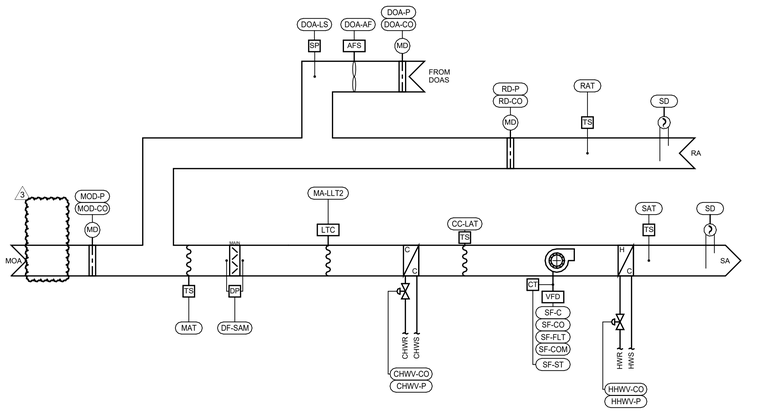
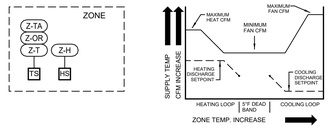


SINGLE ZONE VAV AHU
CONTROL SCHEMATIC
DUAL MAXIMUM CFM
MODULATING HEATER



POINTS LIST - AIR HANDLING UNIT

POINT ID	DESCRIPTION	POINT TYPE	DEFAULT SET POINT	SET POINT RESET RANGE	FAIL POSITION	STATUS ALARM	ALARM RANGE	NOTES
GLOBAL VALUES								
OAT	OUTSIDE AIR TEMPERATURE	AV						A
OAH	OUTSIDE AIR HUMIDITY	AV						A
AIR SENSING								
SAT	SUPPLY AIR TEMPERATURE	AI	54 F CLG; 95 F HTG	52 - 65 F CLG		X	50 F > SAT > 100 F	C
RAT	RETURN AIR TEMPERATURE	AI						
DOA-LS	DEDICATED OUTSIDE AIR LOW STATIC CONTROLLER	BI	-0.5 INWG			X	DOA-LS < SPT	D
MAT	MIXED AIR TEMPERATURE	AI	55 F	52 - 65 F CLG				C
MA-LLT2	MIXED AIR LOW LIMIT TEMPERATURE (LEVEL 2)	BI	35 F			X	ON ACTIVATION	C
CC-LAT	COOLING COIL LEAVING AIR TEMPERATURE	AI	SCHED			X	50 F > CC-LAT > 100 F	C
ZONE LEVEL SENSORS								
Z-T	ZONE TEMPERATURE	AI	SCHED					B, C, F
Z-OR	MANUAL OCCUPANCY OVERRIDE	BI	2 HOURS					D
Z-TA	MANUAL TEMPERATURE SETPOINT ADJUST	AI	+/- 2 F					D
Z-T-DB	ZONE TEMPERATURE - DEAD BAND	BV	5 F	-2.5 F < Z-T < +2.5 F				D
Z-H	ZONE HUMIDITY	AI	SCHED	30-55 PCT		X	15RH > Z-H >65RH	B, C, F
SUPPLY FAN								
SF-COM	SUPPLY FAN VFD COMMUNICATION	COM						
SF-C	SUPPLY FAN COMMAND (START/STOP)	BO						
SF-CO	SUPPLY FAN CONTROL OUTPUT - SPEED (PERCENT)	AO		SCHED				
SF-ST	SUPPLY FAN STATUS	BI				X	SF-ST <> SF-C	
SF-FLT	SUPPLY FAN VFD FAULT	BI				X	COMMON ALARM	
RETURN AIR DAMPER (MODULATING)								
RD-CO	RETURN AIR DAMPER CONTROL OUTPUT	AO			NO			
RD-P	RETURN AIR DAMPER POSITION	AI				X	RD-P <> RD-CO	
MINIMUM OUTSIDE AIR DAMPER (MODULATING)								
MOD-CO	MINIMUM OUTSIDE AIR DAMPER CONTROL OUTPUT	AO			NC			
MOD-P	MINIMUM OUTSIDE AIR DAMPER POSITION	AI				X	MOD-P <> MOD-CO	
DEDICATED OUTDOOR AIR INTAKE DAMPER (MODULATING)								
DOA-CO	DEDICATED OUTSIDE AIR DAMPER CONTROL OUTPUT	AO			NC			
DOA-P	DEDICATED OUTSIDE AIR DAMPER POSITION	AI					DOA-P <> DOA-CO	
DOA-AF	DEDICATED OUTSIDE AIR AIRFLOW QUANTITY (CFM)	AI				X	DOA-AF < SCHED - 15%	
FILTERS								
DF-SAM	DIRTY FILTER INDICATION (SA MAIN FILTER)	BI	SCHED.			X	ON ACTIVATION	C
COOLING COIL - CHILLED WATER MODULATING								
CHWV-CO	CHILLED WATER VALVE CONTROL OUTPUT	AO			NO			
CHWV-P	CHILLED WATER VALVE POSITION (PERCENT)	AI				X	CHWV-P <> CHWV-CO	
HEATING COIL - HOT WATER MODULATING								
HHWV-CO	HEATING HOT WATER VALVE CONTROL OUTPUT	AO			NO			
HHWV-P	HEATING HOT WATER VALVE POSITION (PERCENT)	AI				X	HHW-P <> HHW-CO	
FREEZE PROTECTION MODE SETPOINTS								
LLT1-SP	LEVEL 1 LOW LIMIT TEMPERATURE ALARM SETPOINT	AV	42 F			X	RE: SEQUENCE	C
LLT2	LOW LIMIT TEMPERATURE CONTROLLER 2	BI	35 F			X	ON ACTIVATION	
FZ-DLY	FREEZE PROTECTION LEVEL 1 DELAY SETPOINT	AV	5 MIN.					C
FIRE ALARM/SMOKE DETECTORS								
SD	SMOKE DETECTOR STATUS	BI				X	ON ACTIVATION	E

