

SEQUENCE OF OPERATION FOR DUAL CONVERTOR SYSTEM

- HEAT EXCHANGER SYSTEM OPERATION:**
- HEAT EXCHANGERS 1-1CA AND 1-1CB SHALL OPERATE IN A LEAD/LAG SEQUENCE. THE DESIGNATED LEAD HEAT EXCHANGER SHALL ROTATE EITHER MANUALLY THROUGH THE BMS OR ON A MONTHLY BASIS (ADJUSTABLE).
 - WHEN ENABLED, THE LEAD HEAT EXCHANGERS 2-WAY, 2-POSITION, NORMALLY OPEN, HOT WATER CONTROL VALVE SHALL OPEN. IF THE LEAD HEAT EXCHANGER FAILS TO MAINTAIN HOT WATER SUPPLY TEMPERATURE, THEN THE LAG HEAT EXCHANGER SHALL ACTIVATE AND THE RESPECTIVE CONTROL VALVE SHALL OPEN.
 - THE CONTROLLER SHALL MEASURE THE HOT WATER SUPPLY TEMPERATURE AND MODULATE THE STEAM VALVE TO MAINTAIN THE HWS SETPOINT.
 - THE STEAM VALVE SHALL BE ENABLED WHENEVER:
 - THE ASSOCIATED HEAT EXCHANGER IS ENABLED.
 - AND PROOF OF PUMP STATUS.
 - THE HOT WATER SUPPLY TEMPERATURE SETPOINT SHALL BE RESET BASED ON DIFFERENTIAL BETWEEN SUPPLY AND RETURN WATER TEMPERATURE. SUPPLY WATER TEMPERATURE DEFAULT SETPOINT SHALL BE 180F (ADJ.) WHEN THE SYSTEM IS STARTED. THE DEFAULT SETPOINT SHALL BE MAINTAINED FROM A MINIMUM TIME OF 30 MINUTES (ADJ.). AFTER THE MINIMUM TIME HAS ELAPSED, THE BMS SHALL ADJUST THE SETPOINT BASED ON THE FOLLOWING FORMULA:
 - $\Delta T = (HWS\ TEMP) - (HWR\ TEMP)$ IF $\Delta T < 5$ DEGREES, THEN SETPOINT = SETPOINT - 20 DEGREES
 - $\Delta T = (HWS\ TEMP) - (HWR\ TEMP)$ IF $\Delta T > 5$ DEGREES AND < 10 DEGREES, THEN SETPOINT = SETPOINT - 15 DEGREES
 - $\Delta T = (HWS\ TEMP) - (HWR\ TEMP)$ IF $\Delta T > 10$ AND < 15 DEGREES, THEN SETPOINT = SETPOINT - 10 DEGREES
 - $\Delta T = (HWS\ TEMP) - (HWR\ TEMP)$ IF $\Delta T > 15$ AND < 20 DEGREES, THEN SETPOINT = SETPOINT - 5 DEGREES
 - $\Delta T = (HWS\ TEMP) - (HWR\ TEMP)$ IF $\Delta T > 20$ AND < 25 DEGREES, THEN SETPOINT = SETPOINT + 0 DEGREES
 - $\Delta T = (HWS\ TEMP) - (HWR\ TEMP)$ IF $\Delta T > 25$ DEGREES, THEN SETPOINT = SETPOINT + 5 DEGREES
 - IF SETPOINT > 120 DEGREES, THEN SETPOINT = VALUE OF SETPOINT ELSE SETPOINT = 120 DEGREES.
 - MAINTAIN NEW SETPOINT FOR A TIME PERIOD OF 15 MINUTES (ADJ.) THEN RECALCULATE SETPOINT.
 - ALARMS:
 - HIGH HW SUPPLY TEMPERATURE (GREATER THAN 190 DEG F (ADJ.)). IF HWS TEMP REACHES 190 DEGREES CLOSE STEAM VALVE. WHEN HWS TEMP FALLS BELOW 180 DEGREES RELEASE STEAM VALVE TO CONTROL LOOP.
 - LOW HW SUPPLY TEMPERATURE (LESS THAN 110 DEG F (ADJ.)).
 - IF HWS TEMP FALLS 10 DEGREES BELOW SETPOINT FOR A PERIOD OF 5 MINUTES (ADJ.) GENERATE AN ALARM.

