

**QUALITY ASSURANCE/QUALITY CONTROL  
(QA/QC) PLAN  
FOR  
NOBLEHURST FARMS ANAEROBIC DIGESTER GAS (ADG)  
SYSTEM  
Agreement # ADG-31569**

*Final Draft*

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*Submitted to:*

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*and*

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*Submitted by:*

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## Introduction

This plan describes the approach that will be used to monitor the performance of the anaerobic digester gas (ADG) system that is currently being installed at Noblehurst Farms, Inc. in Pavilion, NY, to produce biogas and electricity. Biogas will be used to fuel one engine-generator to produce power that will be consumed on site and/or exported back to the local utility. A monitoring system will be installed to measure and collect the data necessary to quantify the electric power produced and amount of biogas used by the engine-generator. The data will serve as the basis for payment of ten (10) years of performance incentive payments, which The Farm has applied for under a Standard Performance Contract with NYSERDA based on a Total Contracted Capacity of 440 kW.

## ADG System Description

The digester system at the farm was designed by EnviTec Biogas USA Inc. The power plant equipment was provided by Martin Machinery while the gas conditioning equipment was supplied by EnviTec Biogas USA Inc. Gas and power metering are provided by Gen-Tec and Martin Machinery. The site will operate one 440 kW synchronous engine-generator with gas conditioning equipment, piping and controls installed in a designated building next to the digester. All the electrical loads at the farm have been consolidated into a single 3-phase, 277/480 volt electrical service in order to accommodate the interconnection of the generator system. The electrical system includes controls to synchronize the generator to the grid as well as a protective relay and controls to automatically isolate the units from the utility grid in the event of a utility power outage. The generator will be connected to the National Grid distribution network through a primary net metered system. A 315 kW, diesel generator is connected to the farm electrical system for use during power outages.



*Site*



*Digester*

**Figure 1 - Photos of System Components**

**Table 1 - Biogas Systems at Noblehurst Farms**

Digester	EnviTec Biogas Digester Complete mix co-digestion system
Feedstock	Dairy Manure, Milk Waste, Spoiled Feed; 2,737 animal equivalents
Engine	Guascor HGM 240 Engine 440 kW on biogas at 100% load
Generator	Stamford HCM534D – 480 VAC, 3 Phase
Biogas Conditioning	Air is introduced from a compressor to reduce H <sub>2</sub> S level in the internal layer of digester plus biogas flows through 200 feet horizontal underground pipe which reduces temperature and removes excessive moisture before being introduced to CHP system.
Engine Backup/startup Fuel	None
Heat Recovery Use	Digester heating
Additional Heat Recovery	Heat Technical Building, dry dewatered digestate solids, provide heat for milk processing plant

