## SEQUENCE OF OPERATION

**GENERAL:** THE VAV AIR HANDLER SHALL BE FULLY CONTROLLED BY THE BAS. REFER TO SECTION 15958 FOR GENERAL AIR HANDLER LOGIC STRATEGIES. AIR HANDLER LOGIC STRATEGIES FOR THIS UNIT SHALL INCLUDE:
1. SCHEDULED OCCUPANCY WITH OPTIMUM PREOCCUPANCY
2. DRY BULB COMPARISON AIRSIDE ECONOMIZER
3. SEQUENCED HEATING AND COOLING
4. DIFFERENTIAL RESET FROM MEASURED OA TO MAINTAIN FIXED OA RETURN FAN FLOW TRACKING
5. MIXED AIR LOW LIMIT OVERRIDE
6. FREEZE SAFETY
7. SMOKE SAFETY
8. HIGH AND LOW PRESSURE SAFETY

**SUPPLY FAN:** 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 OR RETURN FAN, BAS SHALL DEENERGIZE THE OTHER FAN AND ENUNCIATE A LEVEL 1 ALARM.
3. VSD CONTROL: WHENEVER THE FAN IS ENERGIZED, BAS SHALL CONTROL THE OUTPUT OF THE VSD TO MAINTAIN THE SUPPLY DUCT STATIC PRESSURE SETPOINT. ON START AND STOP, THE VSD SHALL RAMP TO SPEED AND SLOW DOWN WITHIN ADJUSTABLE ACCELERATION AND DECELERATION LIMITS.
4. SUPPLY DUCT PRESSURE SETPOINT: SETPOINT SHALL BE RESET BETWEEN THE LIMITS OF 0.5" TO 2" (OR THE MAXIMUM AS DETERMINED BY THE TAB CONTRACTOR) TO LIMIT COOLING REQUESTS FROM THE VAV BOXES TO 4 (ALL VALUES ADJUSTABLE).

**RETURN FAN:** 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 SUPPLY FAN STATUS IS PROVEN.
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 VSD PER THE DIFFERENTIAL RESET FROM MEASURED OA TO MAINTAIN FIXED OA RETURN FAN FLOW TRACKING LOGIC STRATEGY. WHEN THE AH IS ENERGIZED IN THE UNOCCUPIED MODE THE BAS SHALL CONTROL THE OUTPUT OF THE VSD AT A FIXED % SPEED OFFSET (INITIALLY 0%) FROM THE OUTPUT OF THE SUPPLY FAN VSD.

**RETURN/EXHAUST/OA DAMPERS:** BAS SHALL CONTROL THE DAMPERS AS FOLLOWS:
1. CLOSED: WHEN AH IS DEENERGIZED, DAMPERS SHALL REMAIN IN THEIR "OFF" POSITIONS. WHEN AH IS ENERGIZED DURING UNOCCUPIED PERIOD THE DAMPERS SHALL REMAIN IN THEIR "OFF" POSITIONS, UNLESS ECONOMIZER IS AVAILABLE.
2. MINIMUM OA CONTROL: SHALL BE PER THE BALANCED POSITION MINIMUM OA CONTROL STRATEGY.
3. ECONOMIZER: BAS SHALL MODULATE THE RETURN, EXHAUST, AND OUTSIDE AIR DAMPERS PER THE DRY BULB COMPARISON AIRSIDE ECONOMIZER STRATEGY. MIXED AIR TEMPERATURE SETPOINT SHALL BE 3'F BELOW THE SUPPLY AIR TEMPERATURE SETPOINT. ECONOMIZER OUTPUT SHALL BE RESTRICTED, AS REQUIRED, PER THE MIXED AIR LOW LIMIT OVERRIDE STRATEGY.

