# Monitoring & Verification Plan

## *Under the NYSERDA*
## *CHP R&D Program*
## *PON 1043*

**For**

**CHP Plant at the**

# Toren Condominiums

**Myrtle Avenue Builders**

**March 9, 2009**

**Energy Concepts Engineering PC**
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# Table of Contents

# 1. Introduction

The purpose of this document is to identify and establish procedures to conform to NYSERDA guidelines for measurement and verification of The Toren CHP plant according to the NYSERDA CHP Systems Manual. This will quantify generator power output (kW) at 15-minute intervals during key on-peak periods; cumulative energy generated and used on-site by the CHP System (MWh) on an annual basis, annual fuel conversion efficiency, and NOx emissions of the CHP plant. The M&V Plan described here will be performed for a minimum of two years after the CHP plant commissioning.

# 2. System Description

## A. General overview

Myrtle Avenue Condominiums has been designed in conformance with LEED green building guidelines and high energy efficiency. In keeping with that concept the facility will receive building heating, cooling and electric power from a state-of-the art Combined Heat and Power (CHP) plant.

The CHP plant uses on-site cogeneration units to generate most of the facility power. The cogeneration units use natural gas fired reciprocating engines in a computer controlled package to turn a generator and make electricity. Hot water heat is then recovered from the engines and combustion exhaust and used for building heat, domestic hot water and absorber air conditioning.

The integrated central CHP plant consists of the cogeneration units, hot water boilers, domestic hot water exchangers and absorber chillers. Together this equipment provides all the building heating, cooling and most electric power needs. The entire system is controlled and monitored by an energy management computer control system (EMS). The EMS system will perform the primary collection of data and reporting for the CHP plant. A few measurements will be manual, including emissions (CTM-030) and parasitic load (refer to schematic mechanical drawings in this section).

## B. Heating System

The primary source of heating for the building is from the heat recovered from the five (5) Tecogen CM-100 cogeneration units. The central plant design also includes six 1700 MBH natural gas fired modular hot water boilers to supplement recovered cogen heat if required. In the event of cogen unit failure, the boilers will automatically maintain the required building heating water temperature and are capable of meeting 100% of the building heating load. The central boiler operation and fuel use is reduced to a fraction of normal boiler use. t.

Heating from the central CHP plant is distributed to the building via a 4 pipe heating and cooling system. Apartment terminal units consist of 2 pipe fan coil heat/cool units with supplemental electric heating coils to provide swing season heating when the building is operating in the cooling mode and heating water is not available.

Central air handlers are 4 pipe heating/cooling and serve residential unit ventilation, corridor ventilation and common areas of the building. Air handlers are provided with heating and cooling coils and can heat and cool independently of the fan coil units.

## C. Domestic Hot Water (DHW) System

Domestic hot water for the building and condos is also provided using either waste heat from the cogeneration units or if necessary supplemental boiler firing. Domestic hot water is provided via 3 pressure controlled zones. Each zone uses dedicated domestic to CHP hot water heat exchangers and storage tanks.

## D. Chiller System

Chilled water for air conditioning is provided from the central CHP plant. The chiller plant consists of a 390 ton hot water absorber with (3) three 50 ton electric chillers for supplemental cooling and backup. The boilers provide supplemental hot water for the absorber chiller as required to accommodate maximum cooling loads during hotter weather.

Chilled water from the central CHP plant is distributed to the building via a 4 pipe heating and cooling system. Room terminal units consist of 2 pipe fan coil heat/cool units with automatic changeover. Central air handlers are provided with cooling coils for conditioning of ventilation air. Air conditioning may be provided during winter, early spring and late fall without cost or operational penalties using air side economizer cycle.

## E. Electrical System

Electric power is provided to the facility through a dual feed 5000 amp 208 volt ConEd service. If at any time one of the ConEd feeds fails then the building can be switched to the second parallel feed.

Power is also transformed on-site to 480 volt power to provide for larger motor loads and central plant equipment. The cogeneration plant power is in parallel with ConEd and connected to the building main distribution panel. If at any time the cogeneration plant is out of service the entire building electric load may be provided by ConEd.

The cogeneration units will also have the ability to act as standby power for the units and the building up to 500kw. In the event of utility failure a special control sequence will shed unnecessary electric load and start the cogeneration plant to provide power to the units and building.

Main power to the building is metered via ConEd master meters. ConEd then bills for supplemental power through the master meters.

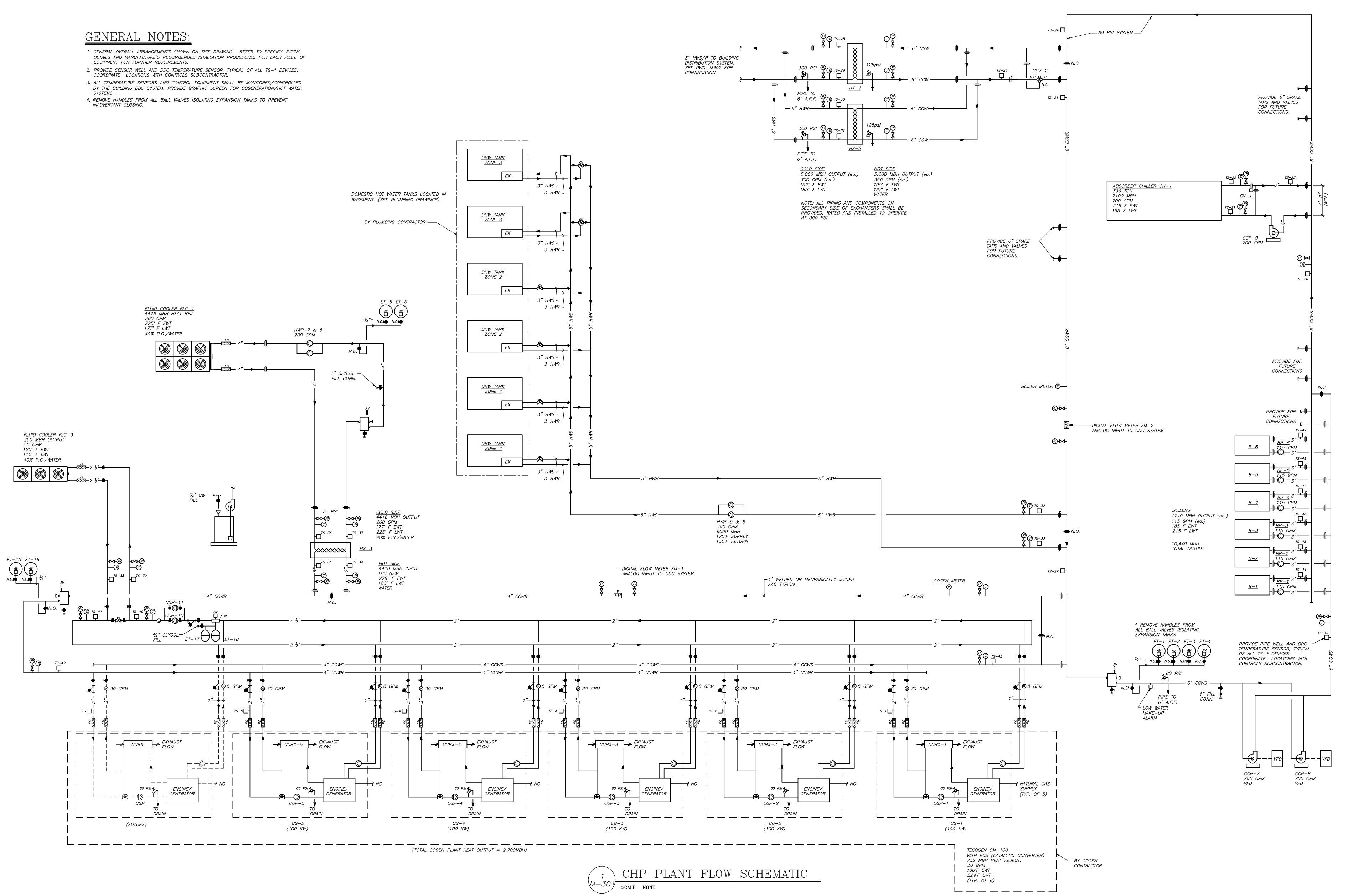
Non-utility sub metering will provided for all residential units, commercial units, common areas and the central plant. Power use is then recorded and billed to the residential units and commercial units through the use of the computerized sub metering system. Sub metered power consist of mostly co-generated power and the remaining ConEd supplemental power.

## *F. Mechanical and Electrical Schematics*

*******Refer to Appendix for additional cut sheets and details.*

# GENERAL NOTES:

1. GENERAL OVERALL ARRANGEMENTS SHOWN ON THIS DRAWING. REFER TO SPECIFIC PIPING DETAILS AND MANUFACTURE'S RECOMMENDED ISTALLATION PROCEDURES FOR EACH PIECE OF EQUIPMENT FOR FURTHER REQUIREMENTS.
2. PROVIDE SENSOR WELL AND DDC TEMPERATURE SENSOR, TYPICAL OF ALL TS-* DEVICES. COORDINATE LOCATIONS WITH CONTROLS SUBCONTRACTOR.
3. ALL TEMPERATURE SENSORS AND CONTROL EQUIPMENT SHALL BE MONITORED/CONTROLLED BY THE BUILDING DDC SYSTEM. PROVIDE GRAPHIC SCREEN FOR COGENERATION/HOT WATER SYSTEMS.
4. REMOVE HANDLES FROM ALL BALL VALVES ISOLATING EXPANSION TANKS TO PREVENT INADVERTANT CLOSING.




1
M-301
CHP PLANT FLOW SCHEMATIC
SCALE: NONE

NOTES:

Structural Engineer: Severud Associates, 485 Seventh Avenue, New York, N.Y. 10018

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| No. | Date | Issue |
|---|---|---|
| 4 | 3-3-2009 | TEMP SENSOR REVISIONS |
| 3 | 2-17-2009 | TEMP SENSOR REVISIONS |
| 2 | 4-28-2008 | UPDATE REVISIONS |
| 1 | 6-15-2007 | TWO-PIPE SYSTEM REVISIONS |
| | 5-15-2007 | COGEN & CHILLER REVISIONS |
| | 4-12-2007 | ISSUED FOR CONSTRUCTION |
| | 3-2-2007 | ISSUED FOR PRICING |
| | 2-9-2007 | ISSUED FOR D.O.B. |
| | 2-2-2007 | 90% REVIEW SET |
| | 11-10-2006 | 100% DESIGN DEVELOPMENT |
| | 10-20-2006 | 75% DESIGN DEVELOPMENT |

Sheet Name:
## CHP PLANT FLOW SCHEMATIC



Date: 00.00.00
Scale: AS NOTED
SOM Job No.: 206144
CAD File Name: 06019-m301_r4.dwg
Sheet No.: M-301

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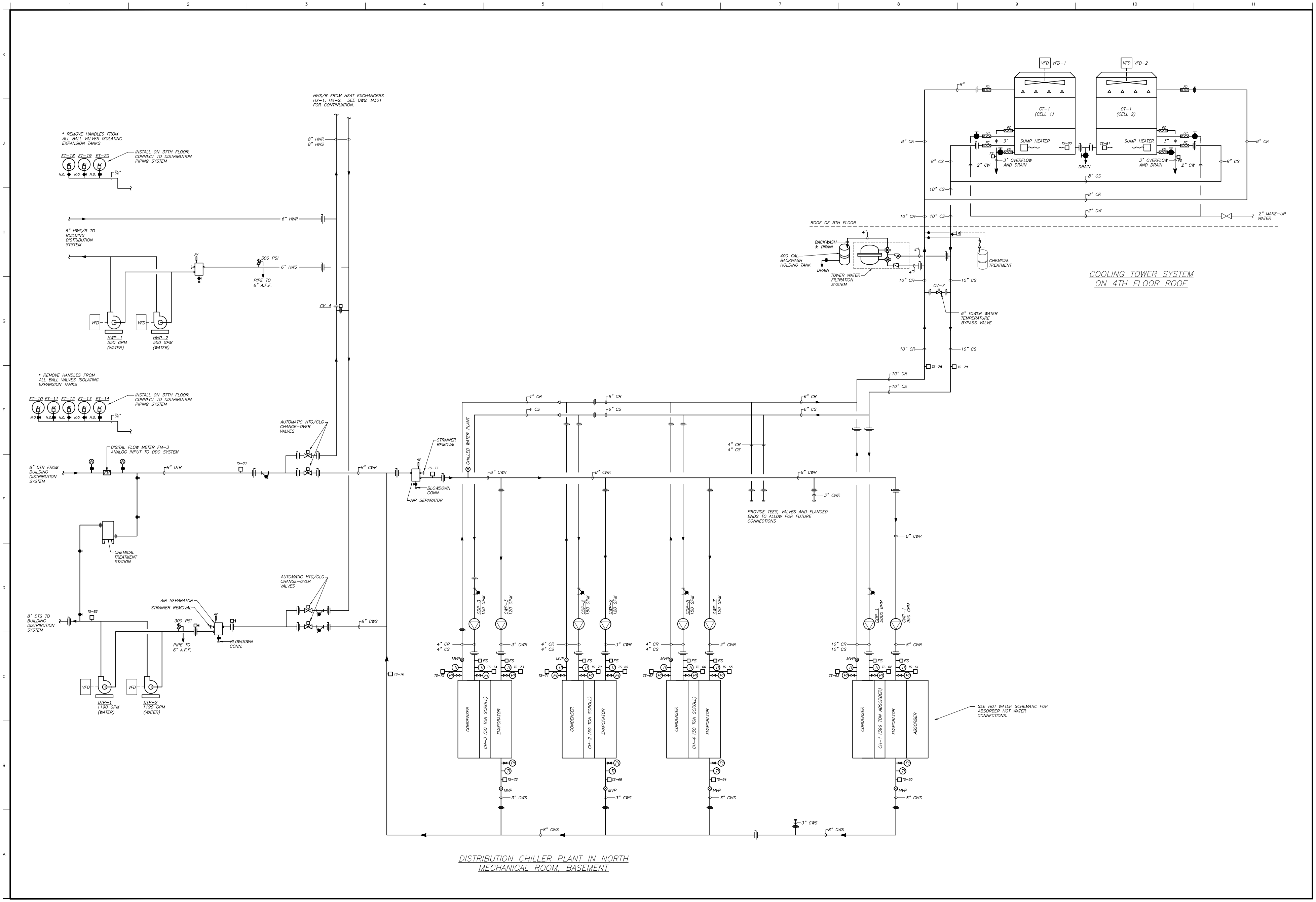


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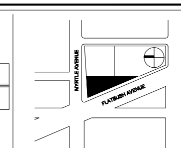


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| No. | Date | Issue |
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| 4 | 3-3-2009 | REVISED TEMP SENSOR NUMBERS |
| 3 | 4-28-2008 | UPDATE REVISIONS |
| 2 | 9-28-2007 | BULLETIN #9 |
| 1 | 6-15-2007 | TWO-PIPE SYSTEM REVISIONS |
| | 5-15-2007 | COGEN & CHILLER REVISIONS |
| | 4-12-2007 | ISSUED FOR CONSTRUCTION |
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| | 2-2-2007 | 90% REVIEW SET |
| | 11-10-2006 | 100% DESIGN DEVELOPMENT |
| | 10-20-2006 | 75% DESIGN DEVELOPMENT |

Sheet Name:
# CHILLED WATER SYSTEM FLOW SCHEMATIC



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SOM Job No.: 206144
CAD File Name: 06019-m302.dwg
Sheet No.: M-302

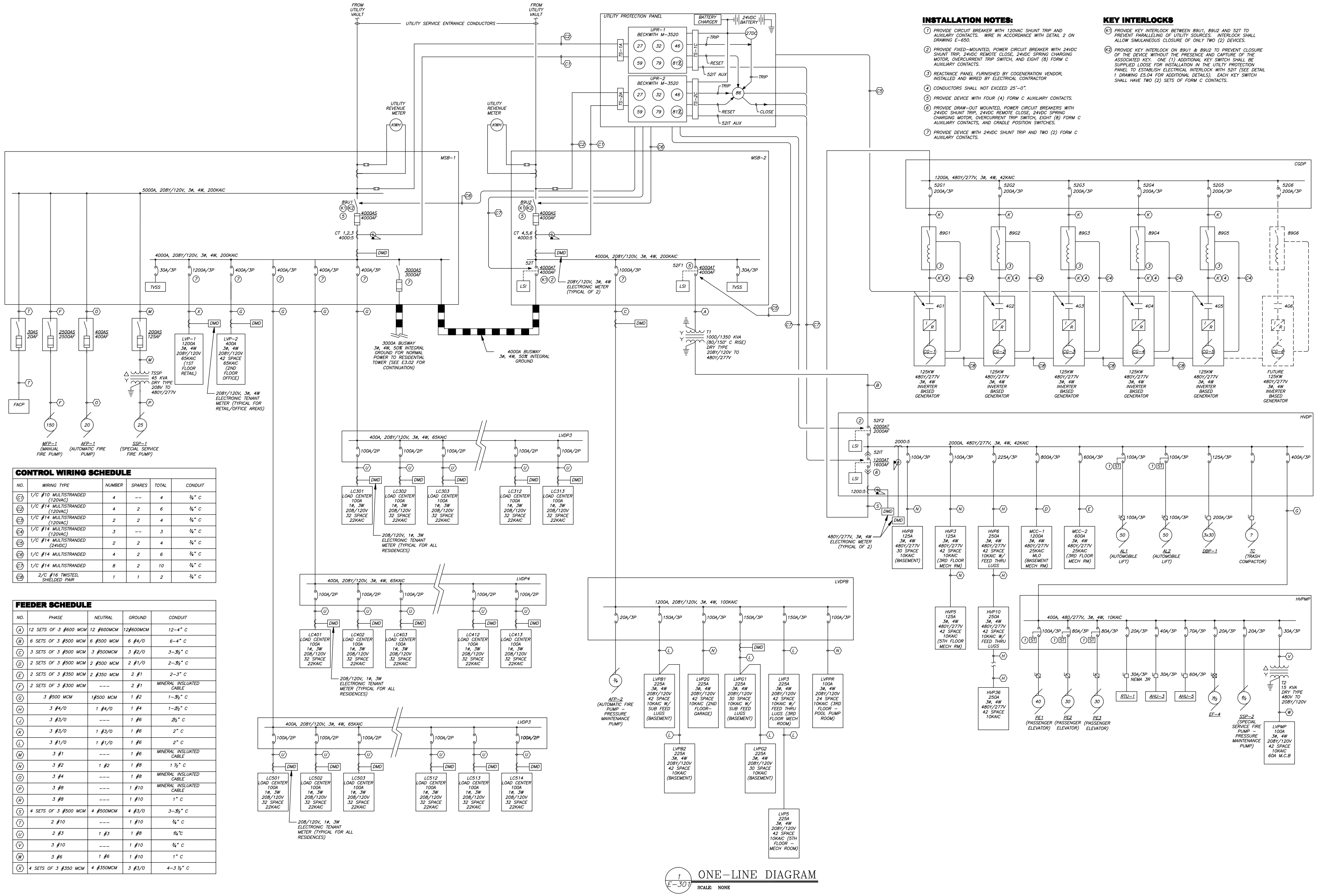
## INSTALLATION NOTES:

1. PROVIDE CIRCUIT BREAKER WITH 120VAC SHUNT TRIP AND AUXILARY CONTACTS. WIRE IN ACCORDANCE WITH DETAIL 2 ON DRAWING E-650.
2. PROVIDE FIXED-MOUNTED, POWER CIRCUIT BREAKER WITH 24VDC SHUNT TRIP, 24VDC REMOTE CLOSE, 24VDC SPRING CHARGING MOTOR, OVERCURRENT TRIP SWITCH, AND EIGHT (8) FORM C AUXILIARY CONTACTS.
3. REACTANCE PANEL FURNISHED BY COGENERATION VENDOR, INSTALLED AND WIRED BY ELECTRICAL CONTRACTOR
4. CONDUCTORS SHALL NOT EXCEED 25'-0".
5. PROVIDE DEVICE WITH FOUR (4) FORM C AUXILIARY CONTACTS.
6. PROVIDE DRAW-OUT MOUNTED, POWER CIRCUIT BREAKERS WITH 24VDC SHUNT TRIP, 24VDC REMOTE CLOSE, 24VDC SPRING CHARGING MOTOR, OVERCURRENT TRIP SWITCH, EIGHT (8) FORM C AUXILIARY CONTACTS, AND CRADLE POSITION SWITCHES.
7. PROVIDE DEVICE WITH 24VDC SHUNT TRIP AND TWO (2) FORM C AUXILARY CONTACTS.

## KEY INTERLOCKS

K1 PROVIDE KEY INTERLOCK BETWEEN 89U1, 89U2 AND 52T TO PREVENT PARALLELING OF UTILITY SOURCES. INTERLOCK SHALL ALLOW SIMULANEOUS CLOSURE OF ONLY TWO (2) DEVICES.

K2 PROVIDE KEY INTERLOCK ON 89U1 & 89U2 TO PREVENT CLOSURE OF THE DEVICE WITHOUT THE PRESENCE AND CAPTURE OF THE ASSOCIATED KEY. ONE (1) ADDITIONAL KEY SWITCH SHALL BE SUPPLIED LOOSE FOR INSTALLATION IN THE UTILTY PROTECTION PANEL TO ESTABLISH ELECTRICAL INTERLOCK WITH 52IT (SEE DETAIL 1 DRAWING E5.04 FOR ADDITIONAL DETAILS). EACH KEY SWITCH SHALL HAVE TWO (2) SETS OF FORM C CONTACTS.




1 / E-301 ONE-LINE DIAGRAM
SCALE: NONE

### CONTROL WIRING SCHEDULE

| NO. | WIRING TYPE | NUMBER | SPARES | TOTAL | CONDUIT |
|---|---|---|---|---|---|
| C1 | 1/C #10 MULTISTRANDED (120VAC) | 4 | -- | 4 | ¾" C |
| C2 | 1/C #14 MULTISTRANDED (120VAC) | 4 | 2 | 6 | ¾" C |
| C3 | 1/C #14 MULTISTRANDED (120VAC) | 2 | 2 | 4 | ¾" C |
| C4 | 1/C #14 MULTISTRANDED (120VAC) | 3 | -- | 3 | ¾" C |
| C5 | 1/C #14 MULTISTRANDED (24VDC) | 2 | 2 | 4 | ¾" C |
| C6 | 1/C #14 MULTISTRANDED | 4 | 2 | 6 | ¾" C |
| C7 | 1/C #14 MULTISTRANDED | 8 | 2 | 10 | ¾" C |
| C8 | 2/C #16 TWISTED, SHIELDED PAIR | 1 | 1 | 2 | ¾" C |

### FEEDER SCHEDULE

| NO. | PHASE | NEUTRAL | GROUND | CONDUIT |
|---|---|---|---|---|
| A | 12 SETS OF 3 #600 MCM | 12 #600MCM | 12#600MCM | 12-4" C |
| B | 6 SETS OF 3 #500 MCM | 6 #500 MCM | 6 #4/0 | 6-4" C |
| C | 3 SETS OF 3 #500 MCM | 3 #500MCM | 3 #2/0 | 3-3½" C |
| D | 2 SETS OF 3 #500 MCM | 2 #500 MCM | 2 #1/0 | 2-3½" C |
| E | 2 SETS OF 3 #350 MCM | 2 #350 MCM | 2 #1 | 2-3" C |
| F | 2 SETS OF 3 #300 MCM | --- | 2 #1 | MINERAL INSLUATED CABLE |
| G | 3 #500 MCM | 1#500 MCM | 1 #2 | 1-3½" C |
| H | 3 #4/0 | 1 #4/0 | 1 #4 | 1-2½" C |
| J | 3 #3/0 | --- | 1 #6 | 2½" C |
| K | 3 #3/0 | 1 #3/0 | 1 #6 | 2" C |
| L | 3 #1/0 | 1 #1/0 | 1 #6 | 2" C |
| M | 3 #1 | --- | 1 #6 | MINERAL INSLUATED CABLE |
| N | 3 #2 | 1 #2 | 1 #8 | 1 ½" C |
| O | 3 #4 | --- | 1 #8 | MINERAL INSLUATED CABLE |
| P | 3 #8 | --- | 1 #10 | MINERAL INSLUATED CABLE |
| R | 3 #8 | --- | 1 #10 | 1" C |
| S | 4 SETS OF 3 #500 MCM | 4 #500MCM | 4 #3/0 | 3-3½" C |
| T | 2 #10 | --- | 1 #10 | ¾" C |
| U | 2 #3 | 1 #3 | 1 #8 | 1¼"C |
| V | 3 #10 | --- | 1 #10 | ¾" C |
| W | 3 #6 | 1 #6 | 1 #10 | 1" C |
| X | 4 SETS OF 3 #350 MCM | 4 #350MCM | 3 #3/0 | 4-3 ½" C |

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| No. | Date | Issue |
|---|---|---|
| 3 | 4-28-2008 | UPDATE REVISIONS |
| 2 | 2-12-2008 | BULLETIN 17 |
| 1 | 11-16-2007 | MAIN SWITCHGEAR REVISIONS |
| | 6-12-2007 | POWER DIST. VALUE ENG |
| | 5-15-2007 | COGEN & CHILLER REVISIONS |
| | 4-12-2007 | ISSUED FOR CONSTRUCTION |
| | 3-2-2007 | ISSUED FOR PRICING |
| | 2-9-2007 | ISSUED FOR D.O.B. |
| | 2-2-2007 | 90% REVIEW SET |
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| | 10-20-2006 | 75% DESIGN DEVELOPMENT |

Sheet Name: ONE-LINE DIAGRAM



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Sheet No.: E-301

## G. *Energy Management (EMS) Control System*

The CHP plant will be fully automated with the installation of a direct digital control system to control electrical and thermal output of the plant. In addition the following equipment is microprocessor controlled with communication to the main EMS system through the industry standard modbus interface:

1. Tecogen CM-100 units
2. Chiller Absorber
3. Utility grade multi-function relay.

The control system will also be used to trend log data points and generate performance reports for selected periods of operation. Following are the EMS control points schedule for the project.

