Albany County Sewer District
North Plant

Heat Recovery & Co-Generation Project

October 2009

Energy Monitoring Plan

Contents

Section 1
Executive Summary

The Albany County Sewer District (ACSD) North Plant's heat recovery and co-generation project was the result of ACSD showing a strong interest in reducing electric and gas usage, while at the same time reducing pollutants, such as greenhouse gasses. The incineration process at the North Plant generates a large amount of heat, and ACSD showed interest in harnessing this heat to generate electricity to power the plant. A feasibility study was performed for the plant, and the feasible solution was determined to be an Organic Rankine Cycle (ORC).

Conceptually, the ORC system would duct the exhaust gas flow and send it to a waste-heat-oil-heater (WHOH) and then turbo-generator. This recovered thermal energy would be used to generate up to 835 kW of electricity. This energy would decrease the North Plant's electric demand from the grid by 69%on an average hourly basis while the incinerator is in operation. This same electrical generation could provide 32% of the electrical consumption on an average weekly basis. The ORC system is a packaged unit and would be located outside on a concrete housekeeping pad. Only the thermal oil and condenser water systems would be located in the building. The waste-heat oil-heater (WHOH) would be configured vertically and parallel the existing duct to the scrubber. The existing duct would be relocated and serve as a by-pass. This would minimize modifications to the existing building. It is anticipated that all equipment will be able to be fit with only minor structural modifications.

Electrically this unit would be connected to the 13.2 kV plant power grid, which distributes electricity among the buildings on site. This connection would be on the plant side of the local grid, using automatic paralleling switch. This will not affect the electrical utility or their system, except for a reduction of billable power.

Data collection will also be in place to monitor parasitic electrical loads, motor performance, temperature, and flow throughout the plant. Through the use of the data collection and monitoring system, the efficiency of the ORC system can be established, and the monitoring goals and requirements for NYSERDA can be verified.

Section 2
Monitoring Narrative

The monitoring system will be incorporated with the existing plant Supervisory Control and Data Acquisition system, SCADA. A new PC will be installed with a second network card to allow for communication to the SCADA system as well as the plant's internal office network. This PC will serve as the new Master SCADA terminal and provide a secure connection to the internet to allow for daily power monitor reports to be transmitted to CDH Energy for posting on the NYSERDA internet site.

The daily report will summarize the plants operation from 12:00 AM of the previous day through 12:00 AM of the current day and shall be approximately one page in length. Values for which there are no data available shall be left blank or identified with a special character. Thus, only values, which are actually zero, shall be printed as such, data points will be recorded on a fifteen minute interval. The Power Monitoring Report shall be available for printing on demand, as often as preferred, until midnight of the following day. Normal operation shall be for reports to automatically generate at an operator specified time on a daily basis and be sent to CDH Energy's internet site.

The first monitoring/data collection point is located at the output of the waste heat oil heater, utilizing incinerator waste heat to heat oil which is then pumped through the system. The waste heat oil heater output (AY-375) is calculated by subtracting the Oil Inlet Temperature (TI-220) from the Oil Outlet Temperature (TI-245) and multiplying the result by the Oil Flow (FI-275) and by the heat capacity (Cp) of the oil. The formula is: WHOH Heat Output (AY-375) = Oil Flow (FI-275) x (Cp) x (Oil Outlet Temperature (TI-245) – Oil Inlet Temperature (TI-220)).

The second monitoring/data collection point is located at the output of heat exchanger HX-1 (AY-385). The output of HX-1 is calculated by subtracting the Water Inlet Temperature (TI-155-1) from the Water Outlet Temperature (TI-155-2) and multiplying the result by the Water Flow (FI-160) and by the heat capacity (Cp) of the water. The formula is: Heat Exchanger HX-1 Heat Output (AY-385) = Water Flow (FI-160) x (Cp) x (Water Outlet Temperature (TI-155-2) – Water Inlet Temperature (TI-155-1)). The heat exchanger HX-1 is used to heat a hot water loop, which provides heating to the plant. Measuring the inlet and outlet temperatures, along with the flows through HX-1, will give an accurate measurement of the efficiency, and output of the heat exchanger.