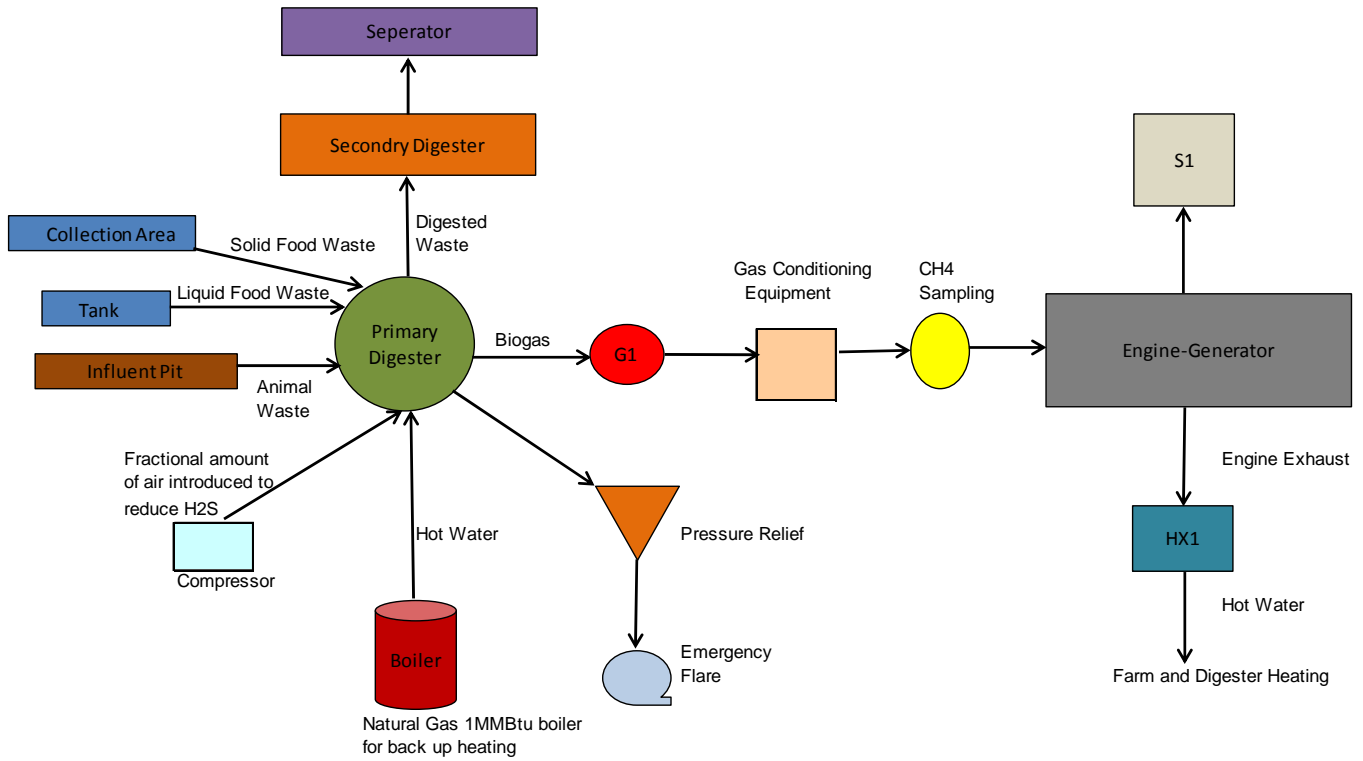


**Figure 2 - Engine-Generator Room**

Figure 3 schematically shows the biogas system and engine-generator. Figure 4 shows the single line electrical diagram for the system. Fractional amount of air is introduced from a small compressor to the underside of the internal layer of the digester to reduce H<sub>2</sub>S levels. This would reduce the average H<sub>2</sub>S levels in the resulting biogas down to the range of 225-300 ppm. Before it is introduced to the genset, the biogas from the digester flows 200 feet in an underground pipe which lowers its temperature and removes excessive moisture.

Biogas from the digester is used in the engine-generator, or flared. When excessive quantities and/or pressures are detected the emergency flare is ignited. Additionally the digester system also has a pressure guard that will release excess renewable biogas under the internal cover

should that be required. Thus, there are three (3) different integrated components (CHP, flare, pressure guard) in the digester system to handle renewable biogas quantities and pressures in order to maintain the integrity of the system. Sage Prime metering devices measure gas flow to the engine-generator.



