QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN
FOR
GREENWOOD DAIRY ANAEROBIC DIGESTER GAS (ADG) SYSTEM
Agreement # ST-AD108N-1

November 5, 2014

Submitted to:

New York State Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

and

Greenwood Dairy
1087 State Highway 310
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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 Greenwood Dairy Farm, LLC, ("The Farm") in Canton, 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 406 kW.

ADG System Description

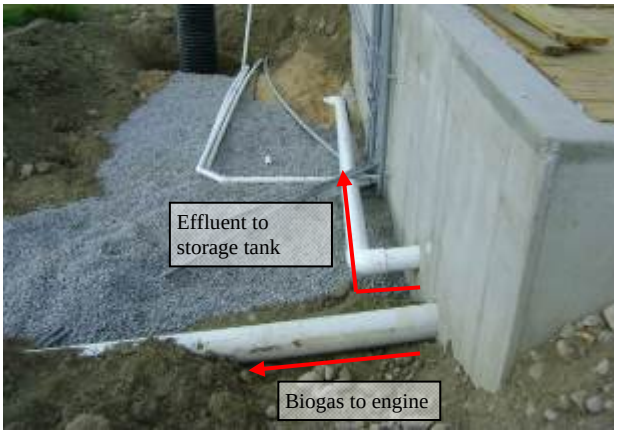
The digester system at the farm was designed by RCM International LLC. The power plant equipment will be provided by Martin Machinery while the gas conditioning equipment will be supplied by RCM International LLC. Gas and power metering are provided by Wattnode and Sage Metering Inc. The site will operate one 484 kW synchronous engine-generator. Biological scrubbers will be located on a platform attached to the digester and gas conditioning equipment will be located next to the engine skid in the utility building. Piping and controls will also be installed in the utility building near 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 farm does expect to export a portion of the generated electricity, and has been approved for net metering.

Installed, covered and filled digester along with mixer locations (5 total in digester).

Digester flare, and flare gas meter.

Generator building.

Installed engine and generator



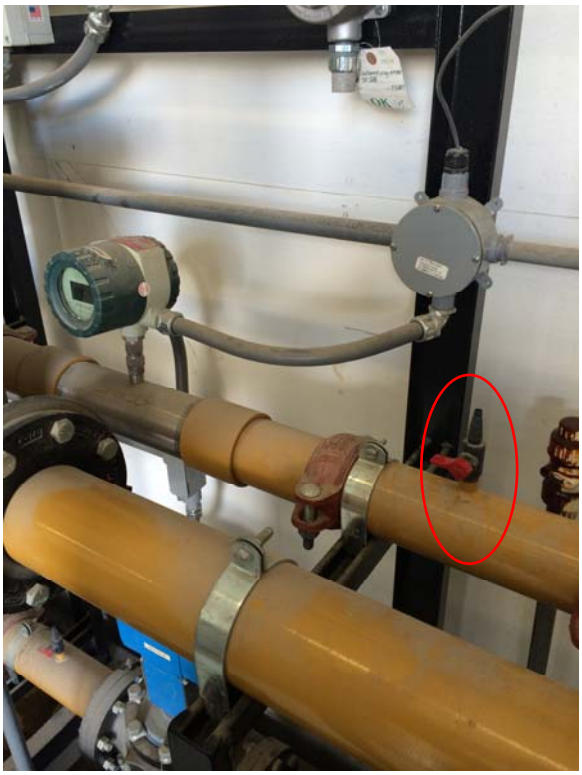
Buried effluent and biogas piping (from side of scrubber platform).

Installed biological scrubbers (2x) and iron sponge tank.

Engine gas flow meter (after dewatering and blower)

Flare gas flow meter.

Nozzle for H2S sampling before scrubbers, located on back side of scrubbers out at the digester.



Nozzle for H2S sampling after scrubbers. Located after blower and gas meter in generator building.

Figure 1 - Photos of System Components

Table 1 - Biogas Systems at Greenwood Dairy

Digester	RCM Anaerobic Digester, fully mixed, soft cover, heated, 180,000 cf capacity, 25 day retention time
Feedstock	Dairy Manure, approximately 2,450 cows
Engine	Guascor MGG-500, 1,200 RPM, 484 kW on biogas
Generator	Stamford HCM636J – 480 VAC, 3 Phase, limited to 406 kW output.
Biogas Conditioning	RCM supplied sulfur abatement system, three RCM (3) biological H_2S scrubbers, de-watering system, and blower, rated for 130 cfm at 2,000 ppm.
Engine Backup/startup Fuel	*Propane Boiler* – Used to heat digester until sufficient biogas is produced to run biogas boiler. *Biogas Boiler* – Used for digester heating until digester produces sufficient biogas to run engine, or farm has utility approval to operate engine (whichever comes last)
Heat Recovery Use	Digester heating
Additional Heat Recovery	Barn Heating

Figure 3 shows the farm layout and general site plan. Manure is provided to the digester (DT) by five (5) separate barns on the property (XB1, XB2, XB3, XB4 and XB5). The three large barns (XB1, XB2, XB3) feed directly into the digester, while the two smaller barns (XB4, XB5) feed into a common pit from where the manure is pumped into the digester (DT). The digester has a 25 day retention time, after which effluent flows from the digester into an effluent tank (ET) before being pumped to the separator building (SB). Should the effluent tank (ET) over fill, excess effluent will flow into storage lagoon XL2.

In the separator building (SB) Solids are removed from the effluent to be dried and used as bedding, while the separated liquids flow to transfer tank 2 (TT2). From the transfer tank (TT2) the separated liquid can be pumped to transfer tank 1 (TT1) across the road at barn XB5, or to any of the three manure lagoons (XL2, XL2, XL3).

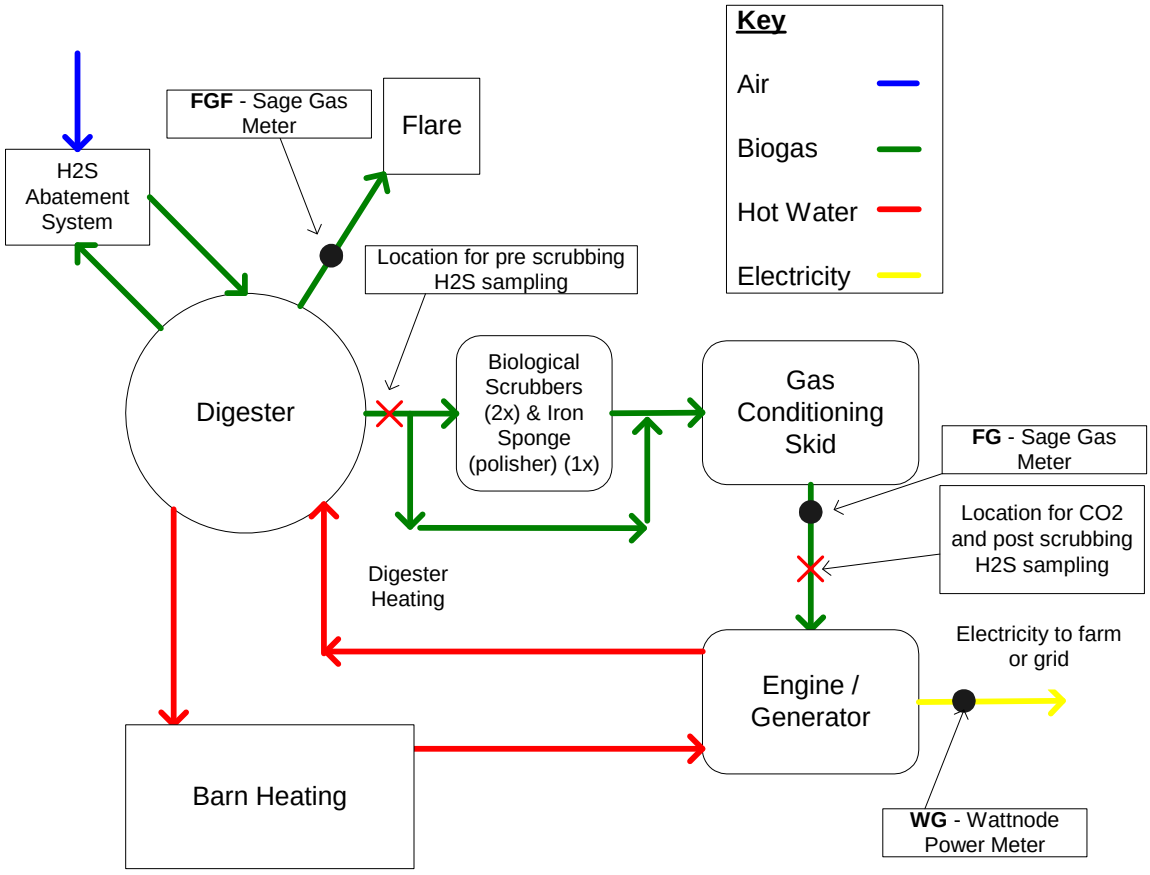


Figure 2. Digester Process Diagram

Figure 2 shows the single line process diagram for the digester and engine system. Biogas from the digester is either used in the engine-generator or flared. The biogas flare operates using a mechanically-actuated relief valve that vents biogas to maintain the digester static pressure requirements. The sulfur abatement system injects a small percentage of air in with the biogas to precipitate out some of the sulfur, in order to reduce H2S levels.

Sage Prime metering devices measure gas flow to the flare (FGF) and to the engine-generator (FG). To further reduce the biogas H2S levels the biogas for the engine passes thru the scrubber system. The system is made up of two biological scrubber tanks, and one iron sponge (polisher). The scrubber tanks are piped so that they can operate in series, parallel, or completely bypassed. Once the gas is scrubbed it continues into the utility building where it is then de-watered and pressurized, via the gas conditioning equipment provided by RCM, before being combusted in the engine.

Heat is recovered from the engine exhaust in the form of hot water. This hot water is pumped thru piping lining the perimeter of the bottom of the digester to help maintain a temperature of around 100 °F. The facility also plans on using some of the recovered heat to help heat one or two of the barns.

