MEASUREMENT AND VERIFICATION PLAN

FOR

DG/CHP SYSTEM
AT
RIVINGTON HOUSE HEALTH CARE

Revised
October 25, 2013

Submitted to:

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

Submitted by:

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1. Introduction

The EN-Power Group is in the process of installing a combined heat and power (CHP) system at the Rivington House facility in lower Manhattan, NY. The proposed CHP system based on four natural gas fueled reciprocating engine-generators having a combined electrical rating of 300 kW. The site's electric demand is sufficient to keep the system operating at or near its rated capacity on a continuous basis. Heat would be recovered as hot glycol from the engine jacket and exhaust at a supply temperature of 230°F. The hot glycol loop will be used to drive a 100-ton hot water absorption chiller, supplement facility space heating, and supplement domestic hot water production. Excess heat is rejected from the hot glycol loop to a dump radiator.

Peak operation of the CHP system will result in the following performance:

Gross electrical output:	300 kW
Parasitic electrical input (estimated):	-15 kW
Hot water output at 230°F:	2.0 MMBtu/h (LHV of 905 Btu/scf)
Fuel input:	3.3 MMBtu/h (LHV of 905 Btu/scf)

Annually the system is anticipated to displace 2.2 million kWh (net) and displace 7,135 Mlbs of utility steam through heat recovery. Annual fuel consumption is 28,740 MMBtu.

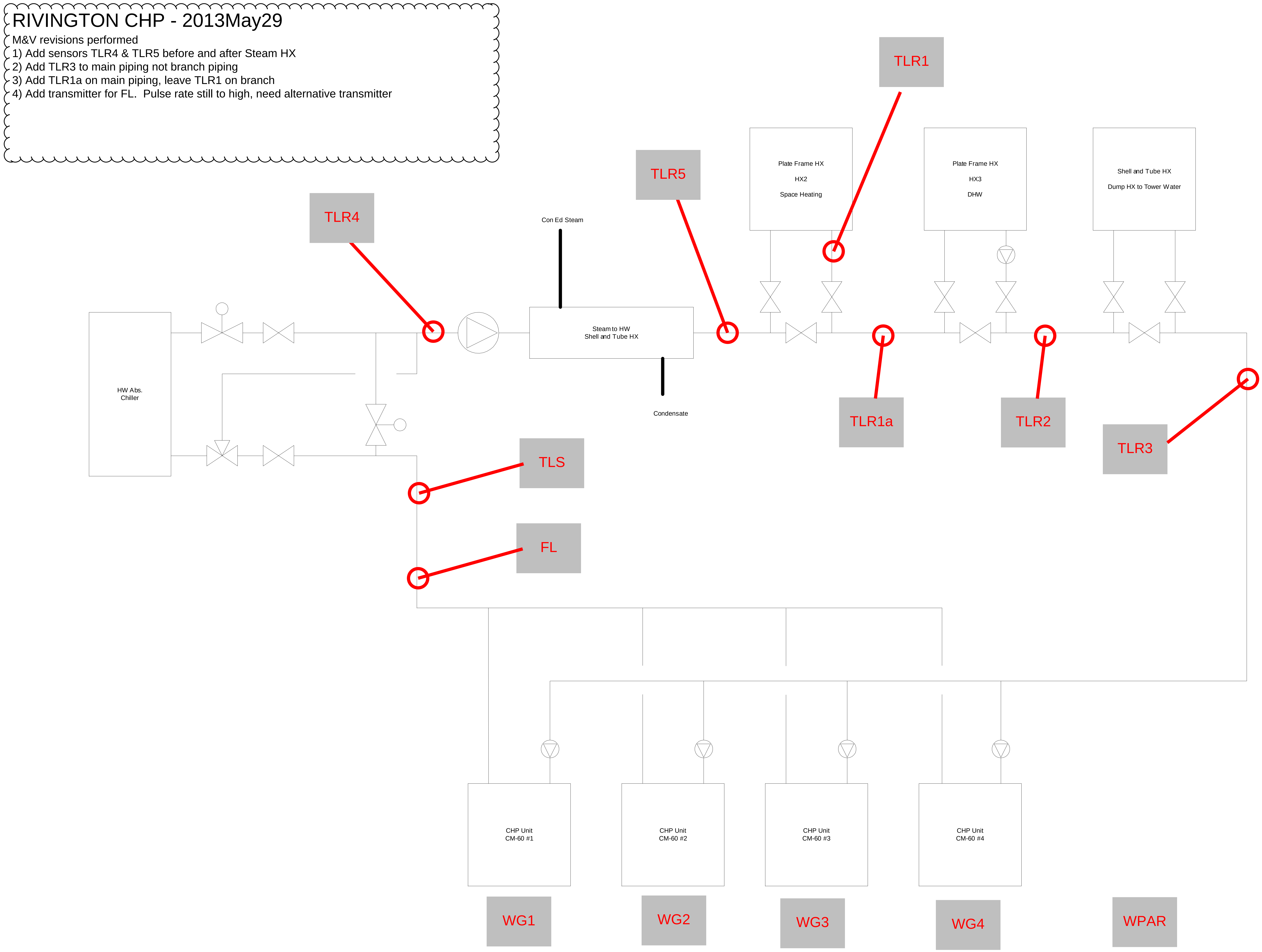
2. Instrumentation

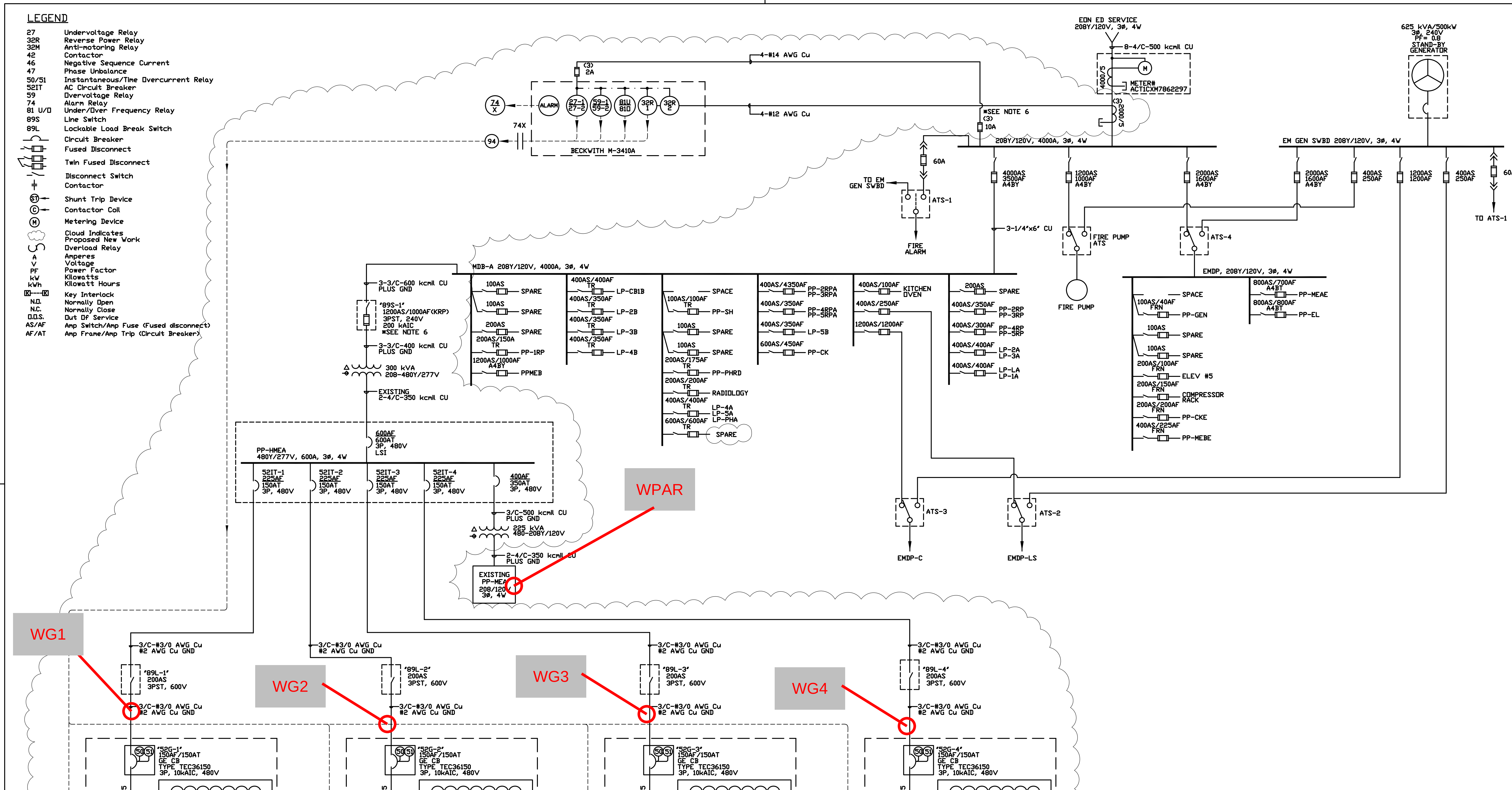
In order to quantify the performance of the proposed CHP system, the CHP system fuel input, net electrical output, and useful thermal output must be measured. To capture these energy flows, an instrumentation plan was developed by CDH Energy and presented to the applicant, the EN-Power Group. The instrumentation plan covers the location and type of sensors necessary to provide the appropriate measurements of the energy flows of the system.