**The EMS system for the project is based on the automated logic hardware and software.*

SYSTEM CONTROL POINTS SCHEDULE

ALL INPUT AND OUTPUT POINTS ARE DISCRETE AND HARD WIRED UNLESS INDICATED OTHERWISE.

| UNIT TAG | DESCRIPTION | DIGITAL INPUTS 1: RUN INDICATION/CURRENT TR. | 2: POSITION - VALVE/DAMPER | 3: RUN INDICATION-DIFF. PRESS. | 4: . | 5: . | 6: . | 7: . | 8: . | 9: SPARE | 10: METER PULSE | DIGITAL OUTPUTS 1: CONTROL ON/OFF | 2: RAMP ENABLE/DISABLE | 3: CONTROL-VALVE/DAMPER | 4: LOAD SHED FUNCTION | 5: . | 6: . | 7: . | 8: . | 9: SPARE | 10: UNIT SIGNAL TO PUMP RELAY IN MCC | ANALOG INPUTS 1: KW LEVEL CONFIRM | 2: ENTERING WATER TEMP | 3: LEAVING WATER TEMP | 4: O.A. TEMP. | 5: ENTERING AIR TEMP. | 6: LEAVING AIR TEMP. | 7: SYSTEM PRESSURE | 8: VFD-OPERATING SPEED-Hz | 9: FLOW RATE | 10: 4-20MA SIGNAL | ANALOG OUTPUTS 1: KW LEVEL CONTROL | 2: CONTROL VALVE/DAMPER | 3: . | 4: 0-12 VOLT | 5: VFD CONTROL - 4-20MA | 6: VFD CONTROL - PRESSURE | 7: . | 8: . | 9: . | 10: 4-20 MA SIGNAL | COMMUNICATIONS AND INTERFACES 1: PHONE CABLE TO UNIT | 2: MODBUS INTERFACE TO EMS | 3: RS 232 INTERFACE TO EMS | 4: RS 485 INTERFACE | 5: . | 6: . | 7: . | 8: METER PULSE | SOFTWARE ALARMS 1: FAILURE | 2: HIGH TEMPERATURE | 3: . | 4: . | 5: . | 6: . | 7: . | 8: SPARE | ALARM SHUTDOWNS 1: SHUTDOWN COGEN PLANT | 2: SHUTDOWN COGEN UNIT | 3: SHUTDOWN AHU/RTU | 4: . | 5: . | 6: . | 7: . | 8: SPARE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COGEN UNITS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CG-1 | GOGEN UNIT 1 | X | | | | | | | | | | X | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | COORDINATE W/ SWITCHGEAR |
| CG-2 | GOGEN UNIT 2 | X | | | | | | | | | | X | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | COORDINATE W/ SWITCHGEAR |
| CG-3 | GOGEN UNIT 3 | X | | | | | | | | | | X | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | COORDINATE W/ SWITCHGEAR |
| CG-4 | GOGEN UNIT 4 | X | | | | | | | | | | X | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | COORDINATE W/ SWITCHGEAR |
| CG-5 | GOGEN UNIT 5 | X | | | | | | | | | | X | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | COORDINATE W/ SWITCHGEAR |
| CG-5 | GOGEN UNIT 6 | X | | | | | | | | | | X | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | COORDINATE W/ SWITCHGEAR |
| | PUMPS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CGP-1 | COGEN PUMP (CG-1) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CGP-2 | COGEN PUMP (CG-2) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CGP-3 | COGEN PUMP (CG-3) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CGP-4 | COGEN PUMP (CG-4) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CGP-5 | COGEN PUMP (CG-5) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CGP-6 | COGEN PUMP (CG-6) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CGP-7,8 | COGEN HOT WATER LOOP | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | X | | | | | | | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CGP-9 | ABSORBER CHILLER (CH-1) | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CGP-10 | GENERATOR/ELECTRONICS COOLING | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CGP-11 | GENERATOR/ELECTRONICS COOLING | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| BP-1 | BOILER PUMP (B-1) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BP-2 | BOILER PUMP (B-2) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BP-3 | BOILER PUMP (B-3) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BP-4 | BOILER PUMP (B-4) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BP-5 | BOILER PUMP (B-5) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BP-6 | BOILER PUMP (B-6) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HWP-1 | HVAC LOOP (FAN COIL RISERS) | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | X | | | | | | | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| HWP-2 | HVAC LOOP (FAN COIL RISERS) | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | X | | | | | | | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| HWP-5,6 | DHW LOOP | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| HWP-7,8 | DRYCOOLER LOOP (FLC-1) | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CWP-1 | ABSORBER CHILLER CH-1 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CWP-2 | CHILLED WATER CH-2 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CWP-3 | CHILLED WATER CH-3 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CWP-4,5 | CHILLED WATER DISTRIBUTION LOOP | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | X | | | | | | | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CWP-6 | CHILLER ECONOMIZER HX-4 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CWP-7 | CHILLER ECONOMIZER CH-4 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CDP-1 | CONDENSER WATER CH-1 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CDP-2 | CONDENSER WATER CH-2 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CDP-3 | CONDENSER WATER CH-3 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CDP-4 | CHILLER ECONOMIZER FLC-2/HX-7 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CDP-5 | CONDENSER WATER CH-4 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| | BOILERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B-1 | BOILER #1 | X | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| B-2 | BOILER #2 | X | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| B-3 | BOILER #3 | X | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| B-4 | BOILER #4 | X | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| B-5 | BOILER #5 | X | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| B-6 | BOILER #6 | X | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| | CHILLER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CH-1 | ABSORBER CHILLER | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | |
| CH-2 | ELECTRIC CHILLER | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | |
| CH-3 | ELECTRIC CHILLER | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | |
| CH-4 | ELECTRIC CHILLER | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | |
| HX-4 | GLYCOL CHILLER ECONOMIZER | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | X | | | | | X | | | | | | | | | | | | | | | | |
| | COOLING TOWER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CT-1 | COOLING TOWER - FAN 1 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | X | | | | | | | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CT-1 | COOLING TOWER - FAN 2 | X | | | | | | | | | | X | | | X | | | | | | | | | | | | | | X | | | | | | | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| | DRYCOOLER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FLC-1 | FLUID COOLER-COGEN HEAT REJECTION | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | PROVIDE CONTROL DEVICES AND WIRING FOR INDIVIDUAL FAN CONTROL ON MULTIPLE FAN FLUID COOLERS |
| FLC-2 | FLUID COOLER-CHILLED WTR ECONOMIZER | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FLC-3 | FLUID COOLER-COGEN GEN./ELEC. CLG. | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | FANS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EF-1 | GARAGE VENTILATION - BASEMENT | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EF-2 | GARAGE VENTILATION - 2ND FLOOR | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EF-3 | TOILET EXHAUST | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EF-4 | TOILET EXHAUST | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EF-5 | COGEN CABINET EXHAUST | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | AIR HANDLING UNITS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU-1 | RESIDENTIAL VENTILATION | X | | | | | | | | | | X | | | X | | | | | | | | X | X | X | X | X | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU-2 | CORRIDOR VENTILATION | X | | | | | | | | | | X | | | X | | | | | | | | X | X | X | X | X | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU-3 | RESIDENTIAL VENTILATION | X | | | | | | | | | | X | | | X | | | | | | | | X | X | X | X | X | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU-4 | CORRIDOR VENTILATION | X | | | | | | | | | | X | | | X | | | | | | | | X | X | X | X | X | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU-5 | GENERAL VENTILATION | X | | | | | | | | | | X | | | X | | | | | | | | X | X | X | X | X | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU-6 | POOL | X | | | | | | | | | | X | | | X | | | | | | | | X | X | X | X | X | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | LOUVERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L-1 | GARAGE VENTILATION - BASEMENT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L-2 | GARAGE VENTILATION - 2ND FLOOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L-3 | GARAGE MUA - BASEMENT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | PROVIDE DIRECT ELECTRIC INTERLOCK WITH ASSOCIATED FAN OR EQUIPMENT AS APPROPRIATE. |
| L-4 | GARAGE MUA - 2ND FLOOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L-5 | GENERAL VENTILATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L-6 | TOILET ROOM EXHAUST | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | MISCELLANEOUS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CV-1 | COOLING TOWER BYPASS | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CV-2 | HX-2 BYPASS | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CV-3 | DRYCOOLER FLC-1 BYPASS | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| CV-4 | FAN COIL LOOP - TEMP RESET | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | |
| P-1 | SYSTEM PRESSURE | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FM-1 | DIGITAL FLOW METER - COGEN HW | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FM-2 | DIGITAL FLOW METER - BOILER LOOP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FM-3 | DIGITAL FLOW METER-SEC. CHILLED WTR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FM-4 | DIGITAL FLOW METER - BLDG. HTG. HW | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | GAS METER - COGEN | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | |
| | GAS METER - BOILERS | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | |
| | GAS METER - RESIDENTIAL | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | |
| SM-1 | SOUND METER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | AT 5TH FLOOR ROOF |
| | POWER SYSTEMS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | RUN 8 PAIR TO BECKWITH |
| BK | BECKWITH RELAY & CONTROL PANEL | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | | | | | X | | | | | | | | X | | | | | | | | |
| DMD 2 | COGEN PANEL METER (KW) DM | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | X | | | | | | | | | | | | X | | X | | | | | | | | | | | | | | | | | | | | | |
| DMD 1 | SERVICE PANEL METER | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | X | | | | | | | | | | | | X | | X | | | | | | | | | | | | | | | | | | | | | |
| | SPARE CONTROL POINTS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | SPARE | | | | | | | | | X | | | | | | | | | | X | | | | | | | | | | | X | | | | | | | | | | X | | | | | | | | | | | | | | | | X | | | | | | | | X | SEE GENERAL NOTE "D" |
| | SPARE | | | | | | | | | X | | | | | | | | | | X | | | | | | | | | | | X | | | | | | | | | | X | | | | | | | | | | | | | | | | X | | | | | | | | X | SEE GENERAL NOTE "D" |

## GENERAL NOTES:

A. PROVIDE ELECTRONIC OPERATORS WITH PROPORTIONAL CONTROL FOR TWO-WAY AND THREE-WAY VALVES.

B. PROVIDE 4-20MA INPUT VERIFICATION OF ACTUAL POSITION OF ALL VARIABLE SPEED DRIVES.

C. PROVIDE DIGITAL INPUT FROM HOA STARTER AUXILARY CONTACTS FOR PROOF OF ACTUAL STARTER RUN INDICATION FOR ALL MOTORIZED UNITS, OR VIA CURRENT TRANSDUCER.

D. TYPE OF LOW VOLTAGE SIGNAL DEPENDENT ON SPECIFIC DEVICES. COORDINATE WITH EQUIPMENT AND CONTROL METHOD FOR PROPER TYPE. MAY BE 4-20MA, 24VAC, 24VDC, OR 0-12 VOLT DEPENDING ON SPECIFIC CONTROL LOOP AND DEVICE.

E. PROVIDE SPARE INPUTS/OUTPUTS FOR ALL FUTURE EQUIPMENT.

F. PROVIDE SPARE POINTS AS INDICATED. SPARES INCLUDE ALL PANEL EQUIPMENT, 100 FT OF CONTROL WIRING OR TUBING, OPERATION, AND COMPLETE INSTALLATION, AND 2 HOURS PROGRAMMING.

G. COGEN VENDER SHALL PROVIDE TELEPHONE SWITCHING DEVICE(S) AND ADDRESSING FOR COMMUNICATION WITH INDIVIDUAL COGEN UNITS.

H. MECHANICAL CONTRACTOR SHALL WORK WITH OWNER TO PROVIDE THREE (3) DEDICATED TELEPHONE LINES TO:

1. COGEN UNIT TELEPHONE SWITCHING DEVICE(S).
2. ABSORPTION CHILLER
3. SPARE

I. CONTROLS CONTRACTOR SHALL WORK WITH OWNER TO PROVIDE CAT V CABLE TO EMS OPERATOR INTERFACE FOR REMOTE CONNECTION TO EMS SYSTEM VIA INTERNET.

J. FOR EQUIPMENT WITH LOAD SHED CAPABILITY, PROVIDE NORMALLY OPEN, NON-RELATCHING RELAYS FOR FOR ON/OFF CONTROL THROUGH EMS. ON POWER FAILURE, EQUIPMENT WILL SHUT OFF. WHEN POWER IS RESTORED, ACTIVE EMS SIGNAL SHALL BE REQUIRED TO RESTART EQUIPMENT IF TOTAL BUILDING LOAD PERMITS. MAXIMUM KW FOR LOAD SHED CONTROL SHALL BE 450 KW (ADJUSTABLE). PRIORITIZE LOAD SHED RESTART BASED ON ENGINEERS' AND OWNERS' PRIORITY LIST.

K. PROVIDE ALL MODBUS CABLESFROM EMS SYSTEM TO DEVICES INDICATED WITH MODBUS CAPABILITY. PROVIDE INTERFACE TABLE IN EMS SOFTWARE TO AQUIRE DATA VALUES FOR EACH MODBUS CONNECTED DEVICE.

L. PROVIDE LOW VOLTAGE AND 120V CONTROL POWER AND WIRING TO ALL CONTROL DEVICES AS REQUIRED, INCLUDING CIRCUIT BREAKER, WIRING AND CONDUIT TO NEAREST POWER PANEL.

M. PROVIDE 22" WIDESCREEN LCD MONITOR AT CONTROL SYSTEM INTERFACE.

NOTES:

Structural Engineers: Severud Associates Consulting Engineers P.C. 469 Seventh Avenue New York, N.Y. 10018

Civil Engineer/Parking Consultant: 228 West 28th Street New York, NY 10001

Lighting Consultant: Vortex Lighting 1510 N Las Palmas Avenue, Suite 7 Hollywood, California 90028

Mechanical Engineers: ENERGY CONCEPTS 25 Chapel Street, Suite 902 Brooklyn, N.Y. 11201

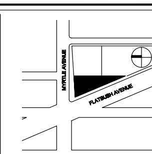
Acoustical/Audio Consultant: Cerami & Associates 404 Fifth Avenue New York, NY 10018

Vertical Transportation Consultant: Van Deusen Associates 1510 N Las Palmas Avenue, Suite 7 Hollywood, California 90028

Architect: SOM SKIDMORE, OWINGS & MERRILL LLP 14 Wall Street New York, NY 10005

MYRTLE AVENUE CONDOMINIUMS
Brooklyn, New York

Client: BFC Partners 2228 First Avenue New York, New York 10029




| No. | Date | Issue |
|---|---|---|
| 1 | 4-28-2008 | UPDATE REVISIONS |
| | 5-15-2007 | COGEN & CHILLER REVISIONS |
| | 4-12-2007 | ISSUED FOR CONSTRUCTION |
| | 3-2-2007 | ISSUED FOR PRICING |
| | 2-9-2007 | ISSUED FOR D.O.B. |
| | 2-2-2007 | 90% REVIEW SET |
| | 11-10-2006 | 100% DESIGN DEVELOPMENT |
| | 10-20-2006 | 75% DESIGN DEVELOPMENT |

Sheet Name: SYSTEM CONTROL POINT SCHEDULE



Date: 00.00.00
Scale: AS NOTED
SOM Job No.: 206144
CAD File Name: 06019-m403.dwg
Sheet No.: M-403

saved on 3/9/2009 12:44 PM by mlsml, plotted on 3/9/2009 12:44 PM by mlsml

# SYSTEM CONTROL POINTS SCHEDULE

| UNIT TAG | DESCRIPTION | DIGITAL INPUTS | | | | | | | | | | DIGITAL OUTPUTS | | | | | | | | | | ANALOG INPUTS | | | | | | | | | | ANALOG OUTPUTS | | | | | | | | | | COMMUNICATIONS AND INTERFACES | | | | | | | | SOFTWARE ALARMS | | | | | | | | ALARM SHUTDOWNS | | | | | | | | REMARKS |
| | | 1 RUN INDICATION/CURRENT TR. | 2 POSITION - VALVE/DAMPER | 3 RUN INDICATION-DIFF. PRESS. | 4 . | 5 . | 6 . | 7 . | 8 . | 9 SPARE | 10 METER PULSE | 1 CONTROL ON/OFF | 2 RAMP ENABLE/DISABLE | 3 CONTROL-VALVE/DAMPER | 4 . | 5 . | 6 . | 7 . | 8 . | 9 SPARE | 10 UNIT SIGNAL TO PUMP RELAY IN MCC | 1 KW LEVEL CONFIRM | 2 WATER TEMP | 3 WATER TEMP | 4 O.A. TEMP. | 5 ENTERING AIR TEMP. | 6 LEAVING AIR TEMP. | 7 SYSTEM PRESSURE | 8 VFD-OPERATING SPEED-Hz | 9 FLOW RATE | 10 4-20MA SIGNAL | 1 KW LEVEL CONTROL | 2 CONTROL VALVE/DAMPER | 3 . | 4 0-12 VOLT | 5 VFD CONTROL - TEMP. | 6 VFD CONTROL - PRESSURE | 7 . | 8 . | 9 . | 10 4-20 MA SIGNAL | 1 PHONE CABLE TO UNIT | 2 MODBUS INTERFACE TO EMS | 3 RS 232 INTERFACE TO EMS | 4 RS 485 INTERFACE | 5 . | 6 . | 7 . | 8 METER PULSE | 1 FAILURE | 2 HIGH TEMPERATURE | 3 . | 4 . | 5 . | 6 . | 7 . | 8 SPARE | 1 SHUTDOWN COGEN PLANT | 2 SHUTDOWN COGEN UNIT | 3 SHUTDOWN RTU | 4 . | 5 . | 6 . | 7 . | 8 SPARE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TS-1 | CG-1 RETURN WATER TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | . |
| TS-2 | CG-2 RETURN WATER TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-3 | CG-3 RETURN WATER TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-4 | CG-4 RETURN WATER TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-5 | CG-5 RETURN WATER TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-6 | (FUTURE) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-19 | CGHWS MAIN LOOP BEFORE BOILERS | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-20 | CGHWS MAIN LOOP AFTER BOILERS | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-21 | ABSORBER CHILLER CH-1 IN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-22 | ABSORBER CHILLER CH-1 OUT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-23 | ABSORBER CHILLER CH-1 OUT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-24 | HX-1&2 HOT SIDE IN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-25 | HX-1&2 HOT SIDE OUT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-26 | HX-1&2 CGV-2 CGWR | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-27 | CGWR AT COGEN LOOP CONNECTION | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-28 | HX-1 COLD SIDE OUT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-29 | HX-1 COLD SIDE IN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-30 | HX-2 COLD SIDE OUT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-31 | HX-2 COLD SIDE IN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-32 | CGHWS TO DOMESTIC WATER HEATING | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-33 | CGHWR FROM DOMESTIC WATER HEATING | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-34 | HX-3 HOT SIDE IN (CGHWR FROM SYSTEM) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-35 | HX-3 HOT SIDE OUT (CGHWR TO UNITS) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-36 | HX-3 COLD SIDE IN (FROM FLC-1) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-37 | HX-3 COLD SIDE OUT (TO FLC-1) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-38 | GR FROM FLC-3 (COGEN ELEC. CLG.) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-39 | GR TO FLC-3 (COGEN ELEC. CLG.) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-40 | GR FROM COGEN UNITS (ELEC. CLG.) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-41 | GS TO COGEN UNITS (ELEC. CLG.) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-42 | CGHWR TO COGEN UNITS | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-43 | CGHWS TO BOILER LOOP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-44 | BOILER 1 LWT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-45 | BOILER 2 LWT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-46 | BOILER 3 LWT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-47 | BOILER 4 LWT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-48 | BOILER 5 LWT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-49 | BOILER 6 LWT | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-50 | BUILDING HEATING WATER SUPPLY TEMP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-51 | BUILDING HEATING WATER RETURN TEMP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-60 | CH-1 CHILLED WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-61 | CH-1 CHILLED WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-62 | CH-1 CONDENSER WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-63 | CH-1 CONDENSER WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-64 | CH-4 CHILLED WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-65 | CH-4 CHILLED WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-66 | CH-4 CONDENSER WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-67 | CH-4 CONDENSER WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-68 | CH-2 CHILLED WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-69 | CH-2 CHILLED WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-70 | CH-2 CONDENSER WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-71 | CH-2 CONDENSER WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-72 | CH-3 CHILLED WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-73 | CH-3 CHILLED WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-74 | CH-3 CONDENSER WATER SUPPLY | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-75 | CH-3 CONDENSER WATER RETURN | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-76 | PRIMARY CHILLED WATER SUPPLY TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-77 | PRIMARY CHILLED WATER RETURN TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-78 | CONDENSER WATER SUPPLY TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-79 | CONDENSER WATER RETURN TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-80 | COOLING TOWER BASIN TEMP (CELL 1) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-81 | COOLING TOWER BASIN TEMP (CELL 2) | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-82 | DUAL TEMP WATER SUPPLY TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-83 | DUAL TEMP WATER RETURN TEMP | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-100 | OUTSIDE AIR | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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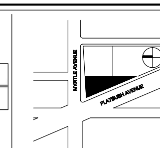



| No. | Date | Issue |
|---|---|---|
| 3 | 3-3-2009 | TEMP SENSOR REVISIONS |
| 2 | 2-17-2009 | TEMP SENSOR REVISIONS |
| 1 | 4-28-2008 | UPDATE REVISIONS |
| | 5-15-2007 | COGEN & CHILLER REVISIONS |
| | 4-12-2007 | ISSUED FOR CONSTRUCTION |
| | 3-2-2007 | ISSUED FOR PRICING |
| | 2-9-2007 | ISSUED FOR D.O.B. |
| | 2-2-2007 | 90% REVIEW SET |
| | 11-10-2006 | 100% DESIGN DEVELOPMENT |
| | 10-20-2006 | 75% DESIGN DEVELOPMENT |

Seal

Sheet Name:
SYSTEM CONTROL POINT SCHEDULE CONTINUED



Date: 00.00.00
Scale: AS NOTED
SOM Job No.: 206144
CAD File Name: 06019-m404.dwg
Sheet No.: M-404

saved on 3/4/2009 3:00 PM by mlaeel, plotted on 3/9/2009 12:30 PM by mlaeel

# 3. Measurement and Monitoring Plan

## *A. Key Automated M&V*

The building and central plant EMS control and monitoring system will be used to perform data logging, data organization, calculations and M & V reporting for the major parameters as required by NYSERDA. The M and V schedule contained in this report describes for each M & V value the following:

a.) M&V Parameter Value Tag
b.) M&V Parameter Value Name
c.) General description of value monitored and measured.
d.) System – Thermal, Electrical , Other
e.) Specific EMS system monitoring point tags to be used for the logging of data and subsequently in associated calculation formula. These control point tags are indicated on the CHP system schematics and point schedules and are mapped out as such in the EMS control and monitoring system.
f.) Reference to the associated schematic diagram illustrating the specific value being monitored and location of the identified data points.
g.) Sampling frequency – used for data gathering for the associated data points.
h.) Logging frequency – used for defined time interval data storage of EMS monitored points.
i.) Report time interval, as separate from the sampling frequency. The reporting interval is the time period for which the data logged will be integrated, scaled and calculated to determine the specific value of the M&V parameter.
j.) Energy and/or value calculation formula to be used to determine the M&V value as indicated.

For each actual EMS system monitoring point, that is temperature, flow, pressure etc cut sheets of the actual devices specified and provided for the project are included in the appendix.

As additional reference the EMS system general logging capacities, log history file size capabilities, and other data gathering software is referenced in the appendix. The EMS system data processing capability is adequate to store and handle the subset of logged and report data required for the CHP M&V plan.

The M&V Parameter schedule lists a variety of values to be measured, both required by the NYSERDA M&V plan and also Values considered as supplemental.
Key M&V Parameters are as follows and are identified in the M&V parameter schedule:

1.) Net measured power output: These are M&V schedule tags MV-28 cogen power in Kw and MV-29 cogen power in Kwh. These are both measured by a power recorder in panel CDP-1 for the total cogen plant power. Parasitic loads will be manually measured but runtime of parasitics will be logged via the EMS system. Then the parasitics will be subtracted as a calculated value (runtime x constant) from the measured power produced.

2.) CHP net useful heat recovery: M&V point MV-8 which is MV-1 minus MV-7. This key value will also be cross-checked by totaling M&V points MV-3, MV-4, MV-5 and subtracting MV-2.

3.) Total natural gas used for the cogeneration units is measured by the EMS system from the dedicated utility gas meter and collected as MVG-1.

With these M&V values the total CHP plant efficiency can then be calculated according to the NYSERDA formula.

### B. Key Manual Instrument M&V

***a.)*** Parasitic loads for the CHP plant such as the cogeneration unit circulating pumps; the dry-cooler excess heat rejection fans and the electronics cooling circuit pumps and fans will be manually measured for their respective current draw and parasitic watts. However, these items will be logged by the EMS system for hours of operation. Net parasitic load will then be for each component: (Manually measured Kw X EMS system logged run time.).

***b.)*** A similar method will be used to measure cogeneration unit air emissions. Manual measurements will be made at a set power operating level for each unit for NOx and CO. Totals for emissions will be based on unit run hours and unit Kw operating levels times the measured emissions.

### C. Supplemental Automated M&V

***a)*** Various supplemental but useful parameters are to be measured and reported along with the base required M&V parameters. These include but are not necessarily limited to the following:
MV-2 Supplemental boiler heat.
MV-3 Absorber chiller heat used.
Mv-4 Building HVAC heat.
MV-5 Domestic hot water heat.
MV-9 Absorber Chiller cooling in tons.
MV-30 Utility power Kw
MV-31 utility power in Kwh
MV-32, MV-33 Total building Kw and Kwh.

***b)*** EMS logs will also be established using MODBUS data gathered from the cogeneration units for power, run time, and thermal output, as well as other parameters.

***c)*** EMS logs will also gather data from the absorber chiller and the multifunction utility power protection relay.

### D. M&V Value Schedule

***a)*** The project M&V schedule follows. Note that both key and critical M&V values are listed along with supplemental values.

***b)*** The M&V tags and names are consistent for reporting purposes. Point schedule tags shown in the M&V value schedule directly map to the actual project EMS point schedules and system schematics, and automated logic control submittals.

**The Toren - Myrtle Avenue Builders** Date: Mar 9, 2009

**CHP Plant Monitoring - Measurement and Verification Schedule - M&V Values to be recorded and calculated**

| M & V Value Tag | Monitoring Value Name | Description and Value Measured | System | Point Schedule Tag 1 Log Data | Point Schedule Tag 2 Log Data | Point Schedule Tag 3 Log Data | Constant Formula Value | Schematic Diagram | Sampling Frequency | Logging Time Interval | Report Time Interval | Energy Value Calculated | Energy Formula | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MV-1** | **Cogeneration Heat** | Total gross heat in therms recovered from the cogeneration units. CG-1 thru CG-5 | Thermal | FM-1, Flow In GPM | Ts -43 | Ts -42 | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | (500 X GPM X (T2-T3)) / 100,000 | |
| **MV-2** | **Boiler Heat** | Total gross heat in therms provided by the boilers B1 - B6 | Thermal | FM-2, Flow In GPM | Ts -20 | Ts -19 | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | (500 X GPM X (T2-T3)) / 100,000 | |
| **MV-3** | **Chiller Heat** | Total gross heat in therms used by absorber CH-1 | Thermal | CGP-9 700 GPM | Ts -21 | Ts -23 | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | (500 X GPM X (T2-T3)) / 100,000 | Fixed flow from final balancing report |
| **MV-4** | **Building HVAC Heat** | Total gross heat in therms used by building HVAC. | Thermal | FM-2, Flow In GPM | Ts -24 | Ts -26 | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | (500 X GPM X (T2-T3)) / 100,000 | |
| **MV-5** | **DHW Heat** | Total gross heat in therms used by domestic hot water. | Thermal | HWP-5&6 300 GPM | Ts -33 | Ts -32 | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | (500 X GPM X (T2-T3)) / 100,000 | Fixed flow from final balancing report |
| **MV-6** | **Total CHP Heat** | Total gross heat in therms recovered from the cogen units and boilers. | Thermal | FM-2, Flow In GPM | Ts -20 | Ts -27 | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | (500 X GPM X (T2-T3)) / 100,000 | |
| **MV-7** | **Drycooler Heat** | Total gross heat in therms rejected to atmosphere from CHP plant. | Thermal | FM-1, Flow In GPM | Ts -35 | Ts -34 | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | (500 X GPM X (T2-T3)) / 100,000 | |
| **MV-8** | **Net Useful Recovery** | Total Heat produced minus net drycooler rejected heat. Total CHP heat Minus Drycooler heat rejection. | Thermal | | | | | M-301 | 20 seconds | 15 minutes | Hourly | Therms | MV-1 minus MV-7 | |
| **MV-9** | **Chiller Heating Energy** | Cooling that should be produced by the chiller based on therms in. | Thermal | | | | | M-301 | 20 seconds | 15 minutes | Hourly | Tons Cooling | (MV-3)*100,000/17,800 | |
| **MVG-1** | **Cogen Gas Use** | Cogen gas use from utility meter | Thermal | | | | | | | | | | | |
| **MVG-2** | **Boiler Gas Use** | Boiler gas use from utility meter | Thermal | | | | | | | | | | | |
| **MV-10** | **Chiller Cooling Energy** | Cooling in tons to building. Entire chiller plant. | Thermal | FM-3, Flow In GPM | Ts -83 | Ts -82 | | M-302 | 20 seconds | 15 minutes | Hourly | Tons Cooling | (500 X GPM X (T2-T3)) / 12,000 | |
| **MV-11** | **Absorber Cool Log** | Tons cooling from ABS-1 Modbus Interface. | Thermal | Data Value | | | | M-302 | 20 seconds | 15 minutes | Hourly | Tons Cooling | (500 X GPM X (T2-T3)) / 12,000 | Fixed flow from final balancing report |
| **MV-12** | **Cogen CG-1 Heat Rec** | Total gross recovered heat in therms provided by the cogen unit CG1 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-13** | **Cogen CG-1 Gas Input** | Total gas input in therms for cogen unit CG1 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |

**The Toren - Myrtle Avenue Builders** Date: Mar 9, 2009

**CHP Plant Monitoring - Measurement and Verification Schedule - M&V Values to be recorded and calculated**

| M & V Value Tag | Monitoring Value Name | Description and Value Measured | System | Point Schedule Tag 1 Log Data | Point Schedule Tag 2 Log Data | Point Schedule Tag 3 Log Data | Constant Formula Value | Schematic Diagram | Sampling Frequency | Logging Time Interval | Report Time Interval | Energy Value Calculated | Energy Formula | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MV-14** | **Cogen CG-1 Run Time** | Total time of operation for cogen unit CG1 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-15** | **Cogen CG-1 Down Time** | Total time cogen unit is disabled due to alarm condition for cogen unit CG1 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-16** | **Cogen CG-2 Heat Rec** | Total gross recovered heat in therms provided by the cogen unit CG2 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-17** | **Cogen CG-2 Gas Input** | Total gas input in therms for cogen unit CG2 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-18** | **Cogen CG-2 Run Time** | Total time of operation for cogen unit CG2 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-19** | **Cogen CG-2 Down Time** | Total time cogen unit is disabled due to alarm condition for cogen unit CG2 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-20** | **Cogen CG-3 Heat Rec** | Total gross recovered heat in therms provided by the cogen unit CG3 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-21** | **Cogen CG-3 Gas Input** | Total gas input in therms for cogen unit CG3 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-22** | **Cogen CG-3 Run Time** | Total time of operation for cogen unit CG3 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-23** | **Cogen CG-3 Down Time** | Total time cogen unit is disabled due to alarm condition for cogen unit CG3 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-20** | **Cogen CG-4 Heat Rec** | Total gross recovered heat in therms provided by the cogen unit CG4 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-21** | **Cogen CG-4 Gas Input** | Total gas input in therms for cogen unit CG4 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-22** | **Cogen CG-4 Run Time** | Total time of operation for cogen unit CG4 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-23** | **Cogen CG-4 Down Time** | Total time cogen unit is disabled due to alarm condition for cogen unit CG4 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-24** | **Cogen CG-5 Heat Rec** | Total gross recovered heat in therms provided by the cogen unit CG5 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-25** | **Cogen CG-5 Gas Input** | Total gas input in therms for cogen unit CG5 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-26** | **Cogen CG-5 Run Time** | Total time of operation for cogen unit CG5 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |
| **MV-27** | **Cogen CG-5 Down Time** | Total time cogen unit is disabled due to alarm condition for cogen unit CG5 | Cogen | Modbus | | | | | | 15 minutes | Hourly | | Direct Input | |

**The Toren - Myrtle Avenue Builders** Date: Mar 9, 2009
**CHP Plant Monitoring - Measurement and Verification Schedule - M&V Values to be recorded and calculated**

| M & V Value Tag | Monitoring Value Name | Description and Value Measured | System | Point Schedule Tag 1 Log Data | Point Schedule Tag 2 Log Data | Point Schedule Tag 3 Log Data | Constant Formula Value | Schematic Diagram | Sampling Frequency | Logging Time Interval | Report Time Interval | Energy Value Calculated | Energy Formula | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MV-28** | **Cogen Power in Kw** | Cogen Power in Kw | Power | CDP-1 Data Card | | | Kw | E-301 | 1 Minute | | 15 Minute | Kw | Sliding 15 minute peak. | |
| **MV-29** | **Cogen Power in Kwh** | Cogen Power in Kwh | Power | CDP-1 Data Card | | | Kwh | E-301 | 1 Minute | | Hourly | Kwh | Integrated hourly total | |
| **MV-30** | **Utility Power in Kw** | Utility Power in Kw | Power | MDP-1 Data Card | | | Kw | E-301 | 1 Minute | | 15 Minute | Kw | Sliding 15 minute peak. | |
| **MV-31** | **Utility Power in Kwh** | Utility Power in Kwh | Power | MDP-1 Data Card | | | Kwh | E-301 | 1 Minute | | Hourly | Kwh | Integrated hourly total | |
| **MV-32** | **Total Building Kw** | Kw | Power | | | | Kw | | 1 Minute | | 15 Minute | Kw | MV-12 + MV-14 | |
| **MV-33** | **Total Building Kwh** | Kwh | Power | | | | Kwh | | 1 Minute | | Hourly | Kwh | MV-13 + MV-15 | |
| **MV-34** | **Cogen Unit 1 Power** | Kw | Power | CG-1 Modbus | | | Kw | | 1 Minute | | 15 Minute | Kw | Sliding 15 minute peak. | |
| **MV-35** | **Cogen Unit 1 Power** | Kwh | Power | CG-1 Modbus | | | Kwh | | 1 Minute | | Hourly | Kwh | Integrated hourly total | |
| **MV-36** | **Cogen Unit 2 Power** | Kw | Power | CG-2 Modbus | | | Kw | | 1 Minute | | 15 Minute | Kw | Sliding 15 minute peak. | |
| **MV-37** | **Cogen Unit 2 Power** | Kwh | Power | CG-2 Modbus | | | Kwh | | 1 Minute | | Hourly | Kwh | Integrated hourly total | |
| **MV-38** | **Cogen Unit 3 Power** | Kw | Power | CG-3 Modbus | | | Kw | | 1 Minute | | 15 Minute | Kw | Sliding 15 minute peak. | |
| **MV-39** | **Cogen Unit 3 Power** | Kwh | Power | CG-3 Modbus | | | Kwh | | 1 Minute | | Hourly | Kwh | Integrated hourly total | |
| **MV-40** | **Cogen Unit 4 Power** | Kw | Power | CG-4 Modbus | | | Kw | | 1 Minute | | 15 Minute | Kw | Sliding 15 minute peak. | |
| **MV-41** | **Cogen Unit 4 Power** | Kwh | Power | CG-4 Modbus | | | Kwh | | 1 Minute | | Hourly | Kwh | Integrated hourly total | |
| **MV-42** | **Cogen Unit 5 Power** | Kw | Power | CG-5 Modbus | | | Kw | | 1 Minute | | 15 Minute | Kw | Sliding 15 minute peak. | |
| **MV-43** | **Cogen Unit 5 Power** | Kwh | Power | CG-5 Modbus | | | Kwh | | 1 Minute | | Hourly | Kwh | Integrated hourly total | |