**Figure 3 - Biogas System Schematic**

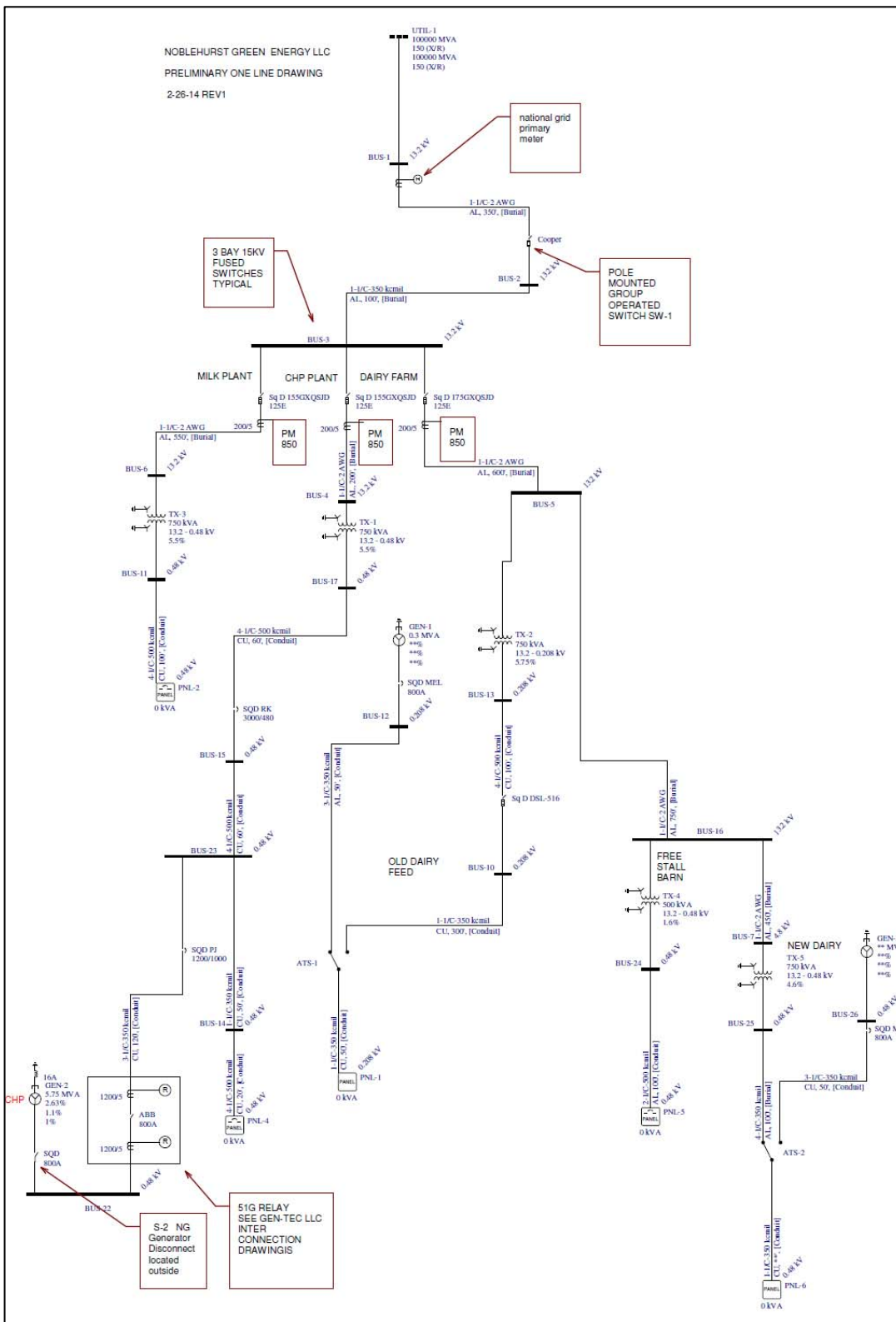


Figure 4 - Single Line Electrical Diagram

## ADG System Capacity Payment Descriptions

This Section describes the Capacity Incentive Payments included in the Agreement, the payment milestones to be achieved in order to receive payment, and the deliverables to be provided in achieving these milestones.

**Capacity Payment #1:** Up to 15% of Total Capacity Incentive or the total of initial payments whichever is less.

**Payment Milestones:** Initial payments made for major equipment and other work, such as the engine generator system, the anaerobic digester system, the gas scrubbing equipment, and other major components and fees for system design, engineering, CESIR study and other “soft costs”.

**Deliverables:** Documentation that initial payments have been made to suppliers or service providers for major project components.

**Capacity Payment #2:** Up to 40% of the Total Capacity Incentive less the amount paid for the first milestone

**Payment Milestones:** Delivery of power generation equipment on-site and approval of QA/QC Plan. In the Agreement, in Section B of the Application Form the planned Guascor engine (Model HGM 240) and generator (Stamford HCM 534D) are stated to have a capacity of 456 kW. The Contracted Capacity in Exhibit A is 440 kW after factoring in system controls to limit output.

**Deliverables:** (a) A QA/QC Plan approved by NYSERDA and (b) Delivery receipts, photos or other documentation acceptable to NYSERDA of delivery of the engine and generator equipment as described in the Agreement in Section B of the Application and adequate explanation of any deviations. *(If the installed equipment deviates from that listed in the Application Package, an explanation of the deviation must be provided for determination by NYSERDA whether the installed equipment adequately meets the terms of the Agreement.)*

**Capacity Payment #3:** 20% of the Total Capacity Incentive for the New Anaerobic Digester

**Payment Milestones:** Completed installation of the New Anaerobic Digester. In the Agreement, in Section B of the Application Form, the following System capabilities are identified:

- Working volume capacity of the mixed digester is stated to be 178,692 cf.
- Estimated Annual biogas generation totals 70.6 million scf/y.