**SPACE TEMPERATURE CONTROL:** THE SPACE TEMPERATURES SHALL BE CONTROLLED VIA INDIVIDUAL VAV BOXES. THE COOLING SETBACK TEMPERATURE SETPOINT FOR CYCLING THE UNIT SHALL BE 85'F (ADJ.) AT ANY ONE VAV BOX SPACE SENSOR. THE HEATING SETBACK TEMPERATURE SETPOINT FOR CYCLING THE UNIT FOR HEATING SHALL BE RESET BETWEEN 50'F AND 60'F, AT ANY VAV BOX SPACE SENSOR, AS THE OUTSIDE AIR TEMPERATURE FALLS FROM 40'F TO 25'F (ALL VALUES ADJ.). CYCLING OF THE UNIT FOR HEATING SETBACK DOES NOT APPLY TO FAN-POWERED VAV BOXES. THESE SETPOINTS SHALL BE OUTSIDE THE RANGE OF ALL BOX CONTROL LOOPS.

**DISCHARGE TEMPERATURE CONTROL:** THE DISCHARGE TEMPERATURE SETPOINT SHALL BE CONTROLLED AS FOLLOWS:
1. DURING THE OCCUPIED PERIOD, THE DISCHARGE TEMPERATURE SHALL BE RESET FROM 55'F TO 62'F AS THE RETURN AIR TEMPERATURE FALLS FROM 75'F TO 70'F WITH ALL VALUES BEING ADJUSTABLE.
2. WHEN THE UNIT IS ENERGIZED FOR SETBACK HEATING DURING THE UNOCCUPIED PERIOD, THE DISCHARGE TEMPERATURE SETPOINT SHALL BE 75'F (ADJ.).
3. WHEN THE UNIT IS ENERGIZED FOR MORNING COOL-DOWN OR SETBACK COOLING, THE DISCHARGE SETPOINT SHALL BE THE WARMEST ZONE TEMPERATURE, MINUS 15 L'F (ADJ.).

**PREHEAT COIL VALVE:** WHENEVER THE AH IS ENERGIZED, N.O. PREHEAT COIL VALVE SHALL MODULATE PER THE HIGHER OF:
1. A RA PID LOOP TO MAINTAIN DISCHARGE AIR AT HEATING DISCHARGE AIR TEMPERATURE SETPOINT (EQUAL TO DISCHARGE TEMPERATURE SETPOINT DEFINED ABOVE LESS 5'F)
2. A PROPORTIONAL ONLY LOOP MAINTAINING A LOW LIMIT OF 45'F MIXED AIR TEMPERATURE. WHEN THE UNIT IS OFF THE VALVE SHALL CONTINUE TO MODULATE TO MAINTAIN A MIXED AIR TEMPERATURE OF 45'F (ADJ.).

**COOLING COIL VALVE:** WHENEVER THE AH IS ENERGIZED, N.C. COOLING COIL VALVE SHALL MODULATE PER THE HIGHER OF:
1. A DA PID LOOP TO MAINTAIN DISCHARGE AIR TEMPERATURE SETPOINT.
2. A PROPORTIONAL ONLY LOOP MAINTAINING RETURN AIR HUMIDITY AT 55% (ADJ.). DURING UNOCCUPIED PERIOD, IF AH IS ENERGIZED FOR HEATING, WARM-UP, OR NIGHT PURGE, THE COOLING COIL VALVE SHALL REMAIN CLOSED.

**HEATING REQUEST:** THE AIR HANDLER SHALL ISSUE A "HEATING REQUEST" TO THE HW SYSTEM WHENEVER THE REHEAT OUTPUT IS GREATER THAN 75%, WITH A 50% CYCLE DIFFERENTIAL.

**COOLING REQUEST:** THE AIR HANDLER SHALL ISSUE A "COOLING REQUEST" TO THE CHW SYSTEM WHENEVER THE REHEAT OUTPUT IS GREATER THAN 75% WITH A 50% CYCLE DIFFERENTIAL.

**OCCUPANCY OVERRIDE:** OCCUPANCY OVERRIDE SHALL BE INITIATED BY ADMINISTRATION TOUCH-SCREEN OVERRIDE PANEL. REFER TO SECTION 15955 FOR ADDITIONAL REQUIREMENTS.

