MEASUREMENT AND VERIFICATION PLAN

FOR

DG/CHP SYSTEM
AT
SILVER TOWERS

February 2013

Submitted to:

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

Submitted by:

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Project Team:

NYSERDA Project Manager:

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Site:

Silver Towers (River Place II)
620 West 42nd St.
New York, NY 10036

Developer/Applicant:

Silverstein Properties, Inc.,
250 Greenwich Street, NY NY 10007

Engineering Consultants:

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1. Introduction

Norgen Consulting Group has designed and overseen the installation of a combined heat and power (CHP) system at Silver Towers at 620 West 42nd St. in New York with engineering services provided by DSM Engineering Associates (DSMEA). The site is receiving an incentive from NYSERDA under the CHP Demonstration program.

The CHP system includes three (3) 100 kW Tecogen InVerde CM-100 engine generator units. The inverter-based systems are intended to produce a gross output of 300 kW and recover jacket water engine heat for 1.) domestic hot water (DHW) for both the North and South Towers, 2.) unit heaters for the garage. The CHP system provides power in parallel with the existing utility service.

2. Instrumentation

In order to quantify the performance of the CHP system, the CHP system fuel input, net electrical output, and useful thermal output will be measured. To capture that data, the Site (or its monitoring contractor) has supplied the meters and instrumentation listed in Table 1.

Table 1. CHP System Monitoring Instrumentation

Data Point	Description	Units	Instrument / Sensor	Output Type	Location
WG1	CHP Generator #1 Electrical Output	kW	Tecogen Inverde Sensor	Modbus RTU	At each generator
WG2	CHP Generator #2 Electrical Output	kW	Tecogen Inverde Sensor	Modbus RTU	
WG3	CHP Generator #3 Electrical Output	kW	Tecogen Inverde Sensor	Modbus RTU	
WPAR1	Parasitic Load DP-CHP-S Electrical Consumption	kW	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-S (Mezzanine)
WPAR2	Parasitic Load DP-CHP-N Electrical Consumption	kW	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-N (CHP Room)
WPAR1_ACC	Parasitic Load DP-CHP-S Electrical Consumption (Accumulator)	kWh	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-S (Mezzanine)
WPAR2_ACC	Parasitic Load DP-CHP-N Electrical Consumption (Accumulator)	kWh	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-N (CHP Room)
FG_ACC	Combined Generator Fuel Input (Accumulator)	CF	Utility Meter	Pulse	Meter dedicated to Generators
FL1	Main (Hot Water) Heat Recovery Loop Flow Rate	GPM	Onicon F1211 Range 0-180 gpm	Analog	Insertion flow meter on hot water loop in hallway near engines
TLS	Heat Recovery Loop Supply Temperature (Hot Water Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	Immersion temperature sensors (2) on hot water loop in hallway near engines
TLR1	Heat Recovery Loop Return Temperature from North Tower DHW Pre-Heat (Hot Water Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	
TLR2	Heat Recovery Loop Return Temperature from South Tower DHW Pre-Heat (Hot Water Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	Immersion temperature sensor on hot water loop in Mezzanine
FL2	Unit Heater / Drycooler (Glycol) Heat Recovery Loop Flow Rate	GPM	Onicon F1211 Range 0-180 gpm	Analog	Insertion flow meter on glycol loop in Mezzanine
TLR3	Heat Recovery Loop Supply Temperature to Unit Heaters (Garage Entrance) UH-1 and UH-2 (Glycol Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	Immersion temperature sensors (3) on glycol loop in Mezzanine
TLR4	Heat Recovery Loop Return Temperature from UH-1 and UH-2 (Glycol Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	
TLR5	Heat Recovery Loop Return Temperature from Drycoolers (Glycol Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	

Data Logger

Readings for the installed instrumentation are recorded by an Obvius AcquiSuite datalogger. The datalogger samples all sensors approximately once per second and records one-minute totals (for pulse or digital sensors) or averages (for analog sensors). The one minute readings of heat recovery temperatures and flow rates 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 (16), the logger will have sufficient memory to store 30 days of data if communications with the logger are interrupted. The data are downloaded from the datalogger once per day via an Internet connection provided by the Site. The data are loaded into a database, checked for validity, and posted on the NYSERDA web site.

Onsite Installation

The Site (or its monitoring contractor) has installed a datalogger panel at a location in the cogeneration room agreeable to the site and developer. The monitoring system panel is approximately 2 ft x 2 ft x 1 ft. The panel is mounted near a 120 VAC power receptacle (it requires 1 amp or less). The panel and an expansion panel in the Mezzanine are conveniently located relative to the sensors listed above as well as the communications line provided by the site.

Communications

The datalogger is connected the Internet via a dedicated static IP address. CDH personnel (who maintain the NYSERDA CHP website) are able to access the logger for remote configuration purposes. The IP address of the datalogger is 209.133.55.252.

On Site Support

The Site will be responsible for providing access to all areas necessary for return trips to verify sensors or service the monitoring system.

3. Data Analysis

The collected data listed in Table 1 will be used to determine the net power output of the system as well as the fuel conversion efficiency (FCE).

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.), defined as:

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

Net Power Output

The generator power meters will measure the individual gross output of the three engine generators (WG1, WG2, WG3). The net power delivered (WG_{net}) is determined by subtracting the sum of the parasitic loads from the gross power output. Parasitic loads will be measured at the feed into DP-CHP-S (WPAR1) and at the feed into DP-CHP-N (WPAR2). A one-time measurement will be performed to determine the magnitude of the parasitic power use by either pump P-CHPHW-1 or P-CHPHW-2 (WPAR3).

$$WG_{net} = (WG1 + WG2 + WG3) - (WPAR1 + WPAR2 + WPAR3)$$

Heat Recovery Rates

The heat recovery rates will be calculated based on the one-minute data collected. The piping arrangement at this site allows for multiple heat rates to be determined with six (6) temperature sensors and two (2) flow reading on the heat recovery loops:

The rate of useful hot water loop heat recovery in Btu/h is defined as:

$$QU = K1 \times \frac{\sum_n [FL1 \times (TLS - TLR2)]}{n} + K2 \times \frac{\sum_n [FL2 \times (TLR3 - TLR4)]}{n}$$

The rate of rejected (unused) heat recovery in Btu/h is defined as:

$$QD = K2 \times \frac{\sum_n [FL2 \times (TLR4 - TLR5)]}{n}$$

where:	K1	=	~ 500 Btu/h-gpm-°F for pure water
	K2	=	~ 467 Btu/h-gpm-°F for 30% glycol at 180 °F
	n	=	Number of 1-minute intervals included in period of interest

The main heat recovery loop fluid is expected to be pure water, while the secondary unit heater and heat rejection loop is expected to be 30% polypropylene glycol. The factor K will be determined based on a periodic reading of the fluid properties with a refractometer to determine the glycol concentration as well as the operating temperature if necessary.

Any heat recovery measurement can be calculated for an interval sum (Btu) by the following:

$$Q_{int} = \sum_N Q \cdot \Delta t$$

where:	N	=	Number of intervals in in period of interest
	Δt	=	interval duration (hrs.)

