

HOT WATER BOILER PLANT SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH & INSTALL ALL FIELD WIRING, CONTROLLERS, CONTROL PANELS, ETC. AS REQUIRED FOR OPERATION BELOW.
2. THE BUILDING MANAGEMENT SYSTEM (BMS) SHALL CONTROL, MONITOR, AND AUTOMATE THE OPERATION OF THE HEATING HOT WATER SYSTEM. THE SYSTEM CONSISTS OF TWO (2) LOW-PRESSURE CONDENSING HOT-WATER BOILERS & TWO (2) VARIABLE-SPEED HOT WATER PUMPS WITH VFD'S.
3. THE BOILERS SHALL OPERATE UNDER THE FACTORY MOUNTED CONTROLS. THE FACTORY CONTROLLER SHALL HANDLE EQUIPMENT LEVEL PARAMETERS SUCH AS FIRING RATE, DAMPER POSITION, BLOWER CONTROL, SAFETIES, ETC. THE CONTROLLER SHALL BE CAPABLE OF HANDLING MULTIPLE BOILERS IN THE ARRAY TO DETERMINE THE OPTIMAL MODE OF OPERATION FOR EFFICIENCY AND LONGEVITY.
4. THE BOILER CONTROLLER SHALL RECEIVE INPUTS FROM THE BMS FOR PARAMETERS INCLUDING, AT MINIMUM:
 - a. BOILER CONTROL SYSTEM START/STOP
 - b. HOT WATER SUPPLY TEMPERATURE SETPOINT
5. THE BOILER CONTROLLER SHALL SEND BACK TO THE BMS ALL AVAILABLE ONBOARD DATA POINTS FROM THE BOILERS.
6. SEQUENCE OF OPERATION:
 - a. THE LEAD BOILER SHALL BE INDEXED ON WHEN OUTSIDE AIR TEMPERATURE FALLS BELOW 50°F (ADJ.) OR THROUGH BMS COMMAND.
 - b. UPON A COMMAND TO ENABLE THE HOT WATER SYSTEM, THE LEAD BOILER SEQUENCING VALVE SHALL OPEN AND THE LEAD HOT WATER PUMP SHALL BE ENERGIZED.
 - c. WHEN SEQUENCING VALVE STATUS IS PROVEN, THE BMS SHALL ENABLE THE LEAD BOILER PACKAGED CONTROLS.
 - d. THE LEAD BOILER PACKAGED CONTROLS SHALL CONTROL TO MAINTAIN THE HOT WATER SUPPLY TEMPERATURE SETPOINT. THE BMS SHALL HAVE THE CAPABILITY OF ADJUSTING THE HOT WATER SUPPLY TEMPERATURE SETPOINT VIA INTERFACE TO THE PACKAGED BOILER CONTROL PANEL.
 - e. THE HOT WATER SUPPLY TEMPERATURE SETPOINT SHALL BE RESET LINEARLY FROM 100°F (ADJ.) TO 150°F (ADJ.) AS THE OUTSIDE AIR TEMPERATURE FALLS FROM 60°F (ADJ.) TO 0°F (ADJ.).
 - f. IF THE HOT WATER SUPPLY TEMPERATURE FALLS BELOW SETPOINT FOR A PERIOD OF 30 MINUTES (ADJ.), THE LAG BOILER WILL BE ENABLED.
 - g. UPON A COMMAND TO ENABLE THE LAG BOILER, THE ASSOCIATED LAG BOILER SEQUENCING VALVE SHALL OPEN LAG HOT WATER PUMP SHALL ENABLE.
 - h. WHEN SEQUENCING VALVE POSITION AND PUMP FLOW IS PROVEN, THE BMS SHALL ENABLE THE LAG BOILER PACKAGED CONTROLS.
 - i. THE BOILER PACKAGED CONTROLS SHALL CONTROL TO MAINTAIN THE HOT WATER SUPPLY TEMPERATURE SETPOINT.
 - j. IF BOTH BOILERS (LEAD AND LAG) ARE ENABLED AND THE HOT WATER LOAD FALLS BELOW THE HEATING CAPABILITIES OF THE LEAD BOILER FOR A PERIOD OF 30 MINUTES (ADJ.), THE LAG BOILER SHALL BE DISABLED. ONCE THE LAG BOILER HAS BEEN DISABLED, THE ASSOCIATED LAG HOT WATER PUMP SHALL BE DE-ENERGIZED.
 - k. THE BOILERS SHALL OPERATE WITH A LEAD/LAG PROGRAM. THE LEAD BOILER SHALL BE THE BOILER WITH THE LOWER RUNTIME HOURS. THE LEAD AND LAG BOILERS SHALL BE INDEXED ON A WEEKLY BASIS AT A MINIMUM (ADJ.). FACILITY PERSONNEL SHALL HAVE THE ABILITY TO OVERRIDE THE PRIORITY OF EACH BOILER.
