saving, Versatile Monitoring Solution with Associated E683x Rope Style CTs (Sold Separately)



E50xxxA/E51xxxA



E683x Series Rope CT (sold separately)

The E5xxxA Series DIN Rail Meter combines exceptional metering performance with a built-in integrator and power supply to deliver a cost-effective, easily installed solution for power monitoring applications. Multiple communication protocol options offer added flexibility for easy system integration.

E5xxxA devices work exclusively with Veris E683x Series rope CTs for fast connection. The rope style CTs allow convenient installation in tight spaces.

The data logging capability (E5xC3A and E5xx5A) protects data in the event of a power or communications failure elsewhere in the system. Different devices in the series offer serial communication, pulse output, and phase alarms to suit a wide variety of applications.

Faster installation

Integrator and power supply for the CTs are built into the meter... fewer devices to purchase and faster installation

0.5% accuracy

ANSI C12.20 0.5% accuracy, IEC 62053-22 Class 0.5S on all E5xxxA...great for cost allocation

Rope CTs

Versatile rope CTs allow convenient installation in tight spaces

Easy installation

DIN rail or screw mounting options

400 to 5000A

Designed to work exclusively with E683x Series rope CTs which offer 1% accuracy from 50 to 5000 A... monitor a wide range of loads with breakers from 400 to 5000 A

Multiple applications

Real energy output and phase loss alarm output on E50BxA and E5xCxA models...one device serves multiple applications

APPLICATIONS

- Energy monitoring in building automation systems
- Renewable energy
- Energy management
- Commercial sub-metering
- Industrial monitoring
- Cost allocation

SPECIFICATIONS

ACCURACY	
Real Power & Energy E5xxxA	0.5% (ANSI C12.20, IEC 62053-22 Class 0.5S)
INPUTS	
Control Power, AC	50/60 Hz; 5 VA max.; 90 V min.; UL Maximums: 600 VL-L (347 VL-N); CE Maximum: 300 VL-N
Control Power, DC	3 W max.; UL and CE: 125 to 300 Vdc (external DC current limiting required)
Voltage Input	UL: 90 VL-N to 600 VL-L; CE: 90 VL-N to 300 VL-N
Current Input Scaling Input Range	50 to 5000 A E683x Series rope style CTs only (CTs must be rated for connection to Class 1 voltage inputs)
Pulse Inputs (E5xHxA & E50FxA only)	Contact inputs to pulse accumulators (one set with E5xH2A & E50F2A; two sets with E5xH5A & E51F5A)*
OUTPUTS	
All Models (except E5xHxA & E50FxA)	Real Energy Pulse: N.O. static**; Alarm contacts: N.C. static**
E50BxA	Reactive energy pulse**
E5xCxA	RS-485 2-wire Modbus RTU (1200 baud to 38.4 kbaud)
E5xHxA	RS-485 2-wire BACnet MS/TP (9600 baud to 115.2 kbaud)
E50FxA	2-wire LON FT
MECHANICAL	
Mounting	DIN rail or 3-point screw mount
ENVIRONMENTAL	
Operating Temp Range	-30 to 70 °C (-22 to 158 °F)
Storage Temp Range	-40 to 85 °C (-40 to 185 °F)
Humidity Range	<95% RH non-condensing; indoor use only
WARRANTY	
Limited Warranty	5 years
AGENCY APPROVALS	
Agency Approvals	UL508, EN61010, California CSI Solar, ANSI C12.20

E51CxA only E50FxA only

*10 kΩ Vac/dc to 4 to 10 Vdc.
**30 Vac/dc, 100 mA max.
***The CE mark indicates RoHS2 compliance. Please refer to the CE Declaration of Conformity for additional details.

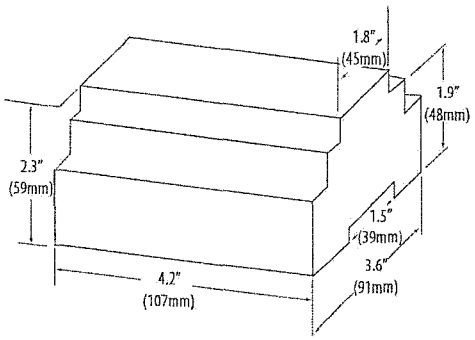
ORDERING INFORMATION

	E50B1A	E50C2A	E50C3A	E50F2A	E50F5A	E50H2A	E50H5A	E51C2A	E51C3A	E51H2A	E51H5A
MEASUREMENT CAPABILITY - FULL DATA SET											
Bi-directional Energy Measurements								•	•	•	•
Power (3-phase total and per phase): Real (kW)/Reactive (kVAR), & Apparent (kVA)	•	•	•	•	•	•	•	•	•	•	•
Power Factor: 3-phase average & per phase	•	•	•	•	•	•	•	•	•	•	•
Present Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)	•	•	•	•	•	•	•	•	•	•	•
Import & Export totals of Present Power Demand: Real (kW), Reactive (kVAR), & Apparent (kVA)								•	•	•	•
Peak Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)	•	•	•	•	•	•	•	•	•	•	•
Current (3-phase average and per phase)	•	•	•	•	•	•	•	•	•	•	•
Voltage: Line-Line and Line-Neutral (3-phase average and per phase)	•	•	•	•	•	•	•	•	•	•	•
Frequency	•	•	•	•	•	•	•	•	•	•	•
ANSI C12.20 0.5% accuracy, IEC 62053-22 Class 0.5S	•	•	•	•	•	•	•	•	•	•	•
Accumulated Net Energy: Real (kWh), Reactive (kVARh), and Apparent (kVAh)	•	•	•	•	•	•	•	•	•	•	•
Accumulated Real Energy by phase (kWh)	•	•	•	•	•	•	•	•	•	•	•
Import and Export Accumulators of Real and Apparent Energy								•	•	•	•
Reactive Energy Accumulators by Quadrant (3-phase total and per phase)								•	•	•	•
Demand Interval Configuration: Fixed or Rolling Block	•	•	•	•	•	•	•	•	•	•	•
Demand Interval Configuration: External Sync to Comms	•	•	•	•	•	•	•	•	•	•	•
DATA LOGGING											
Data Logging: 10 16-Bit Configurable (can include Date/Time) Data Buffers			•						•		
Data Logging: 3 Timestamped 32-Bit Configurable Data Buffers					•		•				•
Store up to 60 days of readings at 15-minute intervals			•		•		•		•		•
OUTPUTS											
Alarm Output (N.C.)	•	•	•	•		•		•	•	•	
1 Pulse Output (N.O.)		•	•					•	•		
2 Pulse Outputs (N.O.)	•										
RS-485 Serial (Modbus RTU Protocol)		•	•					•	•		
RS-485 Serial (BACnet MS/TP Protocol)						•	•			•	•
LON FT Serial (LonTalk Protocol)				•	•						
INPUTS											
2 Pulse Contact Accumulator Inputs					•		•				•
1 Pulse Contact Accumulator Input				•		•				•	

REQUIRED CTS

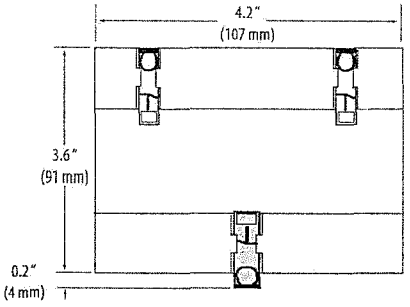
MODEL	DESCRIPTION
E683C502	Rogowski CT, 250 mm (9"), 600 V, 5 kA, U018 equivalent
E683D502	Rogowski CT, 300 mm (12"), 600 V, 5 kA, U018 equivalent
E683G502	Rogowski CT, 460 mm (18"), 600 V, 5 kA, U018 equivalent
E683J502	Rogowski CT, 600 mm (24"), 600 V, 5 kA, U018 equivalent
E683L502	Rogowski CT, 900 mm (35"), 600 V, 5 kA, U018 equivalent

