QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN

FOR

SYNERGY BIOGAS, LLC

ANAEROBIC DIGESTER GAS (ADG) SYSTEM

Contract # ADG131N

June 14, 2012

Submitted to:

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Introduction

Synergy Biogas, LLC, contracted with a dairy farm, located in Wyoming, NY, currently milks approximately 1,850 cows to provide anaerobic digester gas (ADG) facilities. Recently, the farm has installed a complete mix digester and a biogas based electrical generation system to help treat the manure produced by the cows and to utilize the waste gas produced by digestion to generate electricity.

This plan describes the approach to monitor the performance of the ADG system that is installed by Synergy Biogas, LLC to produce biogas and electricity. Biogas is used to drive an engine-generator to produce power that is exported back to the local utility. A monitoring system is installed to measure and collect the data necessary to quantify the electric power produced by the engine-generator. The data will serve as the basis for payment of a capacity incentive to help offset the capital expenses associated with the procurement of the new generation equipment and three (3) years of performance incentive payments, which Synergy Biogas, LLC has applied for under a Standard Performance Contract with NYSERDA based on a Total Contracted Capacity of 400 kW.

ADG System Description

The digester system at the farm was designed by Bigadan A/S. With the addition of the new engine-generator, the site will operate a 1426 kW synchronous engine-generator system with piping and controls installed in the engine room near the digester.

The electrical system includes controls to synch the generator to the grid. The generator is connected through one (1) bi-directional meter to the National Grid distribution system. The electricity generated is used to run the biogas digester plant which uses about 200 kW continuously and the additional power is sold back to the grid.

Figure 1, in Appendix A, includes photographs of the digester and the electric generation system.

Figure 2, in Appendix A, schematically shows the biogas system and engines. Approximately 1,850 cows are kept in three (3) barns, two (2) free-stall barns and one (1) barn housing the milking parlor and approximately 250 cows. Manure is scraped to a trench at the center of the free-stall barns and flows by gravity to the pumping pit. From the pumping pit, manure is pumped to one of the two (2) receiving tanks serving the biogas plant. Food grade industrial waste is delivered by truck to the other receiving tank. Each of the receiving tanks have agitators. The receiving tanks are covered and air is pulled off the tanks and through a Biofilter for odor control. Influent biomass is pasteurized prior to anaerobic digestion. Approximately once an hour, biomass from the receiving tanks is pumped through the heat exchangers and into one of three (3) pasteurization vessels. Biomass is held in a pasteurization vessel at approximately 160°F for one hour. Once pasteurized, biomass is pumped through heat exchangers and into the digester vessel. The digester vessel is an insulated bolted steel tank with a single mixer mounted in the roof. The digester operates in mesophilic range (approximately 102°F). The detention time in the digester is at least 20 days. Digested biomass flows to a bolted steel storage tank fitted with a gas storage cover. From the storage tank, biomass is pumped to screw press separators. Fiber fraction is used for bedding at the dairy and liquid fraction is stored in a lagoon system and land applied to crop land. Biogas flows by natural pressure from the digester through a H_2S (hydrogen sulfide) scrubber to gas storage. From gas storage, biogas flows through the condensate well to the blower feeding the CHP unit and boiler or to the flare. Table 1, below depicts the biogas electric generation system components.

Table 1. Biogas Systems at Synergy Biogas, LLC

Digester	Bigadan A/S Complete Mix, heated, hard cover
Feedstock	Dairy Manure, ~1,850 cows Food Grade Industrial Waste
Engine-Generator	Jenbacher Type 420 cylinder Engine Jenbacher JMC420 Generator – 1426 kW 400 kW contracted output on biogas 480 VAC, 3 phase
Biogas Conditioning	H_2S removal Condensate well Pressurization of biogas to approx. 1.5 psi
Engine Backup/startup Fuel	None
Heat Recovery Use	Heat influent biomass

Monitoring System Equipment, Installation, Operation, and Maintenance

Figure 2 also shows the locations of the three (3) data monitoring points which are used to measure system performance. A gas meter measures biogas input to the flare (**FGF**), and a second meter measures biogas input to the engine (**FGE**). A power meter, located between the engine generator and the circuit breaker panel measures the kilowatts and kilowatt hours generated (**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
Pulse	WG	Engine-Generator Power	Dia.ne XT3 control system	kW kWh	0-1426 kW 0-356.5 kWh/15 minutes
Pulse	FGF	Flared Biogas Flow	Esters Elektronik Model GD100/100/3 Ex (biogas)	m^3/h	10-1000 m^3/hour (every 15 seconds)
Pulse	FGE	Biogas Flow to Engine	Esters Elektronik Model GD100/100/3 Ex (biogas)	m^3/h	10-1000 m^3/hour (every 15 seconds)

The electrical output of the new engine will be measured with a Jenbacher Dia.ne control system (**WG**). This system includes an LCD display and is installed next to the electrical panel for the new engine. The system has the capability to measure kWh data and will be utilized instead of a separate power transducer. The control system was installed according to requirements in the "Dia.ne XT3 User Manual" (Appendix B). The meter will have its own circuit breaker or inline fuse to provide over-current protection.

The biogas input to the engine will be measured by a Esters Elektronik gas meter (**FGE**) with impulse output installed just past the blower on the line to the CHP Unit. A second gas meter (**FGF**), located near the ceiling of the digester, will measure the biogas directed to the flare. The meters were installed in accordance with the provisions of the "Instruction Manual IM 300 E Fluidistor Gas Flowmeter GD 100/LRM (Ex) – Installation, maintenance and troubleshooting" as part of the engine generation equipment provided by Bigadan. Maintenance activities will be performed in accordance with the instructions in the O&M manual. A log of maintenance activities for the meter will be maintained at the site.

The lower heating value for the biogas is conservatively estimated to be 520 Btu/ft^3. Once the system is operational, this value will be verified weekly based on measurements of carbon dioxide using a Sewerin SR2-DO Gas Analyzer for CO_2 range 0-100%. Farm personnel will perform the CO_2 (carbon dioxide) tests and record the results in the project log.

CDH Energy will install a datalogger to log the data from the three (3) monitoring points listed in Table 2. The datalogger will be programmed to average or totalize data for each monitoring point for each 15-minute interval as appropriate. A record of all multipliers and datalogger settings will be maintained. The datalogger will be located in the engine room next to the control panel, and will be connected to an uninterruptible power supply (UPS) to ensure the datalogger retains its settings and data in the event of a power outage. The UPS is capable of powering the data logger for at least one day. The farm will provide a dedicated phone line (or an Ethernet connection with fixed IP address) that will be used to communicate with the data logger. The NYSERDA CHP Website Contractor (CDH Energy Corp.) will communicate with the data logger nightly to extract monitored data from the data logger and transfer the data to the NYSERDA CHP Website. If communications are lost, the data logger is capable of holding at least 15 days of 15-minute interval data.

Synergy Biogas, LLC staff will be responsible for the cost to purchase and install the data logger/power meter (**WG**) and biogas meters (**FGF and FGE**). The bi-directional power meter on the main utility line (**WT_{in}** and **WT_{exp}**) was installed as part of the net metering interconnection agreement with National Grid.

Management of Monitoring System Data (Farm Responsibilities)

The Synergy Biogas, LLC staff will perform the following quality assurance and quality control measures to ensure the data produced from the monitoring system accurately describes system performance.

Upon installation of the monitoring equipment, the Synergy Biogas, LLC equipment manager will work with the installation contractors or equipment vendors to ensure that the monitoring equipment is functioning properly. The Synergy Biogas, LLC equipment manager will review the operation manuals for an understanding on how to use and maintain these meters.

On a daily basis, the Synergy Biogas, LLC equipment manager (or other specified employee) will perform inspections of the digester and engine-generator equipment and record findings into the project log.

On a weekly basis, the Synergy Biogas, LLC 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) and gas flow (m^3) from the new engine in the event that data transfer to the NYSERDA CHP Website fails or other anomalies occur.

On a weekly basis, the Synergy Biogas, LLC staff will review the data stored on the NYSERDA CHP Website (chp.nyserda.org) to ensure it is consistent with their observed performance of the ADG system and logged readings. Synergy Biogas, LLC will review the data using the reporting features at the website, including:

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

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

- A periodic email report summarizing performance and the estimated incentive,
- An email report will be sent out if data are not received at web site or do 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 interval using range and relational checks. The expected ranges for the sensors (see Table 2) will be used for the range checks. The relational check will compare the kWh production data and gas production data for each 15-minute interval to ensure both meters always provide non-zero readings at the same time (e.g., to detect if a meter has failed). Only data that passes the range and relational quality checks are used in the incentive reports listed above. However, all hourly data are available from the NYSERDA CHP Website using the “Download (CSV file)” reporting option.

In the event of a communications or meter failure, Synergy Biogas, LLC personnel will work with CDH to resolve the issue.

If unanticipated loss of data occurs when the engine-generator continues to produce electricity, Synergy Biogas, LLC will follow the procedures outlined in Exhibit D of their contract, i.e. using data from similar periods – either just before or after the outage – to replace the lost data.

