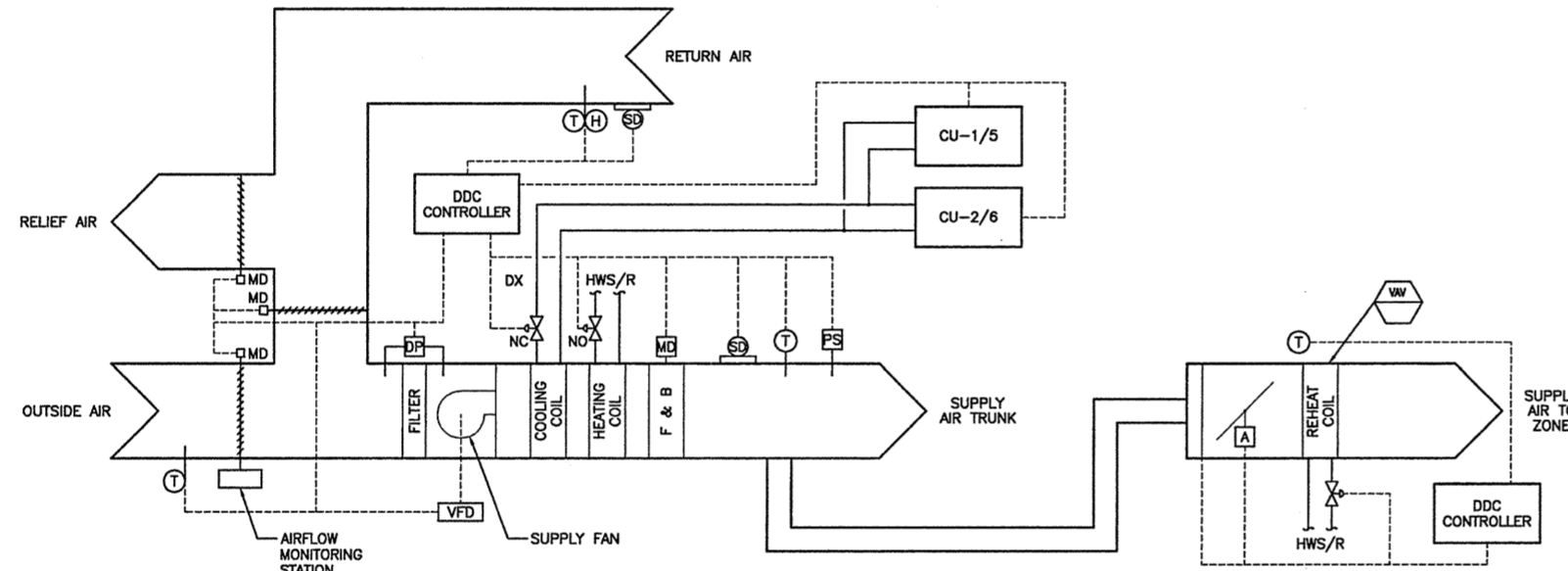


VARIABLE AIR VOLUME AIR HANDLERS SEQUENCE OF OPERATION

- A. GENERAL: WITH THE H-O-A SWITCH IN THE "AUTO" POSITION, THE SYSTEM SHALL START THROUGH THE ATC SYSTEM PROVIDED THE SAFETIES HAVE BEEN SATISFIED. THE START/STOP CONTROL OF FANS SHALL BE BASED ON A USER-DEFINED OCCUPANCY SCHEDULE. THE SYSTEM START/STOP SHALL INCORPORATE AN OPTIMUM START/STOP ROUTINE AUTOMATICALLY CALCULATING THE HEAT UP OR COOL DOWN TIME FOR THE SPACES SERVED AND SHALL PROVIDE SPACES AT THE PROPER TEMPERATURE WHEN THE AREA REACHES THE OCCUPIED PERIOD. WHEN THE AHU IS IN THE OCCUPIED MODE, THE SUPPLY FAN SHALL OPERATE CONTINUOUSLY. THE VFD SHALL MODULATE TO MAINTAIN THE DUCT STATIC PRESSURE, AND THE DX COOLING VALVES, HOT WATER COIL VALVE AND ECONOMIZER AND HOT WATER COIL FACE & BYPASS DAMPERS WILL MODULATE IN SEQUENCE TO MAINTAIN THE DISCHARGE AIR TEMPERATURE. THE OUTSIDE AIR SHALL BE AS REQUIRED (SEE H BELOW) AND MAINTAINED AT ALL TIMES DURING THE OCCUPIED MODE OF OPERATION. AS THE UNIT SWITCHES TO THE OCCUPIED MODE THE VFD SHALL SLOWLY SPEED THE FAN UP TO THE OPERATING STATIC PRESSURE. THE FAN RAMP UP SPEED SHALL BE ADJUSTABLE. LOCATE THE STATIC PRESSURE SENSOR IN THE DUCTWORK 3/4 OF THE LONGEST RUN FROM THE AIR HANDLER. IF THE DUCT STATIC PRESSURE SIGNAL FAILS, THE VFD SHALL OPERATE AT A DEFAULT 40% OF FULL FAN SPEED. THE RELIEF/OUTSIDE AIR DAMPERS SHALL TRACK TO MAINTAIN A SLIGHT BUILDING POSITIVE PRESSURE DURING THE OCCUPIED MODE. THE ATC CONTROLLER SHALL CONTINUOUSLY POLL ALL ZONES AND DETERMINE WHICH MODE OF OPERATION; HEATING, COOLING, DEHUMIDIFICATION OR VENTILATION MODE.
- B. UNOCCUPIED: WHEN THE AHU IS IN THE NIGHT SETBACK MODE, THE SUPPLY FAN SHALL CYCLE ON/OFF TO MAINTAIN THE HEATING SET POINTS IN EACH OF THE SPACES SERVED. THE COOLING SHALL BE OFF. THE SYSTEM SHALL PROVIDE AN ADJUSTABLE ANTI-SHORT CYCLE TIMER TO PREVENT EXCESSIVE FAN STARTS/STOPS.