The third monitoring/data collection point is at the closed circuit cooler rejection heat exchanger (AY-380). The output of the heat exchanger is calculated by subtracting the Glycol Outlet Temperature (TI-125-2) from the Glycol Inlet Temperature (TI-125-1) and multiplying the result by the Glycol Flow (FI-130) and by the heat capacity (Cp) of the glycol. The formula is: CCC Heat Rejection (AY-380) = Glycol Flow (FI-130) x (Cp) x (Glycol Inlet Temperature (TI-125-1) – Glycol Outlet Temperature (TI-125-2)). The heat rejection measurement from the closed circuit cooler is used to calculate the overall ORC system efficiency.

The fourth monitoring/data collection point is at the ORC Generator heat output (AY-390). The ORC generator heat output is calculated by adding the Heat Exchanger HX-1 Heat Output (AY-385) and the CCC Heat Rejection (AY-380). The formula is: ORC Generator Heat Output (AY-390) = Heat Exchanger HX-1 Heat Output (AY-385) + CCC Heat Rejection (AY-380).

The electrical and gas usage for the plant and the ORC system is accomplished through the use of five meters. Two existing power meters supplied by national Grid is used to monitor the two incoming 13.2 kV electric feeds (feeder 1 (JY-345) and feeder 2 (JY-350)). A Veris KWH meter is used to monitor MCC-2A (JY-360) usage, ID Fan (JI-365), and the parasitic load (JY-370) calculation. The parasitic load is calculated by subtracting MCC-2A KWH (JI-360) from ID Fan KWH (JI-365). A MODBUS output from the five meters provides inputs to the ORC Control Panel PLC. The overall parasitic electrical load (JY-370) calculation result is subtracted from the output of the electric generator to determine the overall electrical output for the system. The ORC generator power output is monitored with a Veris KWH meter (JI-325A). To monitor incoming gas (JY-355), a 4-20 mA output from the meter provides an input to the ORC Control Panel PLC.