Synergy Biogas, LLC personnel understand that they can use this approach for up to two (2) 36-hour periods within each 12-month performance reporting period. If more than two (2) such data outages occur, Synergy Biogas, LLC personnel will provide information from other acceptable data sources (e.g., weekly recorded logs) to definitively determine the amount of power that was produced from biogas during the period in question.

Annual Performance Reports

The Farm will prepare the Annual Performance Report summarizing the monthly data over the 12-month performance period. The report will include a table showing the monthly kWh production, biogas used by the engine, and other data listed in Table 3. 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) 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 M&V Report

Start Date of Reporting Period	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								

The Farm will calculate monthly values for lower heating value of the biogas (LHV_{biogas}), total energy content of the biogas (Q_{biogas}), total energy of the propane ($Q_{propane}$), and adjusted kWh production ($kWh_{adjusted}$) as follows.

Monthly Biogas Lower Heating Value

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

$$LHV_{biogas} = LHV_{methane} \cdot (1 - F_{CO_2})$$

where:

- $LHV_{methane}$ - lower heating value of methane (520 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 (ft^3) of biogas in month

Monthly Propane Energy Content

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

$$Q_{propane} = Gallons \cdot \left[83{,}500 \frac{Btu_{LHV}}{gal} \right]$$

where:

- Gallons - propane consumption in the period (gallons)

Monthly Adjusted Electricity Production

Calculate the monthly adjusted electricity production using the following equation:

$$kWh_{adjusted} = kWh_{generator} \left[\frac{Q_{biogas}}{Q_{biogas} + Q_{propane}} \right]$$

where:

- $kWh_{generator}$ - actual electricity production

In some cases, propane data may not be available on a monthly basis. In this event, the calculations to determine the adjusted electric production using $Q_{propane}$ will be completed at the smallest possible interval (not greater than 12 months).

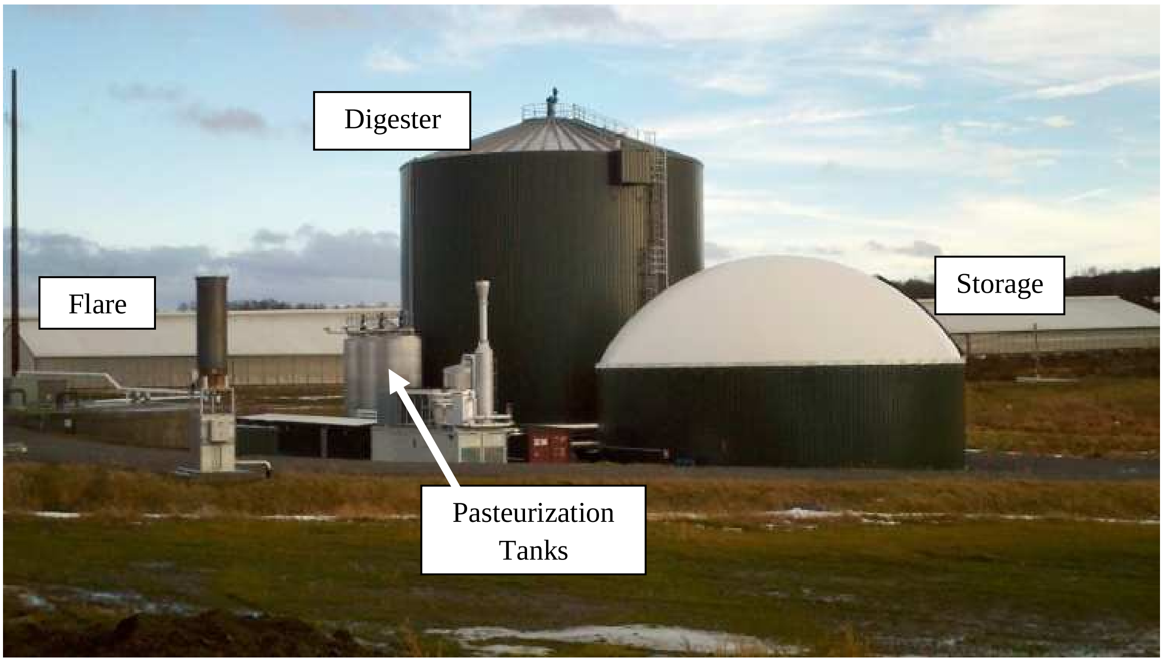
Reasonable Electrical Efficiency

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 ($Q_{biogas} + Q_{propane}$) in similar units and based on lower heating value – should be in the 25% over any interval for the engine generator on Synergy Biogas, LLC site.

