MEASUREMENT AND VERIFICATION PLAN

FOR

DG/CHP SYSTEM AT CLARKSON UNIVERSITY

Revised
December 22, 2008

Submitted to:

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1. Introduction

The CHP system at Clarkson University consists of three (3) 65-kW Carrier microturbines and a Carrier absorption chiller packaged onto a Carrier Pure Comfort system (Figure 1). The turbines have a combined gross output of 195 kW. The system uses heat from the turbine exhaust to drive an absorption chiller/heater that provides chilled and hot water to two buildings on campus. The system has a maximum chilled water output of 100-125 tons, and a maximum hot water output of 798 MBtu/h. No dump radiator is utilized for rejection of excess heat, instead turbine exhaust is bypass around the chiller.

The primary building served by the CHP system is the infill addition called the Technology Advancement Center, between the Education Research Center and the Science Center (Figure 2).

Figure 1. Microturbines and Chiller Building

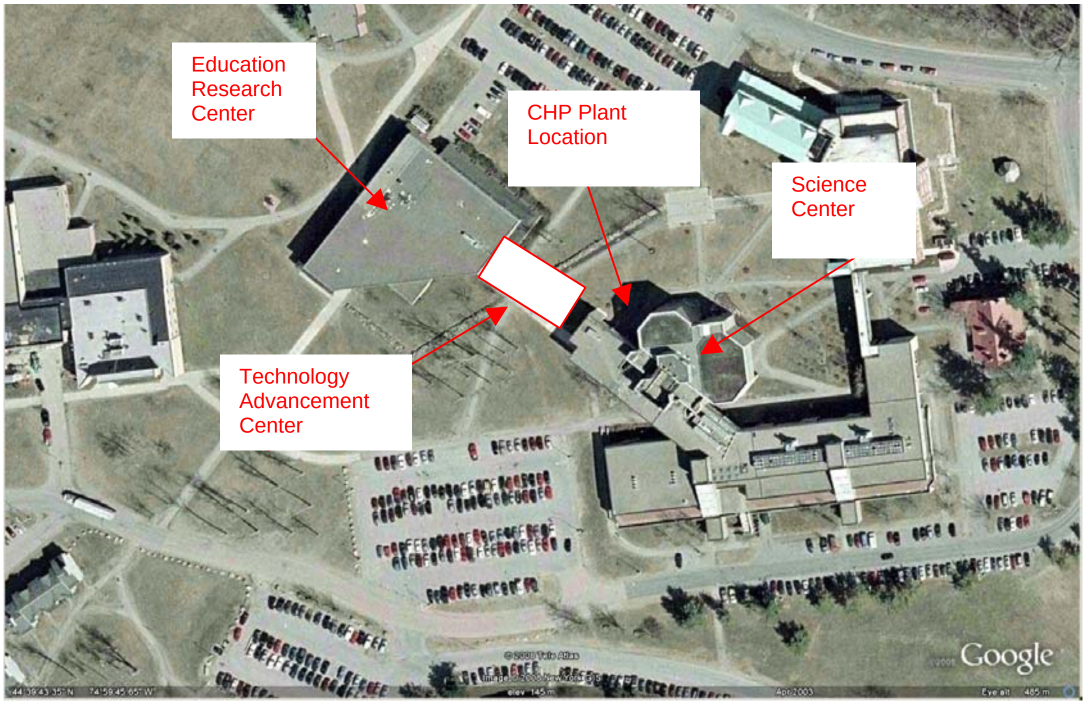


Figure 2. Site Overview

Figure 3. TAC Infill Addition

The CHP system provides electricity, hot and chilled water to the Technology Advancement Center (TAC). Hot water is also provided to the science center as backup for the campus hot water system (but manual tie in valves are operated for this configuration). Also excess electricity (above what the TAC requires) is provided to the Science Center building and to the remainder of the campus, although export beyond the science center is highly unlikely.

Electrical interconnection of the CHP system to the TAC and Science Center buildings are shown in Figure 4. The system will operate in grid parallel mode to meet the full electrical needs of the TAC and partial electrical needs of the Science Center. During a utility outage, the dual mode controller will drop the connection to the Science Center and power the entire TAC building as an emergency load. A manual transfer switch allows the TAC to be powered off the grid while the CHP system is down for any reason.

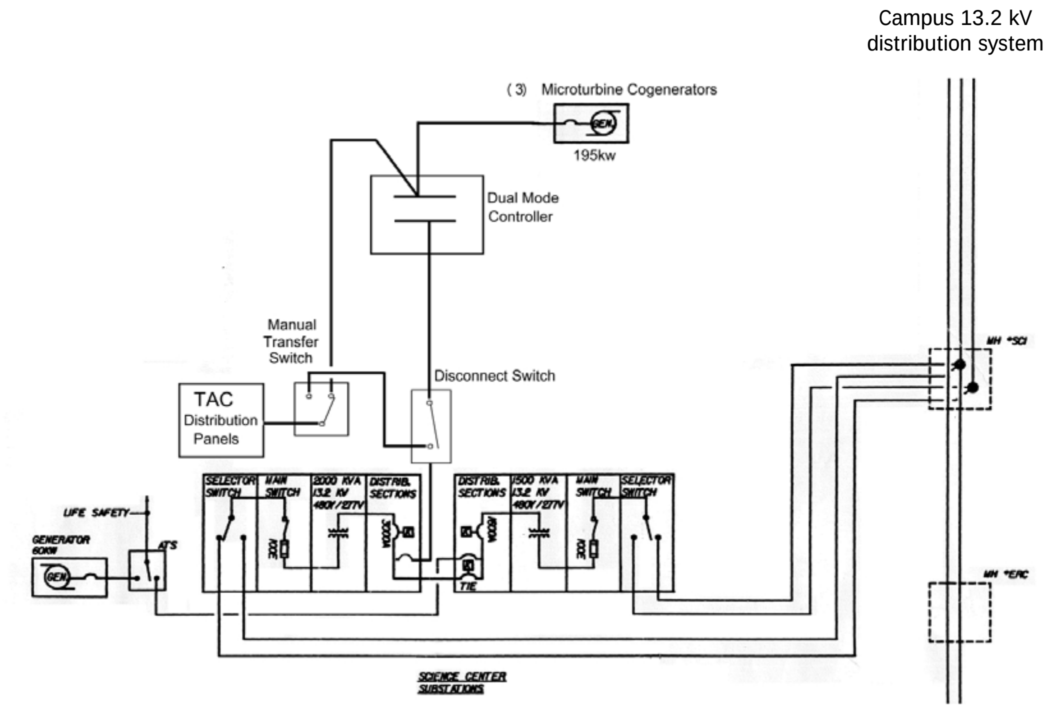


Figure 4. Electric Interconnection Schematic

Hot and chilled water produced by the system are piped directly into common supply and return headers in each building. The chilled water headers in each building are also connected to the campus central chilled water loop, for backup purposes. Hot water piping is confined to each building, but is connected to the campus steam system for supplemental heat. Figure 5 displays a process-piping diagram of the CHP system, showing the connections to the two buildings, (but not the piping arrangement inside the buildings).

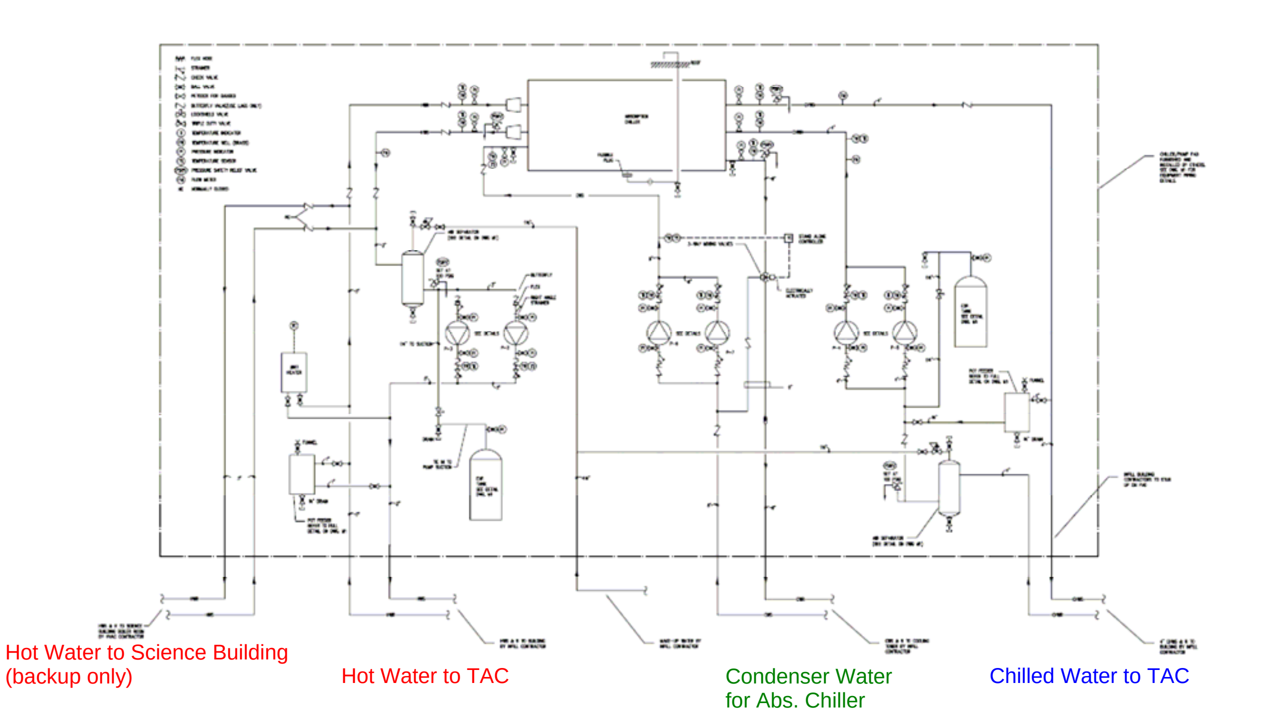


Figure 5. CHP System Process-Piping Diagram

2. Instrumentation and Data Logging

Monitoring of system performance will be accomplished using the Siemens Building Management System as a front end for two back-end instrumentation systems; the Carrier Remote Monitoring System (RMS); and a Trane Building Management System. Both the RMS and Trane system will communicate individual sensor readings to the Siemens BMS using BACNet.

Table 1 lists the data points to be collected, and the associated instrumentation used to measure with. All instrumentation with the exception of the system parasitic power (WPAR) is installed, and field verified that it is in the proper location.