HEATING HOT WATER RESET SCHEDULE

OUTSIDE AIR RESET SCHEDULE	
OUTSIDE AIR TEMPERATURE	PERIMETER HOT WATER TEMPERATURE
ABOVE 60 DEGREES	120 DEG
BELOW 20 DEG	180 DEG

- HOT WATER SETPOINT RESET OPERATION:**
- THE CONTROL OF THE HOT WATER SUPPLY TEMPERATURE SHALL BE VIA AN INVERSE/RESET SCHEDULE. SUPPLY WATER TEMPERATURE SETPOINT SHALL BE 180F (ADJ.) WHEN THE OUTDOOR AIR TEMPERATURE IS 20F (ADJ.) OR LESS. WHEN THE OUTDOOR AIR TEMPERATURE IS 60F (ADJ.) OR GREATER, THE SUPPLY WATER TEMPERATURE SETPOINT SHALL BE 120F (ADJ.). RESET SUPPLY WATER TEMPERATURE LINEARLY BETWEEN THESE TWO TEMPERATURE SETPOINTS.

GENERAL CONTROLS NOTES:

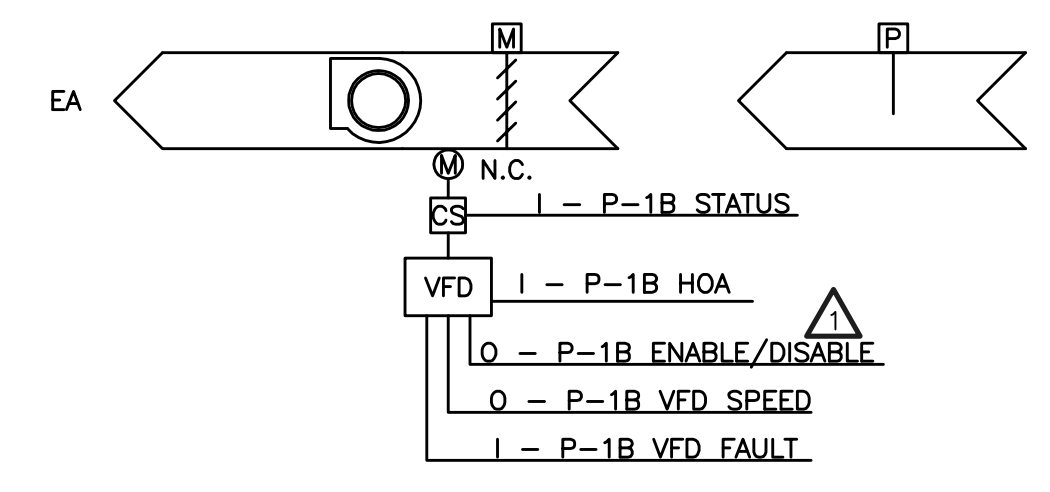
- IN DIAGRAMS, 'I' INDICATES AN INPUT, 'O' INDICATES AN OUTPUT.
- DAMPER OPERATORS SHALL BE PROVIDED BY TEMPERATURE CONTROLS CONTRACTOR.
- TEMPERATURE CONTROL TEST SHALL INCLUDE, BUT NOT BE LIMITED TO:
 - DAMPER OPERATION
 - VALVE ACTUATION RESPONSE AND VALIDATION OF CORRECT OPERATION
 - VERIFIED ENTIRE CONTROL SEQUENCE OPERATES PER DESIGN
 - VERIFY TEMPORARY SEQUENCE OF OPERATION IS ACTIVE SEQUENCE OF OPERATION FOR ALL AIR HANDLING UNITS
 - ACCOUNT FOR ALL CONTROL POINTS LISTED