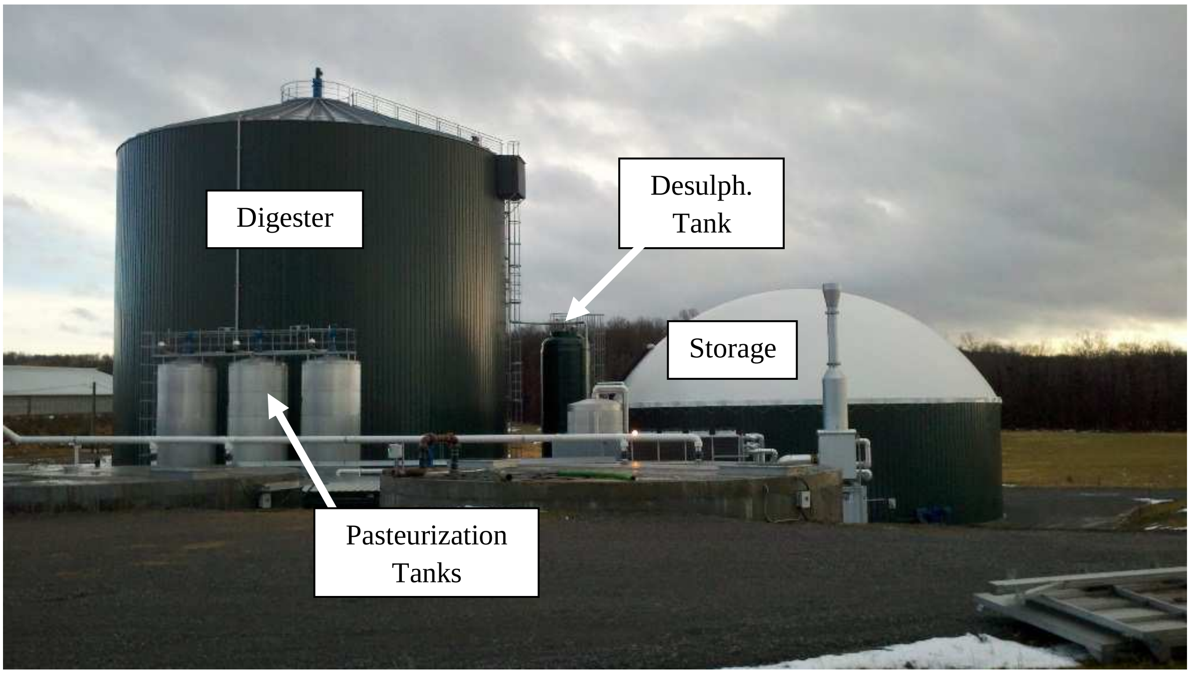
APPENDIX A

FIGURE 1

CHP North side and South side of Engine Respectively



Site looking South East

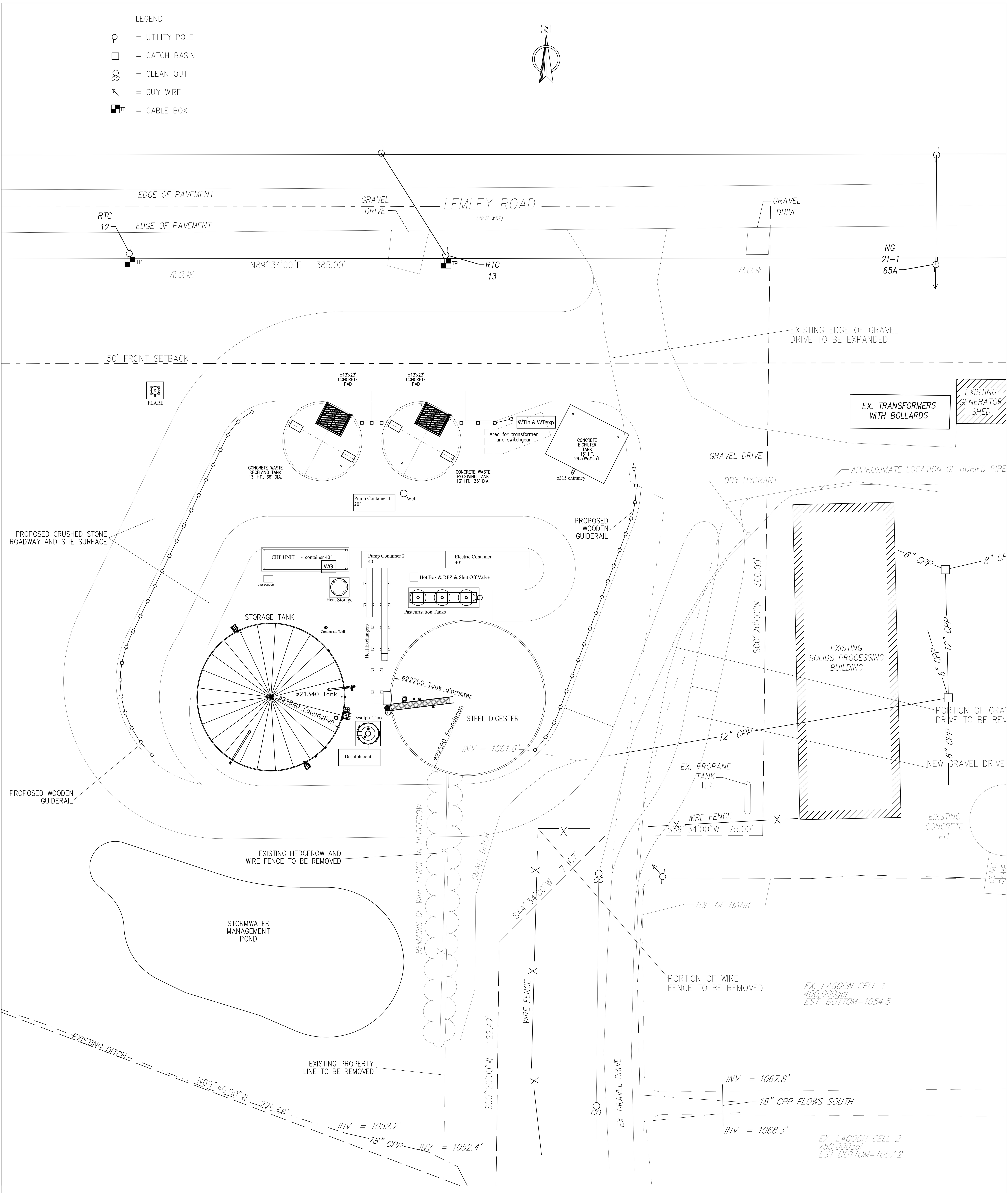


Site looking south

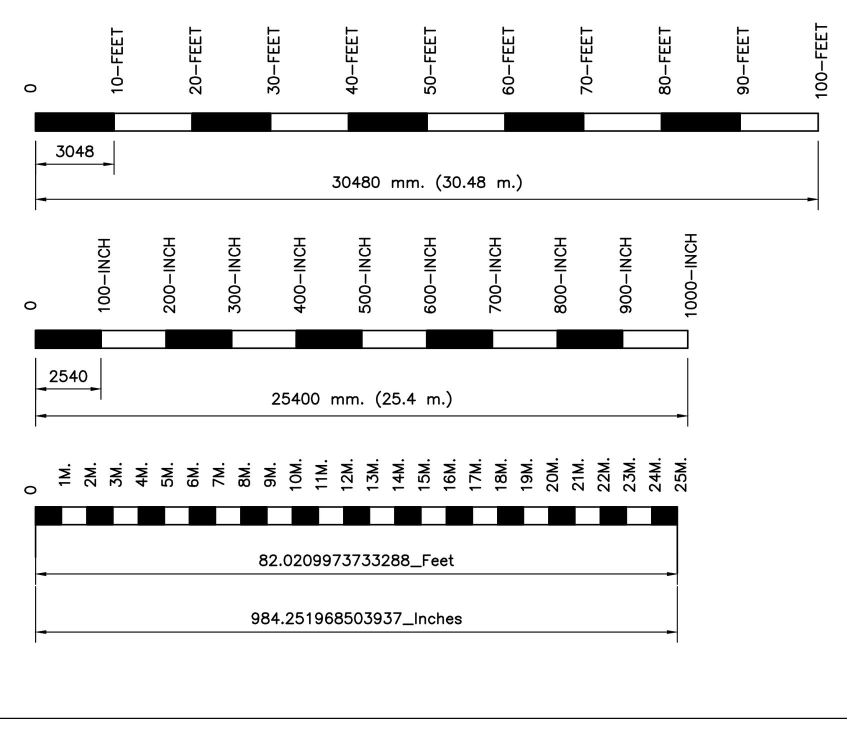
Digester Gas Scrubber and Storage

CHP Main Power

FIGURE 2



GRAPHIC SCALES



Rev.	Revision	Rev. date :	Eng./ Assistent	Approved
A	Update to actual situation	17.06.2011	GSD / ng	Approved

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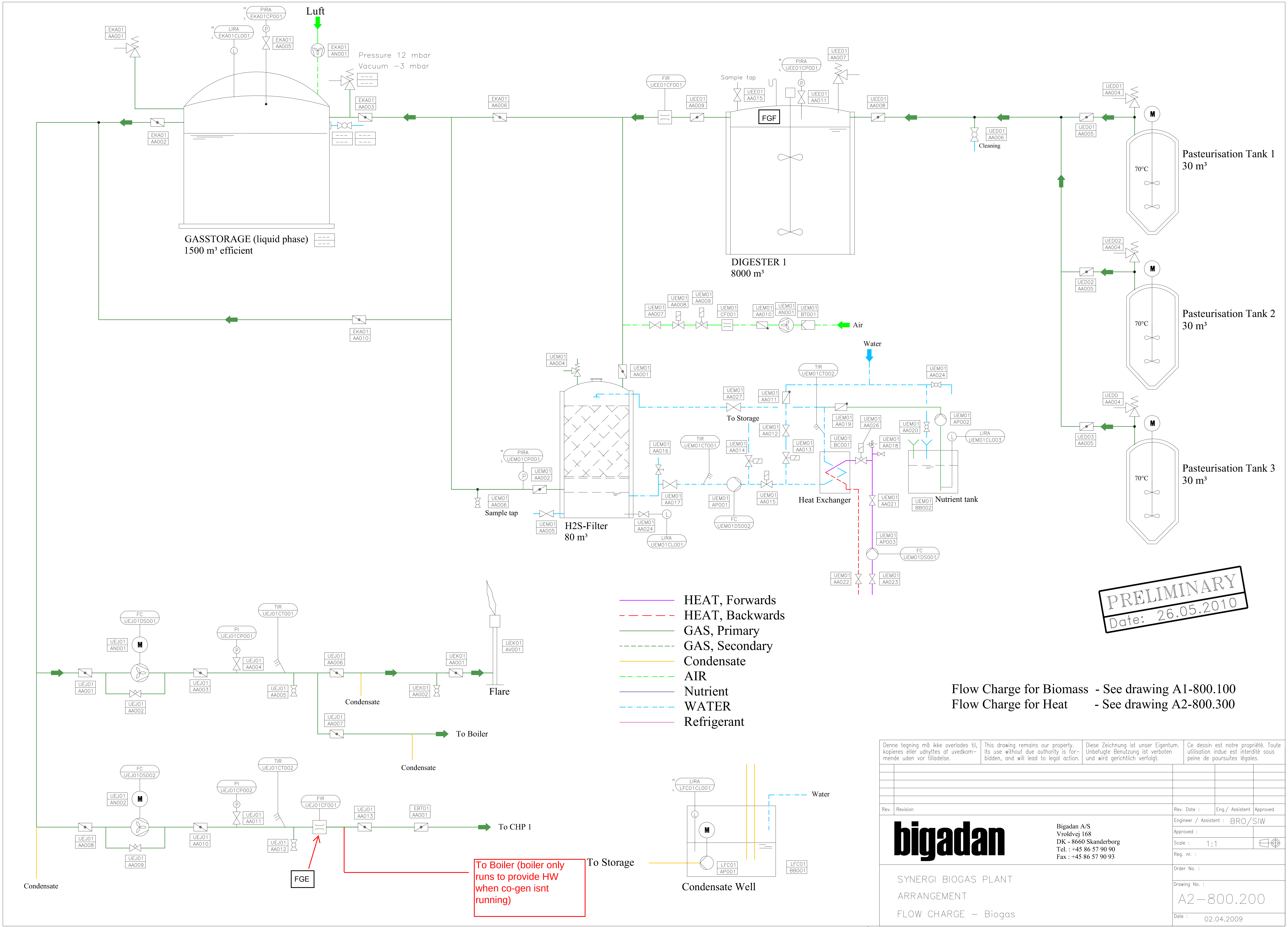
Engineer / Assistent : GSD/NG
Approved :
Scale : 1:250
Reg. nr. :
Order No. :
Drawing No. : A1–800.000.A
Date : 18.03.2011

