QUALITY ASSURANCE/QUALITY CONTROL PLAN
FOR
TWIN BIRCH DAIRY, LLC ANAEROBIC DIGESTER GAS (ADG) SYSTEM

ADG Agreement #27740

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Submitted to:

New York State Energy Research and Development Authority
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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 has been installed at Twin Birch Dairy ("The Farm"), in Skaneateles, NY, to produce biogas and electricity. Biogas is being used to fuel one engine-generator. The power produced is being consumed on site and/or exported back to the local utility. A monitoring system has been installed to measure and collect the data necessary to quantify the electric power produced and amount of biogas used by the engine-generator. This data will serve as the basis for payment of three (3) years of performance incentive payments, which have been applied for under a Standard Performance Contract with NYSERDA. The site has one engine-generator with Total Contracted Capacity of 225 kW.

ADG System Description

The digester system at the farm was designed and provided by Anaerobics, Inc. The power plant was provided by Martin Machinery. Gas and power metering equipment have been provided by Gen-Tec and Sage Metering Inc. The site is operating one 225 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 generator system. The engine-generator 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 is connected to the National Grid distribution network through a two meter system - one outgoing and one incoming. A 225 kW, diesel generator is connected to the farm electrical system through a 400 A disconnect/transfer switch for use during power outages.

Digester and Flare

Engine-Generator Building

Figure 1 - Photos of System Components

Table 1 - Biogas Systems at Twin Birch Dairy

Digester	Anaerobic digester Plug flow, concrete cover, heated
Feedstock	Dairy Manure, 1,270 animal equivalents
Engine	Guascor SFGLD180 Engine – 225 kW on biogas at 100% Load
Generator	Stamford Generator – 480 VAC, 3 Phase
Biogas Conditioning	American Biogas Conditioning - Model 4500
Engine Backup/startup Fuel	None
Heat Recovery Use	Digester heating
Additional Heat Recovery	None

Figure 2 - Engine-Generator Room

Figure 3 shows the process flow diagram and Figure 4 shows the single line electrical diagram for the system. Biogas from the digester is used in the engine-generator, the boiler or flared. The biogas flare operates using a mechanically-actuated relief valve that vents biogas to maintain the gas input from the digester. Sage Prime metering devices measure gas flow to the flare, the boiler and the engine-generator Reduction in H2S is accomplished by the installation of an American Biogas Conditioning, LLC desulphurization unit. This system will reduce the amount of H2S in the gas from the existing conditions of 3500-4000 ppm (Parts Per Million) down to 250 ppm or less by taking the biogras directly from the digester prior to entering the engine and condition the biogas to reduce the amount of H2S in the gas which will ensure longer engine life. Inside a bioreactor, the H2S in the biogas is first absorbed in a washing liquid and then is regenerated by microbial degradation of the dissolved H2S. After the process is complete, the scrubbed biogas can enter the engine. Exhaust gas from the engine passes through a plate heat exchanger where the exhaust heat is transferred to water used to heat the digester.