In addition to the useful heat recovery and the dumped heat, the heat recovered for the specific loads can also be calculated using the equations above with different temperatures:

Heating Load	Flow Rate	Temperature Difference
North Tower DHW	FL1	TLS – TLR1
South Tower DHW	FL1	TLR1 – TLR2
Garage Unit Heaters UH-1 and UH-2	FL2	TLR3– TLR4

Calculated Quantities

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

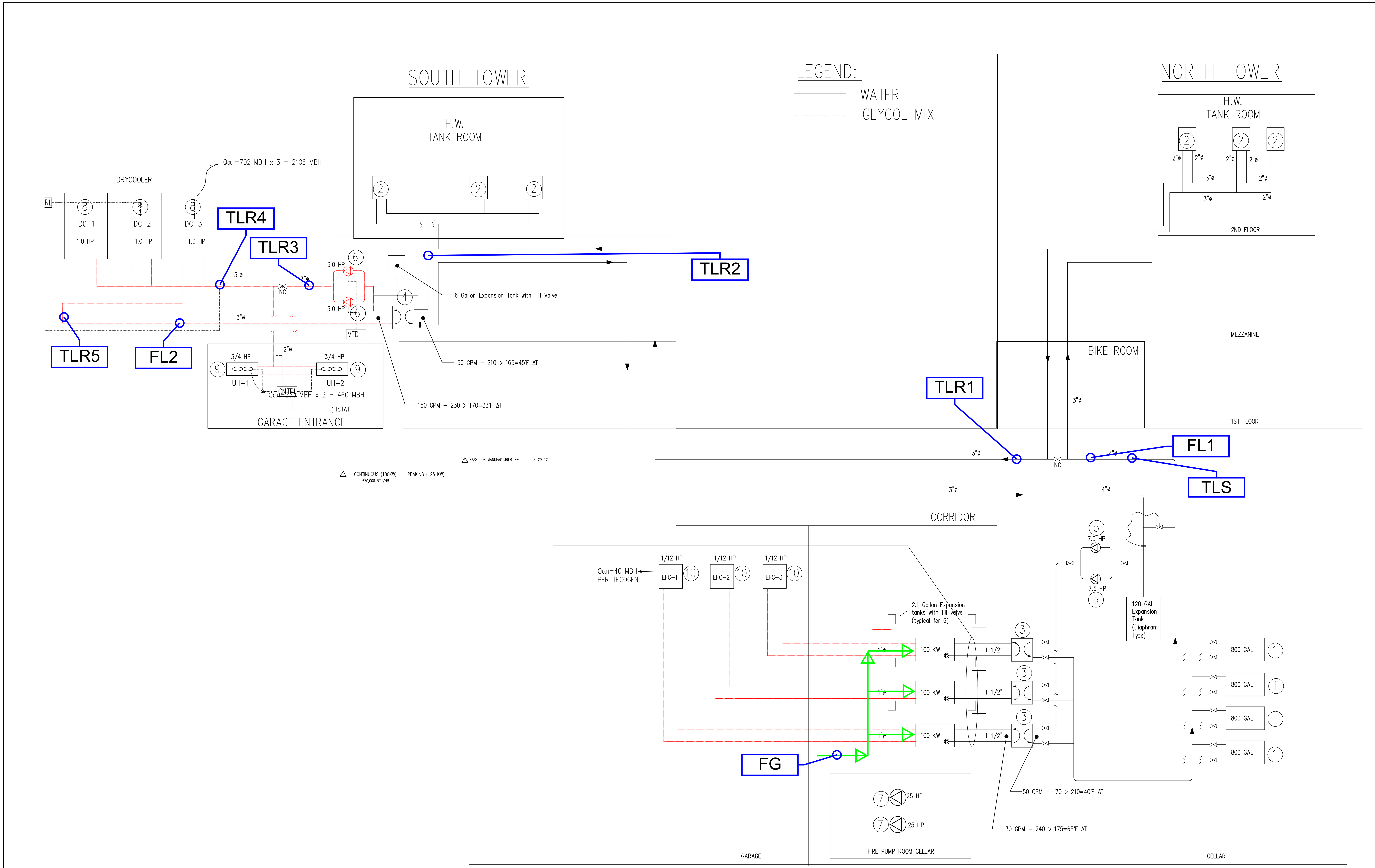
$$FCE = \frac{QU_{int} + 3{,}413 \times (WG_{net})}{0.9 \times HHV_{gas} \times FG}$$

where: QU_{int} = Useful heat recovery (Btu)
WG_{net} = Engine generator net output (kWh)
FG = Generator gas consumption (Std CF)
HHV_{gas} = Higher heating value for natural gas (~1030 Btu/CF)
Where 0.9 is the conversion factor between HHV and LHV

The FCE can be calculated for any time interval of interest (hourly, daily, monthly, etc.), depending on the resolution available for the gas meter reading.

Appendix A

System Schematic and Cut Sheets for Key Sensors and Instruments



NOTE:
ALL MECHANICAL WORK WILL CONFORM TO 2008 BUILDING CODE.

"THIS PLAN IS APPROVED ONLY FOR WORK INDICATED ON THE APPLICATION SPECIFICATION SHEET. ALL OTHER MATTERS SHOWN ARE NOT TO BE RELIED UPON, OR TO BE CONSIDERED AS EITHER BEING APPROVED OR IN ACCORDANCE WITH APPLICABLE CODES"