SYNERGY BIOGAS PLANT
ARRANGEMENTS
LAY – OUT


Luft
Pressure 12 mbar
Vacuum –3 mbar
GASSTORAGE (liquid phase)
1500 m³ efficient
Sample tap
FGF
DIGESTER 1
8000 m³
Cleaning
Pasteurisation Tank 1
30 m³
Pasteurisation Tank 2
30 m³
Pasteurisation Tank 3
30 m³
70°C
Air
Water
To Storage
Heat Exchanger
Nutrient tank
H2S-Filter
80 m³
PRELIMINARY
Date: 26.05.2010
HEAT, Forwards
HEAT, Backwards
GAS, Primary
GAS, Secondary
Condensate
AIR
Nutrient
WATER
Refrigerant
Flow Charge for Biomass - See drawing A1-800.100
Flow Charge for Heat - See drawing A2-800.300
Flare
Condensate
To Boiler
To CHP 1
FGE
To Boiler (boiler only runs to provide HW when co-gen isnt running)
To Storage
Condensate Well
Denne tegning må ikke overlades til, kopieres eller udnyttes af uvedkommende uden vor tilladelse.
This drawing remains our property. Its use without due authority is forbidden, and will lead to legal action.
Diese Zeichnung ist unser Eigentum. Unbefugte Benutzung ist verboten und wird gerichtlich verfolgt.
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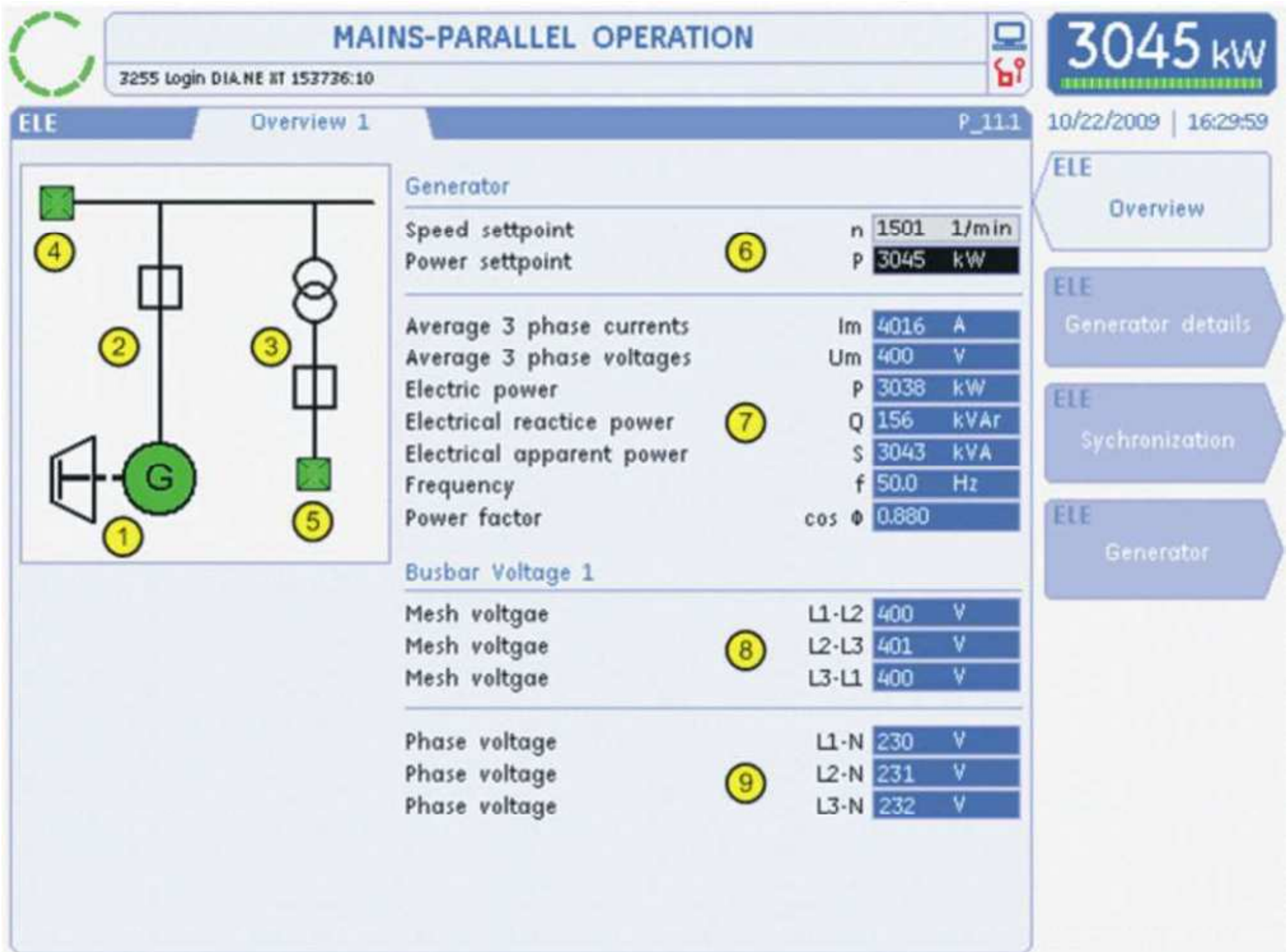
Fax : +45 86 57 90 93
SYNERGI BIOGAS PLANT
ARRANGEMENT
FLOW CHARGE – Biogas
Engineer / Assistent BRO/SIW
Scale : 1:1
Drawing No. : A2–800.200
Date : 02.04.2009

APPENDIX B

7.2.1 Overview (P_11.1)

The Overview screen appears when you press the **ELE** screen selection key. This screen displays the main electrical measured quantities, as well as operating and switching conditions.

Note: Customer View does not show the indications for bus bar voltages ⑧ and ⑨.



① Generator or engine indication

Ten seconds after the starting speed is reached, the display changes colour from white to green.

② Generator switch branch

The switching condition of the generator switch is displayed:

open

closed

An optional transformer can also be displayed in the generator switch branch. This symbol is not animated (no colour change).

Transformer

③ **Mains branch**

Optionally, the switching condition of the mains switch is displayed:

open

closed

An optional transformer can also be displayed in the mains branch. This symbol is not animated (no colour change).

Transformer

④ Bus bar status identification

If the voltage values of the bus bar are OK, a green mains symbol is displayed. In the event of a malfunction the symbol appears black and white.

Bus bar voltage is O.K.

Bus bar voltage error

⑤ Mains status indication

If the mains status is OK, a green mains symbol is displayed. In the event of a malfunction the symbol appears black and white.

Mains voltage is O.K.

Mains voltage error

⑥ **Entering speed and power setpoint**

Speed setpoint n

When the generator switch is open, the entry field is visible and the engine speed setpoint can be altered. The engine speed setpoint value can be entered from User Level customer (10) upwards.

Power setpoint P

Here you can alter the power setpoint value, unless another type of power setting has been installed. The power setpoint value can be entered from User Level customer (10) upwards.

⑦ **Electrical measurement**

Display showing electrical data for the generator.

Abbreviation	Description	Unit
Im	Current average value, 3 phases	[Ampere]
Um	Voltage average value, 3 phases	[Volt]
P	Effective power	[Kilowatts]
Q	Reactive power	[Kilo-Volt-Ampere-reactive]
S	Apparent power	[Kilo-Volt-Ampere]

Abbreviation	Description	Unit
f	Frequency	[Hertz]
cos Φ	Power factor	[1]

⑧ Bus bar voltage interlinked

Optionally, the three interlinked bus bar voltages L1-L2, L2-L3 and L3-L1 are displayed.

