

City of Schenectady
Water Pollution Control Plant

**Solids Treatment Upgrades &
Co-Generation Project**

March 2010

*Energy Monitoring
Plan*

Contents

Section 1 - Executive Summary	2
Section 2 - Monitoring Narrative.....	3
Section 3 - Monitored Data Points	5
Section 4 - System Schematic.....	7
Section 5 - Data Transmission Submission Requirements	8

Section 1

Executive Summary

The City of Schenectady (City) Water Pollution Control Plant (WPCP) project includes the following upgrades:

- Two new gravity belt thickeners for co-thickening of primary and waste activated sludge with sludge holding tanks, mixers, pumps and appurtenances
- Two (Radial Beam) Fixed Steel Digester Covers with Separate Dual Membrane Gas Holder
- Digester Gas Handling and Treatment Equipment with Safety Appurtenances
- One 280 kWe, turbocharged, lean burn engine generator

The new engine generator will be used to produce power from digester gas. This energy would decrease the WPCP's electric demand from the grid by 30% to 50% on an average weekly basis depending on digester gas output.

The engine generator system is a packaged unit and will be located inside a new Cogeneration Building at the WPCP. Waste heat recovered from the engine will be used to generate hot water which will in turn be used to provide heat for the new Cogeneration Building; a portion of the adjacent Auxiliary Sludge Disposal Building; and to maintain proper sludge temperatures for the anaerobic digestion process via heat exchangers located in the existing Digester Control Building.

Electrically this unit would be connected to the WPCP main 480V switchgear on the load side of the 2,500 kVA, 13.2 kV/480V transformer at the plant connection to the power grid. From this switchgear, electricity is distributed among the buildings on site. This connection will use an automatic paralleling switch. This will not affect the electrical utility or their system, except for a reduction of billable power.

Data collection will be in place to monitor parasitic electrical loads associated with the cogeneration process as well as temperature and flow throughout the heat recovery and hot water distribution loops. Through the use of the data collection and monitoring system, the efficiency of the distributed generation/combined heat and power (DG/CHP) system can be established, and the monitoring goals and requirements for NYSERDA can be verified.

Section 2

Monitoring Narrative

The monitoring system is broken into three areas; gas, hot water and electricity.

Digester/Natural Gas

Digester gas production is the summation of the gas produced by each digester as measured by FIT-350 & 351. Digester gas that is not consumed is wasted by releasing it to the Waste Gas Burner, the quantity of gas wasted is measured by FIT-370. The heat content of the digester gas in BTU/CF will be determined by periodic sampling and analysis. Digester gas produced for beneficial use is calculated by subtracting the gas wasted from the summation of the gas produced and multiplying that value by the heat content. The formula is Beneficial Digester Gas Produced (BTU/HR) = (FIT-350 + FIT-351 - FIT-370 SCFM) x Heat Content (BTU/CF) x 60 MIN/HR.

Digester gas consumed by the engine generator is recorded by FIT-490. The Heat Input to the engine generator is calculated by multiplying the digester gas flow by the digester gas heat content. The formula is Engine Heat Input (BTU/HR) = FIT-490 (SCFM) x Heat Content (BTU/CF) x 60 MIN/HR.

Digester gas consumed by the boiler is recorded by FIT-480. The Heat Input to the boiler is calculated by multiplying the digester gas flow by the digester gas heat content. The formula is Boiler Heat Input (BTU/HR) = FIT-480 (SCFM) x Heat Content (BTU/CF) x 60 MIN/HR.

Natural gas consumed by the boiler is recorded by FIT-470. The Heat Input to the boiler is calculated by multiplying the natural gas flow by the natural gas heat content. The formula is Boiler Heat Input (BTU/HR) = FIT-470 (SCFM) x Heat Content (BTU/CF) x 60 MIN/HR.

Hot Water

The heat recovered from the engine jacket water and exhaust loop for beneficial use is calculated by measuring the temperature differential across the jacket water and exhaust heat exchanger (HX-520) and multiplying that value by the hot water loop flow measured by FIT-560 and by 500 to calculate the BTU/HR recovered. The formula is Beneficial Heat Recovered in BTU/HR = (TIT-560B - TIT-560A DEG F) x FIT-560 (GPM) x 500.