In accordance to the instrumentation plan, the EN-Power Group will supply the instrumentation listed Table 1 below for use in meeting the NYSERDA CHP program monitoring requirements.

Table 1. Instrumentation Supplied By the EN-Power Group

Point	Instrument	Output Type	Sensor Location	Notes
Facility Power	None	Utility on-line telemetry system	n/a	• WT
Generator Power Output	Veris H8035-300-2	Modbus RTU	Electrical Control Cabinet for Each CHP Generator	• WG1, WG2, WG3, WG4 • Meter location is gross power output for each CHP generator
System Parasitic (Combined)	Veris H8035-100-2	Modbus RTU	Parasitic Load Transducer	• WPAR
Generator Gas Input	None	Utility on-line telemetry system	n/a	• FG
Heat recovery loop flow rate	Omega FTB-1400	Pulse	Return header to engines	• FL
Heat recovery loop temperatures	Veris TIGC1-D0 10K Type II Thermistor	Resistance	6-inch thermowells	• TLS, TLR1, TLR2, TLR3 • (Supplied by CDH)


RIVINGTON CHP - 2013May29
M&V revisions performed
1) Add sensors TLR4 & TLR5 before and after Steam HX
2) Add TLR3 to main piping not branch piping
3) Add TLR1a on main piping, leave TLR1 on branch
4) Add transmitter for FL. Pulse rate still to high, need alternative transmitter
TLR1
TLR5
Plate Frame HX
HX2
Space Heating
Plate Frame HX
HX3
DHW
Shell and Tube HX
Dump HX to Tower Water
TLR4
Con Ed Steam
Steam to HW
Shell and Tube HX
Condensate
HW Abs.
Chiller
TLR1a
TLR2
TLR3
TLS
FL
CHP Unit
CM-60 #1
CHP Unit
CM-60 #2
CHP Unit
CM-60 #3
CHP Unit
CM-60 #4
WG1
WG2
WG3
WG4
WPAR



NOTES:

1. THIS PROJECT INSTALLS FOUR COGENERATION MODULES, HAVING A 75 kW INDUCTION GENERATOR, AND ALL EQUIPMENT NECESSARY FOR ITS INTERCONNECTION TO THE CON ED ELECTRIC SYSTEM. THESE MODULES ARE NYS SIR APPROVED.
2. ALL FUSES INDICATED WILL PROVIDE SELECTIVE COORDINATION.
3. THE GENERATOR FRAME SHALL BE GROUNDED TO THE MAIN SWITCHBOARD THROUGH EQUIPMENT GROUNDING CONDUCTOR.
4. GENERATOR TO BE INSTALLED IN ACCORDANCE WITH NEW YORK STATE STANDARD INTERCONNECTION REQUIREMENTS AND CON ED EO-2115, RUNNING ONLY WHEN CON ED IS AVAILABLE. GENERATOR WILL SUPPLY BASE LOAD ONLY.
5. ALL ELECTRICAL CONSTRUCTION TO BE IN COMPLIANCE WITH THE 2005 NEC, AS AMENDED BY THE NYC DOB.
6. CABLE TAPS AND FUSING TO BE IN ACCORDANCE WITH SECTION 240 NFPA 70 (NEC).
7. BONDING NOT SHOWN FOR CLARITY, BUT IS NEEDED TO FULFILL THE REQUIREMENTS OF SECTION 250 OF NFPA 70, NEC.

Rev No.	Date:	Description
1	08/09/10	ISSUE FOR REVIEW AND COMMENTS

PE STAMP/SEAL

MAIN ONE-LINE DIAGRAM
RIVINGTON HOUSE
300 kW DISTRIBUTED GENERATION
45 RIVINGTON STREET
NEW YORK, NY 10002

CSA ENGINEERING SERVICES, LLC
15 TROWBRIDGE DRIVE BETHEL, CT 06801
PHONE: (203) 798-0419 FAX: (203) 743-2325

Drawn By: KT | Scale: NONE

E-1.01

Datalogger

Readings for the installed instrumentation will be recorded by an Obvius Acqusuite data logger provided and installed by CDH Energy. The data logger samples all sensors approximately once per second and records one-minute totals (of pulse or digital sensors) or averages (of analog sensors). The one minute readings of heat recovery temperatures and flows will be used to provide an accurate calculation of heat transfer on the heat recovery loops, which are all continuous flow loops.

Based on the number of monitored data points (10), the logger has sufficient memory to store 30-days of data if communications with the logger are interrupted. The data will be downloaded from the datalogger once per day via an internet connection provided by the site/applicant. The data will be loaded into a database, checked for validity, and posted on the NYSERDA web site.

Onsite Installation

CDH Energy has installed a datalogger panel at a location in the cogeneration room adjacent to the parasitic load panel. The monitoring system panel is approximately 16 in x 12 in x 5 in. The panel was mounted near a 120 VAC power receptacle (it will require 1 amp or less). The panel was conveniently located relative to the sensors listed above as well as the communications line provided by the site.

Communications

The data logger uses a connection to the Internet with a dynamic IP address. The logger uploads data every night to the CDH Energy servers, but CDH personnel are not able to access the logger for remote configuration purposes.

On Site Support

The facility is expected to assist in providing a network connection for the data logger. Internet communications are available in the CHP room. The facility is also responsible for facilitating interaction with the utility to provide total facility power and hourly gas-meter readings via Con Ed on-line telemetry system.

The site will be responsible for providing access to all areas necessary to complete the monitoring installation, as well as any return trips for verification of sensors or service to the monitoring system.

3. Data Analysis

The collected data will be used to determine the net power output of the system as well as the fuel conversion efficiency (FCE).

Table 2. Summary of Monitored Data Points

No.	Data Point	Description	Engineering Unit
1	WG1	Generator #1 Electrical Output (Gross)	kW/kWh
2	WG2	Generator #2 Electrical Output (Gross)	kW/kWh
3	WG3	Generator #3 Electrical Output (Gross)	kW/kWh
4	WG4	Generator #4 Electrical Output (Gross)	kW/kWh
5	WPAR	Parasitic Load Electrical Consumption	kW/kWh
6	FG	Combined Generator Fuel Input	CF
7	FL	Glycol Loop Flow Rate	gallon/GPM
8	TLS	Glycol Loop Supply Temperature	deg F
9	TLR1	Glycol Loop Return Temperature from Space Heating HX – Branch Pipe	deg F
10	TLR1a	Glycol Loop Return Temperature from Space Heating HX – Cogen Loop Pipe	deg F
11	TLR2	Glycol Loop Return Temperature from DHW HX loads upstream of Dump HX	deg F
12	TLR3	Glycol Loop Return Temperature downstream of Dump HX	deg F
13	TLR4	Glycol Loop Return Temperature downstream of Abs. Chiller	deg F
14	TLR5	Glycol Loop Return Temperature downstream of Steam HX	deg F
15	WT	Total Facility Energy / Power	kW/kWh
16	TAO	Ambient Temperature	deg F

Peak Demand or Peak kW

The peak electric output or demand for each power reading will be taken as the average kW in a fixed 15-minute interval (0:00, 0:15, 0:30, etc.), or

$$\text{kW} = \sum_{15\text{min}} \frac{\text{kWh}}{\Delta t} = \sum_{15\text{min}} = \frac{\text{kWh per interval}}{0.25\,\text{h}}$$

The generator power meters will measure the individual gross output of each of the four engine generators. The net power delivered is determined by adding together the four individual generator power measurements and subtracting out the parasitic power measured in the parasitic loads panel.