- C. MORNING WARM-UP: WHEN THE AHU IS IN THE MORNING WARM-UP MODE, THE SUPPLY FAN SHALL OPERATE CONTINUOUSLY. THE VFD SHALL MODULATE TO MAINTAIN THE DUCT STATIC PRESSURE, THE OUTSIDE AIR DAMPER SHALL BE CLOSED AND COOLING SHALL BE OFF, THE RETURN AIR DAMPER SHALL BE FULLY OPEN, AND ZONE HEATING VALVES SHALL MODULATE TO ACHIEVE THEIR OCCUPIED SET POINTS. THE ATC SHALL SIGNAL VAV TERMINAL UNITS TO FULL HEATING FLOW AND THE UNIT HEATING COIL VALVE TO FULL HEAT UNTIL THE MORNING WARM-UP SET POINT IS REACHED AND THE AHU RETURNS TO OCCUPIED MODE.
- D. MORNING COOL DOWN: WHEN THE AHU IS IN THE MORNING COOL DOWN MODE, THE SUPPLY FAN SHALL OPERATE CONTINUOUSLY. THE VFD SHALL MODULATE TO MAINTAIN THE DUCT STATIC PRESSURE, THE OUTSIDE AIR DAMPER SHALL BE CLOSED AND THE DX VALVES SHALL BE IN THE FULL COOLING POSITION, THE RETURN AIR DAMPER SHALL BE FULLY OPEN, AND THE ZONE HEATING VALVES SHALL BE CLOSED. FOR OUTSIDE AIR CONDITIONS THAT ARE SUITABLE FOR FREE COOLING, THE OUTSIDE AIR DAMPER SHALL MODULATE OPEN TO MAINTAIN THE DISCHARGE AIR TEMPERATURE AND THE COOLING VALVES SHALL REMAIN CLOSED. THE ATC SHALL SIGNAL VAV TERMINAL UNITS TO FULL COOLING FLOW UNTIL THE MORNING COOL DOWN SET POINT IS REACHED AND THE AHU ENTERS THE OCCUPIED MODE.
- E. COOLING: PROVIDE OUTSIDE AIR AND RETURN AIR TEMPERATURE SENSORS AND RETURN DUCT HUMIDITY SENSORS. AS THE RETURN AIR TEMPERATURE OR THE SPACE SENSORS REQUIRE COOLING, THE UNIT SHALL ENTER THE COOLING MODE OF OPERATION. THE ATC SYSTEM SHALL COMPARE THE RETURN AIR TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE AND EVALUATE THE SUITABILITY OF FREE COOL AND. IF THE OUTSIDE AIR IS SUITABLE FOR FREE COOLING, MODULATE OPEN THE OUTSIDE AIR DAMPER BEYOND ITS MINIMUM POSITION UP TO A MAXIMUM OF 100% OUTSIDE AIR AND PROPORTIONATELY MODULATE THE RETURN DAMPER CLOSED AND THE EXHAUST