Table 1. Instrumentation and Data Points for Performance Monitoring

Point	Instrument	Output Type	Sensor Location	Notes
Facility Power	N/A	N/A	N/A	• Data Point WT • 15-minute interval data for campus electricity consumption to be collected directly from National Grid
Generator Power Output	Shark –100 DG Meter	Full data stream (kW, kWh used) Modbus RTU (COM2)	CHP Main Service Panel (DP-MTA)	• Data points WG • Terminated on RMS RS485
System Parasitic (Combined)	Veris H8043-300	4-20 mA	Main service of DP-MT	• Data point WPAR • Terminated on Trane BMS
Generator Gas Input	Gas Flow Meter (GF01)	4-20 mA 0-310 lb/h 0-6,200 CF/h	On gas main service to CHP system, on standard pressure line	• Data points FGM • Terminated on RMS CH1
Chilled water loop flow rate	SDI Insertion Flow Meter	4-20 mA	On hot water supply leaving chiller	• Data point FCHW • Terminated on RMS CH2
Chilled water loop temperature	Chiller on-board temperature sensor(s)	BACnet read from chiller PLC	Chilled water supply/return connections at chiller	• TCHWS, TCHWR • Terminated on chiller PLC
Hot water loop flow rate	SDI Insertion Flow Meter	4-20 mA	On hot water supply leaving chiller	• Data point FHW • Terminated on RMS CH7
Hot water loop temperature	Chiller on-board temperature sensor(s)	BACnet read from chiller PLC	Hot water supply/return connections at chiller	• THWS, THWR • Terminated on chiller PLC

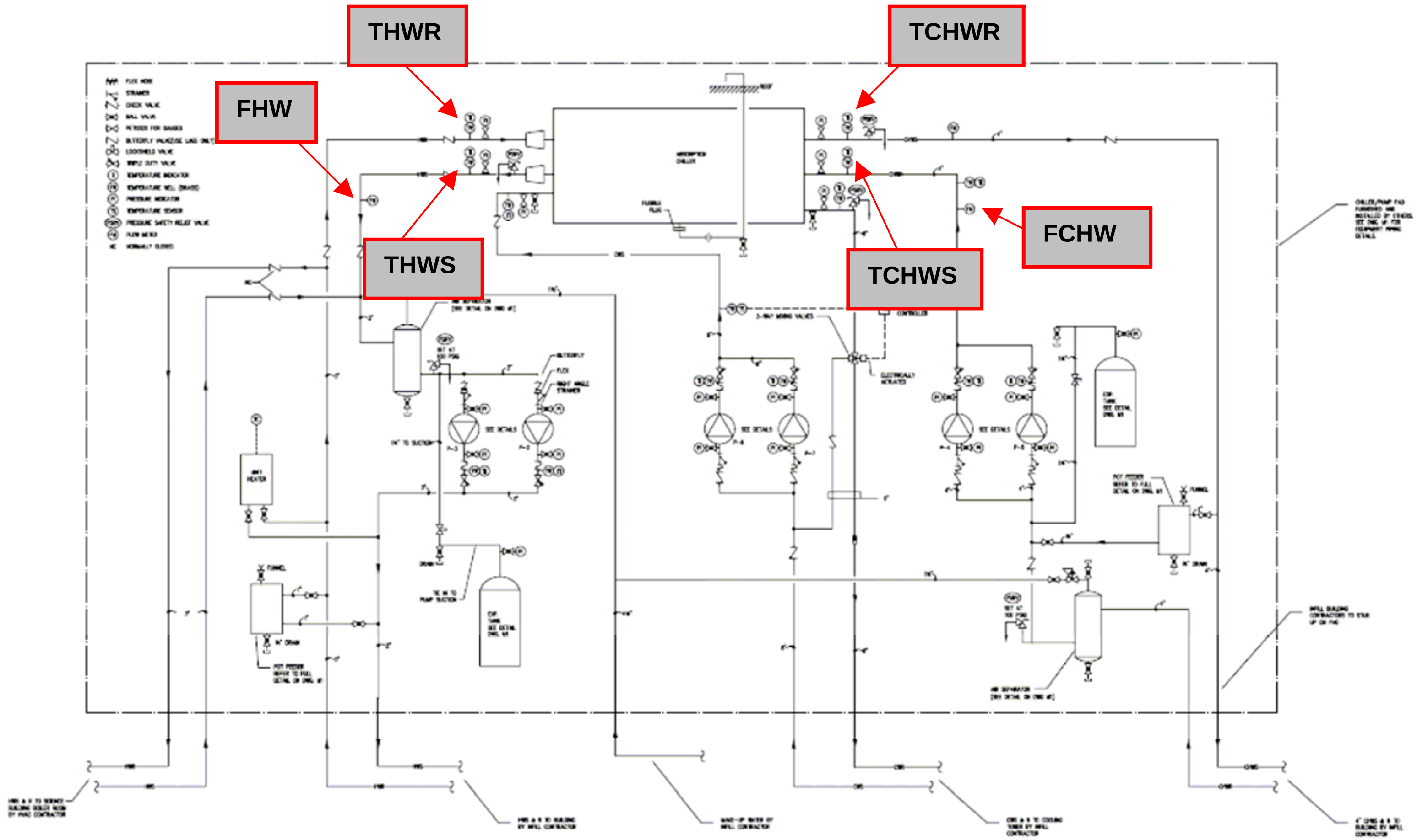


Figure 6. Heat Recovery Temperature and Flow Sensor Locations

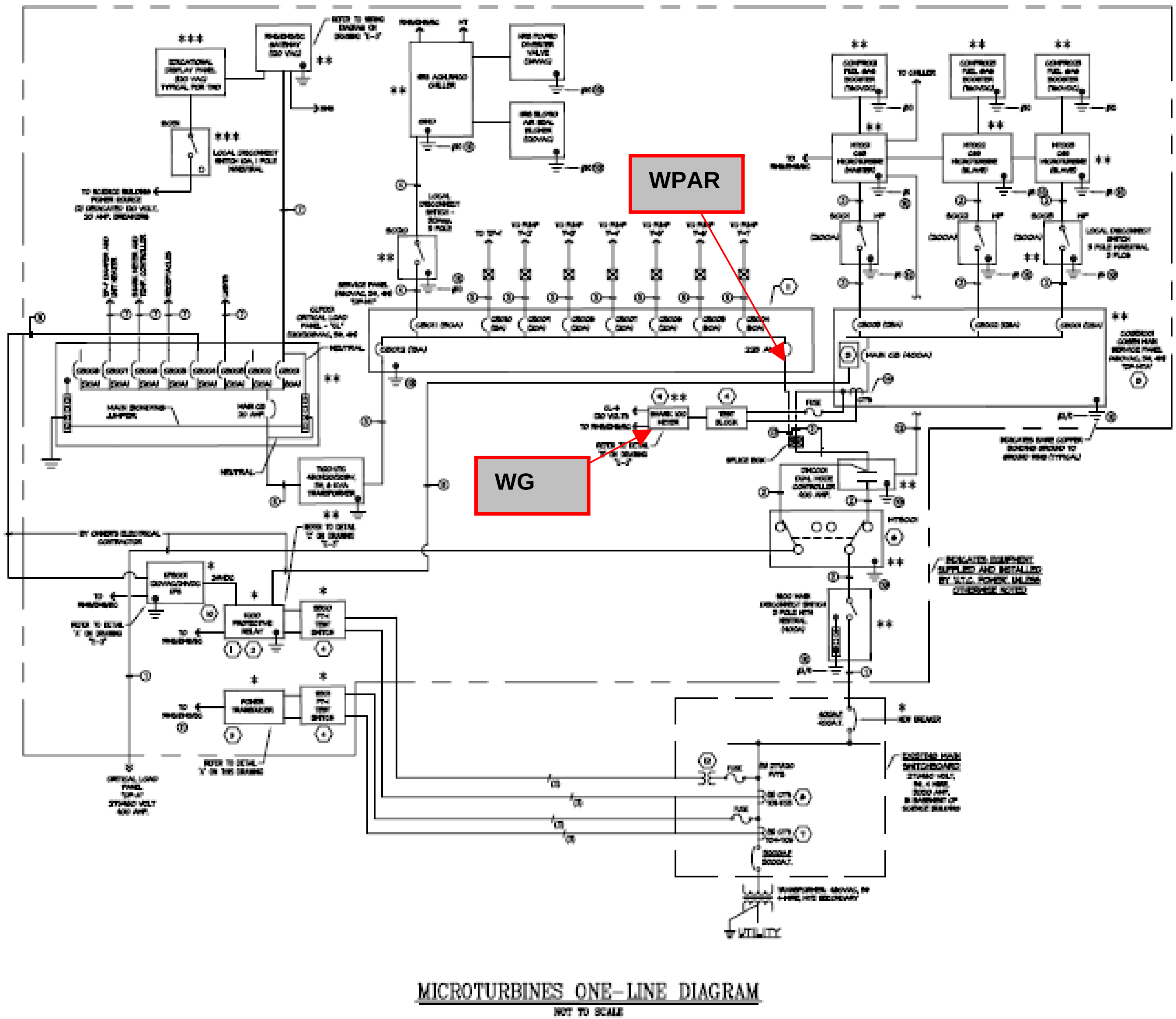


Figure 7. Power Transducer Locations

Monitoring of the listed data points will be accomplished via the Siemens BMS, which can connect to the Trane BMS and Carrier RMS systems via BACnet. All channels will be sampled at a minimum rate of a 1-minute sampling interval, and averaged or summed into 15-minute data records.

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 displays the entire dataset to be collected from the various sources on this project.

Table 2. Summary of Monitored Data Points

No.	Data Point	Description	Eng. Unit	Siemens BMS system point name
1	WT	Whole Campus Energy (from National Grid)	kWh	N/A
2	WG	Microturbine System Energy	kWh	TAC_MTURBINE_GEN_KWH
3	WT_kW	Whole Campus Demand (from National Grid)	kW	N/A
4	WG_kW	Microturbine Power Output	kW	TAC_MTURBINE_GEN_KW
5	WPAR_kW	Parasitic Power	kW	TAC_GEN_BUILDING ELECTRIC
6	FG	Microturbine Fuel Input	CF/h	TAC_MTURBINE_GAS_INPUT
7	FCHW	Chilled Water Flow rate	GPM	TAC_MTURBINE_CWF
8	FHW	Hot Water Flow rate	GPM	TAC_MTURBINE_HWF
9	TCHWS	Chilled Water Supply Temperature Leaving Chiller	ºF	TAC_MTURBINE_CWS
10	TCHWR	Chilled Water Return Temperature Entering Chiller	ºF	TAC_MTURBINE_CWR
11	THWS	Hot Water Supply Temperature Leaving Chiller	ºF	TAC_MTURBINE_HWS
12	THWR	Hot Water Return Temperature Entering Chiller	ºF	TAC_MTURBINE_HWR
13	QH	Heat Transfer to Hot Water Loop	MBtu/h	N/A (Calculated)
14	QC	Heat Transfer to Chilled Water Loop	MBtu/h	N/A (Calculated)

Note: Shaded channels not collected via the Siemens BMS system.

Data collected via the Siemens system will be assembled into one file per day (spanning from 12:00 AM to 11:45 PM). The data file shall be a column oriented, comma delimited file, with one time stamp per row. The data file shall be uploaded to the integrated data system web server once per night, at 12:00 AM.

Energy Channels (kWh)

The total energy produced or consumed in a 15-minute period, typically an accumulator value that continually increases.

Peak Demand or Power Channel (kW)

The peak electric output or demand for each power reading will be taken as the average kW in a 15-minute interval.