Heat Recovery Rates

The heat recovery rates will be calculated offline based on the 1-minute data collected. The piping arrangement at this site allows for multiple heat rates to be determined with 3 temperature sensors and one flow reading on the heat recovery loop:

Useful heat recovery (**QU**) = K·Σ [FL·(TLS-TLR2)] / n

Rejected (unused) heat recovery (**QR**) = K ·Σ [FL·(TLR2-TLR3)] / n

The loop fluid is expected to be glycol. The factor K will be determined based on a periodic reading of the fluid properties with a refractometer to determine the glycol concentration. (K ~ 500 Btu/h-gpm-°F for pure water; ~480 for 20% glycol). 'n' is the number of scan intervals included in each recording interval (e.g., with 1 sec scans and 1-minute data, n=60)

Other heat recovery temperatures will be used for diagnostic purposes to verify if the system is operating in accordance with the proposed operation described in the original EA.

Calculated Quantities

The net power output from the CHP system, WG_{net}, will be defined as the sum of gross power from each engine, WG1, WG2, WG3, and WG4, minus the parasitic power, WPAR.

The fuel conversion efficiency of the CHP system, based on the lower heating value of the fuel, will be defined as:

$$FCE = \frac{QU + 3{,}413 \cdot (WG_{net})}{0.9 \cdot HHV_{gas} \cdot FG}$$

where:

QU	-	Useful heat recovery (Btu) (QU)
WG_{net}	-	Engine generator net output (kWh) (WG1 + WG2 + WG3 +WG4) - (WPAR)
FG	-	Generator gas consumption (Std CF)
HHV_{gas}	-	Higher heating value for natural gas (~1030 Btu per CF). Where 0.9 is the conversion factor between HHV and LHV

The FCE can be calculated for any time interval. When converting to daily, monthly, or annual values, the each value is summed and then the formula is applied:

$$FCE = \frac{\sum^{N} QU + 3{,}413 \cdot \sum^{N} (WG_{net})}{0.9 \cdot HHV_{gas} \cdot \sum^{N} FG}$$

Where N is equal to the number of intervals in the period of interest.

Appendix A

Cut Sheets for Key Sensors and Instruments

obvius

Energy Information Made Obvius

PRODUCT DATASHEET

AcquiSuite

Data Acquisition Server

ACQUISUITE A8812-1 AND A8812-GSM

Obvius' AcquiSuite is an intelligent, flexible data acquisition server allowing users to collect energy data from meters and environmental sensors. Designed to connect to IP-based applications such as enterprise energy management, demand response and smart grid programs, the AcquiSuite server lets you connect thousands of energy points, benchmark energy usage and reduce energy costs.

DATA COLLECTION

The AcquiSuite collects and logs data from connected (wired or wireless) devices based on user selected intervals. Data from downstream devices are time stamped and stored locally in non-volatile memory until the next scheduled upload or manual download. Using an integrated modem or Ethernet (LAN) connection you can push or pull data via HTTP, XML, FTP or any custom protocol utilizing our AcquiSuite Module to build your own application, including integrated cellular communication options.

INSTALLATION & FEATURES

No software is required. Easily access information through ANY web browser. The AcquiSuite has eight integrated flex I/O inputs. Each field selectable input can measure resistive, analog (4/20mA / 0-10V) and standard pulse / KYZ pulse output devices. This simplifies installation for basic projects monitoring electric, gas or water meters. There are several additional features including alarming, SNMP Traps, network configuration, wireless diagnostics, security provisions, alarm relays and backlit LCD. Our integrated meter driver library is designed to speed up installation and lower integration costs through "plug-and-play" connectivity.

COMPATIBILITY

The AcquiSuite is compatible with nearly any front-end software platform allowing customers to use a variety of reporting tools; whether it's a local server or an enterprise wide reporting suite. Obvius offers a free utility for automated .CSV file downloads or an affordable hosted solution for $195.00 annually (unlimited data storage).

PARTNERS

Obvius' outstanding integration and software partners supplement our products and services to ensure you receive the very best energy monitoring solution.

APPLICATIONS

- Utility submetering (electricity, gas, water, etc.)
- Measurement and verification (M&V)
- Reduce energy costs
- Access energy information from local or remote sites
- Benchmark building energy usage
- View "real time" performance data
- Track energy use and peak demand for Demand Response programs
- Monitor performance of critical systems (lighting, HVAC, PDUs, inverters, etc.)
- Alarm notification for data points above or below target levels (including SNMP Traps)
- Monitor renewable energy performance and production
- Create load profiles for energy purchases
- Push or pull meter data to energy dashboards, kiosks and software applications
- LEED / Energy Star certification

ABOUT OBVIUS

Obvius manufactures data acquisition and wireless connectivity products specifically for energy management. We deliver cost-effective, reliable hardware designed to speed up installation. Our products are based on an open architecture allowing our customers to collect and log energy information from virtually any meter or sensor. The ability to support multiple communication options provides remote access to all your energy information. Founded in 2003, Obvius is located in Hillsboro, Oregon. We serve a global clientele and continue to drive innovation by simplifying data collection.

SOLUTIONS

- Data Acquisition
- Wireless Communication
- Meters & Sensors
- Custom Packaged Solutions
- Integration & Software Partners

HEADQUARTERS

Hillsboro, Oregon

CONTACT US

sales@obvius.com

AcquiSuite A8812

Obvius helps customers collect and distribute energy information. Users can begin with one best-of-breed product that satisfies a requirement, or incorporate several products and services for a complete energy management solution.

Specifications	
Processor	ARM9 embedded CPU, ARM7 IO co-processor
Operating System	Linux 2.6
Memory	32 MB RAM
Flash ROM	16 MB NOR Flash (expandable with USB memory device)
Interval Recording	1 to 60 minutes, user selectable
LEDs	8x input, 4 modem activity, Modbus TX/RX, power, system, IO status
Console	2 x 16 LCD character, two push buttons
Power	
North America	110-120VAC, 60Hz, primary
CE/Europe	100-240VAC, 50-60Hz, primary (interchangeable plug adapters optional)
Power Supply	24VDC, 1A, class 2 wall brick transformer included
Communication	
Protocols	Modbus/RTU, Modbus/TCP, TCP/IP, PPP, HTTP/HTML, FTP, NTP, XML, SNMP-Trap
LAN	RJ45 10/100 Ethernet, full half duplex, auto polarity
Modem	V.34 bis, 33,600 bps (A8812-1 only)
Cellular	GSM/GPRS Cellular (A8812-GSM only)
USB	USB expansion port
Inputs	
Serial Port	RS-485 Modbus, supports up to 32 external devices (expandable)
I/O	8x Flex IO inputs with user selectable modes: voltage, current, resistance, pulse and status
Outputs	
Relays	2x, dry contact 30 VDC, 150 mA max
Physical	
Weight	5lbs (2.3kg)
Size	8" x 9.25" x 2.5" (203mm x 235mm x 64mm)
Environment	
North America	0 to 50C, 0-90% RH, non-condensing
CE/Europe	5 to 40C, 0-90% RH, non-condensing
Codes and Standards	
FCC CFR 47 Part 15, Class A, EN 61000, EN 61326, CE	
Additional Notes	
NEMA enclosures available upon request	
Manufactured in the USA	

CE

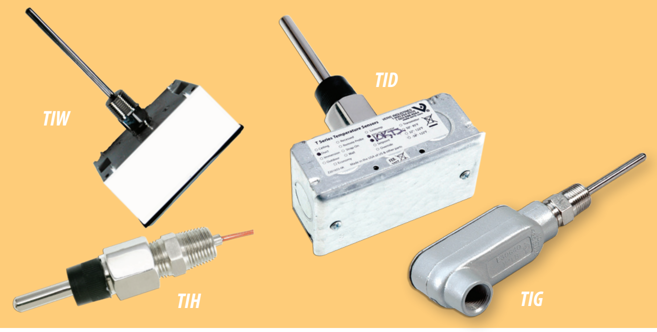
obvius

Obvius
3300 NW 211th Terrace
Hillsboro, OR 97124

503 601 2099
866 204 8134 (USA only)
sales@obvius.com

Immersion Temperature Sensors

Corrosion Resistant Stainless Steel Probe



DESCRIPTION

These immersion probe type temperature sensors are both highly accurate and cost effective. Installation could not be easier. The sensor is encased in a corrosion-resistant stainless steel probe for durability, with a choice of service entry body, indoor junction box, or threaded enclosures. A variety of RTD or thermistor sensor options and probe lengths are available for maximum application versatility.