REVISIONS

NO.	DESCRIPTION	DATE
1	REVISED AS PER COMMENTS	09-5-12

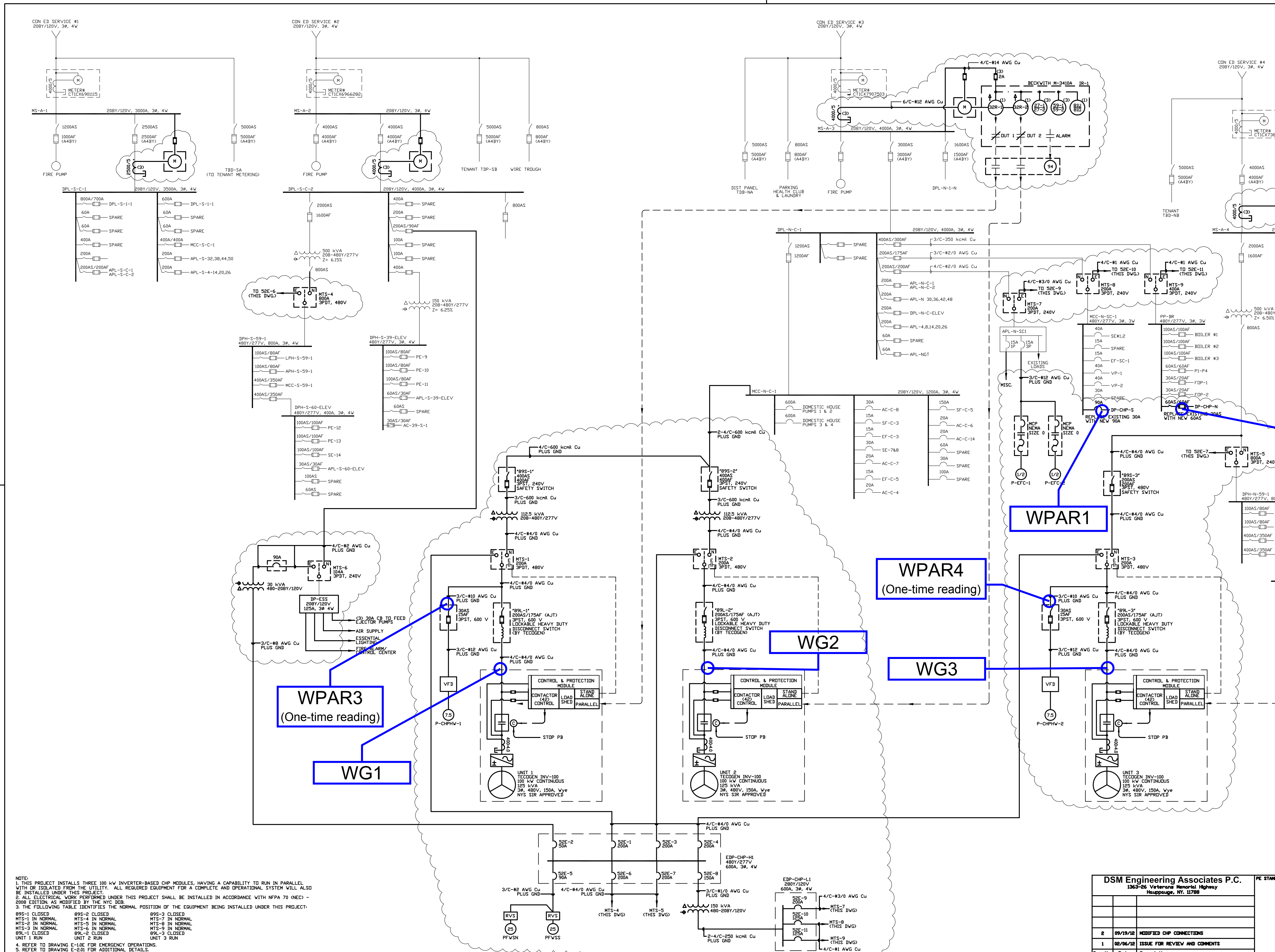
NO.	DATE	ISSUED	TO WHOM

KABACK ENTERPRISES
45 West 25th Street
New York, N.Y. 10010
KE

Job Name: SILVER TOWER COGEN
Address: 620 WEST 42ND STREET
NEW YORK, N.Y 10036

DATE: 08-08-12
DRAWN BY: A LAZZARO
SCALE: NONE
SEAL:
DRAWING NO: M-001.00
SHEET NO. 1 OF 3

M-001, 10/9/2012 3:15:53 PM, 1:1



NOTE:
1. THIS PROJECT INSTALLS THREE 100 kW INVERTER-BASED CHP MODULES, HAVING A CAPABILITY TO RUN IN PARALLEL WITH OR ISOLATED FROM THE UTILITY. ALL REQUIRED EQUIPMENT FOR A COMPLETE AND OPERATIONAL SYSTEM WILL ALSO BE INSTALLED UNDER THIS PROJECT.
2. ALL ELECTRICAL WORK PERFORMED UNDER THIS PROJECT SHALL BE INSTALLED IN ACCORDANCE WITH NFPA 70 (NEC) - 2008 EDITION. AS MODIFIED BY THE NYC DOB.
3. THE FOLLOWING TABLE IDENTIFIES THE NORMAL POSITION OF THE EQUIPMENT BEING INSTALLED UNDER THIS PROJECT:

89S-1 CLOSED	89S-2 CLOSED	89S-3 CLOSED
MTS-1 IN NORMAL	MTS-4 IN NORMAL	MTS-7 IN NORMAL
MTS-2 IN NORMAL	MTS-5 IN NORMAL	MTS-8 IN NORMAL
MTS-3 IN NORMAL	MTS-6 IN NORMAL	MTS-9 IN NORMAL
89L-1 CLOSED	89L-2 CLOSED	89L-3 CLOSED
UNIT 1 RUN	UNIT 2 RUN	UNIT 3 RUN

4. REFER TO DRAWING E-1.0E FOR EMERGENCY OPERATIONS.
5. REFER TO DRAWING E-2.01 FOR ADDITIONAL DETAILS.

LEGEND

27	Undervoltage Relay	AS/AF	Amp Switch/Amp Fuse (Fused disconnect)
32R	Reverse Power Relay	AF/AT	Amp Frame/Amp Trip (Circuit Breaker)
42	Contactor	(symbol)	Contactor
47	Phase Unbalance	(C)	Contactor Coil
50	Instantaneous Overcurrent	(O)	Open
51	Time Overcurrent	(M)	Metering Device
52	AC Circuit Breaker	(UVR)	Undervoltage Release
59	Overvoltage Relay	(CC)	Close Coil
81 U/O	Under/Over Frequency Relay	K—K	Key Interlock
89S	Line Switch	N.O.	Normally Open
89L	Lockable Load Break Switch	N.C.	Normally Close
94	Auxiliary Relay	O.O.S.	Out Of Service
(symbol)	Circuit Breaker (Drawout)	(symbol)	Inverter
(symbol)	Circuit Breaker (Fixed Mount)	(symbol)	Cloud Indicates Proposed New Work
(symbol)	Puller-head Fuse	(symbol)	Reactor
(symbol)	Fused Disconnect		
(symbol)	Twin Fused Disconnect		

NOT FOR CONSTRUCTION

DSM Engineering Associates P.C.
1363-26 Veterans Memorial Highway
Hauppauge, NY. 11788

Rev No.	Date:	Description
2	09/19/12	MODIFIED CHP CONNECTIONS
1	02/06/12	ISSUE FOR REVIEW AND COMMENTS

PE STAMP/SEAL

ONE-LINE DIAGRAM
SILVER TOWERS
300 kW DISTRIBUTED GENERATION
600 42nd STREET
NEW YORK, NY 10036

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

Drawn By:	Scale:	
KT	NONE	E-1.0

Continental Control Systems

WattNode®

Advanced Pulse Output AC Power Measurement

The WattNode is a true RMS AC watt-hour transducer with pulse output (solid state relay closure) proportional to kWH consumed. The WattNode provides accurate measurement at low cost to meet your needs for sub-metering, energy management and performance contract applications.

277/480 VAC 120/240

Easy Installation saves you time and money. The WattNode is small enough to fit entirely within a standard electrical panel and the screw terminals unplug for easy wiring.

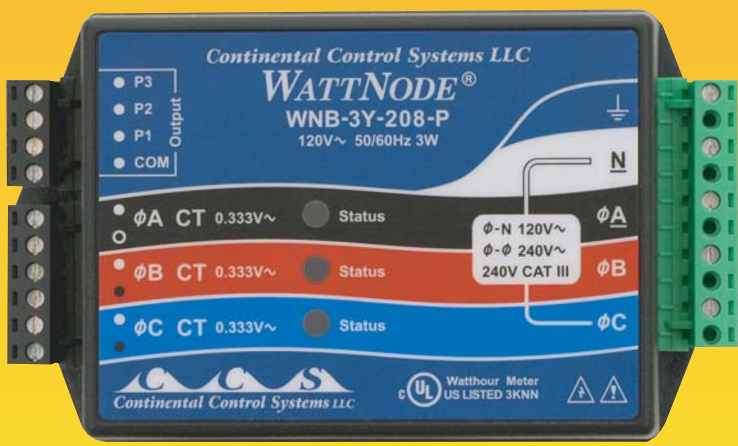
The Advanced Output includes separate pulse channels for positive and negative power, for net metering and PV metering. Optional models are available with one pulse output channel per measurement phase, which can be used to monitor each phase independently or to monitor three separate single-phase circuits with one WattNode.

