

SEQUENCE OF OPERATION

EXISTING AIR COOLED ROOFTOP UNIT – MULTI-ZONE CONSTANT AIR VOLUME WITH BYPASS AND ZONE DAMPER VVT SYSTEM:

- OCCUPANCY SCHEDULE: A TIME OF DAY SCHEDULE SHALL BE CONFIGURED AT THE BUILDING MANAGEMENT SYSTEM (BMS) REFLECTING BUILDING OCCUPANCY WITH OCCUPIED AND UNOCCUPIED OPERATIONAL MODES. OCCUPIED AND UNOCCUPIED MODE SCHEDULES SHALL BE ADJUSTABLE. THE CONTROL CONTRACTOR SHALL COORDINATE SCHEDULING REQUIREMENTS WITH THE OWNER.
- START/STOP: A HAND-OFF-AUTO (H-O-A) SWITCH SHALL BE PROVIDED FOR LOCAL CONTROL OF THE ROOFTOP UNIT (RTU) SUPPLY FAN (SF) START/STOP OPERATION. IN THE HAND POSITION THE RTU SHALL STOP. IN THE AUTO POSITION THE RTU SF SHALL START EITHER IN THE OCCUPIED MODE OR WHEN SPACE CONDITIONS EXCEED THE SETPOINT/BACKTRACK TEMPERATURE AND/OR HUMIDITY SETPOINTS IN THE UNOCCUPIED MODE.
- OPTIMUM START: AN OPTIMUM START ROUTINE SHALL BE PROVIDED THAT ADJUSTS THE OCCUPIED MODE START TIME OF THE RTU. THE BMS SHALL CALCULATE AN OPTIMUM START TIME BASED UPON THE OUTDOOR TEMPERATURE, ZONE TEMPERATURES, AND HISTORICAL OPERATING DATA. FOR EACH DAY WHERE OCCUPIED PERIODS ARE SCHEDULED, THE PROGRAM SHALL CALCULATE THE START TIME IN ORDER TO REACH THE COOLING SPACE SETPOINT TEMPERATURE CONDITIONS AT THE BEGINNING OF THE OCCUPIED MODE. DURING THIS PERIOD, THE RTU SHALL BE IN COOLING SPACE TEMPERATURE SETPOINT MODE.
- UNOCCUPIED MODE OVERRIDE: A TIMED LOCAL OVERRIDE (TLO) SHALL BE AVAILABLE VIA THE OPERATOR'S WORKSTATION AND ON ZONE SPACE TEMPERATURE SENSORS (ADJUSTABLE). WHEN THE HOA SWITCH IS IN THE AUTO POSITION AND THE UNIT IS IN THE UNOCCUPIED MODE, THE TLO SHALL FUNCTION TO PLACE THE RTU IN THE OCCUPIED MODE FOR 2 HOURS (ADJUSTABLE).
- PREVENT FAN FROM RUNNING WHILE THE HEATING/COOLING CONTROL MODE OR INDIVIDUAL ZONES SHALL BE DETERMINED BY THE ZONE DAMPER APPLICATION SPECIFIC CONTROLLER (ASC). THE ZONE DAMPER HEATING/COOLING MODE OF THE HEATING/COOLING CONTROL MODE OR INDIVIDUAL ZONES SHALL BE DETERMINED BY THE ZONE DAMPER APPLICATION SPECIFIC CONTROLLER (ASC). THE CAC SHALL BROADCAST THE SYSTEM SUPPLY AIR TEMPERATURE TO THE ZONE ASC EVERY 15 SECONDS (ADJUSTABLE). THE ZONE ASC SHALL COMPARE THE BROADCAST SYSTEM SUPPLY AIR TEMPERATURE TO ZONE SPACE TEMPERATURE AND ZONE SPACE TEMPERATURE SETPOINT.