DAMPER OPEN. THE UNIT HEATING COIL AND COOLING COIL CONTROL VALVES SHALL BE IN THE OFF POSITIONS. THE ATC SYSTEM SHALL MAINTAIN A SUPPLY AIR TEMPERATURE RESET TO THE COOLING SET POINT IN THE SPACE OR SAMPLING OF SPACES REQUIRING THE MOST COOLING. THE VAV BOX SERVING THE SPACE OR SPACES REQUIRING THE MOST COOLING SHALL BE FULL OPEN. IN THE REMAINING SPACES THE VAV BOXES SHALL MODULATE THE AIRFLOW TO MAINTAIN THE SPACE SET POINT. WHEN THE OUTSIDE AIR IS NO LONGER SUITABLE FOR FREE COOLING OR THE RETURN AIR AND SPACE TEMPERATURES CONTINUE TO RISE OR IF THE RETURN DUCT RELATIVE HUMIDITY EXCEEDS 50%, THE UNIT SHALL ENTER THE SECOND STAGE OF COOLING OR THE DEHUMIDIFICATION MODE. THE SECOND STAGE OF COOLING SHALL MODULATE THE OUTSIDE AIR DAMPER TO THE MINIMUM AIRFLOW AND MODULATE OPEN THE RETURN DAMPER, AND ENERGIZE THE DX COOLING SYSTEM. COMPRESSORS SHALL BE STAGED. 1 = THE LEAD CU (CONDENSING UNIT) SHALL ENERGIZE ONE COMPRESSOR. 2 = THE LAG CU SHALL ENERGIZE THE SECOND COMPRESSOR. 3 = THE LEAD CU SHALL ENERGIZE THE SECOND COMPRESSOR. 4 = THE LAG CU SHALL ENERGIZE THE SECOND COMPRESSOR. THE DX VALVES SHALL STAGE ON TO MAINTAIN A RESET DISCHARGE AIR TEMPERATURE AND SHALL MAINTAIN THE SPACE SET POINTS.
- F. HEATING: IN THE HEATING MODE THE UNIT SHALL OPERATE WITH THE OUTSIDE AIR DAMPER IN THE MINIMUM POSITION AND THE RETURN DAMPER AT THE HEATING AIRFLOW POSITION. THE HEATING VALVE SHALL MODULATE TO MAINTAIN THE DISCHARGE AIR TEMPERATURE OF 60 DEGREES F. THE VAV DAMPER SHALL BE AT THE MINIMUM AIRFLOW POSITION AND THE RE-HEAT VALVE SHALL MODULATE TO MAINTAIN THE SPACE SET POINT.