**Deliverables:** Site inspection and verification by the NYSERDA technical consultant that the installation is complete and operational in accordance with the approved QA/QC Plan. The digester can be considered complete and operational if the digester structures, piping, controls and equipment are all installed for the feeding mixing, heating and unloading of digester feedstocks and for gas treatment and flaring. The completed installation may be documented with (a) a listing of the digester structures, piping, controls and equipment for feeding, mixing, heating and unloading and gas treatment and flaring and other major equipment to be installed in the design and (b) provision of as-built drawings, photos, verification by on-site inspection by

the NYSERDA technical consultant, and/or other means satisfactory to NYSERDA documenting that these have been installed and are ready to operate to produce and manage the annual biogas production total of 70.6 million scf identified in the Section B: ADG System in the Agreement. *(If the installed equipment deviates from that listed in the Application Package, an explanation of the deviation must be provided for determination by NYSERDA whether the installed equipment adequately meets the terms of the Agreement.)*

**Capacity Payment #4:** 20% of Total Capacity Incentive for New Power Generation Capacity

**Payment Milestones:** New Power Generation Capacity operational and interconnection completed.

**Deliverables:** Documentation that (a) the interconnection acceptance test has been accepted by the utility and interconnection approval has been obtained from the utility and (b) the new power generation equipment is complete and operational in accordance with the approved QA/QC Plan. The New Power Generation Capacity can be considered complete and operational if it has produced electricity at a minimum average of 75% capacity factor or 330kWh/h for at least one hour.

**Capacity Payment #5:** 20% of Total Capacity Incentive for Commissioning of the New Power Generation using Anaerobic Digester Gas.

**Payment Milestones:** Successful commissioning and operation of the new power generation system at a minimum average of 75% capacity factor or 330 kWh/h for at least 7 consecutive days and demonstration of (a) the ability to upload information to NYSERDA's DG/CHP Integrated Data System website and (b) high quality gas cleanup documented to produce measured H<sub>2</sub>S output less than 400 ppm.

**Deliverables:** A Project Commissioning Report documenting the completion of all elements of the Commissioning process required by the QA/QC Plan and successful uploading of data to the website that is adequately consistent to NYSERDA's satisfaction with the data recorded on site.

The Project Commissioning Report shall consist of the compilation of information prepared in meeting the deliverables requirements for all payment milestones including:

1. Documentation that construction of the ADG-to Electricity System is complete;
2. Documentation that the System has been interconnected with the utility grid;
3. Documentation that the System's New Equipment has satisfactorily operated for at least seven consecutive days, which is defined as operation with an minimum average 75% Capacity Factor of the Total Contracted Capacity or 330 kWh/h;
4. Documentation that the System has demonstrated the ability to upload information to NYSERDA's DG/CHP Integrated Data System website in conformance with the



following section of the QA/QC Plan: Monitoring System Equipment, Installation, Operation, and Maintenance;

5. Documentation that the gas cleanup produces measured H<sub>2</sub>S output less than 400 ppm in accordance with the section below on QA/QC Procedures for Documenting High Quality Gas Cleanup
6. As-Built Diagrams of the installed system, including an explanation of any deviation of the equipment from that listed in the Application Package. Diagrams may consist of electronic copies of as-built drawings.

## Monitoring System Equipment, Installation, Operation, and Maintenance

Figure 3 shows the location of the meters used to measure fuel gas input to the engine-generator (G1) and meter S1 used to measure the kilowatts generated. Information on these data points is shown in Table 2.

**Table 2 - Monitored Points for ADG System**

Point Type	Point Name	Description	Instrument	Engineering Units	Expected Range
Pulse	S1	Engine-Generator Power	Shark Revenue-grade Meter 200-60-10-V2-D2-20mAOS-X	kW	0-650 kW
Pulse	G1	Engine Biogas Flow	Sage Metering Inc. Model SIP-05-06-DC24-D	SCFH	0 to 15,000 SCFH

Shark200 Revenue grade meter will be installed to provide an output of the energy and power data which will be used to determine Annual Performance Incentives.