Heat Recovery Rates

The heat recovery rates will be calculated on the Siemens BMS at each scan interval and averaged for each 15-minute recording interval.

Heat Recovered for Heating (QH) = K· [FHW·(THWS-THWR)]

Heat Recovered for Cooling (QC) = K· [FCHW·(TCHWS-TCHWR)]

The loop fluid is a 35% propylene glycol-water mixture. The factor K will be estimated 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; ~474 for 20% glycol).

Calculated Quantities

The net power output from the CHP system will be defined as the gross power from the microturbines minus the parasitic power.

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

$$FCE = \frac{(QH + QC / COP) \cdot \Delta t + 3.412 \cdot (WG - WPAR) \cdot \Delta t}{0.9 \cdot HHV_{gas} \cdot FG \cdot \Delta t}$$

where:

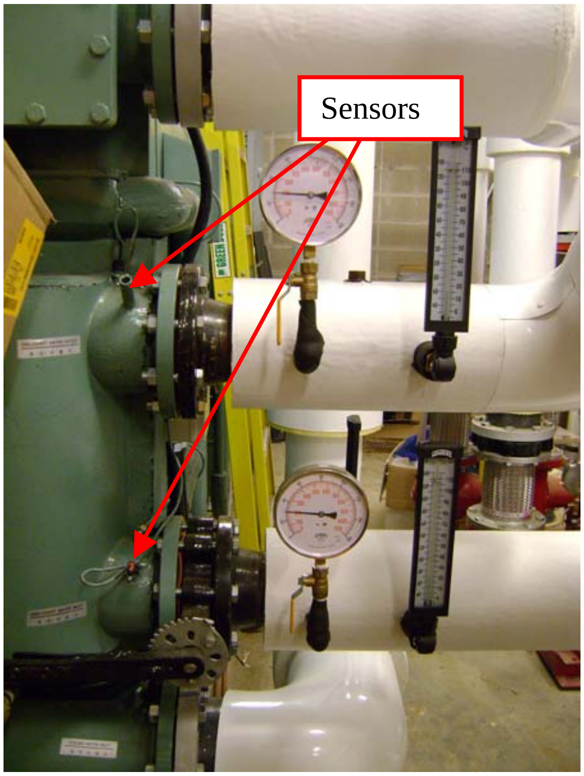
QH	-	Hot Water Heat Recovery
QC	-	Chilled Water Heat Recovery
COP	-	Abs Chiller COP (computed from manufacturer curve)
WG	-	Microturbine gross output (kW)
WPAR	-	Parasitic power (kW)
FG	-	Generator gas consumption (CFH)
Δt	-	0.25 for 15-minute data
HHV_{gas}	-	Higher heating value for natural gas (~1015 Btu per CF). Where 0.9 is the conversion factor between HHV and LHV

4. Calibration of Instrumentation

Documentation of calibration and or verification with another measurement source shall be performed at the time of CHP system commissioning. This shall serve as the only calibration required during the one-year M&V period.

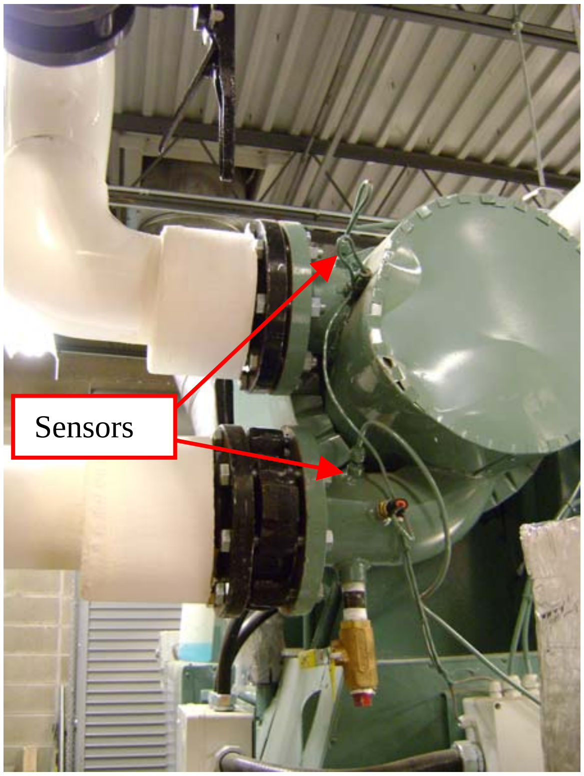
5. Field Documentation of Installed Instrumentation

The following photos show the instrumentation installed. Physical location of the instrumentation was compared to the design drawings and deemed suitable for use in the M&V process.



Chilled Water Supply and Return Sensors at Chiller

Chilled Water Flow Meter On Return Leg

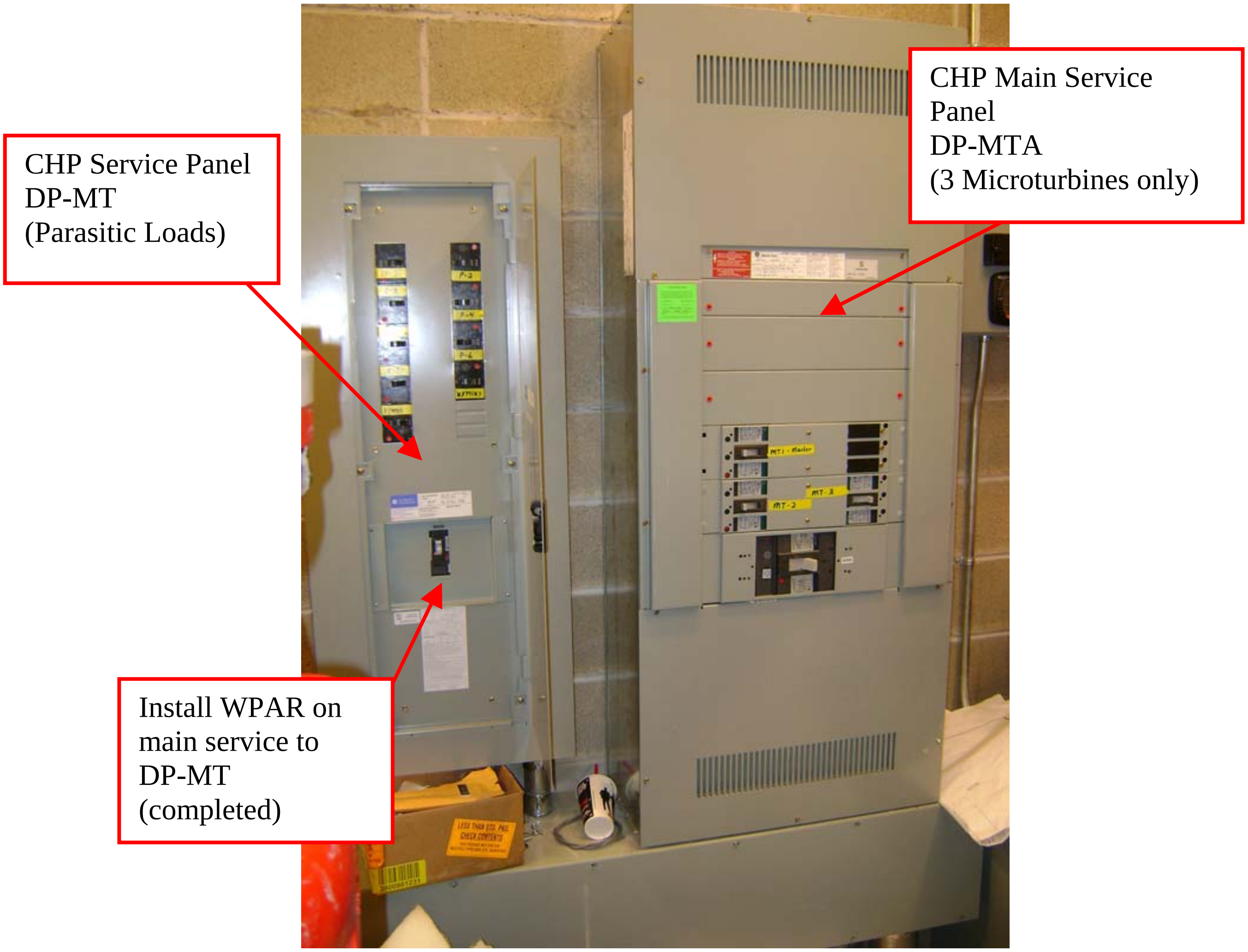


Hot Water Return and Supply Sensors At Chiller

Hot Water Flow Meter on Supply Leg

Shark 100 Power Transducer For Combined Microturbine Power

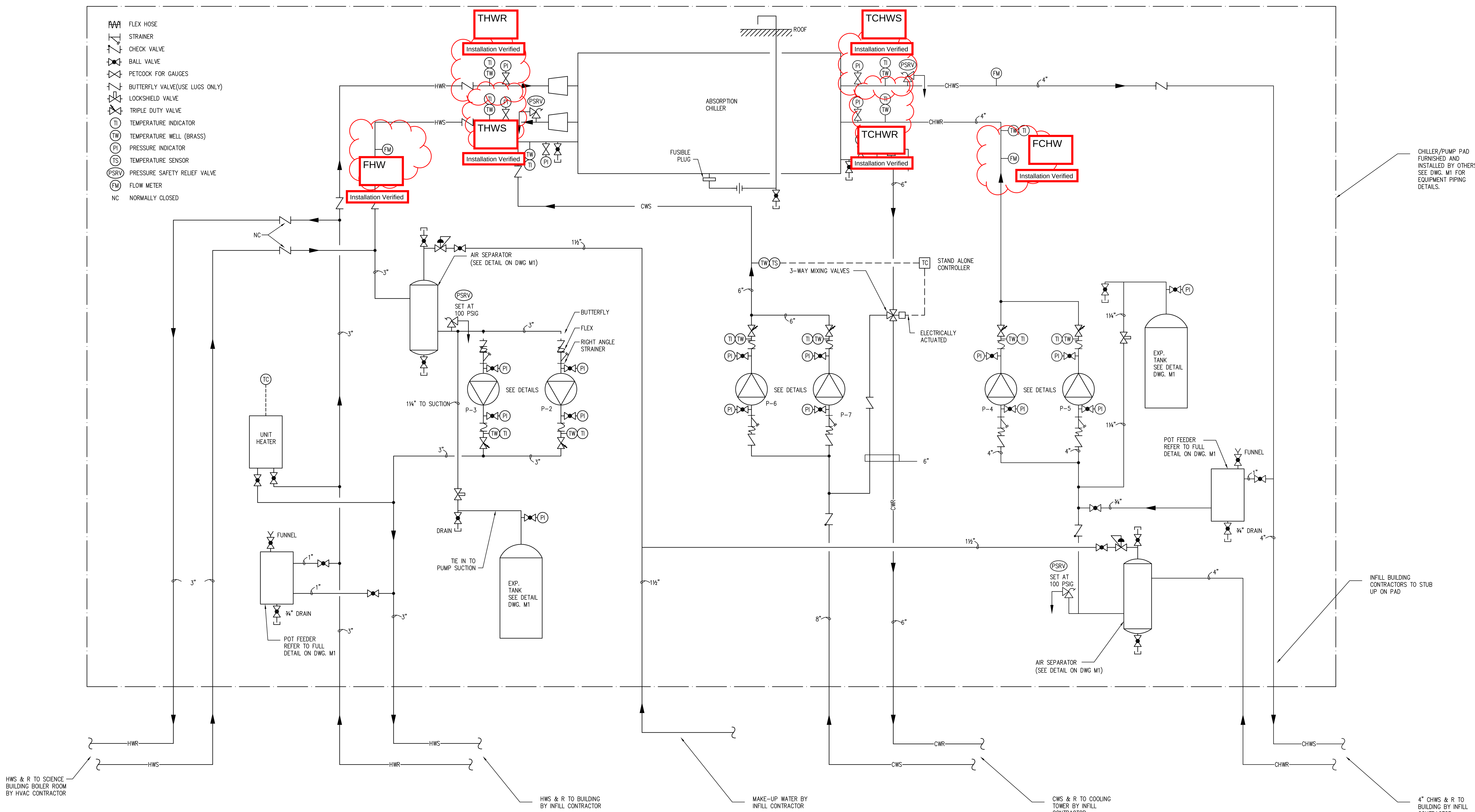
Gas Meter Installed on Gas Main Service to Microturbines For Combined Gas Consumption