APPLICATIONS

- Tanks
- Pipes
- Chillers

FEATURES

- Cost-effective high accuracy thermistors/RTDs
- Corrosion resistant stainless steel probe design...durable
- 1/2" NPT threads standard...ease of selection
- Variety of enclosures include duct mount, service entry body, threaded, and water resistant to fit your application
- Thermowells available...enables easy servicing

TEMPERATURE

Class	Pt RTD		THERMISTOR											
Type	100 Ohm	1000 Ohm	2.2k	3k	10k Type 2	10k Type 3	10k Dale	10k 3A221	10k "G" US	20k	20k "D"	100k	10k Type 2	10k Type 3
Accuracy	±0.3°C	±0.3°C	±0.2°C	±0.2°C	±1.0°C	±0.2°C	±0.2°C	±1.1°C	±0.2°C	Consult	Consult	Consult	±0.1°C 20/70°C	±0.1°C
	0.0385 curve	0.0385 curve	0/70°C	0/70°C	-50/150°C	0/70°C	-20/70°C	0/70°C	0/70°C	Factory	Factory	Factory	±0.2°C 0/20°C	0/70°C
Temp. Response*	PTC	PTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC
													High Accuracy	

*PTC: Positive Temperature Coefficient
*NTC: Negative Temperature Coefficient

STANDARD RTD AND THERMISTOR VALUES (Ohms Ω)

°C	°F	100 Ohm	1000 Ohm	2.2k	3k	10k Type 2	10k Type 3	10k Dale	10k 3A221	10k "G" US	20k NTC	20k "D"	100k	10k Type 2	10k Type 3
-50	-58	80.306	803.06	154,464	205,800	692,700	454,910	672,300	-	441,200	1,267,600	-	-	692,700	454,910
-40	-40	84.271	842.71	77,081	102,690	344,700	245,089	337,200	333,562	239,700	643,800	803,200	3,366,000	344,700	245,089
-30	-22	88.222	882.22	40,330	53,730	180,100	137,307	177,200	176,081	135,300	342,000	412,800	1,770,000	180,100	137,307
-20	-4	92.160	921.60	22,032	29,346	98,320	79,729	97,130	96,807	78,910	189,080	220,600	971,200	98,320	79,729
-10	14	96.086	960.86	12,519	16,674	55,790	47,843	55,340	55,252	47,540	108,380	122,400	553,400	55,790	47,843
0	32	100.000	1000.00	7,373	9,822	32,770	29,588	32,660	32,639	29,490	64,160	70,200	326,600	32,770	29,588
10	50	103.903	1039.03	4,487	5,976	19,930	18,813	19,900	19,901	18,780	39,440	41,600	199,000	19,930	18,813
20	68	107.794	1077.94	2,814	3,750	12,500	12,272	12,490	12,493	12,260	24,920	25,340	124,900	12,500	12,272
25	77	109.735	1097.35	2,252	3,000	10,000	10,000	10,000	10,000	10,000	20,000	20,000	100,000	10,000	10,000
30	86	111.673	1116.73	1,814	2,417	8,055	8,195	8,056	8,055	8,194	16,144	15,884	80,580	8,055	8,195
40	104	115.541	1155.41	1,199	1,598	5,323	5,593	5,326	5,324	5,592	10,696	10,210	53,260	5,323	5,593
50	122	119.397	1193.97	811.5	1,081	3,599	3,894	3,602	3,600	3,893	7,234	6,718	36,020	3,599	3,894
60	140	123.242	1232.42	561.0	747	2,486	2,763	2,489	2,486	2,760	4,992	4,518	24,880	2,486	2,763
70	158	127.075	1270.75	395.5	527	1,753	1,994	1,753	1,751	1,990	3,512	3,100	17,510	1,753	1,994
80	176	130.897	1308.97	284.0	378	1,258	1,462	1,258	1,255	1,458	2,516	2,168	12,560	1,258	1,462
90	194	134.707	1347.07	207.4	-	919	1,088	917	915	1,084	1,833	1,542	9,164	919	1,088
100	212	138.506	1385.06	153.8	-	682	821	679	678	816.8	1,356	1,134	6,792	682	821
110	230	142.293	1422.93	115.8	-	513	628	511	509	623.6	1,016	816	5,108	513	628
120	248	146.068	1460.68	88.3	-	392	486	389	388	481.8	770	606	3,894	392	486
130	266	149.832	1498.32	68.3	-	303	380	301	299	376.4	591	456	3,006	303	380
Sensor Codes		B	C	E	F	D	H	J	S	R	M	U	T	W	Y

To compute Linitemp Temperature:

2-Wire version (1µA/°C)
µA reading - 273.15=Temperature in °C
3-Wire version (10mV/°C)
mV reading/10 - 273.15 = Temperature in °C

SPECIFICATIONS

5 Year Warranty

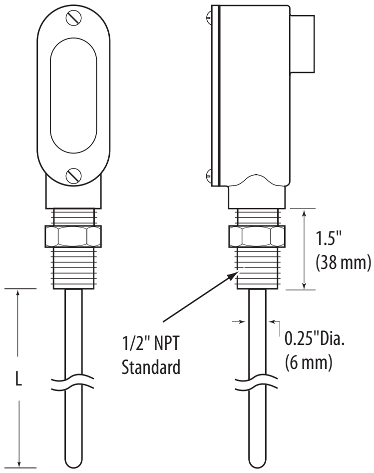
Wiring	22 AWG; 2-wire: RTD Thermistor, 4-20mA; 3-wire: Voltage output models
Probe	Stainless Steel
Test Pressure	200 psi
Linitemp:	
Input Power	5 to 30VDC
Output	1µA/°C or 10mV/°C
Operating Temperature	-25° to 105°C (-13° to 221°F)
Resistive:	
RTD/Thermistor	See table, above
Accuracy:	
Calibration Error	1.5°C (2.7°F) typical; 2.5°C (4.5°F) max. at 25°C (77°F)*
Error over Temperature	1.8°C (3.24°F) typical; 3.0°C (5.4°F) max. over 0° to 70°C (32° to 158°F) range; 2.0°C (3.6°F) typical, 3.5°C (6.3°F) max. over -25° to 105°C (-13° to 221°F) range

Room temperature error documented on each unit.

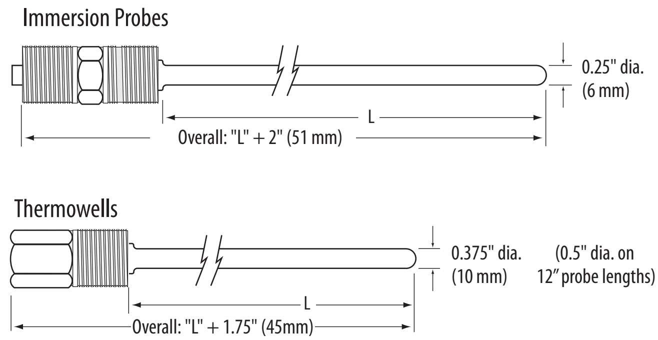
VERIS INDUSTRIES

DIMENSIONAL DRAWINGS

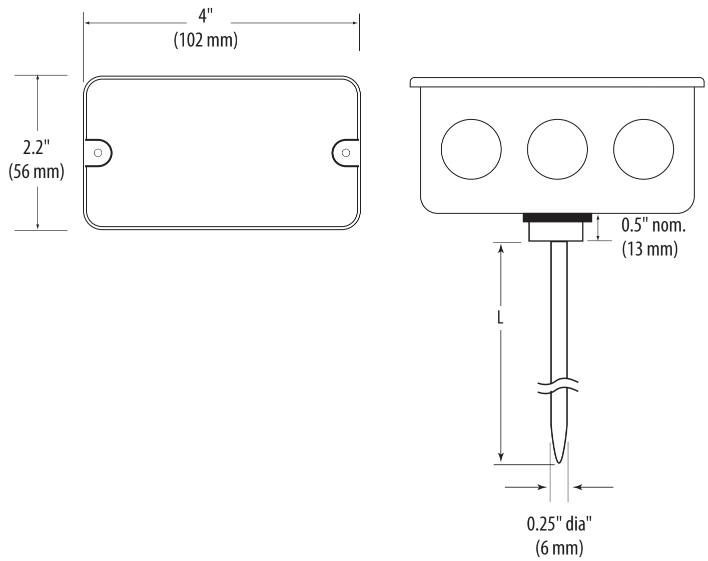
TIG Model



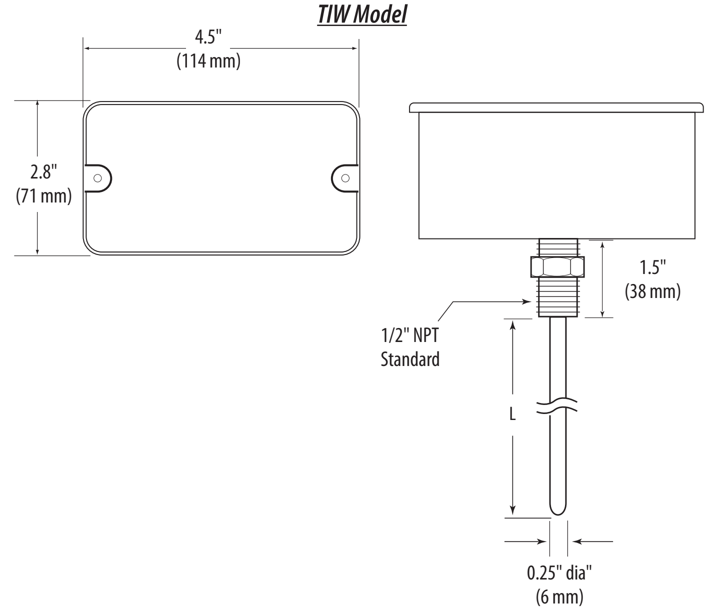
TIH Model



TID Model



TIW Model



ORDERING INFORMATION

T I [Enclosure] [Immersion Probe Length "L"] [Thermowell] [Sensor Type] [OPTIONS: Cal Certificate] [OPTIONS: Threads]

