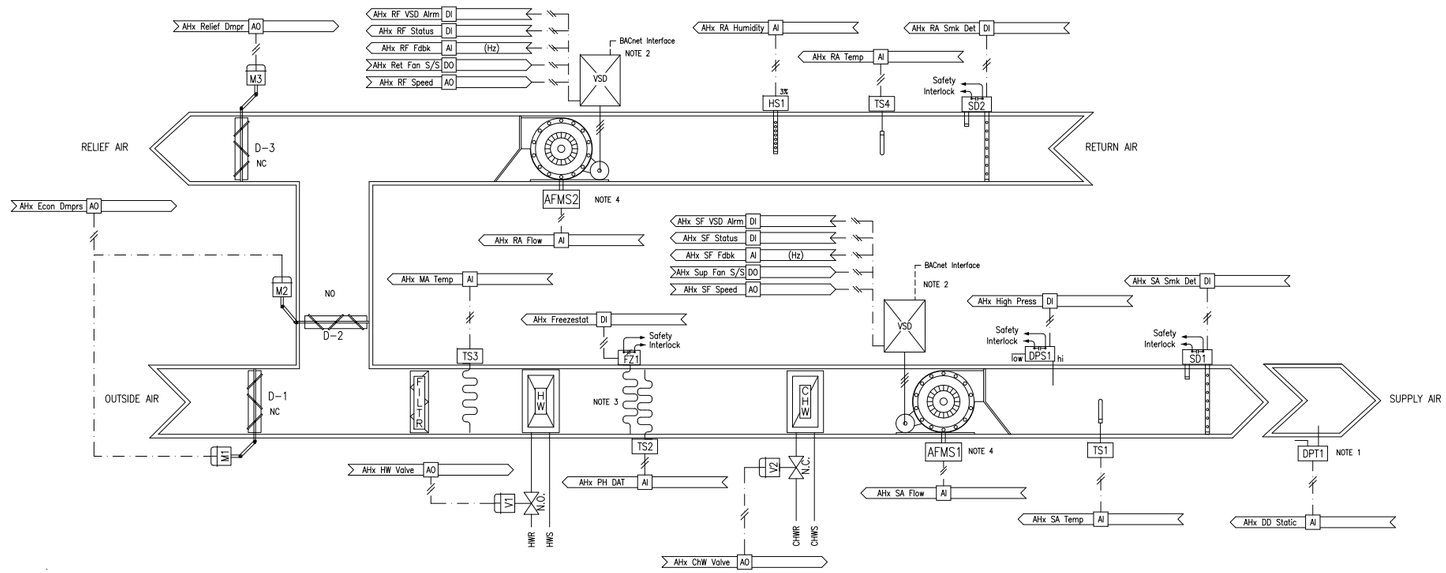


CONTROL SCHEMATIC

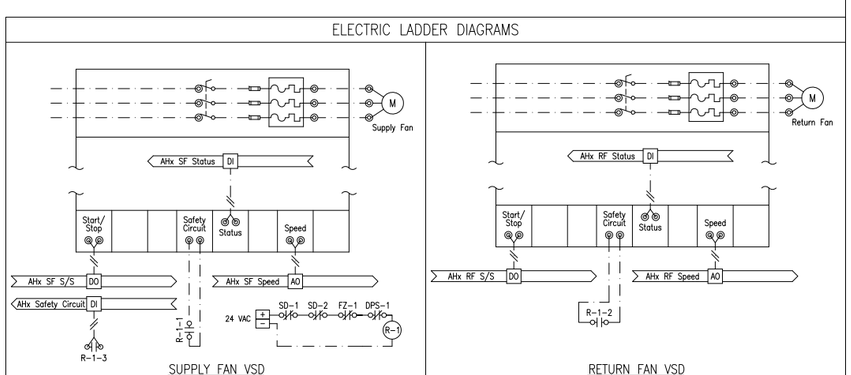
NOTES

1. Locate down stream duct static pressure pitot tube approximately ⅔ down duct. See floor plans for location.
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.
3. Provide multiple freezestats as required to achieve 1ft of linear element for each 1sq.ft. of coil face area. Preheat sensor shall be installed intertwined with freezestat to cover the exact same area. One set of contacts wired directly to drive safety input.
4. Fan AFMS may be duct or inlet type, see plans for design. Coordinate with mechanical design to ensure adequate upstream and downstream straight lengths for duct AFMS.