 - l. AT ANY TIME A BOILER COMMON ALARM IS INDICATED, AN ALARM SHALL BE GENERATED ON THE BMS THAT NOTIFIES THE BMS OPERATOR OF THE SPECIFIC BOILER THAT HAS FAILED AND THAT BOILER AND THE ASSOCIATED HOT WATER PUMP SHALL BE COMMANDED OFF. IF THE FAILED BOILER IS THE LEAD BOILER, THE LAG BOILER SHALL BECOME THE LEAD. IF THE FAILED BOILER IS THE LAG BOILER, THE LAG BOILER SHALL BE LOCKED OUT.
 - m. EACH HOT WATER PUMP SHALL BE DEDICATED TO ONE (1) OF THE BOILERS. AT ANY TIME A PUMP COMMAND DOES NOT EQUAL A PUMP STATUS, EXCEPT IMMEDIATELY AFTER STARTUP, A PUMP FAILURE ALARM SHALL BE GENERATED ON THE BMS THAT NOTIFIES THE BMS OPERATOR OF THE SPECIFIC PUMP THAT HAS FAILED AND THAT PUMP AND THE ASSOCIATED BOILER SHALL BE COMMANDED OFF. THE BMS SHALL WAIT 30 SECONDS AFTER STARTUP TO SEE THE PUMP STATUS CHANGE BEFORE INDICATING A PUMP FAILURE ALARM. IF THE FAILED PUMP IS ASSOCIATED WITH THE LEAD BOILER, THE LAG BOILER SHALL BECOME THE LEAD. IF THE FAILED PUMP IS ASSOCIATED WITH THE LAG BOILER, THE LAG BOILER SHALL BE LOCKED OUT.
 - n. HOT WATER PUMP CONTROL: THE LEAD HOT WATER PUMP SHALL BE ENERGIZED ANY TIME EITHER BOILER IS ENABLED.
 - o. THE LEAD HOT WATER PUMP VFD SHALL MODULATE AS NECESSARY TO MAINTAIN THE SYSTEM DIFFERENTIAL PRESSURE SETPOINT (ADJ.) UPON HOT WATER SYSTEM START UP. ALL HEATING LOOP BYPASS VALVES (3) SHALL BE CLOSED. THE VARIABLE FREQUENCY DRIVE SHALL START AT 0% AND SLOWLY RAMP UP TO SPEED AS REQUIRED BY THE DIFFERENTIAL PRESSURE SENSORS. DIFFERENTIAL PRESSURE SENSORS SHALL BE LOCATED AT THE END OF EACH HEATING LOOP AS SHOWN ON THE MECHANICAL PLANS. THE BMS SHALL MAINTAIN EACH SENSOR AT SETPOINT (I.E., THE SENSOR WITH THE LOWEST READING SHALL BE THE CONTROLLING SENSOR). EACH DIFFERENTIAL PRESSURE SENSOR SHALL BE WIRED TO THE DDC CONTROLLER IN THE AREA AND SHALL BE COMMUNICATED VIA BACNET BACK TO THE MAIN BOILER PLANT CONTROLLER. IF THE VFD IS CONTROLLING AT THE MINIMUM ALLOWED LEVEL, THE RESPECTIVE BYPASS VALVE (CONTROLLING DIFFERENTIAL PRESSURE SENSOR) SHALL BE MODULATED OPEN AS REQUIRED TO MAINTAIN THE SYSTEM DIFFERENTIAL PRESSURE SETPOINT. THE BYPASS VALVE SHALL ONLY BE MODULATED OPEN WHEN THE VFD IS CONTROLLING AT ITS MINIMUM LEVEL. THE BYPASS VALVE SHALL BE MODULATED CLOSED BEFORE THE SIGNAL TO THE VFD IS INCREASED ABOVE THE MINIMUM LEVEL.
 - p. AT ANY TIME A PUMP COMMAND DOES NOT EQUAL A PUMP STATUS, EXCEPT IMMEDIATELY AFTER STARTUP, OR A VFD COMMON ALARM IS INDICATED, A PUMP FAILURE ALARM SHALL BE GENERATED ON THE BMS THAT NOTIFIES THE BMS OPERATOR OF THE SPECIFIC PUMP THAT HAS FAILED AND THAT PUMP SHALL BE COMMANDED OFF. THE BMS SHALL WAIT 30 SECONDS AFTER STARTUP TO SEE THE PUMP STATUS CHANGE BEFORE INDICATING A PUMP FAILURE ALARM. AN AUTOMATIC LEAD/LAG PROGRAM SHALL START THE LAG PUMP IN THE EVENT OF A LEAD PUMP FAILURE.