- G. DEHUMIDIFICATION: THE SPACE RELATIVE HUMIDITY LEVELS AS MEASURED AT THE RETURN AIR DUCT SHALL BE MAINTAINED AT A MAXIMUM OF 50%, ADJUSTABLE. WHEN THE RETURN DUCT HUMIDITY SENSOR MEASURES THE AIR RELATIVE HUMIDITY AT OR BELOW 50%, THE UNIT SHALL FOLLOW THE ABOVE SEQUENCES. WHEN THE RETURN DUCT RELATIVE HUMIDITY EXCEEDS 50%, THE UNIT OUTSIDE AIR SHALL RETURN TO THE MINIMUM POSITION. UPON A CONTINUED RISE IN THE RETURN DUCT RELATIVE HUMIDITY THE UNIT SHALL ENTER THE DEHUMIDIFICATION MODE OF OPERATION. TO DEHUMIDIFY, THE COOLING COIL CONTROL VALVES SHALL STAGE ON TO REDUCE THE COIL DISCHARGE AIR TEMPERATURE TO A MINIMUM TEMPERATURE SUITABLE TO MAINTAIN THE RETURN DUCT RELATIVE HUMIDITY. THE UNIT HEATING COIL SHALL MODULATE TO MAINTAIN THE RESET DISCHARGE AIR TEMPERATURE.
- H. VENTILATION ADJUSTMENT: THE RETURN DUCT MOUNTED CARBON DIOXIDE (CO2) SENSOR SHALL ADJUST THE OUTSIDE AIR ADMITTED BY THE AIR HANDLER TO MAINTAIN THE SPACE CO2 LEVELS BELOW 1000 PPM.
- I. VAV BOXES (TERMINAL AIR UNITS)
- DUAL TEMPERATURE THERMOSTAT SET AT 72 DEGREES F, ADJUSTABLE, MAINTAINS CONSTANT SPACE TEMPERATURE BY MODULATING VARIABLE VOLUME DAMPER OPERATOR. ON A RISE IN TEMPERATURE ABOVE THE COOLING SET POINT, THE VAV TERMINAL UNIT SHALL MODULATE TO ITS MAXIMUM CFM. AS THE SPACE TEMPERATURE DROPS BELOW THE COOLING SET POINT, THE TERMINAL UNIT SHALL MODULATE TO ITS MINIMUM CFM. AS THE SPACE TEMPERATURE CONTINUES TO FALL TO THE HEATING SET POINT, THE PROPORTIONAL HOT WATER VALVE SHALL MODULATE OPEN.
 - PROVIDE NIGHT SETBACK AND MORNING WARM UP AS REQUIRED BY THE ASSOCIATED AIR SYSTEM.
- J. SAFETY DEVICES:
- SMOKE DETECTOR(S) LOCATED IN THE SUPPLY (AND RETURN) DUCTS SHALL STOP THE UNIT FAN AND CLOSE THE OUTSIDE AIR DAMPERS IF SMOKE IS DETECTED. THE CONTROLLER SHALL SIGNAL APPROPRIATE ATC ALARMS.
- K. OTHER DEVICES:
- THE UNIT AIR FILTER STATUS SHALL BE MEASURED AND INDICATED ON THE GRAPHICAL INTERFACE TO INDICATE THE STATIC PRESSURE DROP ACROSS THE UNIT FILTERS AND PROVIDE NOTIFICATION INDICATING THE NEED FOR FILTER CHANGE-OUT.
- L. EQUIPMENT CONTROLLED:
- AIR HANDLING UNITS: AHU-1 & AHU-2
 - VAV BOXES: ALL ASSOCIATED WITH EACH AHU.