ALL POINTS SHOWN SHALL BE PROVIDED BY BAS CONTRACTOR UNLESS NOTED OTHERWISE.

NOTES:
A. DISPLAY VALUE WITH AHU GRAPHIC AT BAS FRONT-END. REFERENCE GLOBAL BUILDING MONITORING SCHEDULE FOR CONTROL POINT.
B. REFERENCE PROJECT DESIGN CONDITIONS SCHEDULE FOR SETPOINT.
C. POINT SHALL BE ADJUSTABLE.
D. DETERMINE SETPOINT DURING TESTING AND BALANCING. COORDINATE WITH THE TEST AND BALANCE CONTRACTOR.
E. DEVICE AND RELAY FROM FIRE ALARM SYSTEM PROVIDED BY DIVISION 26 \3\.
F. POINT SHALL BE AVERAGED IF MULTIPLE SENSORS ARE SHOWN ON PLANS.

1 SINGLE ZONE AIR HANDLING UNIT CONTROL DIAGRAM (AHU 5, AHU 8, AHU 9)
NTS

SEQUENCE OF OPERATIONS
SINGLE ZONE VARIABLE AIR VOLUME AIR HANDLING UNITS (AHU 5, AHU 8, AHU 9)

This sequence of operations is organized into the following main categories: operating modes; control setpoint resets; safeties, overrides and interlocks; and component control loops. The operating modes describe the criteria that either enable or disable the various modes of operation. If a mode of operation is not listed within a component control loop section then that mode of operation has no direct influence on the operation of the component. The control setpoint reset section describes the logic and reference variables that will be used to reset control setpoints to a new value within its reset range. The safeties, overrides, and interlocks section outlines the hardwired interlocks that are required to meet life safety requirements. Safeties and interlocks take precedence over all other control strategies outlined in this document. The control responses of each component for the various modes of operation are described in the component control loop sections. Setpoints shall be adjustable (adj.) as noted.