The heat wasted from the engine jacket water and exhaust loop is calculated by measuring the temperature differential across the jacket water coil in the dump radiator (HX-530) and multiplying that value by the actual flow through the dump radiator as measured by FIT-530 by 500 to calculate the BTU/HR wasted. The formula is Jacket Heat Wasted in BTU/HR = (TIT-530B - TIT-530A DEG F) x FIT-530 (GPM) x 500.

The heat wasted from the engine auxiliary cooling loop is calculated by measuring the temperature differential across the auxiliary water coil in the dump radiator (HX-530) and multiplying that value by the actual flow through the dump radiator as measured by FIT-531 by

500 to calculate the BTU/HR wasted. The formula is Auxiliary Heat Wasted in BTU/HR = (TIT-531A - TIT-531B DEG F) x FIT-531 (GPM) x 500.

The net heat recovered from the engine is calculated by adding the heat wasted with the heat recovered for beneficial use. The formula is Net Engine Heat Recovered (BTU/HR) = Beneficial Heat Recovered (BTU/HR) + Jacket Heat Wasted (BTU/HR) + Auxiliary Heat Wasted (BTU/HR).

The heat produced by the boiler is calculated by measuring the temperature differential across the boiler and multiplying that value by the hot water loop flow measured by FIT-560 and by 500 to calculate the BTU/HR produced. The formula is Boiler Heat Produced (BTU/HR) = (TIT-520 - TIT-560B DEG F) x FIT-560 Flow (GPM) x 500.

Electricity

The electrical usage for the plant is measured by an existing National Grid supplied power meter on the incoming 480V electric feed to the outdoor switchgear after the 13.2 kV/480V utility transformer. The generator electrical power output is monitored with a Veris KWH meter (JI-630).

The parasitic electrical loads are the summation of the MODBUS outputs from the Veris KWH meters in the Digester Control Building MCC on process equipment dedicated to the CHP Process and the Cogeneration Building MCC incoming feed. These processes include; digester heated sludge recirculation pumps, gas membrane blower skid, gas treatment skid, gas treatment chiller, waste heat dump radiator, hot water loop pump and miscellaneous Cogeneration Building HVAC and lighting loads. The calculation is Parasitic Load = JY-311 + JY-312 + JY-360 + JY-640.

The overall electrical output from the DG/CHP system is calculated by subtracting the sum of the parasitic loads from the generator output. The formula is Net Generated Power = Power Generated (JY-630) - Parasitic Load.

Section 3

Monitored Data Points

Table 3-1 – Continuously Monitored Data Points

Channel Type	Data Point Name	Measurement Type	Location	Units	Sensor Type
Analog	FIT-350	Digester No. 1 Gas Output	Digester No. 1 Gas Outlet	SCFM	Thermal Dispersion Mass Flowmeter
Analog	FIT-351	Digester No. 2 Gas Output	Digester No. 2 Gas Outlet	SCFM	Thermal Dispersion Mass Flowmeter
Analog	FIT-370	Digester Gas to Flare	Waste Gas Burner	SCFM	Thermal Dispersion Mass Flowmeter
Analog	FIT-490	Digester Gas to Engine	Engine Gas Inlet	SCFM	Thermal Dispersion Mass Flowmeter
Analog	FIT-480	Digester Gas to Dual Fuel Boiler	Boiler Gas Inlet	SCFM	Thermal Dispersion Mass Flowmeter
Analog	FIT-470	Natural Gas to Dual Fuel Boiler	Boiler Gas Inlet	SCFM	Thermal Dispersion Mass Flowmeter
Analog	FIT-560	Hot Water Loop Flow	P-540 Discharge	GPM	Magnetic Flowmeter
Analog	TIT-560A	Hot Water Loop Return Temperature	Jacket Water & Exhaust HX Hot Water Loop Inlet	F	RTD Temperature Transmitter
Analog	TIT-560B	Hot Water Loop Supply Temperature after Jacket Water & Exhaust HX	Jacket Water & Exhaust HX Hot Water Loop Outlet	F	RTD Temperature Transmitter
Analog	TIT-520	Hot Water Loop Supply Temperature to Digester Heat Exchangers	Hot Water Supply to Digester Heat Exchangers	F	RTD Temperature Transmitter
Analog	FIT-530	Jacket Water Flow Through Dump Radiator	Dump Radiator Jacket Water Outlet	GPM	Magnetic Flowmeter
Analog	TI-530A	Dump Radiator Jacket Water Inlet Temperature	Dump Radiator Jacket Water Inlet	F	RTD Temperature Transmitter
Analog	TI-530B	Dump Radiator Jacket Water Outlet Temperature	Dump Radiator Jacket Water Outlet	F	RTD Temperature Transmitter
Analog	FIT-531	Auxiliary Water Flow Through Dump Radiator	Dump Radiator Auxiliary Water Outlet	GPM	Magnetic Flowmeter