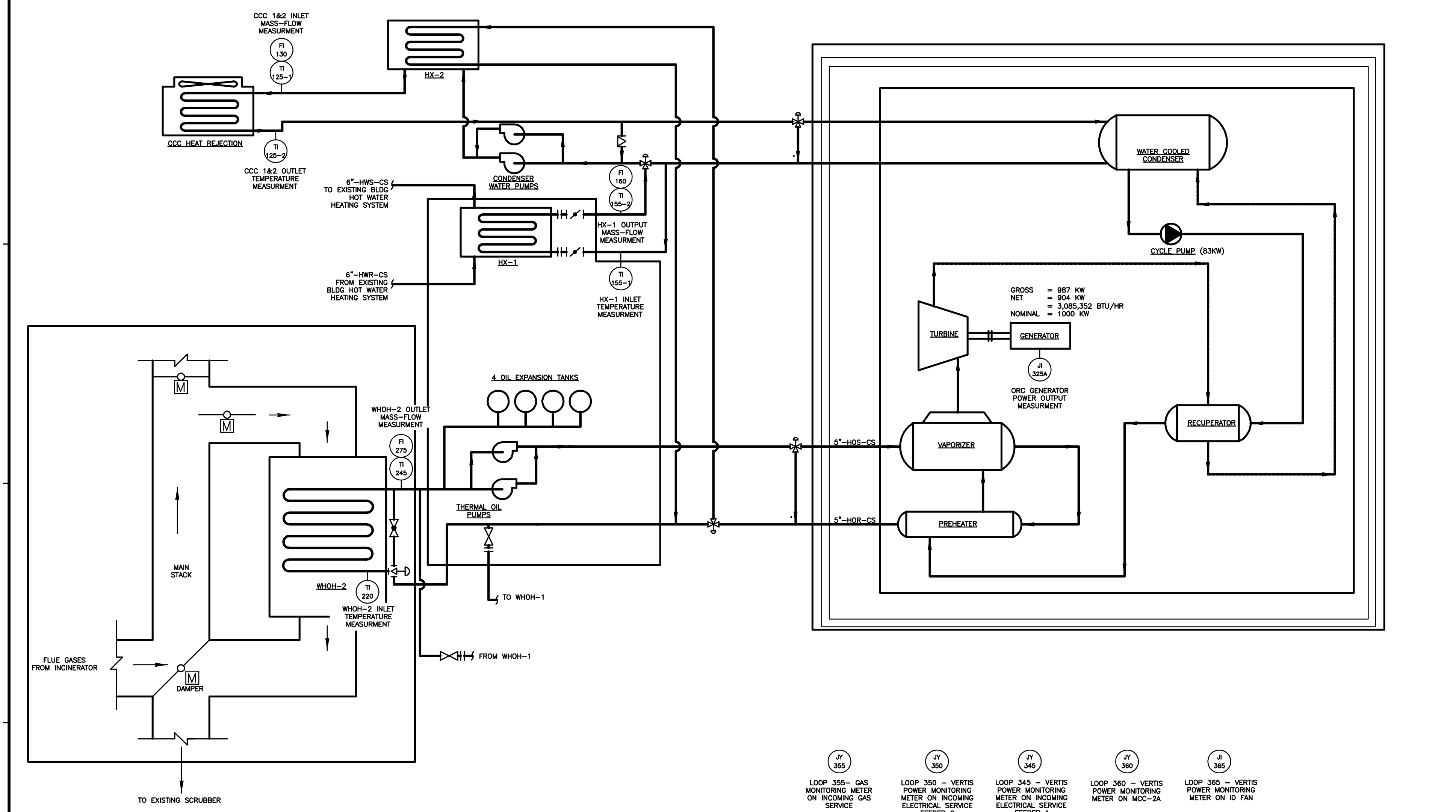
Section 3
Monitored Data Points

Channel Type	Data Point Name	Calculation Type	Location	Units	Sensor Type
Calculated	AY-375	Waste Heat Oil Heater Output	Waste Heat Oil Heater Output	BTU/H	-----
Analog	TI-220	Waste Heat Oil Heater Output	Oil Inlet Temperature	F	YTA110 GS Temperature Transmitter
Analog	TI-245	Waste Heat Oil Heater Output	Oil Outlet Temperature	F	YTA110 GS Temperature Transmitter
Analog	FI-275	Waste Heat Oil Heater Output	Oil Flow	GPM	Vortex Shedding Flow Meter
Analog	TI-155-1	Heat Exchanger HX-1 Output	Water Inlet Temperature	F	YTA110 GS Temperature Transmitter
Analog	TI-155-2	Heat Exchanger HX-1 Output	Water Outlet Temperature	F	YTA110 GS Temperature Transmitter
Analog	FI-160	Heat Exchanger HX-1 Output	Water Flow	GPM	Vortex Shedding Flow Meter
Analog	TI-125-2	Closed Circuit Cooler Output	Glycol Outlet Temperature	F	YTA110 GS Temperature Transmitter
Analog	TI-125-1	Closed Circuit Cooler Output	Glycol Inlet Temperature	F	YTA110 GS Temperature Transmitter
Analog	FI-130	Closed Circuit Cooler Output	Glycol Flow	GPM	Vortex Shedding Flow Meter
Calculated	AY-385	ORC Generator Heat Output	HX-1 Heat Output	BTU/H	-----
Calculated	AY-380	ORC Generator Heat Output	CCC Heat Rejection	BTU/H	-----
MODBUS	JY-345	Feeder 1 Load	Existing Power Meter (Utility)	kW/V/A	Existing
MODBUS	JY-350	Feeder 2 Load	Existing Power Meter (Utility)	kW/V/A	Existing

Channel Type	Data Point Name	Calculation Type	Location	Units	Sensor Type
MODBUS	JY-360	MCC-2A Load	Power Meter	kW/V/A	Veris
MODBUS	JI-365	ID Fan Load	Power Meter	kW/V/A	Veris
Analog	JY-355	Gas Load	Existing Gas Meter (Utility)	CFH	Existing
Calculated	JY-370	Parasitic Load	Power Meter	kW/V/A	-----
MODBUS	JI-325A	ORC Generator Output	Power Meter	KW/V/A	Veris

Section 4
System Schematic

(See Drawing "SS" attached)



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REV. NO.	DATE	DRWN	CHKD	REMARKS
2	06/09	RKA	CDW	ADDENDUM NO. 7; 06-05-09
1	05/09	AJU	CDW	ADDENDUM NO. 5; 05-22-09

DESIGNED BY: CD WERME
DRAWN BY: R AMO
SHEET CHK'D BY: CD WERME
CROSS CHK'D BY: G BOLD
APPROVED BY: CD WERME
DATE: FEBRUARY 2009

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ALBANY COUNTY SEWER DISTRICT
ALBANY COUNTY, NEW YORK
INCINERATOR HEAT RECLAMATION