Enclosure
- **D** = Duct
- **G** = Service Entry Body
- **H** = Threaded NPT Only
- **W** = Water resistant housing

Immersion Probe Length "L"
- **A** = 2 1/2" (64mm)
- **B** = 4" (102mm)
- **C** = 6" (152mm)
- **D** = 8" (203mm)
- **E** = 12" (305mm)

Thermowell
- **0** = None
- **1** = Add Thermowell

Sensor Type
- **B** = 100R Platinum, RTD
- **C** = 1k Platinum, RTD
- **D** = 10k T2, Thermistor
- **E** = 2.2k, Thermistor
- **F** = 3k, Thermistor
- **G** = 10k CPC, Thermistor
- **H** = 10k, T3, Thermistor
- **J** = 10k Dale, Thermistor
- **K** = 10k w/11k shunt,Thermistor
- **M** = 20k NTC, Thermistor
- **N** = 1800 ohm, Thermistor
- **P** = 10mV/°C, Linitemp
- **R** = 10k US, Thermistor
- **S** = 10k 3A221, Thermistor
- **T** = 100k, Thermistor
- **U** = 20k "D", Thermistor
- **W** = 10k T2 high accuracy, Thermistor
- **Y** = 10k T3 high accuracy, Thermistor
- **Z** = 10k E1, Thermistor

OPTIONS

Cal Certificate
- **0** = None
- **1** = 1 point Cal validation
- **2** = 2 point Cal validation

Threads
- **Blank** = NPT
- **A** = BSPT
- **B** = DIN 2999

NOTE:
For 4-20mA transmitter output, order any TI with the 100Ω platinum RTD and accessory AA10xx

Thermowell Sizing

Probe Length	Thermowell Length
A (2 1/2") (64mm)	1 1/2" (38mm)
B (4") (102mm)	3" (76mm)
C (6") (152mm)	5" (127mm)
D (8") (203mm)	7" (178mm)
E (12") (305mm)	11" (279mm)

Example:

T I D B 1 D 2 A

ACCESSORIES

Thermowells (AA22, AA24, AA25, AA33)

AA24

Enercept® Networked Power Transducers (Modbus® RTU)

Integral Monitoring Solution Eliminates the Need for Separate Enclosures

H8035/H8036

U.S. Patent No. 6,373,238

POWER/ENERGY MONITORING

DESCRIPTION

The **Enercept H8035 and H8036 Series** are innovative three-phase networked (Modbus RTU) power transducers that combine measurement electronics and high accuracy industrial grade CTs in a single package. The need for external electrical enclosures is eliminated, greatly reducing installation time and cost.

There are two application-specific platforms to choose from. The Basic Enercept energy transducers (H8035) are ideal for applications where only kW and kWh are required. The Enercept Enhanced power transducers (H8036) output 26 variables including kW, kWh, volts, amps, and power factor, making them ideal for monitoring and diagnostics.

Color-coordination between voltage leads and CTs makes phase matching easy. Additionally, the Enercept automatically detects and compensates for phase reversal, eliminating the concern of CT load orientation. Up to 63 Enercepts can be daisy-chained on a single RS-485 network.

APPLICATIONS

- Energy managment and performance contracting
- Monitoring for commercial tenants
- Activity-based costing in commercial and industrial facilities
- Real-time power monitoring
- Load shedding

FEATURES

- Revenue Grade measurements
- Precision electronics and current transformers in a single package...reduces the number of installed components...creating significant labor savings
- Monitor energy parameters (kW, kWh, kVAR, PF, Amps, Volts) at up to 63 locations on a single RS-485 network...greatly reduces wiring time and cost
- Fast split-core installation eliminates the need to remove conductors...saves time and labor
- Smart electronics eliminate CT orientation concerns...fast trouble-free installation
- CSI approved...eases submission process for California Solar Initiative

SPECIFICATIONS

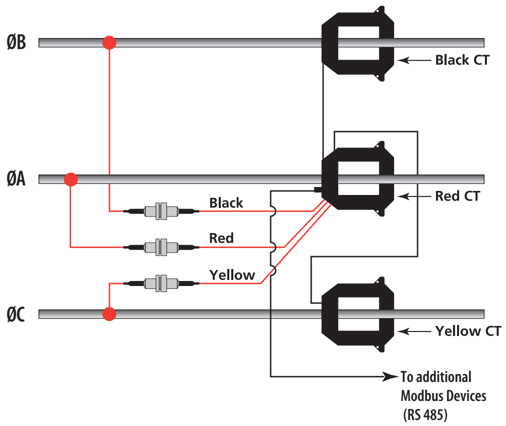
5 Year Warranty

Inputs:	
Voltage Input	208 to 480VAC, 50/60 Hz RMS †(††)
Current Input	Up to 2400A continuous per phase †
Accuracy:	
System Accuracy	±1% of reading from 10% to 100% of the rated current of the CTs, accomplished by matching the CTs with electronics and calibrating them as a system
Outputs:	
Type	Modbus RTU*(**)
Baud Rate	9600, 8N1 format
Connection	RS-485, 2-wire + shield
Environmental:	
Operating Temperature Range	0° to 60°C (32° F to 140°F), 50°C (122°F) for 2400A
Humidity Range	0 - 95% noncondensing
Safety	UL508

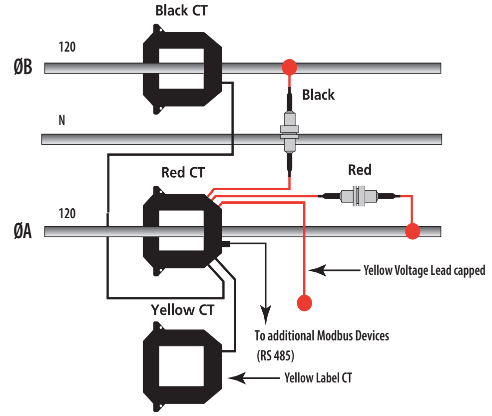
Approved for California CSI Solar applications (check the CSI Solar website for model numbers).
† Contact factory to interface for voltages above 480VAC or current above 2400 Amps.
†† Do not apply 600 V Class current transformers to circuits having a phase-to-phase voltage greater than 600 V, unless adequate additional insulation is applied between the primary conductor and the current transformers. Veris assumes no responsibility for damage of equipment or personal injury caused by products operated on circuits above their published ratings.
** Detailed protocol specifications are available at: http://www.veris.com/modbus*
*** Other protocols available. Please consult factory.*

APPLICATION/WIRING EXAMPLES

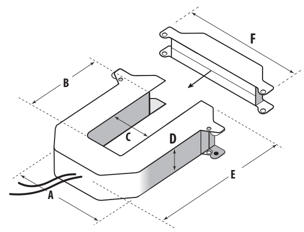
208 or 480VAC 3Ø, Installation



240VAC 1Ø, 3-Wire Installation

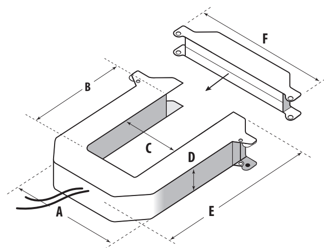


DIMENSIONAL DRAWINGS



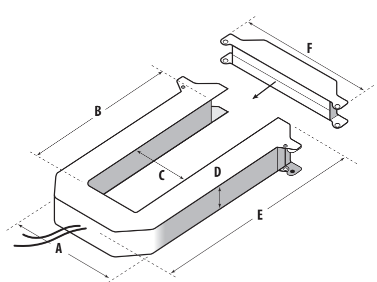
SMALL
100/300 Amp

A =	3.8"	(96 mm)
B =	1.2"	(30 mm)
C =	1.3"	(31 mm)
D =	1.2"	(30 mm)
E =	4.0"	(100 mm)
F =	4.8"	(121 mm)



MEDIUM
400/800 Amp

A =	4.9"	(125 mm)
B =	2.9"	(73 mm)
C =	2.5"	(62 mm)
D =	1.2"	(30 mm)
E =	5.2"	(132 mm)
F =	6.0"	(151 mm)