# 4. M&V Reports and Graphs

## *A. Trend Logs and Graphs*

Following are report templates for the M&V reports to be produced. These will be provided with integrated values for hourly intervals (actual logged data will be at much smaller intervals). Reports will also be provided with daily, weekly, monthly, and annual summaries.
***Tables are shown but may also be established as multiline graphs.**

**Notes:**
**Where FM-1 indicated flow monitored and measured by EMS System.**

**The Toren Condominiums**
**225 Flatbush Avenue**
**Brooklyn, NY 11201**

| Service Electrical Power Report | | | | | | | | | | Total Plant | Total Plant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | CG-1 Output | CG-2 Output | CG-3 Output | CG-4 Output | CG-5 Output | Total Cogen | Utility Power | Total Building Load | Gas Consumption | Gas Consumption |
| | (Hourly) | (Kw) | (Kw) | (Kw) | (Kw) | (Kw) | (Kw) | (Kw) | (Kw) | (CF) | (Therms) |
| | | MV-34 | MV-36 | MV-38 | MV-40 | MV-42 | MV-28 | MV-30 | MV-32 | MVG-1 | MVG-1 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Totals** | | - | - | - | - | - | - | - | - | - | - |

**Note:**
**Totals available for weekly, monthly, and anuual usage**

**The Toren Condominiums**
**225 Flatbush Avenue**
**Brooklyn, NY 11201**

**Cogen Plant Heat Recovery Report**

| Date | Time (Hourly) | Cogen HW Flow (GPM) | Cogen HWR Temp. (F) | Cogen HWS Temp. (F) | Cogen Total Heat Recovery (therms) | Drycooler Staus | Cogen HWR From System EWT (F) | Cogen HWR To Cogens LWT (F) | Drycooler Heat Rejection (MBH) | Net Heat Recovery (MBH) | O.A. Temp. (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FM-1 | TS-42 | TS-43 | MV-1 | on/off | TS-34 | TS-35 | MV-7 | MV-8 | |
| | | | | | | | | | | | |
| **Totals** | | | | | - | | | | - | | |

**Boiler Plant Heat Report**

| Date | Time (Hourly) | Boiler HW Flow (GPM) | HWR Temp. (F) | HWS Temp. (F) | Boiler Plant Heat (therms) | O.A. Temp. (F) |
|---|---|---|---|---|---|---|
| | | FM-2 | TS-19 | TS-20 | MV-2 | |
| | | | | | | |
| **Totals** | | | | | - | |

**Total Plant Heat Report**

| Date | Time (Hourly) | Boiler Heat (MBH) | Cogen Heat Recovery (MBH) | Total Plant Heat (MBH) | O.A. Temp. (F) |
|---|---|---|---|---|---|
| | | MV-2 | MV-1 | MV-6 | |
| | | | | | |
| **Totals** | | - | - | - | |

**Note:**
**Totals available for weekly, monthly, and anuual usage**

**The Toren Condominiums**
**225 Flatbush Avenue**
**Brooklyn, NY 11201**

**Total Plant Chilled Water Report**

| Date | Time (Hourly) | Chiller ID | Chiller Status | Cogen HW Flow (GPM) | Cogen HWS Temp. (F) | Cogen HWR Temp. (F) | Cogen Input (therms) | Chilled Water Flow (GPM) | Chilled Water Return (F) | Chilled Water Return (F) | Chilled Water Produced (Tons) | O.A. Temp. (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CH-1 | on/off | 700 | TS-21 | TS-23 | MVG-1 | 700 | TS-61 | TS-60 | MV-11 | |
| | | CH-2 | on/off | -- | -- | -- | -- | 120 | TS-69 | TS-68 | MV-11 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Totals** | | | | | | | **-** | | | **Total Tons =** | - | |

**Note:**
**Totals available for weekly, monthly, and anuual usage**

**The Toren Condominiums**
**225 Flatbush Avenue**
**Brooklyn, NY 11201**

**Delivered Hot Water and Chilled Water Services Report**

| Date | Time (Hourly) | Service | Flow (GPM) | SUPPLY WATER TEMP (F) | RETURN WATER TEMP (F) | Building HVAC Heat (Therms) | Chiller Cooling Energy (Tons) | DHW Heat (Therms) | O.A. Temp. (F) |
|---|---|---|---|---|---|---|---|---|---|
| | | Heating Hot Water | FM-2 | TS-24 | TS-26 | MV-4 | | | |
| | | Chilled Water | FM-3 | TS-82 | TS-83 | | MV-9 | | |
| | | Domestic Water Heating | 300 | TS-32 | TS-33 | | | MV-5 | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| **Totals** | | | | | | - | - | - | |

**Note:**
**Totals available for weekly, monthly, and anuual usage**

**The Toren Condominiums**
**225 Flatbush Avenue**
**Brooklyn, NY 11201**

| **Annual CHP Plant Summary** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Month** | **Year** | **Cogen Plant Heat Recovery (Therms)** | **Cogen Plant Heat Rejection (Therms)** | **Total Net Plant Heat (Therms)** | **Total Cogen Gas Input (Therms)** | **Total CHP Power (kWh)** | **CHP Efficiency** |
| Jan. | | MV-1 | MV-7 | MV-8 | MVG-1 | MV-29 | (((KWH*3413)/100000))-(PST+MV-8))/MVG-1 |
| Feb. | | | | | | | |
| Mar. | | | | | | | |
| Apr. | | | | | | | |
| May | | | | | | | |
| June | | | | | | | |
| July | | | | | | | |
| Aug. | | | | | | | |
| Sept. | | | | | | | |
| Oct. | | | | | | | |
| Nov. | | | | | | | |
| Dec. | | | | | | | |
| **Totals** | | | | | | | |

**Note:**
**Totals available for weekly, monthly, and anuual usage**

## 5. Appendix

***A. Cogen Unit Manufacturer’s Data and Modbus Info***

***B. Absorption Chiller Manufacturer’s Data and Modbus Info***

***C. Electric Chiller Manufacturer’s Data***

***D. Boiler Manufacturer’s Data***

***E. EMS Controls Components***

***F. Power Meter Equipment***

***G. Sequence of Operations***

# InVerde 100

## *Features & Benefits*

- *100 kW Continuous/125 kW Peaking*
- *Standardized Interconnection*
- *Black-Start Grid-Independent Operation*
- *Premium Quality Wave Form, Voltage and Power Factor for Special Applications (e.g. computer server farms or precision instrumentation)*
- *Power Boost for Demand-Side Response*
- *Enhanced Efficiency from Variable Speed Operation*
- *Simplified Inter-Unit Controls for either Mode of Operation (parallel or standby)*
- *ETL Listed - Labeled for compliance with UL 1741 - Utility Interactive; Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*
- ***Renewable Energy Compatible, a Clean Energy Solution for Today and Tomorrow***


**UL 1741**
**Compliant**

### TECOGEN, Inc.

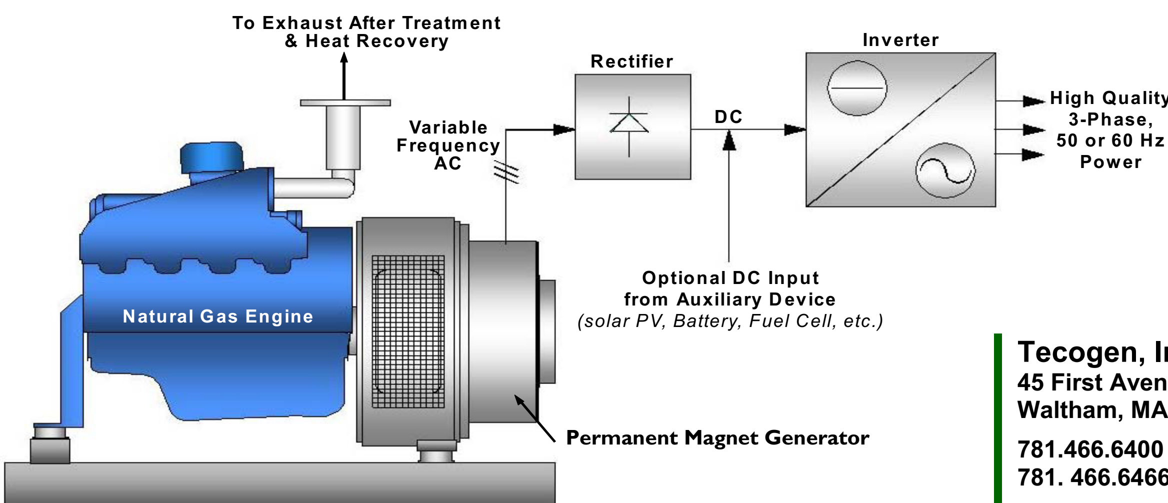
- Over 25 years experience in packaged cogeneration, chillers and refrigeration systems
- More than 1,400 operating units in the field
- Extensive service network with factory-trained technicians exclusively servicing Tecogen products

## *Specifications:* [1]

| | |
|---|---|
| **Engine** | *Proven Low-Emission Natural Gas V-8 Engine, 454 cid, 1000-3000 rpm* |
| **Generator** | *Water-Cooled Permanent Magnet Generator* |
| **Inverter** | *Customized Power Electronics with Patented Topology for Variable Speed and Standby Operation* |
| **Controls** | *TecoNet™ Microprocessor-Based System, Fully Automatic, Fault Monitoring, Lead/Lag Multiple Unit Control, Modbus Networking & Remote Telecommunications* |

| | |
|---|---|
| **Electric Output** | 100 kW Continuous / 125 kW *Peaking* [2]<br>480 VAC / 3 PH / 60 Hz |
| **Standalone Electric Capacity** | 125 kVA |
| **Thermal Output**<br>**Engine**<br>**Generator/Power Electronics** | <br>700,000 Btu/hr @ 230°F Max<br>27,000 Btu/hr @ 129°F Max |
| **Electric Efficiency**<br>**@ LHV of 905 Btu/scf**<br>**@ HHV of 1020 Btu/scf** | <br>30.4%<br>27.0% |
| **System Efficiency** [3]<br>**@ LHV of 905 Btu/scf**<br>**@ HHV of 1020 Btu/scf** | <br>92.9%<br>82.4% |
| **Gas Input** | 1238 scfh<br>1625 scfh *Peaking* |
| **Required Gas Pressure** | 10-28" wc |
| **Hot Water**<br>**Maximum Leaving Water Temperature**<br>**Maximum Entering Water Temperature** | 30 gpm<br>230 °F<br>180 ° |
| **Air Emissions** [5]<br>• **NOx**<br>• **CO**<br>• **VOC** | <br>1.5 lb/MWh<br>2.0 lb/MWh<br>1.0 lb/MWh |
| **Weight** | 4,500 lb |
| **Dimensions** | 7'4"L x 4'W x 5'.9" H |
| **ETL Listed** - Labeled for compliance with UL 1741 - Utility Interactive; Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources | |

1. *All specifications are +/- 5% and are subject to change without notice.*
2. *Peaking capacity is available for 100 hours per year only when grid connected.*
3. *Includes engine heat recovery only (not generator/power electronics heat).*
4. *Above performance data is valid up to 104 °F ambient temperature*
5. *Lower emissions options are available with the use of additional catalyst material.*

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## M.1 Description

Modbus is a standard interface used throughout the controls industry to network devices. It originated with Gould Modicon and has been implemented by a multitude of vendors. Tecogen has added the capability to communicate via this protocol to all its products. It is not the intention of this section to provide the information necessary to implement a Modbus master (the device used to control the bus), but rather to detail the controllers' responses to specific commands. Information on the modbus implementation can be found at Modicon's web site, www.modicon.com.

Modbus communications can be utilized for three separate purposes on the CM-100. These are as follows:

1. External Communications - The CM-100 can interface with a building energy management system that is Modbus compatible.
2. Master/Slave Control of Multiple CM-100 Modules - The CM-100's control system can utilize Modbus for its own internal dispatching of networked units. This scheme can be implemented to control the building power consumption, as well as to prevent a reverse power situation at the PCC. For this, a watt input is required from a building wattmeter or utility grade relay (i.e Beckwith) to the "Master" unit. Alternatively, "Master/Slave" control can also be implemented based on the Hot Water load. In this case, no external input is required.
3. RMCS - Modbus communications can be used for the RMCS if only one phoneline is desired. (A telephone switchbox is another alternative when there is only one phoneline.)

**NOTE**

*Features #1 and #3 can not be used concurrently.*

## M.2 External Communications Network

The ***TecoNet***™ controller's interface is set up as either a two-wire (and ground) RS-232 or RS-485 serial interface running at 9600 baud.

Table M.1 details the DIP switches which must be set to implement the network. These switches are on bank S4 on the Interface Board (see Figure 3.13). Switch S4-1 must be turned on to enable the network. S4-2 is used to set either the ASCII or RTU protocol. Each unit connected to the network must have a unique, non-zero address. This address is determined by switches S4-4 to S4-8, allowing addresses of 0 to 31. The address is simply the sum of all of these switches set. For example if S4-4, S4-7, and S4-8 are set, the associated values are 1, 8, and 16 and the address is 1 + 8 + 16 = 25.

The network can be set up as either single-drop, two-wire (and ground) RS-232 or multi-drop, two-wire RS-485. It is best to use the RS-485 wiring scheme since this is the most noise-immune, allows greater separation between units, and provides for connection of many units on the same set of wires. In either case, Tecogen can supply a cable, part #78158, which connects to P2 on the Processor Board (see Figures 3.12 and M.1) and terminates in a male DB-25 connector. When using the RS-232 mode, the pinout becomes a simple DCE with no flow control suitable for direct connection to a PC or other DTE device. When setting up the port for RS-485 use, DIP switch SW4-3 must be on, and the jumpers in JP5 and JP6 must be moved to their right-hand positions (see Figure 2.11). In this case, pin 16 on the DB-25 is negative and pin 17 is positive. All controllers on the network should have these two pins connected in a daisy-chain fashion. If the customer-supplied network controller does not have a two-wire RS-485, commercial converters are available.

The controller will only process a modbus message at most once every 320 milliseconds. It may therefore be necessary to relax the normal timing of the modbus controller, particularly with the RTU protocol. In addition, the RS-485 protocol is half-duplex, so it may be necessary to transmit a command more than once to ensure that the controller has received it. It is also best to wait at least 15 milliseconds after receipt of the last message before beginning a new one.

### Implementation

Each readable controller variable is mapped to one or more of the standard Modbus I/O points or internal variables. Modbus commands will then allow the polling device to read and or change these variables.

One significant deviation from the standard implementation is that, to protect the machine, there are very few variables which can be forced. The only output coils which can be forced are numbers 23, 24, and 25, the Start Flag, Network Start Flag, and Alarm Reset Flag. In general, the Start Flag should only be forced under manual control. If the network controller needs to start or stop the unit as part of normal sequencing, it should use the Network Start Flag and DIP switch 2-6 (Network Start) should be turned on. Using only this flag will show any personnel near the equipment that is is enabled and ready to start. In addition, if they wish to stop the unit, they can do so by pressing the **STOP** button. The Start Flag should be used with great care since it overrides the **START / STOP** buttons on the keypad display. Setting the Alarm Reset flag is equivalent to pressing the **RESET** button on the display. The only registers which can be forced are the holding registers in Table M.4. These values can be used to adjust the clock and the power and temperature setpoints. Only single value forcing can be done, the controller does not support forcing of multiple coils or holding registers.

Table M.2 shows the Modbus commands to which the ***TecoNet***™ will respond as well as the limits of the range argument. Tables M.3 through M.6 show the different memory range variables which can be addressed.

## M.3 Master / Slave Control

**TECOGEN**® Cogeneration Modules equipped with the ***TecoNet***™ controller can be networked to control overall building electrical consumption or the building hot water load.

### Building Power Control Mode

This is accomplished by allowing one unit, the master or lead unit, to read the building power at the utility interconnect. Through a communications channel to the other slave units, the master starts the proper number of units and controls their power to maintain imported power at a minimum.

### Installation

As shown in Figure M.2, the contractor should supply a building wattmeter with a 4-20 mA output signal. A Beckwith Relay also can be equipped with a wattage output. Using a single twisted pair, this signal is wired to the master ***TecoNet***™ on J-19 V3 (S, -) along with a 501-Ohm precision resistor. If required by the local utility, the master can monitor each of the 3 phases of incoming power separately and act on the lowest of these phases.

The master is connected to up to 30 slaves via a second, daisy-chained twisted pair (shielded). This wire connects to the Interface Board J18 +, J18 - , and the shield to ground (see Figure M.2)

Once the wiring is complete, Jumpers JP5 and JP6 on the processor board should be moved to their right-hand positions. In addition, the DIP switches should be set as indicated in Tables M.7 and M.8.

Any unit may be designated as the master. The master does not operate any differently than the other units, it is merely the unit designated to make the decisions about which units should run and at what power level. Any unit designated as the master will make this decision in the same way as any other unit.

### Operation

The master unit watches the power signal from the wattmeter(s) or Beckwith Relay. When the power rises above the minimum power at which a single **TECOGEN**® will operate, the unit with the least number of run hours will be started. The master will then control this unit's power to maintain the power imported to the building at a minimum. As power increases beyond the point where the first unit can maintain the minimum imported power, the master controller will start another slave and reduce the power on both running units to again maintain the imported power at a minimum.

As building power decreases, the master controller will reverse the sequence. In case the power drops quickly, the master will have a fast shutdown command available, allowing it to immediately disconnect the running units from the grid, preventing power export.

The master also keeps track of which units are ready to run. If any are manually shut off or are in an alarm condition, the master will use others to meet the building demand. In this manner, the plant will run with the fewest number of **TECOGEN**® units possible and thus at peak efficiency. In addition, by keeping the run hours on the units matched, they will require routine service at the same times. Finally, this is all accomplished within the ***TecoNet***™ controller, requiring only a simple wattmeter and interconnecting wire to function properly.

### Building Hot Water Control Mode

The networked group of units can be set to control water temperature rather than building load.

Hot Water Mode stages and cycles the units based upon the building hot water load. If the load is dropping off, resulting in a leaving water temperature (on any of the cogeneration units) that is too hot, the Lead will start shutting units down and/or reduce their power output. Alternatively, if this temperature becomes too cold, the Lead will turn units on and/or increase their power output. Connections to the units are identical to that used for building power control except that the wattage input is not required. Also, DIP switch S3-3 should be "Off".

## M.3 RMCS Networking

Modbus networking can be used to implement the RMCS on multiple units when only one phoneline is available. However, this feature can not be used concurrently for external Modbus communications.

For networking the RMCS, connect the phoneline to the modem of one unit. Then daisy chain the P2 connection on the other units together. Follow the DIP switch setting for a Network as described in Section M2.

| Protoc | Function | P2 | DB-25 |
|---|---|---|---|
| RS-232 | Receive | 3 | 2 |
| | Transmit | 5 | 3 |
| | Ground | 13 | 7 |
| RS-485 | - | 6 | 16 |
| | + | 8 | 17 |

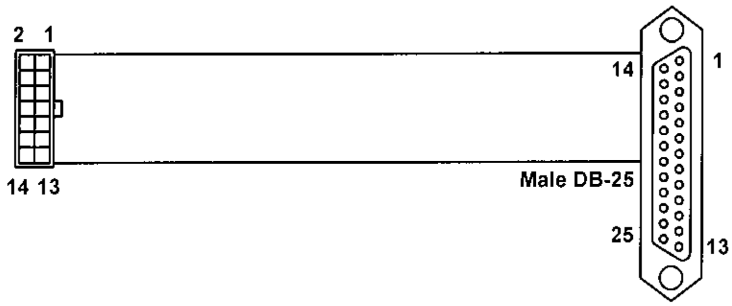


**Figure M.1 P2 Connection Diagram**

**Table M.1 Network DIP Switches– Bank 4**

| No. | Off | On |
|---|---|---|
| S4-1 | No network | Network installed |
| S4-2 | ASCII protocol | RTU protocol |
| S4-3 | RS-232 | RS-485 |
| S4-4 | Add 0 to address | Add 1 to address |
| S4-5 | Add 0 to address | Add 2 to address |
| S4-6 | Add 0 to address | Add 4 to address |
| S4-7 | Add 0 to address | Add 8 to address |
| S4-8 | Add 0 to address | Add 16 to address |

**Table M.2 Supported Commands**

| Function | Name | Minimum | Maximum | Excluded |
|---|---|---|---|---|
| 1 | Read Output Coil Status | 0 | 25 | |
| 2 | Read Input Coil Status | 0 | 103 | |
| 3 | Read Holding Registers | 0 | 44 | |
| 4 | Read Input Registers | 0 | 112 | |
| 5 | Force Output Coil | 23 | 25 | |
| 6 | Preset Single Register | 0 | 44 | |
| 7 | Read Exception Status | | | |
| 8 | Diagnostic | 0 | 20 | 9-15 |
| 11 | Read Comm Event Counter | | | |
| 12 | Read Comm Event Log | | | |
| 17 | Report Slave ID | | | |

# Modbus Networking

### Table M.3 Output Coils

| No. | Use |
|---|---|
| 0 | Fuel valve step command |
| 1 | Fuel valve open command |
| 2 | O2 sensor 1 heater |
| 3 | O2 sensor 2 heater |
| 4 | Gas / Ignition relay |
| 5 | Engine starter relay |
| 6 | Pump relay |
| 7 | Contactor relay |
| 8 | Alarm relay |
| 9 | Radiator fan output |
| 10 | Inverter wakeup |
| 11 | Hourmeter |
| 12 | EFLH meter |
| 13 | Unit started |
| 14 | Load shed |
| 15 | Customer output |
| 16 | Ready LED |
| 17 | Startup LED |
| 18 | Run LED |
| 19 | Shutdown LED |
| 20 | Alarm LED |
| 21 | Start LED |
| 22 | Stop LED |
| 23 | Start flag |
| 24 | Network start flag |
| 25 | Alarm reset flag |

### Table M.4 Input Coils

| No. | Use |
|---|---|
| 0 | High water pressure switch |
| 1 | Low water pressure switch |
| 2 | Low oil pressure switch |
| 3 | Low oil level switch |
| 4 | Ignition power verify |
| 5 | Emergency stop verify |
| 6 | Protective relay input |
| 7 | Customer run switch |
| 8 | Standby run input |
| 9 | Temperature control mode |
| 10 | Unused |
| 11 | Unused |
| 12 | Counter 1 |
| 13 | Counter 2 |
| 14 | Counter 3 |
| 15 | Counter 4 |
| 16 - 79 | Dip switch settings S1-1 to S8-8 |
| | **Inverter Status Bits** |
| 80 | Unused |
| 81 | PCS overload |
| 82 | Unused |
| 83 | Unused |
| 84 | Unused |
| 85 | Unused |
| 86 | PCS PLL OK |
| 87 | PCS AC line OK |
| 88 | PCS MG mode |
| 89 | PCS GT mode |
| 90 | Unused |
| 91 | Unused |
| 92 | Unused |
| 93 | Unused |
| 94 | PCS receive error |
| 95 | PCS system fault |
| 96 | MG feeder mode |
| 97 | MG e voltage OK |
| 98 | MG e frequency OK |
| 99 | MG PLL enable |
| 100 | MG PLL OK |
| 101 | MG PLL fault |
| 102 | MG voltage low |
| 103 | MG contactor fault |

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### Table M.5 Holding Registers

| | |
|---|---|
| 0 | Day of week (0 - 7, Sunday = 0) |
| 1 | Year (0 - 99) |
| 2 | Month (1 - 12) |
| 3 | Date (1 - 31) |
| 4 | Hour (0 - 23) |
| 5 | Minute (0 - 59) |
| 6 | Second (0 - 59) |
| 7 | Hundredth of second (0 - 99) |
| 8 | Permanent power setpoint (kW X 10) |
| 9 | Permanent Temperature setpoint (°F X 10) |
| 10 | Inverter Operation Command |
| 11 | Inverter Control Mode Command |
| 12 | Inverter Readback Command |
| 13 | Inverter Current Set |
| 14 | Microgrid Operating Mode Command |
| 15 | Microgrid Voltage Command (0.1V/Bit) |
| 16 | Microgrid Output Power Command (0.1kW/Bit) |
| 17 | Microgrid Feeder Power Command (0.1kW/Bit) |
| 18 | Microgrid Q Vs E Droop Command (0.01V/kVA/Bit) |
| 19 | Microgrid Q Max Command (0.1kVA/Bit) |
| 20 | Microgrid P Vs Frequency Droop Command (0.00001V/Hz/Bit) |
| 21 | Microgrid Max Power Command (0.1kW/bit) |
| 22 | Microgrid Min Power Command (0.1kW/bit) |
| 23 | Microgrid Feeder Power Vs Frequency Drop Command (0.00001V/Hz/Bit) |
| 24 | Microgrid Frequency Command (0.01Hz/Bit) |
| 25 | Inverter Readback Command |
| 26 | Setting For Overfrequency 1 (Hz X 10) |
| 27 | Setting For Underfrequency (Hz X 10) |
| 28 | Delay For Overfrequency 1 (cycles) |
| 29 | Delay For Underfrequency 1 (cycles) |
| 30 | Setting For Overfrequency 2 (Hz X 10) |
| 31 | Setting For Underfrequency (Hz X 10) |
| 32 | Delay For Overfrequency 2 (cycles) |
| 33 | Delay For Underfrequency 2 (cycles) |
| 34 | Setting For Overvoltage 1 (V) |
| 35 | Setting For Undervoltage 1 (V) |
| 36 | Delay For Overvoltage 1 (cycles) |
| 37 | Delay For Undervoltage 1 (cycles) |
| 38 | Setting For Overvoltage 2 (V) |
| 39 | Setting For Undervoltage 2 (V) |
| 40 | Delay For Overvoltage 2 (cycles) |
| 41 | Delay For Undervoltage 2 (cycles) |
| 42 | Grid-Tie Reconnect Delay (msec) |
| 43 | Sensitivity For Anti-Islanding |
| 44 | GT Settings Readback Command |

**Table M.6 Input Registers**

| No. | Use | No. | Use | No. | Use |
|---|---|---|---|---|---|
| 0 | Day of week (0 - 7, Sunday = 0) | 38 | Oil temperature (°F X 10) | 76 | Micogrid Faults |
| 1 | Year (0 - 99) | 39 | Enclosure temperature (°F X 10) | 77 | Micogrid VLoop |
| 2 | Month (1 - 12) | 40 | Exhaust temperature (°F X 10) | 78 | Inverter DC Voltage |
| 3 | Date (1 - 31) | 41 | Customer 1 temperature (°F X 10) | 79 | Inverter Voltage Phase A |
| 4 | Hour (0 - 23) | 42 | Customer 2 temperature (°F X 10) | 80 | Inverter Current Phase A |
| 5 | Minute (0 - 59) | 43 | Customer 3 temperature (°F X 10) | 81 | Inverter kW Phase A X 10 |
| 6 | Second (0 - 59) | 44 | Customer 4 temperature (°F X 10) | 82 | Inverter kVA Phase A X 10 |
| 7 | Hundredth of second (0 - 99) | 45 | Customer 5 temperature (°F X 10) | 83 | Inverter Voltage Phase B |
| 8 | Operating mode | 46 | Customer 6 temperature (°F X 10) | 84 | Inverter Current Phase B |
| 9 | Active alarm number | 47 | Customer 7 temperature (°F X 10) | 85 | Inverter kW Phase B X 10 |
| 10 | Active prealarm number | 48 | SKiiP temperature (°F X 10) | 86 | Inverter kVA Phase B X 10 |
| 11 | Active runback number | 49 | Catalyst outlet temperature (°F) | 87 | Inverter Voltage Phase C |
| 12 | Present power setpoint (kW X 10) | 50 | Catalyst inlet temperature (°F) | 88 | Inverter Current Phase C |
| 13 | Permanent Temperature setpoint (°F X 10) | 51 | TecoNET output coils as word | 89 | Inverter kW Phase C X 10 |
| 14 | Logic voltage (mV) | 52 | TecoNET input coils as word | 90 | Inverter kVA Phase C X 10 |
| 15 | Analog voltage (mV) | 53 | O2 sensor (mV) | 91 | Inverter Skiip Temperature |
| 16 | Battery voltage (mV) | 54 | Long-term block learn | 92 | Inverter Debug 1 |
| 17 | RPM | 55 | Short-term block learn | 93 | Inverter Debug 2 |
| 18 | Total starts | 56 | Fuel valve position (%) | 94 | Inverter Debug 3 |
| 19 | Total hourmeter (hours) | 57 | Manifold absolute pressure ("Hg X 10) | 95 | Line Voltage Phase A |
| 20 | V1 voltage (V) | 58 | Barometric absolute pressure ("Hg X 10) | 96 | Line Voltage Phase B |
| 21 | V2 voltage (V) | 59 | Customer voltage input 1 | 97 | Line Voltage Phase C |
| 22 | V3 voltage (V) | 60 | Customer voltage input 2 | 98 | Inverter Power X 10 |
| 23 | Average voltage (V) | 61 | Customer voltage input 3 | 99 | Inverter Power Percent X 10 |
| 24 | C1 current (A) | 62 | Customer voltage input 4 | 100 | Inverter Current Sum Of Mean |
| 25 | C2 current (A) | 63 | Customer voltage input 5 | 101 | Micogrid Current D (0.1A/Bit) |
| 26 | C3 current (A) | 64 | Customer voltage input 6 | 102 | Micogrid Current Q (0.1A/Bit) |
| 27 | Average current (A) | 65 | Counter 1 | 103 | Micogrid Voltage D (0.1V/Bit) |
| 28 | Power Leg 1 (X 10) | 66 | Counter 2 | 104 | Micogrid Voltage Q (0.1V/Bit) |
| 29 | Power Leg 2 (X 10) | 67 | Counter 3 | 105 | Micogrid P (0.1kW/Bit) |
| 30 | Power Leg 3 (X 10) | 68 | Counter 4 | 106 | Micogrid Q (0.1kVA/Bit) |
| 31 | Average Power (X 10) | 69 | Total energy (MW-hr) | 107 | Micogrid F (0.1kW/Bit) |
| 32 | Frequency (Hz X 10) | 70 | Total heat (MMBTU) | 108 | Micogrid E0 (0.1V/Bit) |
| 33 | Generator inlet temperature (°F X 10) | 71 | Inverter State | 109 | Micogrid Feeder Current D (0.1A/Bit) |
| 34 | Generator outlet temperature (°F X 10) | 72 | Inverter Status | 110 | Micogrid Feeder Current Q (0.1A/Bit) |
| 35 | Water inlet temperature (°F X 10) | 73 | Inverter Faults | 111 | Micogrid E Out (0.1V.bit) |
| 36 | Water outlet temperature (°F X 10) | 74 | Micogrid State | | Micogrid Frequency (0.01Hz/bit) |
| 37 | Coolant temperature (°F X 10) | 75 | Micogrid Status | | |

