QUALITY ASSURANCE/QUALITY CONTROL PLAN
FOR
WALKER FARMS, LLC ANAEROBIC DIGESTER GAS (ADG) SYSTEM

May 2, 2012

Submitted to:

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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 Walker Farms, in Fort Ann, 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 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. 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 originally planned to have one engine-generator with Total Contracted Capacity of 225 kW. Note, the customer has requested a capacity increase to 300 kW as a larger engine-generator system was installed of the same manufacturer as the originally proposed 225 kW. The 300 kW and 225 kW capacities are consistent with the capacity of the engine generator systems as described by the supplier Martin Machinery, but may differ from the Contracted Capacity used for incentive calculations in the Renewable Portfolio Standard Program administered by NYSERDA.

ADG System Description

The digester system and gas conditioning equipment at the farm was designed and provided by RCM Digesters International, LLC. The power plant was provided by Martin Machinery. Gas and power metering are planned to be provided by Gen-Tec and Sage Metering Inc. The site is operating one 300 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 300 kW, diesel generator is connected to the farm electrical system through a 600 A disconnect/transfer switch for use during power outages.

Engine-Generator/Separator Building

Digester

Biogas Flare

Figure 1 - Photos of System Components

Table 1 - Biogas Systems at Walker Farms

Digester	Anaerobic digester Complete-mix, HDPE plastic cover, heated
Feedstock	Dairy Manure, 1,100 animal equivalents
Engine	Guascor SFGLD240 Engine – 335 kW on biogas at 100% Load
Generator	Stanford HCI636H Generator – 480 VAC, 3 Phase
Biogas Conditioning	RCM Digesters gas conditioning skid
Engine Backup/startup Fuel	None
Heat Recovery Use	Digester heating, milk house water heating
Additional Heat Recovery	None

Figure 2 - Engine-Generator Room

Figure 3 schematically shows the biogas system and engine-generator. Figure 4 shows the process flow diagram and Figure 5 shows the single line electrical diagram for the system. Biogas from the digester is used in the engine-generator 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 and the engine-generator Gas flow data from these meters is also shown on the Gen-Tec/Intelisys graphical display. Reduction in H2S is accomplished by injecting oxygen into the digester through a metered control at the gas recirculating blower. H2S bonds to the oxygen and remains in the manure. Methane gas will rise above the manure level with reduced H2S. Saturated gas is passed through a plate heat exchanger (HX1) which is cooled by an external AC unit. Water is condensed out in a water trap. Exhaust gas from the engine passes through a plate heat exchanger where the exhaust heat is transferred to water used to heat the digester and milk house water heating.