- SYSTEM HEATING/COOLING MODE: THE SYSTEM HEATING/COOLING MODE OF THE ZONE DAMPER ASC SHALL BE DETERMINED AS FOLLOWS:
 - ≥ THE ZONE SPACE TEMPERATURE THE ZONE CONTROL MODE IS COOLING.
 - ≥ THE ZONE SPACE TEMPERATURE + 10°F (ADJUSTABLE) THE ZONE CONTROL MODE IS HEATING.
 - IF THE SYSTEM SUPPLY AIR TEMPERATURE IS BETWEEN THE ZONE SPACE TEMPERATURE AND ZONE SPACE TEMPERATURE + 10°F (ADJUSTABLE), AND THE ZONE SPACE TEMPERATURE IS:
 - ≥ THE COOLING SPACE TEMPERATURE SETPOINT THE CONTROL MODE IS HEATING.
 - ≥ THE COOLING SPACE TEMPERATURE SETPOINT THE CONTROL MODE IS COOLING.
 - < THE HEATING SPACE TEMPERATURE SETPOINT THE CONTROL MODE IS COOLING.
 - BETWEEN THE HEATING AND COOLING SPACE TEMPERATURE SETPOINTS THE CONTROL ACTION DOES NOT CHANGE.
- SYSTEM HEATING OR COOLING MODE ZONE VOTING: EACH ZONE DAMPER ASC SHALL HAVE ONE VOTE (ADJUSTABLE). THE ZONE DAMPER ASC SHALL BE ELIGIBLE TO VOTE OR BE RESTRICTED FROM VOTING. A VOTING RESTRICTED ZONE CONTINUES TO OPERATE AND COMMUNICATE NORMALLY. RESTRICTED AND UNRESTRICTED ZONE VOTING STATUS SHALL BE DISPLAYED ON THE SYSTEM GRAPHIC.
 - A ZONE SHALL BE ELIGIBLE TO VOTE IF:
 - IT IS IN COOLING SPACE TEMPERATURE SETPOINT MODE.
 - THE ZONE HAS A VALID ZONE SPACE TEMPERATURE READING.
 - IT IS NOT TAGGED FOR NO VOTE BY THE CAC.
 - A ZONE SHALL BE RESTRICTED FROM VOTING IF:
 - THE SYSTEM IS NOT IN MORNING WARM-UP OR PRECOOL MODES.
 - THE ZONE IS RECEIVING THE COMMANDED SUPPLY AIRFLOW.
 - THE ZONE SPACE TEMPERATURE IS FURTHER AWAY FROM SETPOINT OF ALL VOTING ZONES RECEIVING THE COMMANDED SUPPLY AIRFLOW.
 - THE ZONE SPACE TEMPERATURE IS > 3°F (ADJUSTABLE) FROM THE ZONE SPACE TEMPERATURE SETPOINT FOR 60 MINUTES (ADJUSTABLE).
 - A VOTE RESTRICTED ZONE SHALL BE MADE ELIGIBLE FOR VOTING IF:
 - THE ZONE RETURNS TO WITHIN 1°F (ADJUSTABLE) OF ITS ACTIVE SPACE TEMPERATURE SETPOINT.
 - THE SYSTEM ENTERS THE UNOCCUPIED MODE.
 - SYSTEM HEATING/COOLING MODE ZONE CALLS: AFTER THE ZONE HEATING/COOLING MODE OF THE ZONE DAMPER ASC IS INITIATED, THE STRENGTH OF ITS CALL FOR HEATING OR COOLING SHALL BE DETERMINED AS FOLLOWS:
 - CALL FOR COOLING: A ZONE OBTAINS A CALL FOR COOLING STATUS IF IT IS ELIGIBLE TO VOTE, AND ITS ZONE SPACE TEMPERATURE IS > 1°F (ADJUSTABLE) ABOVE THE ACTIVE COOLING SPACE TEMPERATURE SETPOINT. A ZONE LOSES ITS CALL FOR COOLING STATUS IF IT BECOMES A RESTRICTED VOTER OR IF ITS ZONE SPACE TEMPERATURE IS < THE ACTIVE COOLING SPACE TEMPERATURE SETPOINT + 0.5°F (ADJUSTABLE).