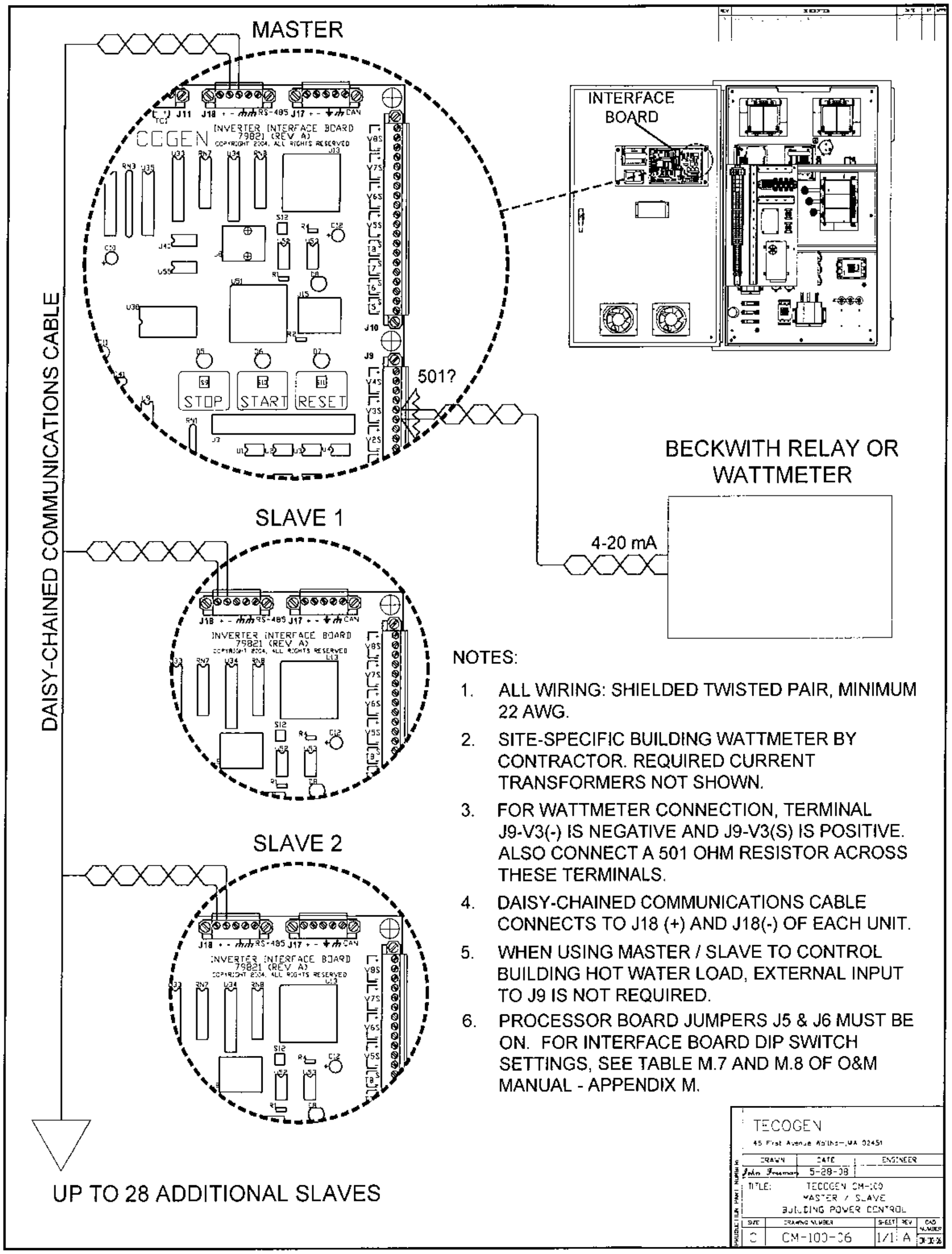



**Figure M.2 Master / Slave Wiring**

### Table M.7 Building Power Control Settings

| DIP Switch | Building Power Control Setting | Building Hot Water Control Setting |
|---|---|---|
| S3-1 | Master—ON, Slave– OFF (See Table M.7) | Master—ON, Slave– OFF (See Table M.7) |
| S3-2 | Master—OFF, Slave– ON (See Table M.7) | Master—OFF, Slave– ON (See Table M.7) |
| S3-3 | On | |
| S3-7 | On * | OFF |
| S4-1 | ON | ON |
| S4-2 | ON | ON |
| S4-3 | Master/Slave (See Table M.7) | Master/Slave (See Table M.7) |
| S4-4 | Master/Slave (See Table M.7) | Master/Slave (See Table M.7) |
| S4-5 | Master/Slave (See Table M.7) | Master/Slave (See Table M.7) |
| S4-6 | Master/Slave (See Table M.7) | Master/Slave (See Table M.7) |
| S4-7 | Master/Slave (See Table M.7) | Master/Slave (See Table M.7) |
| S4-8 | Master/Slave (See Table M.7) | Master/Slave (See Table M.7) |

* *If Beckwith Relay is used*

### Table M.8 Master/Slave Address Settings

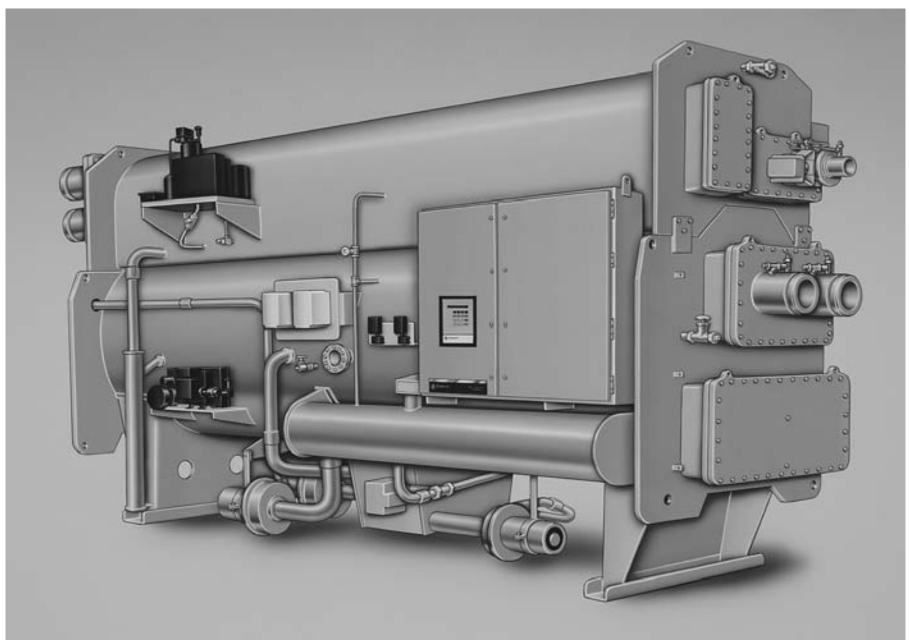
| Unit Designation | DIP Switch Settings | | | | | | |
|---|---|---|---|---|---|---|---|
| | S3-1 | S3-2 | S4-4 | S4-5 | S4-6 | S4-7 | S4-8 |
| Master | On | Off | On | Off | Off | Off | Off |
| Slave 1 | Off | On | Off | On | Off | Off | Off |
| Slave 2 | Off | On | On | On | Off | Off | Off |
| Slave 3 | Off | On | Off | Off | On | Off | Off |
| Slave 4 | Off | On | On | Off | On | Off | Off |
| Slave 5 | Off | On | Off | On | On | Off | Off |
| Slave 6 | Off | On | On | On | On | Off | Off |
| Slave 7 | Off | On | Off | Off | Off | On | Off |
| Slave 8 | Off | On | On | Off | Off | On | Off |
| Slave 9 | Off | On | Off | On | Off | On | Off |
| Slave 10 | Off | On | On | On | Off | On | Off |
| Slave 11 | Off | On | Off | Off | On | On | Off |
| Slave 12 | Off | On | On | Off | On | On | Off |
| Slave 13 | Off | On | Off | On | On | On | Off |
| Slave 14 | Off | On | On | On | On | On | Off |
| Slave 15 | Off | On | Off | Off | Off | Off | On |
| Slave 16 | Off | On | On | Off | Off | Off | On |
| Slave 17 | Off | On | Off | On | Off | Off | On |
| Slave 18 | Off | On | On | On | Off | Off | On |
| Slave 19 | Off | On | Off | Off | On | Off | On |
| Slave 20 | Off | On | On | Off | On | Off | On |
| Slave 21 | Off | On | Off | On | On | Off | On |
| Slave 22 | Off | On | On | On | On | Off | On |
| Slave 23 | Off | On | Off | Off | Off | On | On |
| Slave 24 | Off | On | On | Off | Off | On | On |
| Slave 25 | Off | On | Off | On | Off | On | On |
| Slave 26 | Off | On | On | On | Off | On | On |
| Slave 27 | Off | On | Off | Off | On | On | On |
| Slave 28 | Off | On | On | Off | On | On | On |
| Slave 29 | Off | On | Off | On | On | On | On |
| Slave 30 | Off | On | On | On | On | On | On |

M

# Trane Horizon™ Absorption Series

## Single-Stage Hot Water or Steam-Fired Absorption Water Chillers 500-1350 Tons

*Built for Industrial and Commercial Applications*



March 2006

ABS-PRC001-EN

# Performance Data

*Table PD-1. Performance data at ARI conditions*

**English Units***

| Model | Capacity (Tons) | Coefficient of Performance | Steam Rate (lbm/ton/hr) | Chilled Water Flow Rate (gpm) | Chilled Water Press. Drop (ft Wtr) | Cond/Abs Water Flow Rate (gpm)*** | Cond/Abs Water Press. Drop (ft Wtr) |
|---|---|---|---|---|---|---|---|
| ABSD500 | 571 | 0.71 | 17.71 | 1366 | 19.7 | 1800 | 27.4 |
| ABSD600 | 670 | 0.72 | 17.45 | 1603 | 30.2 | 2160 | 26.6 |
| ABSD700 | 738 | 0.71 | 17.68 | 1766 | 22.3 | 2520 | 12.2 |
| ABSD800 | 859 | 0.72 | 17.62 | 2054 | 32.6 | 2880 | 16.6 |
| ABSD975 | 998 | 0.71 | 17.91 | 2387 | 18.8 | 3510 | 33.5 |
| ABSD1100 | 1105 | 0.70 | 17.98 | 2643 | 24.6 | 3960 | 20.1 |
| ABSD1225 | 1238 | 0.70 | 17.95 | 2960 | 32.7 | 4410 | 25.7 |
| ABSD1350 | 1371 | 0.71 | 17.90 | 3279 | 42.2 | 4860 | 32.2 |

* 3.6 gpm/nominal ton, Pstm = 12 psig, TctwS = 85°F, TcwS = 44°F, TcwR = 54°F, 0.0001 evap fouling, 0.00025 cond/abs fouling

**SI Units****

| Model | Capacity (kW) | Coefficient of Performance | Steam Rate (kg/kW-hr) | Chilled Water Flow Rate ($m^3$/hr) | Chilled Water Press. Drop (m wg) | Cond/Abs Water Flow Rate ($m^3$/hr) | Cond/Abs Water Press. Drop (m wg) |
|---|---|---|---|---|---|---|---|
| ABSD500 | 2008 | 0.71 | 2.28 | 310 | 6.0 | 409 | 8.3 |
| ABSD600 | 2356 | 0.72 | 2.25 | 364 | 9.2 | 491 | 8.1 |
| ABSD700 | 2595 | 0.71 | 2.28 | 401 | 6.8 | 572 | 3.7 |
| ABSD800 | 3021 | 0.72 | 2.27 | 466 | 9.9 | 654 | 5.1 |
| ABSD975 | 3510 | 0.71 | 2.31 | 542 | 5.7 | 797 | 10.2 |
| ABSD1100 | 3886 | 0.70 | 2.32 | 600 | 7.5 | 899 | 6.1 |
| ABSD1225 | 4354 | 0.70 | 2.31 | 672 | 10.0 | 1002 | 7.8 |
| ABSD1350 | 4821 | 0.71 | 2.31 | 745 | 12.9 | 1104 | 9.8 |

** 0.23 $m^3$/nominal kWh, Pstm = 0.83 bar, TctwS = 29.4°C, TcwS = 6.67°C, TcwR = 12.2°C, 0.018 evap fouling, 0.044 cond/abs fouling

# Performance Data

*Figure PD-1. ABSD 500-800 capacity vs. chilled-water supply temperature at various cooling-water supply temperatures*

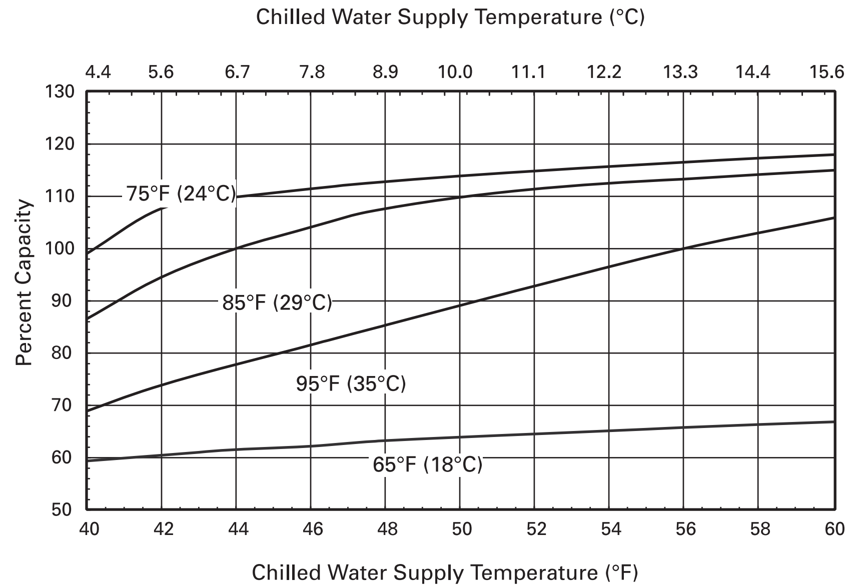
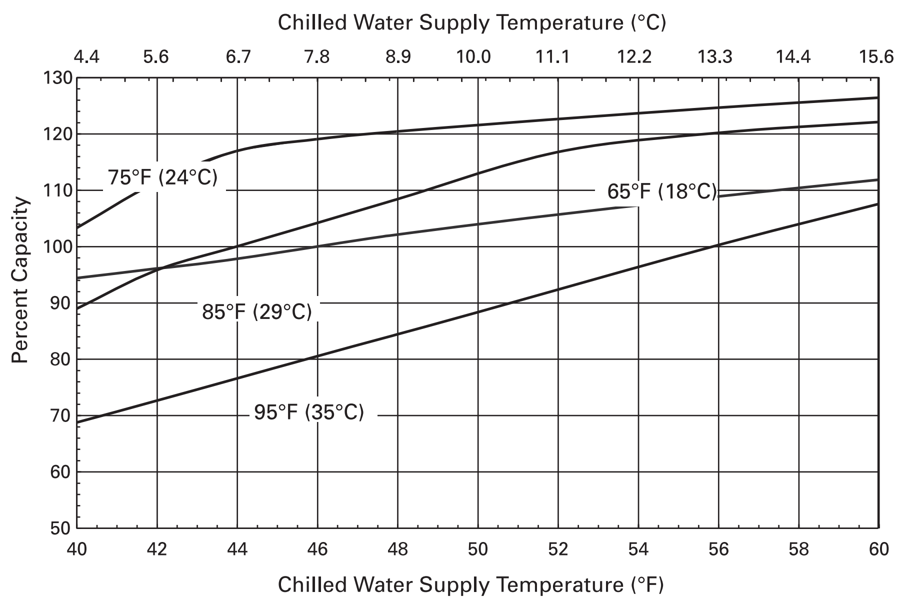



*Figure PD-2. ABSD 975-1350 capacity vs. chilled water supply temperature at various cooling water supply temperatures*



# Performance Data

*Figure PD-3. ABSD 500-800 part load performance - energy input vs. capacity at various cooling water supply temperatures: chilled water supply temperature = 44°F (7°C)*

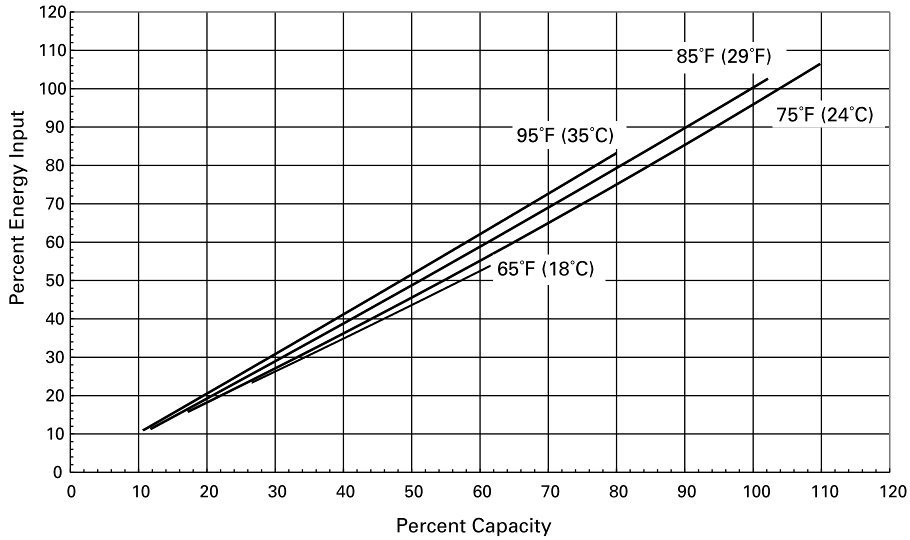
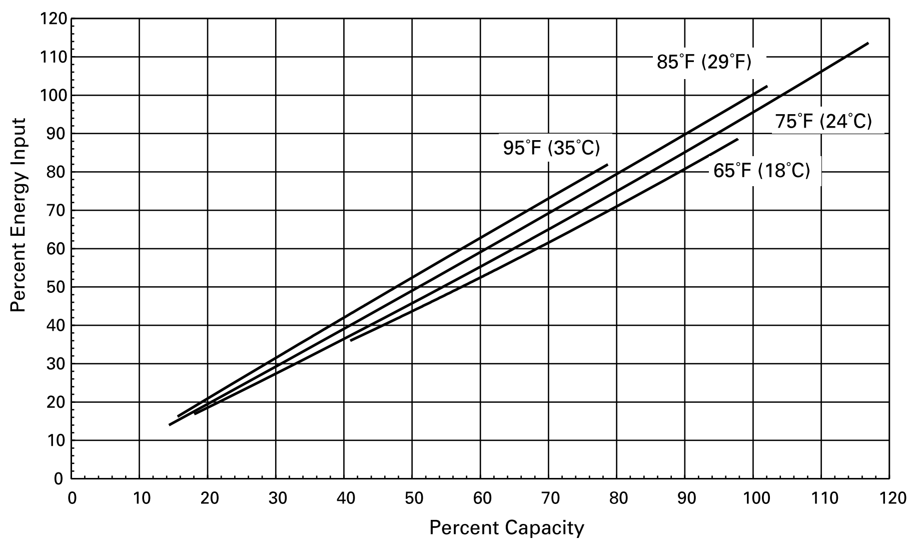



*Figure PD-4. ABSD 975-1350 part load performance - energy input vs. capacity at various cooling water supply temperatures: chilled water supply temperature = 44°F (7°C)*



# Electrical Data

## Electrical Data

Factory-wired and-mounted power control includes main power connections. Total kW includes solution and refrigerant pump, motors, purge pump motor and control panel. Units may be supplied for operation on 230,460 or 575 volt, 3-phase, 60-hertz power, or 190, 220, 380 or 415 volt, 3-phase, 50-hertz power.

***Table ED-1. Electrical data***

| Model | Supply Voltage | FLA | Total Motor HP | Total Motor kW | Control Circuit Amps | MCA | Max Fuse Size Amps |
|---|---|---|---|---|---|---|---|
| **60 Hertz, 3-Phase** | | | | | | | |
| 500 | 200 | 69.0 | 13.0 | 9.7 | 10.0 | 86 | 90 |
| thru | 230 | 60.0 | 13.0 | 9.7 | 8.7 | 75 | 80 |
| 600 | 460 | 30.0 | 13.0 | 9.7 | 4.4 | 37 | 40 |
| | 575 | 25.0 | 13.0 | 9.7 | 3.5 | 31 | 35 |
| 700 | 200 | 90.0 | 17.5 | 13.0 | 10.0 | 109 | 110 |
| thru | 230 | 78.0 | 17.5 | 13.0 | 8.7 | 94 | 100 |
| 800 | 460 | 39.0 | 17.5 | 13.0 | 4.4 | 47 | 50 |
| | 575 | 32.0 | 17.5 | 13.0 | 3.5 | 39 | 40 |
| | 200 | 90.0 | 17.5 | 13.0 | 10.0 | 109 | 110 |
| 975 | 230 | 78.0 | 17.5 | 13.0 | 8.7 | 94 | 100 |
| | 460 | 39.0 | 17.5 | 13.0 | 4.4 | 47 | 50 |
| | 575 | 32.0 | 17.5 | 13.0 | 3.5 | 39 | 40 |
| 1100 | 200 | 96.0 | 20.0 | 14.9 | 10.0 | 115 | 125 |
| thru | 230 | 84.0 | 20.0 | 14.9 | 8.7 | 100 | 110 |
| 1350 | 460 | 42.0 | 20.0 | 14.9 | 4.4 | 50 | 60 |
| | 575 | 34.0 | 20.0 | 14.9 | 3.5 | 41 | 45 |
| **50 Hertz, 3-Phase** | | | | | | | |
| Model | Supply Voltage | FLA | Total Motor HP | Total Motor kW | Control Circuit Amps | MCA | Max Fuse Size Amps |
| 500 | 190 | 62.0 | 13.0 | 9.7 | 10.5 | 79 | 80 |
| thru | 220 | 52.4 | 13.0 | 9.7 | 9.1 | 67 | 70 |
| 600 | 380 | 30.0 | 13.0 | 9.7 | 5.3 | 38 | 40 |
| | 415 | 27.5 | 13.0 | 9.7 | 4.8 | 35 | 35 |
| 700 | 190 | 67.0 | 15.5 | 11.6 | 10.5 | 85 | 90 |
| thru | 220 | 57.4 | 15.5 | 11.6 | 9.1 | 73 | 80 |
| 800 | 380 | 33.0 | 15.5 | 11.6 | 5.3 | 42 | 45 |
| | 415 | 30.5 | 15.5 | 11.6 | 4.8 | 39 | 40 |
| 975 | 190 | 80.0 | 17.5 | 13.0 | 10.5 | 98 | 100 |
| | 220 | 68.0 | 17.5 | 13.0 | 9.1 | 84 | 90 |
| | 380 | 39.0 | 17.5 | 13.0 | 5.3 | 48 | 50 |
| | 415 | 36.0 | 17.5 | 13.0 | 4.8 | 44 | 45 |
| 1100 | 190 | 85.0 | 20.0 | 14.9 | 10.5 | 103 | 110 |
| thru | 220 | 73.0 | 20.0 | 14.9 | 9.1 | 89 | 90 |
| 1350 | 380 | 42.0 | 20.0 | 14.9 | 5.3 | 51 | 60 |
| | 415 | 39.0 | 20.0 | 14.9 | 4.8 | 47 | 50 |

### Hot Water Piping

The hot water system must be designed such that it will avoid fluctuations in the pressure differences across the control valve. Trane absorption chillers for use with hot water may be used at an entering hot-water temperature of 270°F [132°C] or below. Piping for a typical hot water installation using a temperature of 270°F [132°C] or less is shown in Figure JC-2. In this arrangement, a three-way energy valve is used to control capacity by varying the quantity of hot water flowing through the chiller, while maintaining a constant supply and return flow rate. As shown in Figure JC-3, a two-way energy valve can also be used where the return and supply flow rates can vary. The generator design is rated to 150 psig [10.3 bars] with a 400 psig [27.6 bars] optional design available.

When the supply-water temperature exceeds 270°F [132°C], a separate circulating pump is recommended in a run-around loop as shown in Figure JC-4. The hot water for the absorption machine should be taken from a header installed between the hot-water supply and return mains. The flow of hot water through the machine is held constant, but the temperature of the circulating water is varied to meet load requirements by modulating the amount of high-temperature supply water added to the loop. This is done by installing a two-way modulating valve at the loop outlet. The valve responds to the chilled-water temperatures, but limits the water temperature entering the machine to a maximum of 270°F [132°C].

### Hot Water Valves

Trane provides hot-water temperature-control valves with the machine for installation by the contractor at the job site. These valves are selected by The Trane company based on data provided by the contractor (*i.e. water flow to be used and the design pressure-drop across the valve.)

It is desirable to use the smallest valve, with the highest pressure drop, appropriate to the design water flow and allowable pressure drop in the system. The smaller the valve, the better the control. Hot water inlet connection is right end of unit.

*Figure JC-2. Hot water supply piping – 270°F and below with 3-way energy valve*

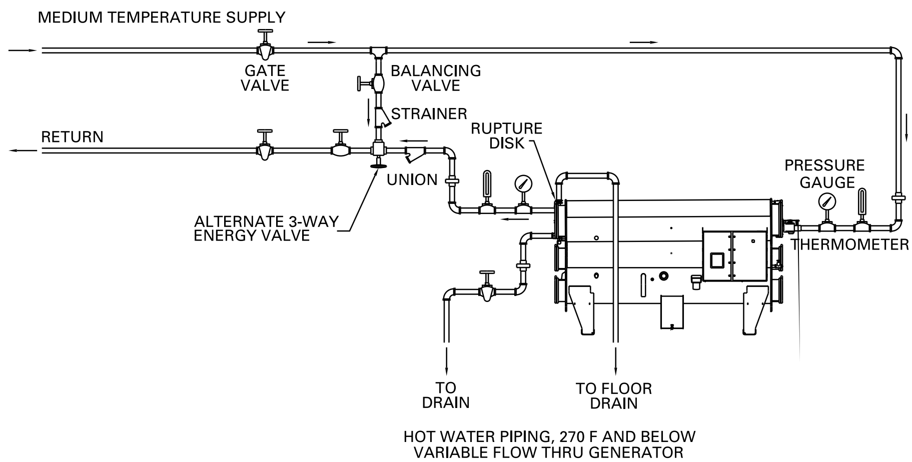
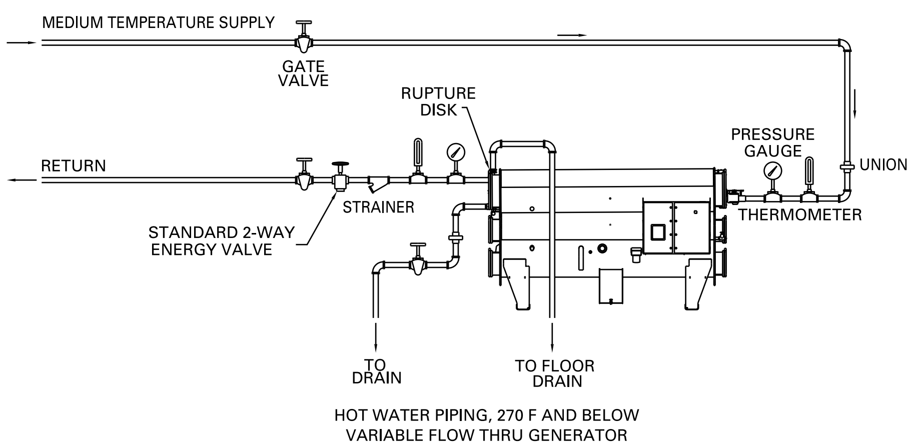



*Figure JC-3. Hot water supply piping – 270°F and below with 2-way energy valve*



# Controls Data

**Setting The Standards**
Trane set the standard for unit microprocessor controls in 1985 with the first generation of Unit Control Panel. Associated with this standard have been:

- Proportional Integral Derivative (PID) control strategies, which provide stable operation and high accuracy for better performance, along with feed forward plus;
- Adaptive Control™ to keep the chiller "on line" and at the same time keep the chiller away from a major failure;
- Software based safeties that do not depend on electromechanical hardware – hardware that means questionable reliability and added cost;
- Operator interface that accesses chiller information and control adjustments at the front of the panel.

**UCP2™**
UCP2 adds more flexibility, more reliability and better system performance than even our most demanding customers expect.

**Flexibility**
Trane offers the ability to adapt to changes easily and effectively without adding prohibitive cost. To provide flexibility, the controller responds to a wide variety of needs for:

- **System Designs,** including equipment, operating conditions and controls variations that are either existing or being considered for new installations.

