CHILLED WATER SYSTEM SEQUENCE OF OPERATION:

NOTE: EXISTING CHILLED WATER SYSTEM SEQUENCE IS SHOWN SHADED. REQUIRED CHANGES ARE SHOWN IN BOLD.

A. GENERAL:

1. THE CHILLED WATER SYSTEM CONSISTS OF **TWO** AIR COOLED CHILLER**S** (**ONE** ADDITIONAL FUTURE AIR-COOLED CHILLER **IS** PLANNED) AND TWO VARIABLE SPEED PUMPS, EACH SIZED FOR 100% OF THE LOAD.

B. CHILLED WATER PUMPS:

1. BUILDING CHILLED WATER PUMPS ARE TO BE SEQUENCED AND CONTROLLED AS REQUIRED TO MAINTAIN THE REMOTE CHILLED WATER DIFFERENTIAL PRESSURE AT SETPOINT (ADJUSTABLE) TO BE DETERMINED BY TAB (TEST AND BALANCE) CONTRACTOR DURING BALANCING PROCEDURES. CHILLED WATER PUMPS SHALL BE SEQUENCED IN A STANDBY ARRANGEMENT. THE LEAD PUMP SHALL BE ALTERNATED ON A REGULAR BASIS TO EQUALIZE WEAR. IN THE EVENT THAT ONE PUMP FAILS, THE OTHER SHALL START AND MODULATE TO MAINTAIN THE PRESSURE SETPOINT. DURING CHANGE-OVER PERIODS FROM AIR-COOLED TO WATER-COOLED CHILLER OPERATIONS, THE CHILLED WATER PUMPS SHALL BE STOPPED. THE PUMPS SHALL RE-START UPON VERIFICATION OF PROPER CHILLER BYPASS VALVE OPERATION. IN THE EVENT OF IMPROPER CHILLER BYPASS VALVE OPERATION, AN ALARM SHALL BE GENERATED AT THE EMS WORKSTATION AND THE CHILLED WATER PUMPS SHALL REMAIN STOPPED.

C. CHILLER:

1. THE AIR COOLED CHILLER**S** SHALL BE PROVIDED WITH CONTROLLER CAPABLE OF STAND-ALONE OPERATION WITH FULL INTEGRATION WITH THE EMS (ENERGY MANAGEMENT SYSTEM). THE CHILLER SHALL BE MODULATED BY THE EMS TO MAINTAIN A LEAVING WATER TEMPERATURE EQUAL TO THE LEAVING AIR TEMPERATURE OF AHU-1 MINUS 10 DEGREES (ADJUSTABLE). (I.E. IF LEAVING AIR TEMPERATURE OF AHU-1 IS 55 DEGREES, THEN THE LEAVING WATER TEMPERATURE SHALL BE 45 DEGREES.) THE MINIMUM LEAVING WATER TEMPERATURE SHALL BE 41 DEGREES AND THE MAXIMUM SHALL BE 55 DEGREES.

D. THE CONTROL SYSTEM:

1. CONTROL SYSTEM SHALL MONITOR CHILLER PERCENT LOADING AND OPERATE CHILLER CH-1 AND CH-2 IN SEQUENCE TO MAINTAIN CHILLED WATER TEMPERATURE AND FLOW. THE AUTOMATIC CHILLED WATER ISOLATION VALVE ON CH-1 AND CH-2 SHALL BE CLOSED ANY TIME THE RESPECTIVE CHILLER IS NOT OPERATING.

E. CHILLER BYPASS:

1. THE AIR-COOLED CHILLER MAY BE BYPASSED IN FAVOR OF UTILIZING THE EXISTING WATER-COOLED CHILLERS CURRENTLY HANDLING THE EXISTING HOSPITAL LOAD IN PERIODS OF LOW UTILIZATION. THE EMS SYSTEM SHALL SHUT DOWN THE AIR-COOLED CHILLER, OPEN THE BYPASS VALVES LABELED "N.O.", AND SHALL CLOSE THE BYPASS VALVES LABELED "N.C." BASED ON OPERATOR COMMAND ENTERED AT EMS WORKSTATION. UPON OPERATOR COMMAND TO RETURN TO SERVICE UTILIZING AIR-COOLED CHILLER FOR COOLING, THE VALVES LABELED "N.O." SHALL OPEN, THE VALVES LABELED "N.C." SHALL CLOSE, AND THE AIR-COOLED CHILLER SHALL RE-START UPON PROOF OF FLOW TO MEET SETPOINTS.