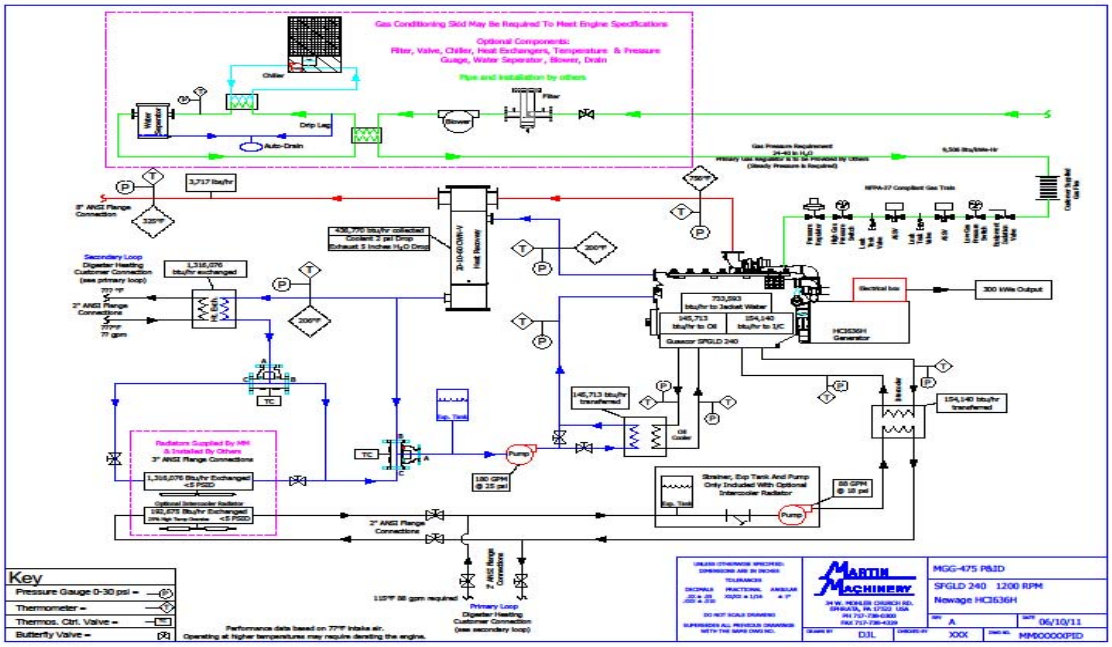

Figure 3 - Schematic Biogas System

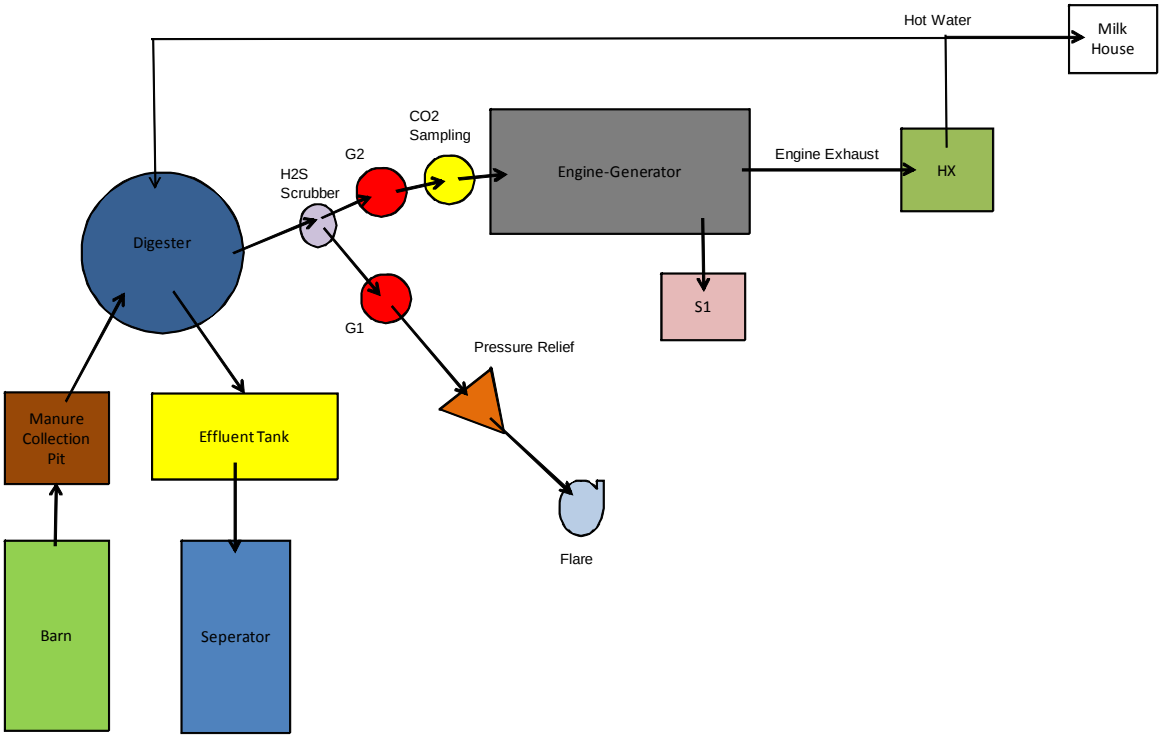

Figure 4 – Process Flow Diagram

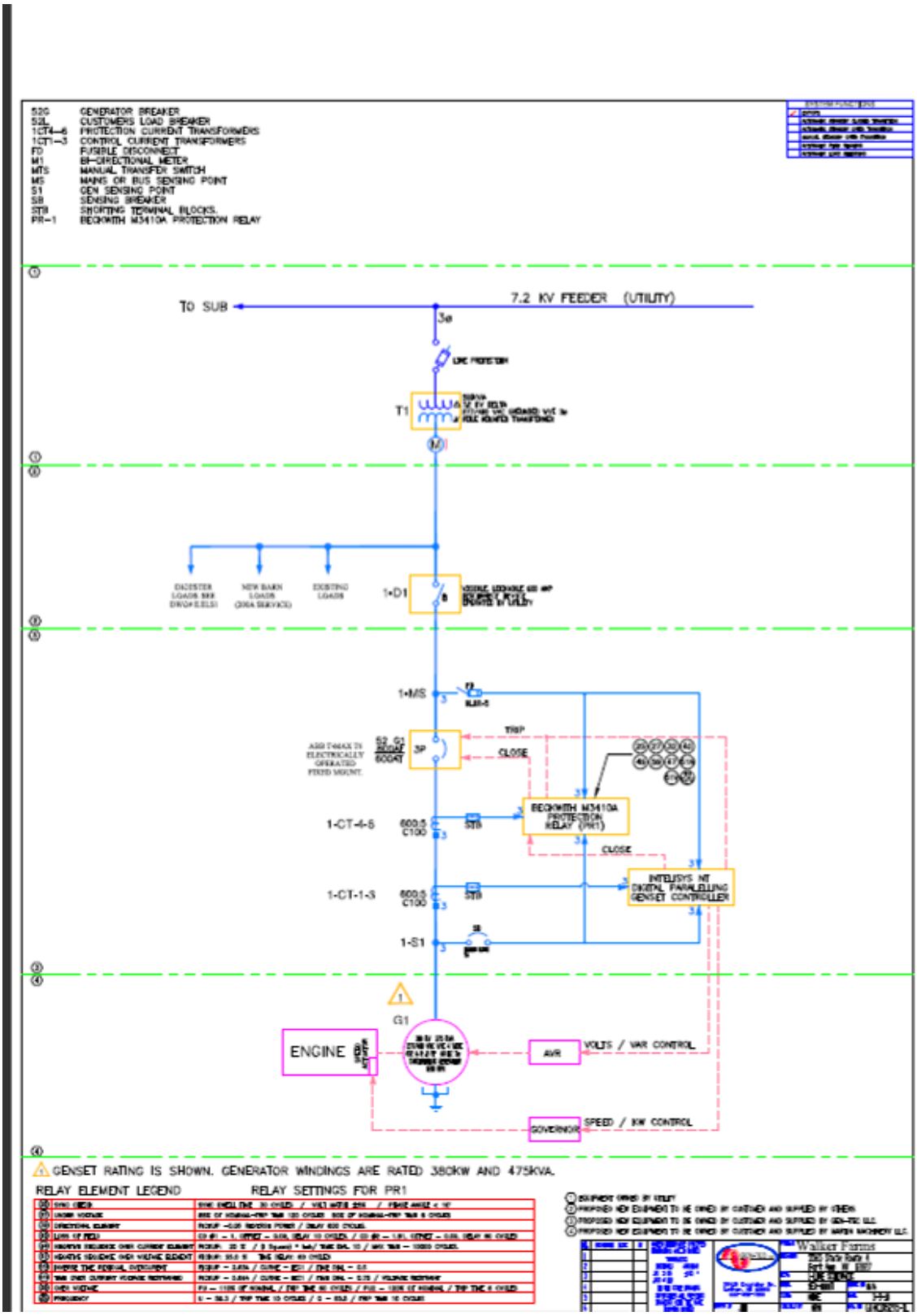

Figure 5 - Single Line Electrical Diagram

Monitoring System Equipment, Installation, Operation, and Maintenance

Figure 4 shows the location of the meters used to measure fuel gas input to the engine-generator (G2) and flare (G1). Figure 5 shows 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	Intelisys Base Box IS-NT-BB with LCD display	kW	0-335 kW
Pulse	G1	Engine Flare Flow	Sage Metering Inc. Model SIP-300-AC115-DIG-GAS	SCFM	0 – 7000 scf/hr
Pulse	G2	Engine Biogas Flow	Sage Metering Inc. Model SIP-300-AC115-DIG-GAS	SCFM	0 – 7000 scf/hr

The electrical output of the engine-generator is measured with the Intelisys NT engine controller. The controller has been installed in a stand alone 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 has been installed according to the requirements in the "IntliGen^{NT}, IG/IS-NT Operator Guide 2.0. The sensor is be protected by a dedicated circuit breaker.

The biogas input to the engine-generator is measured by a Sage Prime mass flow meter (G2) installed in-line just next to the digester control box. A second Sage Prime mass flow meter (G1) is installed near the ceiling on the back wall of the building which measures biogas flow to the flare. The meters have been installed according to the "Sage Thermal Gas Mass Flow Meter Operations and Instruction Manual for Models SIP/SRP, Document 100-0001 Revision 05-SIP/SRG" as part of the engine generation equipment provided by Gen-Tec. A log of maintenance activities for the meters is being maintained at the site.

A separate cabinet supplied by Gen-Tec mounted on the wall across from the controller houses the Intelisys NY Control Panel. This unit illustrates, mass flow and power output data from the three monitoring points described in Table 2. The following data is being logged and compiled by Walker Farms staff:

1. Flare SCFM
2. Total CF to the flare
3. Engine SCFM
4. total CF to the engine
5. Accumulated kWh
6. Engine run Status
7. Flare temperature

A graphical display on the outside of the cabinet shows kWh production and mass flow information. This data is being logged on-site by hand by Walker Farms personnel. An internet or phone accessible data logger will be installed by the NYSERDA CHP Website Contractor to collect, download and transfer the operating data to the NYSERDA CHP Website.