7. EMERGENCY SHUT DOWN:
 - a. ACTIVATION OF THE MANUAL PULL STATION, AS SHOWN ON THE MECHANICAL DRAWINGS, FOR THE EMERGENCY SHUTDOWN OF THE BOILER PLANT SHALL OVERRIDE ALL CONTROL STRATEGIES TO SHUTDOWN THE BOILER PLANT (I.E., BOILERS & HOT WATER PUMPS).
8. LEAK DETECTION:
 - a. TAPE-TYPE LEAK DETECTOR SHALL BE PROVIDED ON THE HOUSEKEEPING PAD FOR EQUIPMENT AS SHOWN ON THE MECHANICAL PLANS.
 - b. THE LEAK DETECTOR SHALL ALARM AT THE BMS AND SHUTDOWN THE BOILER PLANT EQUIPMENT (ADJ.).

VARIABLE AIR VOLUME (VAV-HV) & CONSTANT VOLUME (CV-HV) BOX WITH HOT WATER REHEAT COIL SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH & INSTALL ALL FIELD WIRING, CONTROLLERS, CONTROL PANELS, ETC. AS REQUIRED FOR OPERATION BELOW.
2. COORDINATE FACTORY MOUNTING AND WIRING OF CONTROL PANEL, ACTUATOR, TRANSFORMER AND HOT WATER VALVE WITH THE VAV BOX MANUFACTURER. THE BMS CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING, INSTALLING AND WIRING OF CONTROLS NOT FURNISHED, INSTALLED, OR WIRED BY OTHERS THAT ARE REQUIRED FOR AN OPERATIONAL SYSTEM.
3. OCCUPIED MODE:
 - a. UPON A FALL IN SPACE TEMPERATURE BELOW SETPOINT, 75F-COOLING, 70F-HEATING (ADJ.), THE BOX DAMPER SHALL MODULATE CLOSED TO THE MINIMUM CFM SETPOINT. UPON A FURTHER FALL IN SPACE TEMPERATURE, THE BOX DAMPER SHALL MODULATE TO THE HEATING CFM SETPOINT AND THE HOT WATER REHEAT VALVE SHALL MODULATE AS NECESSARY TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. UPON A RISE IN SPACE TEMPERATURE, THE HOT WATER REHEAT VALVE SHALL CLOSE. UPON A FURTHER RISE IN SPACE TEMPERATURE, THE BOX DAMPER SHALL MODULATE FROM THE MINIMUM TO THE MAXIMUM CFM SETTING AS NECESSARY TO MAINTAIN THE CFM SETPOINT AS RESET BY THE SPACE TEMPERATURE. THE MINIMUM AND MAXIMUM CFM SETTINGS SHALL BE THOSE SCHEDULED ON THE MECHANICAL DRAWINGS.
 - b. THE CAV BOX DAMPER SHALL MODULATE AS NECESSARY TO MAINTAIN THE CFM SETPOINT. THE CAV BOX HOT WATER REHEAT VALVE SHALL MODULATE AS NECESSARY TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. THE CFM SETPOINT SHALL BE AS SCHEDULED ON THE MECHANICAL DRAWINGS
4. UNOCCUPIED MODE:
 - a. THE VAV BOX DAMPER SHALL CLOSE AND THE REHEAT VALVE SHALL REMAIN CLOSED.
 - b. IF THE SPACE TEMPERATURE FALLS BELOW THE UNOCCUPIED SETBACK TEMPERATURE SETPOINT OF 60F (ADJ.) OR RISES ABOVE THE UNOCCUPIED SETUP TEMPERATURE SETPOINT OF 80F (ADJ.), THE FAN SYSTEM SERVING THE VAV BOX SHALL BE ENABLED AND THE VAV BOX SHALL BE INDEXED TO THE MAXIMUM CFM SETTING. THE FAN SYSTEM SHALL RUN FOR A MINIMUM OF 1/2 HOUR (ADJ.).
5. THE VAV BOX SHALL NOT OPEN BEYOND THE MAXIMUM CFM SETTING.
6. FURNISH & INSTALL ONE (1) DDC CONTROLLER AND ONE (1) TEMPERATURE SENSOR FOR EACH VAV BOX.
7. CONSULT MECHANICAL CONTROL POINTS LIST FOR MORE INFORMATION.

VARIABLE AIR VOLUME (VAV) & CONSTANT VOLUME (CV) BOX (COOLING ONLY) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH & INSTALL ALL FIELD WIRING, CONTROLLERS, CONTROL PANELS, ETC. AS REQUIRED FOR OPERATION BELOW.
2. COORDINATE FACTORY MOUNTING AND WIRING OF CONTROL PANEL, ACTUATOR, TRANSFORMER AND HOT WATER VALVE WITH THE VAV BOX MANUFACTURER. THE BMS CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING, INSTALLING AND WIRING OF CONTROLS NOT FURNISHED, INSTALLED, OR WIRED BY OTHERS THAT ARE REQUIRED FOR AN OPERATIONAL SYSTEM.
3. OCCUPIED MODE:
 - a. UPON A FALL IN SPACE TEMPERATURE BELOW SETPOINT, 75F (ADJ.), THE BOX DAMPER SHALL MODULATE CLOSED TO THE MINIMUM CFM SETPOINT. UPON A RISE IN SPACE TEMPERATURE, THE BOX DAMPER SHALL MODULATE FROM THE MINIMUM TO THE MAXIMUM CFM SETTING AS NECESSARY TO MAINTAIN THE CFM SETPOINT AS RESET BY THE SPACE TEMPERATURE. THE MINIMUM AND MAXIMUM CFM SETTINGS SHALL BE THOSE SCHEDULED ON THE MECHANICAL DRAWINGS.
 - b. THE CAV BOX DAMPER SHALL MODULATE AS NECESSARY TO MAINTAIN THE CFM SETPOINT. THE CFM SETPOINT SHALL BE AS SCHEDULED ON THE MECHANICAL DRAWINGS.
4. UNOCCUPIED MODE:
 - a. WHEN THE PRIMARY FAN SYSTEM SERVING THE VAV BOX IS NOT RUNNING, THE VAV BOX DAMPER SHALL CLOSE.
 - b. IF THE SPACE TEMPERATURE FALLS BELOW THE UNOCCUPIED SETBACK TEMPERATURE SETPOINT OF 60F (ADJ.) OR RISES ABOVE THE UNOCCUPIED SETUP TEMPERATURE SETPOINT OF 80F (ADJ.), THE FAN SYSTEM SERVING THE VAV BOX SHALL BE ENABLED AND THE VAV BOX SHALL BE INDEXED TO THE MAXIMUM CFM SETTING. THE FAN SYSTEM SHALL RUN FOR A MINIMUM OF 1/2 HOUR (ADJ.).
5. THE VAV BOX SHALL NOT OPEN BEYOND THE MAXIMUM CFM SETTING.
6. FURNISH & INSTALL ONE (1) DDC CONTROLLER AND ONE (1) TEMPERATURE SENSOR FOR EACH VAV BOX.
7. CONSULT MECHANICAL CONTROL POINTS LIST FOR MORE INFORMATION.

