



**ASHRAE HEADQUARTERS**  
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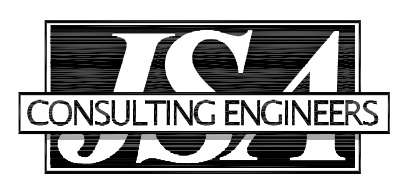
DRAWING TITLE:

**GROUND LOOP HEAT PUMP SEQUENCE & POINTS LIST**

PROJECT NUMBER:  
**200614**

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**5/25/07**

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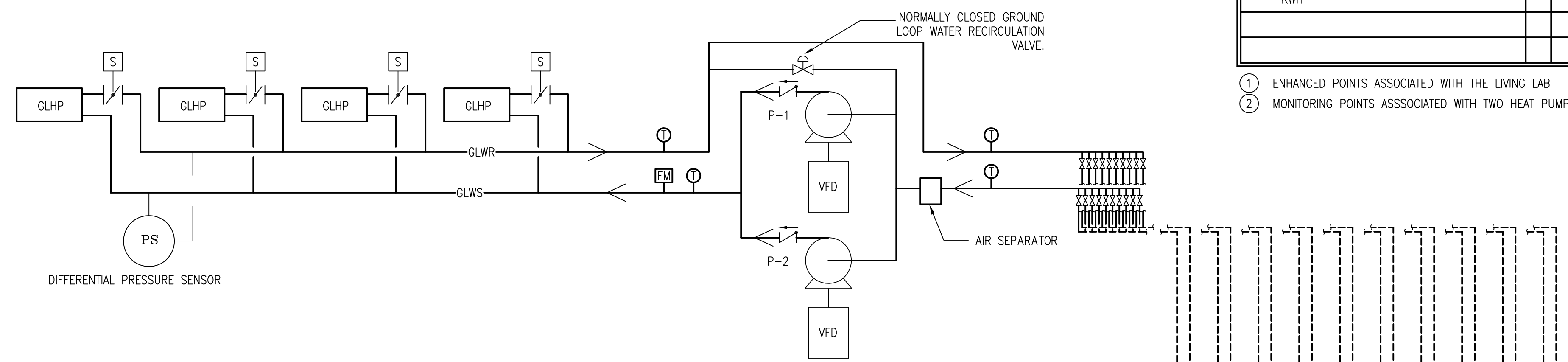


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INPUT/OUTPUT SUMMARY	OUTPUTS		INPUTS										SOFTWARE		NOTES												
	DIGITAL		ANALOG		DIGITAL		ANALOG						ALARM	ENERGY MANAGEMENT													
	START/STOP	ENABLE/DISABLE	OCCUPIED/UNOCCUPIED	SETPOINT ADJUST	DIFF. PRESS. SWITCH	CURRENT SWITCH	ON/OFF	OPEN/CLOSE CONTACT	MANUAL OVERRIDE	AIRFLOW (CFM)	STATIC PRESSURE	GPM	ASPEED/AZ/CURRENT	TEMPERATURE		HUMIDITY/DEWPOINT	POWER (AMPS/KW/KWH)	CO2 LEVEL (PPM)	DIFFERENTIAL PRESSURE	EQUIPMENT FAILURE	H/LO LIMIT	TEMPERATURE	TIME SCHEDULE	RUN TIME	OVERRIDE PROGRAM	DAY/NIGHT SETBACK	
GROUND LOOP PLANT																											
GROUND LOOP WATER SUPPLY PUMPS (VFD)	X					X						X							X				X				TYPICAL OF 2
SUPPLY PUMP VFD POSITION							X												X								TOTAL OF THREE POSITIONS
GROUND LOOP WATER DP SENSOR																		X	X								
GROUND LOOP WATER RECIRCULATION VALVE				X																							
GROUND LOOP WATER SUPPLY TEMP.												X							X								GROUND LOOP & BUILDING LOOP
GROUND LOOP WATER RETURN TEMP.												X							X								GROUND LOOP & BUILDING LOOP
GROUND LOOP WATER FLOW											X																
GROUND LOOP HEAT PUMPS	X						X												X		X	X	X				SEE PLANS FOR LOCATIONS
SPACE TEMPERATURE												X							X								SEE PLANS FOR LOCATIONS
SPACE HUMIDITY													X														SEE PLANS FOR LOCATIONS
SPACE CO2																X											SEE PLANS FOR LOCATIONS
FAN OPERATION STATUS							X	X											X								COOLING/HEATING/FAN ONLY
OPERATION MODE STATUS								X																			
REVERSING VALVE POSITION								X																			
COMPRESSOR OPERATION COMMAND								X																			
DISCHARGE AIR TEMPERATURE												X							X								
RETURN AIR TEMPERATURE												X															
MIXED AIR TEMPERATURE												X															DOWNSTREAM OF O.A. TIE-IN
COOLING STAGES			X																								2 STAGES
HEATING STAGES			X																								2 STAGES
GROUND LOOP WATER SOLENOID VALVE		X																									
CONDENSATE OVERFLOW ALARM									X										X								
AIR FILTER DIFFERENTIAL PRESSURE																		X	X								
GROUND LOOP HEAT PUMPS ENHANCED POINTS																											① ②
DISCHARGE AIR HUMIDITY													X														
RETURN AIR HUMIDITY													X														
MIXED AIR HUMIDITY													X														
OUTSIDE AIR HUMIDITY													X														
WATER FLOW											X																
EWT												X															
LWT												X															
DISCHARGE AIRFLOW												X															
RETURN AIRFLOW												X															
OUTSIDE AIRFLOW												X															
MIXED AIRFLOW												X															
OUTSIDE AIRFLOW												X															
AMPS																					X						
KWH																					X						