Electrical Distribution Panels In Chiller Building

Appendix A

Marked up CHP System Design Drawings



MECHANICAL ROOM SCHEMATIC PLAN

N.T.S

Consultants

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Consulting Mechanical and Electrical Engineers
1090 King Georges Post Rd.
Suite No. 903
Edison, New Jersey 08837
Phone: 732-738-9670
Fax: 732-738-9672

FRANK S. RADOSIN N.Y.P.E. 076657

TMG JOB NUMBER 08-138

MARK	DATE	DESCRIPTION
B	7/31/08	FOR CONSTRUCTION
A	7/21/08	UPDATED FOR BIDDING
	7/10/08	FOR BIDDING PURPOSES

ORIGINAL RELEASE: 07-1724

CUSTOMER
LOCATION

PureComfort® Solution

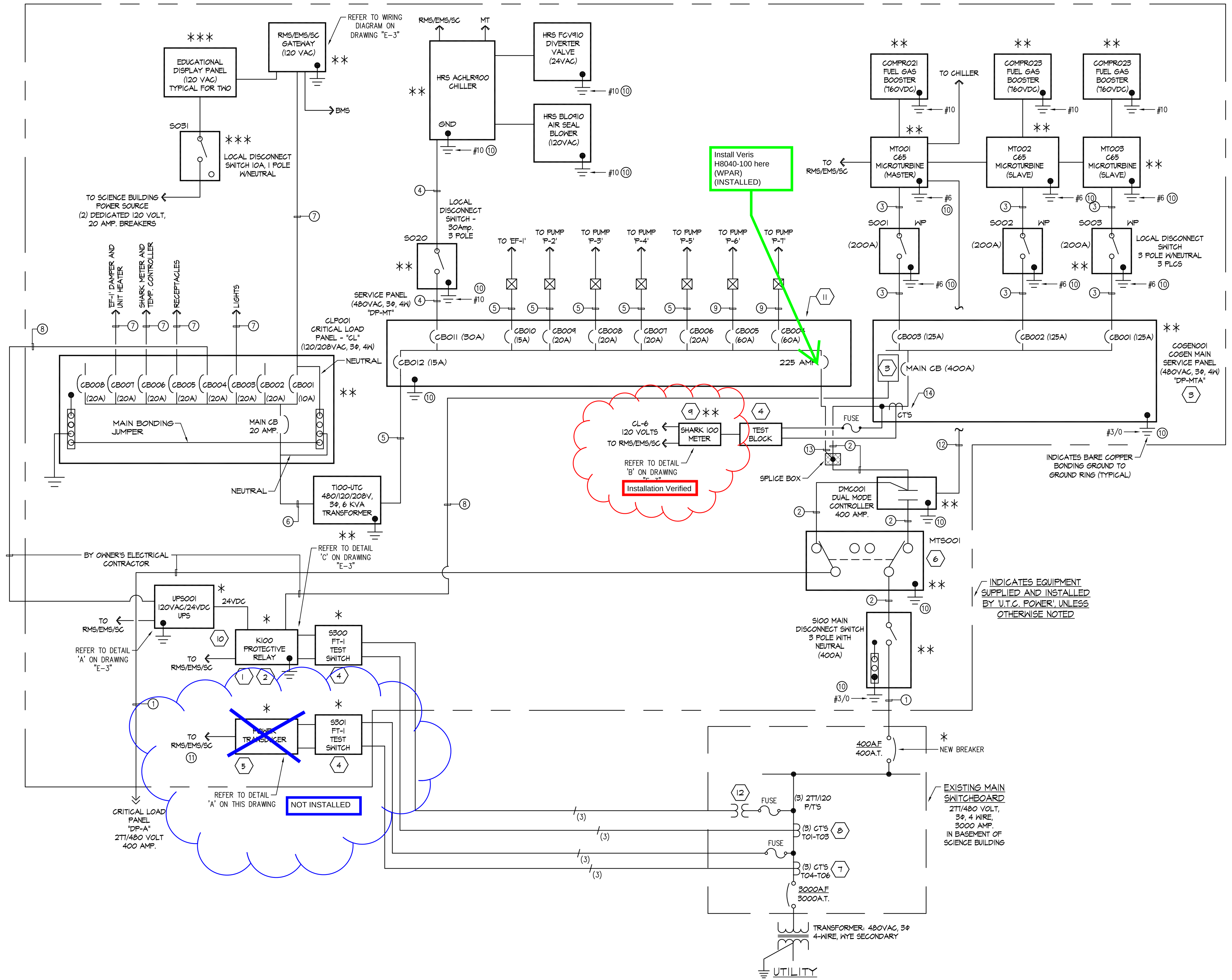
UTC Power
A United Technologies Company
195 GOVERNOR'S HWY
SOUTH WINDSOR, CT, USA
866-900-POWER
WWW.UTCPOWER.COM

M2

MECHANICAL ROOM
SCHEMATIC PLAN

FULL SHEET = 30"X48"

SCALE: 1"=1'-0" | WEIGHT EST: | SHEET 2 OF 10



MICROTURBINES ONE–LINE DIAGRAM

NOT TO SCALE

LEGEND :

1. BECKWITH PROTECTION RELAY MODEL 3520, 24 VOLT DC.
2. THE BECKWITH RELAY WILL BE REQUIRED BY CONNECTING UTILITY TO HAVE REVERSE POWER FLOW PROTECTION. A SHUNT TRIP CONNECT TO THE MAIN CB IN THE COGEN PANEL WILL BE CONNECTED TO BECKWITH RELAY (2) REVERSE POWER OUTPUTS. BECKWITH (2) REVERSE POWER OUTPUTS CONNECTS TO RMS/EMS/SC PROVIDING REVERSE POWER INFORMATION USED FOR PREVENTIVE MEASURES.
3. "G.E." 'SPECTRA' PANEL WITH "G.E." No. SGMOM–1 MOTOR ON MAIN BREAKER. CONTRACTOR TO FIELD INSTALL.
4. ABB FT–1 TEST SWITCH STYLE CS9689A53G01
5. OHIO SEMITRONICS P/N GH–008E–G
6. 480 VOLT, THREE PHASE, 400 AMP. MANUAL TRANSFER SWITCH. ONLY OPERATE THIS TRANSFER SWITCH FOR DMC001 MAINTENANCE. USE 'SQUARED–D' SERIES 'T4' 480 VOLT, THREE POLE, 400 AMP. OR EQUIVALENT.
7. C/T's FOR POWER TRANSDUCER MUST BE .3% 'ANSI' METERING CLASS 3000/5, FOUR WIRE. USE 'GENERAL ELECTRIC' MODEL 120–302 OR EQUIVALENT.
8. C/T's FOR PROTECTIVE RELAY MUST BE .3% 'ANSI' RELAY CLASS 3000/5, FOUR WIRE AND MEET UTILITY REQUIREMENTS. USE 'GENERAL ELECTRIC' MODEL 120–302 OR EQUIVALENT.
9. SHARK 100 POWER METER – MOUNT IN JUNCTION BOX ADJACENT TO PANEL "DP–MT". PROVIDE ALL C/T's, P/T's, WIRING, ETC. USE MODEL No. 100–60–10–V3–D2–485T–DIN.
10. 120/24VDC U.P.S. TO BE BY 'C & D'. CONTRACTOR TO PROVIDE A COMPLETE SETUP, INCLUDING 24 VDC CHARGER MICRO ARE–MZ412;2X MODEL LS–55 BATTERIES; RDO1615WP BATTERY RACK; LS–12–55; RDO1920 BATTERY TRAY INSERT AND OTHER COMPONENTS AS REQUIRED.
11. "G.E." SERIES 'A' PANEL.
12. P/T's FOR PROTECTIVE RELAY SHALL BE 'GENERAL ELECTRI' MODEL JVA–OC PART No. 760X134004

NOTES :

——— DENOTES UTC POWER SUPPLIED AND INSTALLED EQUIPMENT

1. NEUTRAL IS SOLIDLY GROUNDED AT THE UTILITY SERVICE PANEL OF THE FACILITY (SWITCHBOARD)
2. RUN A #3/0 BARE COPPER GROUND CONDUCTOR 30" BELOW GRADE AROUND PAD FOR ALL GROUNDING AS INDICATED. ALL CONNECTIONS TO BE 'CADWELD'. PROVIDE A GROUND TRIAD CONNECTED TO GRID. 30" BELOW GRADE TO TOP OF GROUND RODS. PROVIDE MARKER.

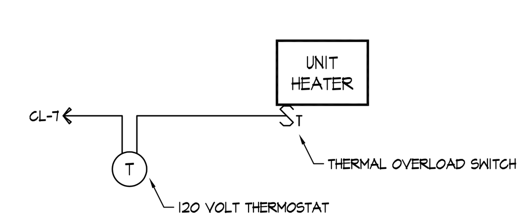
* = DEVICE IN EXISTING BUILDING AT MAIN SWITCHBOARD IN A CABINET.