Additionally, the electrical output of the engine-generator will be measured with the Intelisys NT engine controller engine controller. The controller will be installed in a standalone cabinet on the side of the engine by the electrical contractor. It has an external graphical display which shows real time and total kWh. The controller will be installed according to the requirements in the appropriate operator guide. The controller will be protected by a dedicated circuit breaker. The measurements available on the controller are for backup purposes only.

The biogas input to the engine will be measured by a Sage Prime mass flow meter (G1) that provides pulse output proportional to the volume flow that is compensated for temperature. The meter will be installed and maintained according to the “Sage Thermal Gas Mass Flow Meter Operations and Instruction Manual for Models SIP/SRP,” as part of the engine generation equipment provided by Martin Machinery. A log of maintenance activities for the meters will be maintained at the site.

The lower heating value for the biogas is estimated to be 580 Btu/ft<sup>3</sup>, based on past measurements of the CH<sub>4</sub> content of typical biogas. This value will be verified weekly based on measurements of methane using a LANDTEC GA3000 Plus Fixed Gas Analyzer for CH<sub>4</sub> range 0-100%. The Farm staff will perform the CH<sub>4</sub> tests and log the results in the project log. This test is performed by taking a gas sample from the low pressure gas supply after it exits the gas conditioning equipment. The sampling point is marked in Figure 3 as “CH<sub>4</sub> Sampling”.

There is 1 MMBtu natural gas boiler at the site to heat the digester when the engine generator is down. However, when the engine is up and running, heat from the CHP will be heating the digester.

A separate cabinet supplied by Envitec mounted on the wall across from the controller houses the SCADA system which does the data logging. This unit collects, and assembles mass flow and power output data from the two monitoring points described in Table 2 into .csv format reports. A graphical display on the outside of the cabinet shows kWh production and mass flow information. The data logger will be programmed to record the totalized data for each monitoring point for each 15-minute interval. A record of all multipliers and data logger settings will be maintained.

The data logger will be connected to an uninterruptible power supply (UPS) to ensure the data logger retains its settings and data in the event of a power outage. The Farm will provide a static IP address that will be used by CDH Energy, the NYSERDA CHP Website Contractor, to communicate with the data logger. We have confirmed that CDH Energy will call the data logger nightly, via high speed modem link, to extract monitoring data from our ADG system and transfer the data to the NYSERDA CHP Website. If communications are lost, the SCADA system is capable of holding up to 4 to 5 years of 15 minute interval data.

## **Management of Monitoring System Data**

The Farm will perform the following quality assurance and quality control measures to ensure the data produced from our system accurately describes system performance.

On a daily basis, The Farm equipment manager will perform inspections of the digester and engine-generator equipment and record findings into the project log.

On a weekly basis, The Farm equipment manager will perform inspections of the QA/QC meter installations and complete the routine maintenance on the meters, noting any abnormalities or unexpected readings. The Farm will also maintain a weekly log of the cumulative power generation (kWh) from meter S1 and gas flow (cf or ft<sup>3</sup>) recorded by the Sage meter in the event that data transfer to the NYSERDA CHP Website fails or other anomalies occur.

On a weekly basis, The Farm staff will review the data stored in the NYSERDA CHP Website ([chp.nyserdera.org](http://chp.nyserdera.org)) to ensure it is consistent with our observed performance of the ADG system

and logged readings. The Farm will review the data using the reporting features at the website, including:

- Monitored Data – Plots and Graphs, and
- RPS: Customer-Sited Tier Anaerobic Digester Gas-to-Electricity Program NYSERDA Incentive Program Reports.

In addition, The Farm staff will also setup and use the email reports that are available at the CHP Website to help track the system performance, including:

- a periodic email report summarizing system performance and the estimated incentive,
- an email report sent out if data is not received at the web site or does not pass the quality checks.

The website will automatically take the data collected from the data-logger and evaluate the quality of the data for each 15-minute interval using range and relational checks. The expected ranges for the sensors (see Table 2) will be used to develop the range check values for the 15-minute intervals.

The relational check will compare the kWh production data and gas production data for each 15-minute interval to ensure that both meters are registering at least a minimum reading (gas flow of at least 100 cubic feet per hour and power production of more than 30 kW). If a minimal gas and electric flows are not shown at the same time, this indicates that one or both meters have failed.

