

REV	DESCRIPTION	DATE
0	BIDDING/CONSTRUCTION	7-9-07

GRAPHIC SCALE:  
0" = 1"

SCALE: AS NOTED  
PROJECT MANAGER: SLB  
JC/DRAWN BY: TCM/BGG  
A/E OF RECORD: RWM  
CAD FILE: M-504-06016  
PROJECT NO: 06016  
DATE: 7-9-07

SHEET TITLE:  
**SCHEMATICS**

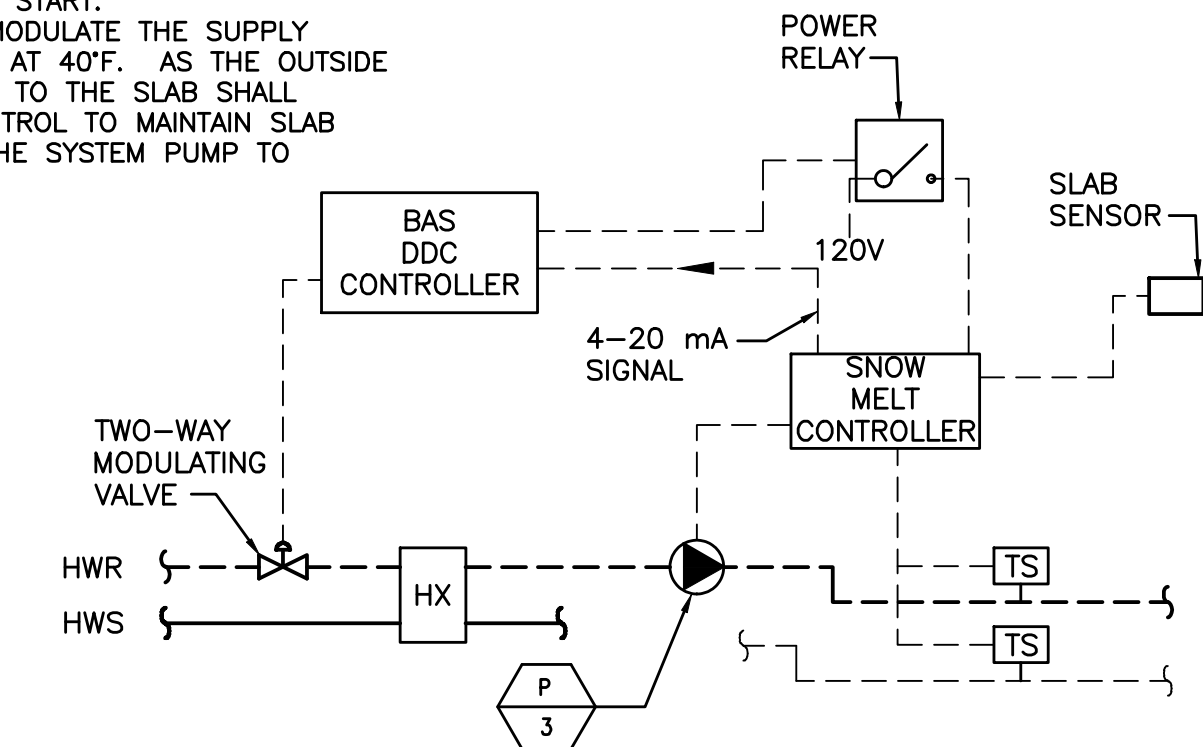
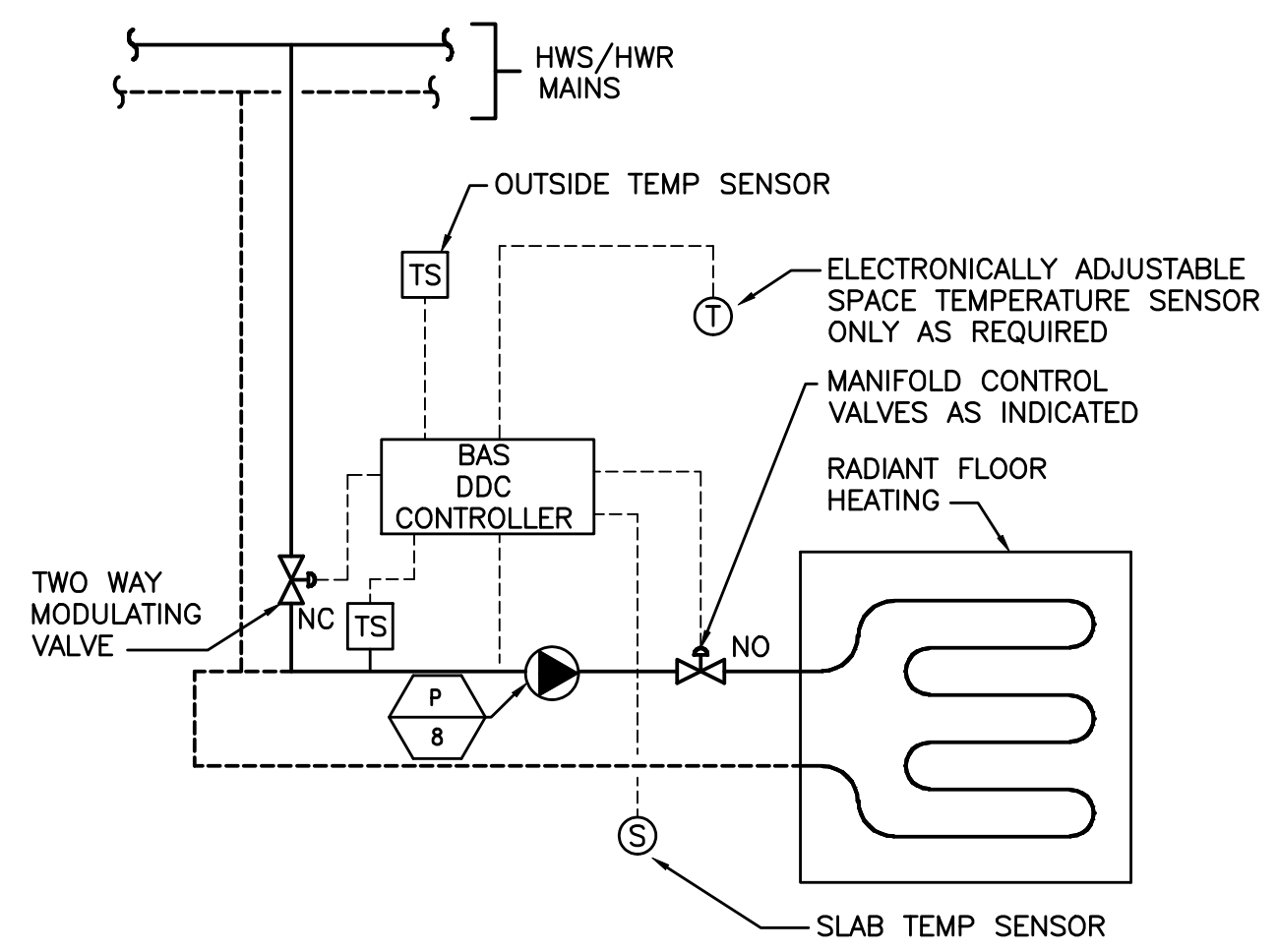
SHEET No.  
**M-651**  
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**SEQUENCE OF OPERATION**