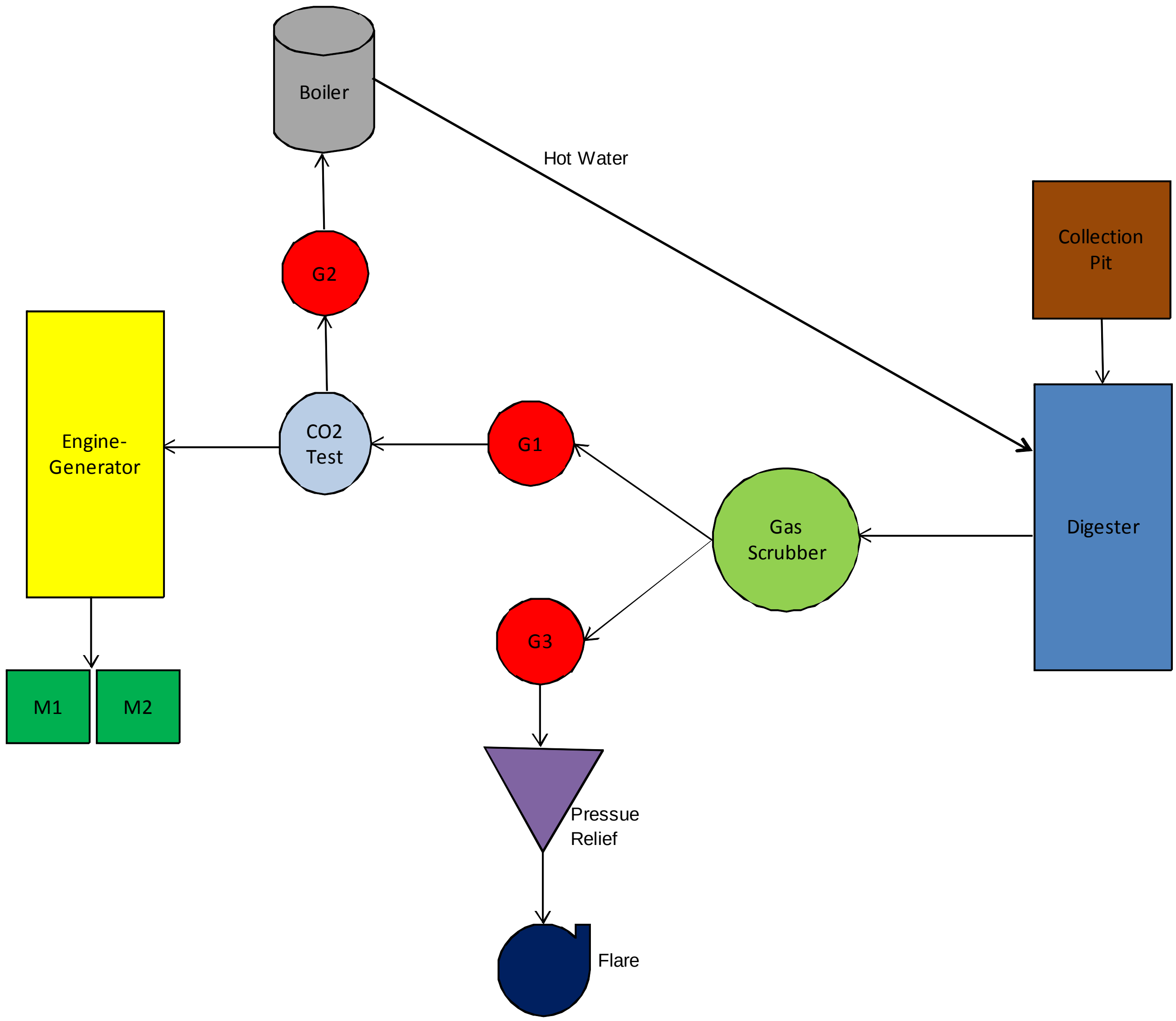

Figure 3 – Process Flow Diagram

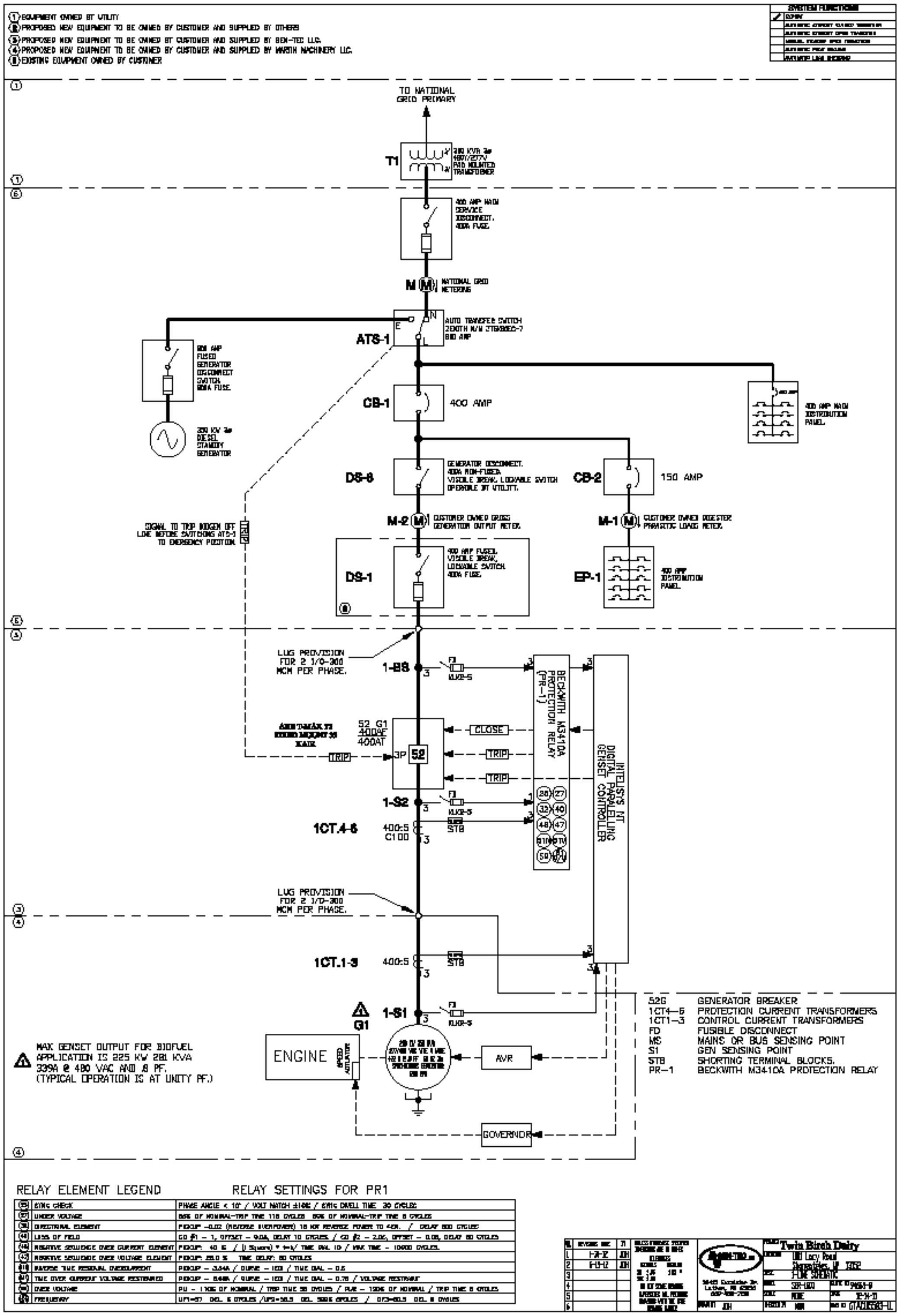

Figure 4 - Single Line Electrical Diagram

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), the auxiliary boiler (G2) and flare (G3). Figure 4 shows the location of the meters (M2) 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	M2	Engine-Generator Power	E-MonD-Mon Model 480400 KIT - Confirmed to comply with ANSI C12.20 (see attachments).	kW	0- 300 kW
Pulse	G1	Engine Biogas Flow	Sage Metering Inc. Model SIG-05-15 Mass Flow Meter	ft^3/15-minute interval	0-1500 ft^3/15-minute interval
Pulse	G2	Boiler Biogas Flow	Sage Metering Inc. Model SIG-05-15 Mass Flow Meter	ft^3/15-minute interval	0-1500 ft^3/15-minute interval
Pulse	G3	Engine Flare Flow	Sage Metering Inc. Model SIG-05-15 Mass Flow Meter	ft^3/15-minute interval	0-1500 ft^3/15-minute interval