DIMENSIONAL DRAWING



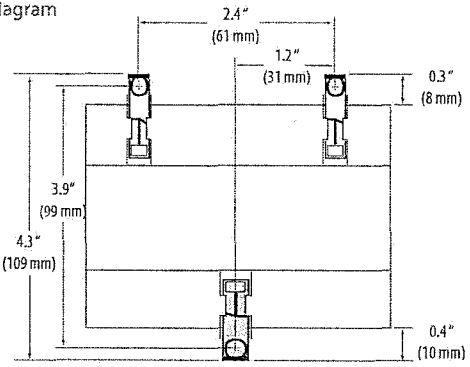
DIN MOUNT CONFIGURATION

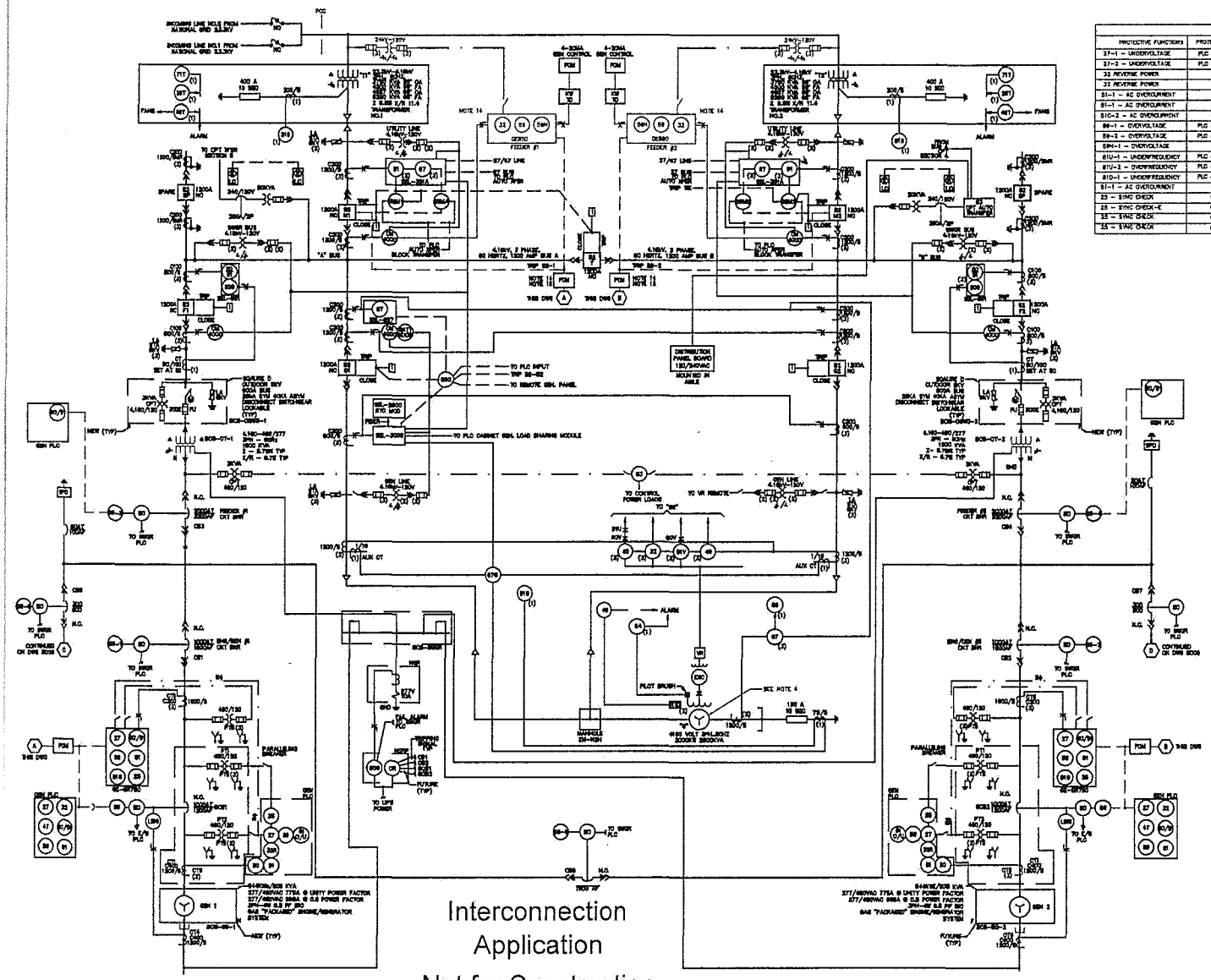
Mounting Diagram



SCREW MOUNT CONFIGURATION

Mounting Diagram





Interconnection
Application
Not for Construction

PROTECTIVE RELAY SETTINGS					
PROTECTIVE FUNCTIONS	PROTECTIVE DEVICE	SETTING	SETTING	CLEARING TIME SEC.	TRIP BREAKER
27-1 – UNDERVOLTAGE	PLC & GE SR750	106Vrms (88%)		2	GCB1 (GCB2)
27-2 – UNDERVOLTAGE	PLC & GE SR750	60Vrms (50%)		0.18	GCB1 (GCB2)
32 REVERSE POWER	GE SR850	32kW		2	GCB1 (GCB2) SEE NOTE 5
32 REVERSE POWER	GE SR850	32kW		5	52-1 (52-2) SEE NOTE 5
51-1 – AC OVERCURRENT	PLC	4.01Arms	SHIFT PHASE TIME 30-11	TD 0.5	GCB1 (GCB2)
51-1 – AC OVERCURRENT	GE SR750	4.7Arms	Curve U4	TD 6.3	GCB1 (GCB2)
51C-2 – AC OVERCURRENT	GE SR750	1.81Arms/106Vrms (88%)	Curve U4	TD 6.3	GCB1 (GCB2)
59-1 – OVERVOLTAGE	PLC & GE SR750	132Vrms (110%)		1	GCB1 (GCB2)
59-2 – OVERVOLTAGE	PLC & GE SR750	144Vrms (120%)		0.18	GCB1 (GCB2)
59N-1 – OVERVOLTAGE	GE-850	120Vrms		3	52-1 (52-2) GCB1 (GCB2)
81U-1 – UNDERFREQUENCY	PLC & GE SR750	58.5~		100	GCB1 (GCB2)
81U-2 – OVERFREQUENCY	PLC & GE SR750	57~		0.18	GCB1 (GCB2)
81O-1 – UNDERFREQUENCY	PLC & GE SR750	60.5~		0.18	GCB1 (GCB2)
51-1 – AC OVERCURRENT	SEL-351A	Tap 5	Curve U4	TD 6.3	52-1 (52-2)
25 – SYNC CHECK	GE-SR750	FREQUENCY MATCH	±0.2Hz		
25 – SYNC CHECK-E	GE-SR750	VOLTAGE MATCH	±5%		
25 – SYNC CHECK	GE-SR750	PHASE MATCH	±15°		
25 – SYNC CHECK	GE-SR750	ACCEPTANCE DELAY	0.3 SEC		

ANSI DEVICE NUMBERS AND ABBREVIATIONS

25	SYNCHRONISM CHECK	51G	GROUND TIME OVERCURRENT
26	TEMPERATURE RELAY	51V	VOLTAGE RESTRAINED OVERCURRENT
27	UNDERVOLTAGE	52	CIRCUIT BREAKER
31	EXCITATION	59	OVERVOLTAGE
32	REVERSE POWER	59N	NEUTRAL OVERVOLTAGE
40	LOW EXCITATION FIELD	60V	VOLTAGE BALANCE
43	AUTO/MANUAL SWITCH	62	TIMING RELAY
46	NEGATIVE SEQUENCE OVERCURRENT	63P	LIQUID OR GAS PRESSURE
49	TEMPERATURE INDICATION DEVICE	64	GROUND PROTECTION
50	INSTANTANEOUS OVERCURRENT	67	DIRECTIONAL OVERCURRENT
50G	GROUND INSTANTANEOUS OVERCURRENT	71	LIQUID OR GAS LEVEL
50/51	INSTANTANEOUS/TIME-DELAY AC OVERCURRENT RELAY	79	RECLOSING
50/52BF	BREAKER FAILURE	81U	UNDERFREQUENCY
51	TIME OVERCURRENT	81O	OVERFREQUENCY
		86	LOCKOUT
		87	DIFFERENTIAL

NOTES:

1. THE EXISTING ONE-LINE INFORMATION IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM PREVIOUSLY DEVELOPED DRAWINGS. ALL REQUIRED INFORMATION WAS ADDED AND APPLIES TO THE PROPOSED INTERCONNECTION RELAYING PROTECTION SCHEME.
2. A ONE-LINE DIAGRAM LEGEND, ANSI DEVICE NUMBERS AND ABBREVIATIONS WERE ADDED TO THIS DRAWING FOR ADDITIONAL CLARIFICATION.
3. ONE (1) NEW G.E. FEEDER PROTECTION RELAY SHALL BE INSTALLED AT EACH INCOMING NATIONAL GRID 23.3kV CIRCUIT, AND SHALL PROVIDE REVERSE POWER AND OVERVOLTAGE PROTECTION.
4. THE EXISTING 4160V, 2500KVA GENERATOR DETAILED ON THIS DRAWING, IS FOR REFERENCE ONLY AND IS NOT CONFIGURED TO PARALLEL WITH THE UTILITY OR PERFORM A CLOSED TRANSITION SEQUENCE.
5. THE G.E. FEEDER RELAY WILL PROVIDE NEUTRAL OVERVOLTAGE (59N) AND REVERSE POWER (32) PROTECTION. THIS RELAY WILL BE PROGRAMMED WITH TWO LEVELS OF TRIPPING. FOR A PROTECTIVE ELEMENT PICK UP, THE INITIAL TRIP WILL BE OF THE LOCAL GENERATOR BREAKER (GCB1 OR GCB2, IF THIS BREAKER DOES NOT CLEAR, THE SECOND LEVEL OF TRIPPING WILL OPEN THE MAIN BREAKER 52-1 OR 52-2.
6. LOCAL PROTECTION OF THE GENERATOR AND ALL OVERCURRENT, UNDERVOLTAGE, OVERVOLTAGE AND FREQUENCY PROTECTION WILL BE PROVIDED BY THE GENERATOR PLC AND REDUNDANT RELAY (SR750) LOCATED IN THE 480V SWITCHGEAR. THE DEVICES WILL TRIP THE LOCAL BREAKER ONLY.
7. THE RELAY SETTINGS FOR THE GE FEEDER RELAY PLC, AND REDUNDANT RELAY (SR750) ARE PROVIDED IN THE PROTECTIVE SETTINGS TABLE
8. THE 67 FUNCTION ON SEL-351A RELAYS FOR 52-1 AND 52-2 ARE SET TO TRIP IN THE REVERSE DIRECTION (FLOWS EXPORT) AT 21.2%~ ON EXPORT OF 120A PRIMARY CURRENT AND INSTANTANEOUSLY ON EXPORT OF 1200A PRIMARY CURRENT.
9. THE RATING OF ALL EXISTING MEDIUM VOLTAGE SWITCHGEAR BREAKERS ARE SQUARE D 4.16kV, 1200A, 25KA BIL 1
10. REDUNDANT RELAY SHALL BE A GE SR750 AND THE GENERATOR PLC IS AN ALLEN BRADLEY 1407-COOH
11. NEW SQUARE D LOW VOLTAGE 480V/277 SWITCHGEAR IS 3200A BUS WITH 100KA BRACING AND 65KA BREAKERS
12. THE GE SR750 REDUNDANT RELAY SHALL BE PROGRAMMED TO TRIP WITHIN 2 SECONDS UPON RELAY FAILURE ALARM.
13. CURRENT INPUTS ARE DIRECTLY TO PLC AS THE PLC IS NOT REMOVED FROM SERVICE WHILE GENERATOR OPERATING. SHORTING BLOCKS OR SHORTING TEST SWITCHES ARE NOT INSTALLED IN GENERATOR CONTROL SCHEME.
14. THE GE850 RELAY PROVIDING REVERSE POWER PROTECTION AND FIBER OPTIC MODEMS (FOM) ARE POWERED BY 125VDC BATTERY LOCATED IN EXISTING NBC 4.16kV SWITCHGEAR.
15. BREAKERS GCB1(2) ARE THE SYNCHRONIZING BREAKERS. CONTROL LOGIC INTERLOCKS WILL FORCE TRIP AND PREVENT THE CLOSING OF GCB1(2), IF ANY BREAKER CB1(2), CB3(4), 83P1(P2), OR 52M1(M2) ARE OPEN.
16. THIS DRAWING REDRAWN FROM DEG DRAWING E-1 REV B DATED 7/19/17

ONE-LINE DIAGRAM LEGEND

POTENTIAL TRANSFORMER
CURRENT TRANSFORMER
CABLE TERMINATION
DRAWOUT CIRCUIT BREAKER
POWER TRANSFORMER
SHORTING TEST SWITCH
VOLTAGE TEST SWITCH
FUSE
SEPARABLE CONNECTOR
SURGE ARRESTER
GANG OPERATED DISC.
DRAWOUT DEVICE
FIBER OPTIC MODEM
KILOWATT TRANSDUCER