 - STRONG CALL FOR COOLING: A ZONE OBTAINS A STRONG CALL FOR COOLING STATUS IF IT IS ELIGIBLE TO VOTE, AND ITS ZONE SPACE TEMPERATURE IS > 2°F (ADJUSTABLE) ABOVE THE ACTIVE COOLING SPACE TEMPERATURE SETPOINT. A ZONE LOSES ITS STRONG CALL FOR COOLING CALLER STATUS IF IT BECOMES A RESTRICTED VOTER OR IF ZONE SPACE TEMPERATURE IS < THE ACTIVE COOLING SPACE TEMPERATURE SETPOINT + 1°F (ADJUSTABLE).
 - CALL FOR HEATING: A ZONE OBTAINS A CALL FOR HEATING STATUS IF IT IS ELIGIBLE TO VOTE, AND ITS ZONE SPACE TEMPERATURE IS > 1°F (ADJUSTABLE) BELOW THE ACTIVE HEATING SPACE TEMPERATURE SETPOINT. A ZONE LOSES ITS CALL FOR HEAT STATUS IF IT BECOMES A RESTRICTED VOTER OR IF ITS ZONE SPACE TEMPERATURE IS > THE ACTIVE HEATING SPACE TEMPERATURE SETPOINT - 0.5°F (ADJUSTABLE).
 - STRONG CALL FOR HEATING: A ZONE WITHOUT LIMITATION, OBTAINS A STRONG CALL FOR HEAT STATUS IF IT IS ELIGIBLE TO VOTE, AND ITS ZONE SPACE TEMPERATURE IS > 2°F (ADJUSTABLE) BELOW THE ACTIVE HEATING SPACE TEMPERATURE SETPOINT. A ZONE LOSES ITS STRONG CALL FOR HEAT STATUS IF IT BECOMES A RESTRICTED VOTER OR IF ITS ZONE SPACE TEMPERATURE IS > THE ACTIVE HEATING SPACE TEMPERATURE SETPOINT - 1°F (ADJUSTABLE).
 - SYSTEM HEATING AND COOLING MODES: WHEN THE OCCUPIED MODE INITIATES, THE INITIAL SYSTEM HEATING OR COOLING MODE SHALL BE DETERMINED BY THE OUTDOOR DEWPOINT TEMPERATURE. QUALITY OUTDOOR AIR SHALL BE USED TO CALCULATE THE OUTDOOR AIR DEWPOINT TEMPERATURE. THE COOLING MODE SHALL BE ACTIVE WHEN THE DEWPOINT TEMPERATURE IS 50°F (ADJUSTABLE) OR GREATER AND THE HEATING MODE SHALL BE ACTIVE WHEN THE DEWPOINT IS BELOW 50°F (ADJUSTABLE). AFTER THE INITIAL HEATING/COOLING MODE IS DETERMINED, THE CAC SHALL SCAN ALL ZONES CONTINUOUSLY (ONCE EVERY 15 SECONDS – ADJUSTABLE) AND DETERMINE THE QUANTITY AND WEIGHT OF ALL ZONE CALLS FOR HEATING AND COOLING VOTING. THE GREATER NUMBER OF VOTES SHALL DETERMINE THE SYSTEM HEATING/COOLING MODE. THE CAC SHALL REQUIRE A MINIMUM OF 2 (ADJUSTABLE) OPPOSITE CALLS TO CHANGE OVER AND ALL CURRENT CALLERS MUST BE SATISFIED BEFORE THE SYSTEM CHANGES FROM THE CURRENT HEATING/COOLING MODE. HEATING/COOLING CHANGEOVER SHALL ALSO OCCUR IF ENOUGH VOTES FOR A STRONG CALL FOR HEATING OR COOLING ARE OBTAINED. ALL CURRENT CALLERS DO NOT HAVE TO BE SATISFIED BEFORE THE SYSTEM IS ALLOWED TO CHANGE OVER. A 15 MINUTE (ADJUSTABLE) MINIMUM RUN TIME BETWEEN CHANGE OVER SHALL BE PROVIDED. THE MINIMUM CHANGE OVER RUN TIME ELAPSED SHALL BE DISPLAYED ON THE SYSTEM GRAPHIC.