HOT WATER UNIT HEATER (HWUH-A & B) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH, INSTALL AND WIRE A SPACE THERMOSTAT TO CONTROL THE HOT WATER UNIT HEATER.
2. OCCUPIED/UNOCCUPIED MODE:
 - a. ON A FALL IN SPACE TEMPERATURE BELOW SETPOINT, 65F (ADJ.), THE THERMOSTAT SHALL ENERGIZE THE UNIT FAN AND OPEN THE CONTROL VALVE TO MAINTAIN THE SPACE TEMPERATURE SETPOINT.
 - b. ON A RISE IN SPACE TEMPERATURE, THE FAN SHALL BE DE-ENERGIZED AND THE CONTROL VALVE SHALL REMAIN CLOSED.
 - c. THE UNIT HEATER SHALL OPERATE INDEPENDENT OF THE BMS.

ELECTRIC UNHEATED AIR CURTAIN (ACUR-1-A&B) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH & INSTALL ALL FIELD WIRING & MOUNTING OF CONTROL PANELS, ETC. AS REQUIRED FOR OPERATION BELOW.
2. THE ELECTRIC AIR CURTAINS SHALL BE CONTROLLED VIA DOOR SWITCH.
3. UPON OPEN OF THE DOOR SWITCH, THE ELECTRIC AIR CURTAIN SHALL ENABLED AND MAINTAIN CONSTANT AIR VOLUME UNTIL THE DOOR SWITCH CLOSURES.
4. THE AIR CURTAIN SHALL OPERATE INDEPENDENT OF THE BMS.

TOILET EXHAUST FAN (TXF ALL) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH & INSTALL ALL FIELD WIRING & MOUNTING OF CONTROL PANELS, ETC. AS REQUIRED FOR OPERATION BELOW.
2. THE FAN SHALL BE STARTED/STOPPED BASED UPON A TIME OF DAY SCHEDULE OR MANUAL COMMAND AND RUN CONTINUOUSLY.
3. UPON A COMMAND TO START THE FAN, THE FAN MOTORIZED DAMPER SHALL OPEN (IF APPLICABLE).
4. WHEN THE DAMPER IS OPEN, AS SENSED BY A DAMPER END SWITCH, THE FAN SHALL ENERGIZE.
5. UPON A COMMAND TO DE-ENERGIZE THE FAN, THE DISCHARGE DAMPER SHALL HAVE AN ADJUSTABLE TIME DELAY TO KEEP THE DAMPER OPEN UP TO 30 SECONDS AFTER THE FAN IS DE-ENERGIZED.

TRANSFER FANS (TF ALL) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH, INSTALL AND WIRE A SPACE THERMOSTAT TO CONTROL THE TRANSFER FAN.
2. OCCUPIED/UNOCCUPIED MODE:
 - a. ON A FALL IN SPACE TEMPERATURE BELOW SETPOINT, 70F (ADJ.), THE THERMOSTAT SHALL ENERGIZE THE UNIT FAN TO MAINTAIN THE SPACE TEMPERATURE SETPOINT.
 - b. ON A RISE IN SPACE TEMPERATURE, THE FAN SHALL BE DE-ENERGIZED.
 - c. THE TRANSFER FAN SHALL OPERATE INDEPENDENT OF THE BMS.

