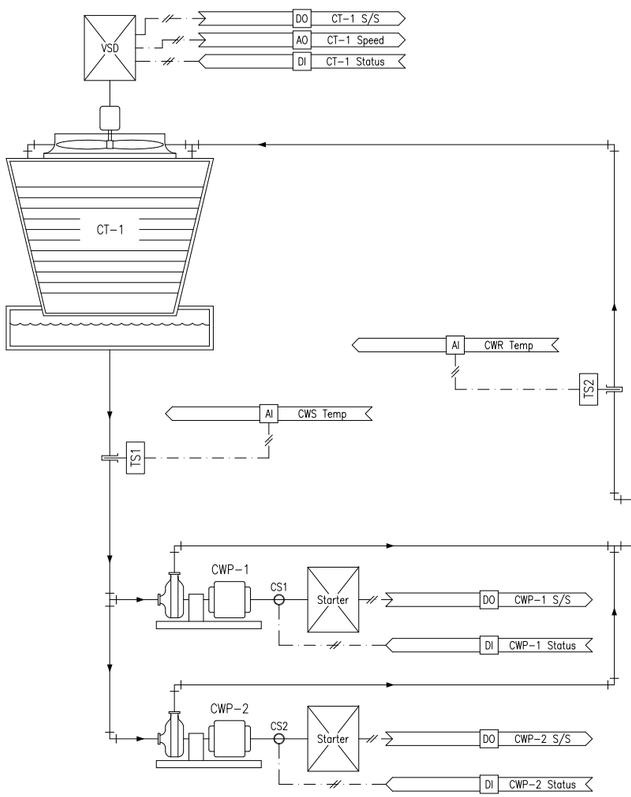
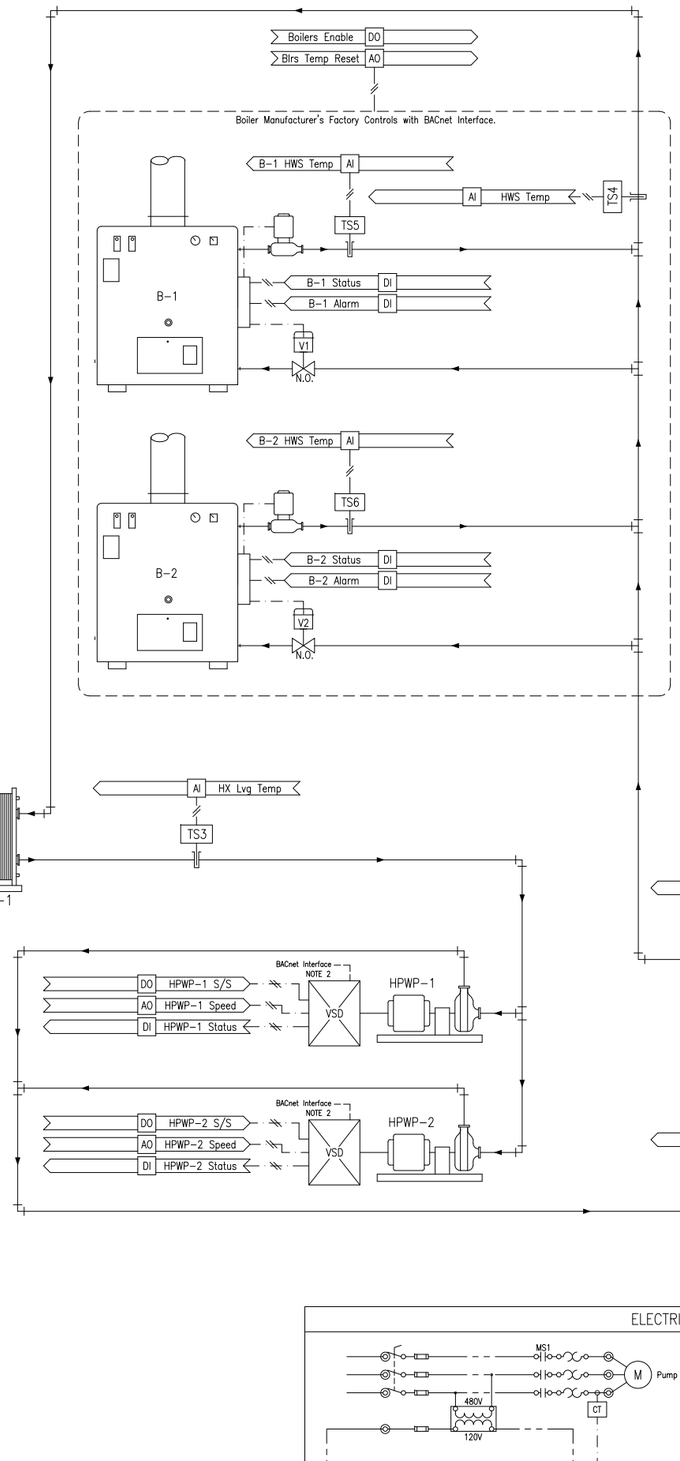
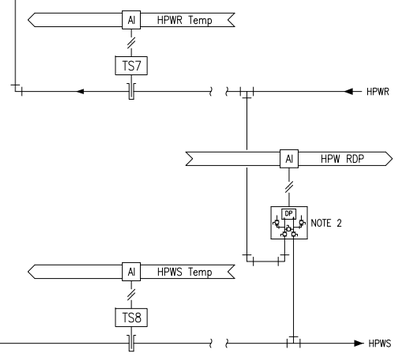