 - SPACE TEMPERATURE SETPOINTS: THERE SHALL BE SEPARATE OCCUPIED AND UNOCCUPIED MODE COOLING AND HEATING SPACE TEMPERATURE SETPOINTS.
 - REFER TO THE DESIGN CONDITIONS SCHEDULE FOR SETPOINT VALUES.
 - SPACE HUMIDITY SETPOINTS: THERE SHALL BE SEPARATE OCCUPIED AND UNOCCUPIED MODE HUMIDITY SETPOINTS.
 - THE OCCUPIED MODE SETPOINT SHALL BE 60% RH (ADJUSTABLE).
 - THE UNOCCUPIED MODE SETPOINT SHALL BE 55% RH (ADJUSTABLE).
 - SUPPLY FAN CONTROL: FAN SPEED SHALL BE CONTROLLED TO MEET COOLING DEW POINT MODE REQUIRED TWO STAGE HIGH/LOW FAN SPEED AIR VOLUME CONTROL AND CONSTANT AIR VOLUME AT HIGH/LOW STAGED AIR VOLUME SETPOINTS AS FILTERS LOAD FROM A CLEAN TO A DIRTY CONDITION AT THE FAN SPEED STAGE AND MAINTAIN ZONE DAMPER DUCT STATIC PRESSURE.
 - A STARTER/VFD/ECM SHALL CONTROL FAN AIR VOLUME AT HIGH/LOW FAN SPEED SETPOINTS FOR COOLING SPACE TEMPERATURE CONTROL.
 - A FANFLOW SWITCH SHALL BE INSTALLED TO MONITOR FANFLOW. THE FANFLOW SWITCH SHALL PROVIDE AN INPUT SIGNAL TO THE CAC. THE CAC SHALL UTILIZE THE INPUT SIGNAL TO PROVIDE AN ANALOG SIGNAL TO THE VFD/ECM FOR CONTROL OF FAN SPEED TO MAINTAIN THE SA AIR FLOW SETPOINT AS FILTERS LOAD FROM A CLEAN TO DIRTY CONDITION AT THE FAN SPEED STAGE. WHEN AIRFLOW FALLS BELOW SETPOINT FAN SPEED SHALL SLOWLY INCREASE TO MAINTAIN SETPOINT. WHEN AIRFLOW RISES ABOVE SETPOINT, FAN SPEED SHALL SLOWLY DECREASE TO MAINTAIN SETPOINT.
 - A DIRECT MOUNTED AIR FLOW SENSOR SHALL BE LOCATED IN THE SUPPLY AIR DUCT DOWNSTREAM OF THE FIRST BYPASS DAMPER BUT UPSTREAM OF THE FIRST ZONE DAMPER ZONE SHALL PROVIDE AN INPUT SIGNAL TO THE CAC AND THE CAC SHALL UTILIZE THE INPUT SIGNAL TO MODULATE THE BYPASS DAMPER OPEN AND CLOSED AND MAINTAIN DAMPER ZONE DUCT PRESSURE SETPOINT.
 - THE TEST AND BALANCE CONTRACTOR SHALL DETERMINE THE INITIAL HIGH/LOW SPEED SF VFD SETPOINTS AND CORRESPONDING DUCT STATIC PRESSURE SETPOINTS WITH CLEAN FILTERS.