HOT WATER FINNED TUBE RADIATORS (FTR) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH & INSTALL ALL FIELD WIRING & MOUNTING OF CONTROL VALVES, TEMPERATURE SENSORS, THERMOSTATS, PANELS, ETC. AS REQUIRED FOR OPERATION BELOW.
2. OCCUPIED MODE:
 - a. DURING OCCUPIED MODE, THE RADIATOR CONTROL VALVE SHALL MODULATE AS REQUIRED TO MAINTAIN THE SPACE TEMPERATURE SETPOINT, 70F (ADJ.).
3. UNOCCUPIED MODE:
 - a. DURING UNOCCUPIED MODE, THE RADIATOR CONTROL VALVE SHALL MODULATE AS NECESSARY TO MAINTAIN THE NIGHT SETBACK SPACE TEMPERATURE SETPOINT, 60F (ADJ.).
4. IF A SPACE IS SERVED BY RADIATOR AND A VAV BOX, THE RADIATOR CONTROL VALVE SHALL NOT BE OPENED TO MAINTAIN SPACE TEMPERATURE UNTIL THE VAV BOX DAMPER IS AT MINIMUM POSITION.
5. THE VAV BOX DAMPER SHALL NOT OPEN BEYOND MINIMUM POSITION UNTIL THE RADIATOR CONTROL VALVE IS FULLY CLOSED.

ELECTRIC RADIANT FLOOR HEATING (ERFH) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL FURNISH, INSTALL AND WIRE A SPACE THERMOSTAT TO CONTROL THE ELECTRIC RADIANT FLOOR HEATING.
2. OCCUPIED/UNOCCUPIED MODE:
 - a. ON A FALL IN SPACE TEMPERATURE BELOW SETPOINT, 70F (ADJ.), THE THERMOSTAT SHALL ENERGIZE THE ELECTRIC RADIANT FLOOR HEATING AS REQUIRED TO MAINTAIN THE SPACE TEMPERATURE SETPOINT.
 - b. ON A RISE IN SPACE TEMPERATURE, THE ELECTRIC RADIANT FLOOR HEATING SHALL BE DE-ENERGIZED.
 - c. THE ELECTRIC RADIANT FLOOR HEATING SHALL OPERATE INDEPENDENT OF THE BMS.
3. THE BMS CONTROL CONTRACTOR SHALL COORDINATE REQUIRED RELAYS WITH THE ELECTRICAL CONTRACTOR AS REQUIRED FOR SINGLE THERMOSTAT OPERATION.

ROOFTOP AIR CONDITIONING UNIT WITH GAS-FIRED FURNACE (RTAC-R-1&2) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL COORDINATE WIRING OF ALL MANUFACTURER SHIPPED LOOSE CONTROL ACCESSORIES, ETC. AS REQUIRED FOR OPERATION BELOW.
2. EACH ROOFTOP AC UNIT SHALL HAVE A MICROPROCESSOR-BASED CONTROLLER WHICH SHALL MONITOR AND CONTROL THE ROOFTOP UNIT IN A STAND-ALONE MODE OR AS DIRECTED BY THE BUILDING MANAGEMENT SYSTEM.
3. THE ROOFTOP AC CONTROL PANEL SHALL HAVE A HUMAN INTERFACE PANEL WITH A CLEAR ENGLISH LCD DISPLAY AND KEYPAD FOR MONITORING, SETTING, EDITING AND CONTROLLING.
4. THE UNIT SHALL BE STARTED AND STOPPED BY THE PACKAGED CONTROLS BASED UPON A TIME OF DAY SCHEDULE OR BMS.
5. FACILITY PERSONNEL SHALL HAVE THE ABILITY TO MANUALLY OVERRIDE THE UNIT ON VIA THE UNIT'S PACKAGED CONTROLS LCD DISPLAY.
6. WHEN THE UNIT IS INDEXED "ON," THE SUPPLY, RETURN & EXHAUST DAMPERS SHALL MODULATE TO THE POSITION AS SET BY THE AIR BALANCER. THE UNIT SHALL START ONLY AFTER ALL DAMPERS ARE IN THE PROPER POSITION, AS PROVEN BY INDIVIDUAL DAMPER END SWITCHES. DAMPERS SHALL BE CONTROLLED VIA THE UNIT'S PACKAGED CONTROLS.
7. THE UNIT SHALL BE PROVIDED WITH AN OUTSIDE AIR TEMPERATURE SENSOR TO DETERMINE OPERATING MODE.
8. COOLING:
 - a. GAS-FIRED HEATING SHALL BE LOCKED OUT, DUCT MOUNTED DISCHARGE AIR TEMPERATURE SENSOR SHALL CYCLE REFRIGERATION CIRCUIT TO MAINTAIN SETPOINT.
9. HEATING:
 - a. COMPRESSORS SHALL BE LOCKED OUT, IF THE OUTSIDE AIR SENSOR INDICATES A WINTER CONDITION, DUCT MOUNTED DISCHARGE AIR TEMPERATURE SENSOR SHALL STAGE THE GAS-FIRED FURNACE TO MAINTAIN SETPOINT.
 - b. AN AIR FLOW SWITCH SHALL PREVENT OPERATION OF THE GAS-FIRED FURNACE WHEN THERE IS A LOSS OF AIR FLOW.