Our Diagnostic LEDs provide a per-phase indication of power (green flashing), negative power (red flashing), and advanced diagnostics (yellow flashing) to help troubleshoot connection problems, like swapped CTs, or excessive line voltage. See the User's Guide for a full description.

The Pulse Series family measures 1, 2, or 3 phases in 2, 3 or 4 wire configurations. With voltage ratings from 120 to 600 VAC and current transformer (CT) rating from 5 to 4000 amps, there is a WattNode combination to meet your AC power measurement requirements.

Accuracy of the WattNode is is 0.5% of reading over a wide range of power factors and harmonic content. You get true kWH measurements even with switching power supplies and variable speed drives.

Our Safe CTs, with internal burden resistors produce a voltage proportional to the load current. At rated current voltage is only 0.333 VAC. Split-core CTs quickly install on existing wiring and solid-core CTs cost less for new wiring.



- **Advanced Pulse Output**
  Separate pulse channels for positive and negative power. Optional models are available with one pulse output channel per measurement phase.
- **Small Size**
  Can be installed in existing service panels or junction boxes.
- **Uses Safe CTs**
  Output limited to one volt.
- **Line Powered**
  No external power supply required.
- **Digital Signal Processing**
  Accurate kWH measurement over a wide harmonic range.
- **Detachable Terminal Blocks**
  Easy to install and remove.

C UL US LISTED

(888) 928-8663

Continental Control Systems LLC
3131 Indian Road, Suite A
Boulder, CO 80301 USA
(888) 928-8663 Fax (303) 444-2903
sales@ccontrolsys.com
www.ccontrolsys.com

SPECIFICATIONS

WattNode®

Advanced Pulse Output AC Power Measurement

Measurement Configurations
Single phase: 2-wire or 3-wire
Three phase: 3-wire or 4-wire

Electrical
Line Powered
Operating Voltage Range: +15%, -20% of nominal
Power Line Frequency: 50/60 Hz
CT Input: 0.333 VAC

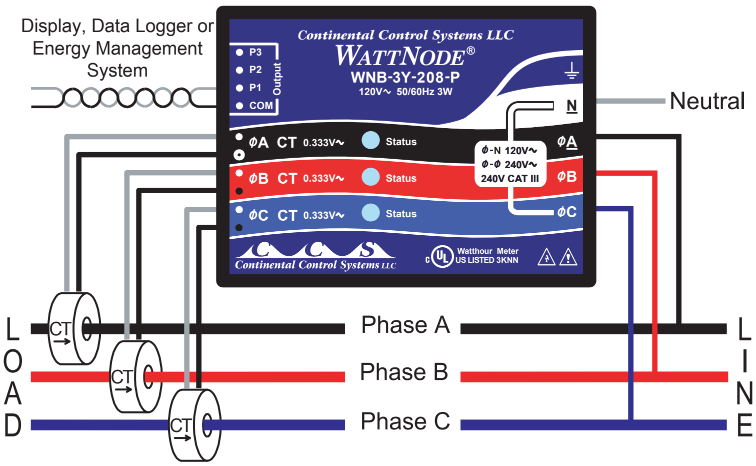
Pulse Output
Optoisolated, solid state relay closures handle up to maximum 60 VDC & to 5mA
Standard: 4.00 Hz Bidirectional Output
Optional: 0.01 Hz to 600 Hz Bidirectional Output Models
Optional: Per-Phase Output Models 0.01 Hz to 150 Hz available

Accuracy
Normal Operation: Line voltage: 80% - 115% of nominal
Power factor: 1.0
Frequency: 50- 60 Hz
Ambient Temperature: 25°C
Current: 5% - 100% of rated current
Accuracy: ±0.5% of reading

Environmental
Operating Temperature: -30°C to +55°C (-22°F to 131°F)
Operating Humidity: 5 to 90% (RH)

Mechanical
Enclosure: High impact, UL rated, ABS plastic
Size: 3.3” x 5.6” x 1.5”
Connectors: UL, CSA recognized, detachable, screw terminals (14AWG), 600V

Optional LCD Display
Display: Eight digits, each 0.43" high
Reset: Wired remote and configurable front panel button
Enclosure: Panel mount box, 2.95" x 1.52"
Battery: Lithium 2/3A, replace every four years



WattNode

Model	VAC Line To Neutral	VAC Line To Line	Phases	Wires
WNB-3Y-208-P	120	208-240	3	4
WNB-3Y-400-P	230	400	3	4
WNB-3Y-480-P	277	480	3	4
WNB-3Y-600-P	347	600	3	4
WNB-3D-240-P	120	208-240	3	3
WNB-3D-400-P	230	400	3	3
WNB-3D-480-P	277	480	3	3

LCD Displays

Model	Displays	Units
LCDA-E	Energy	WH, kWH, or MWH
LCDA-P	Power	W or kW
LCDA-EP	Energy & Power	WH, kWH, or MWH & W or kW

Opening Current Transformers (Split-Core)

Model	Inside Diameter	Rated Amps
CTS-0750	0.75"	5, 15, 30, 50, 70, 100, 150
CTS-1250	1.25"	70, 100, 150, 200, 250, 300, 400, 600
CTS-2000	2.00"	600, 800, 1000, 1200, 1500
CTB	Bus Bar	600, 800, 1200, 2000, 3000 (custom)

Toroidal Current Transformers (Solid-Core)

Model	Inside Diameter	Rated Amps
CTT-0300	0.30"	5, 15, 30
CTT-0500	0.50"	15, 30, 50, 60
CTT-0750	0.75"	30, 50, 70, 100
CTT-1000	1.00"	50, 70, 100, 150, 200
CTT-1250	1.25"	70, 100, 150, 200, 250, 300, 400

Current Transformer Output Voltage: 0 - 0.333 VAC @ rated current

MADE IN THE USA

(888) 928-8663

Continental Control Systems
3131 Indian Road, Suite A
Boulder, CO 80301
(888) 928-8663 Fax (303) 444-2903
sales@ccontrolsys.com
www.ccontrolsys.com

• F-1211 DUAL TURBINE •
INSERTION FLOW METER
ISOLATED ANALOG OUTPUT

ONICON INCORPORATED

Made in the USA

DESCRIPTION

ONICON insertion turbine flow meters are suitable for measuring electrically conductive water-based liquids. The F-1211 model provides isolated 4-20 mA and 0-10 V analog output signals that are linear with the flow rate.