MECHANICAL
ORGANIC RANKINE CYCLE (ORC)
SYSTEM SCHEMATIC
MONITORING POINTS

PROJECT NO. 48148-54592
FILE NAME: MORCPFD1
SHEET NO.
SS

C:\cdmxm\amork\d0108044\ MORCPFD1 06/05/09 11:15 AMORK XREFS: CDM_2234

APPENDIX A

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
```

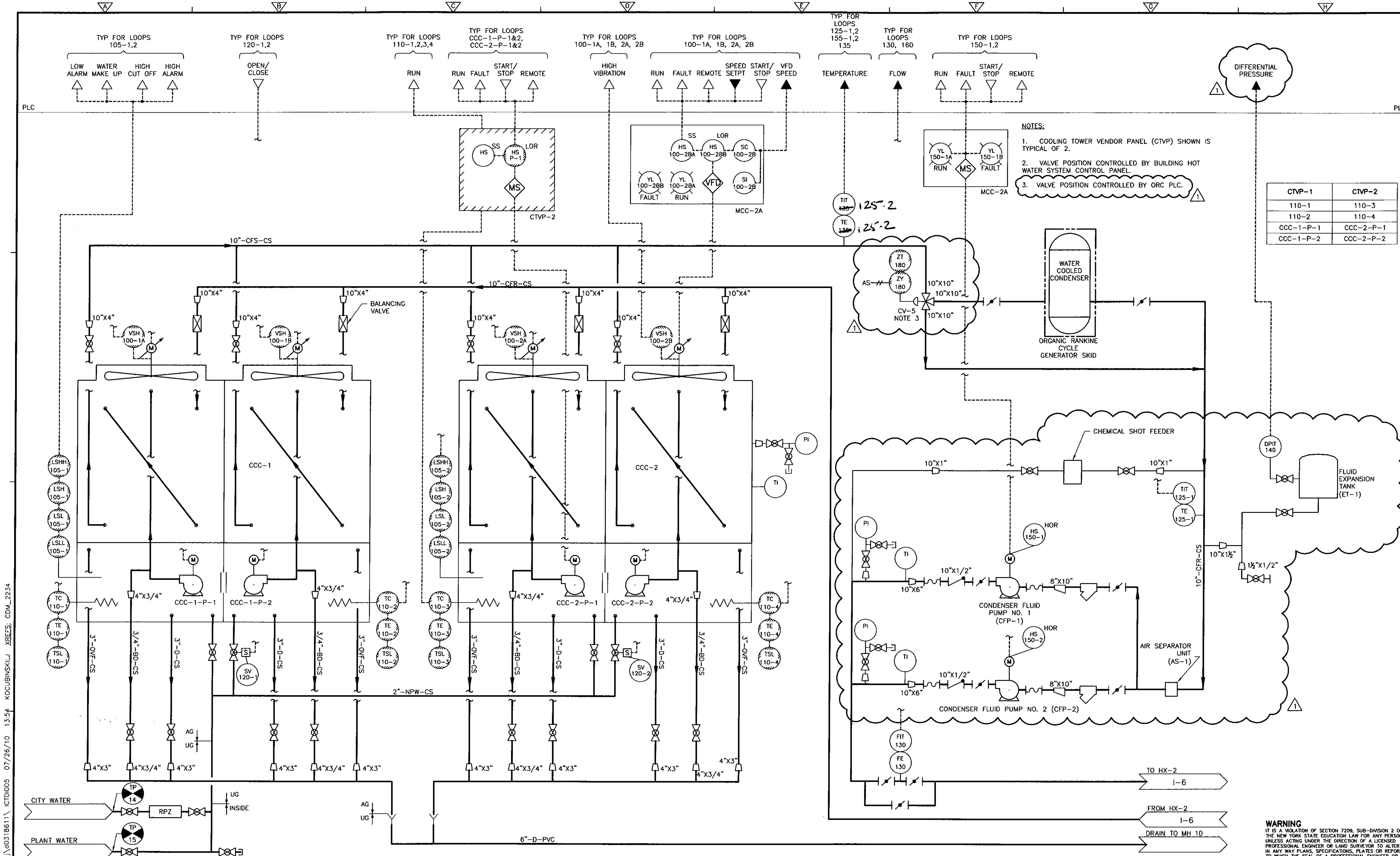
Data can be uploaded in an automated fashion using psftp. Here is an example psftp script:

```
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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REV. NO.	DATE	DRWN	CHKD	REMARKS
1	7/10	LJK		CONFORMED JULY 2010

DESIGNED BY: J MORROW
DRAWN BY: W DICKERSON
SHEET CHK'D BY: J MORROW
CROSS CHK'D BY: R RACETTE
APPROVED BY: J MORROW
DATE: MAY 2010