** = DEVICE AT MT LOCATION

*** = DEVICE IN MAIN LOBBY OF NEW ADDITION

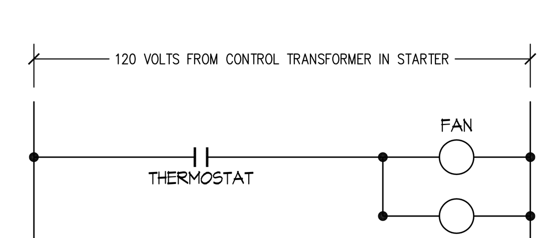
KEY NOTES :

1. (4) 600 MCM AND (1) #3 GROUND IN 4" CONDUIT PLUS (1) 4" CONDUIT SPARE – BY OWNER'S ELECTRICAL CONTRACTOR.
2. (4) 600 MCM AND (1) #3 GROUND IN 4" CONDUIT
3. (4) #1 AND (1) #6 GROUND IN 1½" CONDUIT
4. (4) #10 AND (1) #10 GROUND IN 1" CONDUIT
5. (3) #12 AND (1) #12 GROUND IN ¾" CONDUIT
6. (4) #12 AND (1) #12 GROUND IN ¾" CONDUIT
7. (2) #12 AND (1) #12 GROUND IN ¾" CONDUIT
8. (4) #10 AND (1) #10 GROUND IN ¾" CONDUIT – BY OWNER'S ELECTRICAL CONTRACTOR. (2) FOR SHUNT TRIP AND (2) FOR U.P.S.
9. (3) #8 AND (1) #10 GROUND IN ¾" CONDUIT
10. GROUND CABLE TO GROUND RING VIA SLEEVE (TYPICAL)
11. 'BELDEN' No. 83652
12. 'UTC' SUPPLIED MULTI CONDUCTOR SHIELDED CABLE
13. (4) #4/0 AND (1) #4 GROUND IN 2½" CONDUIT
14. CONTRACTOR TO INSTALL C/T's IN COGEN MAIN SERVICE PANEL ON LINE SIDE OF MAIN.



UNIT HEATER WIRING DIAGRAM

NOT TO SCALE



"EF–1" CONTROL DIAGRAM

NOT TO SCALE

GENERAL NOTES :

1. NOTES ON THIS SHEET APPLY TO ALL ELECTRICAL SHEETS
2. ALL ELECTRICAL WORK SHALL CONFORM TO THE 2005 NATIONAL ELECTRIC CODE.
3. REFER TO DRAWING "ME1" FOR EMBEDDED CONDUITS IN OR UNDER SLAB.
4. COORDINATE ALL EXPOSED CONDUIT RUNS WITHIN THE BUILDING WITH OTHER TRADES.
5. FINAL CONNECTIONS TO ALL PUMPS, FANS, UNIT HEATERS, CHILLER, MICROTURBINES AND ANY OTHER VIBRATING EQUIPMENT, TRANSFORMERS, ETC. SHALL BE 3' OF LIQUID TIGHT FLEXIBLE METAL CONDUIT.
6. ALL UNDERGROUND CONDUITS TO BE PVC, SCHEDULE 40.
7. ALL EXPOSED CONDUITS RUN IN BUILDING TO BE EMT.
8. ALL EXPOSED CONDUITS RUN OUTSIDE TO BE RIGID GALVANIZED STEEL.
9. RESISTANCE BETWEEN EQUIPMENT CHASSIS/FRAME AND GROUND ELECTRODE MUST BE VERIFIED TO BE LESS THAN 25 OHM PER NEC ART. 250.56 BY USING A THREE TERMINAL "GROUND TESTER"
10. RECOMMENDED WIRE/CABLE RATING:
    A. FEEDER CABLES, 600V THWN, 75°C
    B. POWER/CONTROL CONDUCTORS, 600V, PVC, 105°C, UL1015
    C. UL LISTED 2–CONDUCTOR TWSP WITH OVERALL FOIL SHIELD AND STRANDED DRAIN WIRE, 18 AWG, 300V PVC, –20°C TO 90°C
    D. UL LISTED 3–CONDUCTOR TWST CABLE WITH OVERALL FOIL SHIELD WITH DRAIN WIRE, RS–485, BELDEN 9842 OR EQUIVALENT. PLENUM RATED BELDEN 89842
11. ALL WIRES ARE 18 AWG UNLESS OTHERWISE SPECIFIED
12. ENSURE THAT ALL POWER WIRES ARE RUN IN SEPARATE CONDUITS FROM SIGNAL WIRES
13. ENSURE A 90° CROSSING BETWEEN SIGNAL WIRES AND POWER WIRES. KEEP ALL PARALLEL RUNS OF POWER WIRES AND SIGNAL WIRES AT A MINIMUM AND SEPARATED AS MUCH AS POSSIBLE
14. ALL CONDUIT SIZES FOR THE FEEDER CONDUCTORS ARE FOR REFERENCE ONLY. THE CONDUIT SIZES FOR THE FEEDER CONDUCTORS ARE BASED ON THE EMT CONDUITS WITH 40% FILL OF THE COPPER CONDUCTORS (THWN, AT 75°C) AND THE CONDUCTOR PROPERTIES LISTED IN THE LATEST NEC EDITION (CHAPTER 9, TABLE 4 AND TABLE 5). OTHER CONDITIONS MAY REQUIRE LARGER CONDUIT
15. ALL ABOVE GROUND CONDUITS SHALL BE METALLIC. BE SURE THAT CONDUITS ARE GROUNDED TO CHASSIS AT BOTH ENDS WITH NO BREAKS IN END–TO–END CONTINUITY
16. VERIFY THE INTEGRITY OF POWER WIRES BEFORE MAKING FINAL CONNECTIONS
17. GRID PHASE ROTATION MUST BE L1, L2 & L3, COUNTER–CLOCKWISE
18. EARTH GROUND THE SHIELD AT THE HOST OR SOURCE DEVICE ONLY, UNLESS OTHERWISE SPECIFIED
19. FOR A GREEN FIELD APPLICATION, A SYSTEM GROUNDING GRID DIAGRAM (E2.1) IS RECOMMENDED
20. NEUTRAL MUST BE SOLIDLY CIONNECTED TO EARTH GROUND AT A SINGLE LOCATION.
21. WIRING AND HARNESS ASSEMBLIES SHALL CONFORM TO THE REQUIREMENTS OF IPIC/WHMA–A–620, LATEST REVISION
22. MAINTENANCE DISCONNECT DEVICES ARE WITHIN SIGHT OF EQUIPMENT SERVED
23. MICROTURBINES THAT PROVIDE THERMAL ENERGY TO THE CHILLER WILL ALSO PROVIDE DAISY CHAINED MICROTURBINE STATUS SIGNALS FROM NO MORE THAN SIX(6) MICROTURBINES.
    MICROTURBINES CAN NOT OPERATE IN PARALLEL WITH A GENERATOR.
24. ALL WIRING SHALL CONFORM WITH IPC 620–WIRE CRIMPING.
25. ALL WIRE, CABLE & CONDUIT PROVIDED BY OTHERS, UNLESS OTHERWISE SPECIFIED

MICROTURBINE NOTES :

1 – OUTPUT VOLTAGE: 380–528VAC
OUTPUT CONNECTION: L1, L2 & L3 COUNTER–CLOCKWISE.

2 – MAXIMUM GRID IMPEDANCE:

$\leq$10% INDUCTIVE; $\frac{815\mu H}{N}$

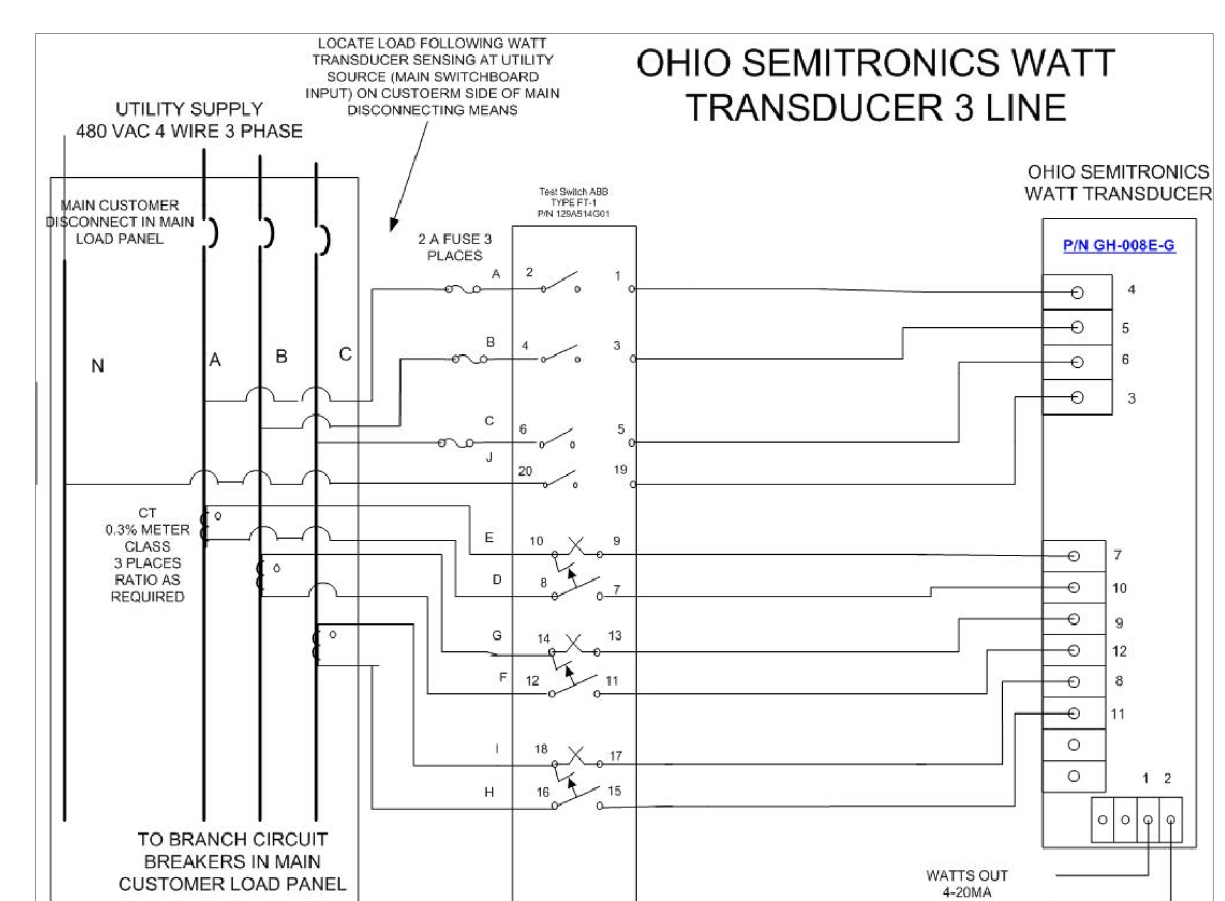
$\leq$5% RESISTIVE; $\frac{0.153\Omega}{N}$

$Z_{BASE} = \frac{3.07\Omega}{N}$

WHERE N=THE NUMBER OF MICROTURBINES.

3 – OUTPUT CURRENT DC CONTENT < 0.6AMP PER TURBINE.