THOMAS J. O'LOUGHLIN
No. 7167
REGISTERED
PROFESSIONAL ENGINEER
ELECTRICAL

FIRM NAME: LIG CONSULTANTS, PC
FIRM REG #: 8084
PROF. ENGINEER: THOMAS O'LOUGHLIN, P.E.
ENGINEER LICENSE #: 7167

REV	DATE	DESCRIPTION	DRW	APR'D
REV	DATE	DESCRIPTION	DRW	APR'D

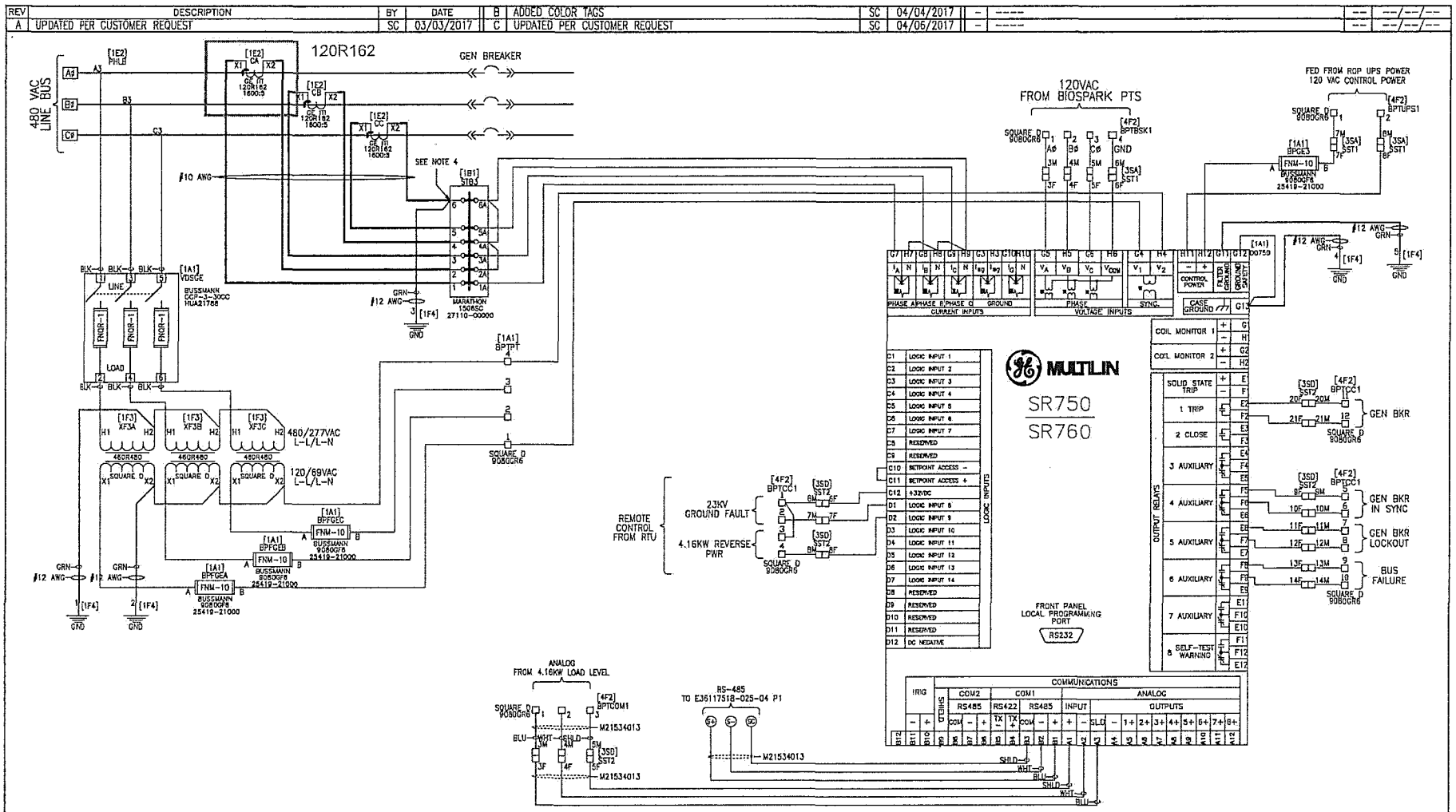
DES
DRW
CHK

LIG Consultants, PC

BIOGAS COGENERATION SYSTEM BUCKET POINT WWTF
ELECTRICAL INTERCONNECT APPLICATION
ONE LINE DIAGRAM

SIZE B
SHEET 1of1
DATE 9/28/2017
SCALE NTS
DWG NO E-1
FILE NO:

REV	DESCRIPTION	BY	DATE
A	UPDATED PER CUSTOMER REQUEST	SC	03/03/2017
B	ADDED COLOR TAGS	SC	04/04/2017
C	UPDATED PER CUSTOMER REQUEST	SC	04/06/2017

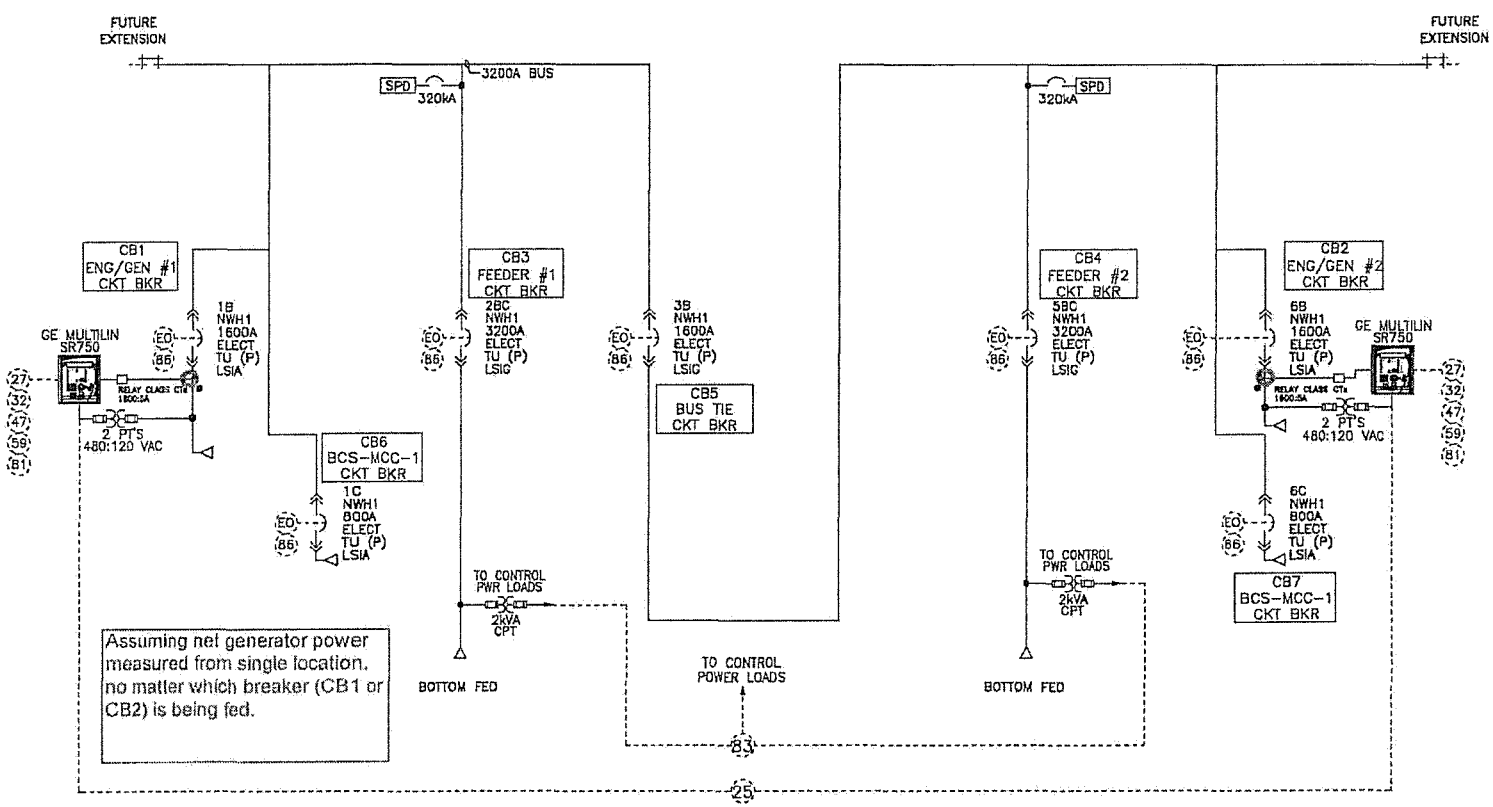


NOTES:
1. ALL WIRING TO BE TYPE "SIS" (UL LISTED)
2. ALL CONTROL FUSES MOUNTED IN FUSED PULLOUTS.
3. USE #14 AWG WIRE UNLESS OTHERWISE NOTED.
4. GROUNDED TERMINAL OF THE SHORTING BLOCK TO BE A PAN HEAD SCREW.
5. RELAY CLASS CT's ARE MOUNTED ON INCOMING BUS

GE MULTILIN 750 METERING FOR CB1 ENG/GEN #1 CKT BKR

JOB NAME:	BIOGAS COGEN BUCKLIN PT WWTF NBC	EQUIPMENT DESIGNATION:	BCS-SWGR
JOB LOCATION:	CHATTANOOGA TN	EQUIPMENT TYPE:	PZ4 SWITCHGEAR
DRAWN BY:	SHANE CARTER	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	SJC/LRB		
DATE:	FEBRUARY 20, 2017		
DRAWING STATUS:	RECORD	DWG#	E36117518-025-03 PG1 OF4 REVC

REV	DESCRIPTION	BY	DATE
A	REPLACED GE PQMII WITH MULTILIN 750	SC	06/14/2016



SYMBOL KEY
27 – Under Voltage
32 – Power Directional Relay
47 – Phase Balance
59 – Over Voltage
81 – Frequency Over/Under Relay
83 – Control Power Auto Throw Over Relay
86 – Lock-out Relay
EO – Electrically Operated

ONE LINE

JOB NAME:	BIOGAS COGEN BUCKLIN PT WWTF NBC	EQUIPMENT DESIGNATION:	GEN SWGR
JOB LOCATION:	CHATTANOOGA TN	EQUIPMENT TYPE:	PZ4 SWITCHGEAR
DRAWN BY:	SHANE CARTER	DRAWING TYPE:	ONE LINE
ENGR:	SJC		
DATE:	JUNE 23, 2016		
DRAWING STATUS:	APPROVAL	DWG#	036117516-025-01

February 16,2018

Debra A. Howland
Executive Director New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

RE:NBC Renewable Energy Source Eligibility for Class I Thermal Sources with Renewable Thermal Energy Capacity Greater than 200,000 BTU/hr.

Dear Ms. Howland,

As the Mechanical Inspector for NBC, I hereby attest that the BTU Meter and the Net Power Meter were both installed as per the approved drawings and requirements by the device manufactures. By contract and specification, this project is to be done in accordance with RI State Codes.
I declare that the above statement is true and accurate to the best of my knowledge.

Sincerely,

Jose Medina

Mechanical Inspector

Meter E - BTU Meter

Specifications, Diagram, Calibration Certificate & Installation Attestation

Proposed to fulfill the requirements of Attachments 3-1 and 3-2 requested on page 5

• SYSTEM-10 BTU METER •

ONICON
FLOW AND ENERGY MEASUREMENT

UL LISTED
PROCESS CONTROL EQUIPMENT
3GF5

FEATURES

Simple Installation and Commissioning - Factory programmed and ready for use upon delivery. All process data and programming functions are accessible via front panel display and keypad.

Single Source Responsibility - One manufacturer is responsible for every aspect of the energy measurement process ensuring component compatibility and overall system accuracy.

N.I.S.T. Traceable Calibration with Certification - Each Btu measurement system is individually calibrated using application specific flow and temperature data and is provided with calibration certificates.

Precision Solid State Temperature Sensors - Custom calibrated and matched to an accuracy better than ±0.15° F over calibrated range.

Highly Accurate Flow Meters - ONICON offers a wide variety of insertion and inline type flow measurement technologies including turbine, electromagnetic and vortex sensing. Each type offers unique advantages depending on the application. All ONICON flow meters are individually wet calibrated and designed to operate over a wide flow velocity range with accuracies ranging from ±0.2% to ±2.0% of rate depending on the model.

Complete Installation Package - All mechanical installation hardware, color coded interconnecting cabling and installation instructions are provided to ensure error-free installation and accurate system performance.

Serial Communications - Optional communications card provides complete energy, flow and temperature data to the control system through a single network connection, reducing installation costs.

DESCRIPTION

The System-10 BTU Meter provides highly accurate thermal energy measurement in chilled water, hot water and condenser water systems based on signal inputs from two matched temperature sensors (included) and any of ONICON's insertion or inline flow meters (ordered separately). The basic model provides a local indication of energy, flow and temperature data through an alphanumeric display. An isolated solid state dry contact is provided for energy total. Optional analog outputs and network communications are also available.

APPLICATIONS

Chilled water, hot water and condenser water systems for:

- Commercial office tenant billing
- Central plant monitoring
- University campus monitoring
- Institutional energy cost allocation
- Performance/efficiency evaluations
- Performance contracting energy monitoring

ORDERING INFORMATION

The System-10 BTU Meter is sold complete with temperature sensors. Thermowell installation kits and flow meters are purchased separately.

ITEM #	DESCRIPTION
SYSTEM-10	System-10 BTU Meter ←
SYSTEM-10-OPT8	High temperature sensors (over 200° F)
SYSTEM-10-OPT9	Add one analog output
SYSTEM-10-OPT10	Add four analog outputs
Choose from the following commonly used thermowell installation kits:	
SYSTEM-10-OPT4	Upgrade to outdoor thermowells (pair)
BTU-ST-INSTL32	Brass kit for welded steel pipe (¾" - 5") ←
BTU-ST-INSTL52	Brass kit for threaded steel pipe (¾" - 2½")
BTU-ST-INSTL34	SS kit for welded steel pipe (¾" and up)
BTU-ST-INSTL36	Brass kit for copper tube (¾" - 2")
BTU-ST-INSTL37	Brass kit for copper tube (2½" - 3")
Choose from the following flow meters:	
F-1100 / F-1200	Insertion Turbine Flow Meter (1¼" - 72")
F-1300	Inline Turbine Flow Meter (¾" - 1")
F-3100 / F-3200	Inline Electromagnetic Flow Meter (¼" - 48") ←
F-3500	Insertion Electromagnetic Flow Meter (3"- 72")
F-4200	Clamp-on Ultrasonic Flow Meter (½" - 48")
F-2000 Series	Inline Vortex Flow Meter (½" - 12")
Refer to catalog for flow meter installation kits. Consult with ONICON for additional thermowell installation kit and flow meter options.	