**DIAGNOSTICS:** BAS SHALL EXECUTE THE FOLLOWING DIAGNOSTIC STRATEGIES, AS DETAILED IN SECTION 15958.
1. RUN-TIME LIMIT

## POINTS LIST

| ADDRESS | POINT DESCRIPTOR | DI | AI | DO | AO | REMARKS |
|---|---|---|---|---|---|---|
| | AHx SF S/S | | | • | | |
| | AHx SF Speed | | | | • | |
| | AHx SF Status | • | | | | |
| | AHx SA VP | | • | | | |
| | AHx SA Temp | | • | | | |
| | AHx DD Static | | • | | | |
| | AHx RA Temp | | • | | | |
| | AHx RA Humidity | | • | | | |
| | AHx RF S/S | | | • | | |
| | AHx RF Speed | | | | • | |
| | AHx RF Status | • | | | | |
| | AHx RA VP | | • | | | |
| | AHx OA Damper | | | | • | |
| | AHx RLA Damper | | | | • | |
| | AHx RLA Damper | | | | • | |
| | AHx OA VP | | • | | | |
| | AHx MA Temp | | • | | | |
| | AHx HW Valve | | | | • | |
| | AHx CHW Valve | | | | • | |
| | AHx Safety Circuit | • | | | | |
| **TOTALS** | | **3** | **8** | **2** | **7** | |

## REVISIONS

| NO. | DESCRIPTION | DATE |
|---|---|---|
| | | |

## ELECTRIC LADDER DIAGRAMS



SUPPLY FAN VSD



RETURN FAN VSD

## NOTES

1. DUCT SMOKE DETECTOR AND FIRE ALARM SYSTEM WIRING PROVIDED AND INSTALLED BY OTHERS. SAFETY CIRCUIT AND DI WIRING BY THIS SECTION.

2. LOCATE DUCT STATIC PRESSURE SENSOR ⅔ DOWN THE LONGEST DUCT RUN AS DIRECTED.

3. AFMS SHALL BE VORTEX SHEDDING TYPE. SUPPLY AND RETURN AFMS SHALL BE MOUNTED AT THEIR RESPECTIVE FAN INLETS.
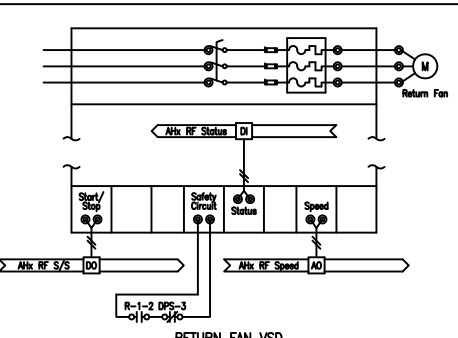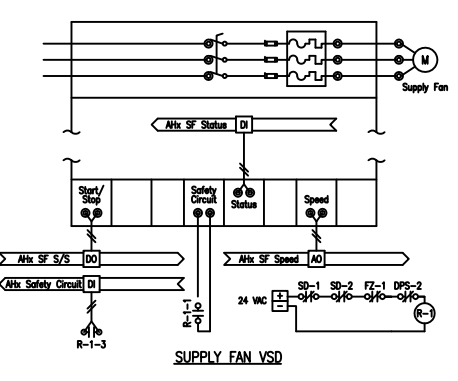
| | |
|---|---|
| Eng | BWR |
| Drawn | BWR |
| Chkd | BWR |
| Appd | JJS |
| Issued | |
| Job No. | XXXXX |
| Scale | N/A |
| Proj Code | |

**HVAC CONTROLS**

**VAV AHU TYPE 2 CONTROLS**

04 OF 30
SHEET NUMBER

**C-2.1**

DWG NUMBER

General: the VAV air handler shall be fully controlled by the BAS. Refer to section 15958 for general air handler logic strategies.

Air handler logic strategies for this unit shall include:

1. Scheduled occupancy with optimum preoccupancy

2. Dry bulb comparison airside economizer

3. Sequenced heating and cooling

4. Differential reset from measured OA to maintain fixed OA return fan flowtracking

5. Mixed air low limit override

6. Freeze safety

7. Smoke safety

8. High and low pressure safety

SUPPLY FAN:

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 runcontinuously whenever the AHU is energized.