Only data that passes the range and relational quality checks will be used in the incentive reports listed above. However, all hourly data is available from the NYSERDA CHP Website using the “Download (CSV file)” reporting option. In the event of a communications or meter failure, the farm will work with CDH Energy to resolve the issue in a few days.

If unanticipated loss of data occurs when the engine-generator continues to produce electricity, The Farm intends to follow the procedures outlined in Exhibit D, of their contract, i.e. use data from similar periods – either just before or after the outage - to replace the lost data. The Farm understands that they can use this approach for up to two 36 hour periods within each 12-month performance period. If more than two such data outages occur, the Farm will provide information from other acceptable data sources acceptable to NYSERDA to definitively determine the amount of power that was being produced from biogas during the period in question.

### **Annual Performance Reports**

Noblehurst Farms will prepare Annual Performance Reports summarizing the monthly data over the 12-month performance period. The reports will include a table (example provided below) showing the monthly kWh production, biogas use by the engine, and other data listed in Table 3, and if used, any natural gas or other fuel used for the engine. The Farm may use acceptable data from the NYSERDA CHP Website or other sources found acceptable to NYSERDA. The methods for calculating these values are provided below.

Table 3 - Summary of Monthly Data for Annual Performance Reports

Start Date of Reporting Period	Number of Days in Each Period	Electricity Production, kWh <sub>generator</sub>	Biogas Used by Engine, (cubic feet)	LHV <sub>biogas</sub> (Btu/cf)	Biogas Energy Content, Q <sub>biogas</sub> (BTU)
TOTALS					

The Farm will calculate monthly values for lower heating value of the biogas (LHV<sub>biogas</sub>), and total energy content of the biogas (Q<sub>biogas</sub>) as follows.

**Monthly Biogas Lower Heating Value**

The readings of CH<sub>4</sub> concentration in the biogas gathered weekly will be used to estimate the average monthly Biogas Lower Heating Value using the following equation:

$$LHV_{biogas} = LHV_{methane} \cdot F_{CH4}$$

where:

- LHV<sub>methane</sub> - lower heating value of methane (911 Btu/ft<sup>3</sup> at standard conditions, 60 °F and 1 atm)
- F<sub>CH4</sub> - fraction of biogas that is CH<sub>4</sub> (average of readings for each month)

**Monthly Biogas Energy Content**

Calculate the average monthly Biogas Energy Content using the following equation:

$$Q_{biogas} = CF \cdot LHV_{biogas}$$

where:

- CF - volume (cubic feet or ft<sup>3</sup>) of biogas in month

## Reasonable Electrical Efficiency

The Annual Performance Report will also provide a comparison of power output and fuel input for the engine to confirm their reasonableness. For instance, the electrical efficiency – measured as power output ( $\text{kWh}_{\text{generator}}$ ) divided by the energy content of the fuel input ( $Q_{\text{biogas}}$ ) in similar units and based on lower heating value – should be in the 25% to 35 % range over any interval for the engine-generator at Noblehurst Farms.

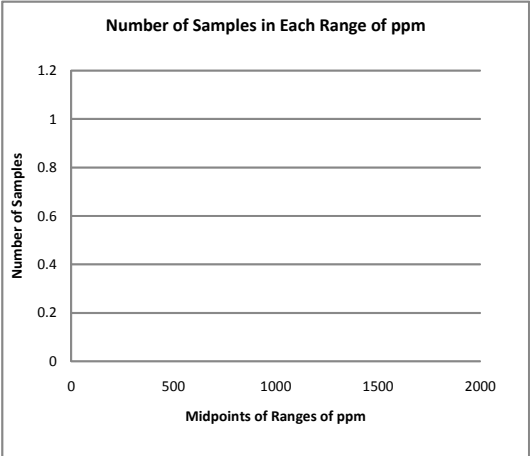
## **QA/QC Procedures for Documenting High Quality Gas Cleanup**

Payment of this incentive shall ultimately be based on adequate measurements of the ability of the High Quality Gas Cleanup Equipment (HQGCE) to reduce  $\text{H}_2\text{S}$  levels to less than 400 ppmv. Measurements can be made with continuous automatic gas sampling and analysis, by daily testing with manual sampling equipment, or by other methods found acceptable to NYSERDA. For this project the LANDTEC GA3000 Plus Fixed Gas Analyzer serial number GA3KP163 will be used to measure the  $\text{H}_2\text{S}$  concentrations. A link to the specifications for the Analyzer is found at the end of the QA/QC Plan. Currently, farm is using Union Gas (INCA 4000) analyzer which gives 10-minute interval readings for  $\text{H}_2\text{S}$  ppm levels.