F. BYPASS VALVE:

1. THE BYPASS VALVE SHALL BE MODULATED BY THE EMS TO MAINTAIN THE MINIMUM WATER FLOW THROUGH THE **CHILLERS** AS DETERMINED BY THE **MANUFACTURERS**. THE CHILLED WATER FLOW RATE SHALL BE DETERMINED BY THE DIFFERENTIAL PRESSURE ACROSS THE **CHILLERS**. WHILE IN THE CHILLER BYPASS MODE, THE CHILLED WATER BYPASS VALVE SHALL BE CLOSED.

EXHAUST FAN SEQUENCE OF OPERATION

A. EF-4 AND EF-5 OPERATING CONTROLS SHALL INCLUDE HAND-OFF-AUTO SWITCH AND MOTOR CURRENT CT.

B. EF-4 AND EF-5 SHALL OPERATE ONLY WHEN AHU-2 IS OPERATING IN OCCUPIED MODE.

C. EF-5 OPERATION SHALL BE INTERLOCKED TO AHU-2 SO THAT UPON AIR FLOW FAILURE IN AHU-2 DURING OCCUPIED MODE EF-5 SHALL ALSO TURN OFF.

D. THE CONTROL SYSTEM SHALL ALARM THE USER INTERFACE ANY TIME EF-4 OR EF-5 FAILS AS DETERMINED BY THE INDIVIDUAL CURRENT FAN MOTOR CURRENT TRANSDUCERS.

AUH-2 CONTROL SEQUENCE

A. SUPPLY FAN OPERATING, AND SAFETY CONTROLS SHALL INCLUDE:
1. WALL MOUNTED DISCONNECT
2. VARIABLE FREQUENCY MOTOR SPEED CONTROL DRIVE (VFD)
3. RETURN AIR SMOKE DETECTOR
4. SUPPLY AIR SMOKE DETECTOR
5. FREEZE PROTECTION THERMOSTAT
6. GENERAL FIRE ALARM CONTACT
7. DUCT OVER PRESSURE SWITCH

B. THE SMOKE DETECTORS, FREEZE PROTECTION THERMOSTAT, DUCT OVER PRESSURE SWITCH AND FIRE ALARM CONTACTOR SHALL BE HARD WIRED IN THE FAN MOTOR CONTROL CIRCUIT AND SHALL SEND A SIGNAL FROM AN AUXILIARY CONTACT TO THE DDC CONTROL SYSTEM. IN ADDITION, THE SMOKE DETECTORS SHALL SEND A SIGNAL TO THE BUILDING FIRE ALARM SYSTEM.

C. WITH THE SAFETY CONTROLS IN THE NORMAL POSITION AND THE VFD IN THE AUTO POSITION THE FAN MOTOR SHALL BE TURNED ON AND OFF BY THE DDC SYSTEM AS FOLLOWS:
1. USING A FIVE DAY OUTSIDE AIR TEMPERATURE PREDICTIVE ALGORITHM TURN ON THE FAN FAR ENOUGH IN ADVANCE TO ENSURE THAT ALL SPACES SERVED ARE AT SETPOINT WHEN NORMAL OCCUPANCY BEGINS. OCCUPANCY TIMES AND DATES SHALL BE VARIABLE AND SCHEDULED THROUGH THE CONTROL SYSTEM.
2. TURN ON THE FAN ANY TIME AT LEAST ONE SPACE TEMPERATURE SENSOR IS MEASURING A SPACE TEMPERATURE OF 85 F (ADJUSTABLE) OR HIGHER.
3. TURN ON THE FAN ANY TIME AT LEAST ONE SPACE TEMPERATURE SENSOR IS MEASURING A SPACE TEMPERATURE OF 60 F (ADJUSTABLE) OR LOWER.
4. TURN OFF FAN WHEN CONDITIONS C-2, AND C-3 ABOVE ARE NOT TRUE, AND THE BUILDING IS NOT OCCUPIED PER MOST RECENT OCCUPANCY SCHEDULE.