- c. ECONOMIZER MODE SHALL BE LOCKED OUT AND THE UNIT SHALL UTILIZE MINIMUM OUTSIDE AIR.
10. ECONOMIZER:
 - a. OUTSIDE AIR TEMPERATURE SENSOR SHALL INDEX SYSTEM TO ECONOMIZER MODE WHENEVER OUTSIDE AIR CONDITIONS PERMIT.
 - b. DISCHARGE AIR TEMPERATURE SENSOR SHALL MODULATE MAXIMUM OUTSIDE AIR AND RETURN AIR DAMPERS TO MAINTAIN SETPOINT.
 - c. SPILL AIR DAMPER SHALL MODULATE OPEN AS REQUIRED.
 - d. WHEN THE UNIT IS INDEXED "OFF," REFRIGERATION CIRCUIT SHALL BE LOCKED OUT AND GAS-FIRED FURNACE SHALL BE DE-ENERGIZED, FANS SHALL BE OFF, OUTSIDE AIR DAMPER SHALL CLOSE AND RETURN AIR DAMPER SHALL OPEN. ALL OTHER DAMPER SHALL BE CLOSED.
11. SMOKE DETECTORS:
 - a. FURNISHED BY ELECTRICAL CONTRACTOR AND INSTALLED BY MECHANICAL CONTRACTOR.
 - b. LOCATED IN THE SUPPLY & RETURN AIR DUCTWORK SHALL AUTOMATICALLY SHUTDOWN FANS UPON THE DETECTION OF SMOKE.
 - c. ELECTRICAL CONTRACTOR SHALL INTERLOCK ALARM SIGNAL WITH BASE BUILDING FIRE ALARM SYSTEM.
12. THIS CONTRACTOR SHALL PROVIDE ALL FIELD WIRING BETWEEN THE UNIT'S PACKAGED CONTROLS AND THE FAN VFD.
13. ALL DAMPER POSITIONS SHALL BE PROVEN THROUGH END SWITCHES.
14. STATIC PRESSURE CONTROL:
 - a. THE STATIC PRESSURE SENSOR SHALL BE INSTALLED IN THE SUPPLY AIR DUCT 2/3 DOWNSTREAM OF THE SUPPLY FAN.
 - b. THE CONTROL CONTRACTOR SHALL WIRE THE SENSOR TO THE UNIT'S PACKAGED CONTROLS.
15. THE BUILDING MANAGEMENT SYSTEM (BMS) SHALL HAVE THE ABILITY TO PERFORM THE FOLLOWING ROOFTOP CONTROL STRATEGIES.
16. UNOCCUPIED MODE:
 - a. WHEN THE BMS INITIATES THE UNOCCUPIED MODE, THE ROOFTOP SHALL ASSUME THE UNOCCUPIED HEATING AND COOLING SETPOINTS (65F AND 80F) ADJUSTABLE.
 - b. IF THE UNOCCUPIED SETPOINTS ARE EXCEEDED, THE UNIT SHALL HEAT OR COOL UNTIL THE ZONE TEMPERATURE IS WITHIN THE UNOCCUPIED SETPOINTS.
17. NIGHT SETBACK TEMPERATURE CONTROL:
 - a. DURING UNOCCUPIED HOURS, THE ROOFTOP UNIT SHALL BE CONTROLLED BY THE BMS TO MAINTAIN USER-DEFINED UNOCCUPIED HEATING AND COOLING SETPOINTS. THE OUTDOOR AIR DAMPER SHALL REMAIN CLOSED FOR NIGHT SETBACK OPERATION (UNLESS ECONOMIZING FOR ZONE COOLING). THE FAN SHALL OPERATE IN THE AUTOMATIC CONTROL MODE.
18. PURGE/NIGHT ECONOMIZER:
 - a. THE PURGE MODE SHALL TURN ON THE FAN AND ENABLE THE ECONOMIZER DURING UNOCCUPIED HOURS TO COOL A ZONE USING COOL NIGHT OUTDOOR AIR, THROUGH THE BMS TIME OF DAY SCHEDULING, THE OPERATOR SHALL SPECIFY WHEN THE PURGE MODE OCCURS. DURING THE PURGE MODE, THE ECONOMIZER SHALL BE ENABLED WHILE MECHANICAL OUTDOOR COOLING AND HEATING ARE DISABLED.
19. TRANSITION FROM UNOCCUPIED TO OCCUPIED:
 - a. WHEN THE UNIT TRANSITIONS FROM THE UNOCCUPIED OPERATION TO OCCUPIED OPERATION, START-UP OR MORNING WARM-UP MODE SHALL BE ACTIVATED.
20. STARTUP MODE:
 - a. THE ROOFTOP UNIT CAN BE CONTROLLED TO THE STARTUP MODE BY THE BMS FOR OPTIMAL START PURPOSES.
 - b. DURING THE STARTUP MODE, HEATING AND COOLING ARE ENABLED FOR THE ROOFTOP. ON VARIABLE AIR VOLUME UNITS, THE TRANSITION FROM THE UNOCCUPIED TO THE STARTUP MODE MAY INITIATE THE MORNING WARMUP MODE. IF THE SPACE TEMPERATURE IS BELOW THE MORNING WARMUP SETPOINT.
 - c. ON BOTH CONSTANT VOLUME AND VARIABLE AIR VOLUME UNITS, THE OUTDOOR AIR DAMPER SHALL REMAIN CLOSED, UNLESS ECONOMIZING, UNTIL THE ZONE'S SCHEDULED OCCUPIED TIME.
21. MORNING WARMUP (CV AND VAV UNITS):
 - a. WHEN THE ROOFTOP SHALL CHANGE FROM THE UNOCCUPIED TO THE OCCUPIED MODE, THE UNIT MAY ENTER THE MORNING WARMUP MODE.
 - b. THE MORNING WARMUP MODE SHALL BE INITIATED IF THE MORNING WARMUP SENSOR VALUE IS LESS THAN THE MORNING WARMUP SETPOINT.
 - c. THE ECONOMIZER SHALL BE KEPT CLOSED AND THE SELECTED ZONE IS HEATED.
 - d. THE BMS SHALL SEND THE ROOFTOP UNIT A MORNING WARMUP TEMPERATURE AND SETPOINT.
 - e. THE MORNING WARMUP SETPOINT SHALL BE BASED ON ONE SPECIFIC ZONE DESIGNATED BY THE OPERATOR OR BASED ON AN AVERAGE ZONE TEMPERATURE.
22. OCCUPIED OPERATION:
 - a. WHEN THE ROOFTOP UNIT IS CONTROLLED TO THE OCCUPIED MODE, ALL ROOFTOP UNIT FUNCTIONS SHALL BE ENABLED.
 - b. VARIABLE AIR VOLUME UNITS SHALL OPERATE IN SUPPLY AIR TEMPERATURE CONTROL MODE.
 - c. THE ROOFTOP UNIT SHALL DEFAULT TO THIS MODE IN THE EVENT THAT COMMUNICATIONS WITH THE BMS ARE LOST.
23. SUPPLY AIR SETPOINT (VARIABLE AIR VOLUME UNITS):
 - a. THE SUPPLY AIR SETPOINT FOR EACH ROOFTOP UNIT SHALL BE 55F FOR COOLING (ADJ) AND 80F FOR HEATING (ADJ).
 - b. THE BMS OR RESET AUTOMATICALLY BASED ON AN OUTDOOR AIR OR ZONE TEMPERATURE.
24. DAYTIME WARMUP (VAV UNITS):
 - a. WHEN THE ZONE TEMPERATURE DROPS BELOW AN OPERATOR-SPECIFIED DAYTIME WARMUP SETPOINT, THE ROOFTOP SHALL ENTER THE DAYTIME WARMUP MODE.
 - b. IN THIS MODE, THE ROOFTOP SHALL SUPPLY HEAT TO THE VAV BOXES BY DRIVING THE VAV BOXES FULLY OPEN AND THE VARIABLE FREQUENCY DRIVE(S) ARE DRIVING TO 100 PERCENT.
 - c. AFTER THE ZONE IS WARMED UP, THE UNIT SHALL RESUME NORMAL COOLING. THE BMS SHALL COMMUNICATE THE DAYTIME WARMUP TEMPERATURE VALUE FOR THE ROOFTOP TO USE TO INITIATE THE NECESSARY HEATING FOR THE ZONE.
25. ECONOMIZER CONTROL (CV AND VAV UNITS):
 - a. THE BMS SHALL OVERRIDE THE ECONOMIZER CONTROLLER ON THE