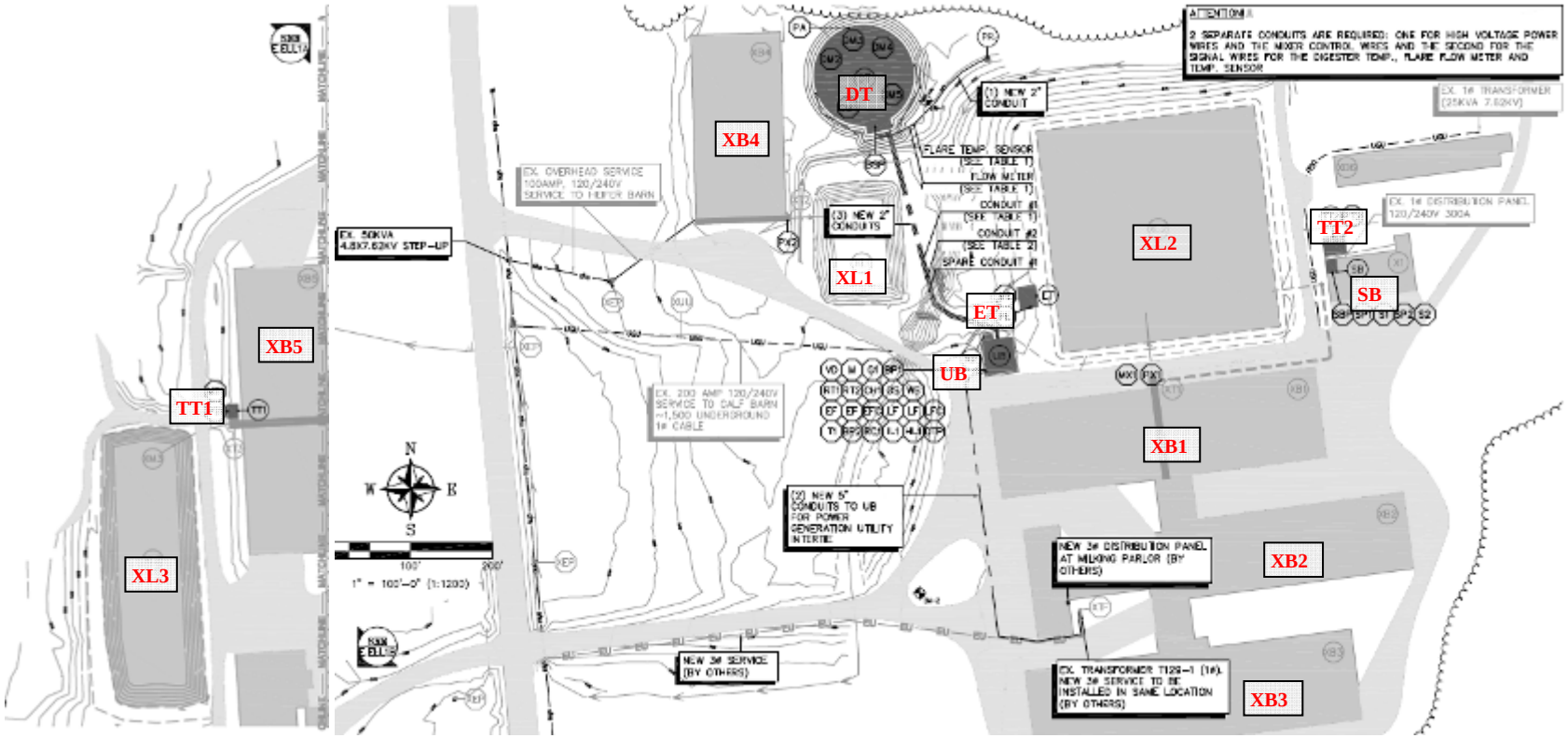


Figure 3 – Site Plan

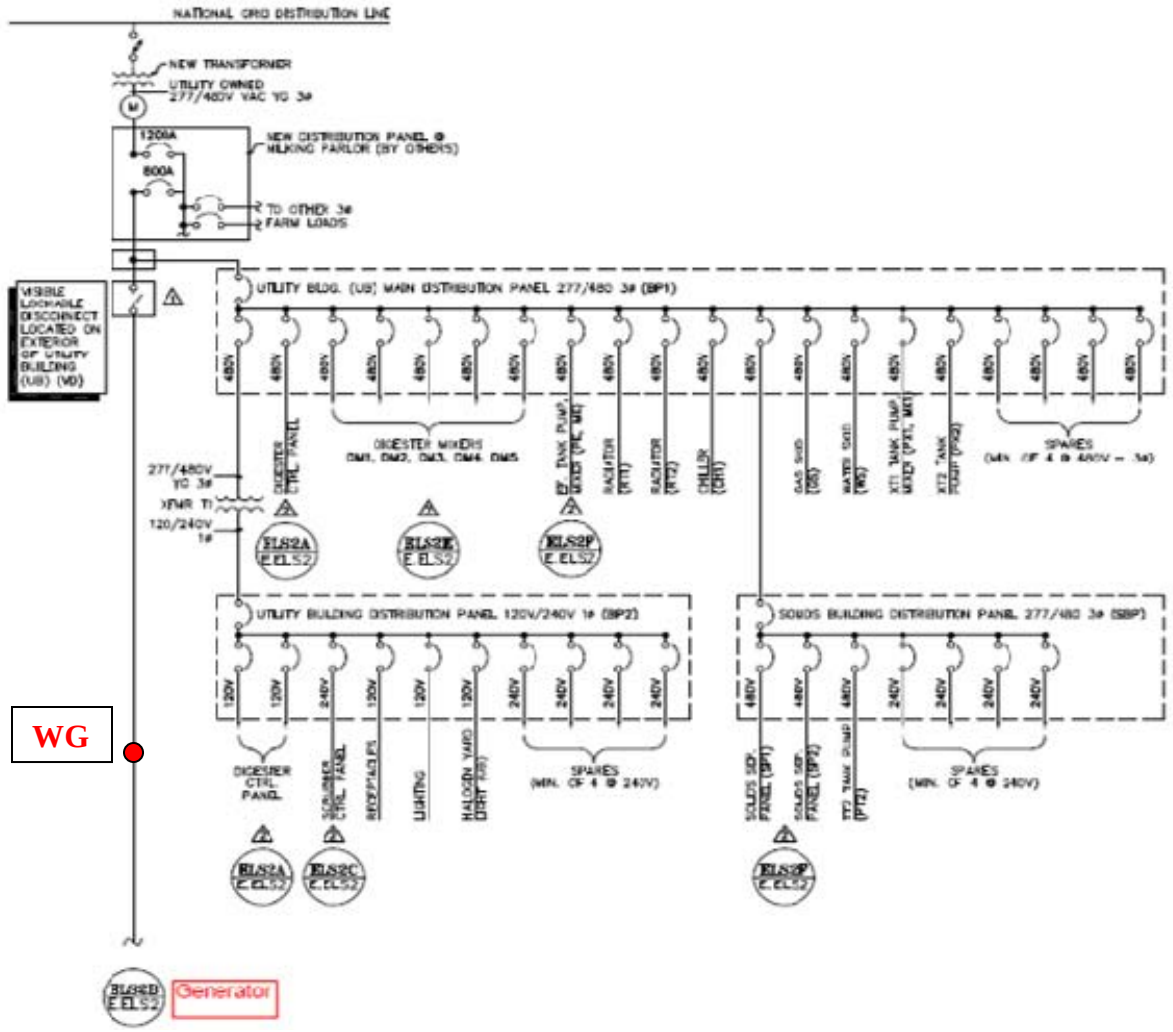


Figure 4 – One Line Electrical Diagram

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, Section B: ADG System of the Application Form the planned Guascor engine and generator assembled by Martin Machinery are stated to have a capacity of 484 kW and the RCM Gas Cleanup Equipment to have throughput of 100 to 200 cfm. The Contracted Capacity in Exhibit A is 406 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 Section B 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, Section B: ADG System of the Application Form, the following System capabilities are identified:

- Working volume capacity of the mixed digester is stated to be 178,059 cf.
- RCM Gas Cleanup Equipment is stated to have throughput of 100 to 200 cfm.
- Estimated Annual biogas generation totals 60,991,180 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 60,991,180 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 304.5 kWh/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 304.5 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, (b) high quality gas cleanup documented to produce measured H2S output less than 400 ppm, and (c) higher cost grid upgrade needed for interconnection greater than $200,000.

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 304.5 kWh/h;

4. Documentation that the System has demonstrated the ability to upload information to NYSERDA's CHP Data Integration 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 H2S output less than 400 ppm in accordance with the section below on QA/QC Procedures for Documenting High Quality Gas Cleanup

6. Documentation of payment to the utility of greater than $200,000 for the cost of grid upgrades for the project. (When available an addendum to the Project Commissioning Report shall be made which provides the final grid upgrade costs after actual cost reconciliation.)

7. 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 2 shows the general location of the meters used to measure biogas input to the engine-generator (**FG**), biogas sent to the flare (**FGF**) and the generator electrical output (**WG**). 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
Modbus	WG	Engine-Generator Power	Revenue Grade Wattnode RWNC-3Y-480-MB	kW	0-500 kW
4-20 mA	FG	Engine Biogas Flow	Sage Metering Inc. Model SIP-300-AC115-DIG-GAS Serial #: 92449-49795 (0-150 scfm)	SCF	0 – 9,000 SCFH

The electrical output of the engine-generator (**WG**) will be measured with the Revenue Grade Wattnode power meter. The power meter will be installed in a stand alone cabinet on the side of the engine by the electrical contractor. The power meter will be installed according to the requirements in the appropriate operator guide. The CT inputs to the power meter will be fused in order to protect the power meter.

The biogas input to the engine will be measured by a Sage Prime mass flow meter (**FG**). The meter is capable of providing a temperature compensated pulse output, 4-20 mA output, or Modbus 485 output. A second Sage Prime mass flow meter (**FGF**) is installed to measure biogas flow to the flare, however this meter is not able to be logged due to insufficient wire pulls into the engine building. The meters will be installed and maintained according to the "Sage Thermal Gas Mass Flow Meter Operations and Instruction Manual for Models SIP/SRP," by the facility. A log of maintenance activities for the meters will be maintained at the site.

The two gas meters are currently spanned for 0 – 150 cfh. Using engine ratings, this should be a large enough range to measure all gas flow, however when using LHV and efficiencies seen previously at other farms, the gas flow may exceed 150 cfh. If this is the case the meters will need to be re-spanned so they can measure a higher flow rate. This can be done on site, without removing the meters, with the purchase of a communications kit and software from Sage.

The lower heating value for the biogas is estimated to be 600 Btu/ft^{3,} based on past measurements of the CO_2 content of biogas. This value will be verified weekly based on measurements of carbon dioxide using a Bacharach Fyrite CO_2 detector for a range of 0-60%. The Farm 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 gas conditioning equipment. The sampling point is marked in Figure 3 as "CO2 Sampling"

The boiler backup/startup fuel flow (propane) will not be continuously metered or logged at this site since it cannot be used by the engine to produce power. The propane will be used to run the boiler during the startup process for the digester. As the digester heats up and begins producing combustible biogas the facility will switch over from the propane boiler to a biogas boiler. In the event the gen-set is down for any length of time the farm will be able to use the biogas boiler to provide heat for the digester.

CDH will provide and install an Obvius AcquiSuite data logger and enclosure. CDH will terminate sensor wiring to the logger, and verify that accurate measurements are being received. The facility will be responsible to provide CDH with 110 V power, and an internet connection. Data will be transferred to CDH servers nightly via SFTP. The data logger has enough memory to store up to 30 days of data in the event that it can't upload the 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 the Wattnode meter (**WG**) and gas flow (cf or ft^3) recorded by the Sage meters (**FG, FGF**) 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.nyserda.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 data collected from the data-logger will be evaluated for the quality of the data for each base time interval using range and relational checks. The range checks will be setup based on the expected ranges for the sensors (see Table 2).

The relational check will compare the kWh production data and gas production data for each base time interval to ensure that both meters are reading properly. This check is to ensure that both meters are operating properly; power cannot be produced without gas, and gas cannot be combusted by the engine without producing power.

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 if the data quality flag of "Data Exists" is selected. 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 (e.g., weekly recorded logs) to definitively determine the amount of power that was being produced from biogas during the period in question.

QA/QC Procedures for Documenting High Quality Gas Cleanup

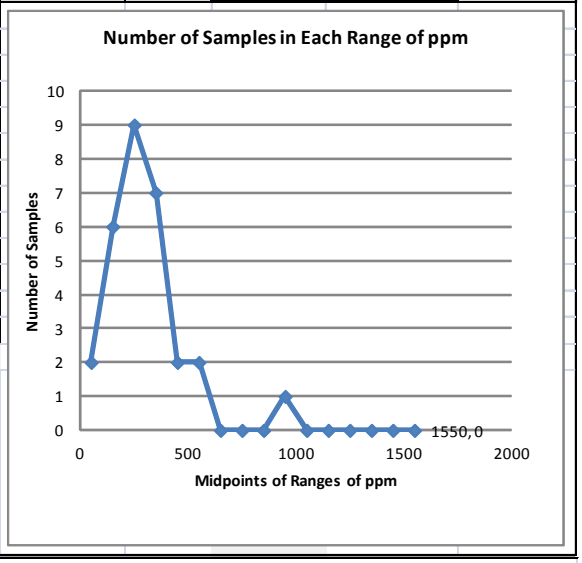
Payment of this incentive shall ultimately be based on adequate measurements of the ability of the High Quality Gas Cleanup Equipment (HQGCE) to reduce H_2S levels to less than 400 ppmv. Measurements can be made with continuous automatic gas sampling and analysis, by daily testing with manual sampling equipment, or by other methods found acceptable to NYSREDA. For this project Draeger tubes will be used to measure the H2S concentrations. A link to the specifications for these tubes is found at the end of the QA/QC Plan.