- ① ENHANCED POINTS ASSOCIATED WITH THE LIVING LAB
- ② MONITORING POINTS ASSOCIATED WITH TWO HEAT PUMPS SERVING THE SECOND FLOOR



**GROUND LOOP PIPING SCHEMATIC**  
SCALE: NO SCALE

1. BUILDING OCCUPANCY SCHEDULES:  
A. Provide occupancy schedules for the area served by the ground loop heat pump system. The dedicated outside air system (DOAS) unit shall be independently scheduled for occupancy such that the operator can change the DOAS operating schedule independently of the associated zone/floor it serves.

B. The ground loop water pumps shall be operational when any heat pump is in the occupied mode.  
C. The DDC System shall transition from scheduled unoccupied to occupied mode (morning warm-up/cool down) with optimized unit start-up to reach occupied setpoint at the start of occupied time, based on historical trended data, in a minimal amount of time, and stager start-up to prevent low/high loop water supply temperatures.

2. GROUND LOOP WATER LOOP CONTROL:

A. The DDC system shall maintain ground loop water supply (GLWS) setpoint for cooling and heating modes. The pumps shall be manually started and stopped from the HAND and OFF position of the HAND-OFF-AUTO switch on the variable frequency drive (VFD) and automatically started and stopped by the DDC system when the switch is in the AUTO position. All safety devices shall operate with the VFD in the HAND or AUTO position. DDC system shall monitor the HOA position and alarm if the switch is in the HAND or OFF position.

B. The lead ground loop water pump shall run during the occupied mode and the stand-by pump shall be off. The lead pump VFD shall modulate pump speed to maintain the loop differential setpoint (20 psi, adjustable). Failure of the lead pump or VFD failure, as sensed by loss of current or alarm contact, shall start the stand-by pump and activate a pump fail alarm. The lead pump shall be automatically alternated every 30 days (adjustable). On a loop dp sensor failure, the pump shall continue to operate at it's current speed and an alarm shall be initiated.

C. TEMPERATURE/FLOW MONITORING. The BAS shall monitor the entering and leaving water temperatures of the ground loop water supply and return to the ground loop heat exchanger and to the connected building load (4 temperatures). DDC system shall measure ground loop water flow in GPM.

D. SELF-TEMPERING MODE: When GLWS is between 60°F (adjustable) and 80°F (adjustable), the ground loop heat exchanger shall be bypassed by opening the ground loop recirculation valve. The lead ground loop water pump shall continue to run during the occupied mode.