LARGE
800/1600/2400 Amp

A =	4.9"	(125 mm)
B =	5.5"	(139 mm)
C =	2.5"	(62 mm)
D =	1.2"	(30 mm)
E =	7.9"	(201 mm)
F =	6.0"	(151 mm)

DATA OUTPUTS

H8035
kWh
kW

H8036
kWh, Consumption
kW, Real Power
kVAR, Reactive Power
kVA, Apparent Power
Power Factor
Average Real Power
Minimum Real Power
Maximum Real Power
Voltage, L-L
Voltage, L-N*
Amps, Average Current

** Based on derived neutral voltage.*

POWER/ENERGY MONITORING

ORDERING INFORMATION

LISTED 44XJ UL 508
C US
E212445

*Modbus Basic Power Transducers**

MODEL	MAX. AMPS	CT SIZE
H8035-0100-2	100	SMALL
H8035-0300-2	300	SMALL
H8035-0400-3	400	MEDIUM
H8035-0800-3	800	MEDIUM
H8035-0800-4	800	LARGE
H8035-1600-4	1600	LARGE
H8035-2400-4	2400	LARGE

**H8035 models work with H8920-5 LON nodes*

*Modbus Enhanced Data Stream Power Transducers**

MODEL	MAX. AMPS	CT SIZE
H8036-0100-2	100	SMALL
H8036-0300-2	300	SMALL
H8036-0400-3	400	MEDIUM
H8036-0800-3	800	MEDIUM
H8036-0800-4	800	LARGE
H8036-1600-4	1600	LARGE
H8036-2400-4	2400	LARGE

**H8036 models work with H8920-1 LON nodes*

ACCESSORIES

LON nodes (H8920)
CT Mounting brackets (AH06)
Modbus-to-BACnet Converter (E8950)
Modbus TCP Converter (U013-0013)

H8920 Series

U013-0012

AH06

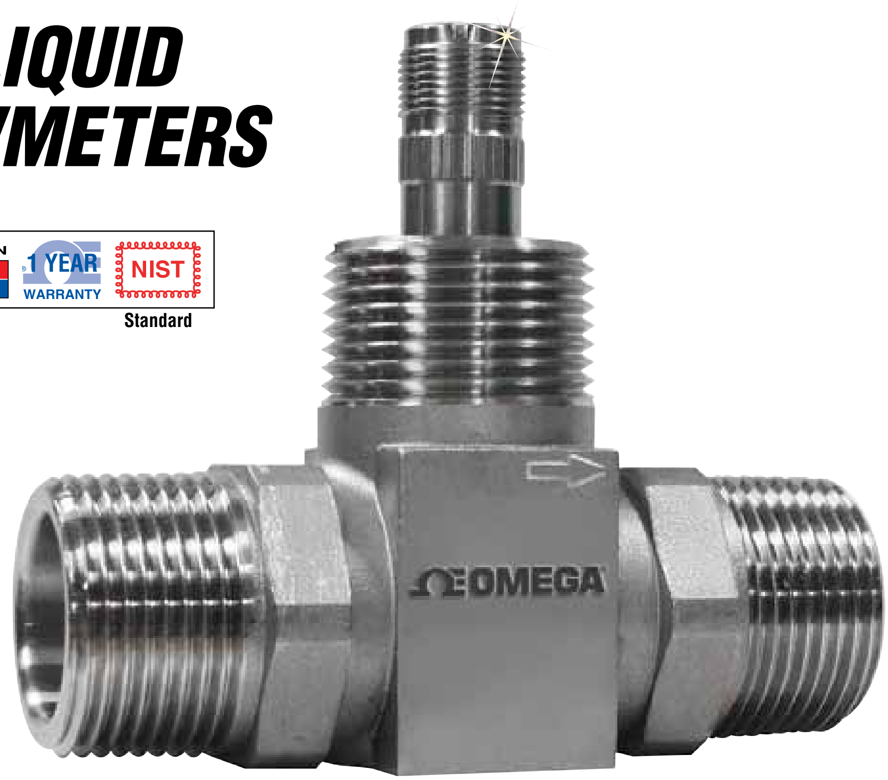
E8950

ECONOMICAL LIQUID TURBINE FLOWMETERS

FTB-1400 Series

MADE IN USA | 1 YEAR WARRANTY | NIST Standard

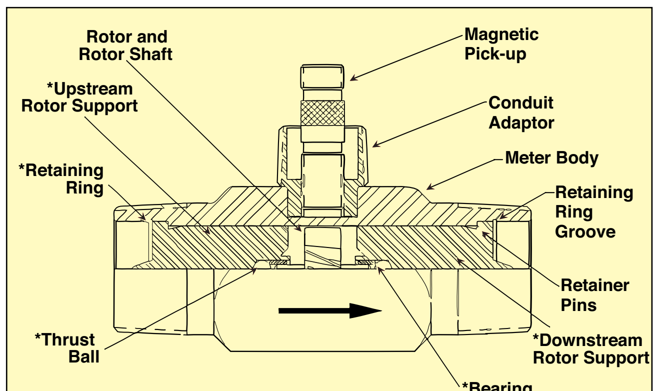
- Cost-Effective Solution for Turbine Flowmeter Applications
- Rugged 316 Stainless Steel Construction Offers Long Service Life in Severe Operating Environments
- Accurate and Repeatable Flow Measurement
- Installation in Pipe Sizes from ½ to 2"
- NIST Calibration



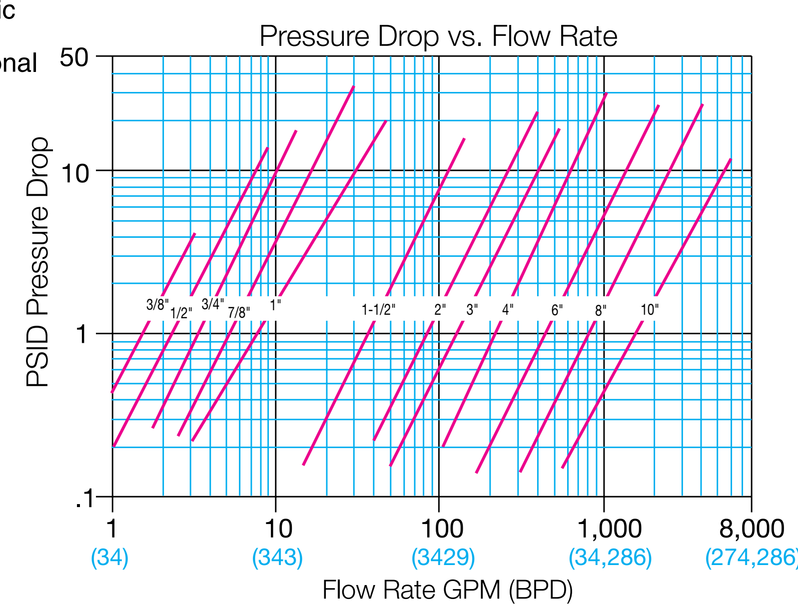
FTB-1425, shown smaller than actual size.

The OMEGA® FTB-1400 turbine flowmeter is designed to meet the demands of the most rigorous flow measurement applications. Originally developed for the secondary oil recovery market, the FTB-1400 is an ideal meter for liquid flow measurement on or off the oilfield. The meter features a 316 Stainless Steel housing and rotor support, CD4MCU Stainless Steel rotor, and abrasion-resistant tungsten carbide rotor shaft and journal bearings. These materials help the meter to maintain accuracy and mechanical integrity when measuring the corrosive and abrasive fluids found in many industries.

Fluid entering the meter first passes through an inlet flow straightener that reduces its turbulent flow pattern. Fluid then passes through the turbine, causing the turbine to rotate at a speed proportional to fluid velocity. As each turbine blade passes through the magnetic field generated by the meters magnetic pick-up, an AC voltage pulse is generated. These pulses provide an output frequency that is proportional to volumetric flow.