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ALBANY COUNTY SEWER DISTRICT
ALBANY COUNTY, NEW YORK
INCINERATOR HEAT RECLAMATION

PROCESS AND INSTRUMENTATION DIAGRAM
AIR COOLING SYSTEM

PROJECT NO. 48148-54592
FILE NAME: ICTDI005
SHEET NO.
I-5

C:\cdmxm\kocubinskij\d0318611\ ICTDI005 07/26/10 13:54 KOCUBINSKIJ XREFS: CDM_2234

NOTES:

1. ROUTE SAFETY RELIEF VALVE OUTLET TO 50 GAL, OPEN TOP STEEL TANK IN THERMAL OIL PUMP CONTAINMENT AREA.
2. CV-3 POSITION CONTROLLED BY TE-235-1 TEMPERATURE.
3. CV-4 POSITION CONTROLLED BY TE-235-2 TEMPERATURE.
4. CV-6 POSITION CONTROLLED BY ORC PANEL.
5. CV-2 POSITION CONTROLLED BY BUILDING ATC PANEL LOCATED IN BOILER.

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1	7/10	LJK		CONFORMED JULY 2010

DESIGNED BY: J MORROW
DRAWN BY: W DICKERSON
SHEET CHK'D BY: J MORROW
CROSS CHK'D BY: R RACETTE
APPROVED BY:
DATE: MAY 2010

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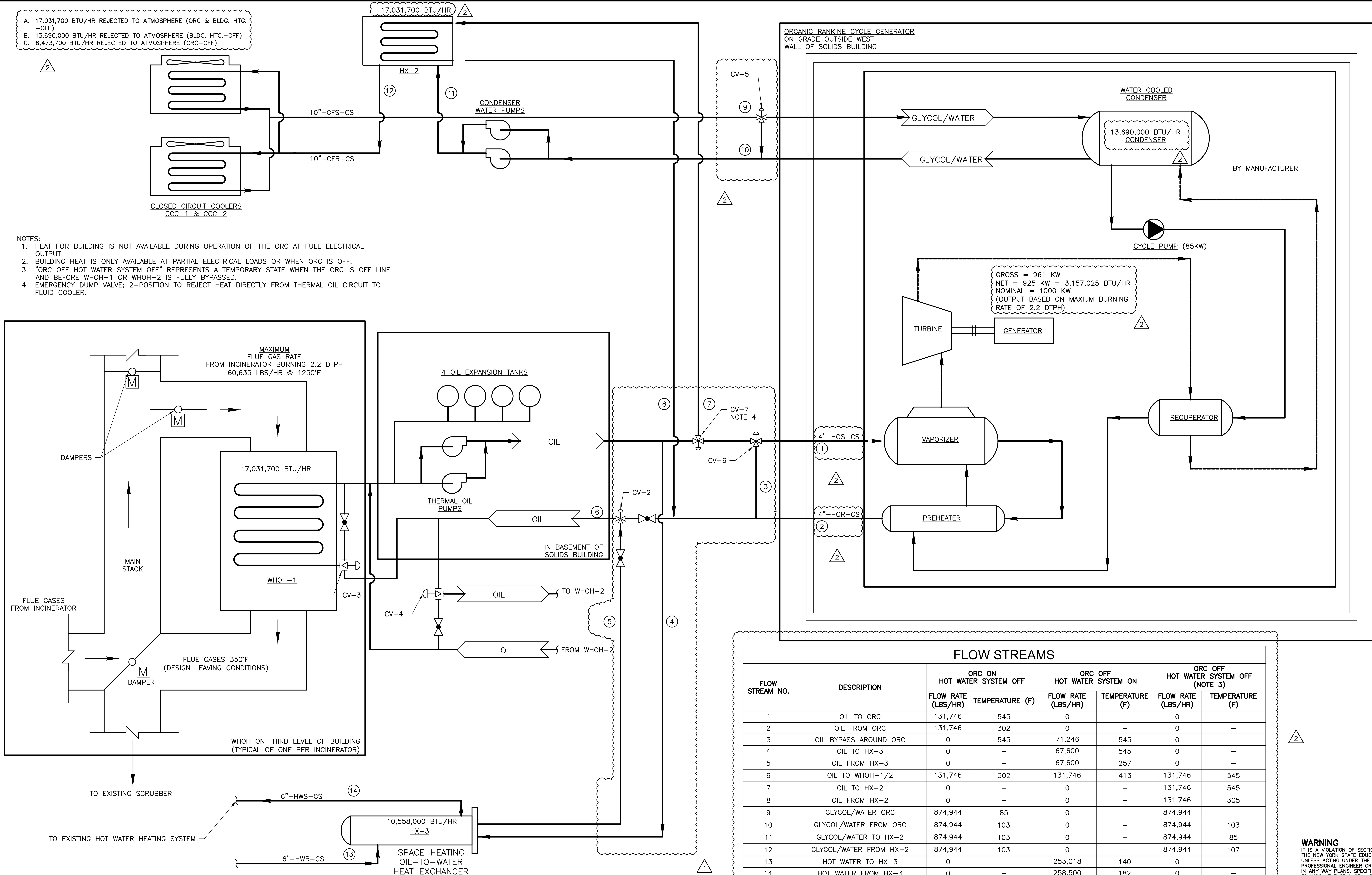
ALBANY COUNTY SEWER DISTRICT
ALBANY COUNTY, NEW YORK
INCINERATOR HEAT RECLAMATION