D. SUPPLY FAN AND CONTROLS INTERLOCK: WHENEVER THE SUPPLY FAN IS OFF AS INDICATED BY NO AIRFLOW, ALL CONTROL ACTUATORS SHALL BE PLACED IN THEIR NORMAL POSITION.

E. SUPPLY FAN SPEED CONTROL:
1. THE DDC SYSTEM SHALL MODULATE THE VFD OUTPUT TO MAINTAIN SUPPLY DUCT STATIC PRESSURE AT SETPOINT.
2. THE CONTROL SYSTEM SHALL RESET THE SUPPLY DUCT STATIC PRESSURE SETPOINT BASED ON THE POSITION OF THE VAV TERMINAL DAMPERS. EVERY 15 MINUTES (ADJUSTABLE) THE CONTROL SYSTEM SHALL LOWER THE SETPOINT BY 0.05" WG (ADJUSTABLE) IF AT LEAST ONE TERMINAL IS AT MINIMUM POSITION AND NO TERMINALS ARE FULLY OPEN. IF AT LEAST ONE TERMINAL IS FULLY OPEN THE CONTROL SYSTEM SHALL INCREASE THE SETPOINT BY 0.05" WG. (ADJUSTABLE).

F. MIXED AIR SECTION:
1. THE MIXED AIR SECTION SHALL OPERATE IN UNOCCUPIED MODE AND MINIMUM OUTSIDE AIR MODE.
2. WHEN IN UNOCCUPIED MODE THE OUTSIDE AIR DAMPER SHALL BE CLOSED.
3. THE SYSTEM SHALL BE IN UNOCCUPIED MODE WHEN THE FAN STARTS DURING UNOCCUPIED HOURS TO MAINTAIN MINIMUM AND MAXIMUM UNOCCUPIED SPACE TEMPERATURES AND WHEN THE SYSTEM STARTS UP IN THE MORNING TO GET THE SPACES TO OCCUPIED TEMPERATURE PRIOR TO THE ARRIVAL OF STAFF AND PATIENTS. AT ALL OTHER TIMES THE SYSTEM SHALL BE IN MINIMUM OUTSIDE AIR MODE.
4. WHEN IN MINIMUM OUTSIDE AIR MODE THE OUTSIDE AIR DAMPER SHALL OPEN TO A CALIBRATED MINIMUM OUTSIDE AIR POSITION, AND THE RETURN DAMPER SHALL MODULATE TO MAINTAIN THE MIXED AIR SECTION STATIC PRESSURE AT SETPOINT.
5. THE MIXED AIR SECTION STATIC PRESSURE SETPOINT AND OUTSIDE AIR DAMPER MINIMUM OUTSIDE AIR POSITION SHALL BE CALIBRATED AND ADJUSTED DURING TEST AND BALANCE USING DUCT TRAVERSES TO ENSURE THAT THE CONTROL SYSTEM CAN MAINTAIN MINIMUM SCHEDULED OUTSIDE AIR FLOW WHEN THE SUPPLY AIR IS AT SCHEDULE MAXIMUM AND MINIMUM FLOW.

G. HYDRONIC COOLING COIL:
1. THE CONTROL SYSTEM SHALL MODULATE THE COOLING COIL VALVE TO MAINTAIN SUPPLY AIR AT SETPOINT.
2. THE INITIAL SET POINT SHALL BE 52°F (ADJUSTABLE).

H. HYDRONIC PRE HEAT COIL:
1. THE CONTROL SYSTEM SHALL MODULATE THE PRE-HEAT COIL VALVE TO MAINTAIN SUPPLY AIR AT SETPOINT (ADJUSTABLE).
2. THE INITIAL SETPOINT SHALL BE 50°F.

I. FILTER MONITORING: THE CONTROL SYSTEM SHALL MONITOR AIR PRESSURE DROP ACROSS THE FILTERS AND RESPOND AS FOLLOWS:
1. ALARM WHEN FILTER PRESSURE DROP EXCEEDS MANUFACTURER'S LIMIT. LIMIT TO BE DETERMINED FROM FILTER AND AIR HANDLING UNIT SUBMITTALS AND UPDATED IN CONTROL CONTRACTOR'S SEQUENCE OF CONTROL.
2. ALARM WHEN FILTER PRESSURE DROP INDICATES THAT A FILTER IS MISSING FROM THE RACK. SETPOINT PRESSURE TO BE DETERMINED DURING TEST AND BALANCE BY REMOVAL OF A FILTER FROM THE RACK.