- A. THE BAS SHALL REGULATE THE INDOOR AIR TEMPERATURE SERVED BY THE FLOOR HEATING ZONES BY THE AMOUNT OF BOILER WATER INJECTED INTO THE CONTINUOUSLY CIRCULATING RADIANT FLOOR HEATING SYSTEM. THE TWO-WAY MODULATING HEAT INJECTION VALVE SHALL CYCLE DEPENDING ON THE QUANTITY OF HEAT REQUIRED FOR THE SPACE SERVED. THE RADIANT HEATING SYSTEM WATER TEMPERATURE SHALL BE REGULATED BASED ON THE OUTSIDE AIR TEMPERATURE AND UTILIZING A PROPORTIONAL-INTEGRAL-DIFFERENTIAL CONTROL SCHEME.
- B. THE CONTROLLERS SHALL LIMIT THE HEATING SYSTEM SUPPLY WATER TEMPERATURE TO A MAXIMUM OF 120 DEGREES F.
- C. THE CONTROLLER SHALL OPERATE IN RESET MODE VARYING THE HEATING PANEL SUPPLY WATER TEMPERATURE BASED ON OUTSIDE AIR TEMPERATURE. THE CONTROLLER SHALL BE CAPABLE OF PROVIDING AN ADJUSTABLE HEATING CURVE.
  - a. THE BASE RESET SCHEDULE SHALL BE 120 DEGREES F SUPPLY WATER TEMPERATURE AT -20 DEGREES OUTSIDE AIR TEMPERATURE AND 70 DEGREES F SUPPLY WATER TEMPERATURE AT 60 DEGREES F OUTSIDE AIR TEMPERATURE.
- D. THE CONTROLLER SHALL PROVIDE WARM WEATHER SHUTDOWN TO STOP THE SYSTEM PUMP (P-8) AND CLOSE THE HEATING VALVE(S) WHEN OUTSIDE AIR TEMPERATURES NO LONGER REQUIRE SPACE HEATING.
- E. PROVIDE TEMPERATURE SENSING AT THE MIXING STATION FOR WATER TEMPERATURE AND AS INDICATED IN THE DRAWING FOR FLOOR SURFACE TEMPERATURE.