- ROOFTOP UNIT TO PROVIDE FREE COOLING. IF POOR OUTDOOR AIR CONDITIONS EXIST, THE BMS SHALL LOCKOUT ALL ECONOMIZERS. ON CONSTANT VOLUME UNITS THE BMS SHALL ALSO SET THE MINIMUM ECONOMIZER POSITION TO MAINTAIN A MINIMUM OUTDOOR AIR FLOW (CFM). ON VAV UNITS, AS THE SUPPLY FAN MODULATES DOWN, THE MINIMUM ECONOMIZER POSITION SHALL ALSO BE RESET TO COMPENSATE FOR THE REDUCTION IN TOTAL AIRFLOW.
26. TIMED OVERRIDE:
 - a. WHEN A TIMED OVERRIDE IS INITIATED BY THE USER, THE ROOFTOP UNIT SHALL RETURN TO ITS NORMAL OCCUPIED MODE FOR A PERIOD OF TIME AS SPECIFIED AT THE BMS. WHEN THE TIMED OVERRIDE PERIOD HAS ENDED, THE UNIT SHALL AUTOMATICALLY RETURN TO ITS UNOCCUPIED CYCLE. THE BMS SHALL MONITOR AND STORE THE OVERRIDE TIME FOR EACH TIMED OVERRIDE INPUT FOR DOCUMENTATION OF AFTER-HOURS OPERATION. THE BMS SHALL ALSO RECOGNIZE A TIMED OVERRIDE FUNCTION IF PROVIDED.