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 measure hydrogen sulfide levels, both before and after the scrubbers, on at least 25 days within a consecutive 30-day period during which the ADG systems is operating at at least 75% of design production rate for biogas (60,991,180 scf/yr as identified in the Agreement) and with CO2 levels reaching the 50% or lower. The pre and post scrubbing measurements are to determine the effectiveness of the installed scrubber system. For the purposes of payment approval, adequate measurements of the ability of the HQGCE to achieve H_2S removal to less than 400 ppmv shall be considered to be documented if 75% or more of the 25 to 30 samples taken in the 30-day time period show H2S 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 HGGCE. Biogas flow and H2S input to and output from the HQGCE will be documented for each the 25 to 30 days that samples are taken. CO2 content of the input gas will be measured for at least for 7 of those days at intervals spread over the 30 days. A Bacharach Fyrite CO2 detector will be used. If the percentage of cumulative samples with 399 ppm H2S and below is 75% or more of the total number of samples, 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 H_2S 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 Measured H2S Concentrations Less than 400 ppm for 75% of Samples

		Data to be completed by operator					Analysis which can be done by Technical Consultant					
A	B	C	D	E	F		G	H	I	J	K	L
Day	Date of sample	Cumulative scf biogas generation input to gas cleanup	CO2 percent in biogas input to gas cleanup	Hydrogen Sulfide ppm in biogas before clean up	Hydrogen Sulfide ppm in biogas after clean up		Sorted Hyrdogen Sulfide Data	Range of H2S concentration ppm	Mid range values for graph	Number of samples in each range	Cumulative number of samples less than range maximum	Percentage of cumulative samples less than range maximum
0	12/30/13	500,000										
1	12/31/13	640,000	40%	1,500	50		50	0 to 99	50	2	2	7%
2	1/1/14	780,000	39%	1,600	50		50	100 to 199	150	6	8	28%
3	1/2/14	920,000	38%	2,000	250		150	200 to 299	250	9	17	59%
4	1/3/14	1,060,000		1,600	250		150	300 to 399	350	7	24	83%
5	1/4/14	1,200,000		2,000	150		150	400 to 499	450	2	26	90%
6	1/5/14	1,340,000		1,100	150		150	500 to 599	550	2	28	97%
7	1/6/14	1,480,000		800	150		150	600 to 699	650	0	28	97%
8	1/7/14	1,620,000	38%	2,000	150		150	700 to 799	750	0	28	97%
9	1/8/14	1,760,000		1,100	250		250	800 to 899	850	0	28	97%
10	1/9/14	1,900,000		800	250		250	900 to 999	950	1	29	100%
11	1/10/14	2,040,000		2,000	250		250	1000 to 1099	1050	0	29	100%
12	1/11/14	2,180,000		1,600	150		250	1100 to 1199	1150	0	29	100%
13	1/12/14	2,320,000		2,000	150		250	1200 to 1299	1250	0	29	100%
14	1/13/14	2,460,000		1,100	250		250	1300 to 1399	1350	0	29	100%
15	1/14/14	2,600,000	42%	800	250		250	1400 to 1499	1450	0	29	100%
16	1/15/14	2,740,000		1,600	250		250	1500 or more	1550	0	29	100%
17	1/16/14	2,880,000		2,000	250		250			Total Samples	29	
18	1/17/14	3,020,000		1,100	350		350					
19	1/18/14	3,160,000		800	450		350					
20	1/19/14	3,300,000		2,000	350		350					
21	1/20/14	3,440,000		1,100	350		350					
22	1/21/14	3,580,000	33%	800	350		350					
23	1/22/14	3,720,000		1,600	350		350					
24	1/23/14	3,860,000		1,600	350		350					
25	1/24/14	4,000,000					450					
26	1/25/14	4,140,000		1,100	450		450					
27	1/26/14	4,280,000		800	350		550					
28	1/27/14	4,420,000		2,000	550		550					
29	1/28/14	4,560,000	33%	1,100	550		950					
30	1/29/14	4,700,000		800	950							
		4,200,000	38%	1,393	298	29						
		Total scf Biogas Generated in 30 Days Greater Than 3,757,881	Average CO2 Percentage Less than 50%	Average ppm H2S in Input Biogas	Average ppm of H2S Output Samples	Number of H2S samples						



Note: 60,961,180 scf/yr would average 5,010,508 scf/30-day period at 100% biogas capacity factor. At 75%capacity factor generation would be 3,757,881 scf/30-day period.

Annual Performance Reports

The farm 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 heating oil or other fuel used for the engine/boiler. The Farm may use the NYSERDA Incentive Program Reports found on the CHP Website. Alternatively, they may provide their own summary of the data (using hourly CSV data downloaded from the Website or on-site sources) along with a narrative justifying why their data and calculations are more appropriate. 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, $kWh_{generator}$	Biogas Used by Engine, (cubic feet)	LHV_{biogas} (Btu/cf)	Biogas Energy Content, Q_{biogas} (BTU)
TOTALS					

The Farm will calculate monthly values for lower heating value of the biogas (LHV_{biogas}) and total energy content of the biogas (Q_{biogas}) as follows.

Monthly Biogas Lower Heating Value

The readings of CO_2 concentration in the biogas gathered weekly will be used to estimate the average monthly Biogas Lower Heating Value using the following equation:

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

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

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

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

where:

CF - volume (cubic feet or ft^3) 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 ($kWh_{generator}$) divided by the energy content of the fuel input (Q_{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 Greenwood Dairy.

Appendices

Cut sheets and Manuals for:

Guascor, MGG-500, 1200 rpm Engine

Stamford, HCM636J Generator

Sage Metering Inc., Model SIP-300-AC115-DIG-GAS Mass Flow Meter

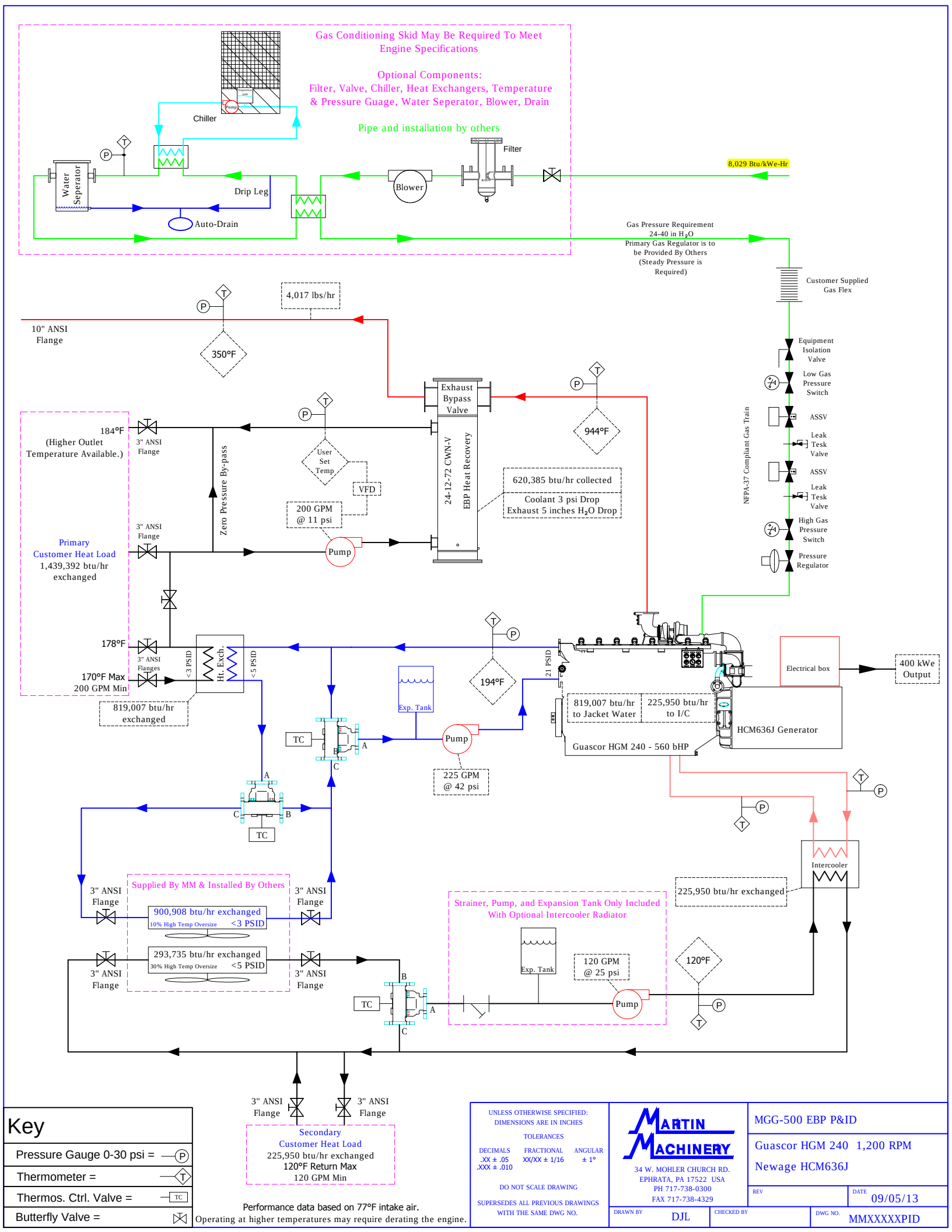
Sage Metering Inc., Model SRP-05-06-STF05-AC115-DIG-GAS Mass Flow Meter

Revenue Grade Wattnode Power Meter, Model RWNC-3Y-480-MB

Bacharach Fyrite CO_2 Detector – Model #10-5032

Draeger, Hydrogen Sulfide 100/a (spec. sheet and training PDF found at link below)

http://www.buydraegertubes.com/hydrogensulfide100a.aspx



Key

Pressure Gauge 0-30 psi =	P
Thermometer =	T
Thermos. Ctrl. Valve =	TC
Butterfly Valve =	

Performance data based on 77°F intake air.
Operating at higher temperatures may require derating the engine.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS .XX ± .05 .XXX ± .010
FRACTIONAL XX/XX ± 1/16
ANGULAR ± 1°
DO NOT SCALE DRAWING
SUPERSEDES ALL PREVIOUS DRAWINGS WITH THE SAME DWG NO.

MARTIN MACHINERY
34 W. MOHLER CHURCH RD.
EPHRATA, PA 17522 USA
PH 717-738-0300
FAX 717-738-4329

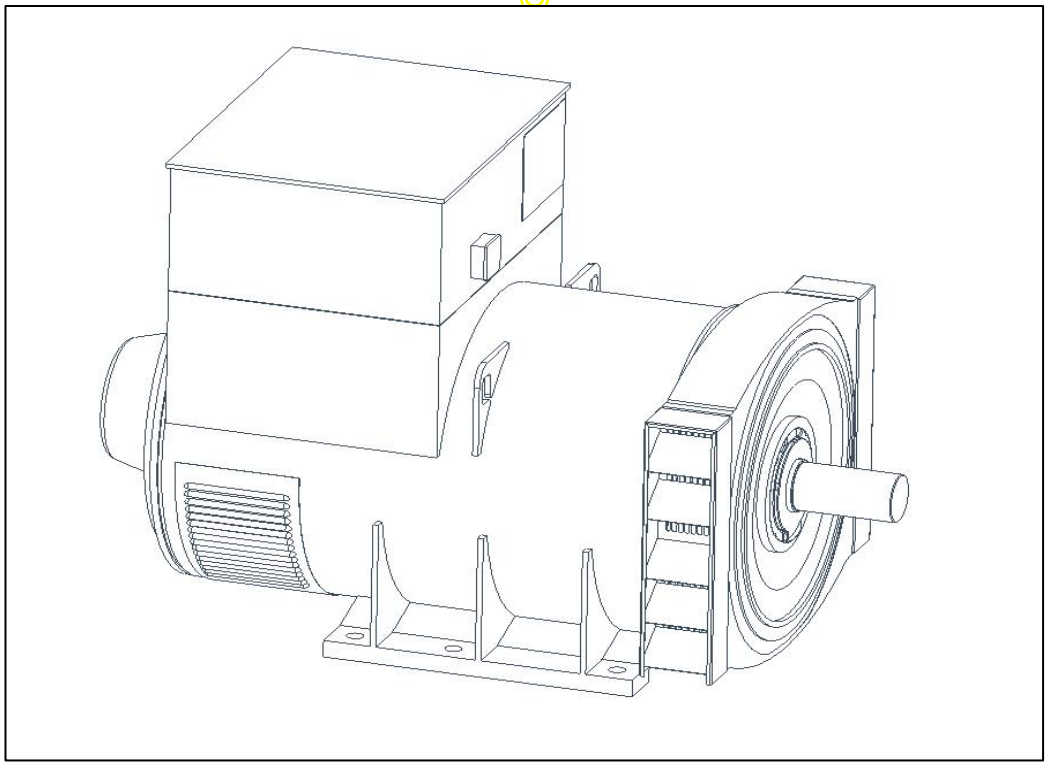
MGG-500 EBP P&ID
Guascor HGM 240 1,200 RPM
Newage HCM636J

REV	DATE	DRAWN BY	CHECKED BY	DWG NO.
	09/05/13	DJL		MMXXXXXPID

STAMFORD®

HCM636J - Winding 312

Technical Data Sheet



SPECIFICATIONS & OPTIONS

STANDARDS

Marine generators may be certified to Lloyds, DnV, Bureau Veritas, ABS, Germanischer-Lloyd or RINA.
Other standards and certifications can be considered on request.