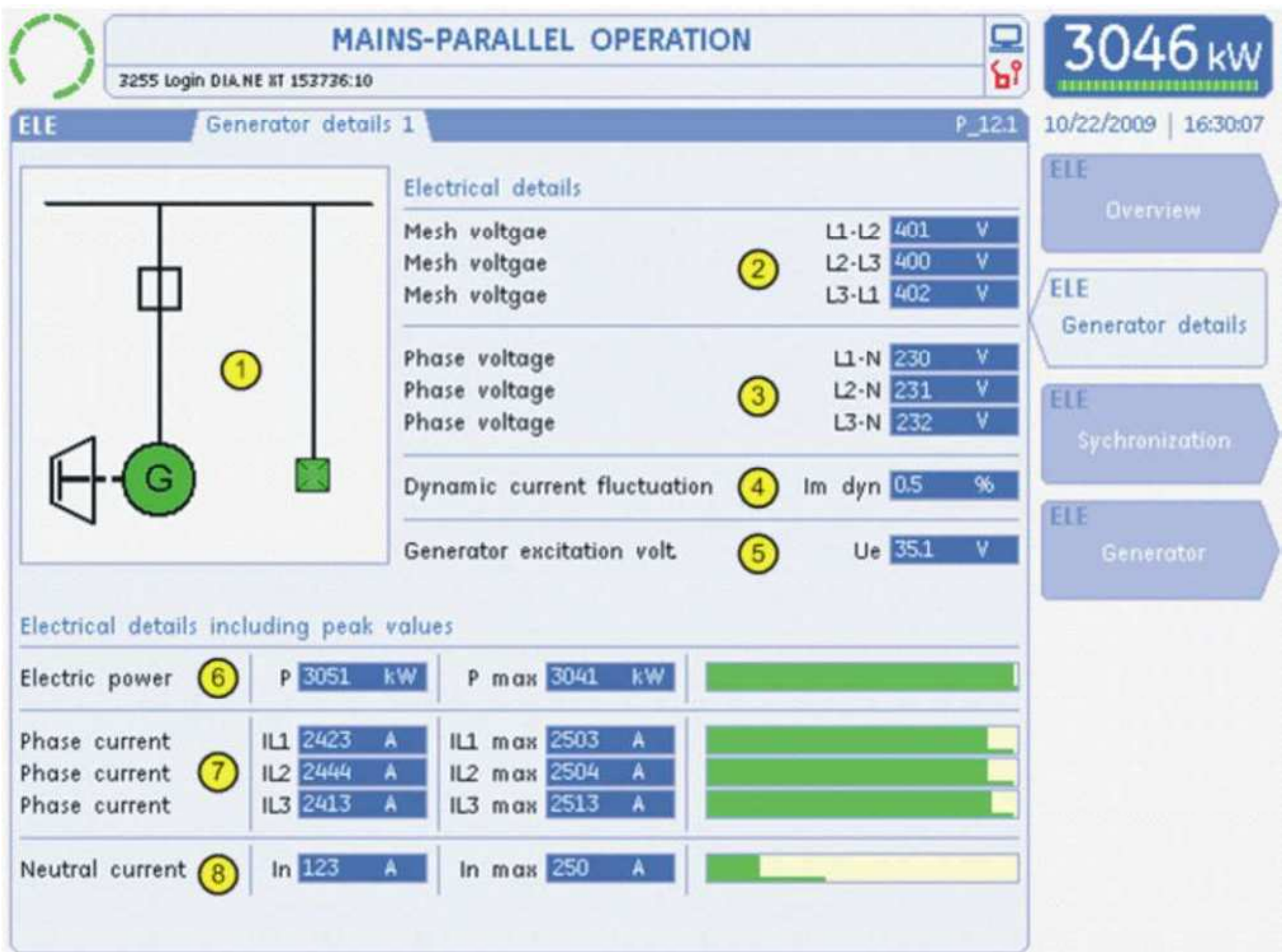
⑨ Bus bar voltage per phase

Optionally, the three bus bar voltages in phases L1, L2 and L3 are displayed in relation to the neutral conductor.

7.2.2 Generator Details 1 (P_12.1)

The Generator Details 1 screen appears when you press the **ELE** main screen selection key, followed by **F2**. The electrical data for the generator are displayed on this screen.

Note: This screen is only displayed in Customer View. Optionally, details of another measuring point can be shown on a second tab (P_12.2).



① Animated switching condition diagram

An explanation of the individual symbols can be seen in the Overview (P_11.1) screen.

② **Generator voltage interlinked**

Optionally, the three interlinked generator voltages L1-L2, L2-L3 and L3-L1 are displayed.

③ **Generator voltage per phase**

Optionally, the three generator voltages in phases L1, L2 and L3 are displayed in relation to the neutral conductor N.

④ **Dynamic pulsation amplitude of phase currents**

The maximum value of the current pulsation amplitude is displayed as a percentage so that the smooth running of the engine can be assessed while in mains-parallel operation. This peak-value memory has a decaying time constant and should ideally display the lowest possible value.

⑤ **Generator excitation voltage**

The generator excitation voltage is displayed in volts.

⑥ **Detailed electrical power indication**

The current electrical power is displayed in kilowatts. In addition, a special display field is used to display the maximum value for this measured quantity. The value is always reset when the generator switch is actuated.

⑦ **Detailed phase current indication**

The three current phase currents are displayed in amperes. In addition, special display fields are used to display the maximum values for the currents. The values are always reset when the generator switch is actuated.

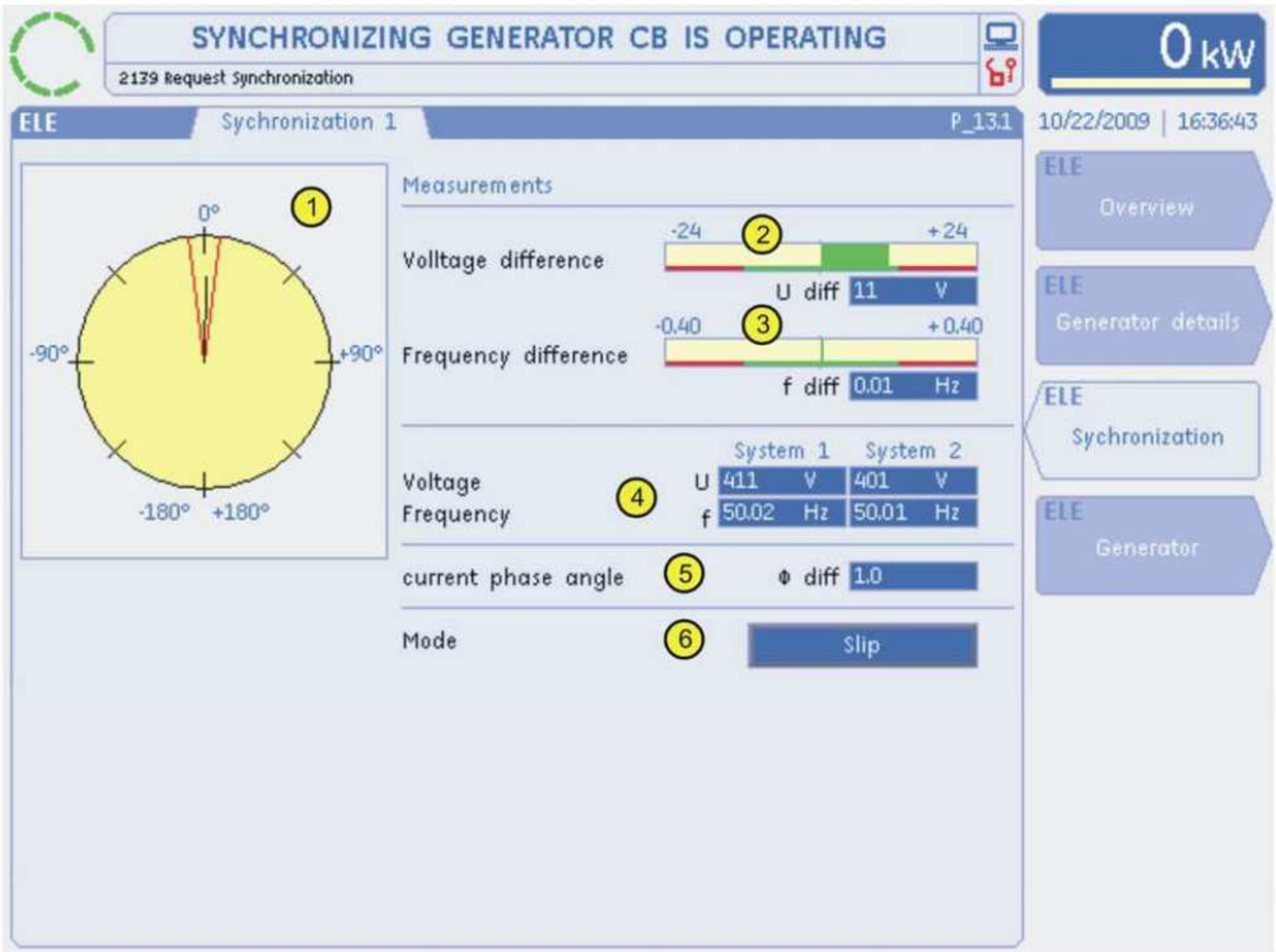
⑧ **Detailed neutral conductor current indication**

The current neutral conductor current is displayed in amperes. In addition, a special display field is used to display the maximum value for the neutral conductor current. The value is always reset when the generator switch is actuated.

7.2.3 Synchronisation (P_13.1

The Synchronisation screen appears when you press the **ELE** screen selection key, followed by **F3**. A synchronoscope, with all the measured values required for synchronisation, is displayed on this screen.

Note: This screen is only displayed in Customer View. Optionally, details of another synchronisation can be shown on a second tab (P_13.2).

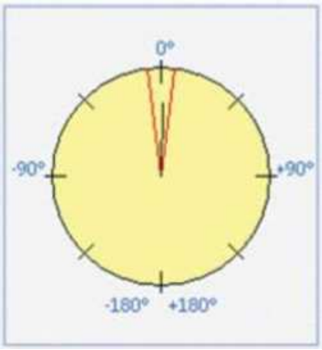


① Synchronoscope

The synchronoscope is used to display the changes in phase position during the synchronisation process. The position of the pointer corresponds to the numerical value of **Φ diff**. The value is displayed from -180 to +180 degrees.

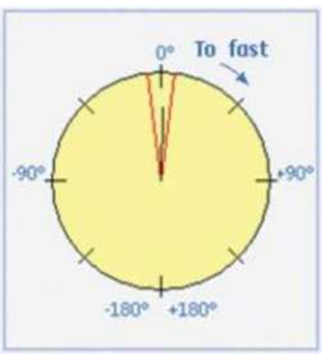
The synchronoscope pointer indicates the current phase position. The lower the differential frequency the more slowly the pointer moves.