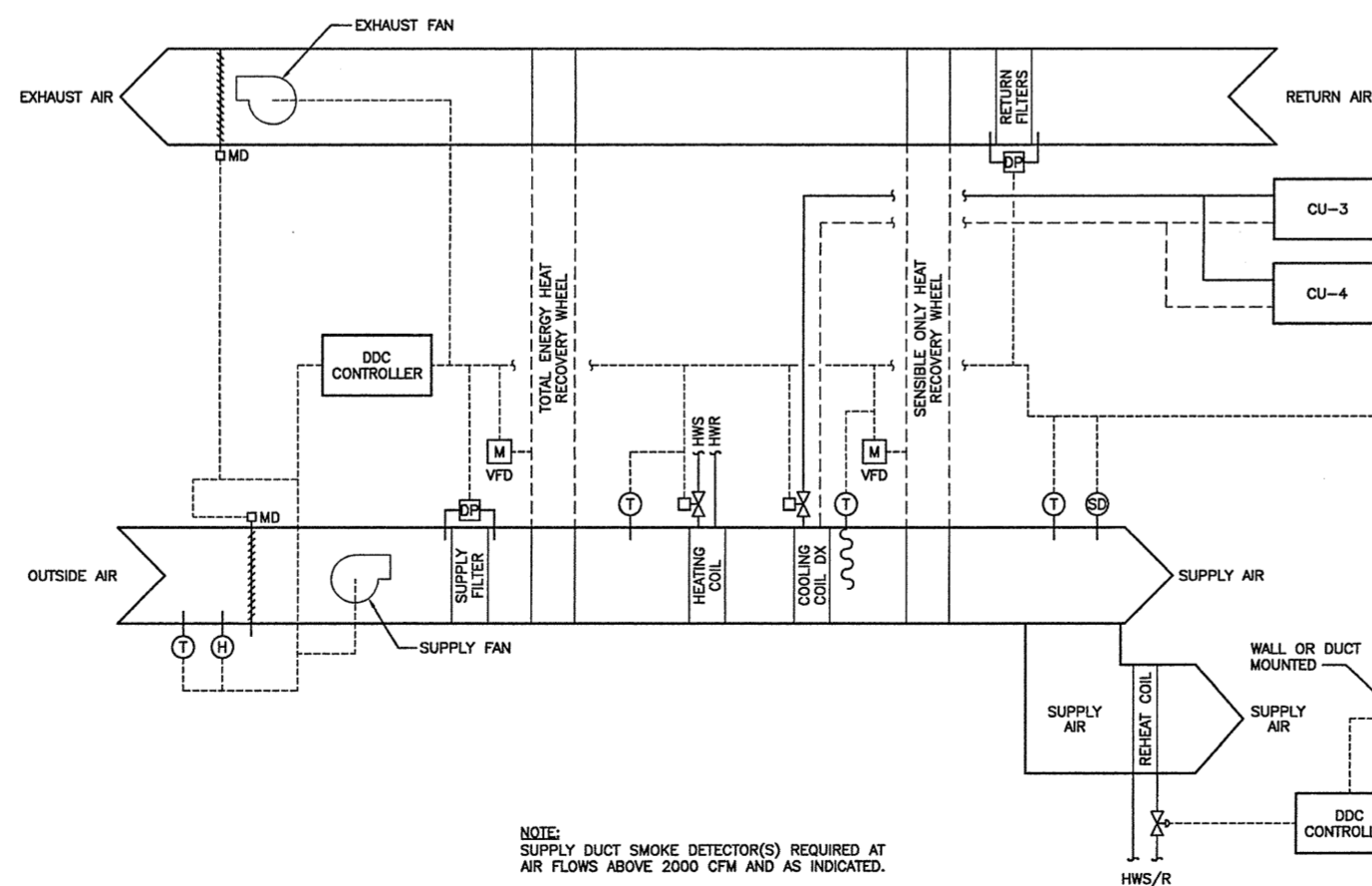
NOTE: SUPPLY DUCT SMOKE DETECTOR(S) REQUIRED AT AIR FLOWS ABOVE 2000 CFM AND AS INDICATED. RETURN DUCT SMOKE DETECTOR(S) REQUIRED AT AIR FLOWS ABOVE 15,000 CFM AND AS INDICATED.