VOLTAGE REGULATORS

MX321 AVR - STANDARD

This sophisticated Automatic Voltage Regulator (AVR) is incorporated into the Stamford Permanent Magnet Generator (PMG) system and is fitted as standard to generators of this type.
The PMG provides power via the AVR to the main exciter, giving a source of constant excitation power independent of generator output. The main exciter output is then fed to the main rotor, through a full wave bridge, protected by a surge suppressor. The AVR has in-built protection against sustained over-excitation, caused by internal or external faults. This de-excites the machine after a minimum of 5 seconds.
Over voltage protection is built-in and short circuit current level adjustment is an optional facility.

WINDINGS & ELECTRICAL PERFORMANCE

All generator stators are wound to 2/3 pitch. This eliminates triplen (3rd, 9th, 15th …) harmonics on the voltage waveform and is found to be the optimum design for trouble-free supply of non-linear loads. The 2/3 pitch design avoids excessive neutral currents sometimes seen with higher winding pitches, when in parallel with the mains. A fully connected damper winding reduces oscillations during paralleling. This winding, with the 2/3 pitch and carefully selected pole and tooth designs, ensures very low waveform distortion.

TERMINALS & TERMINAL BOX

Standard generators feature a main stator with 6 ends brought out to the terminals, which are mounted on the frame at the non-drive end of the generator. A sheet steel terminal box contains the AVR and provides ample space for the customers' wiring and gland arrangements. It has removable panels for easy access.

SHAFT & KEYS

All generator rotors are dynamically balanced to better than BS6861:Part 1 Grade 2.5 for minimum vibration in operation. Two bearing generators are balanced with a half key.

INSULATION/IMPREGNATION

The insulation system is class 'H'.
All wound components are impregnated with materials and processes designed specifically to provide the high build required for static windings and the high mechanical strength required for rotating components.

QUALITY ASSURANCE

Generators are manufactured using production procedures having a quality assurance level to BS EN ISO 9001.

The stated voltage regulation may not be maintained in the presence of certain radio transmitted signals. Any change in performance will fall within the limits of Criteria 'B' of EN 61000-6-2:2001. At no time will the ste ady-state voltage regulation exceed 2%.

DE RATES

All values tabulated on page 8 are subject to the following reductions

5% when air inlet filters are fitted.
10% when IP44 Filters are fitted.
3% for every 500 metres by which the operating altitude exceeds 1000 metres above mean sea level.
3% for every 5°C by which the operational ambient temperature exceeds 50°C.

Note: Requirement for operating in an ambient temperature exceeding 60°C must be referred to the factory.

NB Continuous development of our products entitles us to change specification details without notice, therefore they must not be regarded as binding.

Front cover drawing typical of product range.

HCM636J

WINDING 312

CONTROL SYSTEM	SEPARATELY EXCITED BY P.M.G.							
A.V.R.	MX321							
VOLTAGE REGULATION	± 0.5 %	With 4% ENGINE GOVERNING						
SUSTAINED SHORT CIRCUIT	REFER TO SHORT CIRCUIT DECREMENT CURVES (page 7)							
INSULATION SYSTEM	CLASS H							
PROTECTION	IP23							
RATED POWER FACTOR	0.8							
STATOR WINDING	DOUBLE LAYER LAP							
WINDING PITCH	TWO THIRDS							
WINDING LEADS	6							
STATOR WDG. RESISTANCE	0.0049 Ohms PER PHASE AT 22°C STAR CONNECTED							
ROTOR WDG. RESISTANCE	1.5 Ohms at 22°C							
EXCITER STATOR RESISTANCE	17 Ohms at 22°C							
EXCITER ROTOR RESISTANCE	0.1 Ohms PER PHASE AT 22°C							
R.F.I. SUPPRESSION	BS EN 61000-6-2 & BS EN 61000-6-4,VDE 0875G, VDE 0875N. refer to factory for others							
WAVEFORM DISTORTION	NO LOAD < 1.5% NON-DISTORTING BALANCED LINEAR LOAD < 5.0%							
MAXIMUM OVERSPEED	1500 Rev/Min							
BEARING DRIVE END	BALL. 6224 (ISO)							
BEARING NON-DRIVE END	BALL. 6317 (ISO)							
	1 BEARING				2 BEARING			
WEIGHT COMP. GENERATOR	1959 kg				2024 kg			
WEIGHT WOUND STATOR	809 kg				854 kg			
WEIGHT WOUND ROTOR	885 kg				841 kg			
WR² INERTIA	22.8732 kgm^2				22.3297 kgm^2			
SHIPPING WEIGHTS in a crate	2019 kg				2084 kg			
PACKING CRATE SIZE	183 x 92 x 140(cm)				183 x 92 x 140(cm)			
	50 Hz				60 Hz			
TELEPHONE INTERFERENCE	THF<2%				TIF<50			
COOLING AIR	1.614 m³/sec 3420 cfm				1.961 m³/sec 4156 cfm			
VOLTAGE STAR	380/220	400/231	415/240	440/254	416/240	440/254	460/266	480/277
VOLTAGE DELTA	220	230	240	254	240	254	266	277
kVA BASE RATING FOR REACTANCE VALUES	400	400	400	400	475	500	500	500
Xd DIR. AXIS SYNCHRONOUS	1.49	1.35	1.25	1.11	1.80	1.68	1.54	1.41
X'd DIR. AXIS TRANSIENT	0.15	0.13	0.12	0.11	0.19	0.17	0.16	0.14
X"d DIR. AXIS SUBTRANSIENT	0.12	0.11	0.11	0.10	0.15	0.14	0.12	0.12
Xq QUAD. AXIS REACTANCE	0.94	0.84	0.78	0.69	1.13	1.05	0.96	0.88
X"q QUAD. AXIS SUBTRANSIENT	0.13	0.12	0.11	0.10	0.16	0.15	0.13	0.12
X_L LEAKAGE REACTANCE	0.06	0.05	0.05	0.04	0.07	0.07	0.06	0.05
X_2 NEGATIVE SEQUENCE	0.13	0.12	0.11	0.10	0.16	0.15	0.13	0.12
X_0 ZERO SEQUENCE	0.09	0.08	0.07	0.06	0.11	0.10	0.09	0.08
REACTANCES ARE SATURATED	VALUES ARE PER UNIT AT RATING AND VOLTAGE INDICATED							
T'd TRANSIENT TIME CONST.	0.12 s							
T"d SUB-TRANSTIME CONST.	0.016 s							
T'do O.C. FIELD TIME CONST.	1.1 s							
Ta ARMATURE TIME CONST.	0.035 s							
SHORT CIRCUIT RATIO	1/Xd							