APPLICATIONS

- Closed loop chilled water, hot water, condenser water & water/glycol/brine solutions for HVAC
- Process water & water mixtures
- Domestic water

GENERAL SPECIFICATIONS

ACCURACY
± 0.5% of reading at calibrated velocity
± 1% of reading from 3 to 30 ft/s (10:1 range)
± 2% of reading from 0.4 to 20 ft/s (50:1 range)

SENSING METHOD
Electronic impedance sensing
(non-magnetic and non-photoelectric)

PIPE SIZE RANGE
2½” through 72” nominal diameter

SUPPLY VOLTAGE
24 ± 4 V AC/DC at 100 mA

LIQUID TEMPERATURE RANGE
Standard: 180° F continuous, 200° F peak
High Temp: 280° F continuous, 300° F peak
Meters operating above 250° F require 316 SS construction option

AMBIENT TEMPERATURE RANGE
-5° to 160° F (-20° to 70° C)

OPERATING PRESSURE
400 PSI maximum

PRESSURE DROP
Less than 1 PSI at 20 ft/s in 2½” pipe, decreasing in larger pipes and lower velocities

OUTPUT SIGNALS PROVIDED
Analog Output (isolated)
Voltage output: 0-10 V (0-5 V available)
Current output: 4-20 mA
Frequency Output
0 – 15 V peak pulse, typically less than 300 Hz

(continued on back)

CALIBRATION

Every ONICON flow meter is wet calibrated in our flow laboratory against primary volumetric standards that are directly traceable to N.I.S.T. A certificate of calibration accompanies every meter.

FEATURES

Unmatched Price vs. Performance - Custom calibrated, highly accurate instrumentation at very competitive prices.

Excellent Long-term Reliability - Patented electronic sensing is resistant to scale and particulate matter. Low mass turbines with engineered jewel bearing systems provide a mechanical system that virtually does not wear.

Industry Leading Two-year “No-fault” Warranty - Reduces start-up costs with extended coverage to include accidental installation damage (miswiring, etc.) Certain exclusions apply. See our complete warranty statement for details.

Simplified Hot Tap Insertion Design - Standard on every insertion flow meter. Allows for insertion and removal by hand without system shutdown.

OPERATING RANGE FOR COMMON PIPE SIZES
0.17 TO 20 ft/s
±2% accuracy begins at 0.4 ft/s

Pipe Size (Inches)	Flow Rate (GPM)
2 ½	2.5 - 230
3	4 - 460
4	8 - 800
6	15 - 1,800
8	26 - 3,100
10	42 - 4,900
12	60 - 7,050
14	72 - 8,600
16	98 - 11,400
18	120 - 14,600
20	150 - 18,100
24	230 - 26,500
30	360 - 41,900
36	510 - 60,900

1500 North Belcher Road, Clearwater, FL 33765 • Tel (727) 447-6140 • Fax (727) 442-5699
www.onicon.com • sales@onicon.com

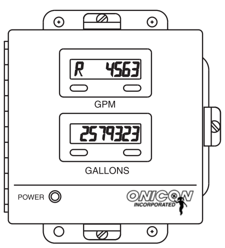
F-1211 SPECIFICATIONS cont.

MATERIAL
Wetted metal components:
Standard: Electroless nickel plated brass
Optional: 316 stainless steel

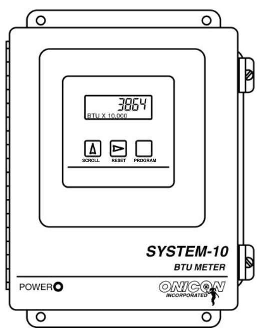
ELECTRONICS ENCLOSURE
Standard: Weathertight aluminum enclosure
Optional: Submersible enclosure

ELECTRICAL CONNECTIONS
4-wire minimum for 4-20 mA or 0-10 V output
Second analog output and/or frequency output requires additional wires
Standard: 10’ of cable with ½” NPT conduit connection
Optional: Indoor DIN connector with 10’ of plenum rated cable

ALSO AVAILABLE



Display Modules



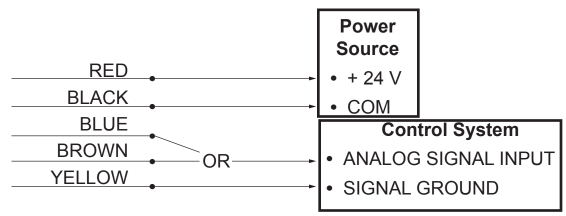
Btu Measurement Systems

F-1211 Wiring Information

WIRE COLOR	DESCRIPTION	NOTES
RED	(+) 24 V AC/DC supply voltage, 100 mA	Connect to power supply positive
BLACK	(-) Common ground (Common with pipe ground)	Connect to power supply negative
GREEN	(+) Frequency output signal: 0-15 V peak pulse	Required when meter is connected to local display or Btu meter
BLUE	(+) Analog signal: 4-20 mA (isolated)	Use yellow wire as (-) for these signals. Both signals may be used independently.
BROWN	(+) Analog signal: 0-10 V (isolated)	
YELLOW	(-) Isolated ground	Use for analog signals only
DIAGNOSTIC SIGNALS		
ORANGE	Bottom turbine frequency	These signals are for diagnostic purposes - connect to local display or Btu meter
WHITE	Top turbine frequency	

F-1211 Wiring Diagram

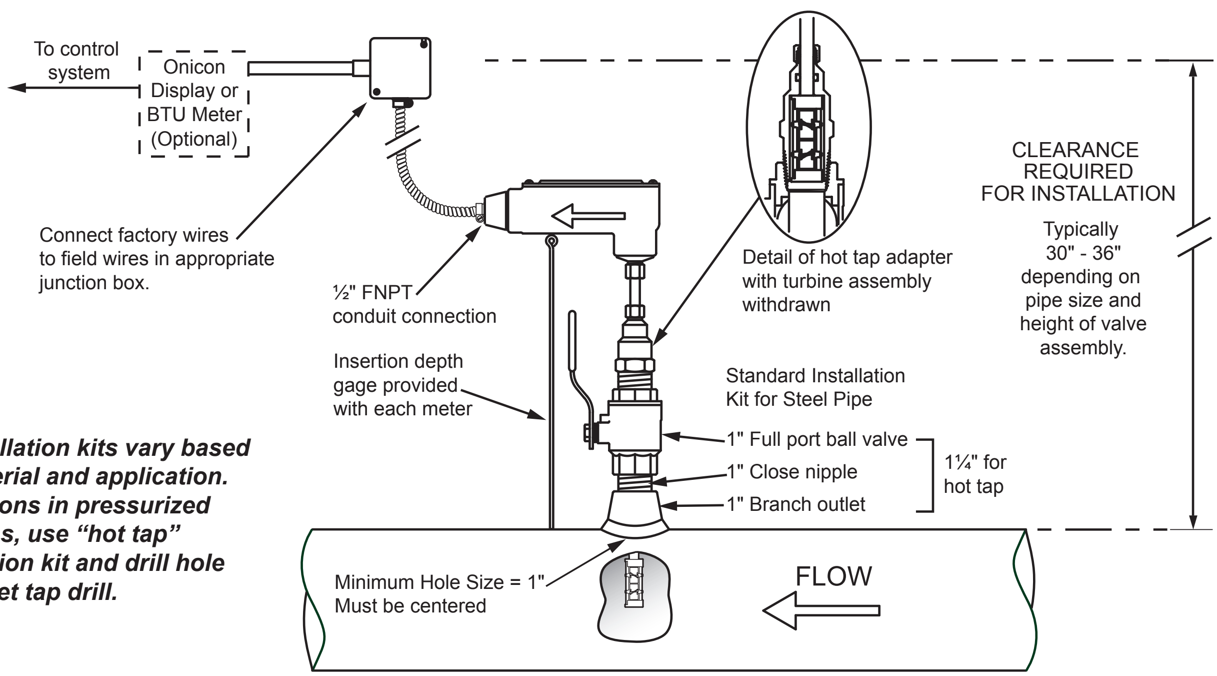
Flow meter in control system (no display or Btu meter)



NOTE: ***1. Black wire is common with the pipe ground (typically earth ground.)***
2. Frequency output required for ONICON display module or Btu meter, refer to wiring diagram for peripheral device.