A1 VAV AIR HANDLER CONTROL SCHEMATIC & SEQUENCE OF OPERATION

NOT TO SCALE

100% OUTSIDE AIR HANDLERS W/HEAT RECOVERY WHEELS AND REHEAT COOLING COILS SEQUENCE OF OPERATION

- A. START STOP CONTROL: WHEN THE HAND-OFF-AUTO (HOA) IS SET TO HAND OR WHEN A CONTACT CLOSURE IS MADE ACROSS THE AUTO CONTACTS WITH THE H-O-A SET TO "AUTO", THE UNIT WILL START, RUN CONTINUOUSLY, AND USE SETPOINTS INPUT AT THE KEYPAD. WHEN THE HOA IS SET TO OFF, THE UNIT IS OFF REGARDLESS OF START COMMAND STATUS FROM THE BAS. WHEN THE HOA IS SET TO AUTO, THE UNIT WILL START IF THERE IS A DRY CONTACT AT THE AUTO START TERMINALS, OR IF THERE IS A START COMMAND OVER THE COMMUNICATION LINE FROM THE BAS.
- B. SETPOINT CONTROL: THE SUPPLY SETPOINT MAY BE ENTERED AT THE KEYPAD, OR RECEIVED FROM THE BAS. A LOCAL/REMOTE SETPOINT SWITCH MAY BE TOGGLED EITHER THROUGH THE KEYPAD OR THE BAS. THE CONDENSATION CONTROL SETPOINT IS AUTOMATICALLY CALCULATED AND SET BY THE CONTROLLER.
- C. ENTHALPHY WHEEL CONTROL: IF THE SPACE IS HUMID AND THE OUTDOOR AIR IS DRY, THE ENTHALPHY WHEEL WILL ROTATE AT MINIMUM SPEED AND USE OUTDOOR AIR TO DEHUMIDIFY. IF THE OUTDOOR AIR HUMIDITY IS GREATER THAN THE SETPOINT THE ENTHALPHY WHEEL WILL ROTATE AT FULL SPEED. OTHERWISE, THE ENTHALPHY WHEEL WILL MODULATE AS THE FIRST STAGE OF HEATING WHEN THE SPACE TEMPERATURE IS BELOW SETPOINT.
- D. HW PRE-HEAT COIL CONTROL: THE HW VALVE MODULATES TO SATISFY THE UNIT DISCHARGE MINIMUM TEMPERATURE SETPOINT AS THE 2ND STAGE OF HEAT, FOLLOWING THE ENTHALPHY WHEEL. THE SENSIBLE WHEEL WILL BE AT MINIMUM SPEED AND THE DX COOLING SIGNAL WILL BE ZERO.
- E. COOLING COIL CONTROL: THE COOLING COIL (DX STAGING) IS CONTROLLED BY THE MAXIMUM LOAD REQUIRED FOR COOLING OR DEHUMIDIFICATION BASED ON THE SPACE TEMPERATURE AND ABSOLUTE SPACE HUMIDITY. WHEN THE SPACE IS ABOVE THE DEWPOINT SETPOINT AND IF THE OUTDOOR AIR DEWPOINT IS ALSO ABOVE SETPOINT, THE (DX OUTPUTS WILL STAGE) TO MAINTAIN A 5°F (ADJUSTABLE) LEAVING AIR TEMPERATURE. IF THE SPACE BECOMES COLD BUT WITH A DEWPOINT ABOVE SETPOINT, THE COOLING LEAVING AIR TEMPERATURE WILL BE GRADUALLY INCREASED UNTIL THE SPACE TEMPERATURE IS ACHIEVED, THEN REVERT TO DEHUMIDIFICATION SETPOINTS.
- F. PRE-HEAT HOT WATER COIL FREEZE PROTECTION: A MANUAL RESET FREEZESTAT IS MOUNTED ON THE LEAVING FACE OF THE COOLING COIL. THE FREEZESTAT WILL RESPOND TO THE COLDEST SECTION OF THE ELEMENT. IF THE FREEZESTAT TRIPS, THE UNIT WILL SHUT DOWN, DAMPERS WILL CLOSE, AND THE PRE-HEAT COIL VALVE WILL GO TO FULL OPEN.
- SENSIBLE WHEEL CONTROL: THE SENSIBLE WHEEL MODULATES TO MAINTAIN THE MINIMUM DISCHARGE TEMPERATURE SETPOINT AND THE SENSIBLE WHEEL CONDENSATION CONTROL SETPOINT. THE WHEEL WILL RECEIVE THE MINIMUM SIGNAL FROM THE SUPPLY AND CONDENSATION CONTROL LOOPS. THE CONTROLLER CALCULATES THE CONDENSATION CONTROL SETPOINT TO BE THE SPACE DEWPOINT PLUS 2 DEGREES. THE WHEEL ALSO MODULATES TO MAINTAIN A MINIMUM ENTHALPHY WHEEL DISCHARGE TEMPERATURE IN HEATING MODE, TO PREVENT ENTHALPHY WHEEL CONDENSATION, AND TO PROTECT WATER COILS.
- ALARM FUNCTIONS: DIGITAL ALARM INPUTS CONSIST OF FILTER PRESSURE SWITCHES, FAN CURRENT SWITCHES, AND WHEEL ROTATION DETECTORS. IF AN ALARM TRIPS, THE ALARM LIGHT ON THE UNIT WILL ENERGIZE, AND THE SOURCE OF THE TRIP MAY BE SEEN ON THE KEYPAD.



NOTE: SUPPLY DUCT SMOKE DETECTOR(S) REQUIRED AT AIR FLOWS ABOVE 2000 CFM AND AS INDICATED.

A1 100% OUTSIDE AIR HANDLER CONTROL SCHEMATIC & SEQUENCE OF OPERATION

NOT TO SCALE

RADIATION SEQUENCE OF OPERATION

- A. THE RADIATION SHALL BE INSTALLED WITH A MANUALLY ADJUSTED NON-ELECTRIC CONTROL VALVES. SET SPACE TEMPERATURE SET POINT TO 55 DEGREES F. HEATING VALVES SHALL FAIL TO THE FULL HEAT POSITION.