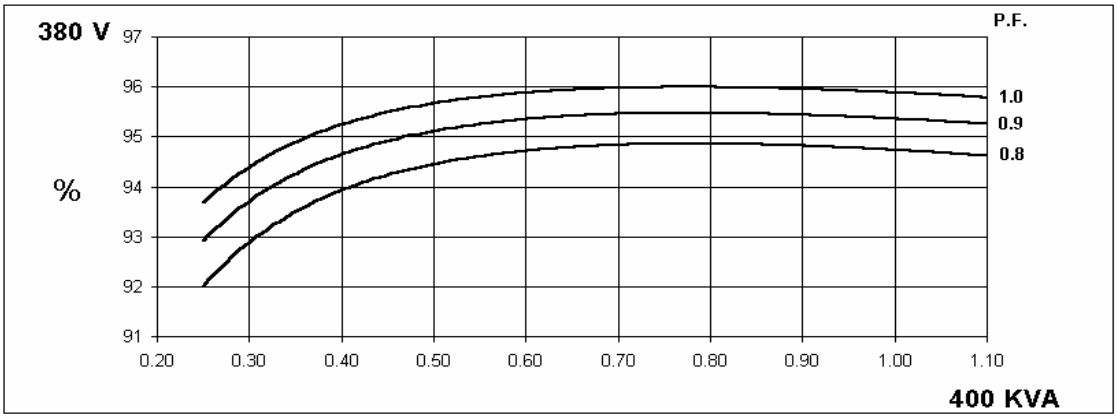
50 Hz

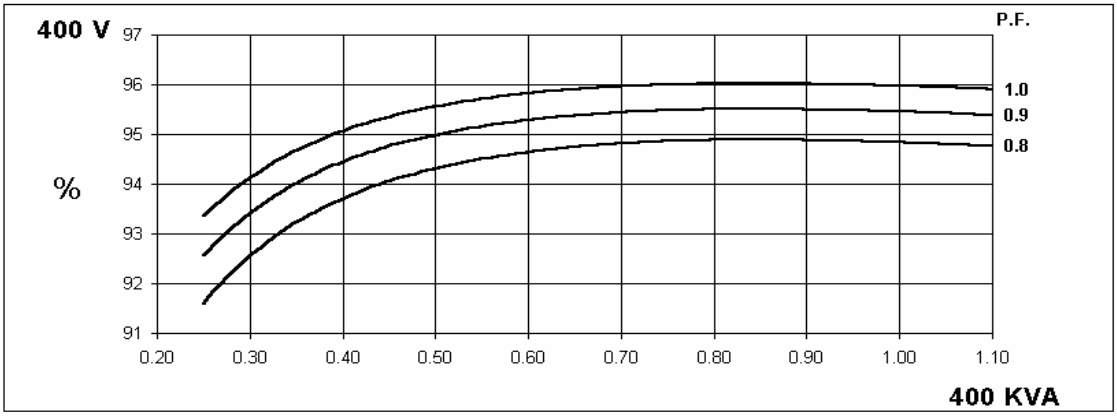
HCM636J

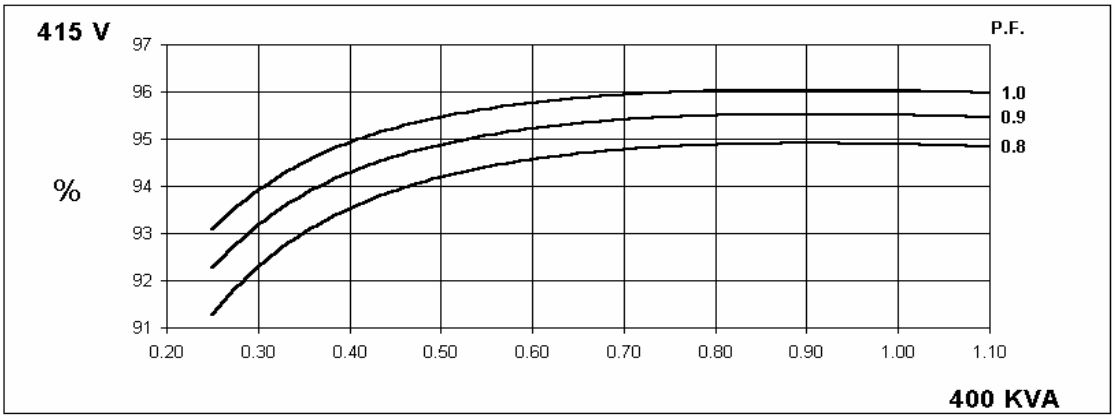
Winding 312

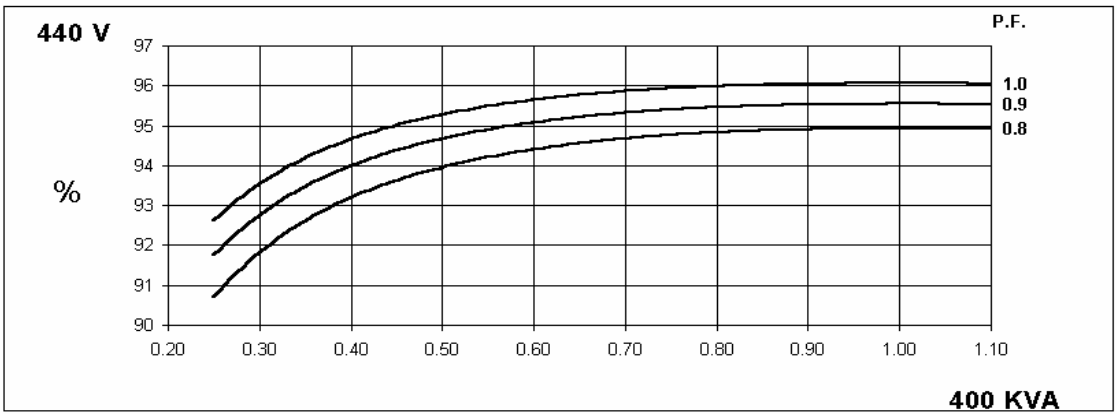
STAMFORD

THREE PHASE EFFICIENCY CURVES









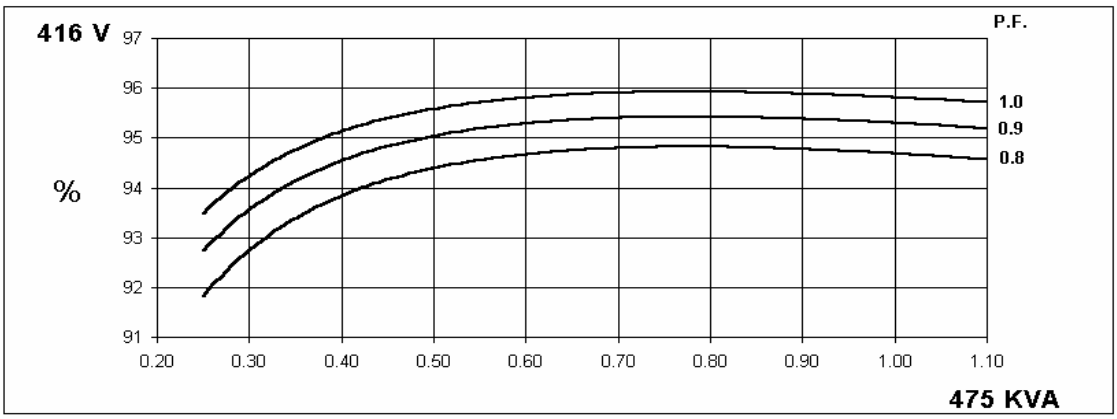
60 Hz

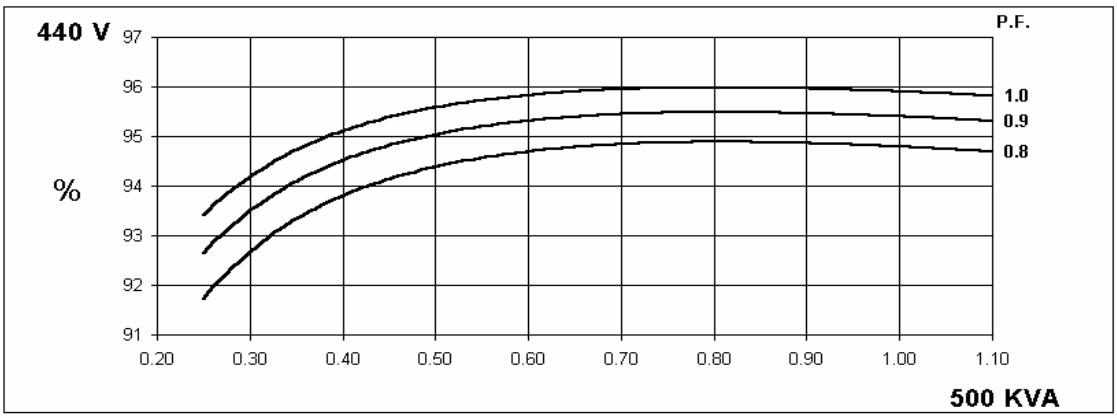
HCM636J

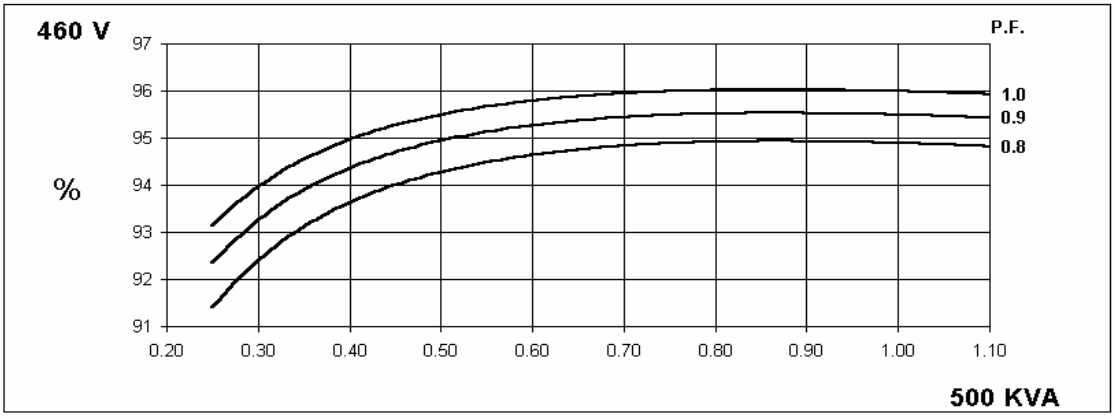
Winding 312

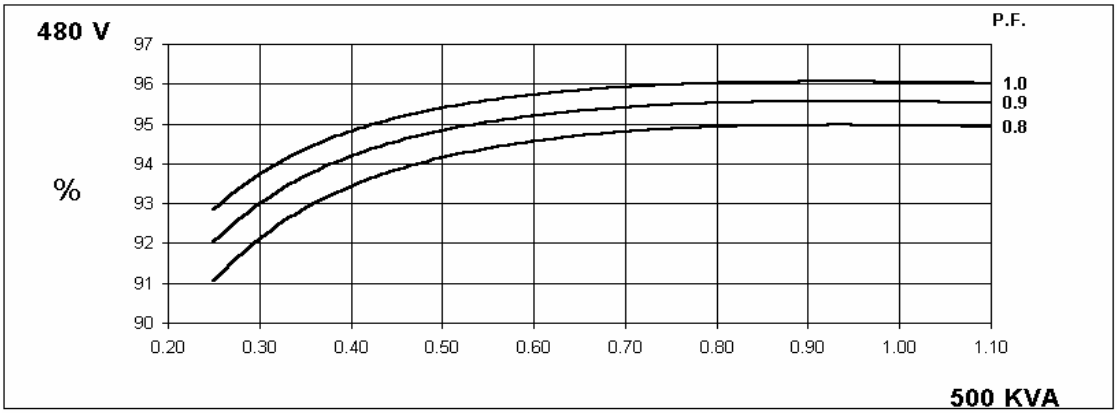
STAMFORD

THREE PHASE EFFICIENCY CURVES

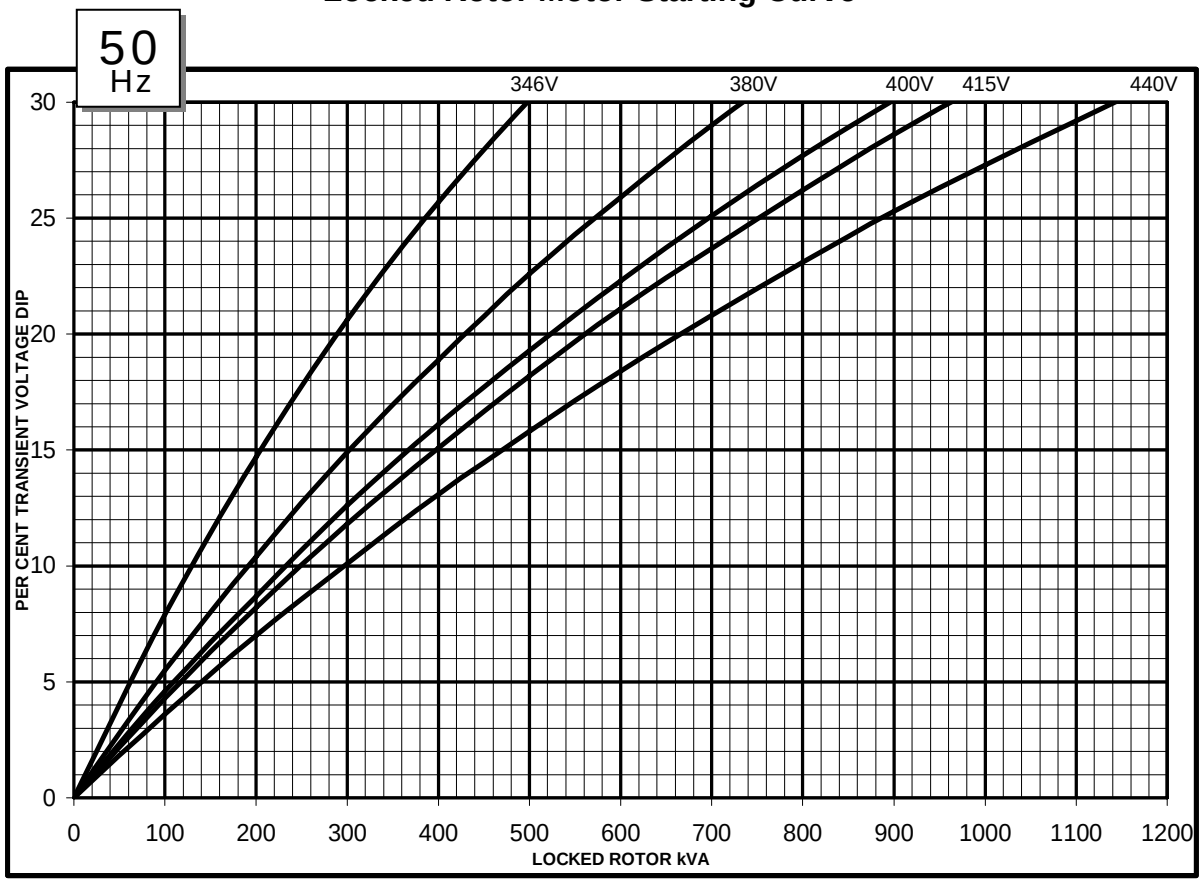


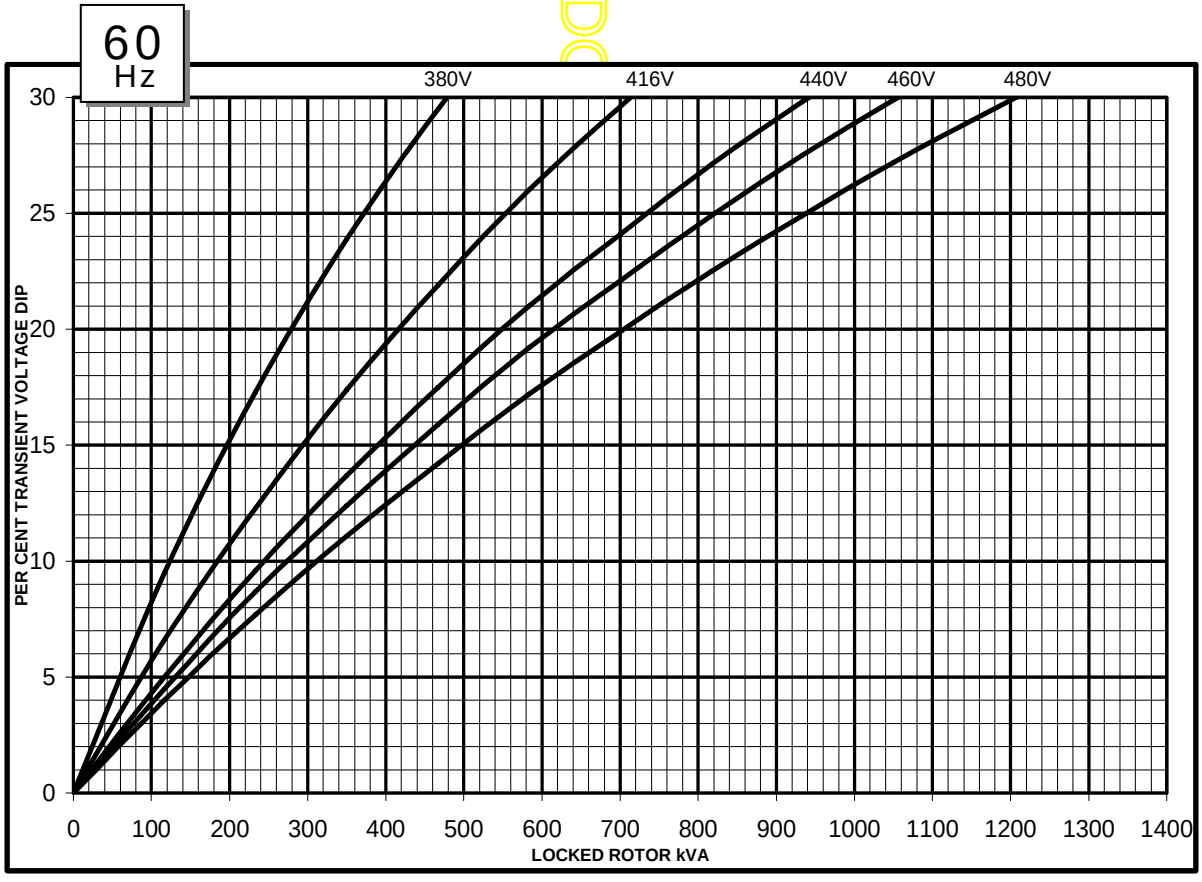






Locked Rotor Motor Starting Curve





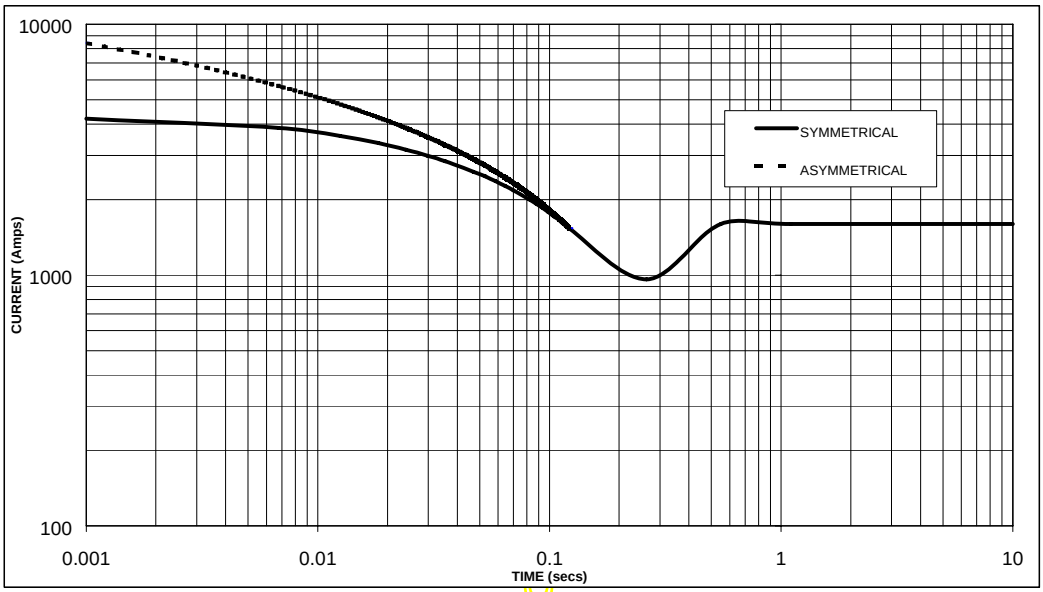
HCM636J

Winding 312

Three-phase Short Circuit Decrement Curve. No-load Excitation at Rated Speed

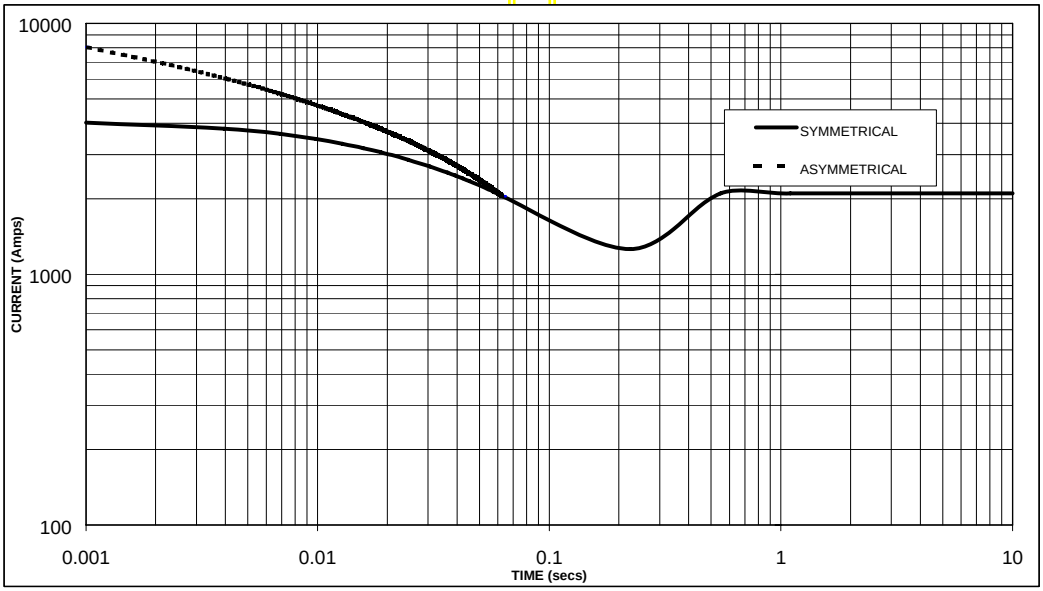
Based on star (wye) connection.

50 Hz



Sustained Short Circuit = 1,600 Amps

60 Hz



Sustained Short Circuit = 2,100 Amps

Note 1

The following multiplication factors should be used to adjust the values from curve between time 0.001 seconds and the minimum current point in respect of nominal operating voltage :

50Hz		60Hz	
Voltage	Factor	Voltage	Factor
380v	X 1.00	416v	X 1.00