BILL OF MATERIAL

DESIG	QTY	MODEL NO.	DESCRIPTION	
TS 1 & 4	2		Temp Sensor, Duct	
TS 2-3	2		Temp Sensor, Duct (Averaging)	
V1, V2	2		Valve Actuators	
SD 1 & 2	2		Smoke Detectors	
DPT 1	1		Differential Pressure Transmitter	
AFMS 1 & 2	2		Airflow Monitoring Stations, Inlet	
FZ1	1		Freezestat 40F, DPDT	
M 1-3	3		Damper Actuators	
HS 1	3		Humidity Sensor, Duct	

ELECTRIC LADDER DIAGRAMS



SEQUENCE OF OPERATION

General: The variable air volume air handler shall be fully controlled by the BAS. Air handler control logic strategies shall include:

1. Scheduled Occupancy: BAS shall determine the occupancy periods (occupied, unoccupied, preoccupancy, and setback). The following details the common control aspects related to the scheduled occupancy.
   a) Occupied Period: BAS shall energize the AH during all occupied periods. Note that the beginning of the occupancy period shall be set sufficiently before the actual start of occupancy to obtain the required building component of ventilation per IMC. Minimum OA flow setpoint shall be as scheduled on the drawings. "Normal" setpoints shall apply.
   b) Unoccupied Period: Minimum OA flow shall be 0 CFM or the minimum OA damper position shall be 0%. If during the unoccupied period there is a request for occupancy override, the occupancy mode shall become active for an adjustable period. The unoccupied period and the preoccupancy period will typically overlap.
   c) Setback Period: the BAS shall deenergize the unit except as required to maintain a setback temperature as indicated in the individual sequences with a 5°F cycle differential. Generally, where setback temperatures apply in multiple zones, the worst zone shall control the system. Setback setpoints generally apply except during preoccupancy [and night purge]. If during the unoccupied period there is a request for occupancy override, the occupancy mode shall become active for an adjustable period.
   d) Preoccupancy: BAS shall energize the AH continuously during the preoccupancy period. Minimum OA flow shall be 0 CFM or the minimum OA damper position shall be 0%. "Normal" setpoints shall apply. Preoccupancy duration shall be:
      1) Optimum: The duration of the morning warm-up period shall vary according to outside air temperature and space temperature such that the space temperature rises to occupied period heating setpoint at the beginning of, but not before, the scheduled occupied period. The duration of the cool-down period shall vary according to outside air temperature and space temperature such that the space temperature falls to the occupied period cooling setpoint at the beginning of, but not before, the scheduled occupied period.
2. Airside Economizer: BAS shall modulate the mixing dampers to provide "free cooling" when conditions merit. The free cooling shall generally be staged before any mechanical cooling. While conditions merit, dampers shall be modulated in a DA PID loop to maintain mixed air temperature at a setpoint as specified for the individual unit. Economizer logic shall remain enabled during setback cooling where applicable. The following strategy shall be used to enable the economizer mode:
   a) Dry Bulb Switch: Economizer mode shall be active while the unit is energized AND when outside air temperature falls below the switching setpoint of 60°F (adj.) (with 5F cycle differential). Economizer mode shall be inactive when outside air temperature rises above switching setpoint, dampers shall return to their scheduled minimum positions as specified above.
3. Sequenced Heating and Cooling: BAS shall control the heating and cooling coils and air side economizer as detailed for the particular AH. Program logic shall directly prohibit the heating and cooling valves as well as the heating valve and economizer damper to be open (or above minimum) simultaneously. This does not apply to cooling and reheat valves that are used simultaneously for dehumidification.
4. VAV Return Fan Capacity Control: BAS shall control the output of the return fan as follows:
   a) Rescaled Output Capacity Control: The output for the return fan capacity control shall be rescaled from the output of the to the supply device such that the design minimum OA temperature is maintained at both maximum and 50% flow conditions. The balancing contractor shall determine the coordinated output.
5. Mixed Air Low Limit Override: BAS shall override the signal to the OA damper via a proportional only loop to maintain a minimum mixed air temperature of 45°F (adj.) (loop shall output 0% at 45°F which shall be passed to the output via a low selector).
6. Freeze Safety: Upon operation of a freezestat the following sequence shall occur:
   a) The unit fans shall be deenergized. Typically supply and return fans where applicable shall be deenergized via a hardwired interlock, and an indication of the operation shall be displayed by the BAS.
   b) All hot water valves and chilled water valves will be commanded to 100% open.
   c) All hot water coil pumps and chilled water coil pumps will be commanded to run.
   d) Outside air dampers shall fully close and return air dampers shall fully open.
   e) BAS shall enunciate appropriate alarm and remove and lock out the start command,
7. Smoke Safety: Upon indication of smoke by a smoke detector, FAC shall deenergize the AH. Smoke detector shall notify the fire alarm system and BAS, shut down the fans, and close the smoke dampers via hard-wired interlock.
8. High or Low Pressure Safety: Upon activation of a high or low pressure safety switch, AH shall be deenergized, fans shall be deenergized via a hard wired interlock[, and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command.