SEQUENCE OF OPERATION

GENERAL: BAS SHALL CONTROL THE HEAT PUMP WATER SYSTEM AND EQUIPMENT AND PROVIDE MONITORING AND DIAGNOSTIC INFORMATION FOR MANAGEMENT PURPOSES.

COOLING/HEATING MODES: COOLING MODE AND HEATING MODE SHALL BE DETERMINED BY THE BAS BASED ON OUTSIDE AIR TEMPERATURE AND HPW SUPPLY TEMPERATURE AS DEFINED BELOW. THE BAS SHALL PREVENT BOTH MODES FROM BEING ON SIMULTANEOUSLY, BUT BOTH MODES MAY BE OFF SIMULTANEOUSLY.
1. HEAT MODE SHALL BE ENABLED WHEN: OUTSIDE AIR TEMPERATURE FALLS BELOW 60°F (ADJ.) OR HPWS TEMPERATURE FALLS TO WITHIN 5°F (ADJ.) OF THE BOILER HPWS SETPOINT (70°F, ADJ.).
2. COOL MODE SHALL BE ENABLED WHEN: OUTSIDE AIR TEMPERATURE RISES ABOVE 65°F (ADJ.) OR HPWS TEMPERATURE RISES TO WITHIN 5°F (ADJ.) OF THE COOLING TOWER HPWS SETPOINT (90°F, ADJ.).

BOILER STAGING:
1. STAGING OF BOILERS SHALL BE PERFORMED BY FACTORY PROVIDED CONTROLLER TO MAINTAIN THE BOILER HPWS TEMPERATURE SETPOINT.

HEATING WATER PUMP CONTROL: BAS SHALL CONTROL THE PUMPS AS FOLLOWS:
1. START/STOP: PUMP SHALL BE STARTED WHENEVER ASSOCIATED BOILER IS REQUESTED.
2. PROOF: BAS SHALL PROVE PUMP OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME.

HPW PUMP CONTROL: BAS SHALL CONTROL THE PUMPS AS FOLLOWS:
1. START/STOP: LEAD PUMP SHALL BE STARTED WHEN HEATING OR COOLING MODE IS ENABLED AND SHALL RUN CONTINUOUSLY.
2. PROOF: BAS SHALL PROVE PUMP OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME. UPON FAILURE OF THE LEAD PUMP, BAS SHALL ENERGIZE THE LAG PUMP AND ENUNCIATE A LEVEL 1 ALARM.
3. VSD CONTROL: WHENEVER HEATING OR COOLING IS ENABLED, BAS SHALL CONTROL THE OUTPUT OF THE ACTIVE PUMP VSDS PER A RA PID LOOP TO MAINTAIN HPW REMOTE DIFFERENTIAL PRESSURE (RDP) SETPOINT (DETERMINED BY TAB; INITIALLY 10 PSID). ON START AND STOP, THE VSD SHALL RAMP TO SPEED AND SLOW DOWN WITHIN ADJUSTABLE ACCELERATION AND DECELERATION LIMITS.
4. STAGING: WHEN THE PUMP VSD OUTPUT IS 100% FOR 10 MINUTES (ADJ.), BAS SHALL START AN ADDITIONAL PUMP. WHEN THE PUMP VSD OUTPUT IS < 50% FOR 2 MINUTES (ADJ.) AND MORE THAN ONE PUMP IS ENABLED, BAS SHALL STOP THE ACTIVE PUMP WITH THE GREATEST ACCUMULATED RUNTIME.