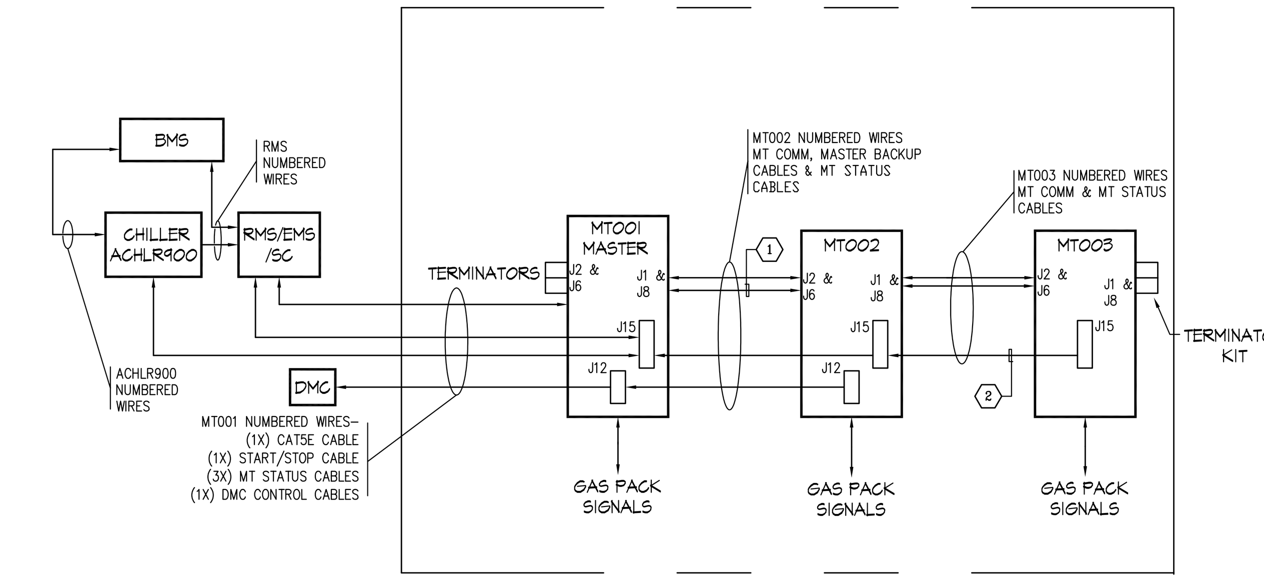
4 – GRID FAULT CONTRIBUTION 145 A RMS PER MICROTURBINE.



DETAIL "A"

OHIO SEMITRONICS WIRING DIAGRAM

NOT TO SCALE

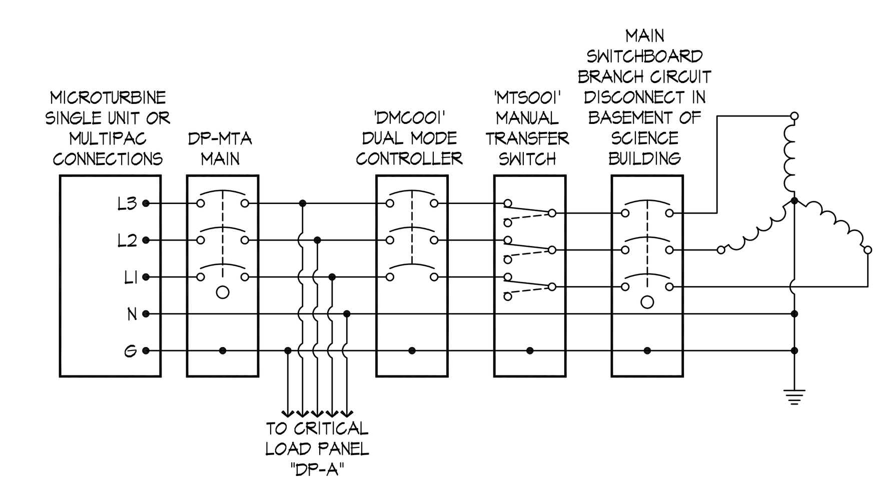


SIGNAL ROUTING DIAGRAM

NOT TO SCALE

LEGEND :

1. MICROTURBINE COMMUNICATION CABLES: MULTI PAC INTERCONNECTION KIT (TYP.) (BY U.T.C.) BETWEEN CONNECTORS ARE TERMINATED.
2. MT STATUS CABLES. NO MORE THAN THREE(3) MICROTURBINE STATUS SIGNALS ARE WIRED TO THE CHILLER.



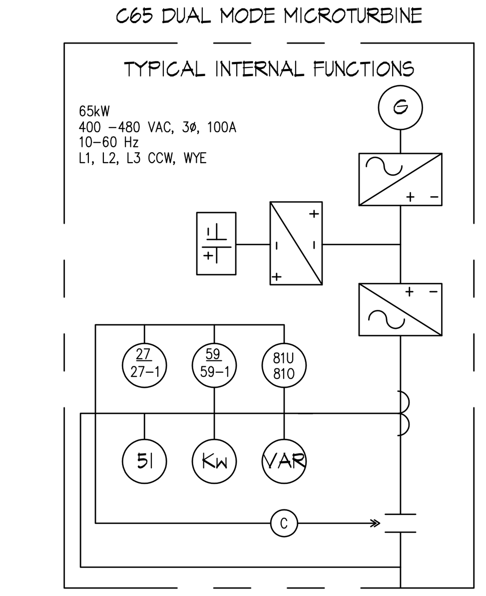
DUAL MODE CONNECTIONS: DIRECT CONNECTION

NOT TO SCALE

NOTE :

THIS DIAGRAM PRESENTS DIRECT CONNECTION USING THE DUAL MODE CONTROLLER. THE DUAL MODE CONTROLLER IS INSTALLED BETWEEN THE MICROTURBINE AND THE PROTECTED LOADS, AND THE UTILITY OR LOCAL TRANSFORMER. THE FACTORY INSTALLED NEUTRAL–TO–GROUND BAR MUST BE REMOVED FROM THE MICROTURBINE USER CONNECTION BAY. A SINGLE NEUTRAL–TO–GROUND CONNECTION "MUST BE" MADE BETWEEN THE MICROTURBINE AND THE LOCAL UTILITY.

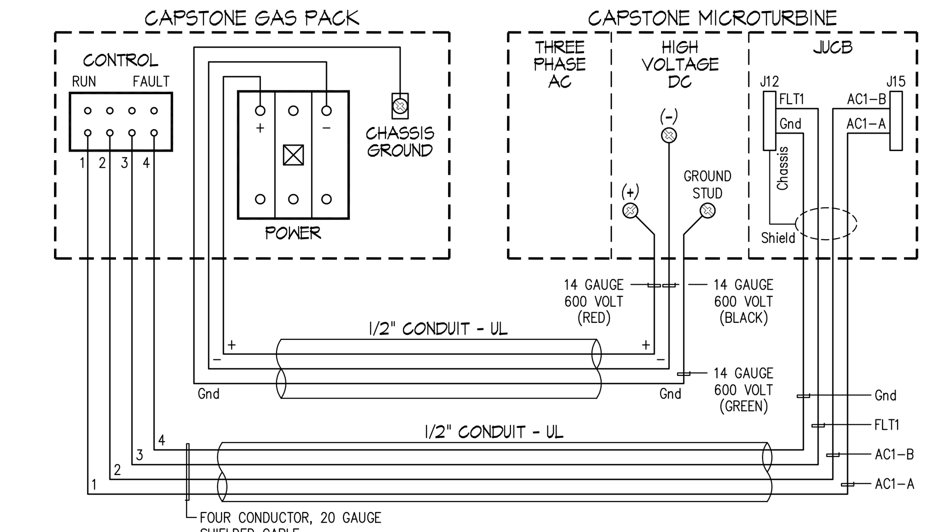
C65 DUAL MODE MICROTURBINE



WIRE NUMBER RANGES

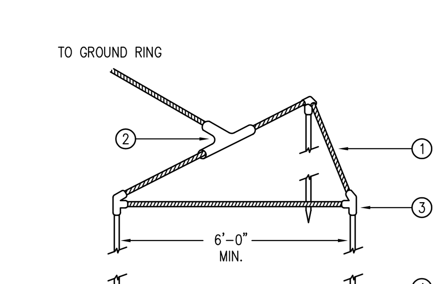
TYPE OF SIGNAL	WIRE NUMBER RANGE	LAST WIRE NUMBER USED	NUMBER NOT USED
POWER DISTRIBUTION	W001–099	W015–RMS001	––––––
DIGITAL SIGNALS	W100–499	W104–MT001	––––––
ANALOG SIGNALS	W500–899	W504–RMS001	––––––
SAFETY	W900–949	W903–RMS001	––––––
COMMUNICATIONS	W950–999	W960–RMS001	––––––
SPARES	SPARE 001–099	––––––	––––––

WIRE NUMBERS ARE IDENTIFIED BY THE NUMBER RANGE FOLLOWED BY THE EQUIPMENT SERVED. SUCH AS: W001–MT001



WIRING BETWEEN DC GAS PACK AND UCB

NOT TO SCALE



1. CONDUCTOR – 4/0 COPPER WIRE 660lbs. PER 1000ft.
2. CONDUCTOR CONNECTION – CADWELD
3. GROUND ROD CONNECTION – CADWELD (TYPICAL FOR 3)
4. COPPERCLAD GROUND ROD – ¾" x 10'–0" LOCATED 18" MIN. BELOW FINISHED GRADE (TYPICAL FOR 3) PROVIDE CONCRETE GROUND MARKER FLUSH WITH GRADE ABOVE EACH ROD.

MAIN GROUND TRIAD

NOT TO SCALE

Consultants

TMG Engineering Inc.
Consulting Mechanical and Electrical Engineers
1090 King Georges Post Rd.
Suite No. 903
Edison, New Jersey 08837
Phone: 732–738–9670
Fax: 732–738–9672