The sequence of operations, the points list and control diagrams shall be used to provide a complete description of the control philosophy for the controlled equipment. Individual setpoint values, reset ranges, and alarm action levels are listed in the points list. Components and control sensor locations are graphically depicted on the control diagram. The controls contractor shall be responsible for coordinating any necessary time delay setpoints to establish stable system operation.

GENERAL DESCRIPTION

The air handling unit(s) described by this sequence of operations consist(s) of a variable speed supply fan, a chilled water cooling coil, and a hot water heating coil to provide heating, ventilation, and air conditioning for the conditioned spaces as shown on the drawings.

OPERATING MODES

OCCUPIED MODE:

The unit shall be in occupied mode per the Project Design Conditions Schedule shown on the control drawings.

COOLING MODE:

The unit shall be in cooling mode when the zone temperature (Z-T) rises above the dead band (Z-T-DB).

MINIMUM COOLING MODE:

The unit shall be in minimum cooling mode when:

The unit is in cooling mode;

And- The supply fan reaches its minimum speed setting for 2 minutes (adj.).

The unit shall return to cooling mode when:

The supply air temperature (SAT) is at or below its cooling setpoint for 2 minutes (adj.);

HEATING MODE:

The unit shall be in heating mode when the zone temperature (Z-T) falls below the dead band (Z-T-DB).

MINIMUM HEATING MODE:

The unit shall be in minimum heating mode when:

The unit is in heating mode;

And- The supply fan reaches its minimum speed setting for 2 minutes (adj.).

The unit shall return to heating mode when:

The supply air temperature (SAT) is at or above its setpoint for 2 minutes (adj.);

UNOCCUPIED MODE:

The unit shall be in unoccupied mode for all periods not included in the occupied hours of operation. Overrides of unoccupied schedule are defined at the zone level control.

DEHUMIDIFICATION MODE:

The unit shall be in dehumidification mode when the zone humidity sensor (Z-H) senses humidity above 50% RH (adj.). The unit shall exit dehumidification mode when the humidity reaches or falls below 45% RH (adj.). The dehumidification mode shall be enabled to operate in occupied and unoccupied mode.

ECONOMIZER MODE - DIFFERENTIAL ENTHALPY WITH FIXED DRY-BULB TEMPERATURE ENABLED:

The unit shall be in economizer mode when:

The supply fan status is on;

And- the unit is in cooling mode;

And- the AHU is not in freeze protection mode;

And - the outside air enthalpy is less than the return air enthalpy.

And- the outside air temperature (OAT) is less than 73 F (adj.)

The unit shall exit Economizer Mode when:

The supply fan status is off

Or- the unit enters Heating Mode

Or- the unit enters Dehumidification Mode

Or- the unit enters Freeze Protection Mode

Or- the outside air enthalpy is greater than the return air enthalpy.

Or- the outside air temperature (OAT) is greater than 73 F (adj.)

FREEZE PROTECTION MODE LEVEL 1:

The unit shall be in Freeze Protection Mode Level 1 when:

The Mixed Air Temperature (MAT) is less than the Level 1 Low Limit Temperature Alarm Setpoint (LLT1-SP).

When in Freeze Protection Mode Level 1, an alarm shall generate at the operator workstation.

The alarm shall automatically reset and exit Freeze Protection Mode Level 1 when the temperature is above the alarm setpoint for a duration that exceeds the Freeze Protection Level 1 Delay (FZ-DLY) setpoint.

