SEQUENCE OF OPERATION

General: The variable volume 100% outside air handler with energy recovery 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, 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. "Normal" setpoints shall apply.
   b) **Unoccupied Period:** 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. If during the unoccupied period there is a request for occupancy override, the occupancy mode shall become active for an adjustable period.

2. **Sequenced Heating and Cooling:** BAS shall control the heating and cooling coils as detailed. Program logic shall directly prohibit the heating and cooling valves to be open simultaneously.

6. **Freeze Safety:** Upon operation of a freezestat the following sequence shall occur:
   a) The unit fans shall be deenergized. Typically supply and exhaust fans where applicable shall be deenergized via a hardwired interlock, and an indication of the operation shall be displayed by the BAS.
   b) All chilled water valves will be commanded to 100% open.
   c) 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 outside air damper open whenever the AH is "energized". Upon proof of the damper position the interlocked supply fan shall run continuously. When any single terminal box served by the AH is sequenced to a mode requiring primary air the VAV AH shall be energized.
2. **Proof:** BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the supply fan, BAS shall 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 (or AFMS flow set point). 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).

Exhaust Fan Control: BAS shall control the starting and stopping of the exhaust fan as follows:
1. **Start/Stop:** BAS shall command the exhaust air damper open whenever the AH is "energized". Upon proof of the damper position the interlocked exhaust fan shall run continuously.
2. **Proof:** BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the exhaust fan, BAS shall enunciate an alarm.
3. **VSD Control:** Whenever the fan is energized, BAS shall control the speed of the VSD to maintain the calculated exhaust air flow differential flow setpoint from supply flow. 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.

Recovery Wheel Control: BAS shall monitor operation of the manufacturer controlled energy wheel which is enabled whenever the unit is energized.

Zone Temperature Control: Zone temperature will be maintained by terminal units served by this unit.

Discharge Temperature Control: The discharge temperature setpoint shall be calculated and controlled as follows:
1. Setpoint shall be reset from 55°F to 65°F both adjustable to maintain terminal box cooling requests at 4 (adj.).

Preheating Section: Control shall be as follows:
1. **Steam Valve:** Whenever the AH is energized, the steam valve will be opened whenever:
   a) Outside air temperature falls below 42°F AND the unit is energized.
   OR
   b) The Integrated Face & Bypass (IFB) damper is more than 15% (adj.) open.
2. **IFB Damper:** BAS will modulate the IFB to maintain the preheat temperature as follows:
   a) a proportional only loop maintaining 45°F minimum preheat temperature.
   AND
   b) a PID loop to maintain discharge air temperature minus 3°F (adj.).

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 50% (adj.)

Humidifier Control: BAS shall control the humidifier as follows:
1. **Humidifier Isolation Valve:** Whenever the AH is energized in occupied mode and outside air temperature is below 55°F (adj.) the isolation valve shall be commanded open.
2. **Humidifier Valve:** Whenever the humidifier isolation valve is open the humidifier valve shall be modulated to maintain the humidification setpoint (40%, adj.) per the lower of:
   a) a RA PID loop to maintain the humidification setpoint
   b) a proportional only loop maintaining maximum supply humidity at 90% (adj.).

Economizer Control: BAS shall control the bypass damper as follows:
BAS shall bypass the energy wheel when outside air conditions allow per the dry bulb switch 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 5°F cycle differential). Economizer mode shall be inactive when outside air temperature rises above switching setpoint.
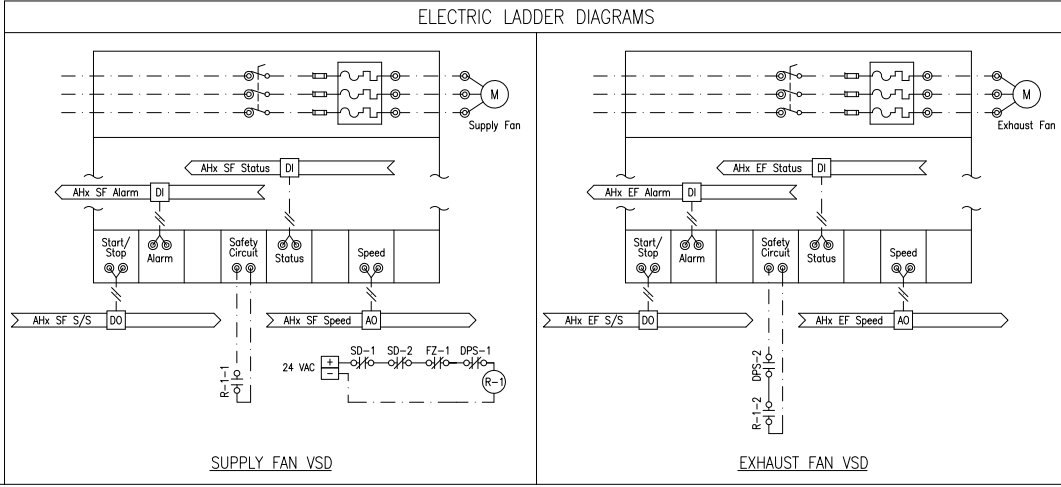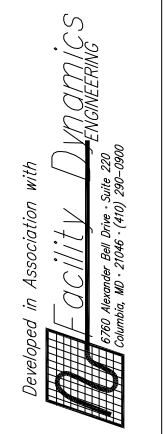Preheat air temperature setpoint shall be equal to the discharge air temperature setpoint minus 3°F.

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 & 5	3		Temp Sensor, Duct
TS 2,3	2		Temp Sensor, Duct (Averaging)
V1, V2	2		Valve Actuators
SD1	1		Smoke Detector
DPT 1	1		Differential Pressure Transmitter
FZ1	1		Freezestat 40F, DPDT
M 1,2	2		Damper Actuators
HS 1	1		Humidity Sensor, Duct

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

100% OA AHU WITH ENERGY RECOVERY WHEEL VAV (SCHEMATIC)

05 OF 30
SHEET NUMBER

C-1.1a
DWG NUMBER

ELECTRIC LADDER DIAGRAMS

SUPPLY FAN VSD

EXHAUST FAN VSD

CONTROL SCHEMATIC