The electrical output of the engine-generator is measured with two E-MonD-Mon model 480400 KIT power transducers labeled M2. These power transducers include an LCD display and are installed above the electrical panel by the electrical contractor. The transducers are installed in accordance to requirements in the “E-MonD-Mon Class 2000 Installation Manual. The meters will be protected by a dedicated circuit breaker. M2 measures output from engine-generator while M1 measures all parasitic loads, which are recorded by the farm. The installed meters comply with ANSI C12.20.

The biogas input to the engine-generator is measured by two Sage mass flow meters, Sage1 measuring total biogas flow to the engine-generator and the auxiliary boiler and Sage 2 measuring biogas flow to the boiler only. The gas flow input to the engine-generator is equal to Sage meter 2 reading subtracted from Sage meter 1 reading. A third Sage meter, Sage 3 measures gas flow to the flare. The meters are installed according to the “Sage Thermal Gas Flow Meter Operations and Instruction Manual for Models SIG/SRG”. A log of maintenance activities for the meters will be maintained at the site.

An internet or phone accessible data logger has been installed by the NYSERDA CHP Website Contractor to collect, compile and log the data from the four monitoring points listed in Table 2 (see datalogger details in Appendix) then download and transfer the operating data to the NYSERDA CHP Website.

The data logger has been 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 NYSERDA CHP Website Contractor 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 hand written logs will be checked for validity.

The lower heating value for the biogas is estimated to be 580 Btu/$ft^{3,}$ based on past measurements of the CO_2 content of the biogas. This value will be confirmed or adjusted based on weekly measurements of carbon dioxide using a Fyrite Gas Analyzer Model No. 10-5032 for CO_2 range 0-60%. Our farm owner, Dirk Young or other qualified staff, will perform the CO_2 tests and log the results in the project log. This test is performed by taking a gas sample from the low pressure gas supply before it enters the skid. The sampling point is marked in Figure 3 as “CO2 Test.”

There is no backup/startup fuel for the engine-generator in this system. The auxiliary boiler runs on digester gas.

Management of Monitoring System Data

We 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, our equipment manager will perform inspections of the digester and engine-generator equipment and record findings into the project log.

On a weekly basis, the equipment manager will perform inspections of the meter installations and complete the routine maintenance on the meters, noting any abnormalities or unexpected readings. We will also maintain a weekly log of the cumulative power generation (kWh) from meter M2 and gas flow (cf or ft^3) recorded by the two Sage meters in the event that data transfer to the NYSERDA CHP Website fails or other anomalies occur.

On a weekly basis, our staff will review the data stored in the NYSERDA CHP Website (chp.nyserda.org) to ensure it is consistent with our observed performance of the ADG system and logged readings. We will use the website notification service provided at no charge by NYSERDA to alert us to any problems with the data between monthly data reviews. We will review the data using the *Monitored Data – Plots and Graphs* and *RPS: Customer-Sited Tier Anaerobic Digester Gas-to-Electricity Program NYSERDA Incentive Program Reports*, which can both be accessed through the NYSERDA CHP Website.

We understand that the CHP Website Contractor will take the data called from the data logger and evaluate the quality of the data for each hour of the day using range and relational checks. The expected ranges from the sensors, which will be used for the range checks, are listed in Table 2 under the “Expected Range” header. We understand that the relational check for new and existing generation will compare the kWh production data ,and gas production data sets for each 15-minute interval for the engine-generator to ensure that both sets of meters always provide non-zero readings at the same time (e.g., to detect if a meter has failed). The value for M2 will be used to measure kWh production from the engine-generator. These values should not exceed the maximum range values and should be greater than zero. The value of G1 will be used for the total gas supplied to the engine-generator. We understand that only hourly data that passes all of these quality checks are used in the *RPS: Customer-*

Sited Tier Anaerobic Digester Gas-to-Electricity Program NYSERDA Incentive Program Reports; however, all hourly data, those that pass the range and relational checks and those that do not, can be downloaded from the NYSERDA CHP Website using the “Download (CSV file)” reporting option.