Permissible activation range



This activation condition is satisfied if the synchronisation pointer is within the permissible phase position.

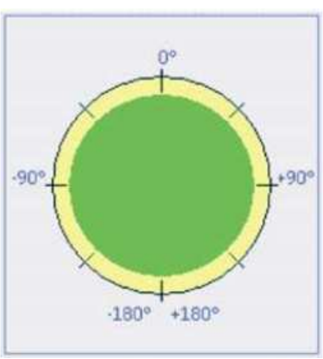
Engine speed deviation



The messages **Too Fast** and **Too Slow** are shown as an additional aid.

The display appears as soon as the permissible differential frequency is exceeded.

Synchronisation completed



Synchronisation will be finished upon receipt of the power switches response. This status is displayed using a green disc. In this way, it is possible to check whether the control system is trying to close the switch.

Deviation from measured value in synchronised condition

Deviations may occur in the measured values because of errors in the measurement accuracy tolerance, despite the fact that the systems are electrically linked.

② **Voltage difference**

The current voltage difference **U diff** between the two networks to be synchronised (U diff = U System 1 - U System 2) is displayed.

③ **Frequency difference**

The current frequency difference **f diff** between the two networks to be synchronised (f diff = f System 1 - f System 2) is displayed.

④ **Comparing two electrical systems**

Electrical System 1

The entry **System 1** lists the current voltage and frequency of electrical system 1. System 1 is activated at the X4 terminals of the multi-measurement converter. The voltage closer to the generator is displayed here during the synchronisation procedure.

Examples:

The generator voltage is connected here during the synchronisation of the generator switch.

The bus bar voltage is connected here during the synchronisation of the mains switch.

Electrical System 2

The entry **System 2** lists the current voltage and frequency of electrical system 2. System 2 is activated at the X6 terminals of the multi-measurement converter. The voltage closer to the mains is displayed here during the synchronisation procedure.

Examples:

The bus bar or mains voltage is connected here during the synchronisation of the generator switch.

The mains voltage is connected here during the synchronisation of the mains switch.

⑤ **Phase angle**

The current phase angle between the networks to be synchronised **Φ diff** (-180° to +180°) is displayed.

⑥ **Synchronisation mode**

There are three ways in which synchronisation can be performed:

Inactive

No function has been selected or synchronisation has already been completed

Slip

The following applies to the generator and synchronisation voltage:

50% < U < 125% of rated voltage UN
80% < f < 110% of rated frequency fN

The generator voltage is adjusted to the synchronisation voltage in terms of amplitude and frequency. The switch command is designed and executed in advance to take account of the parameterised phase angle, a preset transformer connection circuit and the switch response time so that the main contacts of the power switch are closed at the point of synchronisation.

Synchronisation takes place subject to the following conditions:

- The "Select synchronisation" command is set in the software
- The parameterised limit for voltage difference has been maintained (dUmax)
- The parameterised limits for frequency difference have been maintained (dfmax and dfmin)
- The parameterised limit for the phase angle (including transformer connection circuit) has been maintained (dalpha)

If all the conditions have been satisfied, the activation output changes its condition from LOW to HIGH. When the parameterised pulse period has ended, it switches back from HIGH to LOW.

Synchro Check

In this operating mode the device can be used as a synchronisation control.

The "Close LS" relay remains attached as long as the following conditions are satisfied:

- The "Start synchro check" command is set in the software
- The parameterised limit for voltage difference has been maintained (dUmax)
- The parameterised limits for frequency difference have been maintained (dfmax and dfmin)
- The parameterised limit for phase angle has been maintained (phimax)

The activation output remains set so long as all the conditions are satisfied.

Dead bus

The activation command for the power switch is issued without synchronisation if the following conditions are satisfied:

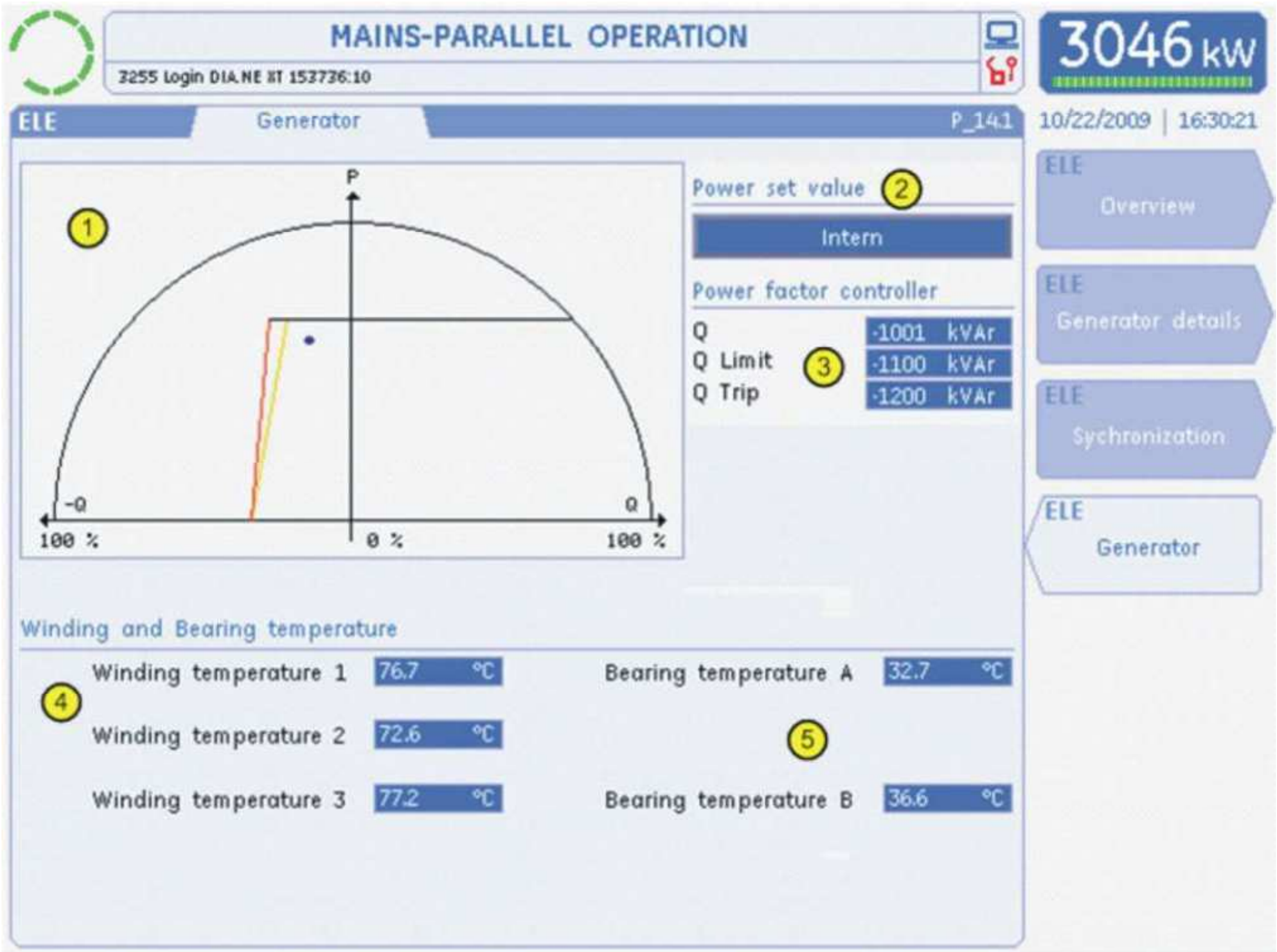
- the "Start dead bus" command is set in the software
- The bus bar is dead (USS < 5% UN)
- The generator voltage and frequency can have any valid value.

If all the conditions have been satisfied, the activation output changes from LOW tot HIGH.

7.2.4 Generator (P_14.1)

The Generator screen appears when you press the main **ELE** screen selection key, followed by **F4**. Optionally, the operating diagram of the synchronous generator and, optionally, its bearing and winding temperatures are displayed.

Details of the function and setting of the generator controller can be found in Technical Instruction 1530-0182.



① Operating diagram of synchronous generator

The operating diagram of the synchronous generator shows the effective power and reactive energy. The blue dot indicates the operating point. The current reactive energy (Q), the maximum permissible reactive energy (Q LIMIT - orange line) and the exciter failure value (Q TRIP - red line)

Where the permissible reactive energy is reached and the generator control system is enabled, an operating notification is issued and the control system is limited to this value.

Where the maximum reactive energy (exciter failure value) has been reached, the engine shuts down due to exciter failure.