SUPPLEMENTARY CONTROL NOTES:

- EXTEND THE EXISTING ANDOVER CONTROL SYSTEM. TO PROVIDE A FULLY AUTOMATED DIRECT DIGITAL CONTROL SYSTEM, INCLUDE CONTROL DEVICES, ACTUATORS, WIRING, PANELS, CONTROLLERS, PROGRAMMING, AS SHOWN AND AS REQUIRED TO EXECUTE THE SEQUENCE OF OPERATION. PROVIDE FIELD LABOR AS REQUIRED TO COMPLETE BALANCING AND COMMISSIONING. CONTRACTOR SHALL SUBMIT FOR APPROVAL TO THE VA COTR AND ENGINEER EACH SYSTEM'S SEQUENCES.
- DAMPER OPERATORS TO BE PROVIDED BY TEMPERATURE CONTROLS CONTRACTOR.
 - TEMPERATURE CONTROL TEST SHALL INCLUDE, BUT NOT BE LIMITED TO:
 - DAMPER OPERATION
 - VALVE ACTUATION RESPONSE AND VALIDATION OF CORRECT OPERATION
 - VERIFIED ENTIRE CONTROL SEQUENCE OPERATES PER DESIGN
 - ACCOUNT FOR ALL CONTROL POINTS LISTED
 - ALL SYSTEMS SHALL BE COMMISSIONED. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION.
 - TEMPERATURE CONTROLS SHALL BE ANDOVER. ALL CONTROLS WORK SHALL INTERFACE WITH EXISTING ANDOVER BUILDING CONTROL SYSTEM.

TRIDIUM CONTROLS SYSTEM NOTES:

- ALL INPUT AND OUTPUT POINTS INDICATED ON THIS DRAWING SHALL BE PROGRAMMED INTO THE EXISTING ANDOVER BAS.
- ADDITIONALLY, ALL INPUT AND OUTPUT POINTS AND ALARMS SHALL BE MAPPED TO EXISTING TRIDIUM CONTROLS SYSTEM FRONT END WORKSTATIONS ON CAMPUS.
- FULL TRIDIUM SYSTEM GRAPHICS SHALL BE DEVELOPED (THIS IS IN ADDITION TO THE ANDOVER SYSTEM GRAPHICS).



SEQUENCE OF OPERATION:

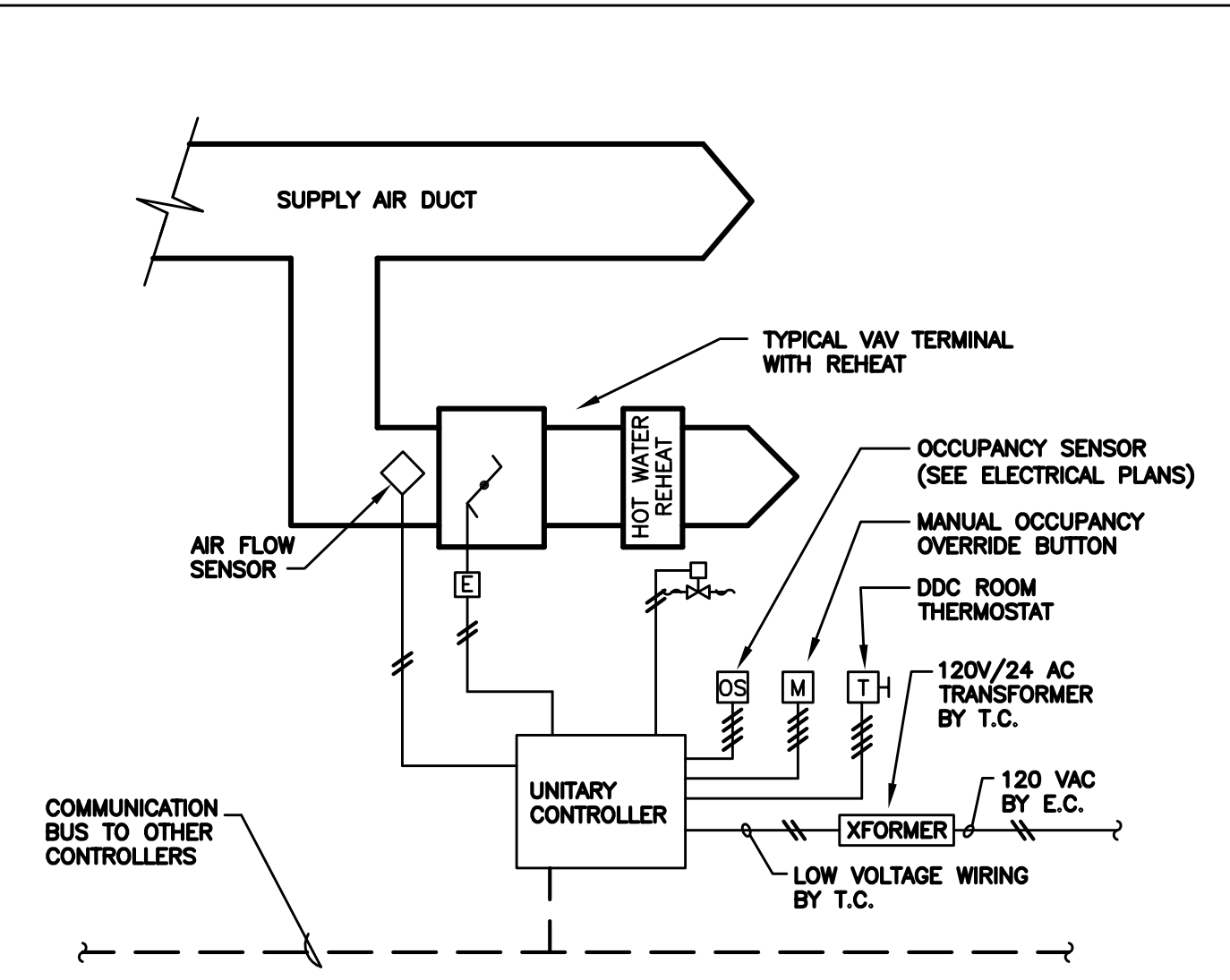
- EXHAUST FAN EF-1:**
- THE EXHAUST FAN SHALL GENERALLY RUN CONTINUOUSLY.
 - VFD WILL MODULATE TO MAINTAIN PRESSURE SETPOINT.
 - DAMPER SHALL OPEN WHEN FAN IS COMMANDED TO RUN AND DAMPER SHALL CLOSE WHEN FAN IS OFF. DAMPER SHALL HAVE AN END SWITCH WHICH WILL PREVENT THE FAN FROM RUNNING WHEN THE DAMPER IS CLOSED.

DUCT PRESSURE SENSOR SHALL BE INSTALLED IN DUCT MAIN AT BASEMENT LEVEL. UPON LOSS IN PRESSURE, AN ALARM SIGNAL SHALL BE SENT TO THE BUILDING CONTROL SYSTEM.