The Farm will sign up for automated emails at the NYSERDA CHP Website in order to receive: 1) a periodic report summarizing system performance and the estimated incentive, 2) an email report sent out if data are not received at the web site or do not pass the quality checks. In the event of a communications or meter failure, we will work to resolve the issue in a few days.

The Farm will communicate any significant discrepancies we find to the CHP Website Contractor, the Project Technical Consultant and the NYSERDA Project Manager. If discrepancies in the data are found, the farm understands that we have the responsibility to clearly explain the discrepancy if we intend to invoice NYSERDA based on the electricity generation associated with the data in question.

If unanticipated loss of data occurs when the engine-generator continues to produce electricity, we intend to follow the procedures outlined in Exhibit D, i.e. use the average data from just before and just after the outage, to replace the lost data. We understand that we 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 for time periods during which production incentives will be requested, we will provide information from other acceptable data sources to definitively demonstrate the amount of power that was being produced from ADG fuel during the period in question.

Annual Performance Reports

Twin Birch Dairy will prepare Annual Performance Reports from data for the new system covered by Agreement # 27740. The reports will include a table (example provided below) showing the monthly kWh production, biogas use by the engine-generator, other data listed in Table 3, and if used, any propane or other fuel used for the subject engine-generator. We may use data summarized in the *RPS: Customer-Sited Tier Anaerobic Digester Gas-to-Electricity Program NYSERDA Incentive Program Reports* to populate this table; however, if we disagree with the *Reports* we will provide our own summary of the data (e.g., hourly CSV data downloaded from the Website using the “Download (CSV file)” reporting option), along with a narrative justifying why we feel our calculations are more appropriate. Our methods for calculating these values are provided below.

Table 3 - Summary of Monthly Data for Annual Performance Reports

Start Date of Reporting Period (e.g. February 14, 2012)	Monthly Periods	Number of Days in Reporting Period	Electricity Production, $kWh_{generator}$	Biogas Production, CF (cubic feet)	Biogas to Boiler, CF	Biogas to Engine, CF	Biogas LHV, BTU/CF	Biogas Energy Content, Q_{biogas} (BTU
TOTALS								

We will calculate monthly values for lower heating value of the biogas, total energy content of the biogas used, and any adjusted kWh production as follows.

Monthly Biogas Lower Heating Value
We will use the readings of CO_2 concentration in the biogas gathered weekly to estimate the average monthly Biogas Lower Heating Value using the following equation:

$$LHV_{biogas} = LHV_{methane} \cdot (1 - F_{CO2})$$

where,

LHV$_{methane}$: lower heating value of methane (911 Btu/ft^3 at standard conditions, 60 °F and 1 atm)
F$_{CO2}$: fraction of biogas that is CO_2 (average of readings for each month)

Monthly Biogas Energy Content
We will calculate the average monthly Biogas Energy Content using the following equation:

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

where,

CF: volume (ft^3) of biogas in month

Reasonable Electrical Efficiency

The 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 (kWhgenerator) divided by the energy content of the fuel input (Qbiogas) in similar units and based on lower heating value – should be in the 25% - 35% range over any interval for the engine-generator at Twin Birch Dairy Farm.

Appendices

Cut sheets and Manuals for:

Sage Metering Inc. - Model SIG-05-15 Mass Flow
http://sagemetering.com/sage-prime.php

E-MonD-Mon Model 480400 KIT
http://www.emon.com/products_class2000.html

Fyrite Gas Analyzer
http://www.bacharach-inc.com/PDF/Brochures/fyrite_gas_analyzers.pdf