Typical Meter Installation
(New construction or scheduled shutdown)

- Acceptable to install in vertical pipe
- Position meter anywhere in upper 240° for horizontal pipe

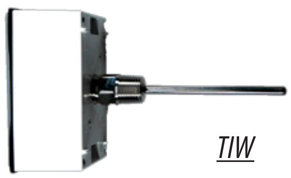


NOTE: Installation kits vary based on pipe material and application. For installations in pressurized (live) systems, use “hot tap” 1¼” installation kit and drill hole using a 1” wet tap drill.

TI SERIES

TID

TIG



TIW

TIH

NOTICE

- This product is not intended for life or safety applications.
- Do not install this product in hazardous or classified locations.
- Read and understand the instructions before installing this product.
- Turn off all power supplying equipment before working on it.
- The installer is responsible for conformance to all applicable codes.

TI SERIES

Immersion Temperature Sensors

Installer's Specifications

Wiring		22AWG; 2-wire:RTD Thermistor, 4-20mA; 3-wire: Voltage output models
Probe		Stainless Steel
Test Pressure		200psi
Linitemp:		
Input Power		5 to 30VDC
Output		1µA/°C or 10mV/°C
Operating Temperature		-25° to 105°C (-13° to 221°F)
Accuracy	Calibration Error:	1.5°C (35°F) typical; 2.5°C (37°F) max. at 25°C (77°F)*
	Error over Temperature:	1.8°C typical (35°F); 3.0°C (34°F) max. over 0° to 70°C (32° to 158°F) range
		2.0°C (35°F) typical, 3.5°C (38°F) max. over -25° to 105°C (-13° to 221°F) range

**Room temperature error documented on each unit.*

QUICK INSTALL

1. Thread assembly into a pipe fitting.
2. Wire as shown (see Wiring section).

PRODUCT IDENTIFICATION

TI □ □ □ □ □ □

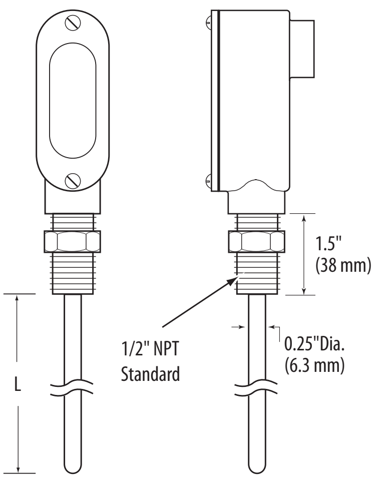
Enclosure	Immersion Probe Length "L"	Thermowell	Sensor Type	Options: Cal Certificate	Options: Threads
D = Duct	A = 2 1/2" (64mm)	0 = None	B = 100R Platinum, RTD	0 = None	Blank = NPT
G = Service Entry Body	B = 4" (102mm)	1 = Add Thermowell	C = 1k Platinum, RTD	1 = 1 point Cal validation	A = BSPT
H = Threaded NPT Only	C = 6" (152mm)		D = 10k T2, Thermistor	2 = 2 point Cal validation	B = DIN 2999
W = Water resistant housing	D = 8" (203mm)		E = 2.2k, Thermistor		
	E = 12" (305mm)		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		

Thermowell Sizing

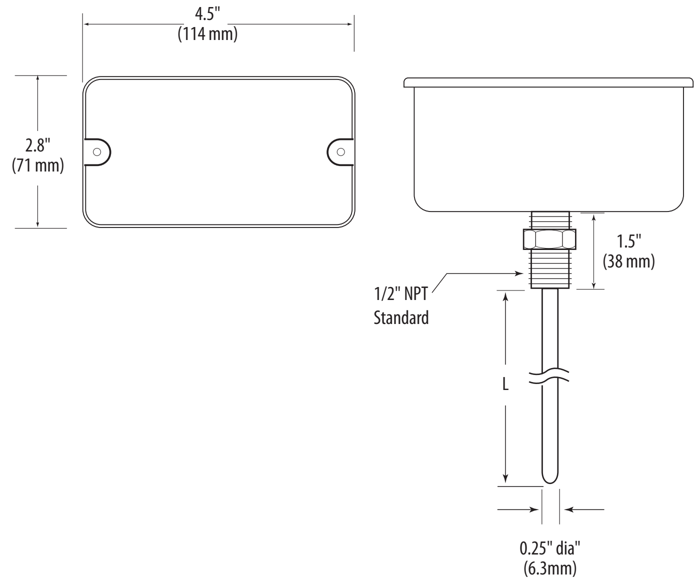
	Probe Length	Thermowell Length
A	(2 1/2") (64mm)	1 1/2" (38mm)
B	(4") (102mm)	3" (76mm)
C	(6") (152mm)	5" (127mm)
D	(8") (203mm)	7" (178mm)
E	(12") (305mm)	11" (279mm)