Channel Type	Data Point Name	Measurement Type	Location	Units	Sensor Type
Analog	TI-531B	Dump Radiator Auxiliary Water Inlet Temperature	Dump Radiator Auxiliary Water Inlet	F	RTD Temperature Transmitter
Analog	TI-531A	Dump Radiator Auxiliary Water Outlet Temperature	Dump Radiator Auxiliary Water Outlet	F	RTD Temperature Transmitter
MODBUS	JY-630	Generator Paralleling Switchgear Output	Power Meter	kW/V/A	Veris
MODBUS	JY-501	Purchased Utility Power	Existing Power Meter (Utility)	kW/V/A	Existing
MODBUS	JY-311	Digester No 1 Heated Sludge Recirculation Pump	Digester Bldg MCC	kW/V/A	Veris
MODBUS	JY-312	Digester No 2 Heated Sludge Recirculation Pump	Digester Bldg MCC	kW/V/A	Veris
MODBUS	JY-360	Gas Membrane Blower Skid Power	Digester Bldg MCC	kW/V/A	Veris
MODBUS	JY-640	Cogeneration Building MCC Power	Cogen Bldg MCC	kW/V/A	Veris

Table 3-2 – One Time Field Measured Data

Data Point Name	Description	Location	Units	Sensor Type
B-550	Boiler Loop Flow	Boiler Loop Return	GPM	Circuit setters on boiler feed/bypass lines

Section 4

System Schematic

See attached Fig-1.

Section 5

Data Transmission Submission Requirements

How to Submit Data to the Data Integrator

This document summarizes the steps for a monitoring contractor to submit data to the CDH Energy for the DG/CHP Integrated Database.

Programs

The data server uses the Secure FTP (SFTP) file transfer protocol for the uploading of files. SFTP is different from FTP and requires different programs.

We recommend using WinSCP for a graphical user interface program that is similar to using Explorer for regular FTP. The project page for this program is located at <http://winscp.net/eng/index.php>.

For automated uploading of files, psftp can be used as a replacement for the command line ftp routine in Windows. It is part of the PuTTY package and located at <http://www.nbcs.rutgers.edu/newdocs/psftp/psftp.php3>.

Steps for Submitting Data

These are the steps for submitting data to the data integrator.

1. Call CDH to ask for a username and password. We will also discuss the format of the data being uploaded and the available channels at this time.
2. After initiation of automated uploading, please contact CDH to verify the data was received.
3. After two weeks of data uploading, CDH will prepare an Initial Data Summary. This summary will include interpretations of the available data and identify any issues we see with the data. Data may be included in the system at this time.
4. The Initial Data Summary will be sent to the monitoring contractor for review. The monitoring contractor must respond to all questions in the summary section of the document. When there are no further issues, the data will be loaded into the system.
5. Periodically, CDH will review the data provided and will notify the monitoring contractor of any issues.

Data Format

Whenever possible, CDH prefers data submitted in comma-separated variable (CSV) format. Column descriptors should go in a header row. Each row should begin with a timestamp. Here is an example of the preferred format:

```
"Standard Date", "Total Utility Import Power", "Elect Service A Import Pwr"  
12/25/07 00:00:00,31.65,20.73  
12/25/07 00:15:00,31.76,21.61
```

CDH can accept data in other formats, however they will be approved on a case-by-case basis. The monitoring contractor should indicate the format of the data when the username and password is requested.