EXHAUST FANS SEQUENCE OF OPERATION

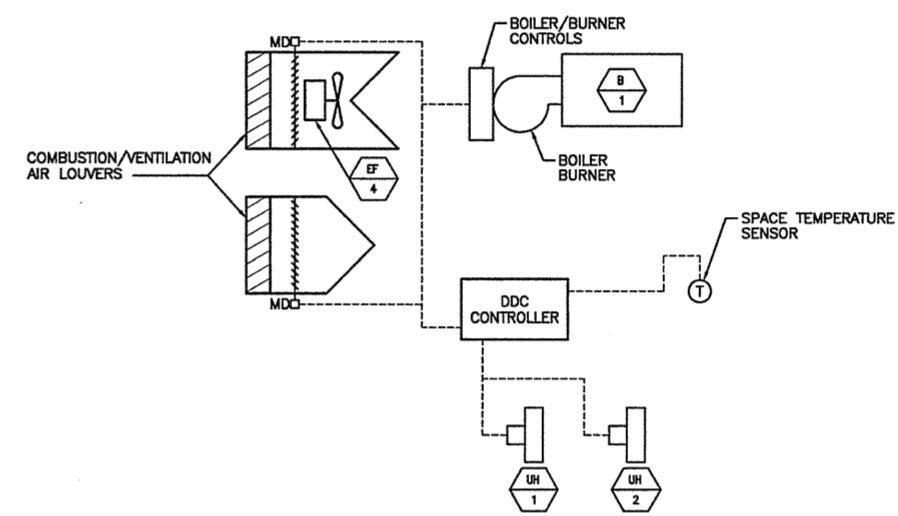
- A. OCCUPIED/UNOCCUPIED OPERATION: EF-1, (BATHROOMS), EF-3, (JANITOR CLOSET).
- B. FAN ON WITH COOLING THERMOSTAT: EF-2/EF-4/EF-9. ACTIVATION OF EXHAUST FAN IF ROOM TEMP. (MECH. ROOM - 404 EF-4) (AIR COMP. ROOM - EF-2) EXCEEDS SETPOINT & (ELEC. RM. - 148).

CABINET UNIT HEATERS (CUH)/UNIT HEATERS (UH) SEQUENCE OF OPERATION

- A. SINGLE TEMPERATURE UNIT ELECTRIC ROOM THERMOSTAT SET AT 68 DEGREES F MAINTAINS CONSTANT SPACE TEMPERATURE BY OPENING THE NORMALLY CLOSED TWO-WAY CONTROL VALVE AND CYCLING THE UNIT FAN MOTOR. FOR UNIT HEATERS, THE TEMPERATURE SENSORS SHALL BE LOCATED AT THE UNIT CABINET.
- B. SINGLE TEMPERATURE THERMOSTAT ON RETURN HEATING WATER LINE DE-ENERGIZES UNIT ON TEMPERATURES BELOW 95 DEGREES F.

MODULAR RADIANT HEATING PANEL

- A. SINGLE TEMPERATURE WALL-MOUNTED ROOM THERMOSTAT SET AT 60 DEGREES F. MAINTAINS CONSTANT SPACE TEMPERATURE BY OPENING THE NORMALLY CLOSED TWO-WAY CONTROL VALVE.



MECHANICAL ROOM VENTILATION AND HEATING EQUIPMENT SEQUENCE OF OPERATION

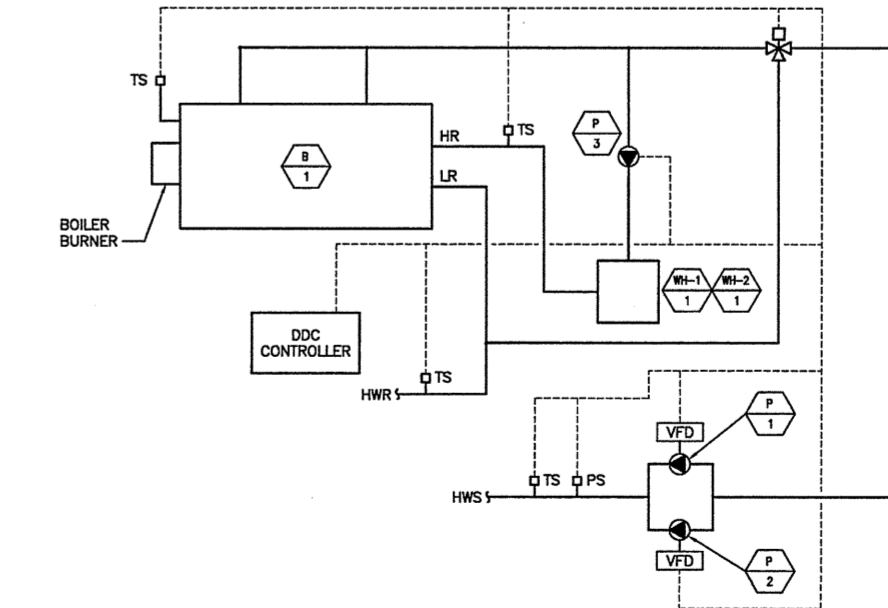
- A. COMBUSTION AIR AND HEAT VENTILATION: THE COMBUSTION AIR DAMPERS SHALL OPEN WHENEVER THE BOILER BURNER IS FIRING. THE DAMPERS SHALL CLOSE TIGHTLY WHEN THE BURNER IS INOPERATIVE. WHEN THE BOILER ROOM TEMPERATURE EXCEEDS 85 DEGREES F (ADJUSTABLE), THE COMBUSTION AIR DAMPERS SHALL OPEN. A DAMPER END SWITCH AT EF-4 SHALL ENERGIZE EXHAUST FAN EF-4. WHEN THE SPACE TEMPERATURE SET POINT IS SATISFIED, THE FAN SHALL BE DE-ENERGIZED AND THE DAMPERS SHALL CLOSE. THE BURNER OPERATION SHALL RESUME CONTROL OF THE DAMPER OPERATION. IF EF-4 IS OPERATING FOR HEAT REMOVAL PURPOSES, THE SPACE UNIT HEATERS SHALL BE DE-ENERGIZED.