**SEQUENCE OF OPERATION**

- NOTE: THE BAS CONTRACTOR SHALL BE RESPONSIBLE FOR THIS COMPLETE SYSTEM AND INSTALLATION.
- A. AN OPERATOR INPUT SIGNAL AT THE DDC GRAPHICAL INTERFACE SHALL ENERGIZE THE SNOW MELTING SYSTEM CONTROLLER. THE DDC SYSTEM SHALL ALLOW A MANUALLY INPUT TOTAL RUN TIME (IN HOURS) FOR THE SNOW MELT OPERATION. THE DDC CONTROLLER SHALL BE CAPABLE OF UP TO A 5 DAY DELAY START.
  - B. ONCE ACTIVATED THE SNOW MELTING CONTROLLER SHALL MODULATE THE SUPPLY GLYCOL TEMPERATURE TO MAINTAIN THE SLAB TEMPERATURE AT 40°F. AS THE OUTSIDE AIR TEMPERATURE DROPS THE SUPPLY WATER TEMPERATURE TO THE SLAB SHALL INCREASE USING THE RESET CAPABILITY OF THE MIXING CONTROL TO MAINTAIN SLAB TEMPERATURE. THE MIXING CONTROL SHALL ALSO CYCLE THE SYSTEM PUMP TO MAINTAIN SLAB TEMPERATURE.