400v	X 1.07	440v	X 1.06
415v	X 1.12	460v	X 1.12
440v	X 1.18	480v	X 1.17

The sustained current value is constant irrespective of voltage level

Note 2

The following multiplication factor should be used to convert the values calculated in accordance with NOTE 1 to those applicable to the various types of short circuit :

	3-phase	2-phase L-L	1-phase L-N
Instantaneous	x 1.00	x 0.87	x 1.30
Minimum	x 1.00	x 1.80	x 3.20
Sustained	x 1.00	x 1.50	x 2.50
Max. sustained duration	10 sec.	5 sec.	2 sec.

All other times are unchanged

Note 3

Curves are drawn for Star (Wye) connected machines. For Delta connection multiply the Curve current value by 1.732

HCM636J

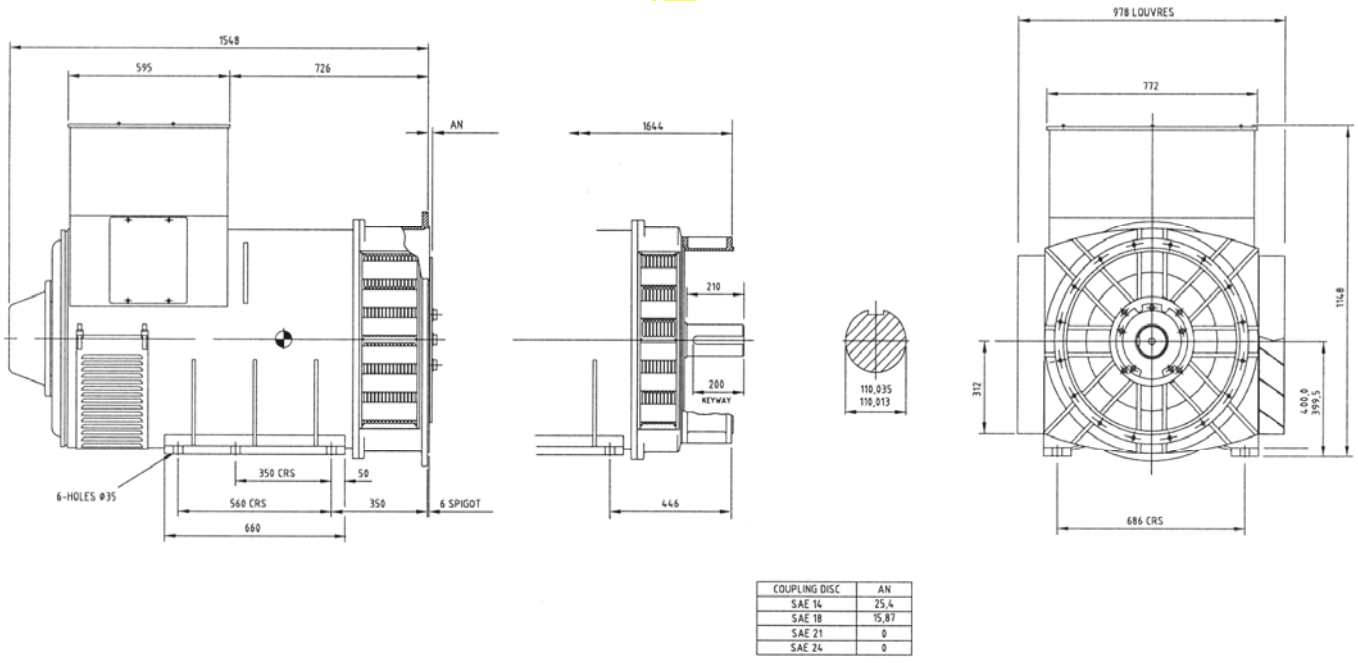
Winding 312 / 0.8 Power Factor

RATINGS

Class - Temp Rise		Cont. B - 70/50°C				Cont. F - 90/50°C				Cont. H - 110/50°C			
50Hz	Star (V)	380	400	415	440	380	400	415	440	380	400	415	440
	Delta (V)	220	230	240	254	220	230	240	254	220	230	240	254
	kVA	350	350	350	350	400	400	400	400	400	400	400	400
	kW	280	280	280	280	320	320	320	320	320	320	320	320
	Efficiency (%)	94.8	94.9	94.9	94.9	94.7	94.8	94.9	94.9	94.7	94.8	94.9	94.9
	kW Input	295	295	295	295	338	338	337	337	338	338	337	337