J11 MECH. RM. VENTILATION & HEATING EQUIPMENT CONTROL SCHEMATIC AND SEQUENCE OF OPERATION

NOT TO SCALE

HEATING SYSTEM CONTROL SEQUENCE

- A. GENERAL: THE HEATING SYSTEM IS BASED ON A 3-WAY MIXING SCHEME. A TEMPERATURE SENSOR SHALL BE PLACED IN THE COMMON SUPPLY LOOP HEADER AND BOILER SUPPLY AND RETURN WATER HEADERS. THE BOILER (B-1) SHALL BE ENERGIZED TO MAINTAIN LOOP WATER TEMPERATURE (120°F). ADJUSTABLE. THE BOILER AND THE LOOP WATER TEMPERATURE SHALL BE MONITORED AND ALARMED (OUT OF RANGE TEMPERATURE). DURING NORMAL OPERATION THE BOILER SHALL SUPPLY 120°F WATER TO P-1 & P-2. IF P-3 SHOULD CALL FOR HEAT TO WH-1, WH-2 THE BOILER SHALL FIRE TO RAISE THE SUPPLY WATER TEMPERATURE TO 180°F. AS THE BOILER WATER TEMPERATURE RISES THE 3-WAY VALVE SHALL MODULATE TO MAINTAIN THE HWS DISCHARGE TEMPERATURE AT 120°F.
- B. BUILDING SIDE PUMPING: HEATING CIRCULATING PUMPS (P-1 AND P-2) SHALL BE CONFIGURED IN A LEAD/LAG ARRANGEMENT. THE LEAD PUMP SHALL RUN CONTINUOUSLY BASED ON A SYSTEM PRESSURE SENSOR INPUT. THE LEAD PUMP SHALL MAINTAIN A CONSTANT SYSTEM PRESSURE BY VARYING THE PUMP SPEED VIA A VARIABLE SPEED DRIVE. A CURRENT SENSOR SHALL MONITOR THE PUMP STATUS AND THE ATC SYSTEM SHALL START THE STANDBY PUMP IF THE LEAD PUMP FAILS. A SCHEDULE SHALL AUTOMATICALLY ROTATE THE PUMPS FOR EVEN PUMP RUNTIME. FAILURE OF EITHER PUMP SHALL ACTIVATE ALARMS AT THE DDC CONTROLLER INTERFACE.



A13 HEATING SYSTEM CONTROL SCHEMATIC & SEQUENCE OF OPERATION

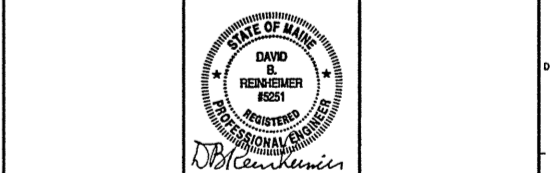
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NOTE:

1. SEE SHEET M-001 FOR LEGEND AND ABBREVIATIONS.

ISSUED FOR CONSTRUCTION 10-23-03

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SCHEMATICS

SHEET TITLE: NOT TO SCALE DATE: 10-23-03
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 A/E OF RECORD: DBR SHEET No. M-651
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