FREEZE PROTECTION MODE LEVEL 2:

The unit shall be in Freeze Protection Mode Level 2 when:

The Low Limit Temperature Controller 2 (LLT2) activates by sensing an air temperature less than its alarm setpoint.

When in Freeze Protection Mode Level 2, an alarm shall generate at the operator workstation.

The unit shall require a manual reset to exit Freeze Protection Level 2.

CONTROL SETPOINT RESETS

Not Used.

SAFETIES, OVERRIDES AND INTERLOCKS

SMOKE DETECTOR INTERLOCK:

The unit shall be disabled via hard wired interlock on activation of a system smoke detector. Display smoke detector relay status (normal or alarm) at the BAS front end.

FIRE ALARM CONTROL PANEL INTERLOCK:

The unit shall be disabled via relay circuit signal from the fire alarm control panel. Division 28 shall provide the relay and leads from relay to unit. BAS contractor shall connect leads to unit. Display relay status (normal or alarm) at BAS front end.

FREEZE PROTECTION MODE INTERLOCK:

The supply fan shall be disabled via hard wired interlock at the supply fan start circuit from the low limit temperature controller.

LOW OUTDOOR AIR STATIC PRESSURE INTERLOCK:

The unit shall be disabled via hard wired interlock at the fan start circuit upon activation of duct low static pressure controller.

MOTORIZED DAMPER AT AIR INTAKE INTERLOCK:

Motorized dampers located at air intake and exhaust locations associated with the air handling unit shall be interlocked to open and prove status before allowing the unit fans to start .

DEDICATED OUTSIDE AIR UNIT INTERLOCK:

Interlock unit with associated OAU to open outdoor air damper when OAU-X is de-energized to maintain building pressurization and ventilation.

FREEZE PROTECTION MODE LEVEL 2 INTERLOCK:

Disable the supply fan via hard wired interlock with the Level 2 Low Limit Temperature (LLT2) controller.

The unit shall require a manual reset.

COMPONENT CONTROL LOOPS

SUPPLY FAN CONTROL- VFD:

When the HOA switch is in hand position, the variable speed supply fan shall operate at a speed set manually by the operator at the user interface of the drive.

When the HOA switch is in off position, the fan shall be off.

When the HOA switch is in auto position, the variable speed supply fan shall operate subject to the unit enable signal, and unit operating modes.

When in Occupied Mode:

The fan shall energize and slowly ramp to the initial minimum fan speed determined during system startup. Minimum fan speed shall be established during balancing.

When in Cooling Mode:

The fan VFD shall modulate to control zone temperature (Z-T) at setpoint. An increase in zone temperature causes an increase in airflow.

When in Heating Mode:

The fan VFD shall modulate to control zone temperature at setpoint. A decrease in zone temperature causes an increase in airflow.

When in Minimum Cooling, or Minimum Heating Mode:

The fan VFD shall maintain minimum speed.

When in Dehumidification Mode:

The fan VFD shall be locked at its current speed until the minimum supply air temperature setpoint is reached. If the humidity is still not satisfied after 5 minutes (adj), increase fan speed by 5% (adj). Repeat fan speed trim and respond sequence until setpoint is satisfied. Return to previous mode of operation upon exiting dehumidification mode.

When in Economizer Mode:

The fan VFD shall modulate to control zone temperature (Z-T) at setpoint. An increase in zone temperature causes an increase in airflow.

When in Unoccupied Mode:

The fan shall be OFF. On a call for cooling/heating or override signal from the zone level, the fan shall operate as in occupied mode until the call is cleared or the override is removed.

When in Dehumidification Mode:

The fan shall operate as in occupied mode.

When in Freeze Protection Mode:

Level 2: The fan shall.be OFF

MIXED AIR DAMPERS DIRECT WITH ECONOMIZER

The mixed air damper assembly consists of a minimum outside air (MOA) damper and return air (RA) damper.