EF-1 CONTROL DIAGRAM

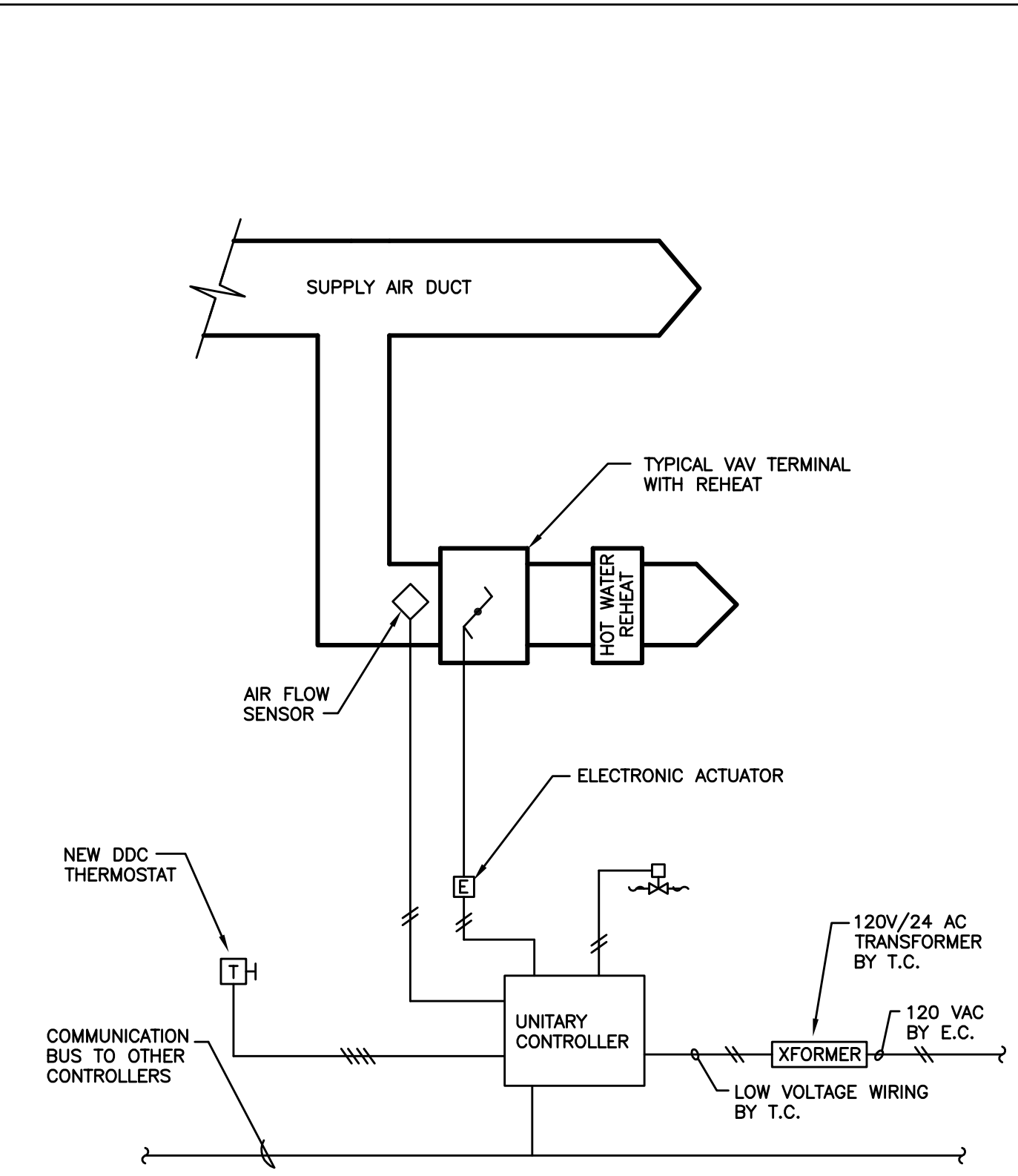
MEDICAL GAS CONTROLS:

- ADDITIONAL SCOPE:**
- TIE INTO MEDICAL GAS AREA ALARM PANEL FOR EACH ALARM MODULE. EACH SHALL GENERATE AN INDIVIDUAL ALARM ON THE BMS.