DIMENSIONS

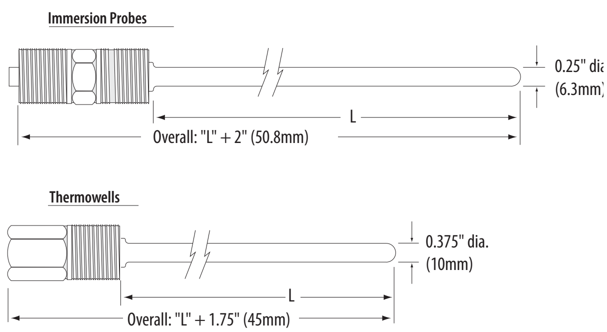
TIG Model



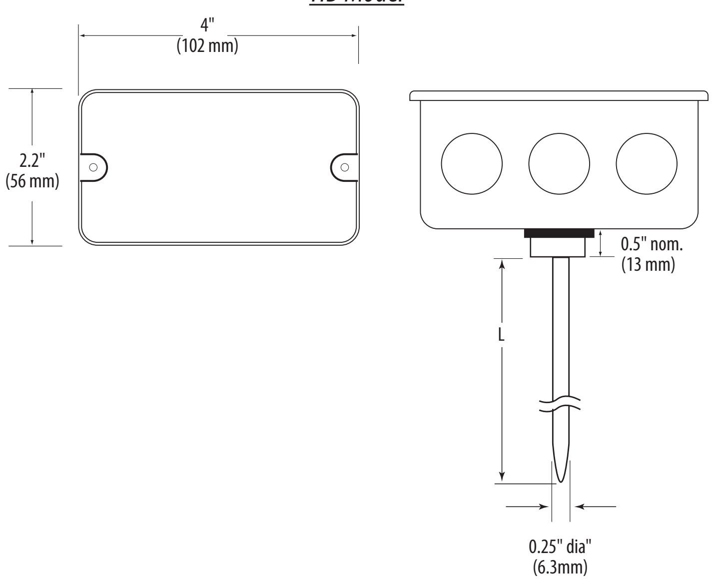
TIW Model



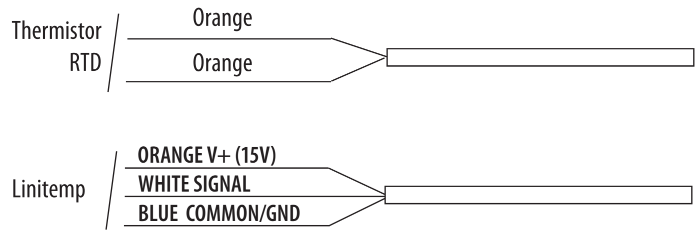
TIH Model



TID Model

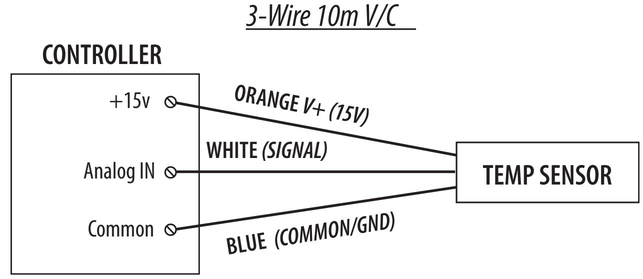


WIRING

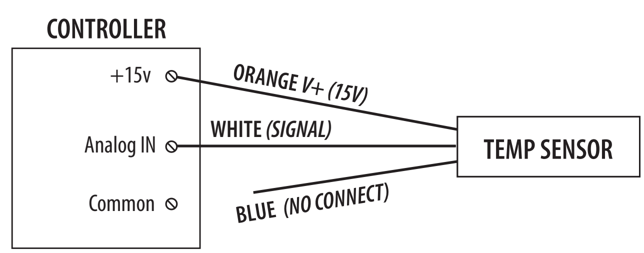


NOTE: All linitemp units are standard 3-wire 10m V/C. For 1µ A/C (2-wire) connect +15V (orange) and (white) signal wire. The (blue) wire is not connected.

3-Wire 10m V/C



2-Wire 1µ A/C



Addendum to Silver Towers Measurement and Verification Plan

Silver Towers
620 West 42nd St.
New York, NY 10036

Site Contact

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127 Livingston Street
Brooklyn, NY 11201
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Tel: 718-522-3736

- CDH was on site January 17, 2013 to begin the monitoring rough-in.
  - CDH Energy mounted the Obvius Acquisuite A8812 datalogger in the enclosure.
    - 120VAC power terminated in the CDH fuse/terminal block
    - 120 VAC power cable terminated in the breaker panel CP-CHP-N and labeled on the breaker card.
    - 4-gang outlet removed from the datalogger enclosure.
    - Currently a switch outside the panel controls power to the datalogger and the other equipment.
  - Wires pulled from three sensors (flow meter FL1, temperature sensors TLS and TLR1) terminated on both ends
    - Thermistors TLS, TLR1 replaced with calibrated thermistors
    - Wire pulled from gas meter terminated in the Obvius datalogger
      - location of the gas meter was not verified.
    - No wires pulled from the parasitic electrical load sensors (the WattNodes) and CTs had not been installed.
  - The 6-conductor wire pulled from the expansion board enclosure to the main datalogger enclosure was verified, and terminated on both ends.
    - The wires pulled to expansion board from five sensors (flow meter FL2, temperature sensors TLR2, TLR3, TLR4, and TLR5) terminated on both ends.
    - Thermistors TLR4 and TLR5 replaced with calibrated thermistors.
    - Thermistors TLR2 and TLR3 not replaced with calibrated thermistors because the thermistors could not be removed from those thermowells.
  - No 18g TSP wire had been pulled from the Tecogen Inverde units to the main datalogger panel.
  - Cat5 wire has been pulled to the Ethernet modem in the panel for Tecogen to communicate with the units.
  - The datalogger was able to access the Internet and upload data using DHCP, but a static IP was not established.

- CDH was on site February 12, 2013 to verify sensor locations and readings and finish the monitoring installation
  - o Flow meter FL1 verified using the Portaflow meter.
    - ▪ The flow meter was installed on 3" diameter copper type L tubing instead of 4" diameter tubing, so the flow meter range was adjusted accordingly.
      - The new range is 0-85.711 gpm.
  - o The gas meter wiring was terminated, and the pulse confirmed to be 1000cf/pulse.
  - o The datalogger was able to establish a static IP and access the Internet to upload data.
    - ▪ Remote access of the datalogger for maintenance and repair is now possible.
  - o The parasitic electrical load sensors (the WattNodes) and CTs have been installed.
    - ▪ 70A CTs installed on the parasitic load panel in the CHP room (DP-CHP-N)
    - ▪ 100A CTs installed on the parasitic load panel in the Mezzanine (DP-CHP-S).
  - o Thermistors TLR2, TLR3, and TLR5 were verified using the Fluke temperature sensor.
  - o Flow meter FL2 was not verified because the Portaflow mete was not able to establish a signal, possibly due to particulate in the flow.
  - o The Modbus connections to the Tecogen INV-100 units was established (in a star pattern) and was confirmed to successfully transmit generator power data.

Summary

All Systems Cogen purchased and installed all metering. CDH provided and installed an AcquiSuite Obvius data logger to record and send out data.

Networking Information

Silver Towers has provided a network connection for the logger. The logger is located on an Ethernet connection:

- Public Static IP – 209.133.55.252
- Subnet – 255.255.255.0
- Local Static IP – 192.168.1.53 (port 4003)
- FTP Ports – 20 and 21
- SSH Port – 22
- HTTP Port – 80

The data logger IP address is 192.168.1.53. The connection allows transmission out to the public internet.