J. ALARMS: THE CONTROL SYSTEM SHALL ALARM THE USER INTERFACE AND TAKE THE INDICATED ACTIONS WHENEVER ANY OF THE FOLLOWING CONDITIONS OCCURS:
1. COOLING COIL OR HEATING COIL LEAVING AIR TEMPERATURE NOT AT SETPOINT FOR FIVE MINUTES (ADJUSTABLE) OR LONGER.
2. SUPPLY DUCT STATIC PRESSURE NOT AT SETPOINT FOR 5 MINUTES (ADJUSTABLE) OR LONGER.
3. WHEN THE SUPPLY FAN IS OPERATING IN MANUAL OVERRIDE AS DETERMINED BY FAN OPERATION OUTSIDE THE CONTROL OF THE CONTROL SYSTEM.
4. TURN OFF FAN WHEN SUPPLY STATIC PRESSURE AS MEASURED BY DISCHARGE STATIC PRESSURE SENSOR EXCEEDS 3.5" WG (ADJUSTABLE).
5. ALARM USER INTERFACE IF "IT" ROOM TEMPERATURE IS 96°F OR HIGHER.
6. ALARM USER INTERFACE IF ELEVATOR MACHINE ROOM TEMPERATURE IS 87°F OR HIGHER.
7. ALARM USER INTERFACE IF ELECTRICAL EQUIPMENT ROOM TEMPERATURE IS 95°F OR HIGHER.

K. VAV TERMINALS SEQUENCE OF CONTROLS
1. THE PRIMARY AIR VALVE SHALL BE MODULATED TO MAINTAIN PRIMARY AIR FLOW AT SETPOINT. THE SETPOINT SHALL BE FULL SCHEDULED FLOW WHEN SPACE TEMPERATURE IS 2 DEGREES F ABOVE
2. TEMPERATURE SETPOINT AND MINIMUM SCHEDULED AIR FLOW WHEN SPACE TEMPERATURE IS 2
3. DEGREES F BELOW TEMPERATURE SETPOINT.
4. THE REHEAT VALVE SHALL BE SEQUENCED TO OPEN WHEN AIR FLOW IS AT MINIMUM AND SHALL MODULATE TO MAINTAIN SPACE TEMPERATURE AT HEATING SETPOINT.
5. THERE SHALL BE A 4 DEGREE F DEAD BAND BETWEEN HEATING AND COOLING SETPOINT.
6. THE CONTROL SYSTEM SHALL MONITOR AND DISPLAY VAV TERMINAL DISCHARGE AIR TEMPERATURE.

FAN COIL UNIT CONTROL SEQUENCE

A. THE FAN COIL UNIT TERMINAL EQUIPMENT CONTROLLER (TEC) SHALL MODULATE THE HEATING AND COOLING COIL VALVES IN SEQUENCE TO MAINTAIN SPACE TEMPERATURE AT SETPOINT.
B. THE DDC CONTROL SYSTEM SHALL ALARM THE SYSTEM USER INTERFACE IF SPACE TEMPERATURE IS 80°F OR ABOVE OR 69°F OR BELOW (BOTH ADJUSTABLE).
C. THE DDC CONTROL SYSTEM SHALL MONITOR AND DISPLAY THE FAN COIL UNIT SUPPLY AIR TEMPERATURE.

RTU-1 ROOF TOP UNIT CONTROL SEQUENCE

A. THE RTU-1 TERMINAL EQUIPMENT CONTROLLER (TEC) SHALL CYCLE THE SUPPLY FAN AND COMPRESSOR TO MAINTAIN THE ELEVATOR MACHINE ROOM TEMPERATURE AT 75°F (ADJUSTABLE).
B. THE DDC CONTROL SYSTEM SHALL ALARM THE USER INTERFACE IF SPACE TEMPERATURE IS 78°F OR ABOVE (ADJUSTABLE).
C. THE DDC CONTROL SYSTEM SHALL MONITOR AND DISPLAY THE RTU-1 SUPPLY AIR TEMPERATURE.

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