HEATING & VENTILATING UNIT (HV-R-1 THRU 12) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL COORDINATE WIRING OF ALL MANUFACTURER SHIPPED LOOSE CONTROL ACCESSORIES, ETC. AS REQUIRED FOR OPERATION BELOW.
2. EACH ROOFTOP HEATING & VENTILATING UNIT SHALL HAVE A MICROPROCESSOR-BASED CONTROLLER WHICH SHALL MONITOR AND CONTROL THE ROOFTOP UNIT IN A STAND-ALONE MODE OR AS DIRECTED BY THE BUILDING MANAGEMENT SYSTEM.
3. THE ROOFTOP HV CONTROL PANEL SHALL HAVE A HUMAN INTERFACE PANEL WITH CLEAR ENGLISH LCD DISPLAY AND KEYPAD FOR MONITORING, SETTING, EDITING AND CONTROLLING.
4. THE HV UNIT SHALL BE STARTED AND STOPPED BY THE PACKAGED CONTROLS BASED UPON A TIME OF DAY SCHEDULE OR BMS.
5. FACILITY PERSONNEL SHALL HAVE THE ABILITY TO MANUALLY OVERRIDE THE UNIT ON VIA THE UNIT'S PACKAGED CONTROLS LCD DISPLAY.
6. WHEN THE UNIT IS INDEXED "ON," THE SUPPLY, RETURN & EXHAUST DAMPERS SHALL MODULATE TO THE POSITION AS SET BY THE AIR BALANCER. THE UNIT SHALL START ONLY AFTER ALL DAMPERS ARE IN THE PROPER POSITION, AS PROVEN BY INDIVIDUAL DAMPER END SWITCHES. DAMPERS SHALL BE CONTROLLED VIA THE UNIT'S PACKAGED CONTROLS.
7. OCCUPIED MODE:
 - a. HEATING:
 - i. IF THE OUTSIDE AIR SENSOR INDICATES A WINTER CONDITION, DUCT MOUNTED DISCHARGE AIR TEMPERATURE SENSOR SHALL STAGE THE GAS-FIRED FURNACE TO MAINTAIN SETPOINT.
 - ii. AN AIR FLOW SWITCH SHALL PREVENT OPERATION OF THE GAS-FIRED FURNACE WHEN THERE IS A LOSS OF AIR FLOW.
 - iii. ECONOMIZER MODE SHALL BE LOCKED OUT AND THE UNIT SHALL UTILIZE MINIMUM OUTSIDE AIR.
 - b. ECONOMIZER:
 - i. OUTSIDE AIR TEMPERATURE SENSOR SHALL INDEX SYSTEM TO ECONOMIZER MODE WHENEVER OUTSIDE AIR CONDITIONS PERMIT.
 - ii. DISCHARGE AIR TEMPERATURE SENSOR SHALL MODULATE MAXIMUM OUTSIDE AIR AND RETURN AIR DAMPERS TO MAINTAIN SETPOINT.
 - iii. SPILL AIR DAMPER SHALL MODULATE OPEN AS REQUIRED.
 - iv. WHEN THE UNIT IS INDEXED "OFF," THE GAS-FIRED FURNACE SHALL BE DE-ENERGIZED, FANS SHALL BE OFF, OUTSIDE RETURN & EXHAUST AIR DAMPERS SHALL CLOSE.
8. UNOCCUPIED MODE:
 - a. THE SUPPLY FAN SHALL REMAIN OFF.
 - b. ALL DAMPERS SHALL CLOSE.
 - c. THE GAS-FIRED FURNACE SHALL BE DISABLED.
9. SMOKE DETECTORS:
 - a. FURNISHED BY ELECTRICAL CONTRACTOR AND INSTALLED BY MECHANICAL CONTRACTOR.
 - b. LOCATED IN THE SUPPLY & RETURN AIR DUCTWORK SHALL AUTOMATICALLY SHUTDOWN FANS UPON THE DETECTION OF SMOKE.
 - c. ELECTRICAL CONTRACTOR SHALL INTERLOCK ALARM SIGNAL WITH BASE BUILDING FIRE ALARM SYSTEM.

DESTRATIFICATION FANS DSF-4-1 THRU 43) SEQUENCE OF OPERATION:

1. THE BMS CONTRACTOR SHALL COORDINATE WIRING AS REQUIRED FOR OPERATION BELOW.
2. THE DESTRATIFICATIONS SHALL BE STARTED THROUGH THE BMS VIA START/STOP COMMAND OR PROGRAMMABLE SCHEDULED.
3. THE DESTRATIFICATION FANS SHALL MAINTAIN CONSTANT VOLUME.

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KEY PLAN

REV	DESCRIPTION	DATE
	ISSUED FOR DOB SUBMISSION	09/10/2021
	ISSUED FOR BID	10/15/2021
	ISSUED FOR PROGRESS	01/18/2022

DRAWN BY :

CHECKED BY :

APPROVED BY :

DATE :

SCALE :

DRAWING TITLE :

**MECHANICAL
CONTROLS SHEET #3**

DWG NUMBER :

M-308

MECHANICAL MBD CONTROL SEQUENCES OF OPERATION

SCALE: NTS

TO THE BEST KNOWLEDGE, BELIEF AND PROFESSIONAL JUDGEMENT, THESE PLANS AND SPECIFICATIONS ARE IN COMPLIANCE WITH THE 2020 ENERGY CONSERVATION CONSTRUCTION CODE OF NEW YORK STATE.