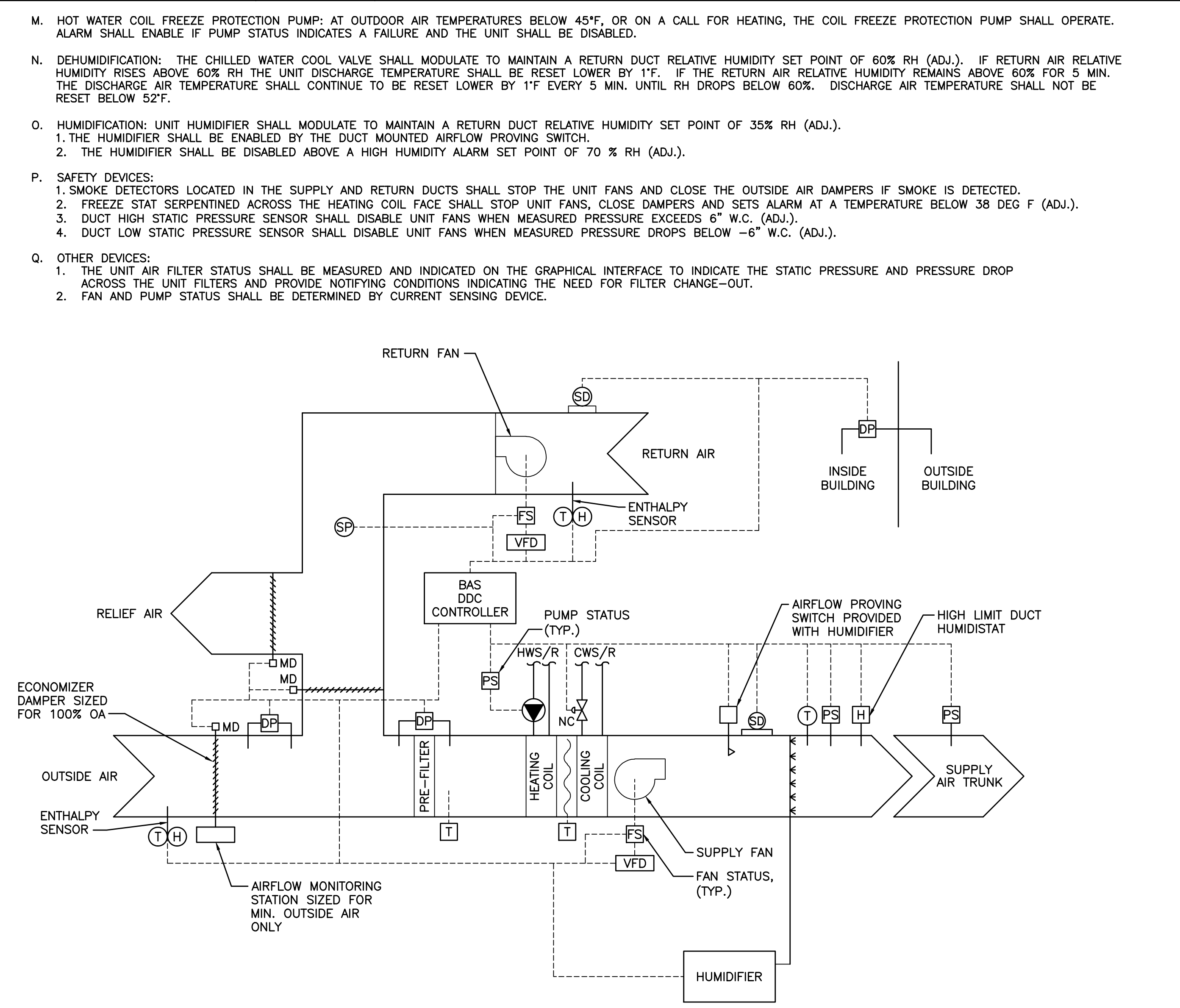


**H1 RADIANT FLOOR HEATING CONTROL SCHEMATIC AND SEQUENCE OF OPERATION**

**H10 SNOW MELT SYSTEM CONTROL SCHEMATIC & SEQUENCE OF OPERATION**

**SEQUENCE OF OPERATION:**

- A. GENERAL:
  1. WITH THE H-O-A SWITCH IN THE "AUTO" POSITION, UNIT SHALL START THROUGH THE BAS SYSTEM PROVIDED THE SAFETIES HAVE BEEN SATISFIED.
  2. BAS PROGRAMMING SHALL DEFINE OCCUPIED AND UNOCCUPIED SCHEDULING.
  3. IN THE EVENT THAT THE UNIT IS DISABLED THE OUTSIDE AIR DAMPER AND CHILLED WATER VALVE SHALL CLOSE THE RETURN DAMPER AND HOT WATER VALVE SHALL OPEN 100%. THE FREEZE PROTECTION PUMP SHALL START.
- B. OCCUPIED PERIODS: SYSTEM SUPPLY AND RETURN FANS SHALL RUN CONTINUOUSLY. SUPPLY AND RETURN FANS SHALL BE INTERLOCKED.
- C. UNOCCUPIED PERIODS: SYSTEM SUPPLY AND RETURN FANS SHALL CYCLE TO MAINTAIN THE HEATING SET POINTS IN EACH OF THE SPACES SERVED. THE SYSTEM SHALL PROVIDE AN ADJUSTABLE ANTI-SHORT CYCLE TIMER TO PREVENT EXCESSIVE FAN STARTS/STOPS.
  1. DURING UNOCCUPIED PERIODS THE OUTDOOR AIR (OA) DAMPER SHALL CLOSE AND THE RETURN AIR DAMPER SHALL OPEN.
- D. OPTIMUM START/STOP: THE SYSTEM FANS SHALL BE STARTED/STOPPED BASED ON THE OCCUPANCY SCHEDULE, WHICH SHALL BE ADJUSTABLE BY OPTIMUM START AND STOP CALCULATIONS. THE TEMPERATURE AT THE END OF THE OCCUPIED PERIOD WILL BE ALLOWED TO DRIFT A MAXIMUM OF 2°F ABOVE OR BELOW TEMPERATURE SET POINT. HEATING AND COOLING COIL VALVES SHALL BE CLOSED. THE SUPPLY AND RETURN FAN WILL CONTINUE TO OPERATE. HISTORICAL PERFORMANCE DATA SHALL BE USED TO DETERMINE HOW QUICKLY THE SPACE HEATS OR COOLS AND WILL START THE SYSTEM AS LATE AS POSSIBLE IN THE MORNING TO ACHIEVE OCCUPIED TEMPERATURE SETPOINT. HISTORICAL DATA WILL ALSO DETERMINE THE EARLIEST POSSIBLE TIME THE SYSTEM CAN STOP TO ALLOW THE MAXIMUM TEMPERATURE DRIFT.
- E. MORNING WARM UP: THE UNIT SHALL OPERATE IN THE MORNING WARM-UP MODE WHEN THE RETURN AIR TEMPERATURE IS BELOW THE WARM-UP MODE SET POINT, 68 DEG F (ADJ.), AS MEASURED BY THE RETURN DUCT TEMPERATURE SENSOR.
  1. THE OA DAMPER AND RELIEF AIR DAMPER SHALL CLOSE TO 0% AND THE RETURN AIR DAMPER SHALL OPEN TO 100%.