11451 Belcher Road South, Largo, FL 33773 • USA • Tel +1 (727) 447-6140 • Fax +1 (727) 442-5699
www.onicon.com • sales@onicon.com

SYSTEM-10 BTU METER SPECIFICATIONS

CALIBRATION
Flow meters and temperature sensors are individually calibrated followed by a complete system calibration.
Field commissioning is also available.

ACCURACY
TEMPERATURE
Overall differential temperature measurement uncertainty of ≤ ± 0.15° F over the stated range
(Includes uncertainty associated with the sensors, transmitters, cabling and calculator input circuitry)
Temperature sensors meet EN1434 / CSA C900.1 accuracy requirements for 1K sensors for cooling applications, 32° F - 77° F
Temperature sensors meet EN1434 / CSA C900.1 accuracy requirements for 2K sensors for heating applications, 140° F - 212° F

CALCULATOR
Computing nonlinearity within ±0.05%
Calculator meets EN1434 / CSA C900.1 class 1 accuracy requirements for 2K sensors for all applications

PROGRAMMING
Factory programmed for specific application
Field programmable via front panel interface

MEMORY
Non-volatile EEPROM memory retains all program parameters and totalized values in the event of power loss.

DISPLAY
Alphanumeric LCD displays total energy, total flow, energy rate, flow rate, supply temperature, return temperature, serial number and alarm status
Alpha: 16 character, 0.2" high
Numeric: 8 digit, 0.4" high
Rate Display Range: 0 - 9,999,999
Total Display Range: 0 - 9,999,999
The totals will roll over to zero when the maximum count is exceeded.

OUTPUT SIGNALS
Standard:
Isolated solid state dry contact for energy total:
Contact rating: 100 mA, 50 V
Contact duration: 0.5, 1, 2, or 6 sec
Optional:
Analog Output(s) (4-20 mA, 0-10 V or 0-5 V):
One or four analog output(s) available for flow rate, energy rate, supply/return temps, or delta-T.
Serial Communications:

BACnet IP or MS/TP	LONWORKS - TP/FT-10F
Siemens Apogee - P1	Johnson Controls Metasys - N2
MODBUS RTU RS485 or TCP/IP	

TEMPERATURE SENSORS
Solid state sensors are custom calibrated using N.I.S.T. traceable temperature standards.
Current based signal (mA) is unaffected by wire length.

TEMPERATURE RANGE
Standard liquid temperature range: 32° F to 200° F
Optional extended temperature ranges available
Ambient temperature range: -20° F to 140° F

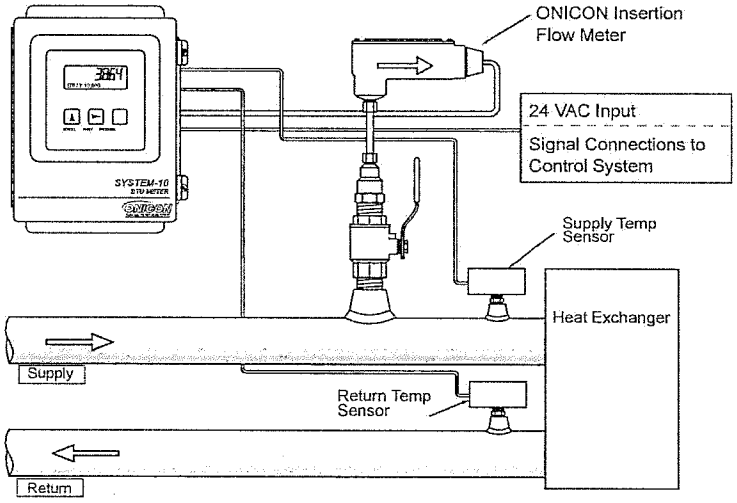
LIQUID FLOW SIGNAL INPUT
0-15 V pulse output from any ONICON flow meter

MECHANICAL
Electronics Enclosure:
Standard: Steel NEMA 13, wall mount, 8"x 10"x 4"
Optional: NEMA 4 (Not UL listed)
Approximate weight: 12 lbs
Temperature Sensor Thermowell Kits:
Thermowells and other kit components vary by fluid type, fluid temperature, pipe material and pipe size. Commonly used kits are listed on the previous page. Contact ONICON for additional thermowell kit options, including hot tap installation kits for retrofit installations.

ELECTRICAL
Input Power: Based on Btu meters configured for network connection without the optional analog outputs
Standard: 24 VAC, 50/60 Hz, 500 mA
Optional: 120 VAC, 50/60 Hz, 200 mA
230 VAC, 50 Hz, 150 mA
Internal Supply:
Provides 24 VDC at 200 mA to electronics and flow meter
Wiring:
Temperature signals: Use 18-22 ga twisted shielded pair
Flow signals: Use 18-22 ga - see flow meter specification sheet for number of conductors.

Note: Specifications are subject to change without notice.

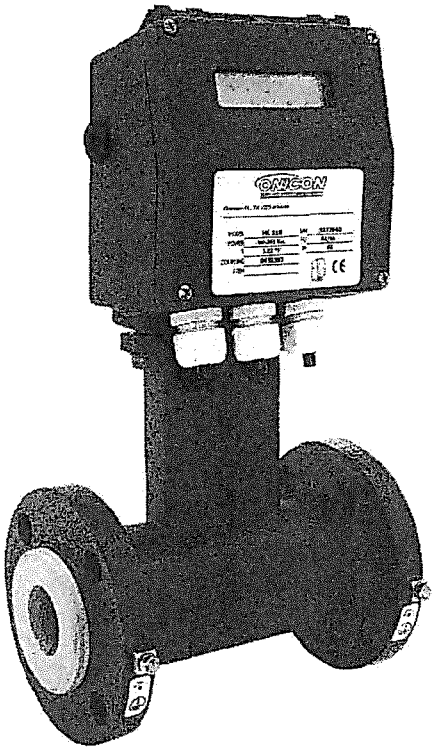
TYPICAL SYSTEM-10 INSTALLATION



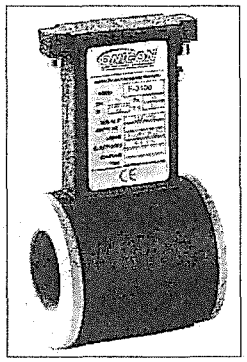
Insertion turbine flow meter shown. Any ONICON flow meter may be used with the System-10 BTU Meter. Consult with ONICON for additional flow meter types.

• F-3100 SERIES •
INLINE ELECTROMAGNETIC FLOW METER

ONICON
FLOW AND ENERGY MEASUREMENT



Wafer style meter is also available



Faraday's Law states that a voltage will be induced in a conductor (the conductive fluid) when it passes through a magnetic field (generated by the meter), and that voltage will be directly proportional to the velocity of the conductor (the fluid). This voltage is measured by electrodes on opposite sides of the flow tube and is used to calculate the flow velocity.

DESCRIPTION

ONICON F-3100 series inline electromagnetic flow meters are suitable for measurement of electrically conductive liquids, in a wide variety of applications. Inherently bi-directional, each F-3100 series meter is equipped with ONICON's standard transmitter that provides a single analog 4-20 mA output for flow rate and two programmable pulse outputs.

APPLICATIONS

- Chilled water, hot water, condenser water & water/glycol/brine solutions used in HVAC
- Bi-directional flow for primary/secondary bypass
- Process flow with conductivity greater than 5 µS/cm
- Domestic/municipal water

GENERAL SPECIFICATIONS

ACCURACY

Accurate to within:

- ± 0.4% of reading from 3.3 to 33 ft/s
- ± 0.75% of reading from 1 to 3.3 ft/s
- ± 0.0075 ft/s at flows less than 1 ft/s

(continued on back)

CALIBRATION

Every ONICON F-3100 series flow meter is wet calibrated in a flow laboratory against standards that are directly traceable to international standards. A certificate of calibration accompanies every meter.

FEATURES

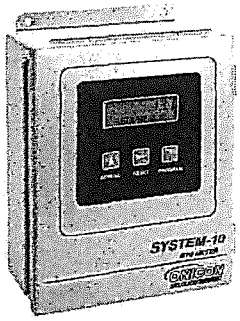
Exceptional Performance & Accuracy - ONICON F-3100 series meters deliver ± 0.4% of reading accuracy with as little as 3 diameters of straight pipe upstream of the meter, an exceptional level of performance by any standard.

Easy to Install and Use - Every ONICON meter is individually calibrated, configured and programmed using customer specific application data. Complex field programming is not required.

Excellent Long Term Reliability - ONICON electromagnetic flow meters have no moving parts. In addition, state-of-the-art electronics and proprietary noise filtering algorithms ensure years of accurate, trouble-free performance. This makes them the ideal choice for critical measurement applications or applications where water quality is less than ideal.

Advanced Design Features - Each meter is equipped with a multifunction user interface and display. Advanced programming options include an empty pipe detector, auto-zero and auto-calibration capabilities. A number of alarm options are also available.

Installation Flexibility - The F-3100 is an ideal choice for difficult installations as it only requires 3 diameters of straight pipe upstream and 2 diameters downstream for proper operation, in most applications.



For energy measurement applications, specify the F-3100 Flow Meter together with the System-10 BTU Meter to form an energy measurement system with exceptional accuracy and reliability.

11451 Belcher Road South, Largo, FL 33773 • USA • Tel +1 (727) 447-6140 • Fax +1 (727) 442-5699
www.onicon.com • sales@onicon.com

GENERAL SPECIFICATIONS (cont.)

ONICON
FLOW AND ENERGY MEASUREMENT

SENSING METHOD
Electromagnetic sensing (no moving parts)

AMBIENT TEMPERATURE RANGE
Electronics: 14° to 122° F
Sensor Body: Refer to Material vs. Temp graph

OUTER BODY MATERIAL OPTIONS
- Carbon Steel, painted
- 316 Stainless Steel

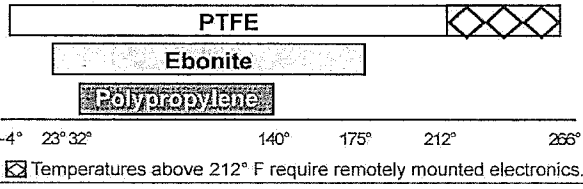
FLOW TUBE (internal)
304 Stainless Steel

CONNECTION TYPES AVAILABLE
- ANSI Class 150 Flange
- ANSI Class 300 Flange
- Wafer

ELECTRICAL CONNECTIONS
Use 18-22 AWG shielded cable

FLUID CONDUCTIVITY
- 5 µS/cm minimum

Liner Material vs. Operating Temperature (°F)



Temperatures above 212° F require remotely mounted electronics.

POWER SUPPLY OPTIONS
- 90 to 265 VAC, 44 to 66 Hz, 35 mA maximum
- 18 to 45 VDC or VAC, 44 to 66 Hz, 300 mA maximum

DISPLAY
16 character, 2-line alphanumeric LCD displays: flow rate and velocity, flow direction, totals, and alarm messages.