  *Key to designing non-traditional systems is the ability to evaluate the cost and reliability issues of these systems in comparison to the more traditional systems. Trane recommends the use of C.D.S. Network Equipment Economics, the Trane Applications Manuals and consultation with a Trane sales engineer for help in this analysis.*

- **System Upgrades,** including the ability to accommodate changes in the chilled-water system design or equipment room requirements, or to accommodate new technologies that become available.
- Modular structure of the UCP2 makes it possible for the designer to select the system controls and associated interfaces to Tracer® (or other building automation systems) that are required for the chiller plant design. With this modular concept, capability can be added or upgraded at any time, with only temporary interruption of chilled-water production.
- The operator can quickly program a Custom Report — so that only what are considered to be the most frequently accessed/important reports are available — at any time, right at the front of the panel.
- With easy front panel programmability of Daily, Service Start-up and Machine Configuration settings and setpoints, the operator, serviceman and system designer can customize the use of the micro controller to unique conditions of the chiller plant — whether the purpose of chilled water is for comfort cooling or for process cooling.
- All data that is necessary for the safe operation and easy serviceability of the chiller is provided as standard on all Horizon® absorption chillers. Options are available that provide additional controls/data that are required for: an industrial/process system design, applications outside of the typical chilled water system design, the need for redundant machine protection or the desire for more system information.

# Controls Data

**Reliability**

To most people, reliability means "dependability — giving the same result on successive trials." To our customers, however, it has come to mean "keep chilled water flowing." In other words, "when I turn the switch on, cold water comes out." In order to do this, the micro controller must be aware of what is happening in the system. But more importantly, it must be able to make decisions and adjustments to keep the chiller running as long as possible, even when non-standard conditions exist — conditions such as bad power, bad water (flow, temperature, fouling) or system component failure. Also, the Trane UCP2 panel continuously monitors for noncondensables and purges automatically.

- With Enhanced Adaptive Control™ the controller does everything it can to avoid taking the chiller offline.
  - — Senses evaporator temperature limit and high temperature limit
  - — Displays a warning message about the potential condition/safety trip
  - — Takes the following corrective action sequentially as the condition worsens:
    - - limits loading
    - - prevents further loading
    - - unloads until condition improves
    - - takes chiller offline
- With more diagnostics and diagnostic history that are time/date stamped and with help messages, the operator or serviceman can take faster and more effective corrective action.

**System Performance**

"Chilled Water System" encompasses many levels of control: Standalone Chiller, Chiller Plant, Applied System, Central Building Automation System. However, regardless of the system level being designed, the unit controls become critical, not just in making every level operate reliably but also in facilitating optimal performance. UCP2 provides more capability and more intelligence to make this operation/optimization possible.

**Panel Features:**

The absorption chiller Unit Control Panel (UCP2) incorporates the following features and components:

**Control Functions**

- Smart dilution-cycle duration based on system requirements
- Adaptive evaporator leaving-fluid temperature control
- Low evaporator-temperature limit
- High solution-temperature limit
- Solution flow control via AFD
- Soft loading
- Nuisance trip prevention via Adaptive Control
- Chilled-water reset
- Optimum concentration control
- Crystallization recovery via SDR

# Controls Data

**Safeties**
- Smart shutdown sequence: condenser/absorber loss of flow
- Low condenser/absorber water temperature
- High-pressure cutout
- Evaporator leaving-fluid temperature cutout
- Motor current overload
- High motor-winding temperature
- Over/under voltage (optional)
- Purge limit
- Sensor failure detection

**Monitored Points**
Chiller information is available at the operator interface via a clear language display. Access to the information is through four dedicated report keys: Customer, Chiller, Cycle and Pump/Purge.

**Customer Report**
User-defined custom report (operator may choose up to 20 points from a list of over 100 choices).

**Chiller Report**
Status, fluid temperatures, and setpoints:
- Operating mode (i.e. run status)
- Chilled-water setpoint
- Evaporator entering/leaving water temperatures
- Absorber entering/leaving water temperatures
- Condenser leaving-water temperature outdoor air temperature
- Evaporator leaving-water temperature
- Chilled-water reset

**Cycle Report**
Refrigerant temperatures and pressures:
- Solution temperature leaving generator
- Solution temperature entering generator
- Generator-leaving concentration
- Generator cutout and monitor temperature
- Crystallization detection temperature
- Crystallization trip temperature
- Saturated condenser refrigerant temperature
- Absorber-entering concentration
- LiBr crystallization margin
- Solution temperature entering absorber
- Absorber spray temperature
- Solution temperature leaving absorber
- Saturated evaporator refrigerant temperature
- Evaporator leaving-water temperature
- Evaporator entering-water temperature
- Absorber entering-water temperature
- Absorber leaving-water temperature
- Condenser leaving-water temperature
- Solution pump auto/manual speed command
- Energy input auto/manual/slaved reported command
- Steam Supply Pressure
- Generator Steam Pressure

**Pump/Purge Report**
- Solution pump
  - — Counters for starts and hours
  - — Motor phase currents
  - — Motor phase voltages (optional)
- Purge Pump
  - — Operating mode and status
  - — Refrigerant suction temperature
  - — Pumpout rate
  - — Total pumpout time
  - — Service log

# Controls Data

**Diagnostics**
The absorption chiller Unit Control Panel (UCP2) provides over 70 different diagnostics such as:
- Water and refrigerant/solution temperatures out of range
- Loss of system waterflows
- Sensor and switch faults
- Overload trips
- Over/under voltage (optional)
- Crystallization recovery
- Emergency stop
- Loss of communication to other modules
- Motor abnormal

**Operator Interface**
The Trane Horizon® steam-fired absorption chiller control panel, UCP2, is easy to use, understand, access information, read, change setpoints, diagnose problems, maintain, and to reset after shutdown.

**Convenience**
Enunciation of all information is at the front panel display (including power, voltage, amps, purge pressures, and number of starts data). Messages are displayed using clear language.

**Readability**
- Two-line, 40-character display that is easy to read from within a 60-degree angle
- LCD backlight so that the display can be read in a variety of equipment-room lighting
- Seven languages available
- Metric (SI) units available
- Complete character human interface available

**Ease of Use**
- Keypad programmability — no manual switches or setpoint potentiometers
- Logically arranged report groups with report header and setpoint groups
- Selectable security
- Variable points updated every two seconds
- Messages that direct user to problem source via a menu item

**Trane ICS Compatibility**
The Trane absorption chiller control panel, UCP2, is 100 percent compatible with the Trane Integrated Comfort™ systems, ICS, UCP2 easily integrates into the Tracer® family of flexible chiller-plant system controllers with a single twisted-wire pair communications cable.

For more information on the Trane absorption chiller unit control panel, please contact your local Trane sales engineer.

# Scroll Liquid Chillers

## Model CGWF and CCAF
## 20 to 60 Tons (60 Hz)
## 17 to 50 Tons (50 Hz)
## Water-Cooled and Condenserless

***Built For the Industrial and Commercial Markets***

January 2004

CG-PRC012-EN

# General Data

*Table GD-1. General data — CGWF water-cooled chiller*

| Size | | 20 | 25 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| Compressor | | | | | | | |
| Quantity (1) | | 2 | 2 | 2 | 2/2 | 2/2 | 2/2 |
| Nominal Size (tons) (2) | | 10/10 | 10/15 | 15/15 | 10-10/10-10 | 10-15/10-15 | 15-15/15-15 |
| Steps of Unloading (%) | | 100,50 | 100,60 | 100,50 | 100,75,50,25 | 100,80,60,30 | 100,75,50,25 |
| Evaporator | | | | | | | |
| Water Storage | (gallons) | 12 | 11 | 16 | 13 | 21 | 40 |
| | (liters) | 45 | 42 | 61 | 49 | 80 | 151 |
| Min. Flow | (gpm) | 24 | 30 | 36 | 48 | 60 | 84 |
| | (L/s) | 1.5 | 1.9 | 2.3 | 3.0 | 3.8 | 4.7 |
| Max. Flow | (gpm) | 72 | 90 | 108 | 144 | 180 | 252 |
| | (L/s) | 4.5 | 5.7 | 6.8 | 9.1 | 11.4 | 17.3 |
| Condenser | | | | | | | |
| Water Storage | (gallons) | 5.0 | 6.1 | 7.6 | 11.7 | 13.9 | 14.0 |
| | (liters) | 18.9 | 23.2 | 28.9 | 44.2 | 52.7 | 53.1 |
| Min. Flow | (gpm) | 30 | 36 | 50 | 60 | 72 | 90 |
| | (L/s) | 1.9 | 2.3 | 3.2 | 3.8 | 4.5 | 5.7 |
| Max. Flow | (gpm) | 90 | 108 | 146 | 180 | 216 | 325 |
| | (L/s) | 5.7 | 6.8 | 9.2 | 11.4 | 13.6 | 20.5 |
| General Unit | | | | | | | |
| Refrigerant | | R-22 | R-22 | R-22 | R-22 | R-22 | R-22 |
| No. of Independent Refrigerant Circuits | | 1 | 1 | 1 | 2 | 2 | 2 |
| Refrigerant | (pound) | 50 | 50 | 90 | 50/50 | 50/50 | 75/75 |
| Charge | (kilogram) | 22.7 | 22.7 | 40.8 | 22.7/22.7 | 22.7/22.7 | 34/34 |
| Oil Charge | (pints) | 16 | 22 | 28 | 16/16 | 22/22 | 28/28 |
| | (liters) | 7.6 | 10.4 | 13.2 | 7.6/7.6 | 10.4/10.4 | 13.3/13.3 |

Notes
1. Data containing information on two circuits shown as follows: CKT 1/CKT 2
2. Nominal compressor sizes based on 60 Hz.

*Table GD-2. General data — CCAF compressor chiller*

| Size | | 20 | 25 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| Compressor | | | | | | | |
| Quantity (1) | | 2 | 2 | 2 | 2/2 | 2/2 | 2/2 |
| Nominal Size (tons) (2) | | 10/10 | 10/15 | 15/15 | 10-10/10-10 | 10-15/10-15 | 15-15/15-15 |
| Steps of Unloading (%) | | 100,50 | 100,60 | 100,50 | 100,75,50,25 | 100,80,60,30 | 100,75,50,25 |
| Evaporator | | | | | | | |
| Water Storage | (gallons) | 12 | 11 | 16 | 13 | 21 | 19 |
| | (liters) | 45 | 42 | 61 | 49 | 80 | 72 |
| Min. Flow | (gpm) | 24 | 30 | 36 | 48 | 60 | 84 |
| | (L/s) | 1.5 | 1.9 | 2.3 | 3.0 | 3.8 | 4.7 |
| Max. Flow | (gpm) | 72 | 90 | 108 | 144 | 180 | 252 |
| | (L/s) | 4.5 | 5.7 | 6.8 | 9.1 | 11.4 | 17.3 |
| General Unit | | | | | | | |
| Refrigerant | | R-22 | R-22 | R-22 | R-22 | R-22 | R-22 |
| No. of Independent Refrigerant Circuits | | 1 | 1 | 1 | 2 | 2 | 2 |
| Refrigerant | (pound) | 6 | 8 | 12 | 6/6 | 8/8 | 12/12 |
| Charge | (kilogram) | 2.7 | 3.6 | 5.4 | 2.7/2.7 | 3.6/3.6 | 5.5/5.5 |
| Oil Charge | (pints) | 16 | 22 | 28 | 16/16 | 22/22 | 28/28 |
| | (liters) | 7.6 | 10.4 | 13.2 | 7.6/7.6 | 10.4/10.4 | 13.3/13.3 |

Notes:
1. Data containing information on two circuits shown as follows: CKT 1/CKT 2
2. Nominal compressor sizes based on 60 Hz.

TRANE

# Performance Data

# Full Load Performance

*Table PD-1. 60 Hz CGWF performance data in English units*

| Evaporator Leaving Water Temperature (F) | Unit Size | Entering Condenser Water Temperature (F) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 75 | | | 80 | | | 85 | | | 90 | | | 95 | | |
| | | Tons | kW | EER | Tons | kW | EER | Tons | kW | EER | Tons | kW | EER | Tons | kW | EER |
| 40 | 20 | 19.2 | 13.8 | 16.7 | 19.0 | 14.5 | 15.7 | 18.6 | 15.4 | 14.6 | 18.1 | 16.1 | 13.5 | 17.7 | 17.1 | 12.4 |
| | 25 | 23.8 | 17.2 | 16.5 | 23.2 | 18.1 | 15.4 | 22.7 | 19.1 | 14.3 | 22.1 | 20.1 | 13.2 | 21.6 | 21.2 | 12.2 |
| | 30 | 28.3 | 20.7 | 16.4 | 27.6 | 21.7 | 15.3 | 27.0 | 22.9 | 14.1 | 26.3 | 24.1 | 13.1 | 25.6 | 25.4 | 12.1 |
| | 40 | 38.0 | 27.3 | 16.8 | 37.2 | 28.7 | 15.6 | 36.5 | 30.2 | 14.5 | 35.5 | 31.8 | 13.4 | 34.6 | 33.6 | 12.4 |
| | 50 | 47.0 | 34.1 | 16.6 | 46.0 | 35.8 | 15.4 | 44.9 | 37.7 | 14.3 | 43.8 | 39.7 | 13.2 | 42.7 | 41.0 | 12.2 |
| | 60 | 57.7 | 42.1 | 16.4 | 56.4 | 44.2 | 15.3 | 55.0 | 46.5 | 14.2 | 53.7 | 49.0 | 13.1 | 52.3 | 51.7 | 12.1 |
| 42 | 20 | 20.0 | 13.9 | 17.3 | 19.8 | 14.6 | 16.3 | 19.3 | 15.4 | 15.1 | 18.9 | 16.2 | 14.0 | 18.4 | 17.1 | 12.9 |
| | 25 | 24.7 | 17.3 | 17.1 | 24.2 | 18.2 | 15.9 | 23.6 | 19.2 | 14.8 | 23.0 | 20.2 | 13.7 | 22.4 | 21.3 | 12.6 |
| | 30 | 29.4 | 20.8 | 17.0 | 28.7 | 21.8 | 15.8 | 28.0 | 23.0 | 14.7 | 27.3 | 24.2 | 13.6 | 26.6 | 25.5 | 12.5 |
| | 40 | 39.5 | 27.4 | 17.3 | 38.7 | 28.8 | 16.1 | 37.8 | 30.3 | 15.0 | 36.9 | 32.0 | 13.9 | 36.0 | 33.8 | 12.8 |
| | 50 | 48.9 | 34.2 | 17.2 | 47.8 | 36.0 | 16.0 | 46.7 | 37.9 | 14.8 | 45.6 | 39.9 | 13.7 | 44.4 | 42.1 | 12.7 |
| | 60 | 59.9 | 42.3 | 17.0 | 58.5 | 44.4 | 15.8 | 57.2 | 46.7 | 14.7 | 55.7 | 49.2 | 13.6 | 54.3 | 51.9 | 12.6 |
| 44 | 20 | 20.8 | 13.9 | 17.3 | 20.5 | 14.7 | 16.8 | 19.9 | 15.4 | 15.5 | 19.6 | 16.3 | 14.5 | 19.1 | 17.2 | 12.9 |
| | 25 | 25.7 | 17.4 | 17.7 | 25.1 | 18.3 | 16.5 | 24.5 | 19.1 | 15.4 | 23.9 | 20.3 | 14.2 | 23.3 | 21.4 | 13.1 |
| | 30 | 30.6 | 20.8 | 17.6 | 29.9 | 21.9 | 16.4 | 29.2 | 22.9 | 15.3 | 28.4 | 24.3 | 14.0 | 27.7 | 25.6 | 13.0 |
| | 40 | 41.1 | 27.5 | 17.9 | 40.2 | 28.9 | 16.7 | 39.4 | 30.3 | 15.6 | 38.4 | 32.1 | 14.4 | 37.4 | 33.9 | 13.3 |
| | 50 | 50.8 | 34.4 | 17.7 | 49.7 | 35.1 | 16.5 | 48.6 | 37.8 | 15.4 | 47.4 | 40.1 | 14.2 | 46.2 | 42.3 | 13.1 |
| | 60 | 62.1 | 42.5 | 17.6 | 60.7 | 44.6 | 16.3 | 59.4 | 46.8 | 15.2 | 57.9 | 49.4 | 14.1 | 56.4 | 52.1 | 13.0 |
| 46 | 20 | 21.5 | 14.0 | 18.5 | 21.3 | 14.7 | 17.4 | 20.9 | 15.5 | 16.2 | 20.4 | 16.3 | 15.0 | 19.9 | 17.3 | 13.8 |
| | 25 | 26.6 | 17.4 | 18.3 | 26.1 | 18.3 | 17.1 | 25.5 | 19.3 | 15.8 | 24.9 | 20.3 | 14.7 | 24.2 | 21.5 | 13.5 |
| | 30 | 31.7 | 20.9 | 18.2 | 31.0 | 22.0 | 16.9 | 30.3 | 23.1 | 15.7 | 29.5 | 24.4 | 14.5 | 28.7 | 25.7 | 13.4 |
| | 40 | 42.6 | 27.6 | 18.5 | 41.7 | 29.0 | 17.3 | 40.8 | 30.6 | 16.0 | 39.9 | 32.3 | 14.8 | 38.9 | 34.1 | 13.7 |
| | 50 | 52.8 | 34.5 | 18.4 | 51.6 | 36.3 | 17.1 | 50.4 | 38.2 | 15.9 | 49.2 | 40.2 | 14.7 | 48.0 | 42.4 | 13.6 |
| | 60 | 64.4 | 42.6 | 18.1 | 63.0 | 44.8 | 16.9 | 61.5 | 47.1 | 15.7 | 60.0 | 49.6 | 14.5 | 58.5 | 52.3 | 13.4 |
| 48 | 20 | 22.4 | 14.0 | 19.1 | 22.1 | 14.8 | 18.0 | 21.6 | 15.6 | 16.7 | 21.1 | 16.4 | 15.5 | 20.6 | 17.3 | 14.3 |
| | 25 | 27.6 | 17.5 | 19.0 | 27.0 | 18.4 | 17.6 | 26.4 | 19.4 | 16.4 | 25.8 | 20.4 | 15.2 | 25.2 | 21.6 | 14.0 |
| | 30 | 32.9 | 21.0 | 18.8 | 32.2 | 22.1 | 17.5 | 31.4 | 23.2 | 16.2 | 30.7 | 24.5 | 15.0 | 29.9 | 25.8 | 13.9 |
| | 40 | 44.2 | 27.8 | 19.1 | 43.3 | 29.2 | 17.8 | 42.4 | 30.7 | 16.6 | 41.4 | 32.4 | 15.3 | 40.4 | 34.2 | 14.2 |
| | 50 | 54.7 | 34.6 | 19.0 | 53.6 | 35.4 | 17.7 | 52.3 | 38.3 | 16.4 | 51.1 | 40.4 | 15.2 | 49.8 | 42.6 | 14.0 |
| | 60 | 66.7 | 42.8 | 18.7 | 65.2 | 45.0 | 17.4 | 63.7 | 47.3 | 16.2 | 62.2 | 49.8 | 15.0 | 60.7 | 52.5 | 13.9 |
| 50 | 20 | 23.2 | 14.1 | 19.7 | 22.9 | 14.8 | 18.6 | 22.4 | 15.6 | 17.2 | 21.9 | 16.5 | 16.0 | 21.4 | 17.4 | 14.8 |
| | 25 | 28.7 | 17.6 | 19.6 | 28.0 | 18.5 | 18.2 | 27.4 | 19.4 | 16.9 | 26.8 | 20.5 | 15.7 | 26.1 | 21.6 | 14.5 |
| | 30 | 34.1 | 21.1 | 19.5 | 33.4 | 22.1 | 18.1 | 32.6 | 23.3 | 16.8 | 31.8 | 24.6 | 15.6 | 31.0 | 25.0 | 14.4 |
| | 40 | 45.9 | 27.9 | 19.8 | 44.9 | 29.3 | 18.4 | 43.9 | 30.8 | 17.1 | 42.9 | 32.5 | 15.8 | 41.9 | 34.3 | 14.6 |
| | 50 | 56.8 | 34.8 | 19.6 | 55.5 | 36.5 | 18.2 | 54.3 | 38.5 | 16.9 | 53.0 | 40.5 | 15.7 | 51.7 | 42.8 | 14.5 |
| | 60 | 69.1 | 43.0 | 19.3 | 67.6 | 45.1 | 18.0 | 66.0 | 47.5 | 16.7 | 64.5 | 50.0 | 15.5 | 62.9 | 52.8 | 14.3 |

Notes:
1. Rated in accordance with ARI Standard 550/590-98 with fouling factors of 0.0001 in the evaporator and 0.00025 in the condenser.
2. Consult Trane representative for performance at temperatures outside of the ranges shown.
3. kW input is for compressors only.
4. EER = Energy Efficiency Ratio (Btu/watt-hout). Power inputs include compressors and control power.
5. Ratings are based on an evaporator temperature drop of 10°F.
6. Interpolation between points is permissible. Extrapolation is not permitted.

# Performance Data

# Part Load Performance

*Table PD-5. Part-load performance for CGWF 20-60 ton – 60 Hz in English units*

| Unit Size | | 100% | IPLV |
|---|---|---|---|
| | Tons | 19.9 | |
| 20 | kW | 15.2 | 20.3 |
| | EER | 15.5 | |
| | Tons | 24.5 | |
| 25 | kW | 19.0 | 20.5 |
| | EER | 15.4 | |
| | Tons | 29.2 | |
| 30 | kW | 22.8 | 20.3 |
| | EER | 15.3 | |
| | Tons | 39.4 | |
| 40 | kW | 30.1 | 20.7 |
| | EER | 15.6 | |
| | Tons | 48.6 | |
| 50 | kW | 37.6 | 19.6 |
| | EER | 15.4 | |
| | Tons | 59.4 | |
| 60 | kW | 46.5 | 19.8 |
| | EER | 15.2 | |

Notes:
1. IPLV values are rated in accordance with ARI Standard 550/590-98.
2. EER and IPLV values include compressor and control kW.
3. kW input is for compressors only.

*Table PD-6. Part-load performance for CGWF 20-60 ton – 50 Hz in English units*

| Unit Size | | 100% | IPLV |
|---|---|---|---|
| | Tons | 16.7 | |
| 20 | kW | 12.4 | 21.0 |
| | EER | 16.1 | |
| | Tons | 20.6 | |
| 25 | kW | 15.5 | 20.9 |
| | EER | 16.0 | |
| | Tons | 24.5 | |
| 30 | kW | 18.5 | 20.7 |
| | EER | 15.9 | |
| | Tons | 33.0 | |
| 40 | kW | 24.5 | 21.3 |
| | EER | 16.2 | |
| | Tons | 40.8 | |
| 50 | kW | 30.6 | 20.3 |
| | EER | 16.0 | |
| | Tons | 50.1 | |
| 60 | kW | 37.6 | 20.4 |
| | EER | 16.0 | |

Notes:
1. IPLV values are rated in accordance with ARI Standard 550/590-98.
2. EER and IPLV values include compressor and control kW.
3. kW input is for compressors only.

# Electrical Data and Connections

*Table E-1. Electrical data for CGWF water-cooled chillers*

| | Unit Wiring Data | | | | Compressor | | | Controls |
|---|---|---|---|---|---|---|---|---|
| Unit Size | Rated Voltage | Minimum Circuit Ampacity | Maximum Fuse Size | Recommended Dual Element Fuse Size | Quantity | RLA Each | LRA Each | kW |
| 20 | 208-230/60 | 77 | 110 | 100 | 2-10 | 34 | 251 | 0.16 |
| | 380/60 | 38 | 50 | 50 | | 17 | 142 | 0.16 |
| | 460/60 | 32 | 45 | 40 | | 14 | 117 | 0.16 |
| | 575/60 | 27 | 40 | 40 | | 12 | 94 | 0.16 |
| | 400/50 | 32 | 50 | 50 | | 14 | 110 | 0.16 |
| 25 | 208-230/60 | 99 | 150 | 125 | 1-10 | 52/34 | 376/251 | 0.16 |
| | 380/60 | 51 | 70 | 70 | 1-15 | 27/17 | 215/142 | 0.16 |
| | 460/60 | 43 | 60 | 60 | | 23/14 | 178/117 | 0.16 |
| | 575/60 | 35 | 50 | 45 | | 18/12 | 143/94 | 0.16 |
| | 400/50 | 42 | 50 | 45 | | 22/14 | 174/110 | 0.16 |
| 30 | 208-230/60 | 117 | 150 | 150 | 2-15 | 52 | 376 | 0.16 |
| | 380/60 | 61 | 80 | 80 | | 27 | 215 | 0.16 |
| | 460/60 | 52 | 70 | 70 | | 23 | 178 | 0.16 |
| | 575/60 | 41 | 50 | 50 | | 18 | 143 | 0.16 |
| | 400/50 | 50 | 80 | 80 | | 22 | 174 | 0.16 |
| 40 | 208-230/60 | 145 | 175 | 175 | 4-10 | 34 | 251 | 0.24 |
| | 380/60 | 72 | 80 | 90 | | 17 | 142 | 0.24 |
| | 460/60 | 60 | 70 | 70 | | 14 | 117 | 0.24 |
| | 575/60 | 51 | 60 | 70 | | 12 | 94 | 0.24 |
| | 400/50 | 60 | 90 | 90 | | 14 | 110 | 0.24 |
| 50 | 208-230/60 | 185 | 225 | 225 | 2-10 | 52/34 | 376/251 | 0.24 |
| | 380/60 | 95 | 110 | 110 | 2-15 | 27/17 | 215/142 | 0.24 |
| | 460/60 | 80 | 100 | 100 | | 23/14 | 178/117 | 0.24 |
| | 575/60 | 65 | 80 | 80 | | 18/12 | 143/94 | 0.24 |
| | 400/50 | 78 | 110 | 125 | | 22/14 | 174/110 | 0.24 |
| 60 | 208-230/60 | 221 | 250 | 250 | 4-15 | 52 | 376 | 0.24 |
| | 380/60 | 115 | 125 | 150 | | 27 | 215 | 0.24 |
| | 460/60 | 98 | 110 | 110 | | 23 | 178 | 0.24 |
| | 575/60 | 77 | 90 | 90 | | 18 | 143 | 0.24 |
| | 400/50 | 94 | 125 | 150 | | 22 | 174 | 0.24 |

*Table E-2. Electrical data for high temperature condenser CGWF chillers and CCAF compressor chillers*

| | Unit Wiring Data | | | | Compressor | | | Controls |
|---|---|---|---|---|---|---|---|---|
| Unit Size | Rated Voltage | Minimum Circuit Ampacity | Maximum Fuse Size | Recommended Dual Element Fuse Size | Quantity | RLA Each | LRA Each | kW |
| 20 | 208-230/60 | 88 | 125 | 110 | 2-10 | 39 | 251 | 0.16 |
| | 380/60 | 45 | 60 | 60 | | 20 | 142 | 0.16 |
| | 460/60 | 38 | 50 | 50 | | 17 | 117 | 0.16 |
| | 575/60 | 32 | 45 | 40 | | 14 | 94 | 0.16 |
| | 400/50 | 38 | 50 | 50 | | 17 | 117 | 0.16 |
| 25 | 208-230/60 | 112 | 150 | 150 | 1-10 | 58/39 | 376/251 | 0.16 |
| | 380/60 | 59 | 80 | 80 | 1-15 | 31/20 | 215/142 | 0.16 |
| | 460/60 | 50 | 70 | 70 | | 26/17 | 178/117 | 0.16 |
| | 575/60 | 40 | 60 | 60 | | 21/14 | 143/94 | 0.16 |
| | 400/50 | 48 | 70 | 70 | | 25/17 | 178/117 | 0.16 |
| 30 | 208-230/60 | 131 | 175 | 175 | 2-15 | 58 | 376 | 0.16 |
| | 380/60 | 70 | 100 | 90 | | 31 | 215 | 0.16 |
| | 460/60 | 59 | 80 | 80 | | 26 | 178 | 0.16 |
| | 575/60 | 47 | 60 | 60 | | 21 | 143 | 0.16 |
| | 400/50 | 56 | 80 | 80 | | 25 | 178 | 0.16 |
| 40 | 208-230/60 | 166 | 200 | 200 | 4-10 | 39 | 251 | 0.24 |
| | 380/60 | 85 | 100 | 100 | | 20 | 142 | 0.24 |
| | 460/60 | 72 | 80 | 90 | | 17 | 117 | 0.24 |
| | 575/60 | 60 | 70 | 70 | | 14 | 94 | 0.24 |
| | 400/50 | 72 | 80 | 90 | | 17 | 117 | 0.24 |
| 50 | 208-230/60 | 209 | 250 | 250 | 2-10 | 58/39 | 376/251 | 0.24 |
| | 380/60 | 110 | 125 | 150 | 2-15 | 31/20 | 215/142 | 0.24 |
| | 460/60 | 93 | 110 | 110 | | 26/17 | 178/117 | 0.24 |
| | 575/60 | 75 | 90 | 90 | | 21/14 | 143/94 | 0.24 |
| | 400/50 | 90 | 110 | 110 | | 25/17 | 178/117 | 0.24 |
| 60 | 208-230/60 | 247 | 300 | 300 | 4-15 | 58 | 376 | 0.24 |
| | 380/60 | 132 | 150 | 150 | | 31 | 215 | 0.24 |
| | 460/60 | 111 | 125 | 125 | | 26 | 178 | 0.24 |
| | 575/60 | 89 | 110 | 100 | | 21 | 143 | 0.24 |
| | 400/50 | 106 | 125 | 125 | | 25 | 178 | 0.24 |

Notes:
1. Minimum circuit ampacity is 125% of the largest compressor RLA, plus 100% of the remaining compressor(s) RLA, per NEC 440-32 and NEC 440-33.
2. Maximum fuse size is 225% of the largest compressor RLA, plus 100% of the remaining compressor(s) RLA, per NEC 440-33.
3. Recommended dual element fuse size is 175% of the largest compressor RLA, plus 100% of remaining compressor(s) RLA, per NEC 440-33.
4. Use copper conductors only.
5. Voltage Utilization Range:

| Rated Voltage | Utilization Range |
|---|---|
| 208-230/60 | 188-253 |
| 380/60 | 342-418 |
| 460/60 | 414-506 |
| 575/60 | 517-633 |
| 400/50 | 360-440 |

6. Local codes may take precedence.
7. If unit is ordered with the High Condenser Entering Water Temperature Range (90-130), use CCAF electrical information.