SEQUENCE OF OPERATION FOR VAV BOXES

- OPERATION (APPLIES TO BOXES SERVING ROOMS WITH OCCUPANCY SENSORS. REFER TO VAV SCHEDULE):**
- SPACE THERMOSTAT SHALL MODULATE DAMPER TO MAINTAIN SET POINT.
 - ON CALL FOR HEAT, RETURN DAMPER TO MINIMUM POSITION AND MODULATE HOT WATER VALVE TO MAINTAIN SETPOINT.
- OCCUPANCY CONTROL (APPLIES TO CONTROL TYPE 1. REFER TO VAV SCHEDULE):**
- OCCUPANCY SHALL BE DETERMINED FROM OCCUPANCY SENSOR SYSTEM FOR RESPECTIVE SERVICE AREA. CONTRACTOR SHALL TIE INTO OCCUPANCY SENSOR VIA AUXILIARY DRY CONTACTS ON SENSORS. REFER TO ELECTRICAL PLANS FOR ADDITIONAL INFORMATION.
 - ROOM OVERRIDE SHALL BE POSSIBLE FROM MANUAL OCCUPANCY BUTTON. OVERRIDE SHALL BE LIMITED TO 60 MINUTES (ADJ.).
 - OCCUPIED: VAV TERMINAL SHALL OPERATE UNDER STANDARD COOLING/HEATING MODES TO MAINTAIN ROOM THERMOSTAT SETPOINTS AS LISTED IN ROOM DESIGN SCHEDULE ON DRAWING 1-H1.
 - UNOCCUPIED:
 - VAV TERMINAL SHALL RESET TO UNOCCUPIED MINIMUM. UNOCCUPIED MINIMUM SHALL BE 50% OF OCCUPIED MINIMUM (OCCUPIED MINIMUM IS LISTED MINIMUM AIR FLOW IN VAV SCHEDULE).
 - VAV TERMINAL SHALL OPERATE COOLING/HEATING MODES TO MAINTAIN 'UNOCCUPIED' SPACE THERMOSTAT SETPOINTS:
- HEATING: 68° F (ADJ.)
 - COOLING: 78° F (ADJ.)