CONDENSER WATER PUMP CONTROL: BAS SHALL CONTROL THE PUMPS AS FOLLOWS:
1. START/STOP: LEAD PUMP SHALL BE STARTED WHENEVER COOLING MODE IS ENABLED AND SHALL RUN CONTINUOUSLY.
2. PROOF: BAS SHALL PROVE PUMP OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME. UPON FAILURE OF THE LEAD PUMP, BAS SHALL ENERGIZE THE STANDBY PUMP AND ENUNCIATE A LEVEL 1 ALARM.

COOLING TOWER FAN CONTROL: BAS SHALL CONTROL THE TOWER FAN AS FOLLOWS:
1. START/STOP: TOWER FAN SHALL BE STARTED WHEN COOLING IS ENABLED AND CONDENSER WATER PUMP STATUS IS PROVEN.
2. PROOF: BAS SHALL PROVE FAN OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME.
3. VSD CONTROL: WHENEVER THE TOWER IS ENABLED, BAS SHALL CONTROL THE OUTPUT OF THE FAN VSD PER A DA PID LOOP TO MAINTAIN HEAT PUMP WATER SUPPLY TEMPERATURE COOLING SETPOINT OF 85°F (ADJ.). ON START AND STOP, THE VSD SHALL RAMP TO SPEED AND SLOW DOWN WITHIN ADJUSTABLE ACCELERATION AND DECELERATION LIMITS.

MAINTENANCE MODE: OPERATORS SHALL BE ABLE TO LOCK OUT BOILERS AND HPW PUMPS IN MAINTENANCE MODE. THIS MEANS THAT THE REQUESTS FOR THIS EQUIPMENT AND ASSOCIATED APPURTENANCES SHALL BE BYPASSED. THIS SHALL BE DONE THROUGH A GRAPHIC ICON ASSOCIATED WITH A VIRTUAL POINT INDICATING WHETHER THE MAINTENANCE MODE IS ACTIVE OR VIA A PROPERTY ASSOCIATED WITH THE BOILER ICON.

HPW AVAILABILITY: BAS SHALL GENERATE A 'HPW AVAILABLE' BROADCAST TO ALL HEAT PUMPS WHEN HEATING OR COOLING MODE IS ENABLED AND HPW SUPPLY TEMPERATURE IS WITHIN SETPOINT LIMITS.

NOTES

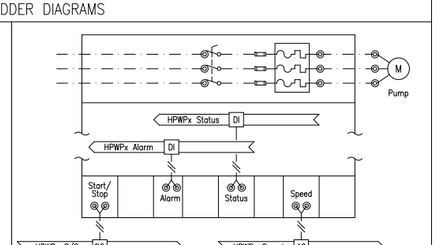
1. Locate remote differential pressure sensor at most remote heat pump, as directed. Install transmitter and bypass assembly no higher than 6 feet AFF.
2. Provide BACnet interface to the control system for diagnostic point information. VSD rate of change (Acceleration/Deceleration) shall be programmed in to the VSD controller and not rely on BAS logic.

BILL OF MATERIAL

DESIG	QTY	MODEL NO.	DESCRIPTION	
TS 1–8	8		Temp Sensor, Well	
DPT	1		Differential Pressure Transmitter	
DPS	2		Differential Pressure Switch	

ELECTRIC LADDER DIAGRAMS

TYPICAL PUMP STARTER



TYPICAL VSD PUMP

Developed in Association with
Facility Dynamics ENGINEERING
8780 Alexander Bell Drive, Suite 220
Columbia, MD 21046 (410) 290-0360

UNIVERSITY of VIRGINIA
FACILITIES MANAGEMENT

HVAC CONTROLS STANDARDS

Eng	HJN
Drawn	HJN
Chkd	---
Appd	---
Issued	8/4/11
Job No.	10080
Scale	N/A
Proj Code	

STANDARD

HEAT PUMP WATER SYSTEM CONTROL (SCHEMATIC)

24 OF 30
SHEET NUMBER

C–3.2a
DWG NUMBER