Monitored Data Points

Data Point	Description	Units	Instrument / Sensor	Output Type	Location
WG1	CHP Generator #1 Electrical Output	kW	Tecogen Inverde Sensor	Modbus RTU	At each generator
WG2	CHP Generator #2 Electrical Output	kW	Tecogen Inverde Sensor	Modbus RTU	
WG3	CHP Generator #3 Electrical Output	kW	Tecogen Inverde Sensor	Modbus RTU	
WPAR1	Parasitic Load DP-CHP-S Electrical Consumption	kW	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-S (Mezzanine)
WPAR2	Parasitic Load DP-CHP-N Electrical Consumption	kW	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-N (CHP Room)
WPAR1_ACC	Parasitic Load DP-CHP-S Electrical Consumption (Accumulator)	kWh	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-S (Mezzanine)
WPAR2_ACC	Parasitic Load DP-CHP-N Electrical Consumption (Accumulator)	kWh	WattNode WNB-3Y-208-P	Pulse	In panel DP-CHP-N (CHP Room)
FG_ACC	Combined Generator Fuel Input (Accumulator)	CF	Utility Meter	Pulse	Meter dedicated to Generators
FL1	Main (Hot Water) Heat Recovery Loop Flow Rate	GPM	Onicon F1211 Range 0-180 gpm	Analog	Insertion flow meter on hot water loop in hallway near engines
TLS	Heat Recovery Loop Supply Temperature (Hot Water Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	Immersion temperature sensors (2) on hot water loop in hallway near engines
TLR1	Heat Recovery Loop Return Temperature from North Tower DHW Pre-Heat (Hot Water Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	
TLR2	Heat Recovery Loop Return Temperature from South Tower DHW Pre-Heat (Hot Water Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	Immersion temperature sensor on hot water loop in Mezzanine
FL2	Unit Heater / Drycooler (Glycol) Heat Recovery Loop Flow Rate	GPM	Onicon F1211 Range 0-180 gpm	Analog	Insertion flow meter on glycol loop in Mezzanine
TLR3	Heat Recovery Loop Supply Temperature to Unit Heaters (Garage Entrance) UH-1 and UH-2 (Glycol Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	Immersion temperature sensors (3) on glycol loop in Mezzanine
TLR4	Heat Recovery Loop Return Temperature from UH-1 and UH-2 (Glycol Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	
TLR5	Heat Recovery Loop Return Temperature from Drycoolers (Glycol Loop)	deg F	Veris TI 10k T2 Thermistor	Analog	

Procedure

- Power measurements were made with a Fluke 39 handheld meter from phase to phase (p-p) and phase to neutral (p-n) and were compared to the power recorded by the data acquisition system (DAS).
  - Generator power measurements have not been verified.
  - Parasitic loads were measured on the CTs in the parasitic load panels.

- Temperatures were measured using a Fluke 51-II and a surface probe and were compared to the temperatures recorded by the data acquisition system (DAS).
  - All temperature measurements were taken from the surface of the copper piping.

- The hot water loop flow rate (FL1) was verified using a Portaflow ultrasonic flow meter, mounted on a straight section of the return piping. This verification was performed on February 12, 2013.

  - The Portaflow meter was mounted on 3 inch Type L Copper piping. The outside diameter (OD) of the piping was 3.125 inches and the piping had a thickness of 0.090 inch.

- The Onicon flow meter had been programed for 4 inch piping, so a geometric correction was applied to determine the true flow rate being measured by the Onicon meter. $\left(FL_{3"True} = \frac{A_{3"True}}{A_{4"}} \times FL_{4"}\right)$ Using that equation, the true range of the Onicon flow meter has been set as 0 – 85.7 gpm. The Onicon meter was seated by bottoming it out in the 3 inch pipe and then pulling it back ¼ inch.

- The glycol loop flow rate in the Mezzanine (FL2) was not verified. The Portaflow meter could not establish a signal through the piping.

- Natural gas verification has not been performed as of February 12, 2013.

Verification Data – February 12, 2013

Parasitic Power WPAR1:

Phase to Ground

WPAR1 - Phase to Ground	
Fluke Power Meter	DAS
Total (kW)	**Total (kW)**
3.1	**3**

Parasitic Power WPAR2:

Phase to Ground

WPAR2 - Phase to Ground					
	Fluke Power Meter				DAS
	Blue -> Ground (kW)	Red -> Ground (kW)	Black -> Ground (kW)	**Total (kW)**	**Total (kW)**
kW	1	220	27	**248**	**246.1**

Parasitic Power WPAR3 (One-Time Measurement):

Phase to Phase and Phase to Neutral

WPAR3 - Pump P-CHPHW-1 or -2 - Fluke Power Meter						
Phase to Phase			**Phase to Neutral**			
Yellow -> Brown (kW)	Orange -> Brown (kW)	**Total (kW)**	Yellow -> Ground (kW)	Orange -> Ground (kW)	Brown -> Ground (kW)	**Total (kW)**
3.6	3	**6.6**	2.2	2	2.2	**6.4**
(480 V)		Amps	11.4	10.5	11.5	

Temperatures:

TLR2		
Fluke Temp (°F)	DAS (°F)	**Delta (°F)**
128.3	129.6	-1.30
128.4	129.6	-1.20
128.1	129.5	-1.40
127.9	129.3	-1.40
128.5	129.2	-0.70
128.6	129.15	-0.55
128.5	129.1	-0.60
128.6	129	-0.40
128.7	128.9	-0.20
	Average (°F)	**- 0.8611**
Offset TLR2 : - 0.8611 °F		

TLR3		
Fluke Temp (°F)	DAS (°F)	**Delta (°F)**
99.5	104.03	-4.53
99.7	104.63	-4.93
100.1	105.75	-5.65
102.9	106.9	-4.00
105.2	108.4	-3.20
105.3	110.62	-5.32
106.3	111.73	-5.43
107.3	112.9	-5.60
107.9	113.9	-6.00
108.5	114.8	-6.30
109.4	115.01	-5.61
110.3	116.5	-6.20
	Average (°F)	**- 5.2308**
Offset TLR3 : - 5.2308 °F		

TLR5 - Thermistor #2-42		
Fluke Temp (°F)	DAS (°F)	**Delta (°F)**
122.1	122.92	-0.82
122.3	123.30	-1.00
122.5	123.30	-0.80
122.9	123.55	-0.65
123.3	123.60	-0.30
123.7	123.90	-0.20
124	124.20	-0.20
124.1	124.34	-0.24
124.3	124.53	-0.23
124.5	124.75	-0.25
	Average (°F)	**- 0.4690**
Calibration	**Mult**	**Offset**
	0.99613	**+ 0.7364**
Adjustment : 0.9961 * d.TLR5 + 0.7364		

TLS - Thermistor #2-35		
Verification not performed on TLS because the thermistor was calibrated before installation.		
Calibration	**Mult**	**Offset**
	0.98907	**+ 0.9054**
Adjustment : 0.9891 * d.TLS + 0.9054		

TLR1 - Thermistor #2-38		
Verification not performed on TLS because the thermistor was calibrated before installation.		
Calibration	**Mult**	**Offset**
	0.99291	**+ 0.6356**
Adjustment : 0.9929 * d.TLR1 + 0.6356		

TLR4 - Thermistor #2-41		
Verification not performed on TLS because the thermistor was calibrated before installation.		
Calibration	**Mult**	**Offset**
	0.99441	**+ 0.9280**
Adjustment : 0.9944 * d.TLR4 + 0.928		

Flows:

FL1 - Range 0 - 85.7 gpm		
Portaflow (gpm)	DAS (gpm)	**Delta (gpm)**
49.1	*53.3*	-4.21
49.4	*53.8*	-4.43
49.4	*53.5*	-4.08
50.0	*53.6*	-3.57
49.2	*53.7*	-4.54
49.9	*53.4*	-3.50
48.8	*53.3*	-4.51
49.1	*52.7*	-3.61
49.0	52.5	-3.50
47.5	52.5	-5.00
	Average (gpm)	**- 4.0956**
Offset FL1 : - 4.0956 gpm		

FL2 - Range 0 - 150 gpm		
Portaflow (gpm)	DAS (gpm)	**Delta (gpm)**
Verification not performed on FL2 because the portaflow meter could not establish a signal, possibly due to particulate in the flow.		
	Average (gpm)	**+ 0.0000**
Offset FL2 : + 0 gpm		