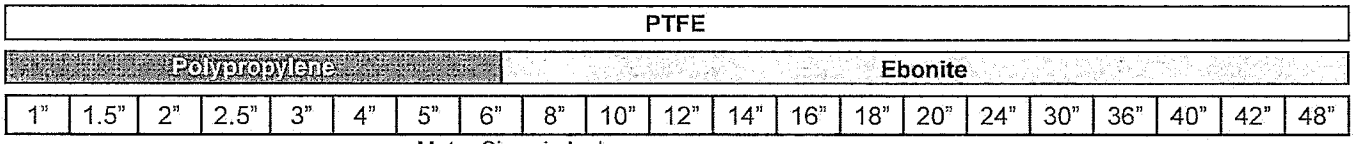
OUTPUT SIGNALS PROVIDED
- Isolated 4 - 20 mA analog output for flow rate
- (2) Programmable digital/pulse outputs (configurable for frequency, pulse or directional flow)
- Optional: MODBUS RTU (RS485)

ELECTRONICS ENCLOSURE
- Reinforced Nylon, NEMA 4X (IP65)
- Optional: For outdoor use, epoxy painted aluminum NEMA 6 (IP67)
- Optional: Remote mount transmitter (either version) available, maximum distance from the sensor - up to 164 ft @ conductivities ≥ 200 µS/cm.

MAXIMUM OPERATING PRESSURE
230 - 580 psi depending on liner material and flange rating (Consult ONICON when higher pressure ratings are required)

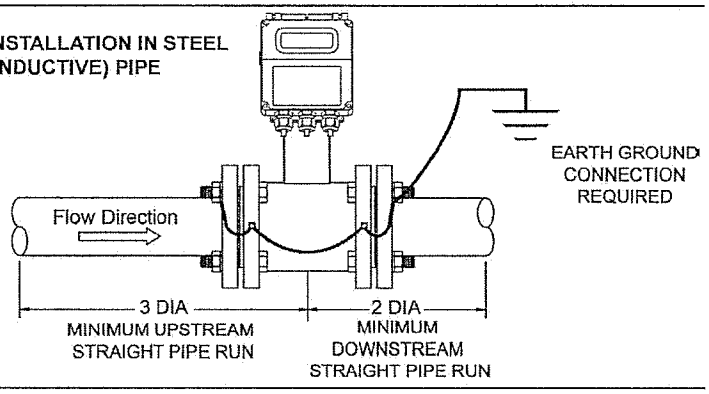
APPROVALS CE NSF - 61

Liner Material vs. Meter Size



Meter Sizes in Inches (other sizes available upon request)

TYPICAL INSTALLATION IN STEEL (CONDUCTIVE) PIPE



OPERATING RANGE

Pipe Size (Inches)	Flow Rate (GPM) (0.1 ft/sec* - 33 ft/sec)
1	0.2 - 79
1½	0.6 - 203
2	0.9 - 317
2½	1.6 - 536
3	2.4 - 812
4	3.8 - 1,268
5	5.9 - 1,981
6	8.5 - 2,853
8	15 - 5,072
10	24 - 7,925
12	34 - 11,412
14	47 - 15,533
16	61 - 20,288
18	77 - 25,678
20	95 - 31,701
24	137 - 45,649
30	214 - 71,326
36	308 - 102,710
40	380 - 126,803
42	417 - 139,800
48	547 - 182,596

*Note: The default low flow cut-off is set for 0.1 ft/sec

F-3100 Model Numbering System

F-31BB - CDE

BB = Meter Size in Inches
01 = 1" 05 = 5"
15 = 1.5" 06 = 6"
02 = 2" 08 = 8"
25 = 2.5" 10 = 10"
03 = 3"
04 = 4" Above 10": BB = meter size

C = Body Material & Liner Material
1 = Carbon steel / PTFE
2 = Carbon steel / Polypropylene
3 = Carbon steel / Ebonite

D = Wafer or Flange Connection
0 = Wafer
1 = ANSI 150 Flange
3 = ANSI 300 Flange

E = Integral or Remote Mount Electronics Enclosure
1 = Integral Mount
2 = Remote Mount

Default configurations include the following:
- (2) 316 SS electrodes
- Viton o-rings on Polypropylene lined meters

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QUOTATION

LEONHARDT COMPANY

ONICON INCORPORATED

Date: October 26, 2017
Company: DANIEL O'CONNELLS SONS
City/State: FRANKLIN, MA
Contact: GREG WAUGH
Fax Number:
Phone Number:
E-Mail: gwaugh@connells.com
Page 1 of : 1

Project: **BUCKLIN POINT NARRAGANSETT, RI - (REV)**

Thank you for considering ONICON for your flow and energy measurement needs.
We are pleased to offer the following quotation. Submittal information is attached (if applicable).
Should we be favored with an order, please send your purchase order and calibration data to CustomerService@onicon.com.

Item	Description	Qty.	Lead Time	Net Each	Extended Amount
1	***ONICON Model F-3104-111 Electromagnetic Flow Meter*** * Factory programmed - re+B19ady for use upon delivery * Meter Size: 4" * Process Connections: ANSI class 150 flange * Liner Material: PTFE * Electrode Material: 316SS * Body Material: epoxy coated steel * Integral transmitter (0.4% of rate) & display module * Outputs: 4-20mA and programmable pulse * Wet calibrated in accordance with international government standards with certificate	1	2 WKS	3,905.00	$3,905.00
3	***INSTL32- Standard Thermowell Kit for 3/4" - 5" welded steel pipe*** * For installation during new construction or during scheduled system shutdown; includes brass thermowells, 1/2 inch weld-on carbon steel branch outlets, and transmitter enclosures	1	STOCK	64.00	$64.00
4	**ONICON SYSTEM-10-MOD BTU Meter** **Modbus TCP/IP compatible** * Factory programmed w/certificate of calibration * Integral LCD/keypad; scroll to display total energy, total flow, energy rate flow rate, supply and return temperatures * Includes two bath-calibrated HIGH TEMPERATURE sensors with delta-T accuracy within ± 0.15 °F * Output Signals: Modbus TCP/IP network card provides total energy, energy rate, total flow, flow rate, supply and return temperatures. * Additional Output Signal: Isolated solid state dry contact for energy total * 25' CABLES	1	2 WKS	2,158.00	$2,158.00
5	**FREIGHT ALLOWANCE**	1		175.00	$175.00
6	**1-DAY START-UP AND TRAINING**	1		1,000.00	1,000.00
			NET TOTAL		**$7,302.00**

Lead time begins upon receipt of order and all calibration data.
Payment terms: net 30 days with approved credit or via Major Credit Card.
Subject to ONICON's Standard Conditions of Sale

Quoted By: LARRY LEONHARDT

Local Rep: LEONHARDT COMPANY, INC. WELLESLEY, MA 02482

11451 Belcher Road South, Largo, FL 33773 USA Phone (727) 447-6140 Fax (727) 442-5699
CustomerService@onicon.com

ORDER FORM: System-10 BTU Meter with Inline Mag Flow Meter

Please provide ship to & bill to information on purchase order

ONICON INCORPORATED

Company Name: and location (city,ST)	Daniel O'Connells Sons	**Requested delivery date:**	ASAP
Contact Name:	Greg Waugh	*Note: Standard lead time for meters is two weeks, contact factory if shorter lead time is required. Installation hardware and t-wells can usually ship immediately*	
Purchase Order #:	2015-102-020	**Ship meters via:**	*2 day*
Project Name: and location (city,ST)	Bucklin Point Biogas, East Providence, RI	**Ship install kits in advance?**	*No*
Specified By: (Onicon spec'd? Y or N) (Engineering firm, city, ST)	Brown & Caldwell	**Ship kits via:**	*2 day*

FLOW & TEMPERATURE INFORMATION

FLOW METER MODEL: (Do not enter model; auto-fill based on options below)	F-3104-111
FLOW METER TAG INFORMATION:	TBD
APPLICATION TYPE: *(CHW, HW, condenser water, etc.)*	HW
LIQUID TYPE: A. Water B. x% Ethylene Glycol C. x% Propylene Glycol D. Other	30% Glycol (type TBD)
PIPE SIZE *(nominal)*:	4
PIPE MATERIAL: *(i.e:. Carbon steel, copper tube, pvc, etc.)*	CARBON
MAXIMUM SYSTEM PRESSURE:	50
TYPICAL FLOW RATE: *Expected "typical" flow rate for the system*	Varies
DESIGN MAXIMUM FLOW RATE: *Maximum flow per system design*	309
ANALOG OUTPUT RANGE: (1.25 x design max.) *Or use default range based on 0-12 ft/s*	
MAX. OPERATING TEMPERATURE: † *Required for hot water systems only*	212
DESIGN SUPPLY TEMPERATURE: *Provide both values for dual mode systems*	200.4
DESIGN RETURN TEMPERATURE: *Provide both values for dual mode systems*	180.0

BTU METER PROGRAMMING INFORMATION

BTU METER MODEL:	System-10-MOD TCP/IP
BTU METER TAG INFORMATION:	TBD
MODBUS RTU ADDRESS: *(field programmable)*	
MODBUS IP ADDRESS: *(TCP version only)* Select default or enter custom IP address *(default = 192.168.1.24)*	
Baud Rate: choose 9600, 19200, other *(for RTU version only)*	
SYSTEM TYPE: A. Single Mode: cooling or heating B. Dual Mode: 2-pipe heating & cooling C. Dual Mode: Bi-directional flow	A
FLOW RATE DISPLAY UNITS: *(gpm, gal/hr, l/s, l/m or m³/hr)*	GPM
FLOW TOTAL DISPLAY UNITS: *(gal, liters or m³)*	GAL
ENERGY RATE DISPLAY UNITS: *(Btu/hr, tons or kW)*	BTU/HR
ENERGY TOTAL DISPLAY UNITS: *(Select Btu, ton-hrs or kW-hrs)*	BTU/HR
TEMPERATURE DISPLAY UNITS: *(Select °F or °C)*	F
SUPPLY VOLTAGE: *(24V ac 50/60 Hz is standard when connected to mag flow meter)*	120V

FLOW METER OPTIONS:

Options that affect price	
Transmitter/Converter Type: 1- Standard: 0.4% of Reading Accuracy 2- Advanced: 0.2% of Reading Accuracy	1
Meter Size (nominal diameter in inches): enter 2-digit size in inches such as "04"	04
Body & Liner Materials : 1- Carbon steel body/ PTFE liner 2- Carbon steel body/ Polypropylene liner 3- Carbon steel body/ Ebonite liner 4- 304SS body/ PTFE liner (check lead time) 5- 316SS body/ PTFE liner (check lead time)	1
Connection Type: 0- Wafer 1- ANSI Class 150 Flanges 3- ANSI Class 300 Flanges	1
Transmitter Mounting Options: 1-Integral 2-Remote w/o Pre-amp: 65 ft max 3-Remote w/Pre-amp: 1600 ft max(F-32xx)	1
Remote Mount Cable Length in Feet: 16, 32, 49 or 65 (>65ft, specify)	N/A
# of 316SS Electrodes: A- 2 Electrodes B- 3 Electrodes C- 2 Electrodes with grounding rings	A
Special Notes or configuration instructions:	

† HW applications with max. operating temp. over 200° F require extended range temperature sensors at additional cost.
HW with max. operating temp over 212° F requires remote mount transmitter

BTU METER OPTIONS:

Options that affect price	
Temperature Thermowells: **SS t-wells required for pipe sizes 6 inch and larger (except hot tap wells).	
A. Standard Thermowells B. Hot Tap Thermowells C. **SS Thermowells (also select A or B) D. Outdoor Thermowells (also select A or B)	B
Analog Output Signals: *Typically not required with serial network interface. (Note: Isolated dry contact for energy total is included in BTU Meter base price.)*	
1. Select A, B, or C A. No analog outputs (standard) B. One output (choose 1 of 5 below) C. Four outputs (choose 4 of 5 below)	
2. Select output(s), if applicable: A. Energy rate B. Liquid flow rate C. Supply temp D. Return temp E. Delta-T	
3. Select signal type, if applicable: A: 4-20 mA B: 0-10V C: 0-5V	
Temperature Sensor Type: † A. Standard: 32 - 200° F operating range B. Optional: 122 - 300° F operating range	
Sensor Cable Type: A. Standard: PVC sheathed cables B. Optional: plenum rated cables	A
Sensor Cable Length: A. Standard: 10 ft. cables B. Optional: 25, 50, 100 ft. cables	25
Electronics Enclosure: A. Standard: NEMA 13, steel B. Optional: NEMA 4, steel	A

Tel (727) 447-6140 Fax (727) 442-5699 e-mail: CustomerService@onicon.com

BTU METER
CERTIFICATE OF CALIBRATION

ONICON INCORPORATED

METER INFORMATION

Meter Tag: BTU-1
BTU Meter Model: SYSTEM-10-MODBUS_TCP
Serial No: 372124
Attached Flow Meter Model: F-3104-111
Serial No: 372124

SPECIFIED INSTALLATION & OPERATING PARAMETERS

Pipe Information: 4 Inch Mat'l Unknown Carbon Steel
Design Maximum Flow Rate: 309.0 GPM
Design Supply Temperature: MODE 1: 200°F
Design Return Temperature: MODE 1: 180°F
Fluid: 30% Propylene Glycol
Fluid Specific Heat: 0.964 BTU/lb°F
Fluid Density: 61.65 lb/ft³

CONFIGURATION DATA

Enclosure Type: NEMA 13
Input Supply Voltage: 120 AC
Thermowell Type:

CALIBRATION DATA

Firmware Version: DDM3.3
Communications Protocol: MODBUS_TCP
Device Network Address: 192.168.1.24
Flow Meter MCU Code: 30.000
Display Units & Multipliers:
Energy Total: BTU x 10K Energy Rate: BTU/HR x 1K
Flow Total: GAL x 100 Flow Rate: GPM x 1
Temperature: °F
Damping: 5

Pulse Duration: 500 ms
Supply Temperature Slope: 8.892 Offset: 76.880
Return Temperature Slope: 8.891 Offset: 76.910
Flow Diagnostic Test Output (60 Hz): 120 GPM

OUTPUT SIGNAL SCALING

Energy Total(s): 1 Pulse = BTU x 10K
Flow Rate: NA
Energy Rate: NA
Supply T: NA
Return T: NA
Delta T: NA

Calibrated By: Kurt Gunning
Kurt Gunning

Date: **11/10/2017**

ONICON Incorporated certifies that the flow and temperature sensors provided with this Btu meter have been individually calibrated based on the application specific data provided above; using standards directly traceable to the U.S. National Institute of Standards and Technology (N.I.S.T.).

11451 Belcher Road South, Largo, Florida 33773 Tel (727) 447-6140 Fax (727) 442-5699

FLOW METER
CERTIFICATE OF CALIBRATION

ONICON INCORPORATED

CALIBRATION & CONFIGURATION DATA for F-3000 SERIES MAGNETIC FLOW METERS

METER DATA

Meter Tag: **FM-1**
Model: **F-3104-111**
Serial Number: **372124**
Component S/N's: **04V001535 38U003419**

Meter Size: **4"**
Max. Operating Pressure: 225 psi
Max. Operating Temperature: 212 °F
Connections: ANSI 150# Class Flanges
Peripheral device serial number **372124**

CALIBRATION of PRIMARY FLOW ELEMENT

Ka factor: **1.4148**
Medium: **Water**

Primary Calibration Date: **4/6/2017**

ONICON certifies that this flow meter was calibrated in accordance with ISO 9104:1991 and ISO 17025:2005 using standards that are directly traceable to international standards.

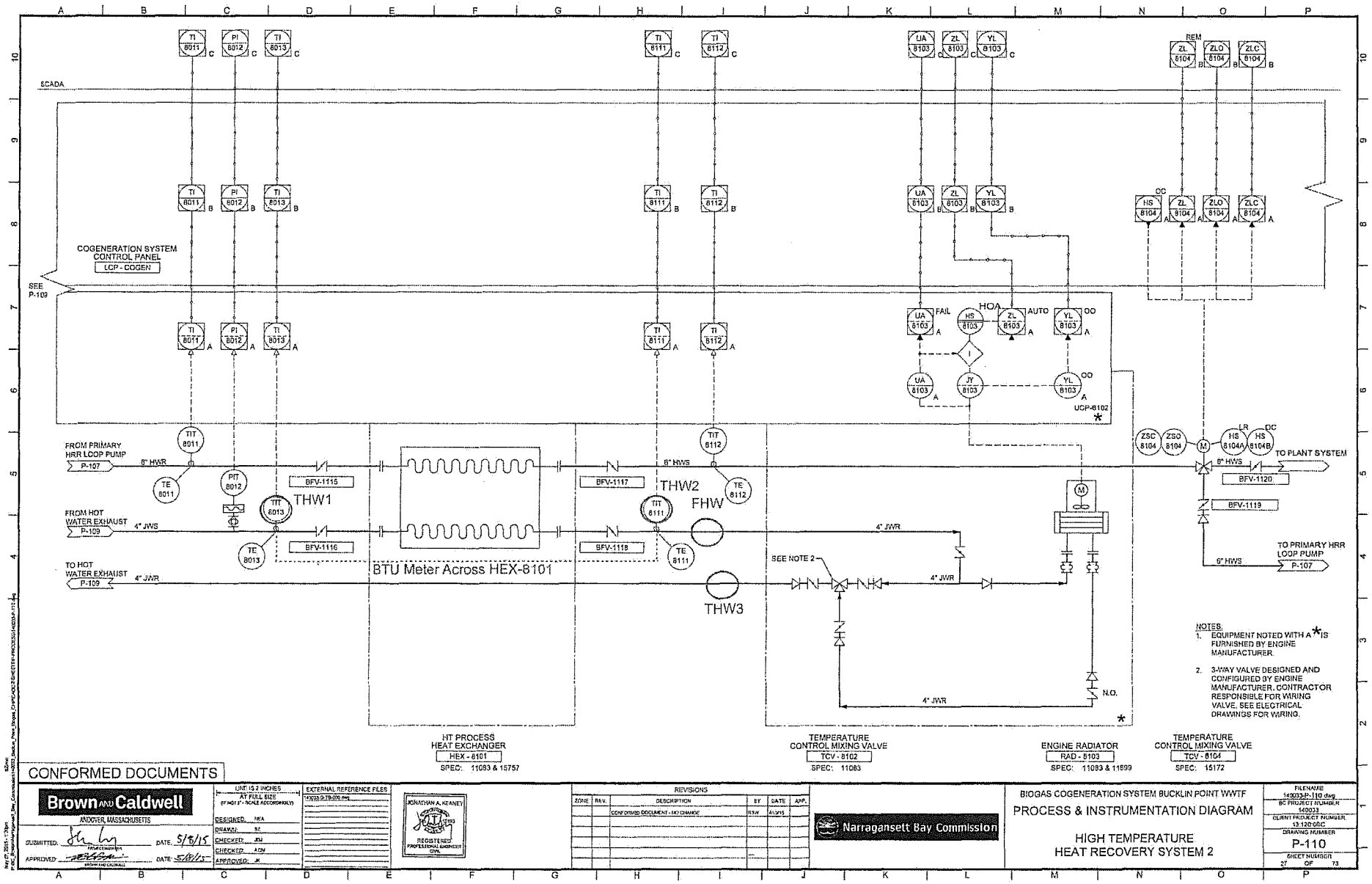
FACTORY PROGRAMMED OUTPUT SIGNALS

(Performed at ONICON Factory; can be reprogrammed in the field)

Analog Flow Range: 4-20 mA = 0 to	400.00	GAL/Min
Frequency Output Meter Factor	30.00	ppG
Scaled Pulse Output: 1 pulse =	100	Gallons

Programmed By: L.E.B. Date: 11/9/2017

11451 Belcher Road South, Largo, Florida 33773 Tel (727)447-6140 Fax (727)442-5699



NOTES:
1. EQUIPMENT NOTED WITH A * IS FURNISHED BY ENGINE MANUFACTURER.
2. 3-WAY VALVE DESIGNED AND CONFIGURED BY ENGINE MANUFACTURER. CONTRACTOR RESPONSIBLE FOR WIRING VALVE. SEE ELECTRICAL DRAWINGS FOR WIRING.

CONFORMED DOCUMENTS

Brown AND Caldwell
ANDOVER, MASSACHUSETTS

SUBMITTED: _____ DATE: 5/6/15
APPROVED: _____ DATE: 5/6/15

UNIT IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)
DESIGNED: MEA
DRAWN: SA
CHECKED: JDM
CHECKED: ADM
APPROVED: JK

EXTERNAL REFERENCE FILES
14093-S-TB-005.dwg

JONATHAN A. KEANEY
No. 37703
REGISTERED PROFESSIONAL ENGINEER
CIVIL

REVISIONS					
ZONE	REV.	DESCRIPTION	BY	DATE	APP.
		CONFORMED DOCUMENT - NO CHANGE	RSW	6/3/15	

Narragansett Bay Commission

BIOGAS COGENERATION SYSTEM BUCKLIN POINT WWTF

PROCESS & INSTRUMENTATION DIAGRAM

HIGH TEMPERATURE HEAT RECOVERY SYSTEM 2

FILENAME: 14093-P-110.dwg
BC PROJECT NUMBER: 140033
CLIENT PROJECT NUMBER: 13.120.06C
DRAWING NUMBER: P-110
SHEET NUMBER: 27 OF 73

February 16,2018

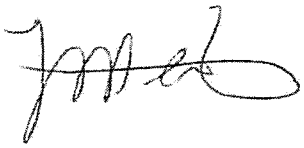
Debra A. Howland
Executive Director New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

RE:NBC Renewable Energy Source Eligibility for Class I Thermal Sources with Renewable Thermal Energy Capacity Greater than 200,000 BTU/hr.

Dear Ms. Howland,

As the Mechanical Inspector for NBC, I hereby attest that the BTU Meter and the Net Power Meter were both installed as per the approved drawings and requirements by the device manufactures. By contract and specification, this project is to be done in accordance with RI State Codes.
I declare that the above statement is true and accurate to the best of my knowledge.

Sincerely,



Jose Medina

Mechanical Inspector

RI Department of Environmental Management

Minor Air Source Approval No. 2337

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

12 December 2016

Mr. Raymond J. Marshall
Executive Director
Narragansett Bay Commission
Bucklin Point Waste Water Treatment Facility
102 Campbell Avenue
East Providence, RI 02916

Dear Mr. Marshall:

The Department of Environmental Management, Office of Air Resources has reviewed and approved your application for the construction, installation and operation of a sewage sludge digester-gas fired combined heat and power engine/generator set to be located at the Bucklin Point Waste Water Treatment Facility, 102 Campbell Avenue, East Providence, RI.

Enclosed is a minor source permit issued pursuant to our review of your application (Approval No. 2337).

If there are any questions concerning this permit, please contact me at (401)-222-2808, extension 7028 or at *aleida.whitney@dem.ri.gov*.

Sincerely,

Aleida M. Whitney
Senior Air Quality Specialist
Office of Air Resources

cc: East Providence Building Official
Kathryn Kelly, Narragansett Bay Commission
Eric Pearson, ESS Group, Inc.

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OFFICE OF AIR RESOURCES

MINOR SOURCE PERMIT

NARRAGANSETT BAY COMMISSION

APPROVAL NO. 2337

Pursuant to the provisions of Air Pollution Control Regulation No. 9, this minor source permit is issued to:

Narragansett Bay Commission

For the following:

Installation of a 644 kW Dresser-Rand Guascor lean-burn engine, Model No. SFGLD 360. The engine shall fire digester gas containing 100 ppm hydrogen sulfide or less, or natural gas.