When in Occupied Mode:

When OAU-X is disabled:

3 MOA Active Control- The MOA and RA dampers shall vary together to satisfy the minimum outside airflow setpoint.

When in Economizer Mode:

The MOA and RA dampers shall modulate in opposing directions to maintain the mixed air temperature (MAT) setpoint.

When in Freeze Protection Mode:

Level 2: The MOA damper shall be fully closed and the RA damper shall be fully open.

When in all other modes:

The MOA shall be fully closed.

MIXED AIR DAMPERS MINIMUM OA FROM DEDICATED UNIT

The mixed air damper assembly consists of a dedicated outside air (DOA) damper, DOA airflow sensor and return air (RA) damper.

When in Occupied Mode:

The DOA damper shall modulate with the RA damper to satisfy the minimum outside airflow setpoint as measured by the airflow measurement station (DOA-AF).

When in Unoccupied Mode:

The DOA damper shall be fully closed and the RA damper shall be fully open. On a call for cooling/heating or override signal, the DOA damper shall remain closed.

When in Freeze Protection Mode:

Level 2: The DOA damper shall be fully closed and the RA damper shall be fully open.

When in Economizer Mode:

The DOA damper shall modulate to satisfy the minimum outside airflow setpoint as measured by the airflow measurement station (DOA-AF).

FILTER MONITORING

When in All Modes:

The controller shall monitor the differential pressure across each filter bank and shall provide a signal when the setpoint is exceeded.

HEATING COIL- HOT WATER VALVE- MODULATING

When in Occupied Mode:

When in Cooling Mode:

The coil shall be OFF.

When in Minimum Heating Mode:

The controller shall modulate the heating to maintain the zone temperature setpoint (Z-T).

When in Heating Mode:

The controller shall modulate the heating to maintain the supply air temperature setpoint (SAT).

When in Unoccupied Mode:

The valve shall be closed.

On a call for heating or override signal from the zone level the valve shall operate as in occupied mode until the call is cleared or the override is removed.

When in Economizer Mode:

The valve shall be closed.

When in Morning Warm-Up Mode:

The valve shall operate as in occupied mode.

When in Pre-Occupancy Purge Mode:

The valve shall operate as in occupied mode.

When in Freeze Protection Mode:

Level 2: The valve shall be fully open.

When in Dehumidification Mode:

The controller shall modulate the heating to maintain the zone temperature setpoint (Z-T).

COOLING COIL CHILLED WATER VALVE - MODULATING

When in Occupied Mode:

When in Minimum Cooling Mode:

The valve shall modulate to maintain the zone temperature setpoint (Z-T).

When in Cooling Mode:

The valve shall modulate to maintain the supply air temperature setpoint (SAT).

When in Heating Mode:

The coil shall be OFF.

When in Dehumidification Mode:

The valve shall modulate to maintain the cooling coil leaving air temperature setpoint (CC-LAT).

When in Unoccupied Mode:

The valve shall be closed.

On a call for cooling or override signal from the zone level the valve shall operate as in occupied mode until the call is cleared or the override is removed.

On a call for dehumidification the valve shall operate as in occupied mode until the call is cleared or the override is removed.

When in Freeze Protection Mode:

Level 2: The valve shall be fully open.

When in Economizer Mode (integrated economizer control):

Cooling coil is second stage to economizer for cooling duty.

Enable cooling coil only when MOA damper is proven fully open. When enabled, modulate the Chilled Water Valve to maintain the Supply Air Temperature (SAT) at the setpoint.

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ISSUE/REVISION LOG:

No.	DESCRIPTION	DATE
1	Revision 1 - Owner Changes	09/09/2024
3	Revision 3 - Owner Changes	04/23/2025

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 17560
4/24/2025

ISSUED FOR REVIEW: 05/14/2024
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ISSUED FOR PERMIT: 05/14/2024

M7.05

MECHANICAL CONTROLS

LSL PROJECT NUMBER: 2024-107.000

BENTON, ARKANSAS