Note: * Indicates Parts Contained in Repair Kits



SPECIFICATIONS

Accuracy: ±1% of reading for 1" and larger, ±1% of reading over the upper 70% of the measuring range for ½" meters
Repeatability: ±0.1%
Magnetic Pickup: 30 mV/P-P
Materials of Construction
- **Body:** 316 Stainless Steel
- **Rotor:** CD4MCU Stainless Steel
- **Rotor Support:** 316 Stainless Steel
- **Rotor Shaft:** Tungsten carbide

Turndown Ratio: 10:1
Calibration: Water (NIST traceable calibration)
Pressure Rating: 5000 psi (maximum)
Turbine Temperature: -101 to 177°C (-150 to 350°F); -101 to 232°C (-150 to 450°F) (with **"-HT"** option)
End Connections: NPT, BSPP optional

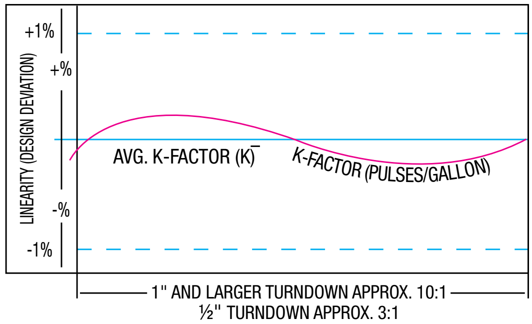
K-Factor

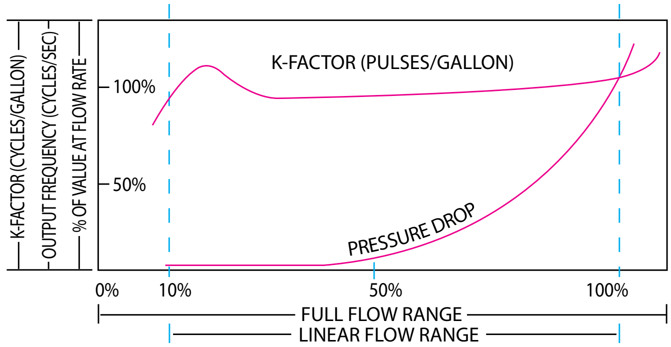
The K-Factor represents the number of output pulses transmitted per gallon of fluid passing through the turbine meter. Each turbine has a unique K-Factor. However, turbine meters are not functionally consistent throughout the full flow range of the meter.

There are several forms of “friction” inherent in turbine meters that retard the rotational movement of the turbine rotor. These frictional forces include: magnetic drag, created by electromagnetic force of pickup transducers; mechanical drag, due to bearing friction; and viscous drag, produced by flowing fluid. See charts on right.

As flow increases, the frictional forces are minimized and the free-wheeling motion of the turbine rotor becomes more linear (proportional to flow). The K-Factor becomes relatively constant and linear throughout the balance of the linear flow range. This is approximately a 10:1 turndown ratio from the maximum flow rate down to the minimum flow rate.

Typical K-Factor Curve (Pulses Per Gallon)





To Order *Visit omega.com/ftb1400_series for Pricing and Details*

Model No.	Connection MNPT	Range			K-Factor Pul/Gal	Lay Length mm (inch)
		LPM	GPM	Barrels/Day		
FTB-1411	½	2.3 to 11.3	0.6 to 3	20 to 100	18,000	76 (3)
FTB-1412	½	2.8 to 28	0.75 to 7.5	25 to 250	13,000	76 (3)
FTB-1413	½	7.6 to 56.7	2 to 15	68 to 515	3300	76 (3)
FTB-1421	1	2.3 to 11.3	0.6 to 3	20 to 100	18,000	76 (3)
FTB-1422	1	2.8 to 28	0.75 to 7.5	25 to 250	13,000	76 (3)
FTB-1423	1	7.6 to 56.7	2 to 15	68 to 515	3300	76 (3)
FTB-1424	1	11.3 to 113	3 to 30	100 to 1000	3100	101 (4)
FTB-1425	1	18.9 to 189	5 to 50	170 to 1700	870	101 (4)
FTB-1431	1½	56.8 to 681	15 to 180	515 to 6000	330	152 (6)
FTB-1441	2	56.8 to 681	15 to 180	515 to 6000	330	152 (6)

Accessories

Model No.	Description
FTB-1400-CABLE	3 m (10') cable assembly with 2-pin connector (required for remote display)
FTB-1400-90CABLE	3 m (10') cable assembly with 2-pin 90° connector (required for remote display)
FTB-1400-MP	Replacement standard magnetic pick-up
FTB-1400-MD	Battery powered basic meter mount display
FTB-1400-MD-A	Battery powered advanced meter mount display
FTB-1400-RD	Battery powered basic remote mount display
FTB-1400-RD-A	Battery powered advanced remote mount display
FTB-1400-SD	Battery powered basic swivel mount display
FTB-1400-SD-A	Battery powered advanced swivel mount display

Comes complete with operator’s manual and 5 point NIST calibration certificate for water. Cable with connector sold separately. Cable/connector are required for operation.

*For units with high temp magnetic pulse output, add suffix **“-HT”** to model number, consult Flow Engineering for price (not available on **“-AMP”** models).*

*For units with amplified pulse output, add suffix **“-AMP”** to model number consult Flow Engineering for price (not available on **“-HT”** models).*

*For units with BSPP threads, add suffix **“BSP”** to model number for additional cost.*

***Ordering Examples: FTB-1424,** 1 NPT stainless turbine and **FTB-1400-MD,** battery powered basic meter mount.*

***FTB-1411,** ½ NPT stainless turbine and **DPF701,** digital panel meter for rate of total display, **FTB-1400-CABLE,** 3 m (10') cable assembly with 2-pin connector. For details on DPF701 meter, visit **omega.com/dpf700** for details.*

Addendum – Rivington Health Care

45 Rivington St.
New York, NY 10002

Site Contact

- CDH was on site February 21, 2013 to install the Obvius datalogger, thermistors, power meters, and terminate sensor wiring to the datalogger. There were some issues with the installed metering that need to be addressed:
  - Flow meter not providing pulse output. A transmitter for this meter is required.
  - TLR3 (loop temperature after dump HX) is on the dump HX branch piping, not cogen main loop. This sensors needs to be moved to main loop.
  - Additional temperature sensors (TLR4, TLR5) need to be added on either side of Con Ed. steam HX on cogen loop, to account for heat added by non CHP sources.
  - Gas meter to have pulse module installed.

- CDH returned to the site May 29, 2013 to address the following metering issues:
  - Four (4) Surface mount temperature sensors were added.
    - CHP loop temp. leaving absorption chiller (TLR4)
    - CHP loop temp. leaving steam HX (TLR5)
    - CHP loop temp. leaving building HX – on main piping (TLR1a)
    - CHP loop temp. leaving dump HX (TLR3)
  - Added magnetic pickup to pulse transmitter to customer supplied Omega flowmeter.
    - Pulse rate is too high for data logger to count, so CDH will furnish an additional transmitter to convert from pulse to 4-20 mA.
  - CHP gas data based on billing intervals added to database.

- CDH returned to the site October 24, 2013 to address the following metering issues:
  - Pulse to 4-20 mA transmitter added for flowmeter.
    - Datalogger is now reading measured flow from Omega flowmeter & flow was verified with ultrasonic.
  - Mod Hopper wireless transmitters were added in the gas meter room, and at the data logger.
    - Gas meter pulse output now transmitted back to data logger.

Summary

Monitored Data Points

Logger Channel	Data Point	Description	Eng Units	Instrument / Transducer
-	WG1	Gross Generator Output - Cogen Unit #1	kW	Calculated
-	WG2	Gross Generator Output - Cogen Unit #2	kW	Calculated
-	WG3	Gross Generator Output - Cogen Unit #3	kW	Calculated
-	WG4	Gross Generator Output - Cogen Unit #4	kW	Calculated
-	WP	Parasitic Loads	kW	Calculated
-	WG	Net Generator Power	kW	Calculated
Mod-250 IN1	FL	Recovered Heat Loop Flow	gpm	Omega FTD-1400
Mod-250 IN2	TLS	Recovered Heat Loop - Supply Temp.	^oF	Veris 10k Type 2 Thermocouple
Mod-250 IN3	TLR1	Recovered Heat Loop - Return Temp. - After Space HX (on branch piping)	^oF	Veris 10k Type 2 Thermocouple
Mod-250 IN4	TLR2	Recovered Heat Loop - Return Temp. - After DHW	^oF	Veris 10k Type 2 Thermocouple
Mod-250 IN5	TLR3	Recovered Heat Loop - Return Temp. - After Dump	^oF	Veris 10k Type 2 Surface Mount Thermocouple
Mod-250 IN6	TLR4	Recovered Heat Loop - Return Temp. - After Abs. Chiller	^oF	Veris 10k Type 2 Surface Mount Thermocouple
Mod-250 IN7	TLR5	Recovered Heat Loop - Return Temp. - After Steam HX	^oF	Veris 10k Type 2 Surface Mount Thermocouple
Mod-250 IN8	TLR1a	Recovered Heat Loop - Return Temp. - After Space HX (on main loop)	^oF	Veris 10k Type 2 Surface Mount Thermocouple
-	FG	Total Gas to Generators	cfh	Calculated
Mod-001	WG1_ACC	Accumulated Gross Generator Output - Cogen Unit #1	kWh	Veris H8035
Mod-002	WG2_ACC	Accumulated Gross Generator Output - Cogen Unit #2	kWh	Veris H8035
Mod-004	WG3_ACC	Accumulated Gross Generator Output - Cogen Unit #2	kWh	Veris H8035
Mod-003	WG4_ACC	Accumulated Gross Generator Output - Cogen Unit #2	kWh	Veris H8035
Mod-005	WP_ACC	Accumulated Parasitic Loads	kWh	Veris H8035
Mod-250 IN1	FL_ACC	Accumulated Recovered Heat Loop Flow	gpm	Omega FTD-1400
Mod-016	FG_ACC	Accumulated Gas to Generators	cf	Roots Utility Meter
-	QS	Heat Added to Cogen Loop From Steam HX	Mbtu/h	Calculated
-	QC	Useful Heat Recovery - Absorption Chiller	Mbtu/h	Calculated
-	QDHW	Useful Heat Recovery - DHW	Mbtu/h	Calculated
-	QSH	Useful Heat Recovery - Space Heating	Mbtu/h	Calculated
-	QD	Dumped Heat	Mbtu/h	Calculated
-	QU	Total Useful Heat Recovery	Mbtu/h	Calculated