② Control type indication

The following control types are available for power factor control:

None	only operating diagram displayed
Internal	Setpoint value preset via parameter setting
External - analogue	Power factor setpoint preset via analogue signal
External - bus	Power factor setpoint value preset via bus

③ **Reactive energy indication**

The following information on reactive energy is displayed:

Q	current reactive energy
Q Limit	Limit level for warning and control limit
Q Trip	Limit level for shutdown due to exciter failure

④ **Generator winding temperature**

Optionally, generator winding temperatures can be displayed in degrees Celsius, degrees Fahrenheit or in Kelvin.

Depending on the generator type, either one or three measured values can be visualised.

⑤ **Generator bearing temperature**

Optionally, generator bearing temperatures can be displayed in degrees Celsius, degrees Fahrenheit or in Kelvin.

7.3 Hydraulic diagram (HYD)

The **HYD** screen group contains information on the hydraulic system. Pressure and temperature data for the oil and cooling water circuits are displayed.

7.3.1 Oil/Cooling Water screen (P_21.1)

The Oil/Cooling Water screen appears when you press the **HYD** screen selection key. This screen displays the main hydraulic measured quantities, as well as operating conditions in the cooling circuits.

Fluidistor Gas Flowmeter GD 100 (Ex)

for measuring of all technical and medical gases DN25 - DN400

Rev. Nr. DS 300 E V1.1 2011-03-01

- Oscillating measuring principle, without moving parts
- Resistent to dirt, e.g. oil and rust residues in compressed-air systems
- Best results measuring wet biogas with a newly developed biogas-sensor
- Short response time T90 ≤ 100 ms
- High accuracy (± 1,5% of true value)
- High reproducibility (0,1% of true value)
- Low loss of pressure
- Maximum operating pressure 40 bar, temperature 120°C
- Each flowmeter with calibration report
- Ex II 1 G EEX ia IIC T4 SP 03ATEX3614X (Standard)

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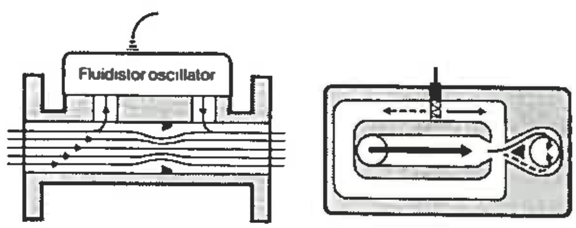
Principle of measurement

The meter is a fluidistor oscillator with an oscillating frequency which is directly proportional to the gas passing through it.

The frequency / velocity ratio is constant for all gases within a large flow range. The volume per pulse is not affected by changes in gas density and viscosity.

The fluidistor works as a bypass to the main housing. The main flow is throttled by an orifice plate, thus creating the same flow coefficient as in the fluidistor. The flow through the fluidistor is a part of the total flow through the meter.
As there is a fixed ratio between these two flows, the oscillating frequency of the fluidistor is regarded as the measurement of the total flow through the meter.



The right hand picture shows a cross section of the fluidistor. The gas flow enters the meter on the left and leaves it through the connection to the right.

The flow alternately selects one of the two channels directly upstream of the outlet. The occuring oscillation is caused by the reciprocating flow within the U-shaped channel connecting the control channels.

The oscillating frequency is measured in the U-shaped channel by a hot wire sensor. The sensor can easily be replaced without removing the meter and does not have an influence on the calibration of the meter.

In the signal converter, the oscillations are amplified to a pulse or analogue signal to be received by a counter, a recorder or an indicating instrument.

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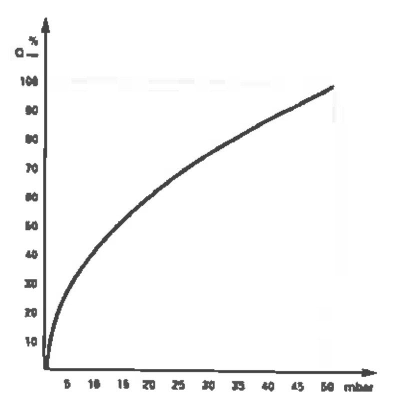
Pressure loss / Pressure flow

The diagram applies to gases of air density at NTP, e.g. 0°C and 1000 mbar.

The decrease of pressure is always proportional to the gas density.

If e.g. the operating pressure rises by 100%, the pressure drop is double.



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Dimension and weight

DN (NOMINAL WIDTH)	mm L	D	Dh	H	H WITH AVF	WEIGHT (kg)
25	300	115	85	140	180	10
32	300	140	100	160	200	11
40	300	150	110	145	185	12
50	300	165	125	145	185	13
65	300	185	145	175	215	14
80	300	200	160	160	205	20
100	360	220	180	190	230	23
125	300	250	210	245	285	20
150	350	285	240	240	280	26
200	350	340	295	265	305	36
250	450	405	355	290	330	53
300	500	460	410	320	360	70
350	500	520	470	335	375	83
400	500	580	525	400	400	90

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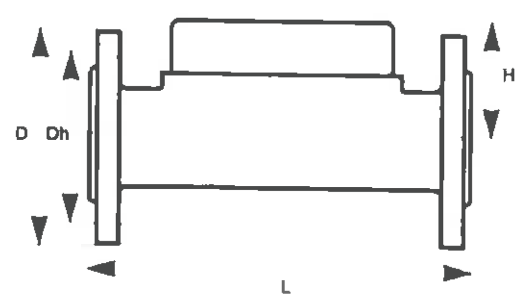
Flanges according to EN-1092-2

DN100 with orifice plate 3



Option

AVF — Ball valve (Blocking valve)
Removal / installation of the flow-sensor without emptying the system

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Technical details

The usage of the ball valve increases the availability of the plant. The installation / removal of the flow-sensor in the GD 100 can be carried out during operation.

During system engineering it has to be considered that the nominal width of the pipe must not be increased in order to avoid tampering the measurand. It is important that the defined measurement range of each nominal width must not be exceeded.

Measurand below the limit value Q_{min} (flow range) can not be displayed.

Technical data

Meter Size	DN25 to DN400
Pressure-Classification	PN16 (standard), PN25 and PN40 (option)
Temperature	-30 to +120°C; gas as well as enviroment Max. 60°C Ex-model.
Material	Meter housing: cast iron or optional stainless steel 1.4571 Orifice plate: stainless steel Fluidistor: polyethersulphone (PPS) Sensor: platinum wire Sealings: Silicon, nitrile or viton Protection class: IP65
Ex-model	II 1 G EEX ia IIC T4 SP 03ATEX3614X ATEX-Certificate No. SP06ATEX3634

For the measurement of wet biogas a newly developed sensor is available.

Installation information

The meter can be installed in horizontal as well as vertical pipes.

In case of potential risk of condensate or liquid in the gas, the GD 100 has to be installed horizontally with the meterhead upwards.

Up-stream the meter requires a straight pipe length of 10 x DN (D=pipe diameter), downstream 5 x DN is required.

The gas velocity of an upstream flow may not exceed supersonic speeds anywhere. Thus supercritical pressure drops must be avoided.

To install the sensor cable, the cover of the GD 100 has to be lifted, therefore the device has to be installed at a minimum distance of 10 cm to the ceiling.

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Flow range

DN (mm)	m³/h					
	1		2		3	
	Q_{min}	Q_{max}	Q_{min}	Q_{max}	Q_{min}	Q_{max}
25	0,20	20	0,35	35	0,70	70
32	0,20	20	0,60	60	1,00	100
40	0,20	20	0,90	90	2,00	200
50	0,20	20	1,10	110	2,50	250
65	0,90	90	1,70	170	4,50	450
80	1,40	140	4,50	450	8,00	800
100	2,70	270	6,50	650	10,00	1000
125	4,00	400	8,00	800	15,00	1500
150	6,00	600	12,00	1200	30,00	3000
200	12,00	1200	25,00	2500	60,00	6000
250	20,00	2000	40,00	4000	75,00	7500
300	30,00	3000	50,00	5000	113,00	13000
350	40,00	4000	70,00	7000	140,00	14000
400	50,00	5000	100,00	10000	160,00	16000

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Accuracy of measurement

At low flow rates the density of the gas influences the accuracy.

Above the limit value (Q_l), the accuracy is 1,5% of measuring value.

Below Q_l the accuracy is 5% of the measuring value.

Example:

At a density of x kg/m³ the limit value is Q_l = x % of Q_{max}

Density		Limit value Q_l
0,5 kg/m³	=	16 %
1,0 kg/m³	=	8 %
2,0 kg/m³	=	4 %
4,0 kg/m³	=	2 %
8,0 kg/m³	=	1 %

Natural gas with a methan component of 85 % a density of 0,85 kg/m³ is assumed.

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Evaluation Electronics

Flow Rate Correction Calculator GDR 1403 for all technical and medical gases

The Flow Rate-Correction Calculator detects the impulse signals of up to two fluidistor gas flow meters GD 100 using 1 or 2 channels. According to the assignment it converts the impulse signals into m³/h or Nm³/h. The actual flow rate is displayed in m³/h resp. Nm³/h or the quantity in m³ resp. Nm³ on the LCD-display.

For further information see datasheet DS 303 E.