2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the supply or return fan, BAS shall deenergize the other fan and enunciate a level 1 alarm.

3. VSD control: whenever the fan is energized, BAS shall control the output of the VSD to maintain the supply duct static pressure setpoint. On start and stop, the VSD shall ramp to speed and slow down within adjustable acceleration and deceleration limits.

4. Supply duct pressure setpoint: setpoint shall be reset between the limits of0.5" to 2" (or the maximum as determined by the tab contractor) to limit cooling requests from the VAV boxes to 4 (all values adjustable).

RETURN FAN:

BAS shall control the starting and stopping of the return fan asfollows.

1. Start/stop: BAS shall command the operation of the return fan and it shall run continuously whenever the supply fan status is proven.

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 VSD per the differential reset from measured OA to maintain fixed OA return fan flow tracking logic strategy. When the AHU is energized in the unoccupied mode the BAS shall control the output of the VSD at a fixed % speed offset (initially 0%) from the output of the supply fan VSD.

RETURN/EXHAUST/OA DAMPERS:

BAS shall control the dampers as follows:

1. Closed: when AHU is de-energized, dampers shall remain in their "off" positions. When AHU is energized during unoccupied period the dampers shall remain in their "off" positions, unless economizer is available.

2. Minimum OA control: shall be per the balanced position minimum OA controlstrategy.

3. Economizer: BAS shall modulate the return, exhaust, and outside air dampers per the dry bulb comparison airside economizer strategy. Mixed air temperature setpoint shall be 3°f below the supply air temperature setpoint. Economizer output shall be restricted, as required, per the mixed air low limit override strategy.

SPACE TEMPERATURE CONTROL:

The space temperatures shall be controlled via individual VAV boxes. The cooling setback temperature setpoint for cycling the unit shall be 85°f (adj.) At any one VAV box space sensor. The heating setback temperature setpoint for cycling the unit for heating shall be reset between 50°fand 60°f, at any one VAV box space sensor, as the outside air temperature falls from 40°f to 25°f (all values adj.). Cycling of the unit for heating setback does not apply to fan-powered VAV boxes. These setpoints shall be outside the range of all box control loops.

DISCHARGE TEMPERATURE CONTROL:

The discharge temperature setpoint shall be controlled as follows:

1. During the occupied period, the discharge temperature shall be reset from 55°fto 62°f as the return air temperature falls from 75°f to 70°f with all values beingadjustable.

2. When the unit is energized for setback heating during the unoccupied period, the discharge temperature setpoint shall be 75°f (adj.)

3. When the unit is energized for morning cool-down or setback cooling, the discharge setpoint shall be the warmest zone temperature, minus 15°F (adj.).

PREHEAT COIL VALVE:

Whenever the AHU is energized, N.O. preheat coil valve shall modulate per the higher of:

1. A rapid loop to maintain discharge air at heating discharge air temperature setpoint (equal to discharge temperature setpoint defined above less 5°F

2. A proportional only loop maintaining a low limit of 45°f mixed air temperature. When the unit is off the valve shall continue to modulate to maintain a mixed air temperature of 45°f (adj.).

COOLING COIL VALVE:

Whenever the AHU is energized, N.C. cooling coil valve shall modulate per the higher of:

1. A DA PID loop to maintain discharge air temperature setpoint.

2. A proportional only loop maintaining return air humidity at 55% (adj.).during unoccupied period, if AHU is energized for heating, warm-up, or night purge, the cooling coil valve shall remain closed.

HEATING REQUEST:

The air handler shall issue a "heating request" to the HW system whenever the reheat output is greater than 75%, with a 50% cycle differential.

COOLING REQUEST:

The air handler shall issue a "cooling request" to the CHW system whenever the reheat output is greater than 75%, with a 50% cycle differential.

OCCUPANCY OVERRIDE:

Occupancy override shall be initiated by administration touch-screen override panel. Refer to section 15955 for additional requirements.

DIAGNOSTICS:

BAS shall execute the following diagnostic strategies, as detailed in section 15958.1. Run-time limit.