E. HEATING MODE: Upon a drop in the ground loop water supply (GLWS) temperature below 60°F (adjustable), the ground loop recirculation valve shall modulate from 100% open to 50% closed. The valve shall fully closed at GLWS temperatures below 55°F (adjustable). Upon a fall in GLWS temperature to 45°F, the BAS shall disable 4 heating mode GLHP's for 15 minutes (adjustable). If after these 15 minutes the GLWS is still below 45°F, a second group of 4 heating mode GLHP's shall be disabled for 15 minutes, with the process repeated for a third or fourth group until the TWS is above 45°F. A drop in the GLWS temperature below 40°F (adjustable) shall activate a low loop water temperature alarm.

F. COOLING MODE: Upon a rise in the ground loop water supply (GLWS) temperature above 80°F (adjustable), the ground loop recirculation valve shall modulate from 100% open to 50% closed. The valve shall fully closed at GLWS temperatures above 85°F (adjustable). A rise in the GLWS above 95°F (adjustable) shall activate a high loop water temperature alarm.

3. GROUND LOOP HEAT PUMP UNITS

A. The ground loop heat pumps are packaged premium efficiency units, that include a variable speed supply fan, and two-stage compressor. Each unit is controlled by the DDC system using electric actuation and is scheduled for automatic operation on a time of day basis. Occupied, Unoccupied and Safety modes are as follows:

- B. Occupied:
- a. The supply fan operates continuously without cycling. The units ECM fan motor speed is automatically adjusted to maintain constant cfm over the static operating range of the fan.
  - b. Zone space sensors provide feedback for maintaining the space temperature and humidity set points of 75°F/50%rh (adjustable) for cooling and 70°F (adjustable) for heating. Space temperature is controlled by the heat pump unitary controller based on requests for either cooling or heating from the DDC system as follows:

c. COOLING: Upon a rise in space temperature of 1.5°F above the cooling setpoint, the unitary controller shall register a demand for cooling and energize the first stage of cooling. Upon a further rise in space temperature 2.5°F or greater than the cooling setpoint, the unitary controller shall execute a call for second stage cooling. If conditions are being satisfied with first stage only, based on the Optimized Staging conclusion, second stage shall be delayed until conditions are no longer being maintained by first stage. Upon a decline in demand to 1.0°F of setpoint, second stage cooling shall be released. Upon a further decline in demand to 0.4°F of setpoint, first stage cooling shall be released.

d. HEATING: Upon a fall in space temperature of 1.5°F below the heating setpoint, the unitary controller shall register a call for first stage heating. Upon a further fall in space temperature of 2.5°F below the heating setpoint, the unitary controller shall execute a call for second stage heating. If conditions are being satisfied by first stage only based on the Optimized Staging conclusion, second stage shall be delayed until conditions are no longer being maintained by first stage. Upon a decline in demand to 1.0°F of the heating setpoint, second stage heating shall be released. Upon a further decline in demand to 0.4°F of the heating setpoint, first stage heating shall be released.

e. DEHUMIDIFICATION: If room humidity increases above 60% relative humidity (adjustable), the unit controller starts first stage cooling and reduces the supply fan airflow by 25% until the humidity is reduced to below set point.

f. Normally open ground loop water solenoid valve shall close when the compressor stops (both cooling and heating modes).

g. See Input/Output Summary for the various status inputs to be monitored.

C. Unoccupied:

a. If space temperature increases to 85°F (adjustable) or drops to 55°F (adjustable), the unit supply fan will cycle with operation of the respective cooling or heating sections until the space temperature is satisfied.

b. Upon activation of the override switch the DDC system shall change the system status to the occupied mode.

D. Safety:

a. The heat pumps are hard-wired from the factory with a 5-minute anti-short cycle delay timer for each compressor

b. Upon activation of the override switch the DDC system shall change the system status to the occupied mode.

c. A smoke detector in the supply duct will shut down the unit fan when activated (selected heat pumps).

d. Each heat pump equipped with a duct-mounted smoke detector shall be provided with a fire alarm shutdown (hardwired, no DDC processing) interlocked with the fire alarm system to shut down upon activation. Extend wiring from unit connection to fire alarm relay and coordinate final connection with fire alarm contractor.

e. Activation of the Emergency Fan Stop switch shall stop all heat pump supply fans.

f. Activation of the overflow switch in the auxiliary drain pan shall stop the unit (where shown).