# HIGH EFFICIENCY COMMERCIAL BOILERS

## POWER-fin®

SMART SYSTEM™

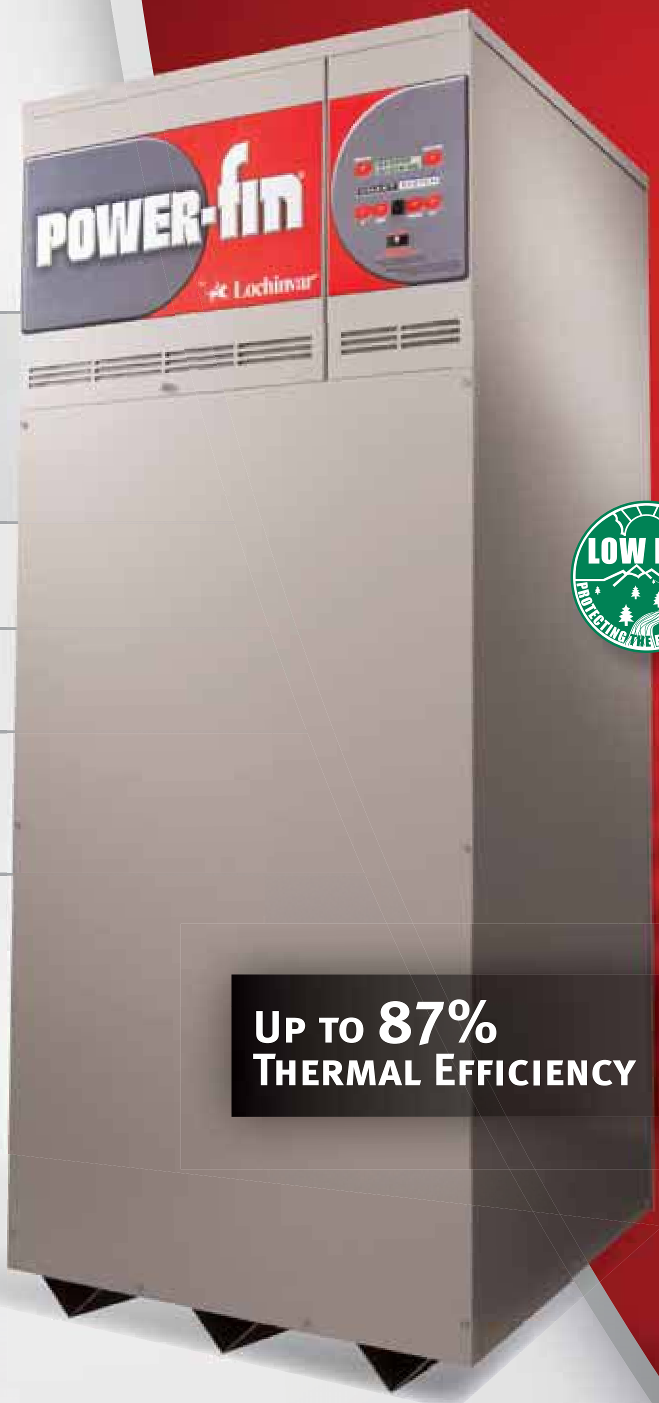
OPERATING CONTROL FEATURING
A BUILT-IN CASCADING SEQUENCER

UP TO 87% THERMAL EFFICIENCY

500,000 TO 2,000,000 BTU/HR

MODELS AVAILABLE IN 100% ON/OFF,
2:1 TURNDOWN OR 5:1 TURNDOWN

LESS THAN 30 ppm NOx




LOW NOx Certified
PROTECTING THE ENVIRONMENT

**UP TO 87%**
**THERMAL EFFICIENCY**

Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters

lochinvar.com

# POWER-fin®

## A Symbol of Lochinvar's Commitment to Excellence!

In 1986, Power-Fin® redefined the water heating industry with space-saving design, groundbreaking efficiency and venting flexibility. Twenty years later, we're again raising the standard for innovation, reliability and LEED-conscious design.

The latest generation of Power-Fin offers expanded burner modulation and the advanced SMART SYSTEM™ operating control, including a built-in cascading sequencer for up to eight boilers.

In today's market, sophisticated, versatile control systems and equipment that meets "green building" criteria are increasingly in demand. Power-Fin boilers continue to evolve, with new "Built-in Advantages" from Lochinvar Corporation®.

*First Power-Fin in 1986*

## Infinite Modulation

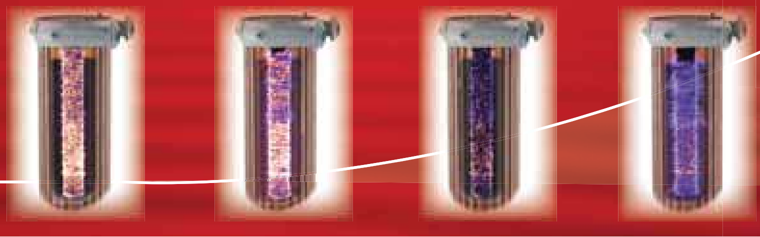
With thermal efficiencies up to 87%, Power-Fin boilers feature infinitely modulating burner firing rates (turndown), precisely matching the firing rate to domestic water load requirements. The result is better overall efficiency and less cycling.

Power-Fin boilers may be specified as either 5:1 turndown (502 - 2001), 2:1 turndown (1501 - 2001), or 100% ON/OFF (502 - 1302). With 5:1 turndown the burner fires as low as 20% of maximum input when demand is lowest and increases the firing rate up to 100% as demand increases. Models with 2:1 turndown modulate from 50% to 100% of maximum input.

## Gasketless Heat Exchanger

The Power-Fin heat exchanger features an array of 20 or 24 copper-finned tubes surrounding the burner for maximum heat transfer.  Lochinvar also pioneered the "gasketless" heat exchanger, which eliminates the use of O-rings and gaskets. Because of the time-proven reliability of this design, the Power-Fin heat exchanger is backed by a 10-year limited warranty.

The vertical heat exchanger also makes Power-Fin compact and easy to handle, install and service. All access for installation or service is through the front or back, and multiple units can line up side-by-side with zero clearance to combustibles.



# SMART SYSTEM™

## Featuring the First *Built-in* Cascading Sequencer!

In commercial buildings requiring a multiple-boiler system, modulating operation of individual units should be sequenced so that the system functions efficiently as an integrated whole. Sequencing rotates the system regularly and efficiently so that every unit handles an equal amount of boiler run time.

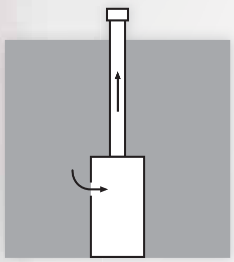

Power-Fin® is the first modulating boiler with a built-in cascading sequencer for up to 8 units. This integral component of the new SMART SYSTEM™ control eliminates the initial cost and labor required with installation of a separate sequencer. And because it's engineered specifically for Power-Fin, it removes any uncertainty about using a "third-party" sequencer, to ensure precise, dependable cascading operation.

When utilizing the built-in cascading sequencer, Power-Fin Boilers communicate through a simple 2-wire daisy chain connection. On demand, one boiler in the system functions as the lead unit and modulates with demand to capacity. The additional load then "cascades" to the second boiler, which fires and modulates to meet added demand.

Cascading continues as additional boilers fire in sequence, until all units are in operation or demand is satisfied. When demand drops, the cascading process reverses, with the precision control and performance you expect from Lochinvar.

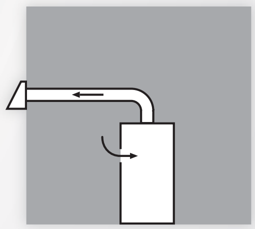
# Venting Solutions

Power-Fin features flexible two-pipe, independent air inlet and exhaust vent piping. When equipped with 100% ON/OFF (F#) Firing Controls (502 - 1302), 2:1 (B#) Modulating Firing Controls (1501 - 2001), the Power-Fin utilizes Category I, Type B vent material and is ideal for replacement/retrofit applications with an existing vent stack. When equipped with 5:1 (M#) Modulating Firing Controls, (502 - 2001) the Power-Fin requires Category IV, corrosion-resistant, sealed vent pipe. Category IV models provide more venting flexibility and expanded turndown. In addition, (M#) Modulating units may be installed as Category II appliances, allowing multiple units to be manifolded together into a common vent stack – giving you even more design options!



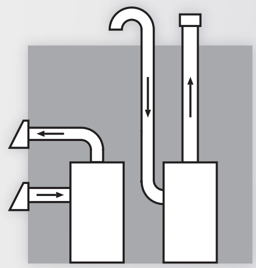
### Vertical Venting

*Using Category I or Category IV vent materials*



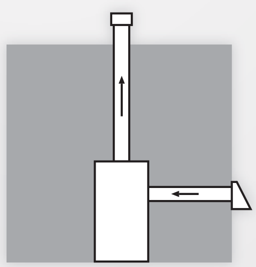
### Sidewall Venting*

*Horizontal venting up to 50 equivalent feet using Category IV vent materials. This option only available with 5:1 (M#) firing code models.*



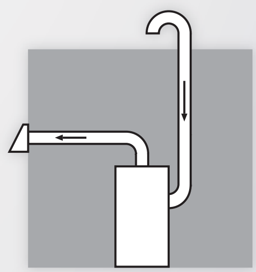
### Direct Venting*

*Horizontal or vertical venting up to 50 equivalent feet. Draws combustion air from the same pressure zone using Category IV vent materials. This option only available with 5:1 (M#) firing code models.*



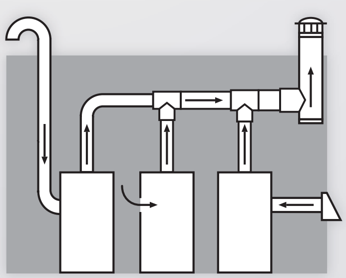
### DirectAire Vertical*

*Vertical venting up to 50 equivalent feet. Draws combustion air up to 50 ft. from a different pressure zone using Category I or IV vent materials.*



### DirectAire Horizontal*

*Vents horizontally up to 50 equivalent feet. Draws combustion air up to 50 ft. from a different pressure zone using Category IV vent materials. This option only available with 5:1 (M#) firing code models.*

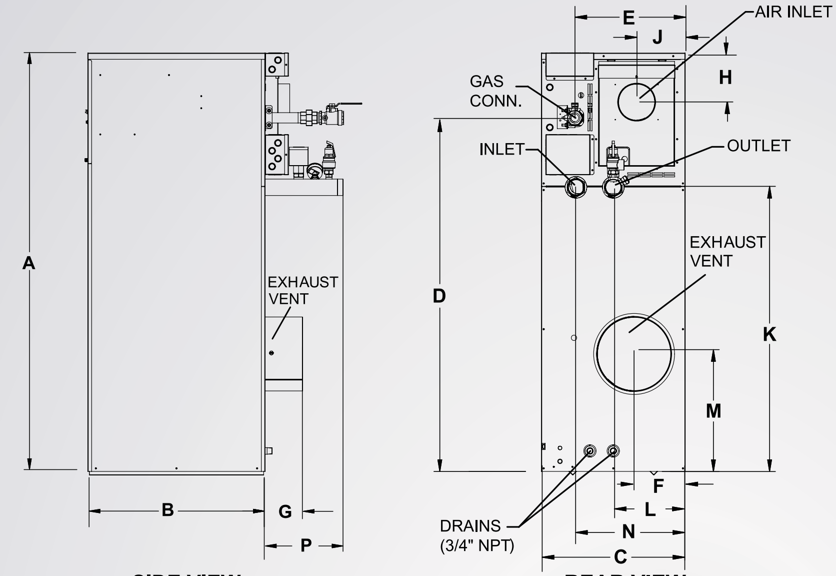


### Common Venting*

*Vents multiple units horizontally through one vent termination and draws combustion air from the room, roof or sidewall. Category IV to II conversion kit required with (M#) firing code models.*

**Requires factory-supplied vent kit with M firing code models.*
*See Specification Chart for specific venting sizes based on venting materials category type.*

# Power-Fin® Boiler Dimensions and Specifications




SIDE VIEW    REAR VIEW

**Model Number Guide**

| PB | N | 1501 | M9 |
|---|---|---|---|
| Model | Natural Gas | Btu/hr Input | Firing Controls |

***P**ower-Fin **B**oiler,*
***N**atural Gas,*
***1,500**,000 Btu/hr input,*
***M9** firing controls*

| Model Number | Btu/Hr Input | Output B9/F9 | Rate M9 | A | B | C | D | E B9/F9 | E M9 | F | G | H | J |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PBN0502 | 500,000 | 425,000 | 425,000 | 44-1/2″ | 28-1/2″ | 23-1/4″ | 34″ | 17-3/4″ | 19-1/2″ | 6-1/2″ | 6″ | 8″ | 7-3/4″ |
| PBN0752 | 750,000 | 637,000 | 637,000 | 52″ | 28-1/2″ | 23-1/4″ | 41-1/2″ | 17-3/4″ | 19-1/2″ | 6-3/4″ | 6″ | 8″ | 7-3/4″ |
| PBN1002 | 1,000,000 | 850,000 | 850,000 | 59-1/4″ | 28-1/2″ | 23-1/4″ | 48-3/4″ | 17-3/4″ | 19-1/2″ | 7-1/4″ | 6″ | 8″ | 7-3/4″ |
| PBN1302 | 1,300,000 | 1,105,000 | 1,105,000 | 67-3/4″ | 28-1/2″ | 23-1/4″ | 57-1/4″ | 17-3/4″ | 19-1/2″ | 8-1/4″ | 6″ | 8″ | 7-3/4″ |
| PBN1501 | 1,500,000 | 1,260,000 | 1,305,000 | 65-1/2″ | 29-3/4″ | 27-1/4″ | 58-3/4″ | 21″ | 21″ | 13-1/2″ | 8″ | 10″ | 9-1/2″ |
| PBN1701 | 1,700,000 | 1,428,000 | 1,479,000 | 70″ | 29-3/4″ | 27-1/4″ | 63-1/4″ | 21″ | 21″ | 13-1/2″ | 8″ | 10″ | 9-1/2″ |
| PBN2001 | 2,000,000 | 1,680,000 | 1,740,000 | 76-3/4″ | 29-3/4″ | 27-1/4″ | 70″ | 21″ | 21″ | 13-1/2″ | 8″ | 10″ | 9-1/2″ |

| Model Number | K | L | M | N | P B9/F9 | P M9 | Gas Conn. | Air Inlet | Vent Sizes Cat I B9/F9 | Vent Sizes Cat II M9 | Vent Sizes Cat IV M9 | Shipping Wt. (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PBN0502 | 23″ | 11-1/2″ | 11-1/4″ | 17-1/2″ | 15-1/4″ | 15-1/4″ | 1″ | 5″ | 7″ | 7″ | 4″ | 571 |
| PBN0752 | 30-1/2″ | 11-1/2″ | 11-1/4″ | 17-1/2″ | 15-1/4″ | 15-1/4″ | 1-1/4″ | 5″ | 9″ | 9″ | 5″ | 620 |
| PBN1002 | 37-3/4″ | 11-1/2″ | 11-1/4″ | 17-1/2″ | 15-1/4″ | 15-1/4″ | 1-1/4″ | 6″ | 10″ | 10″ | 6″ | 669 |
| PBN1302 | 46-1/4″ | 11-1/2″ | 19-1/2″ | 17-1/2″ | 15-1/4″ | 15-1/4″ | 1-1/4″ | 6″ | 12″ | 12″ | 8″ | 718 |
| PBN1501 | 43-1/2″ | 5-3/4″ | 22-1/4″ | 21-1/2″ | 24-1/2″ | 19-1/2″ | 1-1/2″ | 6″ | 12″ | 8″ | 6″ | 1,115 |
| PBN1701 | 48″ | 5-3/4″ | 25″ | 21-1/2″ | 24-1/2″ | 19-1/2″ | 1-1/2″ | 7″ | 14″ | 9″ | 7″ | 1,150 |
| PBN2001 | 54-3/4″ | 5-3/4″ | 27-1/2″ | 21-1/2″ | 24-1/2″ | 19-1/2″ | 1-1/2″ | 8″ | 14″ | 10″ | 8″ | 2,045 |

*Notes: Change ‘N’ to ‘L’ for LP Gas Model.    No deration on LP models.    Temperature rise calculations based on firing rate of 100%.    All water connections are 2-1/2”*

## Standard Features

- Up to 87% Thermal Efficiency (M#)
- Up to 84% Thermal Efficiency (B#/F#)
- 160 psi ASME Copper-Finned Tube Heat Exchanger
- Gasketless Heat Exchanger Design
- SMART SYSTEM Control, with:
  - 2-Line 16-Character LCD Display
  - Password Security
  - Outdoor Reset
  - Built-in Sequencing for 2-8 Boilers
  - 0-10Vdc BMS Input
  - Product Service Indicator
  - Time Clock
  - PC Connection Port
  - 3-Pump Control (System, Boiler, DHWP)
  - Pump Delay w/ Freeze Protection
  - Pump Exercise
- Selectable Supply/Return Temperature Controls
- Slideout Control Panel
- Low-NOx Operation
- Low Gas Pressure Operation
- Zero Clearance to Combustible Materials
- Temperature and Pressure Gauge
- ASME Pressure Relief Valve
- Downstream Test Cock
- Line Voltage Terminal Strip
- Low Voltage Terminal Strip
- Contacts on Any Failure
- Alarm Contacts
- Runtime Contacts
- Contacts for Air Louvers
- Adjustable High Limit with Manual Reset
- Flow Switch
- 120V Power Supply
- On/Off Switch
- Combustion Air Filtration
- 10-Year Limited Warranty on Heat Exchanger
- 1-Year Limited Warranty on Parts
- Category I and Category IV Venting

## Firing Control Systems

(M#) indicates 5:1 turndown, Category IV
(B#) indicates 2:1 turndown, Category I
(F#) indicates On/Off, Category I

| | |
|---|---|
| M9, B9 or F9 | Hot Surface Ignition with Electronic Supervision (Standard) |
| M13, B13 or F13 | GE GAP/FM/IRI |
| M7, B7 or F7 | California Code |

## Optional Equipment

- Alarm Bell
- Cupro-Nickel Heat Exchanger
- High and Low Gas Pressure Switch
- Low Water Cutoff with Manual Reset
- SMART SYSTEM PC Software
- Venting Options:
  - Horizontal Air Intake Cap
  - Horizontal Vent Cap
  - Category IV to II Vent Conversion Kit

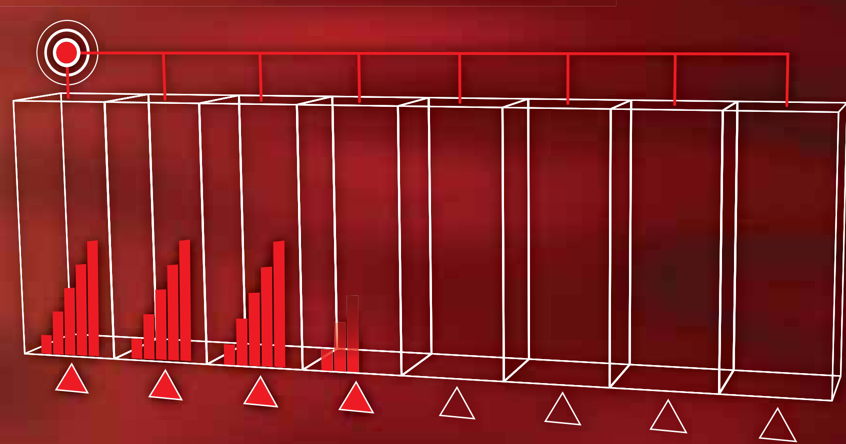
member gama

Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters


# SMART SYSTEM™

## Control Features

- Built-in cascading sequencer controls up to 8 units
- 2-line 16-character LCD readout of setup, system status and diagnostic data in words, not codes
- Password security
- 3-pump control for operation of boiler pump, system pump, domestic hot water prioritization pump
- Low-voltage terminal strip with 28 points of connection
- Outdoor reset adjusts setpoint based on a reset curve
- Compatibility with hot water generators – one boiler in the system can be assigned for domestic hot water prioritization (DHWP) to meet domestic water demand
- 0-10 Vdc BMS input for easy integration into Building Management Systems
- Optional SMART SYSTEM PC software for advanced setup and diagnostics



## Lead-Lag Rotation

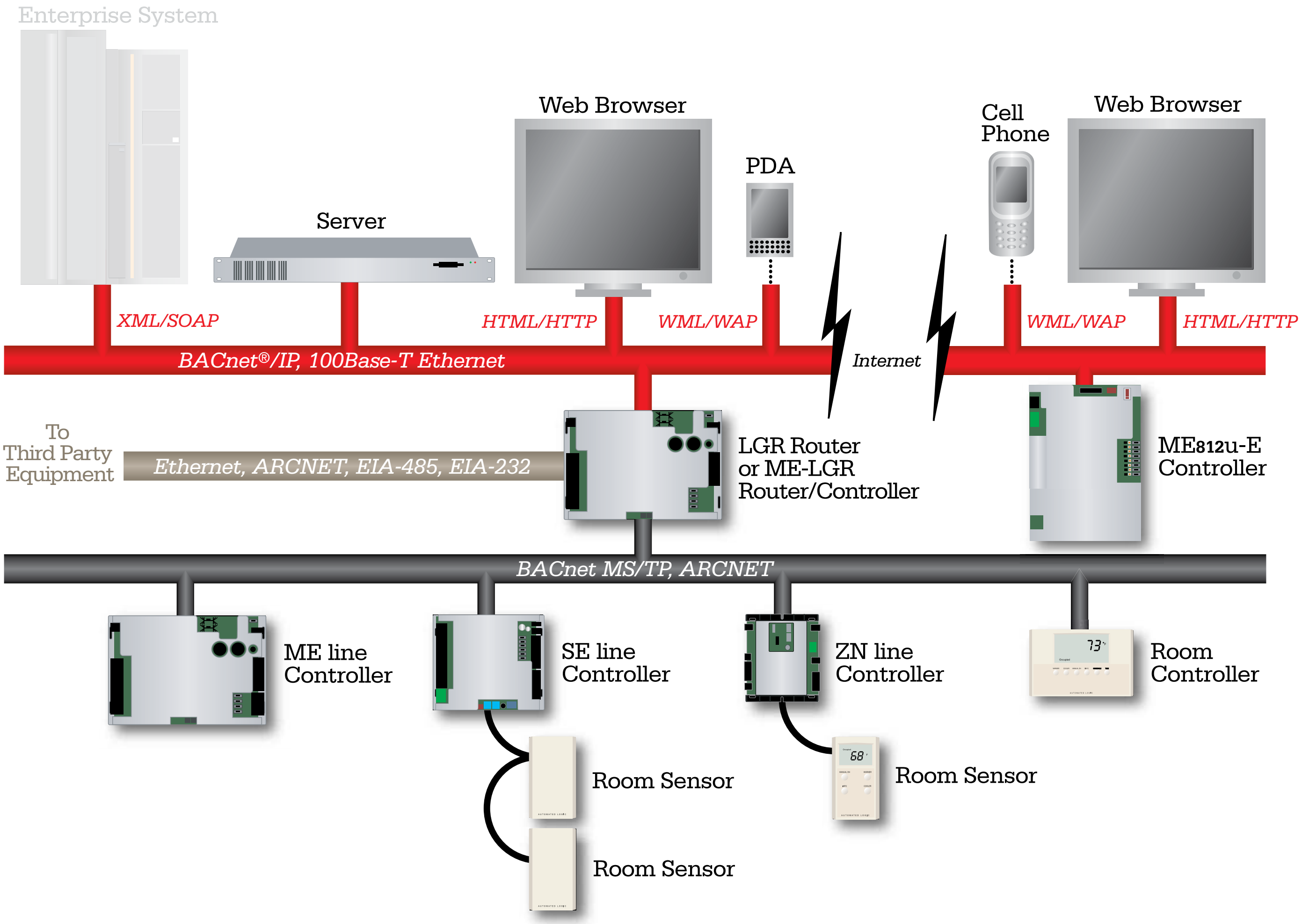
Every 24 hours, the SMART SYSTEM automatically shifts the lead boiler role to the next unit in the sequence. This rotation ensures long life by distributing "lead-lag" run times equally over each unit in the system.

WebCTRL®

Web-Based Building Automation

AutomatedLogic®
CORPORATION

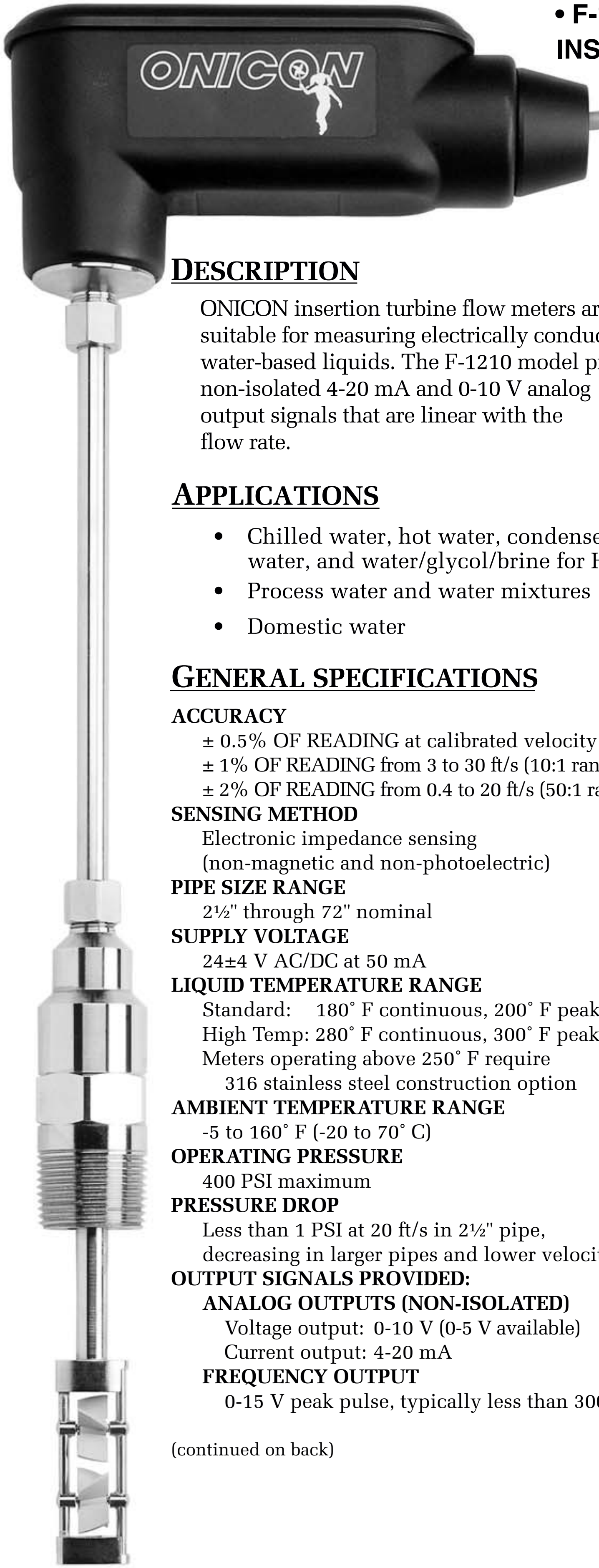
...the power of simplicity




WebCTRL®

## You be the Judge!

See it for yourself! For more information, including an on-site demonstration, contact your local authorized dealer, call us at 770/429-3000 or visit www.automatedlogic.com.




# • F-1210 DUAL TURBINE •
# INSERTION FLOW METER
# 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-1210 model provides non-isolated 4-20 mA and 0-10 V analog output signals that are linear with the flow rate.

## APPLICATIONS

- Chilled water, hot water, condenser water, and water/glycol/brine for HVAC
- Process water and 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

**SUPPLY VOLTAGE**
24±4 V AC/DC at 50 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 stainless steel 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 OUTPUTS (NON-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 directly traceable to NIST. Certification of calibration is included with 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.

**Installation Flexibility** - Patented dual turbine models deliver outstanding accuracy in short pipe runs.

**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) |
|---|---|
| 2½ | 2.5 - 230 |
| 3 | 4 - 460 |
| 4 | 8 - 800 |
| 6 | 15 - 1800 |
| 8 | 26 - 3100 |
| 10 | 42 - 4900 |
| 12 | 60 - 7050 |
| 14 | 72 - 8600 |
| 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, Florida 33765 Tel (727) 447-6140 Fax (727) 442-5699*
*www.onicon.com E-mail: sales@onicon.com*

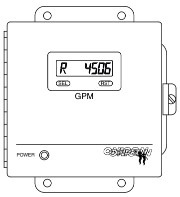
# F-1210 SPECIFICATIONS cont.