CHP Gas Monitor GDR 1404 for the sector biogas

In addition to the calculation of flow, the GDR 1404 offers the following functions:

- Calculation of efficiency (ETA)
- Calculation of feeding loss (EVU)
- Integration of various gas analysis

For further information see datasheet DS 307 E.

Fermenter-Gas-Controller GDR 1406 for the sector biogas

In addition to the calculation of flow at the fermenter, the GDR 1406 offers the following functions:

- Integrated gate control for the feeding pressure control in the gas collecting pipe
- Control of under- and overpressure at filling and withdrawal at the fermenter

For further information see datasheet DS 308 E.

The devices share the following options:

- Integrated recorder to log measured values in the ring buffer (2 GB) for fast identification of faults during operation
- Saving logged data in external SQL-database using the Energy Management and Configuration Software E3DM
- Visualisation of data in time series using the Energy Management and Configuration Software E3DM
- Integration into IT-networks via Ethernet TCP/IP
- Data transfer via PROFIBUS-DP, Modbus-RTU, Modbus-TCP, Ethernet/IP

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Ordering information

A)	Minimum flow rate (m³/h)
B)	Maximum flow rate (m³/h)
C)	Medium, e.g. wet biogas
D)	Nominal width DN (e.g. DN50)
E)	Operating pressure (bar)
F)	Operating temperature (°C)
G)	Maximum pressure loss (mbar)
H)	Display in Nm³/h or m³/h
I)	4 - 20 mA and impulse output
J)	BUS-output, e.g. PROFIBUS-DP, Modbus-RTU, instead of mA-output

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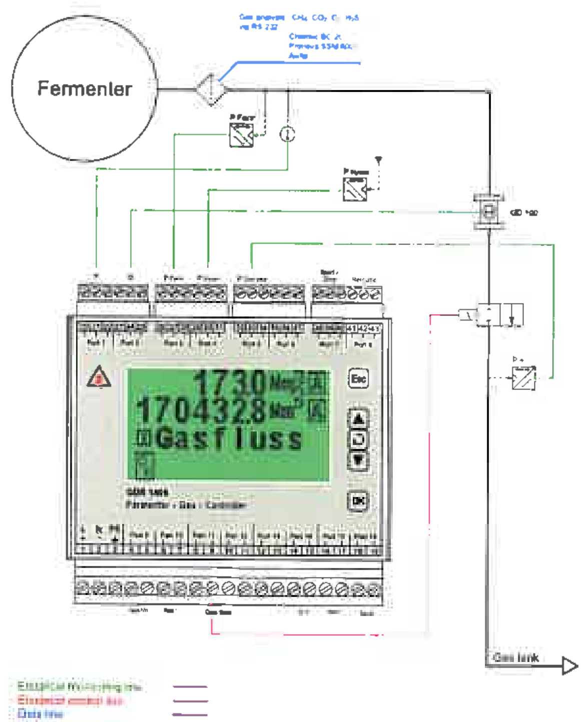
Application example

Fermenter-Gas-Controller GDR 1406 with control of the feed pressure



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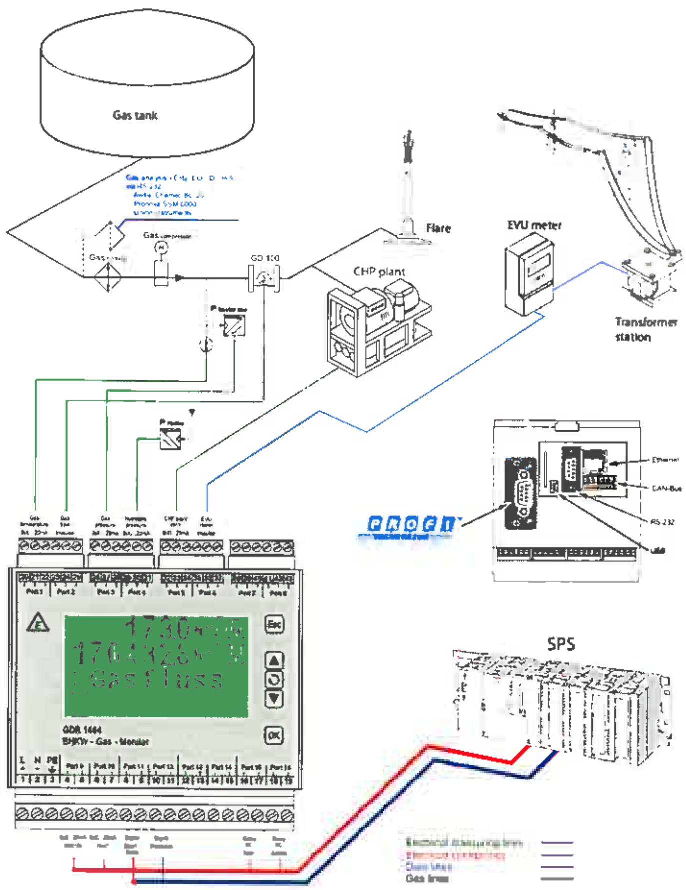
CHP Gas Monitor GDR 1404 with gas engine



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Instruction Manual IM 300 E
Fluidistor Gas Flowmeter GD 100/LRM (Ex)

Installation, maintenance and troubleshooting

Principle of operation

The meter is a fluidistor-type and contains no moving parts. A restrictor plate in the lower half of the meter housing creates a flow resistance that forces part of the flow to enter the fluidistor in the meterhead.
A spontaneous oscillation of the gas is generated in the fluidistor.
The oscillation frequency is proportional to the flow rate and thereby to the flow volume. Since the relationship between the flow through the fluidistor and the flow through the meter housing is constant, the oscillation frequency is proportional to the total flow volume through the meter. A hot wire sensor detects the oscillations in the fluidistor and the measured pulses can be converted in a signal converter to an analogue signal proportional to the flow. The over range limit is 1,5 Q_{max} (final value of the flow range). If the flow rate exceeds the over range limit, the hot wire sensor will be destroyed and output pulses are generated that influences an accumulating flow meter or similar.

Installation

The meter should be mounted horizontally, with the measuring head uppermost. Vertical installation is possible, but extraneous particles can cause problems. For the meter to achieve its specified accuracy there should be a straight run-in of at least 10 times the diameter upstream of the meter, and a straight run-out of at least 5 times the diameter downstream. It can be advantageous to insert a flow straightener upstream the meter to eliminate possible flow rotation.

In case of a high amount of condensate (e.g. measurement at a fermenter with a metal roof), it is important to consider the amount of fluid that if the amount of fluid is too high the meter head will be filled with water even though a condensate removal is integrated. In that case a condensate separator must be installed.

Connections

Please refer to the separate connection diagram for the devices of the series GDR 1403 (IM 303 E), GDR 1404 (IM 307 D), GDR 1406 (connection plan AZ0702162). The converter or the device should be located near the meter, at a maximum cable distance of 30 meters. The galvanical isolation is realized with the integrated module UNI-100 (ATEX-certificate No. SP06ATEX3634).
The two-wire screened signal cable (0,5 mm²) between the meter and the evaluating unit must be a twisted-pair type and must be routed as far away as possible from 220 V, AC control cabling and power cabling. The signal cables of more than one flow meters should not be laid close together over a long distance or even be laid as a bunched cable.

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The Gas Flowmeter LRM-SF2/GD100 and the devices of the GDR 1403, GDR 1404 or GDR 1406 are a calibrated unit. The calibration is factory-provided and documented with an inspection record. To avoid confusion the identification label on the gas flowmeter and the appropriate device GDR 1403, GDR 1404 or GDR 1406 contains a meter-number.

The devices of the GDR 1403, GDR1404 and GDR1406 can be recalibrated using the configuration software EstersConfig (download: http://www.esters.de/download/sw000.shtml)

Maintenance

The only maintenance that the meter may need is to exchange or in extreme cases lavation. The sensor can burst or become coated with condensate, water, oil or other impurities of the gas. If the sensor has to be changed, open the bypass valve, if available, and close the valves both upstream and downstream of the meter. If the meter is equipped with shut-off valves between the measuring head and the main housing, only these need to be closed, and the plant can continue operating during the exchange.

Exchange of the sensor: Move off the cable contacts from the fluidistor. Remove the four screws securing the sensor in the fluidistor lid. Carefully lift off the sensor. If necessary transfer the O-ring from the old sensor to the new one, and then insert the new sensor correctly oriented noting that it is in a 90° angle to the direction of the flow. Refit the cover. Moistening the rubber band simplifies the fitting. Return the exchanged sensor to us for repair.

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Troubleshooting

The sensor resistance is between 35 - 45 Ohm. The value can be measured using an ohmmeter. If the measured value deviates from the normal value, the sensor must be exchanged (see maintenance). A recalibration is not necessary.

Advice for setting-up operation

The use of gases which are supporting combustion, e.g. oxygen, nitrous oxide or a gas mixture, forbid the recableing in the devices GDR 1403, GDR 1404 and GDR1406 with applied voltage. Danger of a burn out!

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