  2. THE HOT WATER PREHEAT COIL VALVE SHALL MODULATE TO MAINTAIN A SUPPLY AIR TEMPERATURE OF 85 DEG F (ADJ.).
  3. ALL VAV BOXES SHALL OPEN TO 100% UNTIL OCCUPIED SET POINT TEMPERATURE IS ESTABLISHED. AS ZONES REACH OCCUPIED MODE SET POINT THEY SHALL MODULATE TO PREVENT OVERHEATING.
- F. MORNING COOL DOWN: THE UNIT SHALL OPERATE IN THE MORNING COOL DOWN MODE WHEN THE RETURN AIR TEMPERATURE IS ABOVE THE COOL DOWN MODE SET POINT, 75 DEG F (ADJ.), AS MEASURED BY THE RETURN AIR DUCT TEMPERATURE SENSOR.
  1. THE OA DAMPER AND RELIEF AIR DAMPER SHALL CLOSE TO 0% AND THE RETURN AIR DAMPER SHALL OPEN 100%.
  2. THE CHILLED WATER COIL VALVE SHALL MODULATE TO MAINTAIN A SUPPLY AIR TEMPERATURE OF 55 DEG F (ADJ.).
  3. ALL VAV BOXES SHALL OPEN TO 100% UNTIL OCCUPIED SET POINT TEMPERATURE IS ESTABLISHED. AS ZONES REACH OCCUPIED MODE SET POINT THEY SHALL MODULATE TO PREVENT OVER COOLING.
- G. SUPPLY FAN CONTROL: THE UNIT SUPPLY FAN SPEED SHALL MODULATE, THROUGH ITS VFD, TO MAINTAIN A SUPPLY DUCT STATIC PRESSURE BETWEEN 0.5" W.G. AND THE MAXIMUM STATIC PRESSURE DETERMINED FROM THE SYSTEM TAB (ADJ.).
  1. THE STATIC PRESSURE SET POINT SHALL BE RESET TO MAINTAIN THE VAV BOX CFM REQUIRING THE MOST STATIC PRESSURE AT 90% OPEN.
  2. ALL VAV BOX DAMPER POSITIONS SHALL BE CONTINUOUSLY POLLED TO DETERMINE THE VAV BOX THAT IN THE MOST OPEN.
  3. THE STATIC PRESSURE SENSOR SHALL BE LOCATED AS SHOWN ON MECHANICAL DRAWINGS BUT NOT LESS THAN THE DISTANCE OF THE LONGEST SUPPLY DUCT RUN.
  4. FINAL STATIC PRESSURE SET POINT SHALL BE DETERMINED DURING TESTING AND BALANCING OF THE SYSTEM.
- H. RETURN FAN CONTROL: THE SYSTEM RETURN FAN SHALL OPERATE WHEN THE ASSOCIATED SUPPLY FAN IS PROVEN ON. THE RETURN FAN SPEED SHALL MODULATE, THROUGH ITS VFD, TO MAINTAIN DISCHARGE STATIC PRESSURE AT SET POINT. THE STATIC PRESSURE SENSOR SHALL BE LOCATED APPROXIMATELY BETWEEN THE RETURN FAN DISCHARGE AND THE RELIEF DAMPER. THE RETURN FAN DISCHARGE STATIC PRESSURE SET POINT SHALL BE THE LARGER OF THE TWO FOLLOWING CONDITIONS.
  1. THE STATIC PRESSURE REQUIRED TO DELIVER THE DESIGN RETURN AIR VOLUME ACROSS THE RETURN DAMPER WHEN THE SUPPLY AIR FAN IS AT DESIGN AIRFLOW AND THE OUTSIDE AIR DAMPER IS SET TO ITS MINIMUM POSITION