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

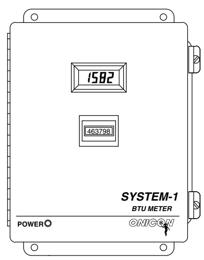
**ELECTRONICS ENCLOSURE**
Standard: Weathertight aluminum enclosure
Optional: Submersible enclosure

**ELECTRICAL CONNECTIONS**
3-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



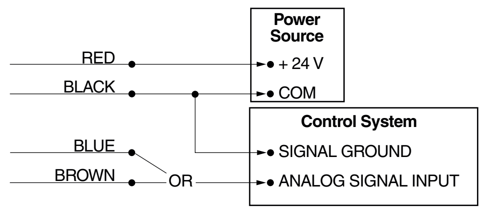

BTU Measurement Systems

# F-1210 Wiring Information

| WIRE COLOR CODE | | NOTES |
|---|---|---|
| RED | (+) 24 V AC/DC supply voltage, 50 mA | Connect to power supply positive |
| BLACK | (–) Common ground (Common with pipe ground) | Connect to power supply negative & analog input ground |
| 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 (non-isolated) | Both signals may be used independently |
| BROWN | (+) Analog signal: 0-10 V (non-isolated) | |
| **DIAGNOSTIC SIGNALS** | | |
| ORANGE | Bottom turbine frequency | These signals are for diagnostic purposes - connect to local display or BTU Meter |
| WHITE | Top turbine frequency | |

## F-1210 Wiring Diagram

**Flow Meter into Control System (No Display or BTU Meter)**

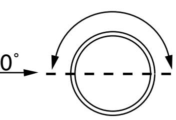


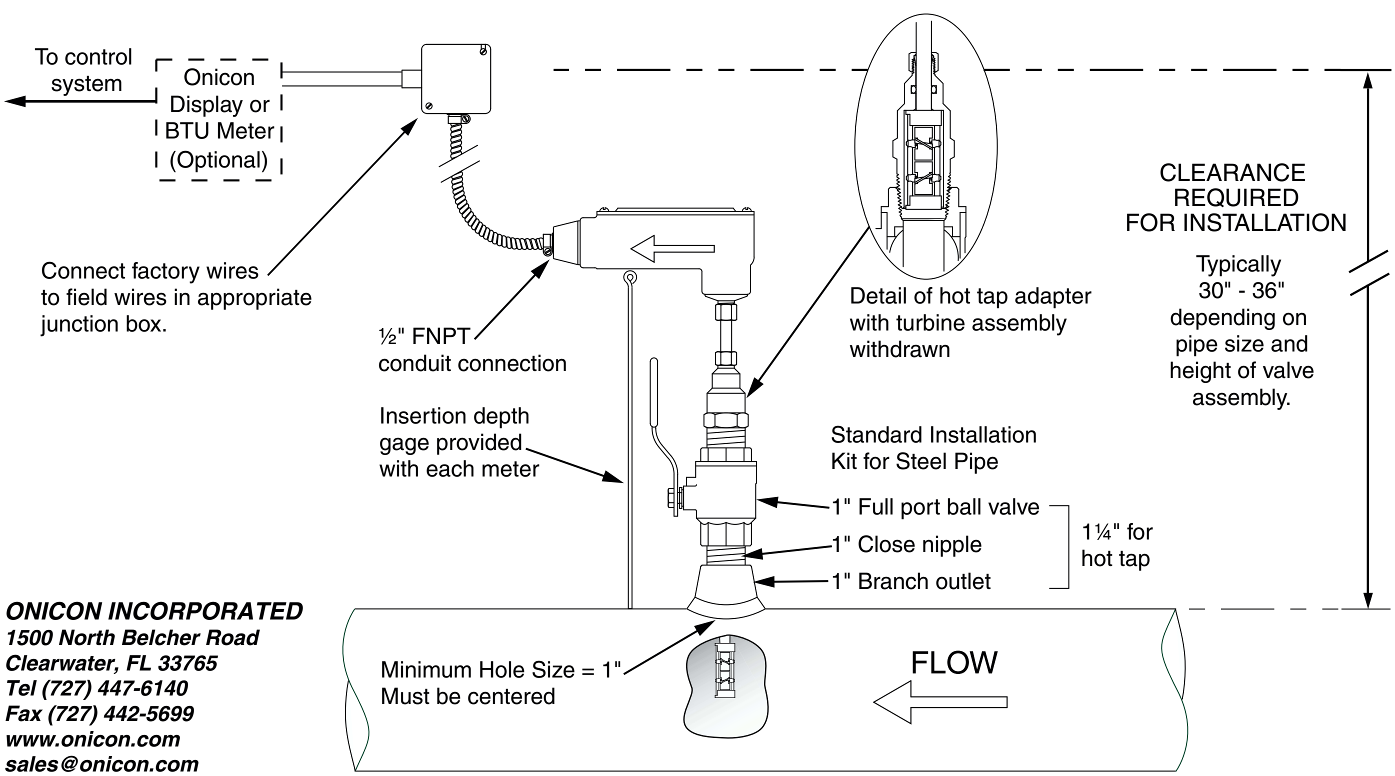

*NOTE: 1. Black wire is common with the pipe ground (typically earth ground).*
*2. Frequency output required for ONICON display module or BTU meter, refer to wiring diagram for peripheral device.*

# Typical Meter Installation

**(New construction or scheduled shutdown)**

- Acceptable to install in vertical pipe
- Position meter anywhere in upper 180˚ for horizontal pipe







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


Note: Installation kits vary based on pipe material and application. For installations in pressurized (live) systems, use "Hot tap" 1¼ inch installation kit and drill hole using a 1 inch wet tap drill.

# Immersion Units

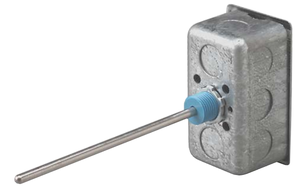
## *Temperature Sensors*

CE *

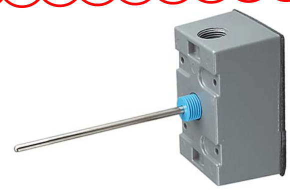
Rev. 05/28/08

## *Features & Options*

- Probe Lengths: 2", 4" and 8" (fit standard BAPI Thermowell lengths)
- Series 304 Stainless Steel Probes
- Four Enclosure Styles
- Limited Lifetime Warranty
- Double Encapsulated Sensors & Etched Teflon Leadwires
- Wide Selection of Temperature Sensing Elements



**J-Box**



**Weatherproof (WP) Enclosure**

**Weather Tight (EU) Enclosure**

**BAPI-Box (BB) Enclosure**

Immersion Units are available in 2", 4" and 8" probe lengths. The sensor is potted inside a 1/4" stainless steel probe with thermally conductive epoxy. All Immersion Units have etched Teflon leadwires and double encapsulated sensors to create a watertight package that can withstand high humidity and condensation.

**Enclosure Styles**

Immersion Units come standard with a 2"x4" steel J-Box but are also available with three styles of enclosure: Weatherproof (**WP**), Weather Tight (**EU**) or BAPI-Box (**BB**). The metal **WP** enclosure carries a NEMA 3R rating, while the ABS polymer **EU** carries an IP66 rating and is available in a UV-resistant material (**EUO**). The BAPI-Box (**BB**) is made of UV-resistant polycarbonate and carries an IP66 rating. BAPI also offers optional liquid-tight fittings. For a comparison of the enclosure styles, please see the App. Notes section.

### BAPI Thermowells

Immersion Unit Probes are designed to be inserted into a Thermowell. BAPI Thermowells are available in machined stainless steel or brass, or welded stainless steel, in lengths to match our Immersion Unit Probe Lengths. For more info, see page A50.

***For detailed specs on the individual Sensors & Transmitters, turn to the "Sensors" section.***

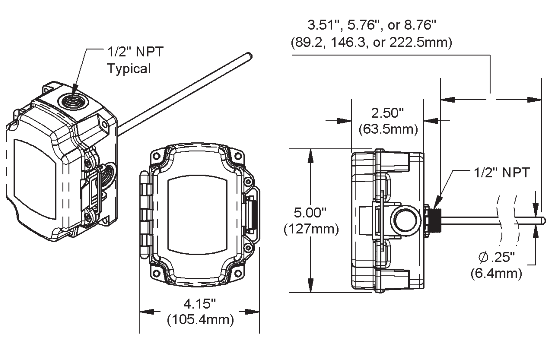
*Some items may not be CE compliant, call BAPI for additional information.

## *Specifications*

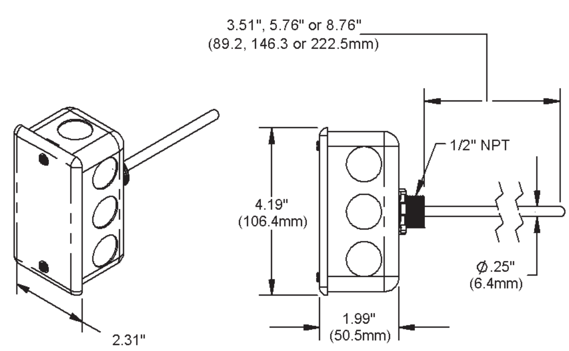
**Encl. Material:**
J-Box Model: Galv. Steel
WP Model: Cast Aluminum
EU Model: ABS Plastic, UL94, V-0
BB Model: UV-resistant polycarbonate, UL94, V-0

**Encl. Rating:** WP Model: NEMA 3R
EU & BB Model: IP66

**Environmental Operation Range:**
Temperature:
EU & BB Enclosure: -40 °C to 85 °C
J-Box, WP Enclosure: -40 °C to 85 °C
Humidity: 0 to 100%, non-condensing




**Immersion Unit with BAPI-Box (BB)**



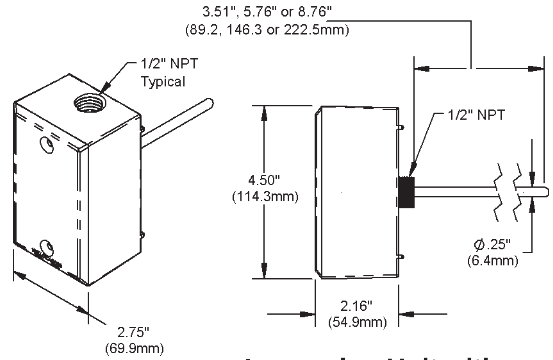

**Immersion Unit with J-Box**

Building Automation Products, Inc., 750 North Royal Avenue, Gays Mills, WI 54631 USA
Tel: +1-608-735-4800 • Fax: +1-608-735-4804 • E-mail:sales@bapihvac.com • Web:www.bapihvac.com

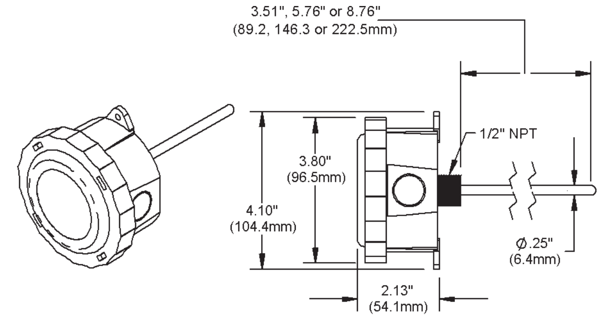
BAPI®

Rev. 05/28/08

## *Specifications*




**Immersion Unit with Weather Proof (WP) Enclosure**




**Immersion Unit with Weathertight (EU) Enclosure**

### *Ordering Information* — Immersion Units - Temperature

**BA/**

#### Sensor Type — Use the designator number (shown to the left in bold) to indicate the sensor

| # | THERMISTORS | | RTDs |
|---|---|---|---|
| **1.8K** | 1.8K Ω @ 25 °C | **100** | 100 Ω Platinum @ 0 °C, .385 Ω/°C temp. coeff. |
| **3K** | 3K Ω @ 25 °C | **100[3W]** | 3 Wire 100 Ω Plat. @ 0 °C, .385 Ω/°C temp. coeff. |
| **3.3K** | 3.3K Ω @ 25 °C | **1K[375]** | 1K Ω Platinum @ 0 °C, 3.75 Ω/°C temp. coeff. |
| **10K-2** | 10K Ω @ 25 °C | **1K[NI]** | 1K Ω Nickel @ 21°C, 5 Ω/°C temp. coeff. |
| **10K-3** | 10K Ω @ 25 °C | **1K** | 1K Ω Platinum @ 0 °C, 3.85 Ω/°C temp. coeff. |
| **10K-3[11K]** | 5,238 Ω @ 25 °C | **2K** | 2K Ω Silicon @ 20 °C, 8 Ω/°C temp. coeff. |
| **20K** | 20K Ω @ 25 °C | | **SEMICONDUCTORS** |
| **50K** | 50K Ω @ 25 °C | **334** | LM334 Semiconductor |
| **100K** | 100K Ω @ 25 °C | **592** | AD592 Semiconductor, 273 μA @ 0 °C |
| | | **592-10K** | AD592 Semicond. w/ 10 kΩ shunt resistor, 2.73 V @ 0 °C |

**TEMPERATURE TRANSMITTERS** ***Must include a "range" figure***

| | |
|---|---|
| **T100[range]** | 100 Platinum RTD, 100 Ω @ 0 °C with 4 to 20 mA Output |
| **T100M[range]** | 100 Platinum RTD, 100 Ω @ 0 °C with MATCHED* 4 to 20 mA Output |
| **T1K[range]** | 1K Platinum RTD, 1,000 Ω @ 0 °C with 4 to 20 mA Output |
| **T1KM[range]** | 1K Platinum RTD, 1,000 Ω @ 0 °C with MATCHED* 4 to 20 mA Output |
| **T10K[range]** | 10K Thermistor, 10,000 Ω @ 25 °C with 4 to 20 mA Output |

**TEMPERATURE TRANSMITTER RANGES**

Custom temperature transmitter ranges are available. Common ranges are listed below

| | | | |
|---|---|---|---|
| 30 TO 81F | -1 TO 27C | 32 TO 212F | 0 TO 100C |
| 0 TO 100F | -18 TO 38C | 40 TO 240F | 4 TO 116C |
| 20 TO 120F | -7 TO 48C | 50 TO 250F | 10 TO 121C |
| 32 TO 134F | 0 TO 57C | | |

#### Configuration

| | |
|---|---|
| **-I-2"** | 2" length of ¼" Diameter, Stainless Steel Probe |
| **-I-4"** | 4" length of ¼" Diameter, Stainless Steel Probe |
| **-I-8"** | 8" length of ¼" Diameter, Stainless Steel Probe |
| **-I-XX** | Custom lengths of ¼" Diameter, Stainless Steel Probe are available. Call for Details. |

#### Options ***2"x4" J-Box comes standard***

| | |
|---|---|
| **-BB** | BAPI-Box Enclosure - IP66 rated, UV-resistant polycarbonate |
| **-EU** | Weather Tight Enclosure - IP66 rated ABS polymer enclosure |
| **-EUO** | Weather Tight Enclosure - IP66 rated UV-resistant enclosure |
| **-WP** | Weatherproof Enclosure - NEMA 3R rated metal enclosure |

EXAMPLE

| | | | |
|---|---|---|---|
| **BA/** | **10K-2** | **-I-8"** | **-EU** |

Part Number: BA/10K-2-I-8"-EU

**Your Part Number:**

Call BAPI if you have questions about the above ordering grid or the configuration of the product you are ordering.

Building Automation Products, Inc., 750 North Royal Avenue, Gays Mills, WI 54631 USA
Tel: +1-608-735-4800 • Fax: +1-608-735-4804 • E-mail:sales@bapihvac.com • Web:www.bapihvac.com

## DDC CONTROL SYSTEM – OPERATORS WORK STATION SPECIFICATION

SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).

1. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 sec.
2. Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
3. Configuration and Tuning Screens: Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
4. Object Command: Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 15 sec.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance: Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciations: Each workstation on the network shall receive alarms within 5 sec of other workstations.
9. Reporting Accuracy: System shall report values with minimum end-to-end accuracy listed in Table 1.
10. Control Stability and Accuracy: Control loops shall maintain measured variable at set point within tolerances listed in Table 2.

**Table 1**
**Reporting Accuracy**

| Measured Variable | Reported Accuracy |
|---|---|
| Space Temperature | ±0.5ºC (±1ºF) |
| Ducted Air | ±0.5ºC (±1ºF) |
| Outside Air | ±1.0ºC (±2ºF) |
| Dew Point | ±1.5ºC (±3ºF) |
| Water Temperature | ±0.5ºC (±1ºF) |
| Delta-T | ±0.15ºC (±0.25ºF) |
| Relative Humidity | ±5% RH |
| Water Flow | ±2% of full scale |
| Airflow (terminal) | ±10% of full scale (see Note 1) |
| Airflow (measuring stations) | ±5% of full scale |
| Airflow (pressurized spaces) | ±3% of full scale |
| Air Pressure (ducts) | ±25 Pa (±0.1 in. w.g.) |
| Air Pressure (space) | ±3 Pa (±0.01 in. w.g.) |
| Water Pressure | ±2% of full scale (see Note 2) |
| Electrical (A, V, W, Power Factor) | ±1% of reading (see Note 3) |
| Carbon Monoxide (CO) | ±5% of reading |
| Carbon Dioxide ($CO_2$) | ±50 ppm |

**Note 1: 10% - 100% of scale**
**Note 2: For both absolute and differential pressure**
**Note 3: Not including utility-supplied meters**

**Table 2**
**Control Stability and Accuracy**

| Controlled Variable | Control Accuracy | Range of Medium |
|---|---|---|
| Air Pressure | ±50 Pa (±0.2 in. w.g.)<br>±3 Pa (±0.01 in. w.g.) | 0-1.5 kPa (0-6 in. w.g.)<br>-25 to 25 Pa (-0.1 to 0.1 in. w.g.) |
| Airflow | ±10% of full scale | |
| Space Temperature | ±1.0ºC (±2.0ºF) | |
| Duct Temperature | ±1.5ºC (±3ºF) | |
| Humidity | ±5% RH | |
| Fluid Pressure | ±10 kPa (±1.5 psi)<br>±250 Pa (±1.0 in. w.g.) | MPa (1-150 psi)<br>0-12.5 kPa (0-50 in. w.g.) differential |

## OPERATOR INTERFACE

A. Operator Interface. One stationary and one portable PC based work station shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.

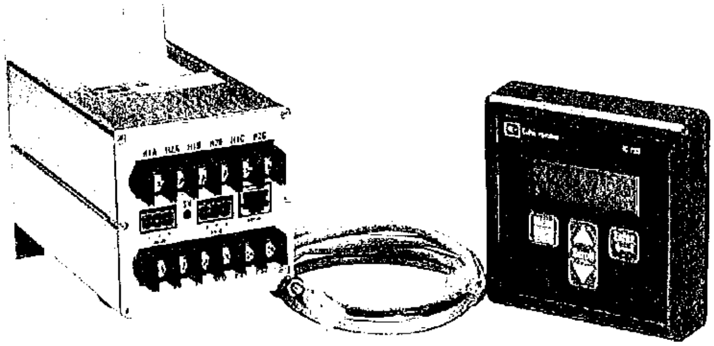
B. Communication: Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2001, BACnet Annex J.

C. Hardware: Each workstation or web server shall consist of the following:

1. Hardware Base: Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified in Section 15972 Paragraph 1.6. Hard disk shall have sufficient memory to store system software, one year of data for trended points specified by the Engineer, and a system database at least twice the size of the existing database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance. Web server or workstations shall be IBM-compatible PCs with a minimum of:

   a. Intel Pentium 2.66 GHz processor
   b. 1 GB RAM
   c. 40 GB hard disk providing data at 100 MB/sec
   d. 48x CD-ROM drive
   e. Read/Write CD drive
   f. Monitor: 17" .24-bit color monitor with minimum 1024x768 resolution.
   g. Serial, parallel, and network communication ports and cables required for proper system operation
   h. Printer: HP550 Inkjet, or equal

# IQ 210/220/230 Meters



*IQ 220 Digital Meter*

## General Description

The IQ 200 is a family of microprocessor-based metering and monitoring devices. Its compact size and flexible mounting capabilities make it suitable for machine control panels such as panelboard and switchboard mains and feeders, low voltage metal-enclosed switchgear feeders, and motor control centers. The IQ 200 series meter includes a base module and a display module. The IQ 200 base module has the flexibility to be directly mounted to the display or separately panel mounted. The display is integrally designed to fit a standard 1/4 DIN or a 100 mm ANSI cutout for new retrofit applications.

The IQ 200 is ideal for individual load monitoring or provides an alternative to multiple ammeters, voltmeters, ammeter and voltmeter switches, wattmeters, varmeters, power factor meters, frequency meters, watthour and demand meters. ANSI C12 Class 10 revenue metering accuracy make the IQ 200 ideal for sub-metering and sub-billing applications. The IQ 200 can be easily programmed from the display keypad, which features a 4 line x 20 character LED backlit LCD display. This menu driven device displays a variety of selectable electrical system values and may be programmed for password protection.

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The IQ 200 series includes four variations all containing the same display module. The IQ 210 base module is a reduced function variation, while the IQ 220, IQ 230 and IQ 230M offer additional functionality. The IQ 220 contains a wider ranging power supply, built-in INCOM communications, and a KYZ pulse output. The IQ 230 provides all the same functionality of the IQ 220 but adds digital inputs, digital outputs and an analog input. The IQ 230M includes all the benefits of the IQ 230 but replaces INCOM communication with Modbus®.

### Features

- Five different mounting options.
- 1/4 DIN standard 3.60 inches (91.4 mm) x 3.60 inches (91.4 mm) cutout that meets global standards.
- One meter style with multiple mounting choices — mount on panel, DIN rail or back of meter.
- Autoranging power supply; one style for any voltage up to 600 Vac (IQ 220 and IQ 230 only).
- Direct connection up to 600 Vac. PTs are not required.
- ac or dc powered.
- Polarity sensing for errors such as improper wiring or forward and reverse power flow.
- Membrane faceplate designed and tested to meet NEMA® 12 and IP52.
- Nonvolatile storage of all set points and recorded peaks and minimums.
- Built-in INCOM or Modbus® communications capability (IQ 220 and IQ 230 only).
- Digital and analog I/O (IQ 230 only).
- Utility seal provision (IQ 230 only).

### Monitored Values

- Phase currents.
- Voltage, L-L, L-N.
- System and per-phase power including watthours, varhours and VA-hours.
- System demand including watt demand, VA demand and var demand.
- Apparent and displacement power factor.
- Frequency.
- True rms metering of distorted currents and voltages up to the 31st harmonic.
- KYZ pulse output is available for use with a watthour pulse recorder or totalizer (IQ 220 and IQ 230 only).
- Recorded minimums and maximums of most values.

**Table 26-14. Catalog Numbers — Dimensions in Inches (mm) and Feet (m)**

| Description | Catalog Number |
|---|---|
| IQ 230 Complete Meter<br>Includes Base, Display and 14-inch Cable with INCOM Communications, KYZ Output, Digital Inputs, Digital Outputs, Analog Input, and Utility Seal Provision | IQ230 |
| IQ 230M Complete Meter<br>Includes Base, Display and 14-inch Cable with Modbus Communications, KYZ Output, Digital Inputs, Digital Outputs, Analog Input, and Utility Seal Provision | IQ230M |
| IQ 230 Base Module | IQ230TRAN |
| IQ 230M Base Module | IQ230MTRAN |
| IQ 220 Complete Meter<br>Includes Base, Display Module and 14-inch (355.6 mm) Cable with INCOM Communications and KYZ Output | IQ220 |
| IQ 210 Complete Meter<br>Includes Base, Display and 14-inch (355.6 mm) Cable | IQ210 |
| IQ 220 Transducer Base Only with INCOM Communications and KYZ Output | IQ220TRAN |
| IQ 200D IQ 210/220 Display Module | IQ200D |
| 3-foot (.9 m) Category 5 Cable<br>6-foot (1.8 m) Category 5 Cable<br>10-foot (3.0 m) Category 5 Cable | IQ23CABLE<br>IQ26CABLE<br>IQ210CABLE |

## Technical Application Data

**Table 26-15. Technical Data**

**Compatible with the following systems:**
- 3-phase, 3-wire
- 3-phase, 4-wire
- 1-phase, 2-wire
- 1-phase, 3-wire

**Current Input (Each Channel)**
- Current Range: 2 Times
- Nominal Full Scale Current: 5 amperes ac
- Overload Withstand: 10 amperes ac continuous; 150 amperes ac 1 second
- Input Impedance: 0.01 Ohms
- Burden: 0.025 VA

**Voltage Input (Each Channel)**
- Voltage Range (Nominal) 90 – 600/347 Vac
- Nominal Full Scale Voltage 120 – 600/347 Vac
- Overload Withstand 660 Vac continuous; 800 Vac 1 second
- Input Impedance 2 megaohm

**CT (Primary) Settings**
Select from 256 values ranging from 5 to 8000 amperes
- PT Primary 256 values with ratios up to 200 kV

**Environmental Conditions**

| | Base | Display |
|---|---|---|
| Operating Temperature | -20°C to 50°C | 0°C to 50°C |
| Storage Temperature | -30°C to 85°C | -20°C to 60°C |
| Operating Humidity | 0.0% to 95% Noncondensing | |
| Maximum Relative Humidity | 80% up to 31°C | |

**Electrical Standards**
- UL and cUL® listed
- UL File Number E185559
- CSA certified (Not ANSI revenue certified as a single-phase meter)
- CE mark for applications where European compliance is required

**Safety**
- IEC 1010-1 (1990) Incl. Amend. 1 and 2 (1995)
- EN61010-1 (1993)
- CSA® C22.2 #1010.1 (1992)
- UL 3111

**Frequency Range**
50/60 Hz

**EMC**
- Emissions
  - FCC Part 15 Class A
  - CISPR 11 (1990)/EN55011 (1991) Group 1 Class A
- Immunity
  - Electrostatic Discharge
    - EN61000-4-2 (1995)/EN50082-2 (1995)
      - 4 kV Contact Discharge
      - 8 kV Air Discharge
  - Electrical Fast Transient
    - EN61000-4-4 (1995)/EN50082-2 (1995)
      - 2 kV Power Lines
      - 2 kV Signal Lines
  - Radiated Immunity
    - EN61000-4-3 (1997)/EN50082-2 (1995)
      - 10V/m
  - Conducted Immunity
    - EN61000-4-6 (1996)/EN50082-2 (1995)
      - 10V rms
  - Power Frequency Magnetic Field
    - EN61000-4-8 (1995)
      - 30 A/m

**Metered Values and Accuracies at Full Scale**

| | | Accuracy |
|---|---|---|
| ac Ampere | Phase A<br>Phase B<br>Phase C | +/- 0.5% |
| ac Voltage<br>Phase A-B<br>Phase B-C<br>Phase C-A | Phase A<br>Phase B<br>Phase C | +/- 0.5% |
| Watts | | +/- 1.0% |
| Vars | | +/- 1.0% |
| VA | | +/- 1.0% |
| Watthours | | +/- 1.0% |
| Varhours | | +/- 1.0% |
| VA-Hours | | +/- 1.0% |
| Power Factor | | +/- 2.0% |
| Frequency | | +/- 0.1% |
| % THD | | +/- 1.0% |

**Control Power Input**

| | Vac | Vdc |
|---|---|---|
| IQ 210 | 110 – 240 +/-10% | 125 – 250 +/-10% |
| IQ 220 | 100 – 600 +/-10% | 48 – 250 +/-10% |
| IQ 230 | 100 – 600 +/-10% | 48 – 250 +/-10% |
| Frequency Range | 50 – 60 Hz +/-10% | — |
| Burden | 180 mA | 700 W |

**Communications**
INCOM Compatible 1200/9600 Baud
- (IQ 220 only — does not require IPONI)

Modbus Compatible 9600/19200 Baud
- (IQ 230M only — does not require PONI)

**Input/Output**
KYZ Solid-State Relay Output
- 96 mA at 240 Vac/300 Vdc (IQ 220 and IQ 230 only)
- Digital Input 96 mA at 12 – 48 Vdc (IQ 230 only)
- Digital Output 96 mA at 125 Vac/176 Vdc (IQ 230 only)
- Analog Output 4 – 20 mA (IQ 230 only)

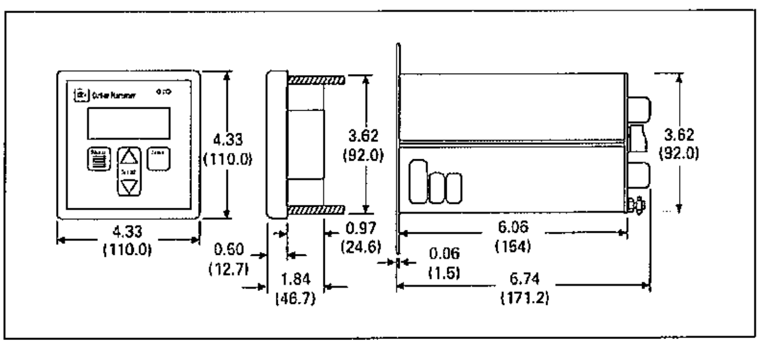


**Figure 26-18. IQ 220 — Dimensions in Inches (mm)**

26

Toren Condominiums
BFC Development
225 Flatbush Avenue
Brooklyn, NY

## SEQUENCES OF OPERATION

### 1. COGENERATION PLANT

A. The cogeneration plant consists of one or more cogenerator units with associated mechanical and electrical gear. Mechanical gear includes associated pumping, piping, valves, heat exchangers, fuel supply hardware, flow meters, exhaust and ventilation equipment. Electrical equipment includes controls, switch gear, power quality monitoring equipment, transformers and electric metering.

B. All cogeneration points from the unit microprocessor shall be displayed through the BMS via a modbus interface.

C. Operational Overview:

1) The cogeneration plant shall be controlled to provide electric power to the facility based upon electric demand requirements. The primary function shall be to meet building electrical demand and usage requirements (topping cycle).

2) Heat from the cogeneration loop is distributed to building thermal loads through a primary/secondary heating loop. A fluid cooler is provided for selectively rejecting heat to the atmosphere, to allow cooling for the plant during periods of low building thermal requirements. Heat rejection to the dry cooler shall only be allowed under user defined schedules when operation as a topping cycle is desired.

3) In either central plant mode (heating or cooling), the cogeneration plant shall act as the lead heat source by default. Supplemental gas fired boilers are allowed to operate on a sustained and consistent call for additional heat.

4) The cogeneration plant is designed and programmed to operate automatically, with owner intervention necessary only when a particular component fails, operates improperly, or the desired sequence of operation is to be changed within defined limits.

D. Demand and Electrical Operation:

1) Operation of the cogeneration units shall be automatically controlled through the cogen manufacturer's unit mounted controls and the BMS system based on electrical demand of the building. This is the primary method of operation. Under this method each cogeneration unit ramps up or down sequentially, as needed to provide electric power based on watt transducer input. Ramping shall be controlled by the cogen unit microprocessor. The cogeneration unit(s) shall ramp down in sequence when the demand from the utility service is less than a pre-determined minimum demand, in kW. The cogeneration unit(s) ramp back up when the demand from the utility meter is greater than a predetermined maximum, in Kw. The minimum import level from the electric utility shall be a minimum of 20 kw at the service entrance (adj.).

2) Start-up

(1) The cogeneration units shall be enabled and disabled through the BMS through an adjustable time schedule. Overide capabilities shall be provided in the BMS to manually enable or disable a specific cogeneration unit at the discretion of owner.

(2) The cogen cooling pump and cabinet ventilation fan for the each cogenerator are started first, by the cogenerator manufacturers unit mounted controls. After these components are running, the cogenerator unit is started.

(3) Cabinet exhaust fan EF-5: When any one cogenerator unit is running, cabinet exhaust fan EF-5 shall be energized. Fan EF-5 shall be controlled through the BMS. Fan shall run continuously at a constant volume. When all cogenerator units are OFF, Fan EF-5 shall continue to run for 15 minutes after shutdown of the last cogenerator unit. Fan shall be Off after the 15 minute time delay (adj.).

3) Ramp Up Operation

(1) During ramp up operation, cogenerator unit(s) not yet operating cycle on at a user adjustable low limit, and ramp up until they are at full load. This creates a time delay between startup of additional units. A minimum time delay of two (2) minutes shall be established to allow the cogenerator to stabilize. The minimum time delay shall be user adjustable.

4) Steady State Operation

(1) Steady state operation continues provided that building demand remains above the pre-programmed, user selected minimum import kW level from the utility.

5) Ramp Down Operation

(1) The ramp down operation begins when building electrical demand drops off to a point where demand from the utility service falls below a pre-programmed, user selected minimum import kW level.

6) Cogen Operation Summary

(1) The cogenerator manufacturers unit mounted controls shall modulate the Kw output of all cogenerator units allowing all units to operate above minimum output levels and maintain the minimum required import Kw level from the electric utility.