The following paragraph describes how daily test results can be used to document the ability of the equipment to achieve the required output level to receive the added incentive for the High Quality Gas Cleanup Equipment (HQGCE). The individual who operates the ADG-to-Electricity system will compile hourly hydrogen sulfide levels on at least 25 days within a consecutive 30-day period during which the ADG system operates (a) at at least 75% of the design production rate for biogas of 70.6 million scf/yr and thereby produces 4.35 million scf in the 30-day period and (b) with average  $\text{CH}_4$  levels in the biogas reaching 50% or higher over the 30-day period. For the purposes of payment approval, adequate measurements of the ability of the HQGCE to achieve  $\text{H}_2\text{S}$  removal to less than 400 ppmv shall be considered to be documented if 75% or more of the daily average  $\text{H}_2\text{S}$  concentrations for those 25 to 30 days within that 30 day period show  $\text{H}_2\text{S}$  levels in the output of the HQGCE to be less than 400 ppmv.

The worksheet below will be used as a template for documenting the capabilities of the HQGCE. Biogas flow and  $\text{H}_2\text{S}$  output from the HQGCE will be documented for each the 25 to 30 days that samples are taken. Average  $\text{CH}_4$  content shall be determined by taking measurements for at least 7 of the 25 to 30 days. If the percentage of cumulative daily averages with 399 ppm  $\text{H}_2\text{S}$  and below is 75% or more of the total number of daily averages, the worksheet can be submitted to document adequate compliance with the requirement for payment of the HQGCE incentive. NYSERDA may direct its technical contractors to sample the biogas, determine  $\text{H}_2\text{S}$  removal efficiency, and compare the results to the data originally provided by the operator.

Worksheet to Document Ability of High Quality Gas Cleanup to Produce Average Daily H2S Concentrations Less than 400 ppm for 75% of Daily Averages											
Data to be completed by operator					Analysis which can be done by Technical Consultant						
A	B	C	D	E	F	G	H	J	K	L	
Day	Date	Cumulative scf biogas generation	CH4 percent in biogas	Daily average Hydrogen Sulfide ppm in biogas after clean up	Sorted Hydrogen Sulfide Data ppm	Range of H2S daily average concentration ppm	Mid range values for graph	Number of daily averages in each range	Cumulative number of daily averages less than range maximum	Percentage of cumulative daily averages less than range maximum	
0											
1						0 to 99	50		0		
2						100 to 199	150		0		
3						200 to 299	250		0		
4						300 to 399	350		0		
5						400 to 499	450		0		
6						500 to 599	550		0		
7						600 to 699	650		0		
8						700 to 799	750		0		
9						800 to 899	850		0		
10						900 to 999	950		0		
11						1000 to 1099	1050		0		
12						1100 to 1199	1150		0		
13						1200 to 1299	1250		0		
14						1300 to 1399	1350		0		
15						1400 to 1499	1450		0		
16						1500 or more	1550		0		
17								Total Samples	0		
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
		0	#DIV/0!	#DIV/0!	0						
		Total scf biogas generated in 30 Days is greater than 4.35 million scf	Average CH4 Percentage is greater than or equal to 50%	Average ppm of daily average H2S results	Number of H2S samples						



Note: 70.6 million scf/yr would average 5.8 million scf/30-day period at 100% biogas capacity factor. At 75% capacity factor generation would be 4.35 million scf/30-day period.

**Additional Attachments to document**

**Cut sheets and Manuals for:**

**Sage Metering Inc., Model SIP-05-06-DC24-DIG-GAS Mass Flow Meter**

**ComAP Intelisis NT Controller IS-NT-BB**

**Shark200 Revenue Grade Meter 200-60-10-V2-D2-20mAOS-X**

**LANDTEC GA3000 Plus Fixed Gas Analyzer**

**Union Gas Analyzer Model INCA4000**