 - DEHUMIDIFICATION MODE CONTROL:
 - GENERAL: IN THE COOLING MODE, THE COOLING CONTROL SEQUENCE SHALL BE INITIATED. WHEN THE RTU SF IS PROVED OPERATIONAL, A COIL LEAVING AIR TEMPERATURE SENSOR SHALL BE UTILIZED TO MAINTAIN A CONSTANT LEAVING AIR TEMPERATURE SETPOINT (SEE EQUIPMENT SCHEDULE). THE COOLING MODE SHALL REMAIN ACTIVE UNTIL THE HEATING MODE IS INITIATED.
 - COOLING CAPACITY CONTROL: CONDENSING SECTION CAPACITY AND SUPPLY FAN HIGH/LOW AIR VOLUME STAGING SHALL BE CONTROLLED TO MAINTAIN SETPOINT. THE INITIAL SF SPEED SETPOINT SHALL BE HIGH. WHEN THE SPACE HUMIDITY LEVEL IS BELOW SETPOINT, THE SF SHALL SLOWLY STAGE UPWARD IN CAPACITY STEPS UNTIL THE SPACE HUMIDITY LEVEL IS PROPORTIONAL TO THE OFFSET BETWEEN LEAVING AIR TEMPERATURE SETPOINT AND THE LEAVING AIR TEMPERATURE. WHEN THE LEAVING AIR TEMPERATURE FALLS TOWARDS SETPOINT, CAPACITY STEPS SHALL BE SLOWLY STAGED OFF IN PROPORTION TO THE OFFSET BETWEEN THE LEAVING AIR TEMPERATURE SETPOINT AND THE LEAVING AIR TEMPERATURE. THE SF LOW SPEED SETPOINT SHALL BE THE LAST STAGE OF SYSTEM STAGING CONTROL. THE CU OFF BYPASS SHALL PROVIDE INHERENT MODULATING CAPACITY CONTROL BETWEEN CU FIRST STAGE AND CU OFF CAPACITY STAGES. THE COOLING MODE SHALL REMAIN ACTIVE AND THE CU REMAINS IN THE STAGING MODE UNTIL HEATING MODE IS INITIATED.
 - DEHUMIDIFICATION MODE CONTROL:
 - GENERAL: IN THE UNOCCUPIED COOLING MODE, THE SPACE HUMIDITY LEVEL SHALL BE MONITORED. IF A HIGH HUMIDITY CONDITION IS INDICATED FOR AT LEAST 15 MINUTES (ADJUSTABLE), THE DEHUMIDIFICATION SEQUENCE SHALL BE INITIATED.
 - REHEAT CONTROL: MAXIMUM CONDENSING SECTION STAGING SHALL BE ENABLED AND ELECTRIC HEAT IN THE REHEAT POSITION SHALL MODULATE OR STAGE CAPACITY (SEE HEATING SPACE TEMPERATURE CONTROL) TO MAINTAIN A 70°F SPACE TEMPERATURE SETPOINT UNTIL THE SPACE HUMIDITY FALLS BELOW SETPOINT. THE SYSTEM SHALL EXIT THE DEHUMIDIFICATION MODE WHEN THE SPACE HUMIDITY LEVEL IS BELOW SETPOINT FOR 30 MINUTES (ADJUSTABLE). IF THE SPACE HUMIDITY LEVEL HAS NOT RETURNED TO NORMAL AFTER 1 HOUR (ADJUSTABLE), AN ALARM SHALL BE GENERATED INDICATING THIS CONDITION.
 - UNOCCUPIED MODE:
 - GENERAL: IN THE UNOCCUPIED COOLING MODE, THE SPACE HUMIDITY LEVEL SHALL BE MONITORED. IF A HIGH HUMIDITY CONDITION IS INDICATED FOR AT LEAST 15 MINUTES (ADJUSTABLE) AND THE RTU HAS BEEN IN AT LEAST 1 HOUR (ADJUSTABLE) SINCE ENTERING THE UNOCCUPIED MODE, THE DEHUMIDIFICATION MODE SHALL BE INITIATED.