Located at: *Bucklin Point Waste Water Treatment Facility*

102 Campbell Avenue, East Providence, RI

This permit shall be effective from the date of its issuance and shall remain in effect until revoked by or surrendered to the Department. This permit does not relieve *Narragansett Bay Commission* **from compliance with applicable state and federal air pollution control rules and regulations. The design, construction and operation of this equipment shall be subject to the attached permit conditions and emission limitations.**

Douglas L. McVay, Chief
Office of Air Resources

Date of Issuance

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OFFICE OF AIR RESOURCES

Permit Conditions and Emission Limitations

Narragansett Bay Commission

Approval No. 2337

I. The following requirements are applicable to:

- The Dresser-Rand Guascor, Model No. SFGLD 360, 0.644 MW, combined heat and power (CHP) internal combustion engine, capable of firing sewage sludge digester gas and natural gas. The heat input capacity of the engine while firing sewage sludge digester gas is 6.08 MMBtu/hr and 6.04 MMBtu/hr while firing natural gas.

A. Emission Limitations

1. Nitrogen Oxides (as Nitrogen Dioxide (NO_2))

   The emission rate of nitrogen oxides discharged to the atmosphere from the engine exhaust shall not exceed 1.53 pounds per megawatt-hour (lbs/MWh) or 0.98 pounds per hour, whichever is more stringent.

2. Carbon Monoxide (CO)

   The emission rate of carbon monoxide discharged to the atmosphere from the engine exhaust shall not exceed 5.50 pounds per megawatt-hour (lbs/MWh) or 3.54 pounds per hour, whichever is more stringent.

3. Volatile Organic Compounds (VOC)

   The emission rate of volatile organic compounds discharged to the atmosphere from the engine exhaust shall not exceed 2.14 pounds per megawatt-hour (lb/MWh) or 1.38 pounds per hour, whichever is more stringent.

4. Sulfur Dioxide (SO_2)

   a. The sulfur content of all digester gas burned in the engine shall not exceed 100 ppm by volume, dry.

   b. The emission rate of sulfur dioxide discharged to the atmosphere from the engine exhaust shall not exceed 0.19 pounds per hour.

5. Particulate Matter (as PM)

The emission rate of particulate matter discharged to the atmosphere from the engine exhaust shall not exceed 0.31 pounds per megawatt-hour (lb/MWh) or 0.20 pounds per hour, whichever is more stringent.

6. Opacity

Visible emissions from the engine exhaust shall not exceed 10% opacity.

7. Listed Toxic Air Contaminants

The emissions of 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide and formaldehyde discharged to the atmosphere from the engine exhaust while firing digester gas shall not exceed the levels specified in the following table:

Pollutant	lbs/hr	lbs/day	lbs/year
1,3-Butadiene	--	--	46.43
Acetaldehyde	--	--	744.61
Acrolein	3.00E-03	--	26.28
Benzene	0.017	0.408	148.92
Ethylene dibromide	--	0.084	30.66
Formaldehyde	0.011	0.264	96.36

B. Operating Requirements

1. Sewage sludge digester gas and natural gas shall be the only fuels fired in the engine.

2. All sewage sludge digester gas shall be directed through the hydrogen sulfide (H_2S) remediation system and the siloxane remediation system prior to being fired in the engine.

3. The maximum firing rate of the engine shall not exceed 11,237 ft^3/hr of sewage sludge digester gas or 6,491 ft^3/hr of natural gas.

4. The engine must be equipped with an automatic fail-safe block valve, which must be designed to stop the flow of sewage sludge digester gas in the event of an engine failure.

5. In the event that the engine is not operational, all sewage sludge digester gas from the digester tanks shall be routed to the flares or digester tank boilers.

6. The owner/operator shall operate and maintain the hydrogen sulfide (H_2S) remediation system and the siloxane remediation system according to the manufacturer's design specifications and operating procedures.

C. Monitoring Requirements

1. The engine shall be equipped with a non-resettable elapsed time meter to indicate, in cumulative hours, the elapsed engine operating time for the unit.

2. The generator shall be equipped with a kilowatt-hour meter to indicate, in cumulative kilowatt-hours, the power generated by the engine-generator set.

3. Sewage sludge digester gas and natural gas flow to the engine shall be continuously measured and recorded.

4. The engine shall be equipped with an air-to-fuel ratio controller and ignition timer to maintain efficient fuel combustion.

5. The owner/operator shall, on a daily basis, measure and record the O_2 content in the exhaust of the engine.

D. Compliance Demonstration/Stack Testing

1. Within 90 days of startup, initial performance testing shall be conducted for the engine for nitrogen oxides, carbon monoxide, and volatile organic compounds.

   For nitrogen oxides, carbon monoxide, and volatile organic compounds, performance testing shall be conducted in accordance with 40 CFR 60.4244. The test report shall indicate the engine power in (kW and BHP) during the test and the biogas heating value. To demonstrate compliance with this permit, the performance test results shall be reported in lb/hr and lb/MWh. To demonstrate compliance with NSPS 40 CFR Part 60, Subpart JJJJ emission limits, the performance test results shall be reported in g/bhp-hr.

   Thereafter, emissions testing for the engine shall be conducted every 8760 hours of operation or every 3 years, whichever is first, to determine compliance with the nitrogen oxides, carbon monoxide, and volatile organic compounds. Each emission test for nitrogen oxides, carbon monoxide, and volatile organic compounds shall be conducted in accordance with the procedures specified in 40 CFR 60.4244.

2. Additionally, during the initial performance test, the owner/operator shall measure the emissions of sulfur dioxide, particulate matter, 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide and formaldehyde from the engine stack to demonstrate compliance with the emission limitations in Conditions I.A.4-5 and I.A.7 of this permit. Additionally, the owner/operator shall determine and quantify individual species of volatile organic compounds (VOC) emissions other than the six listed toxic air contaminants.

3. A stack testing protocol shall be submitted to the Office of Air Resources and the USEPA at least 60 days prior to the performance of any emissions test. The owner/operator shall provide the Office of Air Resources and the USEPA at least 60 days prior notice of any emissions test.

4. All test procedures used for stack testing shall be approved by the Office of Air Resources and the USEPA prior to the performance of any stack tests.

5. The owner/operator shall install any and all test ports or platforms necessary to conduct the required stack testing, provide safe access to any platforms and provide the necessary utilities for sampling and testing equipment.

6. All testing shall be conducted under operating conditions deemed acceptable and representative for the purpose of assessing compliance with the applicable emissions limitations.

7. All emissions testing must be observed by the Office of Air Resources or the USEPA to be considered acceptable, unless the Office of Air Resources or the USEPA provides written authorization to the owner/operator to conduct the testing without an observer present.

8. A final report of the results of the initial and subsequent performance tests shall be submitted to the Office of Air Resources and the USEPA no later than 60 days following completion of testing.

E. Recordkeeping and Reporting

1. The owner/operator shall, on a monthly basis, no later than 15 days after the first of each month, determine and record the following for the engine for the previous month:

   a. The hours of operation and the total hours of operation for the prior consecutive 12-month period.

   b. The fuel use.

   c. The gross electrical power generated in kilowatt-hours.

   The owner/operator shall keep records of this determination and provide such records to the Office of Air Resources or its authorized representative upon request.

2. The owner/operator shall, on a daily basis, measure and record the O_2 content in the exhaust of the engine and the date, time and measurement shall be recorded. The owner/operator shall keep records of this determination and provide such records to the Office of Air Resources or its authorized representative upon request.

3. The owner/operator shall, on a monthly basis, no later than 15 days after the first of the month, determine the total quantity of 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide and formaldehyde discharged to the atmosphere from the engine during the previous month while firing sewage sludge digester gas. Hourly emission averages shall be calculated for acrolein, benzene and formaldehyde. These hourly averages shall be used for comparison to the hourly emission limitations. Daily emission totals shall be calculated for benzene, ethylene dibromide, and formaldehyde to be used for comparison the daily emission limitations. Monthly and annual emission averages shall be calculated for 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide and formaldehyde

to be used for comparison to the annual emission limitations. The owner/operator shall keep records of this determination and provide such records to the Office of Air Resources upon request.

4. The owner/operator shall notify the Office of Air Resources in writing, within 15 days of determining that the total quantity of 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide or formaldehyde, discharged to the atmosphere from the engine exceeds the hourly, daily, or annual emission limitations.

5. The owner/operator shall develop a maintenance plan for the engine and air pollution control system and shall maintain records of all maintenance conducted.

6. The owner/operator shall notify the Office of Air Resources in writing of the date of actual initial start-up of the engine no later than fifteen days after such date.

F. Other Permit Conditions

1. The emission limitations of Conditions I.A. shall not apply during engine startup/shutdown conditions. Engine startup shall be defined as the first ten minutes of firing following the initiation of firing. Engine shutdown shall be defined as the cessation of operation for any purpose.

2. The owner/operator is subject to the requirements of 40 CFR 60, Subpart A (General Provisions) and Subpart JJJJ (Standards of Performance for Stationary Spark Ignition Internal Combustion Engines). Compliance with all applicable provisions therein is required.

II. The following requirements are applicable to the three existing 3.891 MMBtu/hr Gordon Piatt digester tank boilers, Model No. R12.8-GG-30, capable of burning sewage sludge digester gas and natural gas:

A. Emission Limitations – Digester Gas Firing

1. Listed Toxic Air Contaminants

The emissions of acetaldehyde, acrolein, benzene, and formaldehyde discharged to the atmosphere from each boiler shall not exceed the levels specified in the following table:

Pollutant	lbs/hr	lbs/day	lbs/year
Acetaldehyde	--	--	0.088
Acrolein	6.30E-06	--	0.055
Benzene	1.87E-05	4.49E-04	0.164
Formaldehyde	3.97E-05	9.53E-04	0.348

B. Operating Requirements

1. Sewage sludge digester gas and natural gas shall be the only fuels combusted in each boiler.

2. The maximum firing rate of each boiler shall not exceed 7,192 ft^3/hr of sewage sludge digester gas or 3,891 ft^3/hr of natural gas.

3. All sewage sludge digester gas shall be directed through the hydrogen sulfide (H_2S) remediation system prior to being combusted in each boiler.

4. The owner/operator shall maintain and operate each boiler according to the manufacturer's design specifications and operating procedures.

B. Monitoring Requirements

1. Sewage sludge digester gas flow to each boiler shall be continuously measured and recorded.

C. Recordkeeping and Reporting

1. The owner/operator shall maintain the following records and provide such records to the Office of Air Resources upon request:

   a. The sewage sludge digester gas flow rate to each boiler;

   b. The dates and times when each boiler is combusting sewage sludge digester gas.

2. The owner/operator shall, on a monthly basis, no later than 15 days after the first of the month, determine the total quantity of sewage sludge digester gas combusted in each boiler. The owner/operator shall keep records of this determination and provide such records to the Office of Air Resources upon request.

3. The owner/operator shall, on a monthly basis, no later than 15 days after the first of the month, determine the total quantity of acetaldehyde, acrolein, benzene, and formaldehyde discharged to the atmosphere from each boiler during the previous month while firing digester gas. Hourly emission averages shall be calculated for acrolein, benzene, and formaldehyde. These hourly averages shall be used for comparison to the hourly emission limitations. Daily emission totals shall be calculated for benzene and formaldehyde to be used for comparison the daily emission limitations. Monthly and annual emission averages shall be calculated for acetaldehyde, acrolein, benzene, and formaldehyde to be used for comparison to the annual emission limitations. The owner/operator shall keep records of this determination and provide such records to the Office of Air Resources upon request.