FRANK S. RADOSIN N.Y.P.E. 076657

TMG JOB NUMBER 08–138

MARK	DATE	DESCRIPTION
B	7/31/08	FOR CONSTRUCTION
A	7/21/08	UPDATED FOR BIDDING
	7/10/08	FOR BIDDING PURPOSES

ORIGINAL RELEASE: 07–1724

CUSTOMER
LOCATION

PureComfort® Solution

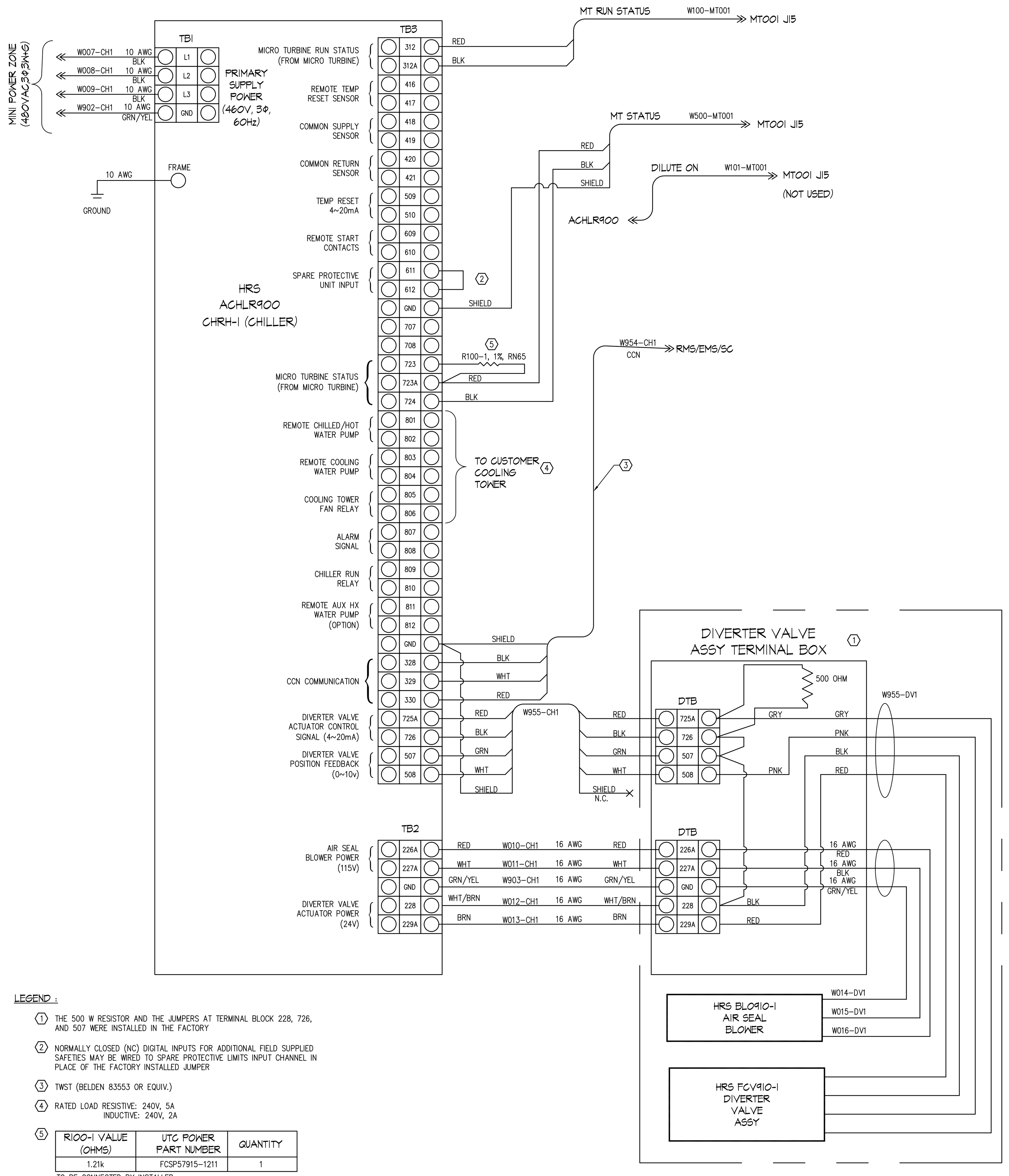
UTC Power
A United Technologies Company
195 GOVERNOR'S HWY
SOUTH WINDSOR, CT, USA
866-900-POWER
WWW.UTCPOWER.COM

E2

ELECTRICAL DIAGRAMS AND NOTES

FULL SHEET = 30"X48"

SCALE: NONE | WEIGHT EST: | SHEET 2 OF 4



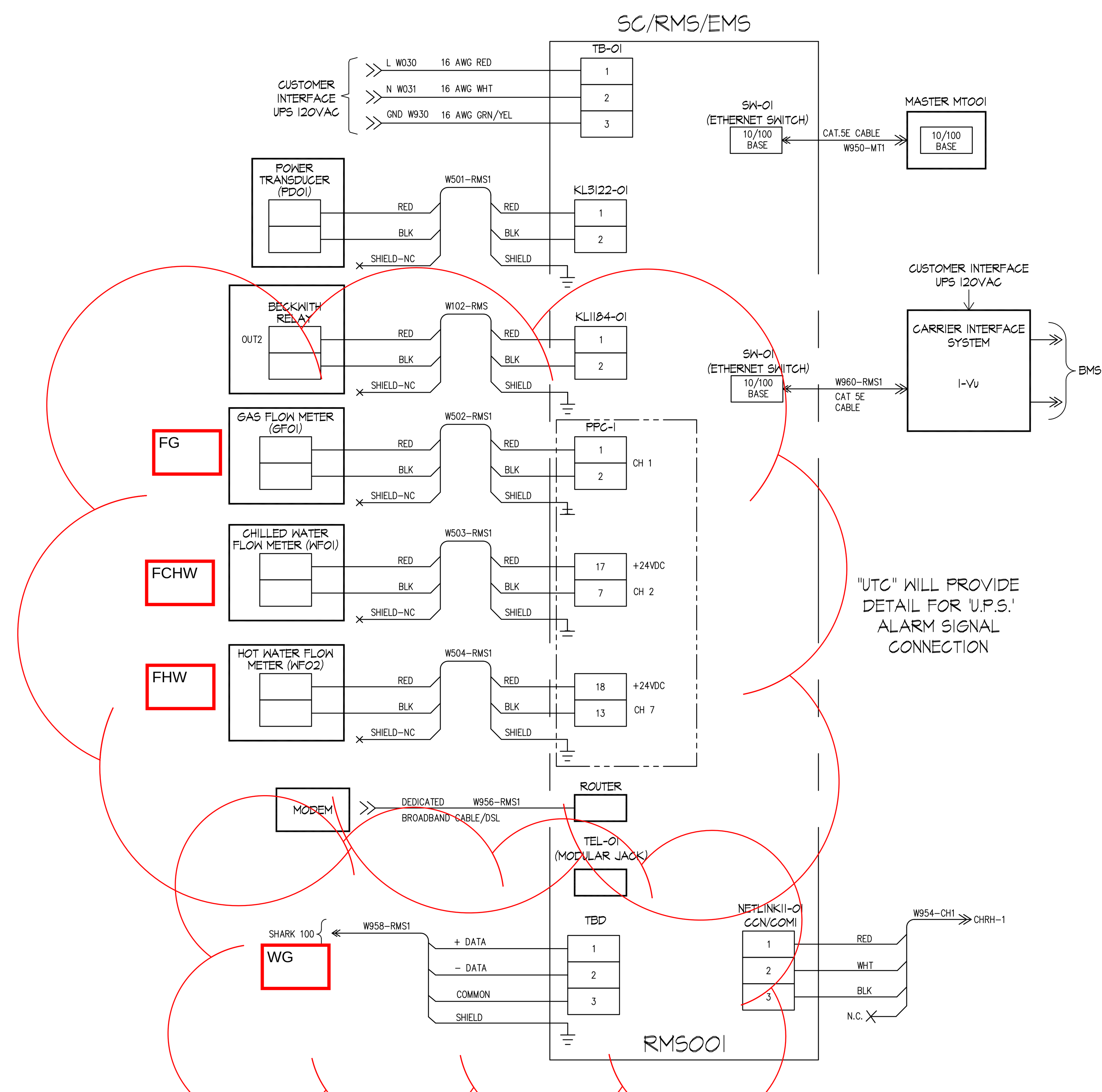
LEGEND :

1. THE 500 W RESISTOR AND THE JUMPERS AT TERMINAL BLOCK 228, 726, AND 507 WERE INSTALLED IN THE FACTORY
2. NORMALLY CLOSED (NC) DIGITAL INPUTS FOR ADDITIONAL FIELD SUPPLIED SAFETIES MAY BE WIRED TO SPARE PROTECTIVE LIMITS INPUT CHANNEL IN PLACE OF THE FACTORY INSTALLED JUMPER
3. TWST (BELDEN 83553 OR EQUIV.)
4. RATED LOAD RESISTIVE: 240V, 5A
   INDUCTIVE: 240V, 2A
5.

R100-1 VALUE (OHMS)	UTC POWER PART NUMBER	QUANTITY
1.21k	FCSP57915-1211	1

TO BE CONNECTED BY INSTALLER

SCHEMATIC FOR CHILLER AND DIVERTER VALVE



FIELD WIRING FOR SC/RMS/EMS

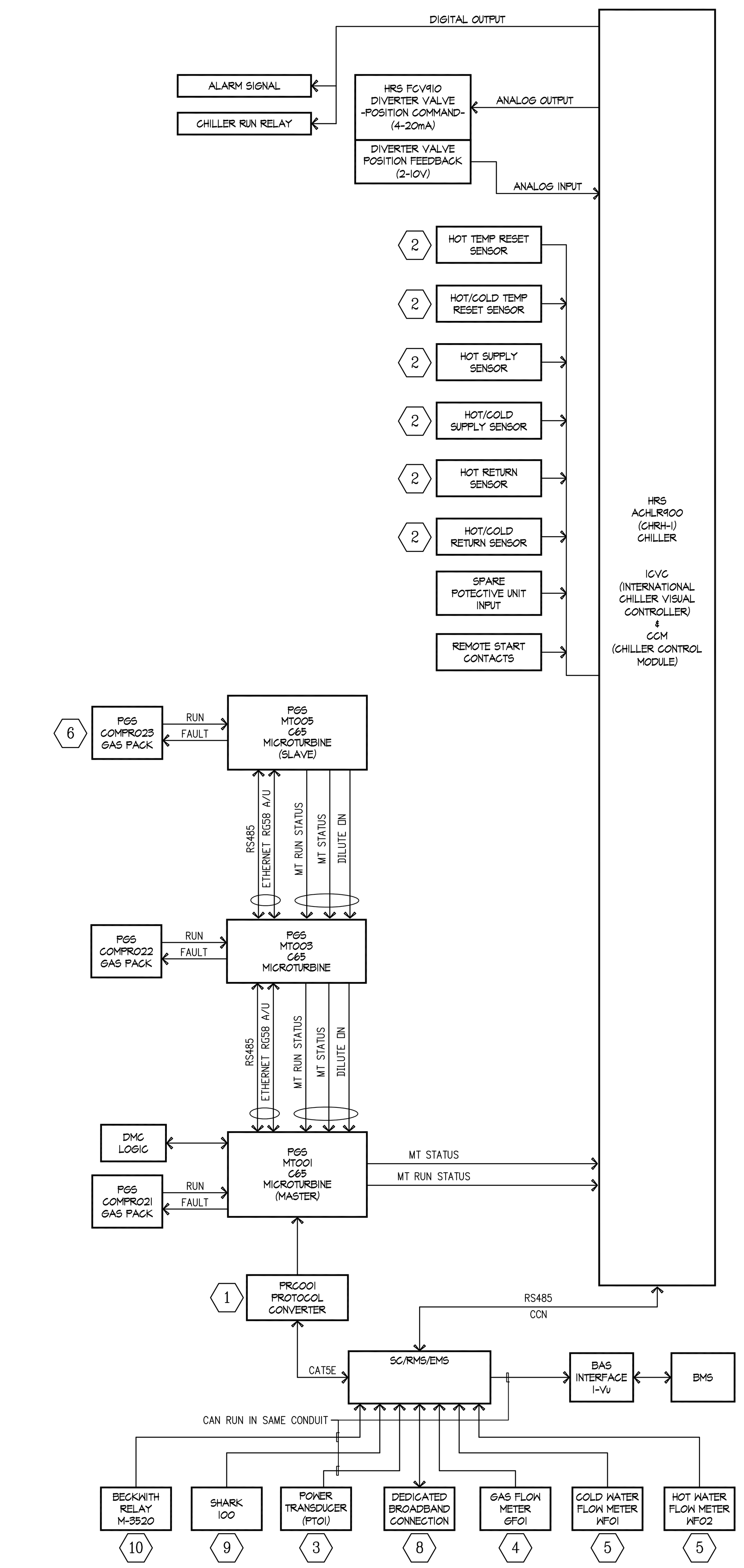
NOTES :