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 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%. A qualified staff member of Walker Farms, LLC 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 after it goes through the gas conditioning equipment. The sampling point is marked in Figure 4 as "CO2 Sampling".

There is no backup/startup fuel for the engine-generator in this system.

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 M&V 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 S1 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 S1 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 G2 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 M&V Reports

Walker Farms LLC will prepare Annual M&V Reports from data for the new system covered by Agreement 101-N. 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 M&V 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 Flare, 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 M&V 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 the Walker Farm.

Appendices

Cut sheets and Manuals for:

Sage Metering Inc. Model SIP-300-AC115-DIG-GAS Mass Flow Meter
http://www.sagemetering.com/pdf/datasheets/100-0108_SIP-IN-LINE-InstrumentDataSheet1.pdf

ComAP Intelisys NT Controller IS-NT-BB
http://www.comap.cz/products/detail/intelisys-nt

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

Addendum – Walker Dairy

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Site Contact
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- CDH was on site June 6, 2012 to install the Obvius datalogger, wire the power and gas meters, and verify metering.
- Website data begins June 6, 2012.

Summary

CDH Energy purchased and installed the data logger while the metering was provided by the facility.

Monitored Data Points

Logger Channel	Data Point	Description	Eng. Units	Instrument / Transducer	Output
1	WG_acc	Generator Output - Accumulated	kWh	IntelisysNT Engine Controller	Pulse
2	FGE	Biogas Flow - To Engine	cfm	Sage SIP-300-AC115-DIG-Gas	4-20 mA
3	FGF	Biogas Flow - To Flare	cfm	Sage SRP-05-06-AC115-DIG-Gas	4-20 mA

Procedure

- Generator power was verified with a Fluke 39 handheld power meter, and compared to the GenTec Panel display.

- Gas use was verified by comparing the Sage meter display to the values read by the Obvius.

Verification Data – June 6, 2012

Generator Power:

The generator power was verified in the GenTec panel, and was measured phase to neutral. The discrepancy between the handheld measured power and GenTec Display readings is believed to be due to the fact the handheld power meter CT had difficulty fitting around both conductors of a single phase.

	Phase	A	B	C	Total	GenTec Display
Trial 1	Voltage (V)	283	284	285	-	-
	Current (A)	193	227	234	-	-
	Power (kW)	67	60	59	***186****	***225***

* Handheld CT had difficulty fitting around conductors.

The electrical efficiency for the unit is between 25%-27%, using 600 Btu/cf for the biogas, indicating the IntelisysNT data / GenTec Display is accurate. CDH will keep an eye on the power values and efficiency, and stop back at the facility next time we are in the area, to re-verify the power readings using a rope CT as opposed to the clamp on CT that was initially used.

Gas

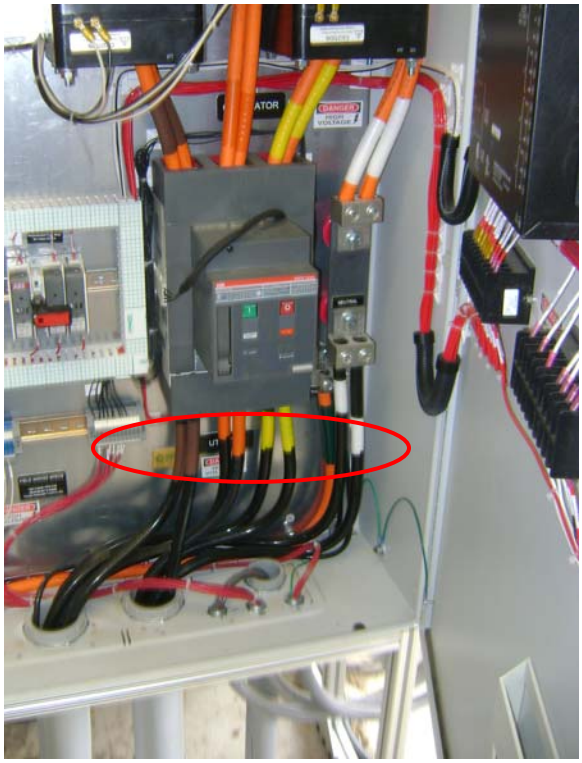
FGE	Sage	Obvius
	76.5	77.2
	77.1	77.4
	78.1	78.2
Avg.	***77.2***	***77.6***

FGF	Sage	Obvius
	6.8	6.5
	6.5	6.5
	7.9	7.4
Avg.	***7.1***	***6.8***

Site Photos

CDH enclosure

Interior of CDH enclosure – Obvius AcquiSuite data logger.



Interior of GenTec panel, and location of handheld power verification.

FGE – Sage flowmeter measuring biogas to engine.