 - REHEAT CONTROL: MAXIMUM CONDENSING SECTION STAGING SHALL BE ENABLED AND ELECTRIC HEAT IN THE REHEAT POSITION SHALL MODULATE OR STAGE CAPACITY (SEE HEATING SPACE TEMPERATURE CONTROL) TO MAINTAIN A 70°F SPACE TEMPERATURE SETPOINT UNTIL THE SPACE HUMIDITY FALLS BELOW SETPOINT. THE SYSTEM SHALL EXIT THE DEHUMIDIFICATION SEQUENCE WHEN THE SPACE HUMIDITY LEVEL IS BELOW SETPOINT FOR 30 MINUTES (ADJUSTABLE). IF THE HIGH HUMIDITY LEVEL HAS NOT RETURNED TO NORMAL AFTER 2 HOURS (ADJUSTABLE), THEN AN ALARM SHALL BE GENERATED.
 - AN ADDITIONAL ALARM SHALL BE PROVIDED IF SPACE HUMIDITY DOES NOT RETURN TO ACCEPTABLE LEVELS FOR A PERIOD OF 24 CONTINUOUS HOURS.
 - A LEAVING AIR TEMPERATURE SENSOR SHALL MONITOR ELECTRIC HEAT LEAVING AIR TEMPERATURE (SEE EQUIPMENT SCHEDULE FOR THE MAXIMUM LEAVING AIR TEMPERATURE).
 - HEATING MODE CONTROL:
 - GENERAL: IN THE HEATING MODE, WHEN THE RTU SF IS PROVED OPERATIONAL AND THE SPACE TEMPERATURE FALLS BELOW THE HEATING SPACE TEMPERATURE SETPOINT, THE HEATING MODE SHALL BE INITIATED. THE SF SPEED SETPOINT SHALL BE AT HIGH SPEED TO LIMIT SUPPLY AIR TEMPERATURE NO GREATER THAN 85°F. THE HEATING MODE SHALL REMAIN ACTIVE UNTIL THE COOLING MODE IS INITIATED. ELECTRIC HEAT (EH) CAPACITY MAY BE SCHEDULED AS EITHER MODULATING OR STAGED PER THE EQUIPMENT SCHEDULE.
 - MODULATING HEAT: WHEN THE SPACE TEMPERATURE RISES TOWARDS SETPOINT, EH CAPACITY SHALL BE SLOWLY MODULATED TOWARDS 100% CAPACITY TO MAINTAIN SETPOINT. WHEN THE SPACE TEMPERATURE RISES TOWARDS SETPOINT, EH CAPACITY SHALL BE SLOWLY MODULATED TOWARDS OR CAPACITY. WHEN THE SPACE TEMPERATURE RISES ABOVE THE SETPOINT, THE EH SHALL BE DISABLED.
 - STAGED HEAT: WHEN THE SPACE TEMPERATURE FALLS BELOW SETPOINT, THE EH SHALL BE ENABLED AND EH CAPACITY STAGED UPWARD IN CAPACITY STEPS IN PROPORTION TO THE OFFSET BETWEEN THE SPACE TEMPERATURE SETPOINT AND THE SPACE TEMPERATURE. WHEN THE SPACE TEMPERATURE RISES TOWARDS SETPOINT, EH CAPACITY STEPS SHALL BE STAGED OFF IN PROPORTION TO THE OFFSET BETWEEN THE SPACE TEMPERATURE SETPOINT AND THE SPACE TEMPERATURE. WHEN THE SPACE TEMPERATURE RISES ABOVE SETPOINT THE EH SHALL BE DISABLED.
 - VENTILATION OUTDOOR AIR FLOW CONTROL: WHEN THE RTU SF IS OFF, THE OUTDOOR AIR DAMPER SHALL CLOSE. WHEN THE RTU SF IS PROVED OPER

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