Supply Fan Control: BAS shall control the starting and stopping of the supply fan as follows:

1. Start/Stop: BAS shall command the operation of the supply fan and it shall run continuously whenever the AH is "energized".
2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the supply fan, BAS shall remove the command to run the return fan, lockout the run command to both fans, and enunciate an alarm.
3. VSD Control: Whenever the fan is energized, BAS shall control the speed of the VSD to maintain the supply duct static pressure setpoint without commanding the VSD below the motors minimum rated speed. On start and stop, the VSD shall ramp to speed and slow down within adjustable acceleration and deceleration limits. BAS shall monitor a common alarm output from the drive and enunciate a level 2 alarm when active.
4. Supply Duct Pressure Setpoint: The down duct static pressure setpoint shall be reset between the limits of ½" to 2" to maintain cooling requests from the VAV boxes at 4 (with all values adjustable).

Return Fan Control: BAS shall control the starting and stopping of the return fan as follows:

1. Start/Stop: BAS shall command the operation of the return fan and it shall run continuously whenever the AH is "energized".
2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime.
3. VSD Control: BAS shall control the output of the return fan per the "Rescaled Output Capacity Control" logic strategy without commanding the VSD below the motors minimum rated speed.

Return/Relief/OA Dampers: BAS shall control the dampers as follows:

1. Closed: When AH is commanded off, dampers shall remain in their off positions (outside/relief closed; return open). When AH is energized during the unoccupied period the OA damper shall remain closed unless economizer mode is available.
2. Minimum OA Control: BAS shall maintain minimum OA flow using the fixed damper control strategy.
3. Economizer: BAS shall modulate dampers per the dry bulb switch economizer mode described above. Mixed air temperature setpoint shall be equal to the discharge air temperature setpoint minus 3F.

Space Temperature Control: The space temperatures shall be controlled via individual VAV boxes.

Discharge Temperature Control: The discharge temperature setpoint shall be calculated and controlled as follows:

1. Setpoint shall be reset from 55F to 65F both adjustable to maintain VAV box cooling requests at 4 (adj.)
2. When the unit is energized for setback heating during the unoccupied period, the discharge temperature setpoint shall be 75F (adj.)
3. When the unit is energized for morning cool-down or setback cooling, the discharge setpoint shall be the warmest zone temperature, minus 15F.

Preheating Section: Control shall be as follows:

1. HW Heating Valve: Whenever the AH is energized, N.O. valve shall modulate per the higher of:

a) a PID loop to maintain a leaving temperature of the discharge air temperature setpoint minus 3F AND

b) a proportional only loop maintaining a low limit of 40F preheat air temperature.

Cooling Section: Control shall be as follows:

1. Cooling Coil Valve: Whenever the AH is energized, N.C. valve shall modulate per the higher of:

a) a DA PID loop to maintain discharge air temperature setpoint

b) a proportional only loop maintaining return air humidity at 55% (adj.).

During the unoccupied period, if AH is energized for heating or warm-up, the cooling coil valve shall remain closed.

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FACILITIES MANAGEMENT

HVAC CONTROLS STANDARDS

Eng	HJN
Drawn	HJN
Chkd	---
Appd	---
Issued	8/4/11
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Scale	N/A
Proj Code	

STANDARD

VAV AIR HANDLER (SCHEMATIC)

03 OF 30
SHEET NUMBER

C-1.0a
DWG NUMBER