60Hz	Star (V)	416	440	460	480	416	440	460	480	416	440	460	480
	Delta (V)	240	254	266	277	240	254	266	277	240	254	266	277
	kVA	405	430	430	430	475	500	500	500	475	500	500	500
	kW	324	344	344	344	380	400	400	400	380	400	400	400
	Efficiency (%)	94.8	94.9	94.9	95.0	94.7	94.8	94.9	95.0	94.7	94.8	94.9	95.0
	kW Input	342	362	362	362	401	422	421	421	401	422	421	421

DIMENSIONS



COUPLING DISC	AN
SAE 14	25,4
SAE 18	15,87
SAE 21	0
SAE 24	0

APPROVED DOCUMENT

STAMFORD

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Fax: +44 (0) 1780 484100

www.cumminsgeneratortechnologies.com

Sage Integral Prime
Insertion Style, 115VAC Power

Specifications

Wetted Parts:	316L SS Wetted parts, C267 Hastelloy Options Available
Process Temperature:	Standard -40° to 200°F, Optional to 300° F and 450° F
Pressure Rating:	500psig, 1000psig Optional
Accuracy:	+/- ½ % of Full Scale +/- 1% of Reading
Repeatability:	0.2%
Outputs:	4-20mA (Flow), 24VDC Pulse (Total)
Digital Communication:	Modbus RS485/RTU
User Supplied Power:	115VAC (100-230V~, 50/60Hz)
Enclosure:	Nema 4, Powder Coated Aluminum
Electronics Temp Rating:	-40° to 150° F (-40° to 66° C)

Model Number

(Example: SIP-05-06-AC115-CO2)

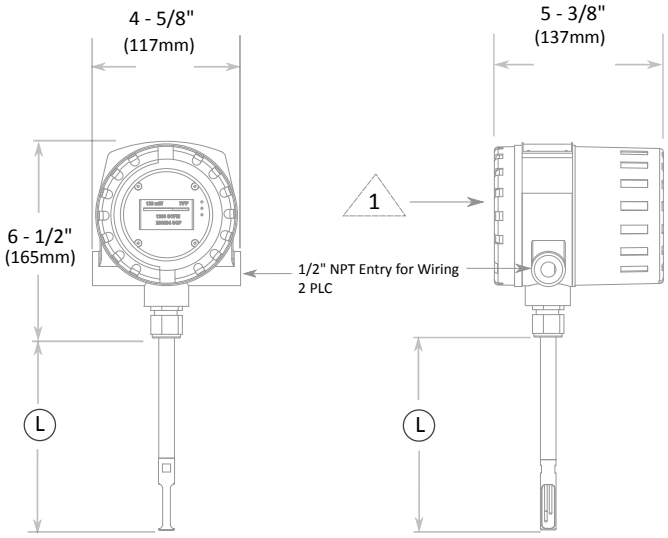
SIP-[ ]-[ ]-AC115-[ ]

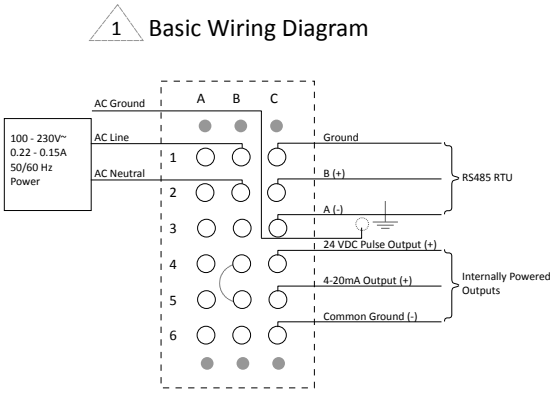
Probe Lengths

Code (L) 1/2" Diameter		Code (L) 3/4" Diameter	
05-06	6" (152 mm)	**07-06**	6" (152mm)
05-12	12" (305 mm)	**07-12**	12" (305mm)
05-15	15" (381 mm)	**07-15**	15" (381mm)
05-18	18" (457 mm)	**07-18**	18" (457mm)
05-24	24" (610 mm)	**07-24**	24" (610mm)
05-30	30" (762 mm)	**07-30**	30" (762mm)
05-36	36" (914 mm)	**07-36**	36" (914mm)
		07-48	48" (1219mm)

Gas

Code		Code	
AIR	AIR	**CL2**	CHLORINE
N2	NITROGEN	**CO**	CARBON MONOXIDE
NG	NATURAL GAS	**HE**	HELIUM
CH4	METHANE	**H2**	HYDROGEN
PROPANE	PROPANE	**DIG GAS**	DIGESTER GAS
BUTANE	BUTANE	**BIOGAS**	BIOGAS
NH3	AMMONIA	**LFG**	LANDFILL GAS
CO2	CARBON DIOXIDE	**FLARE GAS**	FLARE GAS
AR	ARGON	**FLUEGAS**	FLUEGAS
O2	OXYGEN	**MIX**	MIXTURE
O3	OZONE		





Sage Remote Prime
In-Line Style With NPT End Connections, 115VAC Power

Specifications

Wetted Parts:	316L SS Wetted parts, C267 Hastelloy Options Available
Process Temperature:	Standard -40° to 200°F, Optional to 300° F and 450° F
Pressure Rating:	500psig, 1000psig Optional
Accuracy:	+/- ½ % of Full Scale +/- 1% of Reading
Repeatability:	0.2%
Outputs:	4-20mA (Flow), 24VDC Pulse (Total)
Digital Communication:	Modbus RS485/RTU
User Supplied Power:	115VAC (100-230V~, 50/60Hz)
Enclosure:	Nema 4, Powder Coated Aluminum
Electronics Temp Rating:	-40° to 150° F (-40° to 66° C)

Model Number

(Example: SRP-050-AC115-CO2)

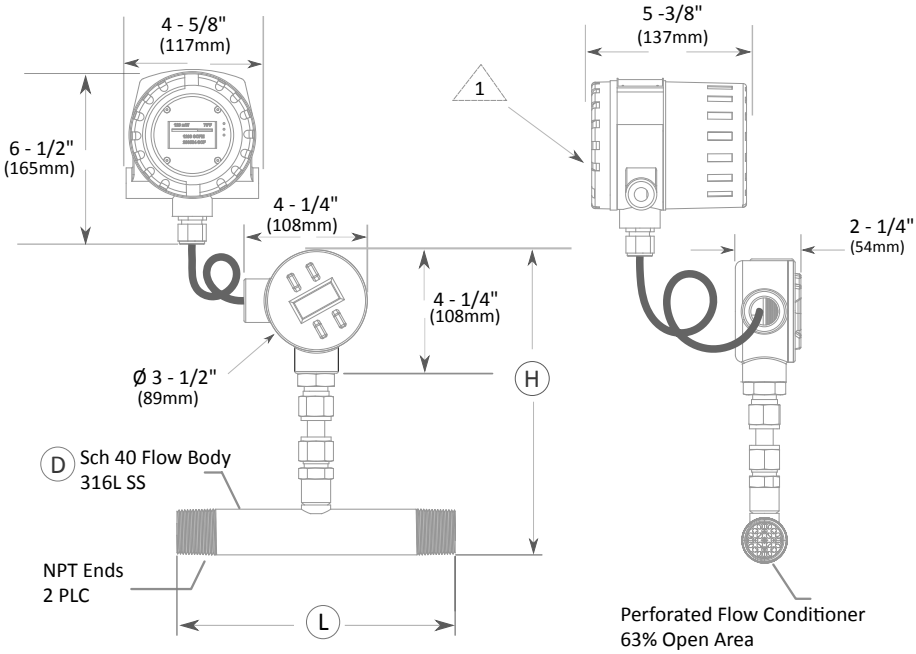
SRP-[ ]-AC115-[ ]

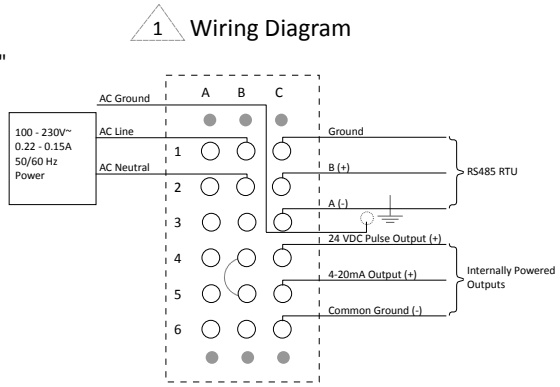
Flow Bodies

Code	D	L	H
025	1/4" (8mm)	6" (152.4mm)	10.09" (256mm)
030	3/8" (10mm)	6" (152.4mm)	10.15" (258mm)
050	1/2" (15mm)	7" (177.8mm)	10.24" (260mm)
075	3/4" (20mm)	7" (177.8mm)	10.35" (263mm)
100	1" (25mm)	8" (203.2mm)	10.47" (266mm)
125	1-1/4" (32mm)	10" (254mm)	10.65" (271mm)
150	1-1/2" (40mm)	12" (304.8mm)	10.77" (274mm)
200	2" (50mm)	12" (304.8mm)	11.00" (279mm)
250	2-1/2" (65mm)	12" (304.8mm)	11.25" (286mm)
300	3" (80mm)	12" (304.8mm)	11.57" (294mm)
400	4" (100mm)	12" (304.8mm)	12.07" (307mm)

Gas

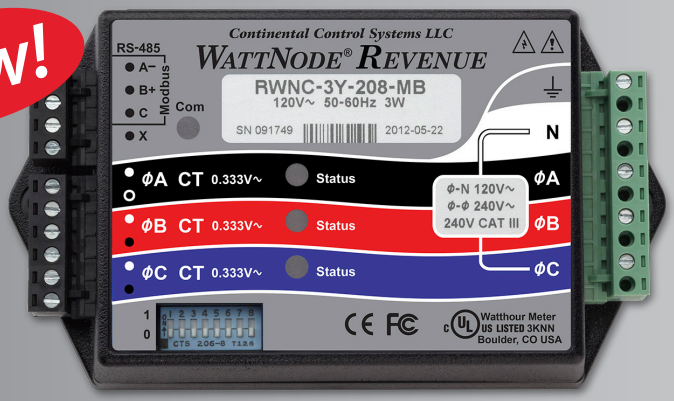
Code		Code	
AIR	AIR	CL2	CHLORINE
N2	NITROGEN	CO	CARBON MONOXIDE
NG	NATURAL GAS	HE	HELIUM
CH4	METHANE	H2	HYDROGEN
PROPANE	PROPANE	DIG GAS	DIGESTER GAS
BUTANE	BUTANE	BIOGAS	BIOGAS
NH3	AMMONIA	LFG	LANDFILL GAS
CO2	CARBON DIOXIDE	FLARE GAS	FLARE GAS
AR	ARGON	FLUEGAS	FLUEGAS
O2	OXYGEN	MIX	MIXTURE
O3	OZONE		





WattNode® Revenue

New!



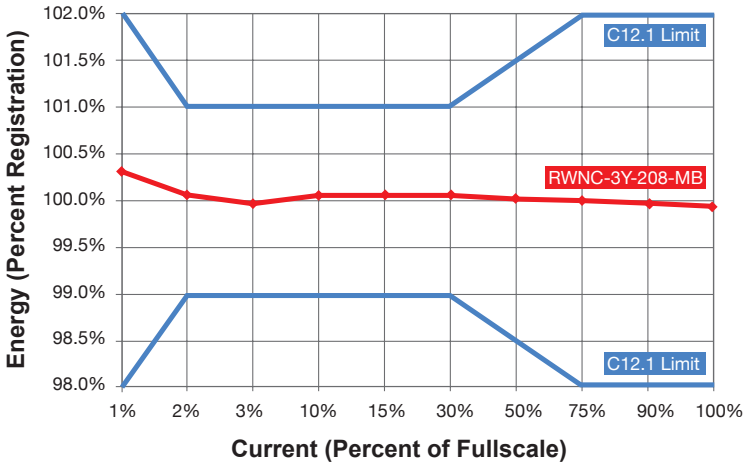
Revenue-grade Energy and Power Meters

The WattNode Revenue meters are designed for use in applications where revenue-grade or utility-grade accuracy is required. The WattNode Revenue meters meet the accuracy requirements of ANSI C12.1 and support Modbus®, BACnet® or LonTalk® communications protocols or a pulse output.