1. ALL CABLES/WIRES ARE 18 AWG TWP CABLES UNLESS OTHERWISE SPECIFIED
2. RS485, TWST (BELDEN 83553 OR EQUIV.)

WIRE NUMBER RANGES

TYPE OF SIGNAL	WIRE NUMBER RANGE	LAST WIRE NUMBER USED	NUMBER NOT USED
POWER DISTRIBUTION	W001–099	W015–RMS001	-------
DIGITAL SIGNALS	W100–499	W104–MT001	-------
ANALOG SIGNALS	W500–899	W504–RMS001	-------
SAFETY	W900–949	W903–RMS001	-------
COMMUNICATIONS	W950–999	W960–RMS001	-------
SPARES	SPARE 001–099	-------	-------

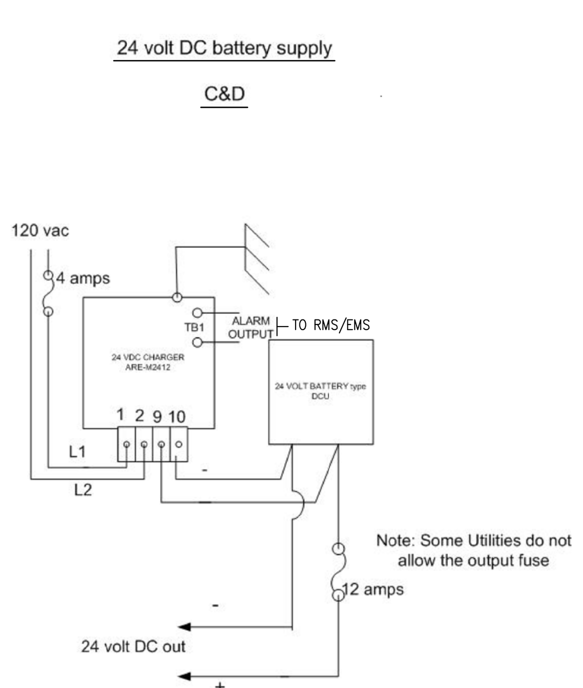
WIRE NUMBERS ARE IDENTIFIED BY THE NUMBER RANGE FOLLOWED BY THE EQUIPMENT SERVED. SUCH AS: W001–MT001



CONTROL SIGNALS DIAGRAM DUAL MODE OPTION

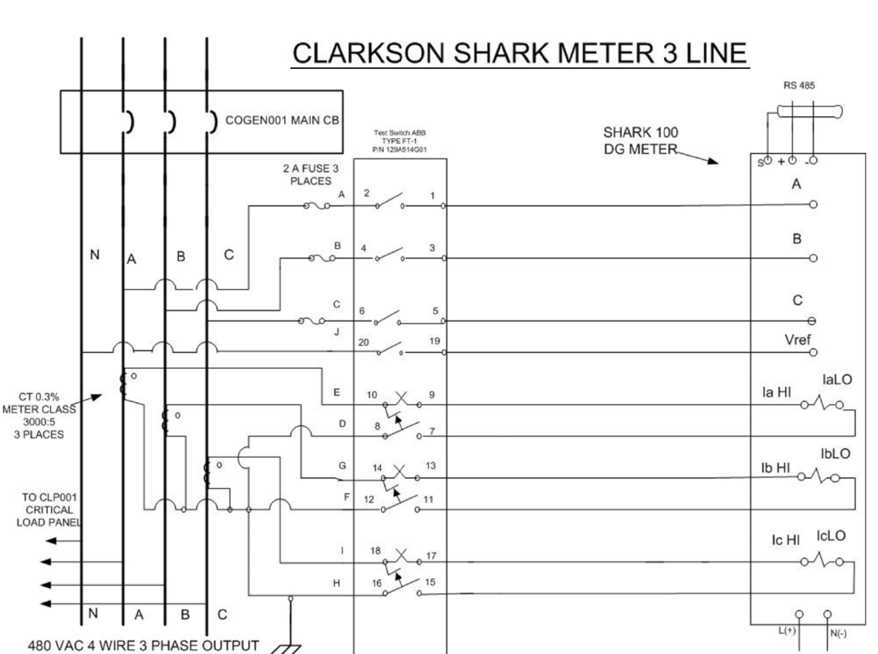
LEGEND :

1. PROTOCOL CONVERTER PRC001 WILL BE MOUNTED INSIDE MT001 BY A FIELD INSTALLER.
2. SENSOR BY BAS CONTRACTOR PROVIDES SIMULTANEOUS CHILLED WATER AND HOT WATER CAPABILITY
3. OHIO SEMITRONICS :
   GH–007E;
   GH–008E;
   SELECTION IS SITE SPECIFIC
4. UTILITY GAS FLOW METER, 4–20 mA
5. WATER FLOW METER, 4–20 mA
6. THE NUMBER OF FUEL GAS BOOSTERS USED VARIES WITH TYPE AND SITE REQUIREMENTS. BACKPACKED FUEL GAS BOOSTERS(GAS PACKS) ARE MOUNTED DIRECTLY TO MT
7. NOT USED
8. DEDICATED BROADBAND WITH STATIC IP ADDRESS
9. ELECTRO INDUSTRIES SHARK 100 (OPTIONAL) UTILITY GRADE METER USED TO MEASURE MICROTURBINE POWER OUTPUT. NOT FOR CONTROL.
10. UNDELAYED N/O DRY CONTACT REVERSE POWER SIGNAL FOR PRE–EMPTIVE CONTROL



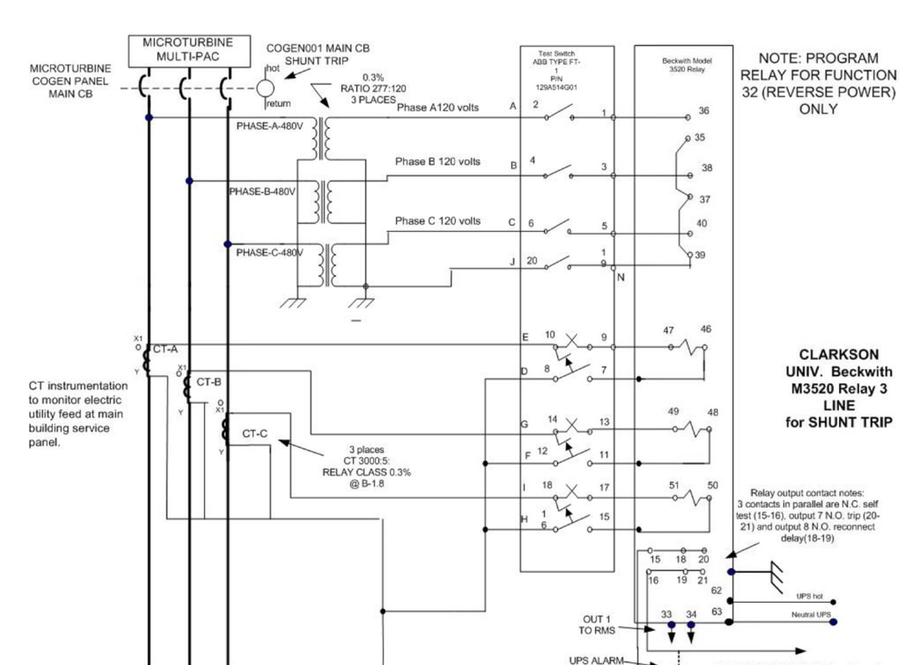
DETAIL "A"

U.P.S. WIRING DIAGRAM



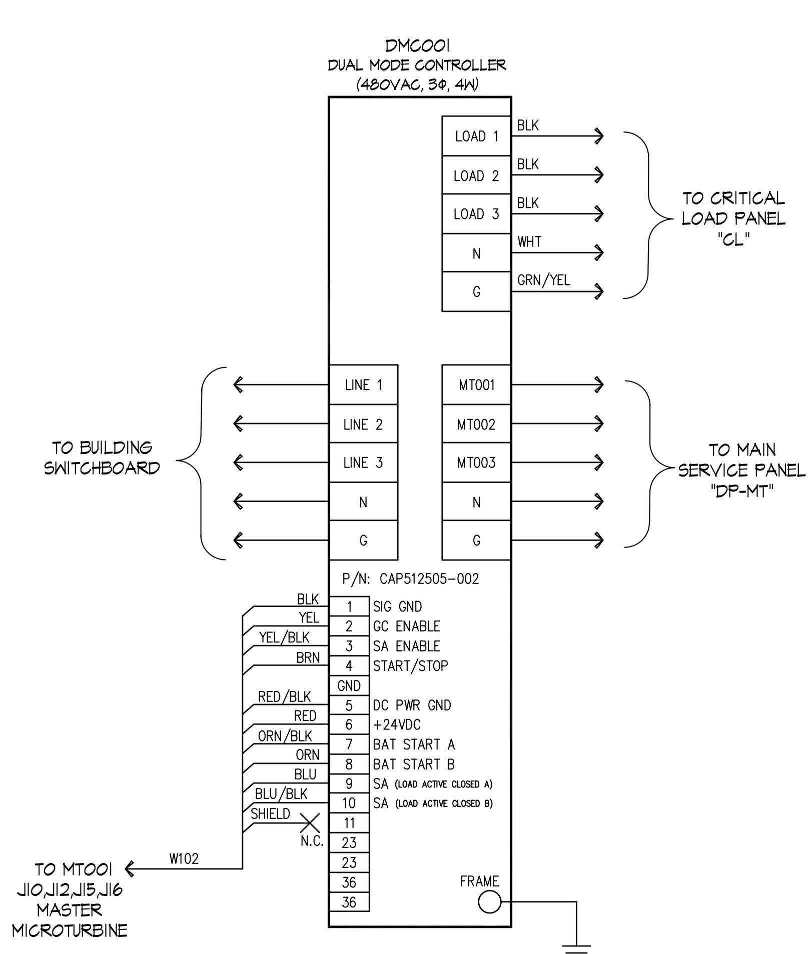
DETAIL "B"

SHARK METER WIRING DIAGRAM



DETAIL "C"

BECKWITH PROTECTIVE RELAY WIRING DIAGRAM



THREE LINE SCHEMATIC FOR DUAL MODE CONTROLLER

Consultants

TMG Engineering Inc.
Consulting Mechanical and Electrical Engineers
1090 King Georges Post Rd.
Suite No. 903
Edison, New Jersey 08837
Phone: 732–738–9670
Fax: 732–738–9672

FRANK S. RADOSIN N.Y.P.E. 076657

TMG JOB NUMBER 08–138

MARK	DATE	DESCRIPTION
B	7/31/08	FOR CONSTRUCTION
A	7/21/08	UPDATED FOR BIDDING
	7/10/08	FOR BIDDING PURPOSES

ORIGINAL RELEASE: 07-1724

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LOCATION

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E3

ELECTRICAL DIAGRAMS

FULL SHEET = 30"X48"
SCALE: NONE | WEIGHT EST: | SHEET 3 OF 4