PROCESS AND INSTRUMENTATION DIAGRAM
HOT OIL SYSTEM

PROJECT NO. 48148-54592
FILE NAME: IPRDI006
SHEET NO. I-6



NOTES:

1. HEAT FOR BUILDING IS NOT AVAILABLE DURING OPERATION OF THE ORC AT FULL ELECTRICAL OUTPUT.
2. BUILDING HEAT IS ONLY AVAILABLE AT PARTIAL ELECTRICAL LOADS OR WHEN ORC IS OFF.
3. "ORC OFF HOT WATER SYSTEM OFF" REPRESENTS A TEMPORARY STATE WHEN THE ORC IS OFF LINE AND BEFORE WHOH-1 OR WHOH-2 IS FULLY BYPASSED.
4. EMERGENCY DUMP VALVE; 2-POSITION TO REJECT HEAT DIRECTLY FROM THERMAL OIL CIRCUIT TO FLUID COOLER.

FLOW STREAMS

FLOW STREAM NO.	DESCRIPTION	ORC ON HOT WATER SYSTEM OFF		ORC OFF HOT WATER SYSTEM ON		ORC OFF HOT WATER SYSTEM OFF (NOTE 3)	
		FLOW RATE (LBS/HR)	TEMPERATURE (F)	FLOW RATE (LBS/HR)	TEMPERATURE (F)	FLOW RATE (LBS/HR)	TEMPERATURE (F)
1	OIL TO ORC	131,746	545	0	–	0	–
2	OIL FROM ORC	131,746	302	0	–	0	–
3	OIL BYPASS AROUND ORC	0	545	71,246	545	0	–
4	OIL TO HX-3	0	–	67,600	545	0	–
5	OIL FROM HX-3	0	–	67,600	257	0	–
6	OIL TO WHOH-1/2	131,746	302	131,746	413	131,746	545
7	OIL TO HX-2	0	–	0	–	131,746	545
8	OIL FROM HX-2	0	–	0	–	131,746	305
9	GLYCOL/WATER ORC	874,944	85	0	–	874,944	–
10	GLYCOL/WATER FROM ORC	874,944	103	0	–	874,944	103
11	GLYCOL/WATER TO HX-2	874,944	103	0	–	874,944	85
12	GLYCOL/WATER FROM HX-2	874,944	103	0	–	874,944	107
13	HOT WATER TO HX-3	0	–	253,018	140	0	–
14	HOT WATER FROM HX-3	0	–	258,500	182	0	–

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REV. NO.	DATE	DRWN	CHKD	REMARKS
2	07/10	RKA	CDW	CONFORMED JULY 2010
1	5/24/10	RKA	CDW	CONFORMED MAY 2010

DESIGNED BY: CD WERME
DRAWN BY: R AMO
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ALBANY COUNTY SEWER DISTRICT
ALBANY COUNTY, NEW YORK
INCINERATOR HEAT RECLAMATION

MECHANICAL
ORGANIC RANKINE CYCLE (ORC)
PROCESS FLOW DIAGRAM

PROJECT NO. 48148-54592
FILE NAME: MORCPFD2
SHEET NO.
M-13

C:\cdmxm\amork\dms04438\ MORCPFD2 05/19/10 11:59 AMORK XREFS: CDM_2234