Automated Uploading

Here are directions for automated submission of data from a Windows machine. Uploading should occur at least once per day. To ensure the Integrated Data System will show a full set of data for the previous day for your site, data should be submitted at least once between 2 and 4am. Files should be prefixed with the site name and include a timestamp for the time of their creation. If data is uploaded multiple times per day, the filenames should look like:

```
supermarket_YYYYMMDD_hhmm.csv
```

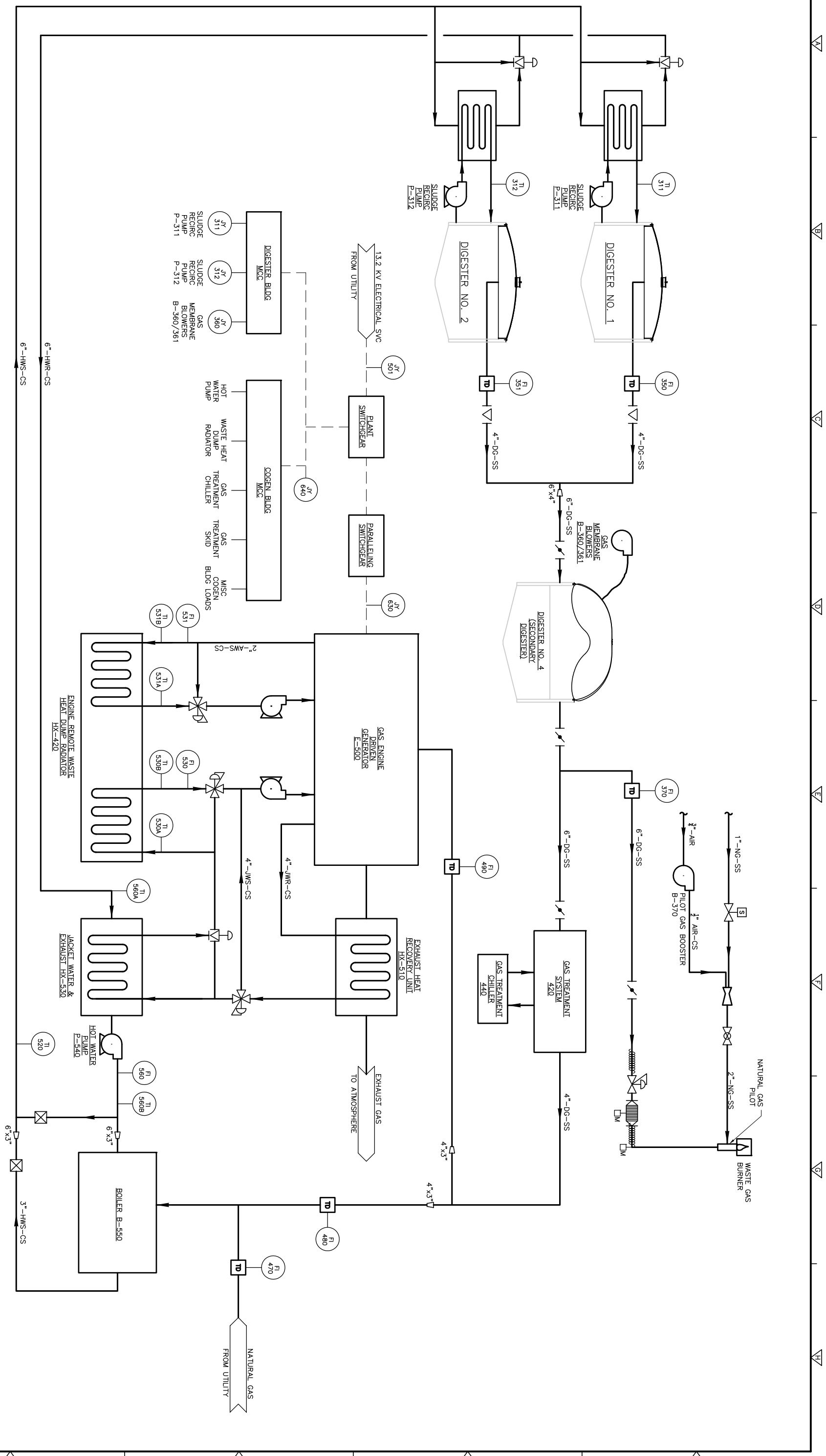
Data can be uploaded in an automated fashion using psftp. Here is an example psftp script:

```
open cdhenrgy.user.openhosting.com  
mput supermarket*.csv  
quit
```

This can be called from the command line using a batch file. Here is an example Batch File:

```
psftp -l username -pw password -b upload.psftp
```

For Unix support, please call CDH if you require assistance.



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ENERGY MONITORING PLAN MONITORING POINTS				
PROJECT NO.	5438-69000			
FILE NAME:	M003PRFD			
SHEET NO.				
FIG-1				

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