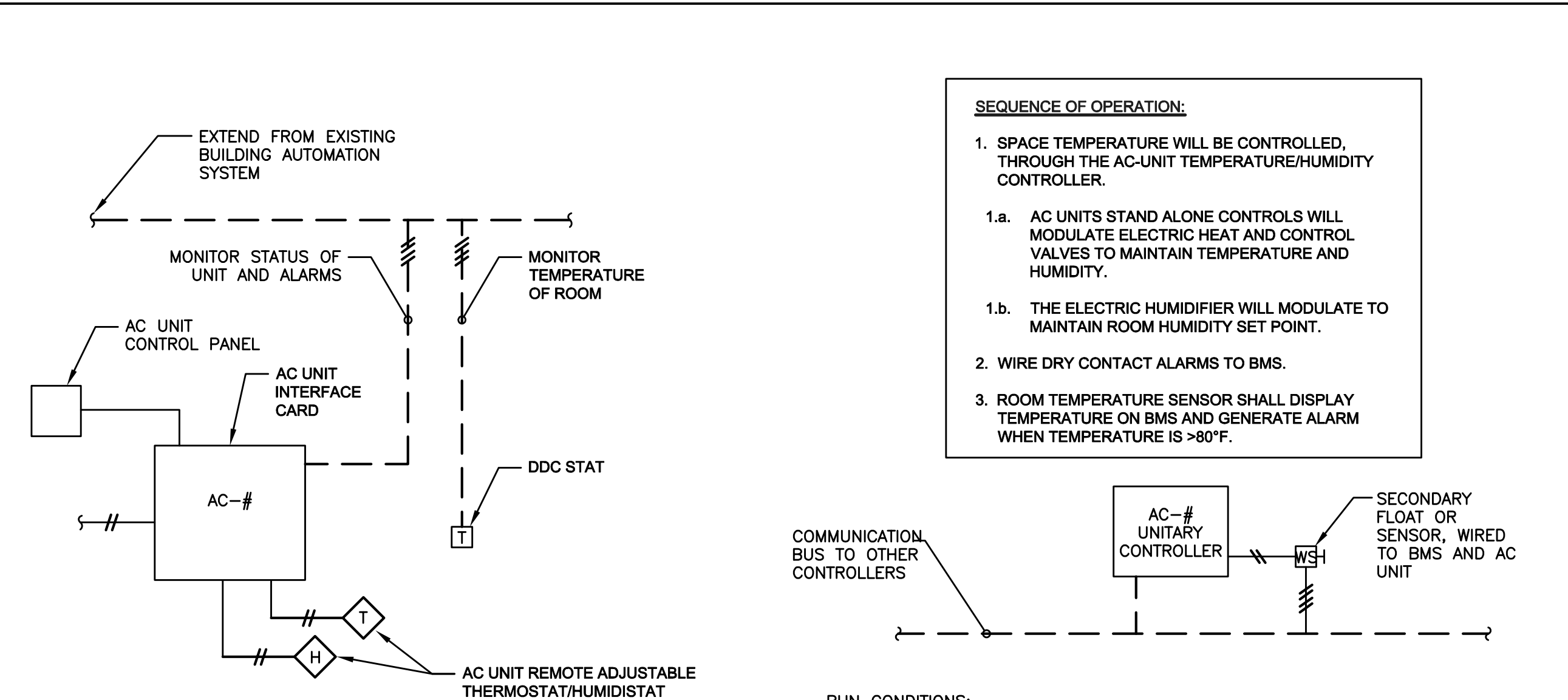


VAV CONTROL DIAGRAM

SEQUENCE OF OPERATION:

- VARIABLE AIR VOLUME TERMINALS:**
- SPACE THERMOSTAT SHALL MODULATE DAMPER TO MAINTAIN SET POINT.
 - ON CALL FOR HEAT, RETURN DAMPER TO MINIMUM POSITION AND MODULATE HOT WATER VALVE TO MAINTAIN SETPOINT.

AC UNIT TEMPERATURE CONTROLS AND SEQUENCE OF OPERATION



SEQUENCE OF OPERATION:

- SPACE TEMPERATURE WILL BE CONTROLLED, THROUGH THE AC-UNIT TEMPERATURE/HUMIDITY CONTROLLER.
 - AC UNITS STAND ALONE CONTROLS WILL MODULATE ELECTRIC HEAT AND CONTROL VALVES TO MAINTAIN TEMPERATURE AND HUMIDITY.
 - THE ELECTRIC HUMIDIFIER WILL MODULATE TO MAINTAIN ROOM HUMIDITY SET POINT.
- WIRE DRY CONTACT ALARMS TO BMS.
- ROOM TEMPERATURE SENSOR SHALL DISPLAY TEMPERATURE ON BMS AND GENERATE ALARM WHEN TEMPERATURE IS $> 80^{\circ}\text{F}$.

RUN CONDITIONS:

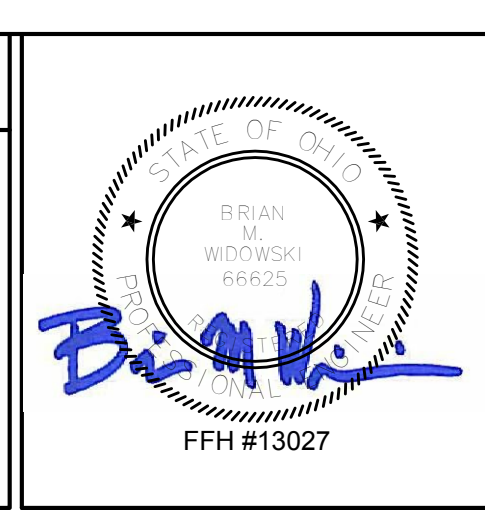
- PROVIDE A SECONDARY FLOAT OR WATER SENSOR, IN THE PUMP RESERVOIR, THAT WILL INDICATE AN OVERFLOW SITUATION AND START THE OVER FLOW SEQUENCE.
- THE OVERFLOW SEQUENCE SHALL INCLUDE THE FOLLOWING
 - SHUTDOWN THE AC UNIT, HARDWIRED.
 - SEND ALARM TO THE B.A.S., WITH GRAPHICS INDICATING AN OVERFLOW CONDITION.
- PROVIDE MEANS TO RESET THE ALARM CONDITION AFTER THE PROBLEM HAS BEEN CORRECTED.
- CONTRACTOR SHALL TEST AND VERIFY SENSOR/ALARM OPERATION.

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TEMPERATURE CONTROLS

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Project Title
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