  2. THE STATIC PRESSURE REQUIRED TO EXHAUST ENOUGH AIR TO MAINTAIN SPACE PRESSURE AT SET POINT (0.05" W.G. ADJ.) WHEN THE SUPPLY AIR FAN IS AT DESIGN AIR FLOW AND THE OUTSIDE AIR DAMPER IS AT 100% OUTSIDE AIR. SEE BUILDING PRESSURE CONTROL BELOW.
  3. FINAL STATIC PRESSURE SET POINT SHALL BE DETERMINED DURING TESTING AND BALANCING OF THE SYSTEM.
- I. BUILDING PRESSURE CONTROL: THE RELIEF/EXHAUST AIR DAMPER SHALL MODULATE TO MAINTAIN A BUILDING STATIC PRESSURE SET POINT OF 0.05" W.C. BUILDING STATIC PRESSURE SHALL BE TIME AVERAGED WITH A SLIDING FIVE MINUTE WINDOW.
- J. ECONOMIZER CONTROL: ECONOMIZER CYCLE OPERATION SHALL BE INTEGRATED WITH MECHANICAL COOLING TO ACT AS THE FIRST STAGE OF COOLING.
  1. THE ECONOMIZER CYCLE SHALL BE ENABLED WHEN THE OA ENTHALPY IS EQUAL TO OR LESS THAN 28 BTU/LB.
  2. OA DAMPER SHALL MODULATE BETWEEN MINIMUM POSITION AND 100% OPEN TO MAINTAIN SUPPLY AIR TEMPERATURE SET POINT OF 55 DEG F (ADJ.).
  3. THE RETURN AIR DAMPER SHALL OPERATE IN INDIRECT PROPORTION WITH THE OA DAMPER.
  4. IF THE DISCHARGE AIR TEMPERATURE RISES ABOVE THE SET POINT BY 1.5°F FOR 5 MIN. AND THE OUTSIDE DAMPER IS 100% OPEN THE COOLING COIL VALVE SHALL MODULATE OPEN.
- K. VENTILATION CONTROL: THE OA MINIMUM DAMPER POSITION SHALL BE DYNAMIC AND ESTABLISHED BY MODULATING THE RETURN AIR DAMPER TO MAINTAIN THE DIFFERENTIAL PRESSURE SET POINT ACROSS THE OUTSIDE AIR DAMPER. THE RETURN DAMPER SHALL MODULATE TO MAINTAIN THE SYSTEM MINIMUM VENTILATION RATE INDICATED IN THE AIR HANDLER SCHEDULE. T-A-B CONTRACTOR SHALL DETERMINE DP SET POINT.
- L. DISCHARGE AIR TEMPERATURE CONTROL:
  1. WHEN SUPPLY AIR TEMPERATURE RISES ABOVE THE 55 DEG F SET POINT (ADJ.), THE CHILLED WATER VALVE SHALL MODULATE OPEN TO MAINTAIN SET POINT.
  2. WHEN THE SUPPLY AIR TEMPERATURE DROPS BELOW THE 55 DEG F SET POINT (ADJ.), THE HOT WATER PREHEAT COIL VALVE SHALL MODULATE OPEN TO MAINTAIN SET POINT.
  3. THE HOT WATER PREHEAT VALVE SHALL BE DISABLED ABOVE OA TEMPERATURES OF 50 DEG F (ADJ.).



**A1 VAV AIR HANDLER CONTROL SCHEMATIC & SEQUENCE OF OPERATION**

NOT TO SCALE TYPICAL FOR RTU-1, RTU-2, RTU-3