(2) As each additional cogenerator unit is activated, the generator output of cogenerators already in operation shall be automatically adjusted by the cogenerator manufacturers unit mounted controls to allow all cogenerator units to operate above minimum output

levels and maintain the minimum required import Kw level from the electric utility.

E. Heat Recovery:

1) Each cogen unit shall have a dedicated coolant flow pump that will circulate cooling water to and from a main cogen hot water loop serving the building thermal loads. Waste heat is recovered from the engine and exhaust heat recovery heat exchanger and delivered to the main cogen hot water loop for distribution throughout the building.

2) The coolant flow pump shall be enabled/disabled through the cogen manufacturers unit mounted controls. Unit mounted controls shall also monitor pumps status and generate an alarm upon detection of pump failure. Cogen manufacturer shall provide all conduit, wiring and control devices for interlock with coolant flow pump.

3) Each cogen unit shall be provided with a integral self-contained three-way modulating valve to maintain a minimum entering water temperature to the engine of 150 degrees F.

4) Each cogen unit shall be provided with a dedicated cabinet ventilation fan to ventilate the engine enclosure. The fan shall be enabled/disabled through the cogen unit manufacturers unit mounted controls such that when the cogen unit is operating, the ventilating fan is “ON”. Cogen manufacturer shall provide all conduit, wiring and control devices for interlock with cabinet exhaust fan.

5) Cogen hot water temperature sensors shall be provided at the inlet and outlet of each cogen unit and at the outlet of the exhaust heat recovery heat exchanger. Sensor output shall be made available to the building DDC system through a terminal block mounted in the cogen control panel for each unit.

**and**

Redundant cogen return water sensors shall also be furnished by the and installed by the controls contractor for monitoring by the building BMS system.

6) Each Cogen unit shall be supplied with a catalytic converter to reduce air emissions. Thermocouples shall be provided at the inlet and outlet of the catalytic converter to detect failure. Thermocouples shall be furnished, installed and monitored by the cogen unit manufacturer. Sensor output shall be made available to the building BMS system through a terminal block mounted in the cogen control panel for each unit.

F. Electrical System:

1) Each cogenerator unit has its own microprocessor controller to check for a variety of alarm conditions and modulate the induction generator speed to control power output. The generators shall automatically match the voltage and frequency (cycles/sec.) as supplied by the utility.

(a) Inputs are to be provided to the control system from the Beckwith power protection unit (refer to point schedule in specifications).

(b) When the Beckwith unit senses cogenerator power out of set specifications, it sends a signal to the cogeneration system protective breaker, which trips open. When this shunt opens and disconnects the cogeneration plant on the electrical side, the cogenerator units simultaneously shut down.

(c) This particular sequence operates independently of the Energy Management System. The Beckwith unit and generator breaker shall be automatically reset.

(d) If the cogeneration plant is shut down on a power quality trip, primary pumps and the cabinet exhaust fan shall continue to run. In addition, individual cogenerator pumps are to be kept running to allow the cogenerator units to avoid “hot sweating” while they are off. Pumps and fans continue to operate until the water jacket temperature drops below 150 degrees F.

2) Restart (After Closure of Inter-tie Breaker)

(a) Through digital inputs, the DDC system will be notified if the Beckwith unit has signaled a power quality trip. When the system senses that the protection breaker has been re-closed (reset), the controller will begin a cogeneration plant restart process.

3) The following cogenerator points are to be provided to the Building DDC system by the cogen unit vender through a terminal strip located in the cogen control panel. Wiring from the cogen control panel to the the DDC control system shall be furnished and installed by the controls contractor. Points shall be provided for each cogeneration unit provided.

a. Cogen unit remote start/stop
b. Cogen unit generator output (Kw)
c. Utility import level (Kw)
d. Engine inlet cooling water temperature (F)
e. Engine outlet cooling water temperature (F)
f. Exhaust heat recovery heat exchanger outlet cooling water temperature (F)
g. Engine cooling water flow (GPM)
h. Engine exhaust catalytic converter inlet thermocouple temperature (F)
i. Engine exhaust catalytic converter outlet thermocouple temperature (F)
j. General failure alarm

## 2. COGEN LOOP PUMPS: CGP-7, CGP-8

A. Cogen loop pumps shall run continuously. Provide start/stop through BMS.

B. Cogen loop pumps shall operate at constant volume, but shall be adjusted to summer/winter volume set points via the BMS per the following:

1) Heating Mode: BMS shall modulate pump speed to maintain a cogen hot water return temperature of 180 deg F (adj.), with a minimum flow setpoint of 180 gpm (adj.). As cogen hot water return temperature decreases below 180 deg F, pump speed shall increase to maintain cogen hot water return temperature setpoint. As cogen hot water return temperature increases above 180 deg F, pump speed shall decrease to maintain cogen hot water return temperature setpoint.

2) Cooling Mode: When chillers are enabled, cogen loop pumps shall modulate to maintain 700 gpm constant flow.

C. In the event of normal cogen system shutdown or shutdown due to system failure, cogen loop pumps shall continue to operate. As boiler loop temperature decreases below setpoint, supplemental boiler control sequence shall be initiated.

D. Pumps CGP-7 and CGP-8 shall operate as lead/lag. Only one pump shall run at any given time. In the event that the lead pump fails, the lag pump shall be energized. DDC system shall alternate operation of lead/lag pumps on a scheduled basis.

E. If the main loop hot water supply temperature decreases below 130 degrees F, an alarm shall be generated at the DDC system operators work station.

F. Cogen hot water flow shall be monitored through a system flow meter (FM-1).

**3. <u>FLUID COOLER: FLC-1 AND PUMPS HWP-7 & HWP-8</u>**

A. Fluid cooler FLC-1 shall be DDC controlled to maintain a cogen return water temperature of 180 degrees F to 185 degrees F back to the cogen units.

B. Upon a rise in the heat exchanger (HX-3) primary entering water temperature above 180 deg F, the lead hot water pump shall be energized. The hot water pump shall operate at constant speed.

C. Pumps shall operate as lead/lag. Only one pump shall operate at any given time.In the event that the lead pump fails, the lag pump will be energized. The BMS shall alternate operation of the lead/lag pumps at system startup to equalize run time as much as possible.

D. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.

E. Upon a further rise in temperature in the heat exchanger (HX-3) primary entering water temperature above 182 deg F, the individual dry cooler fans shall be staged ON individually to maintain a cogen loop return water temperature setpoint of 180 to 188 deg F (adj.) back to the cogen units.

F. As the heat exchanger (HX-3) primary entering water temperature decreases below 180 deg F, dry cooler fans shall be staged OFF individually and the hot water pumps de-energized.

4. **FLUID COOLER: FLC-3**

A. Fluid cooler FLC-3 shall be DDC controlled to maintain a generator/electronics cooling return water temperature of 110 degrees F (adj.) back to the cogen units.

B. Upon a rise in the generator/electronics cooling return water temperature above 110 deg F, the fluid cooler bypass valve shall modulate closed. Upon a further rise in the generator/electronics cooling water return temperature above 115 deg F, individual dry cooler fans shall be staged ON to maintain a generator/electronics cooling return water temperature of 110 deg F back to cogen units.

C. As the generator/electronics cooling return water temperature decreases below 110 deg F, dry cooler fans shall be staged OFF individually and the fluid cooler bypass valve shall modulate open.

5. **BOILER PLANT: MODULAR SYSTEM, B1, B2, B3, B4, B5, B6**

A. When the central plant is placed in the heating mode, the cogeneration plant shall act as the lead hot water heat source. The supplemental gas fired boilers are allowed to operate on a sustained call for additional heat.

B. The BMS shall monitor the temperature of the boiler loop, enable/disable boilers and stage boilers in sequence to maintain an adjustable boiler loop supply water temperature setpoint according to a heating or cooling mode reset schedule. The boiler loop supply water temperature shall be reset based on outside air temperature according to the following schedule:

| | **Outside Air Temp. (F)** | **HWS Loop Set point Temp. (F)** |
|---|---|---|
| **Summer (Cooling Mode)** | ≤55 | 170 |
| | Scale | Scale |
| | ≥80 | 215 |
| | | |
| **Winter (Heating Mode)** | 0 | 195 |
| | Scale | Scale |
| | ≥55 | 150 |

C. Boilers shall not cycle on unless the sensed hot water temp is below set point for a minimum of 10 minutes (adjustable).

D. In the event that the cogen main loop supply water temperature decreases below the set point for more than 10 minutes (adj.), the BMS shall energize the lead boiler pump. Upon proof of boiler pump status, the lead boiler shall energize at minimum firing rate to maintain the main loop supply water temperature set point. If the boiler loop supply water temperature continues to drop, boiler firing rate shall be modulated up to 100% firing rate as required to maintain the main loop supply water temperature set point. If set point temperature is not achieved after a five minute time delay (adj.), a second boiler and its associated boiler pump shall be energized. Boilers shall be staged in this fashion based on a five minute (adj.) time delay for each boiler.

E. As main loop return water temperature increases above set point temperature, boilers and associated boiler pumps shall be staged “OFF” on five minute time delays.

F. Individual boiler pumps shall continue to operate for one minute (adj.) after boiler is disabled.

G. The lead boiler shall be rotated on a weekly basis to equalize runtime.

H. Individual boiler status and general alarms indication shall be provided at the operator work station from individual boiler controls.

I. Boilers shall be software interlocked with dry cooler control valve such that any time the control valve is not 100% closed, the boilers shall be disabled.

## 6. CHILLED WATER PLANT

A. General:

1) The chiller plant shall be enabled to operate when the central plant is placed in cooling mode. Absorption chiller CH-1 shall be the lead chilled water cooling source. In the event that the primary chilled water temperature differential is greater than 10 deg F (adj.) for more than 10 minutes (adj.), the BMS shall energize the lead scroll chiller. If after a 10 minute (adj.) time delay, the chilled water temperature differential continues to rise, a second scroll chiller shall be enabled. Additional chillers shall be staged in this fashion based on a 10 minute (adj.) time delay for each chiller.
2) Once enable, each chiller will operate using manufacturer’s unit mounted controls to maintain the chilled water supply temperature setpoint. The chilled water set point shall be adjustable through the BMS operator work station.
3) If the lead chiller fails, the chiller shall be commanded OFF and the next scroll chiller in the sequence shall be commanded ON. The lead chiller shall be the chiller with the lowest runtime hours. The lead chiller shall be rotated after 168 hours of run time.
4) Absorption chiller CH-1 control points shall be monitored by the BMS via a BACnet over Ethernet interface.
5) If at any time the chilled water return temperature exceeds 95 degrees F an alarm will indicate at the central console and the secondary chilled water (dual temp) pumps will cycle off.

B. Absorption Chiller:

1) Absorption chiller CH-1 shall be enabled by the BMS. The chiller manufacturer's unit mounted controls shall send a signal (contact closure) to the DDC controller to start/stop chilled water, condenser water and hot water pumps.
2) Upon receiving a call to run signal from the chiller manufacturer's unit mounted controls, the absorber hot water pump (CGP-9) shall be started via the DDC controller. The absorber hot water pump shall remain in operation as long as the call to run signal is in effect. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.
3) Once enabled, the absorber hot water control valve shall be modulated as necessary by the chiller manufacturer's unit mounted microprocessor controls. If the hot water supply temperature decreases below 150 deg F an alarm shall be generated at the BMS operator workstation.
4) Upon receiving a call to run signal from the chiller manufacturer's unit mounted controls, chilled water pump CWP-1 shall be started via the DDC controller. The pump shall operate at constant volume. The chilled water pump shall remain in operation as long as the call to run signal is in effect. When the call to run signal is interrupted, chilled water pump shall continue to run for 15 minutes to stabilize all system temperatures. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.
5) Upon receiving a call to run signal from the chiller manufacturer's unit mounted controls, condenser water pump CDP-1 shall be started via the DDC controller. The pump shall operate at constant volume. The chilled water pump shall remain in operation as long as the call to run signal is in effect. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.
6) Chiller operation shall be controlled through the chiller manufacturers microprocessor controls to maintain a chilled water supply temperature of 44 deg F (adj.). The chw supply temperature set point can be confined to operate within maximum and minimum values by the operator. The operator shall be able to select one of the following methods of determining the set point:

   (a) Fixed but manually changeable by the operator.
   (b) Reset by an operator changeable schedule based on outside air temperature

7) Duplex Pumps shall operate as lead/lag. Only one pump shall run at any given time. In the event that the lead pump fails, the lag pump shall be

energized. DDC system shall alternate operation of lead/lag pumps at system startup to equalize run time as much as possible.

8) Cogen hot water flow to the absorption chiller shall be monitored through a system flow meter (FM-2). Flow meter shall be provided by the controls contractor and installed by the mechanical contractor.
9) When the outside air temperature is below 50 deg F, the chiller shall be disabled.
10) DDC System shall control/monitor the following chiller points

    (a) Remote enable/disable
    (b) Chiller status
    (c) Chiller alarms & safeties

C. Scroll Chillers:

1) The scroll chillers shall be enabled by the BMS. The chiller manufacturer's unit mounted controls shall send a signal (contact closure) to the DDC controller to start/stop chilled water and condenser water pumps.
2) Upon receiving a call to run signal from the chiller manufacturer's unit mounted controls, the respective chilled water pump shall be started via the DDC controller. The pump shall run at constant volume. The chilled water pump shall remain in operation as long as the call to run signal is in effect. When the call to run signal is interrupted, chilled water pump shall continue to run for 15 minutes to stabilize all system temperatures. Pump status shall be monitored by a current switch. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.
3) Upon receiving a call to run signal from the chiller manufacturer's unit mounted controls, the respective condenser water pump shall be started via the DDC controller. The pump shall operate at constant volume. The condenser water pump shall remain in operation as long as the call to run signal is in effect. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.
4) Chiller operation shall be controlled through the chiller manufacturers microprocessor controls to maintain a chilled water supply temperature of 44 deg F (adj.). The chw supply temperature set point can be confined to operate within maximum and minimum values by the operator. The operator shall be able to select any of the following three methods of determining the set point:

    (a) Fixed but manually changeable by the operator.

    (b) Reset by an operator changeable schedule based on outside air temperature.

5) A PID control loop, comparing the actual chw supply temperature to its set point, shall sequence the compressor stages, individual compressors and/or their unloaders in order to achieve the set point target. Chw ramp up/ramp down parameters (operator changeable) define the maximum rate at which the chw PID output is allowed to increase on start-up, and to decrease the chw PID output on shutdown such that the output is always at minimum load before the chiller run output is turned off or on. Compressor minimum ON/OFF times shall prevent short cycling.

6) When the outside air temperature is below 50 deg F, the chiller shall be disabled.

## 7. COOLING TOWER: CT-1

A. Upon proof of condenser water flow, as sensed by a flow switch, cooling tower fans 1 and 2 shall be energized modulated though variable frequency drive to maintain an adjustable condenser water supply temperature set point of 85 deg F. As condenser water supply temperature increases above set point of 85 degrees F, both tower fans shall increase their respective speeds simultaneously to maintain setpoint. As condenser water supply temperature decreases below set point of 85 deg F, fans shall decrease speed accordingly.

B. Tower sump temperatures shall be monitored through the DDC system and shall initiate a software alarm when sump temperatures decrease below 35 degrees F to indicate sump heater failure.

C. An ultrasonic level sensor shall be installed in each cooling tower basin to detect make-up water valve malfunction. If the basin water level exceeds user definable high/low limits, an alarm shall be generated at the BMS operator work station.

D. Condenser Water Bypass Valve:

1) BMS system shall modulate condenser water bypass control valve to maintain a minimum condenser water inlet temperature of 70 deg F (adj.).

## 8. TWO PIPE CHANGEOVER HEATING/COOLING SYSTEM

A. Automatic Changeover Function:

1) Upon an operator command the EMS system shall automatically changeover the central plant and HVAC systems from the heating mode to the cooling mode and from the cooling mode to the heating mode. The EMS system shall provide a graphic display of the pertinent changeover valves and devices and a command input tutorial for operator command and review of the heating/cooling changeover sequence. The changeover control shall automatically perform the following to establish proper changeover from the heating to the cooling mode and vice versa:

(a) Operate the automatic changeover valves on the two pipe secondary distribution system to select from either hot water or chilled water.

(b) Set the central plant cogeneration and boiler loop supply temperature depending on either the heating or cooling mode. In both modes, the cogeneration units act as the lead hot water heat source by default. The supplemental gas fired boilers are only allowed to operate on a sustained call for additional heat in both the heating and cooling modes.

B. Heating to Cooling Changeover:

1) On a transition from heating to cooling mode the HVAC heat exchanger valve shall fully close off primary heating to the main heat exchangers.

2) The lead dual temperature pump shall continue to run. The automatic changeover valves shall be locked out until the dual temperature water return temperature drops below 90 deg F. Below 90 deg F, the lead dual temperature pump shall cycle off until the automatic valve changeover is complete, as sensed by position switches on the valves. Once the valves are in the cooling position, the lead dual temperature pump shall restart.

3) When valve changeover is complete, the chiller plant shall be enabled and cooling allowed to sequence. (See chiller plant control.)

C. Cooling to Heating Changeover:

1) On a transition from cooling to heating mode the chilled water central system and chillers shall be disabled.

2) The chiller plant shall be disabled and the lead dual temperature pump shall continue to run. The automatic changeover valves shall be locked out until the dual temperature water return temperature rises above 60 deg F. above 60 deg F, the lead dual temperature pump shall cycle off until the automatic valve changeover is complete, as sensed by position switches on the valves. Once the valves are in the heating position, the lead dual temperature pump shall restart.

3) The primary boiler loop water 3-way valve serving the heat exchangers shall then be allowed to operate. Hot water boiler supply temp shall be reset differently as described for the boiler reset control.

## 9. <u>HEAT EXCHANGERS HX-1 & HX-2 (BUILDING HEAT)</u>

A. Coordinate control of the main HVAC heating plate and frame exchanger 3-way valve to close and disable HVAC hot water heat in the cooling mode and to allow operation of the HVAC heat exchangers in heating mode.

B. The three-way control valve serving the heat exchangers shall modulate to maintain the secondary leaving water temperature from the heat exchangers. The secondary leaving water temperature setpoint shall be reset based on the outside air temperature according to the following schedule:

| OA Temperature (Deg F) | Leaving Water Temperature (Deg F) |
|---|---|
| 0 | 185 (adj.) |
| 55 | 120 (adj.) |

## 10. AHU LOOP CONTROL: HOT WATER PUMPS HWP-1 & HWP-2

A. The lead hot water pump shall be start/stopped through the BMS and run continuously.

B. The BMS shall monitor the AHU loop differential pressure. Each hot water pump shall be equipped with a variable frequency drive. The DDC controller shall modulate the lead pump VFD speed to maintain the loop differential pressure at its setpoint of 15 psi (adj.).

C. Hot water pumps HWP-1 and HWP-2 shall operate as lead/lag. Only one pump shall run at any given time. In the event that the lead pump fails, the lag pump shall be energized. The BMS shall alternate operation of the lead/lag pumps based on runtime.

D. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.

## 11. FAN COIL LOOP CONTROL: DUAL TEMPERATURE PUMPS DTP-1 & DTP-2

A. In the heating mode, the fan coil loop temperature control valve shall modulate to maintain the dual temperature loop (Pumps DTP-1 & DTP-2) hot water supply temperature setpoint. The dual temperature loop hot water supply temperature setpoint shall be reset based on outside air temperature according to the following schedule:

| OA Temperature (Deg F) | Supply Water Temperature (Deg F) |
|---|---|
| 0 | 130 (adj.) |
| 55 | 95 (adj.) |

B. The lead dual temperature water pump shall be start/stopped through the BMS and run continuously.

C. The BMS shall monitor the dual temperature loop differential pressure. Each dual temperature pump shall be equipped with a variable frequency drive. The DDC controller shall modulate the lead pump VFD speed to maintain the loop differential pressure at its setpoint of 15 psi (adj.).

D. Dual temperature water pumps DTP-1 and DTP-2 shall operate as lead/lag. Only one pump shall run at any given time. In the event that the lead pump fails, the lag pump shall be energized. The BMS shall alternate operation of the lead/lag pumps based on runtime.

E. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.

F. Dual temperature loop flow shall be monitored through the BMS using digital flow meter FM-3.

G. Individual room fan coil control (not on DDC/BMS): Individual fan coil controllers shall maintain set point based on local set point adjustment by occupants. There shall be a separate set point for cooling and heating with a minimum 3 degree dead band. The fan coil unit controllers shall automatically sense the heating or cooling mode via a pipe inserted aqua stat.

## 12. DOMESTIC WATER PUMPS (HWP-5 & HWP-6)

A. The domestic hot water heating system shall be enabled by a time-of day schedule. Once enabled, the lead hot water pump shall be started and run continuously at constant speed.

B. Domestic water heating pumps HWP-5 and HWP-6 shall operate as lead/lag. Only one pump shall run at any given time. In the event that the lead pump fails, the lag pump shall be energized. The BMS shall alternate operation of the lead/lag pumps based on runtime.

C. Pump status shall be monitored by a current switch. If the pump is commanded ON and the pump status is off, a pump failure alarm shall be generated at the BMS operator workstation. Conversely, if the pump is commanded OFF and the status is ON, a pump HAND alarm shall be generated.

D. The domestic heating water supply and return temperatures shall be monitored by the BMS. If either temperature exceeds its user definable high or low limits, an alarm shall be generated at the operator work station.

E. Individual water heaters (not on DDC/BMS): Individual water heater controllers provided by the unit manufacturer shall maintain set point based on local set point adjustment. Control valves for each heater shall be modulated to maintain a hot water storage temperature of 140 deg F.

## 13. UTILITY MONITORING

A. Building gas consumption shall be monitored through the BMS through meter pulsers provided by the gas utility.

B. Building electrical consumption, utility power and cogen power shall be monitored via a modbus interface to demand meters.

## 14. AIR HANDLING UNIT CONTROL

A. Central air handler control sequences shall be coordinated as appropriate for responding to the heating/cooling changeover master command. However, AHU's shall be allowed in all modes to supply cooler air based on outside air economizer cycles, or in the case of 100% outside air units discharge cooler air temperatures based on zone conditions by limiting heating coil discharge temperature.

B. Start/Stop:

1) In response to a request for heating, cooling, and/or ventilation, the supply fan shall be turned on.

2) A return air fan shall be interlocked with the supply air fan.

3) When a fan is turned on, the fan status shall be determined by means of monitoring the air movement in the duct. After an operator definable feedback time delay, if there is no air movement, an alarm shall be generated. Conversely, if air movement is detected while a fan is turned off, a separate alarm shall be generated.

C. A digital input shall monitor the existing AHU safeties circuit and alarms when on.

D. A digital input shall monitor for excessive pressure drop across the filter. If present, a dirty filter alarm shall be generated.

E. Supply Air Temperature Control

1) A PID control loop, comparing the actual cold (hot) deck temperature to its set point, shall modulate the cooling (heating) coil valve to achieve the set point target.

2) The operator shall be able to select any of the following three methods of determining the cold (hot) deck temperature set points:

(a) Fixed but manually changeable by the operator.

(b) Reset based on the requirements of the individual zones served by the air handler. These reset functions are based on four operator definable variables for heating and four for cooling, and they are:

(i) The length of time between reset adjustments,
(ii) The decrease (increase) in temperature set point that is desired when a zone reaches its maximum cooling (heating) position,
(iii) A high limit on the rate of temperature set point change.
(iv) Reset by an operator changeable schedule based on outside air temperature. Both set points can be confined to operate within maximum and minimum values by the operator.

F. Preheat Control

1) When the preheat coil discharge air temperature falls below a definable low limit, the preheat valve shall modulate open on a proportional basis.

2) Additionally, the PID control loop, comparing the actual hot deck temperature to its set point, modulates the preheating coil valve after the primary heating coil valve has been fully opened, when additional heating is required.

G. OA Economizer Control

1) Application shall be based on dry bulb outside air temperature, with both high and low limits, or on outside enthalpy where humidity sensors are also utilized.

2) A PID loop, comparing actual supply air temperature to its set point, shall modulate the outside air dampers, prior to sequencing mechanical cooling, to achieve the supply air temperature set point target. High and low outside air temperature limits may be set by the operator to force the outside air dampers to a definable minimum position.

3) If the outside air dampers are modulating open, their position will be limited by an operator definable mixed air temperature low limit.

4) If cooling is required, but the return air temperature is lower than the OA temperature, the outside air dampers will go to their minimum position.

5) If the return air temperature is below an operator definable limit, then a warm-up cycle shall be initiated forcing the outside air dampers to their minimum position. (See WARM-UP CYCLE.) When return air temperature increases above the limit, plus a definable differential, then the warm-up cycle shall be terminated.

6) When cooling is required, a high OA enthalpy limit may be defined to force the OA dampers to their minimum position.

7) When cooling is required, but the OA enthalpy is higher than the return air enthalpy, the OA dampers are forced to their minimum position.

H. Warm-Up Cycle Control

1) If the return air temperature is below an operator definable limit, then a "warm-up cycle" shall initiate. The warm-up cycle shall position OA dampers closed, position heating valves to maximum open, and broadcast a message over the network to all of the terminal boxes served by that AHU that a warm-up cycle is in progress. This message may be used by those terminal boxes where, during the warm-up cycle only, full terminal box reheat and fully open damper position is advantageous.

2) When return air temperature increases above the limit, plus a definable differential, the warm-up cycle shall be terminated.

I. Duct Static Pressure Control (VAV Systems Only)

1) A PID loop, comparing actual supply air static pressure to its set point, shall modulate the fan speed or vortex vane position to achieve the set point target. Upon fan start-up, the fan speed or vortex vanes shall start at a minimum position and "ramp up" at an operator definable rate.

2) The static pressure set point can be either:

(a) Fixed but manually changeable by the operator,

(b) Reset based on the airflow requirements of the individual terminal boxes served by the VAV air handler. If one or more terminal boxes is operating with their dampers in the maximum open position, then the static pressure set point is increased to provide additional airflow capacity. If none of the terminal boxes served by the air handler is in the maximum open position, then the static pressure set point is decreased to save fan energy.

3) The reset function is based on four operator definable variables. They are:

(a) The length of time between reset adjustments,
(b) The increase in static pressure set point that is desired when a terminal box reaches its maximum open position,
(c) The decrease in static pressure set point that is desired when none of the terminal boxes are in a maximum open position, and
(d) A high limit on the rate of static pressure increase. The set point can be confined to operate within maximum and minimum values by the operator.

J. Fan Tracking Control

1) A PID control loop, comparing actual return air velocity pressure to its set point, shall modulate the air fan speed, or vortex vane position, to achieve the set point target. The return air velocity set point is equal to the actual supply air velocity pressure, minus a differential which is changeable by the operator.

K. Humidification/Dehumidification Control

1) When humidification is required, a PID control loop, comparing supply air relative humidity to its set point, shall modulate the humidity injection valve to achieve the set point target.

2) The supply air relative humidity set point is reset by a schedule based on return air (or space) relative humidity.

3) This schedule is changeable by the operator. The supply air relative humidity set point can be confined to operate within definable maximum and minimum values.

4) When dehumidification is required, the PID control loop, comparing supply air relative humidity to its set point, shall modulate the cooling coil valve to achieve the set point target.

## 15. SPACE TEMPERATURE CONTROL

A. Space Temperature Measurement

B. There shall be two space temperature set points, one for cooling and one for heating, separated by a dead band. Only one of the two set points shall be operative at any time.

C. The cooling set point is operative if the actual space temperature has more recently been equal to or greater than the cooling set point. The heating set point is operative if the actual space temperature has more recently been equal to or less than the heating set point.

D. All systems and space temperature control shall be coordinated with the status of the master signal for building heating and cooling mode and/or the status of the two pipe heating/cooling change over system.

E. The occupied/unoccupied modes may be scheduled by time, date, or day of week.

F. One of seven colors shall be generated to represent the comfort conditions in the space, and shall be displayed graphically at the operator station.

G. If the actual space temperature is in the dead band between the heating set point and the cooling set point, the color displayed shall be green for the occupied mode, representing ideal comfort conditions. If in the unoccupied mode, the color displayed shall be gray representing "after-hours" conditions.

H. If the space temperature rises above the cooling set point, the color shall change to yellow. Upon further rise beyond the cooling set point plus an offset, the color shall change to orange. Upon further rise beyond the cooling set point plus the yellow band offset plus the orange band offset, the color shall change to red indicating unacceptable high temperature conditions. At this point an alarm shall be generated to notify the operator.

I. When space temperature falls below the heating set point, the color shall change to light blue. Upon further temperature decrease below the heating set point minus an offset, the color shall change to dark blue. Upon further space temperature decrease below the heating set point minus the light blue band offset minus the dark blue band offset the color shall change to red indicating unacceptable low temperature conditions. At this point an alarm shall be generated to notify the operator.

J. All set points and offsets shall be operator definable. When in the occupied mode, start-up mode, or when heating or cooling during the night setback unoccupied mode, a request shall be sent over the network to other equipment in the HVAC chain, such as to an AHU fan that serves the space, to run for ventilation. The operator shall be able to disable this request function if desired.

K. When comfort conditions are warmer than ideal, indicated by the colors yellow, orange, and high temperature red, a request for additional cooling shall be sent over the network to other cooling equipment in the HVAC chain, such as a chiller. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.

L. When comfort conditions are cooler than ideal; indicated by the colors light blue, dark blue, and low temperature red; a request for additional heating shall be sent over the network to other heating equipment in the HVAC chain, such as a boiler. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.

M. The cooling (and heating) set points may be increased (decreased) under demand control conditions to reduce the cooling (heating) load on the building during the demand control period. Up to three levels of demand control strategy shall be provided. The operator may predefine the amount of set point increase (decrease) for each of the three levels. Each space temperature sensor in the building may be programmed independently.

N. An optimum start-up program transitions from the unoccupied set points to the occupied set points. The optimum start-up algorithm considers the rate of space temperature rise for heating and the rate of space temperature fall for cooling under nominal outside temperature conditions; it also considers the outside temperature; and the heat loss and gain coefficients of the space envelope. (AI: Space Temperature)

O. A PID control loop, comparing the actual space temperature to its set point, shall modulate the dampers (and heating coil valve or heating stages in sequence) to achieve the set point target.

P. The fan is interlocked with the heating sequence. When the fan is turned on, the fan status determines if there is air movement in the duct. After an operator definable feedback time delay, if there is no air movement, an alarm shall be generated.

Q. Packaged HVAC Control

1) A PID control loop, comparing the actual space temperature to its set point, shall modulate the cooling coil valve or cooling stages (and heating coil valve or heating stages in sequence) to achieve the set point target.