4. The owner/operator shall notify the Office of Air Resources in writing, within 15 days of determining that the total quantity of acetaldehyde, acrolein, benzene, or formaldehyde discharged to the atmosphere from each boiler exceeds the respective hourly, daily or annual emission limitations.

5. The owner/operator shall maintain records of all maintenance conducted on each boiler.

III. The following emission limitations are applicable to the two existing 5.150 MMBtu/hr Varec candlestick flares, Model No. 244W:

A. Emission Limitations – Digester Gas Firing

1. Listed Toxic Air Contaminants

The emissions of acetaldehyde, acrolein, benzene, and formaldehyde discharged to the atmosphere from each flare shall not exceed the levels specified in the following table:

Pollutant	lbs/hr	lbs/day	lbs/year
Acetaldehyde	--	--	1.17
Acrolein	3.09E-05	--	0.27
Benzene	4.91E-04	0.0118	4.30
Formaldehyde	3.61E-03	0.0866	31.62

2. Each flare shall be designed for and operated with no visible emissions as determined by the methods specified in condition III.D.1, except for periods not to exceed a total of 5 minutes during any 2 consecutive hours.

B. Operating Requirements

1. Sewage sludge digester gas shall be the only fuel combusted in each flare, except the use of propane as an auxiliary fuel shall be allowed to light the pilot.

2. Excess sewage sludge digester gas generated from the digester tanks and not combusted by the CHP engine or the boilers, shall be treated by the flares before discharge to the atmosphere.

3. Each flare shall be operated with a flame present at all times.

4. Each flare shall be used only with the net heating value of the gas being combusted being 200 BTU/SCF or greater. The net heating value of the gas being combusted shall be determined by the methods specified in 40 CFR 60.18(f)(3).

5. The owner/operator shall visually inspect each flare system to confirm that a flame is present at least once per shift. The date and time of each observation shall be recorded.

6. Each flare shall be operated at all times when sewage sludge digester gas is being vented to it.

7. The owner/operator shall maintain and operate each flare according to the manufacturer's design specifications and operating procedures.

C. Monitoring Requirements

1. The owner/operator shall monitor each flare to ensure that it is operated and maintained in conformance with its design.

2. The owner/operator shall install, calibrate, maintain and operate according to the manufacture's specifications, the following equipment:

   a. A heat sensing device, such as an ultraviolet beam sensor or thermocouple, at the pilot light or the flame itself to indicate the continuous presence of a flame; and

   b. A gas flow rate measuring device that shall record the flow to each flare at least every 15 minutes.

D. Testing Requirements

1. Method 22 of Appendix A to 40 CFR 60 shall be used to determine the compliance of each flare with the visible emission provisions of condition A.1. The observation period is 2 hours and shall be used according to Method 22.

E. Recordkeeping and Reporting

1. The owner/operator shall maintain the following records and provide such records to the Office of Air Resources upon request:

   a. The sewage sludge digester gas flow rate to each flare;

   b. The dates and times when each flare is combusting sewage sludge digester gas;

   c. All visible emission readings;

   d. Heat content determinations;

   e. Exit velocity determinations; and,

   f. Continuous records of pilot flame or flare flame monitoring and records of all periods of operations during which the pilot flame or the flare flame is absent.

2. The owner/operator shall, on a monthly basis, no later than 15 days after the first of the month, determine the total quantity of acetaldehyde, acrolein, benzene, and formaldehyde discharged to the atmosphere from each flare during the previous month. Hourly emission averages shall be calculated for acrolein, benzene, and formaldehyde. These hourly averages shall be used for comparison to the hourly emission limitations. Daily emission totals shall be calculated for benzene and formaldehyde to be used for comparison the daily emission limitations. Monthly and annual emission averages shall be calculated for acetaldehyde, acrolein, benzene, and formaldehyde to be used for comparison to the annual

emission limitations. The owner/operator shall keep records of this determination and provide such records to the Office of Air Resources upon request.

3. The owner/operator shall notify the Office of Air Resources in writing, within 15 days of determining that the total quantity of acetaldehyde, acrolein, benzene, or formaldehyde discharged to the atmosphere from each flare exceeds the respective hourly, daily or annual emission limitations.

4. The owner/operator shall maintain records of all maintenance conducted on each flare.

5. The owner/operator shall keep up-to-date, readily accessible continuous records for each flare of the flame or flare pilot flame monitoring and up-to-date, readily accessible records of all periods of operation which the flame or flare pilot flame is absent.

IV. The following requirements are applicable to operations on a facility-wide basis:

A. Emission Limitations

1. Listed Toxic Air Contaminants

The total quantity of emissions discharged to the atmosphere from the entire facility, of any listed toxic air contaminant, with the exception of 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide, and formaldehyde shall not exceed the minimum quantity for that contaminant as specified in Appendix A of Air Pollution Control Regulation No. 9, during a calendar year. Emissions from activities exempted from the provisions of APC Regulation No. 22 in subsection 22.2.2 are not included in this limitation.

2. Odors

Any air contaminant or combination of air contaminants discharged to the atmosphere from the facility shall not create an objectionable odor beyond the property line of this facility. Odor evaluations shall be conducted according to the provisions of Air Pollution Control Regulation No. 17.

B. Monitoring Requirements

1. The owner/operator shall, upon startup and at least daily, measure the hydrogen sulfide concentration (in ppm by volume) at both the inlet and the outlet of the H_2S remediation system and the date, time and measurement shall be recorded.

2. All monitoring equipment used for measuring all parameters required by this permit shall be calibrated periodically, consistent with the manufacturer's recommendations.

C. Recordkeeping and Reporting

1. The owner/operator shall maintain records of the hydrogen sulfide concentration (in ppm by volume) at the inlet and the outlet of the H_2S remediation system and provide such records to the Office of Air Resources upon request.

2. The owner/operator shall notify the Office of Air Resources in writing, within 15 days of determining that the concentration of H_2S in the digester gas at the outlet of the H_2S remediation system exceeds 100 ppm, by volume, dry.

3. The owner/operator shall, for each calendar year, determine the total quantity of each listed toxic air contaminant in Appendix A of Air Pollution Control Regulation No. 9 discharged to the atmosphere from all operations at the entire facility excluding 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide, and formaldehyde. The owner/operator shall keep records of this determination and provide such records to the Office of Air Resources upon request.

4. The owner/operator shall notify the Office of Air Resources in writing, within 15 days of determining that the total quantity of emissions discharged to the atmosphere from the entire facility, of any listed toxic air contaminant excluding 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide, and formaldehyde, exceeds the minimum quantity for that contaminant as specified in Appendix A of Air Pollution Control Regulation No. 9. In accordance with Air Pollution Control Regulation No 22, this notification shall be included in the annual air pollution inventory.

5. Any breakdown or malfunction of the engine, flares or digester tank boilers resulting in the discharge of sewage sludge digester gas shall be reported to the Office of Air Resources within one hour after the occurrence. A written report of any breakdown or malfunction shall be submitted within five (5) days of the breakdown or malfunction. The following information shall be provided in each report:

   a. The date the breakdown or malfunction occurred

   b. The suspected reason for the malfunction

   c. The corrective action taken

   d. The time needed to make repairs

   A copy of each report shall be kept at the facility.

6. The owner/operator shall notify the Office of Air Resources of any anticipated noncompliance with the terms of this permit or any other applicable air pollution control rules and regulations.

7. The owner/operator shall notify the Office of Air Resources in writing of any planned physical or operational change to any equipment that would:

a. Change the representation of the facility in the application.

b. Alter the applicability of any state or federal air pollution rules or regulations.

c. Result in the violation of any terms or conditions of this permit.

d. Qualify as a modification under APC Regulation No. 9.

Such notification shall include:

- Information describing the nature of the change.
- Information describing the effect of the change on the emission of any air contaminant.
- The scheduled completion date of the planned change.

Any such change shall be consistent with the appropriate regulation and have the prior approval of the Director.

8. The owner/operator shall notify the Office of Air Resources, in writing, of any noncompliance with the terms of this permit within 30 calendar days of becoming aware of such occurrence and supply the Director with the following information:

a. The name and location of the facility;

b. The subject source(s) that caused the noncompliance with the permit term;

c. The time and date of first observation of the incident of noncompliance;

d. The cause and expected duration of the incident of noncompliance;

e. The estimated rate of emissions (expressed in lbs/hr or lbs/day) during the incident and the operating data and calculations used in estimating the emission rate;

f. The proposed corrective actions and schedule to correct the conditions causing the incidence of noncompliance.

9. The owner/operator shall maintain properly signed, contemporaneous operating logs or other relevant evidence to document actions during startup/shutdown periods.

10. All records required in this permit shall be maintained for a minimum of five years after the date of each record and shall be made available to representatives of the Office of Air Resources or its authorized representative and EPA upon request.

D. Other Permit Conditions

1. To the extent consistent with the requirements of this permit and applicable federal and state laws, the equipment shall be designed, constructed and operated in accordance with the representation of the equipment in the permit application.

2. Employees of the Office of Air Resources and its authorized representatives shall be allowed to enter the facility at all times for the purpose of inspecting any air pollution source, investigating any condition it believes may be causing air pollution or examining any records required to be maintained by the Office of Air Resources.

3. At all times, including periods of startup, shutdown and malfunction, the owner/operator shall, to the extent practicable, maintain and operate the facility in a manner consistent with good air pollution control practice for minimizing emissions. The general duty to minimize emissions does not require you to make any further efforts to reduce emissions if levels required by this permit have been achieved. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Office of Air Resources which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures and inspection of the source.

4. The emission and dispersion characteristics of all sources of 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide, and formaldehyde at the facility shall be consistent with the parameters used in the air quality modeling to demonstrate that the emissions of 1,3-butadiene, acetaldehyde, acrolein, benzene, ethylene dibromide, and formaldehyde from the facility do not cause or contribute to air pollution in violation of RI Air Pollution Control Regulation No. 22. The Office of Air Resources, in its sole discretion, may reopen this minor source permit if it determines that the emission and dispersion characteristics have changed significantly and that emission limitations must be revised and/or added to this permit to ensure compliance with RI Air Pollution Control Regulation No. 22.

E. Malfunctions

1. The owner/operator may seek to establish that a malfunction of any air pollution control system that would result in noncompliance with any of the terms of this permit or any other applicable air pollution control rules and regulations was due to unavoidable increases in emissions attributable to the malfunction. To do so, the owner/operator must demonstrate to the Office of Air Resources that:

   a. The malfunction was not attributable to improperly designed equipment, lack of preventative maintenance, careless or improper operation or operator error;

   b. The malfunction is not part of a recurring pattern indicative of inadequate design, operation or maintenance;

   c. Repairs were performed in an expeditious fashion. Off-shift labor and overtime should be utilized, to the extent practicable, to ensure that such repairs were completed as expeditiously as practicable.

d. All possible steps were taken to minimize emissions during the period of time that repairs were performed.

e. Emissions during the period of time that the repairs were performed will not:

(1) Cause an increase in the ground level ambient concentration at or beyond the property line in excess of that allowed by Air Pollution Control Regulation No. 22 and any Calculated Acceptable Ambient Levels; and

(2) Cause or contribute to air pollution in violation of any applicable state or national ambient air quality standard.

f. The reasons that it would be impossible or impractical to cease the source operation during said period.

g. The owner/operator's actions in response to the excess emissions were documented by properly signed, contemporaneous operating logs or other relevant evidence.

This demonstration must be provided to the Office of Air Resources within two working days of the time when the malfunction occurred and contain a description of the malfunction, any steps taken to minimize emissions and corrective actions taken.

The owner/operator shall have the burden of proof in seeking to establish that noncompliance was due to unavoidable increases in emissions attributable to the malfunction.