The WatttNode Revenue marks a new level of performance for the WattNode brand of electric power meters. The WattNode Revenue electric power meters are optimized for tenant submetering in residential and commercial spaces, PV energy generation metering, UMCS metering on military bases and more.

The WattNode Revenue meters are designed for 120/208 and 277/480 Vac applications. For ANSI C12.1 accuracy, current transformers compliant with IEEE C57.13 Class 0.6 are required. Each meter is calibrated using NIST traceable equipment following the procedures specified by ANSI C12.1 metering standards and is supplied with a certificate of calibration.

ANSI C12 Load Performance Test - RWNC-3Y-208-MB WattNode Revenue



- **Meets ANSI C12.1 accuracy standards**
- **Supplied with NIST traceable certificate of calibration**
- **Offers bidirectional, true net metering**
- **120/208-240 Vac or 277/480 Vac services**
- **Line powered, compact, easy to install**
- **Use with safe, low voltage (333 mVac) current transformers**
- **Available interfaces: BACnet®, LonWorks®, Modbus®, or pulse output**

WattNode Revenue for BACnet

- Native BACnet MS/TP (RS-485)
- Selectable serial baud rates to 76,800
- Field upgradable firmware
- 50+ measurements (kW, kWh, volts, amps, PF, demand and more)

WattNode Revenue for Modbus

- Modbus RTU protocol (RS-485)
- Supports 127 DIP switch select able addresses
- 50+ measurements (kW, kWh, volts, amps, PF, demand and more)
- Pulse meter input or 5 volt control output (optional)
- 100+ data registers

WattNode Revenue for LonWorks

- LonWorks network variables (SNVTs)
- Logger option
- 30+ measurements (kW, kWh, volts, amps, PF, demand and more)
- LNS plug-in (free)

WattNode Revenue Pulse

- Low cost, high accuracy kWh pulse output
- Bidirectional metering, (consumption and production)
- Single and three phase metering, (energy and power)
- 3-Single phase meters in one (optional)
- Remote display (LCD) available

Current Transformers

- Split-core, solid-core, bus bar and mini
- High accuracy model meets IEEE C57.13 class 0.6
- Ranges from 15 to 400 amps
- Safe 333 mVac output

Continental Control Systems LLC

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RWNC-06.07.13: Specifications are subject to change

Fyrite®
Gas Analyzers

Fast, accurate and easy to use instruments for measuring and analyzing carbon dioxide or oxygen. Fyrite Analyzers are available for either CO_2 or O_2 analysis, and each model is produced in three scale ranges.

All six instruments are similar in appearance and size, but differ in important construction details, as well as in the absorbing fluids.

Each model, therefore, is suitable only for the particular gas analysis or scale range for which it has been manufactured. Accuracy is within $\pm$1/2% CO_2 or O_2.

Operation

Fyrite absorbing fluid is selective in the chemical absorption of carbon dioxide or oxygen, respectively. Therefore, the Fyrite's accuracy, which is well within the range required for industrial and professional applications, does not depend upon complicated sequential test procedures. In addition, Fyrite readings are unaffected by the presence of most background gases in the sample.

The number of tests possible with one fluid charge depends on the concentration of samples being tested. At midpoint scale reading the CO_2 fluid is good for approximately 300 gas samples and the O_2 fluid for 100 tests. The need to replace fluid can be easily determined with a simple test, and replacement is an easy procedure. These test procedures, as well as other good information, are provided in the Fyrite manual 11-9026.

Features

Fyrite Indicators have a broad range; they may be exposed to ambient temperatures from -30° to 150°F, and gases up to 850°F may be tested with standard aspirator sampling equipment (special sampling equipment for higher gas temperatures or dry gases is available). Order Fyrite Instruction Manual 11-9026. For temperatures above 1400°F, a ceramic sampling tube (Bacharach Part # 11-0164) is available.

Applications

0-7.6% CO_2 –
CO_2 tests of controlled atmospheres in fruit, vegetable, meat storage rooms, and incubator monitoring.

0-7.6% O_2 –
Oxygen determination in flammable gases; oxygen tests to check inertness of atmosphere in silos, fuel tanks, etc.

0-20% CO_2 –
Flue gas combustion tests; CO_2 tests of heat treating atmospheres.

0-21% O_2 –
Flue gas combustion tests, oxygen deficiency test. Checking oxygen concentrations in hydrogen cooled generators and oil sealed inert gas transformers.

0-60% CO_2 –
Checking CO_2 in inert gas blankets in tankers and barges carrying gasoline and other combustibles; CO_2 tests on lime kilns; checking CO_2 in sewage plant digesters.

0-60% O_2 –
Oxygen test in connection with oxygen and gas anesthesiology.

Note: United States and Foreign Postal Regulations prohibit Fyrite fluid, in or out of any unit, from being shipped parcel post.

Single Kits - Single Kits contain either a Fyrite CO_2 or a Fyrite O_2 Indicator, Sampling Assembly and a carrying case.

Duplex Kits - Special Fyrite Kits containing various combinations of Oxygen and Carbon Dioxide Indicators, Sampling Assembly and a carrying case.

Repair Kits - One bottle of Fyrite fluid, valve plunger gasket, top gasket, screws, diaphragm, and envelope of filtering material.

Refill Kits - Two bottles of Fyrite fluid, top gasket, screws, and envelope of filtering material.

USA

COMPLETE KIT ITEM NO.[1]	SCALE RANGE	FYRITE	ASPIRATOR ASSEMBLY
CO_2 Testing			
10-5053	0-7.6%	11-7042	11-7039
10-5000[2]	0-20%	11-7032	11-7029
10-5032	0-60%	11-7034	11-7029
O_2 Testing			
10-5054	0-7.6%	11-7044	11-7039
10-5011	0-21%	11-7036	11-7029
10-5046	0-60%	11-7038	11-7029

EXPORT

COMPLETE KIT ITEM NO.[3]	SCALE RANGE	FYRITE (DRY)	ASPIRATOR ASSEMBLY
CO_2 Testing			
10-5083	0-7.6%	11-7041	11-7039
10-5001	0-20%	11-7031	11-7029
10-5033	0-60%	11-7033	11-7029
O_2 Testing			
10-5084	0-7.6%	11-7043	11-7039
10-5012	0-21%	11-7035	11-7029
10-5042	0-60%	11-7037	11-7029

DUPLEX KITS

COMPLETE KIT ITEM NO.[4]	CO_2 FYRITE	OXYGEN FYRITE	ASSEMBLY ITEM NO.
10-5020	0-20%	0-21%	11-7029
10-5021[4]	0-20%	0-21%	11-7029
10-5090[5,6]	0-7.6%	0-7.6%	11-7039
10-5106[5,6]	0-7.6%	0-21%	11-7039
10-5111[5,6]	0-60%	0-21%	11-7029

[1]Domestic shipments only
[2]Also includes Fire Efficiency Finder
[3]Export use only. Kits shipped without fluid.
[4]Export only
[5]Special order only: check factory for price and availability
[6]No export equivalent. Order components separately

FYRITE FLUID*

GAS TYPE	RANGE	ITEM NO. 3 BOTTLE CTN.
Carbon Dioxide		
	0-7.6%	10-5100 (11-0053)
	0-20%	10-5057 (11-0057)
	0-60%	10-5057 (11-0057)
Oxygen		
	0-7.6%	10-5103 (11-0059)
	0-21%	10-5060 (11-0169)
	0-60%	10-5060 (11-0169)

REPAIR KITS

GAS TYPE	RANGE	ITEM NO.
Carbon Dioxide	0-7.6%	11-7053
	0-20%	11-7052
	0-60%	11-7052
Oxygen	0-7.6%	11-7055
	0-21%	11-7054
	0-60%	11-7054

REFILL KITS

GAS TYPE	RANGE	ITEM NO.
Carbon Dioxide	0-7.6%	not available
	0-20%	11-7047
	0-60%	11-7047
Oxygen	0-7.6%	not available
	0-21%	11-7050
	0-60%	11-7050

**Note: Only genuine Bacharach Fyrite Fluid is to be used in your Fyrite Analyzer. Substitute fluids may cause the Fyrite to be inaccurate or inoperative. Numbers in parentheses are old part numbers for reference only and not to be used for ordering.*

Hydrogen Sulphide 100/a

Order No.
CH 29101

ST-129-2001

Standard Measuring Range	:	100 to 2,000 ppm
Number of Strokes (n)	:	1
Time for Measurement	:	app. 30 s
Standard Deviation	:	± 5 to 10 %
Colour Change	:	white —> brown

Ambient Operating Conditions

Temperature	:	0 to 40 °C
Absolute Humidity	:	3 to 40 mg H_2O / L

Reaction Principle

$H_2S + Pb^{2+} \longrightarrow PbS + 2\ H^+$

Cross Sensitivity

No interference by:
2,000 ppm sulphur dioxide
100 ppm nitrogen dioxide

Addendum – Greenwood Dairy

Jon Greenwood
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Canton, NY 12203
315-386-3231
lindargreenwood@yahoo.com

- 12/18/2013 - CDH on site to install Obvius datalogger, replace power meter with revenue grade power meter, and terminate meter wiring.
    - Internet not yet available in generator building.
- 2/18/2013 – CDH on site to verify meter readings, fix IT issue, and establish automated data collection.

Summary

RCM provided and installed the power meter and gas meter. CDH provided and installed the data logger and terminated meter wiring. Greenwood Dairy is providing an internet connection in the generator building.

Monitored Data Points

Logger Channel	Data Point	Description	Eng. Units	Instrument / Transmitter	Output
IN1	WG	Gross Generator Output	kWh	Wattnode RWNB-3Y-480-P	Pulse
IN2	FG	Biogas to Generator	cfm	Sage SIP-300-AC115-DIG-GAS	4-20 mA

IP Info

IP :	192.168.0.113
Netmask:	255.255.255.0

Procedure

- Power was verified by comparing the InteliVision8 engine controller display to the data collected from the Revenue Grade Wattnode by the Obvius Data Logger

- Gas was verified by comparing the engine Sage Prime Flowmeter display to the data being collected by the Obvius Data Logger.

Verification Data – February 18, 2014

Generator Power:

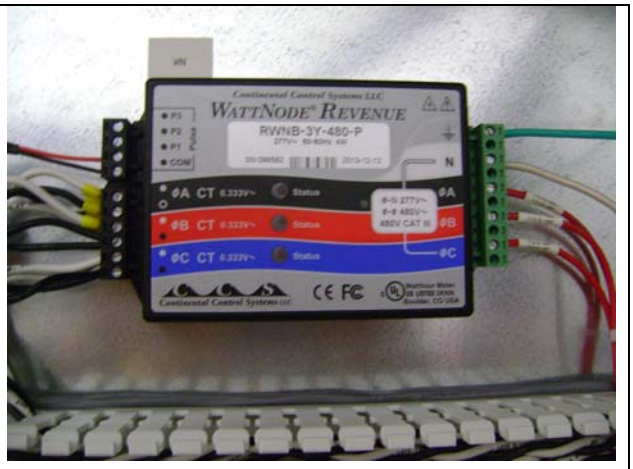
Obvius (kW)	Engine Controller (kW)
220.8	221
220.8	222
229.1	234
Avg: 223.6	*225.7*

Biogas to Engine:

Obvius (cfm)	Sage (cfm)
79.3	79.2
80.1	79.9
83.6	83.8
Avg: 81.0	*81.0*

Site Photos

Guascor MGG-500 engine and Stamford HCM636J generator



Wattnode Revenue power meter

Sage Prim gas meter; gas to engine

CDH data logger and enclosure (left)