Verification

October 24, 2013

Hot Water Flow

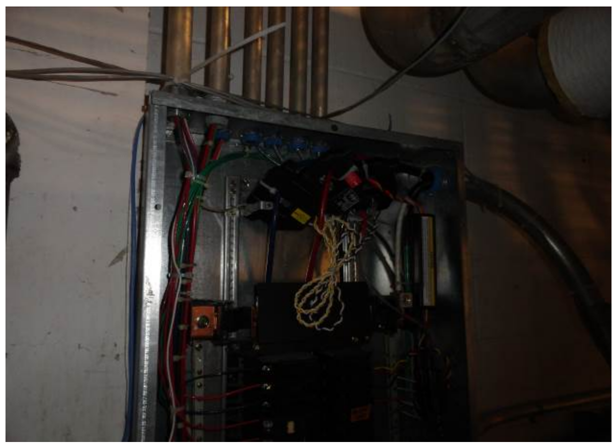
	Obvius	Portaflow
	80.2	83.5
	81.4	84.3
	80.7	83.6
	81.5	84.5
	81.2	84.2
Avg:	*81.0*	*84.0*

Site Photos

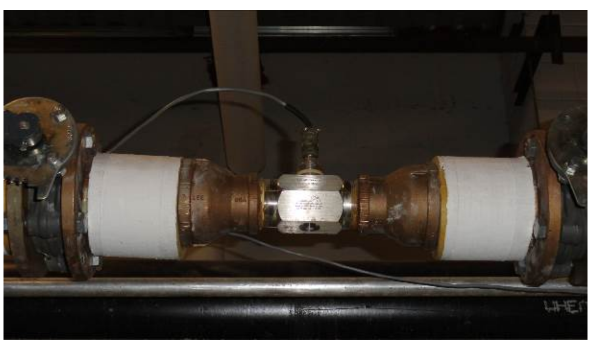
CDH panel – Obvius datalogger.

Site view – four (4) CM-60 cogen units, located in loading dock area.

Veris H8035 power meter installed in cogen electrical cabinet. Typical for all four (4) units.



Veris H8035 power meter installed in breaker panel to measure parasitic loads.

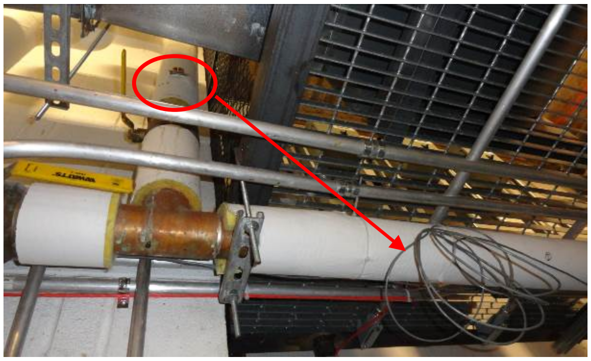


Omega FTB-1400 flow meter.

TLS – Recovered heat loop supply temperature.

TLR1 – Recovered heat loop temperature after chiller, Con. Ed. steam HX, and space heating HX.

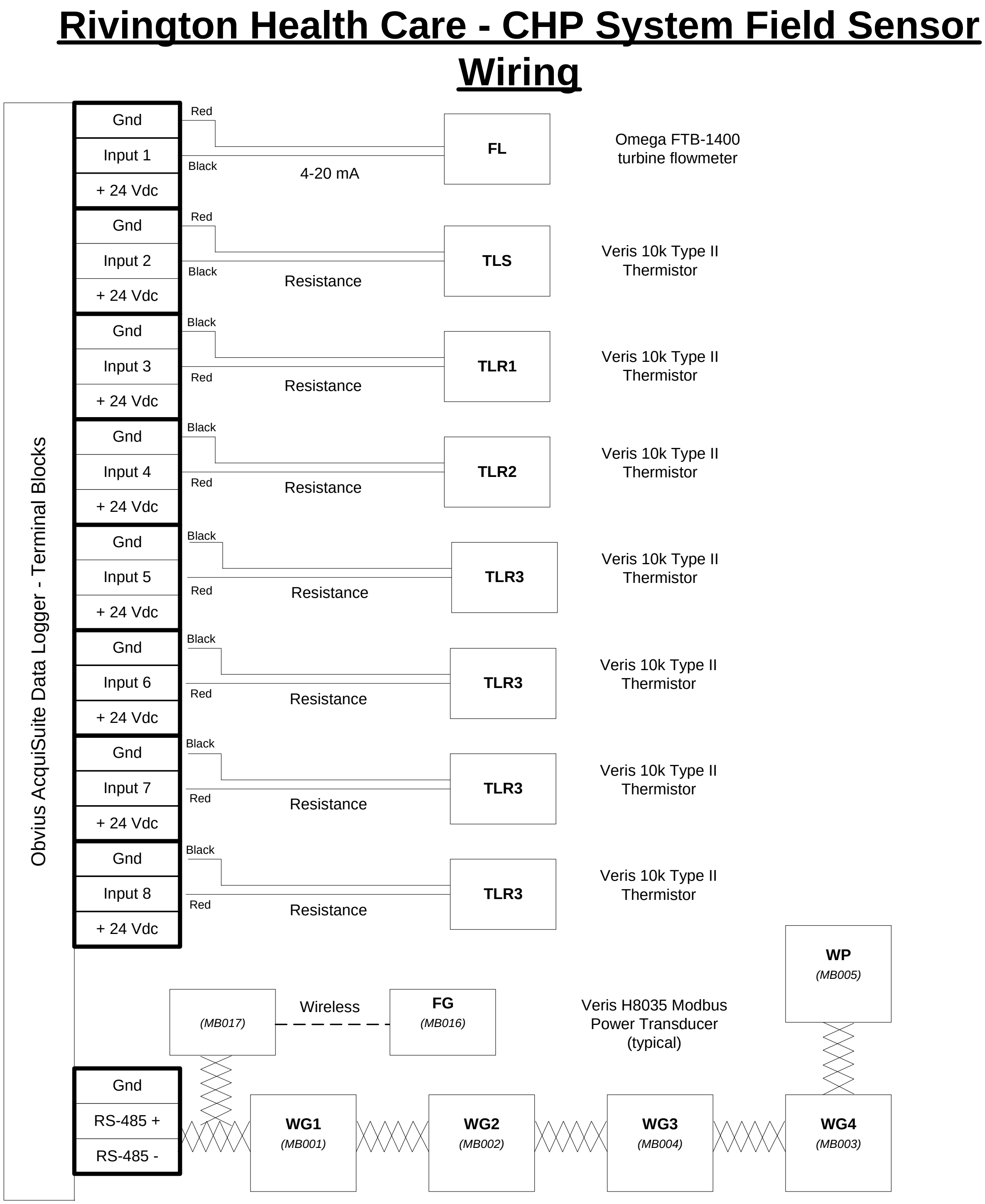
TLR2 – Recovered heat loop temperature after DHW.



TLR3 – Recovered heat loop temperature after dump radiator. Located on dump radiator loop, needs to be moved to main loop.

Con Ed demarcation enclosure (right) and Mod Hopper wireless transmitter (right) – located in gas meter room in basement.

Wiring Diagram



RIVINGTON CHP - 2013May29

M&V revisions performed
1) Add sensors TLR4 & TLR5 before and after Steam HX
2) Add TLR3 to main piping not branch piping
3) Add TLR1a on main piping, leave TLR1 on branch
4) Add transmitter for FL. Pulse rate still to high, need alternative transmitter