SEQUENCE OF OPERATIONS: 1. <u>GENERAL</u>: A. THIS CONTRACTOR SHALL PROVIDE ALL REQUIRED CONTROL ELEMENTS AS REQUIRED FOR A COMPLETE AND OPERATIONAL SYSTEM INCLUDING BUT NOT LIMITED TO CONTACTS, RELAYS, WIRING (24V AND 120V), CONDUIT, CONTROL PANELS, TRANSFORMERS, THERMOSTATS, SENSORS, ACTUATORS, DAMPERS, TIME CLOCKS, SPEED 2. DISHWASHER EXHAUST FAN (EF-2): A. EXHAUST FAN SHALL OPERATE WHEN THE DISHWASHER IS ACTIVATED. LOCAL CONTROLS WITHIN THE DISHWASHER ASSEMBLY SHALL TURN ON/OFF THE EXHAUST FAN. WHEN THE EXHAUST FAN IS CALLED TO RUN, THE ASSOCIATED MOTORIZED BACKDRAFT DAMPER SHALL OPEN AND THEN THE FAN SHALL TURN ON. WHENEVER THE EXHAUST FAN IS SHUT-DOWN THE ASSOCIATED MOTORIZED DAMPER SHALL CLOSE. PROVIDE ALL CONTROLS REQUIRED TO INTERLOCK EXHAUST FAN OPERATION WITH DISHWASHER ASSEMBLY. 3. TOILET AND GENERAL EXHAUST FANS (EF-3, EF-4 AND EF-5): A. THE EXHAUST FAN SHALL RUN CONTINUOUSLY DURING OCCUPIED HOURS AS PROGRAMMED THROUGH A 24-HOUR TIME CLOCK. COORDINATE OCCUPIED HOURS WITH OWNER'S REPRESENTATIVE. WHEN THE EXHAUST FAN IS CALLED TO RUN, THE ASSOCIATED MOTORIZED BACKDRAFT DAMPER SHALL OPEN AND THEN THE FAN SHALL TURN ON. WHENEVER THE EXHAUST FAN IS SHUT-DOWN THE ASSOCIATED MOTORIZED DAMPER SHALL CLOSE. 4. <u>LAB EXHAUST FAN (EF-6)</u>: A. A MANUAL WALL MOUNTED SWITCH, LOCATED IN THE SPACE, SHALL TURN THE FAN ON AND OFF. WHEN THE EXHAUST FAN IS CALLED TO RUN, THE ASSOCIATED MOTORIZED BACKDRAFT DAMPER SHALL OPEN AND THEN THE FAN SHALL TURN ON. WHENEVER THE EXHAUST FAN IS SHUT-DOWN THE ASSOCIATED MOTORIZED DAMPER SHALL CLOSE. 5. EXHAUST FANS (EF-7 AND EF-8): A. EXHAUST SHALL BE COMMANDED ON/OFF BASED ON SPACE TEMPERATURE. ON A RISE IN SPACE TEMPERATURE ABOVE SET-POINT THE MOTORIZED DAMPER ASSOCIATED WITH THE EXHAUST FAN SHALL OPEN AND THEN THE EXHAUST FAN SHALL TURN ON. THE EXHAUST FAN SHALL CONTINUE TO RUN UNTIL THE SPACE TEMPERATURE DROPS BELOW SET-POINT, AT WHICH POINT THE FAN SHALL STOP AND THE MOTORIZED DAMPER SHALL CLOSE. WHENEVER THE EXHAUST FAN IS SHUT-DOWN THE ASSOCIATED MOTORIZED DAMPER SHALL CLOSE. 6. <u>KITCHEN EXHAUST HOOD EXHAUST FAN AND MAKE-UP AIR UNIT (EF-1 AND MUA-1:</u> A. THE EXHAUST FAN AND MAKE-UP AIR UNIT OPERATION SHALL BE OPERATED BY A FACTORY CONTROL PANEL MOUNTED WITHIN THE KITCHEN EXHAUST HOOD ASSEMBLY. WHENEVER THE HOOD PANEL IS INDEXED ON THE EXHAUST FAN AND THE MAKE-UP AIR UNIT SHALL OPERATE. THE GAS BURNER IN THE MAKE-UP AIR UNIT SHALL FIRE TO MAINTAIN DISCHARGE AIR SET-POINT. WHEN THE MAKE-UP AIR UNIT IS ON, ITS ASSOCIATED INTAKE MOTORIZED DAMPER SHALL BE OPEN. WHEN THE MAKE-UP AIR UNIT IS OFF. ITS ASSOCIATED INTAKE MOTORIZED DAMPER SHALL BE CLOSED. WHENEVER THE SYSTEM IS SHUT-DOWN THE OUTSIDE AIR INTAKE DAMPER SHALL REMAIN CLOSED. PROVIDE ALL CONTROLS REQUIRED TO INTERLOCK EXHAUST FAN AND MAKE-UP AIR UNIT OPERATION TO THE EXHAUST HOOD OPERATION. B. PROVIDE A LOW LIMIT SENSOR IN THE MAKE-UP AIR UNIT DISCHARGE ARRANGED TO PREVENT WINTER DISCHARGE TEMPERATURE FROM DROPPING BELOW 50°F (ADJUSTABLE). C. PROVIDE A HIGH LIMIT SENSOR IN THE MAKE-UP AIR UNIT DISCHARGE ARRANGED TO PREVENT WINTER DISCHARGE TEMPERATURE FROM RISING ABOVE 120°F (ADJUSTABLE). 7. <u>ELECTRIC HEATERS (EH-1, EH-3, EH-4 AND EH-5)</u>: A. ELECTRIC HEATERS SHALL BE OPERATED THROUGH FACTORY CONTROLS. A FACTORY THERMOSTAT SHALL ENERGIZE THE ELECTRIC HEATING ELEMENT AS REQUIRED TO MAINTAIN SPACE SET-POINT. WHENEVER ELECTRIC HEATING ELEMENT IS ENERGIZED THE UNIT FAN SHALL BE OPERATIONAL. 8. <u>ELECTRIC HEATER (EH-2)</u>: A. ELECTRIC HEATER SHALL BE MANUALLY CONTROLLED VIA LOCAL CONTROLS PROVIDED WITH ELECTRIC HEATERS. 9. CONSTANT VOLUME GAS FIRED PACKAGED ROOFTOP UNITS (RTU-1, RTU-2, RTU-4 AND RTU-6): GENERAL: UNIT SHALL BE PROVIDED WITH, AND OPERATED THROUGH, A 24-7 PROGRAMMABLE THERMOSTAT WITH NIGHT SET-BACK AND UNIT MOUNTED CONTROLS CAPABLE OF PROVIDING AUTOMATIC OPERATION, SET-POINT ADJUSTMENT AND ALL SEQUENCES INDICATED BELOW. SUMMER OCCUPIED OPERATION: UPON START-UP, THE CONTROL CIRCUITS SHALL BE ENERGIZED. DURING OCCUPIED MODE THE SUPPLY FAN SHALL RUN CONTINUOUSLY. THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL OPEN TO THE MINIMUM POSITION AND THE RETURN DAMPER SHALL BE OPEN. A TEMPERATURE SENSOR LOCATED IN THE SUPPLY AIR DUCTWORK SHALL BE ARRANGED TO CYCLE DX COOLING ON/OFF IN STAGES AS REQUIRED TO MAINTAIN A CONSTANT DISCHARGE SFT-POINT WINTER OCCUPIED OPERATION: UPON START-UP, THE CONTROL CIRCUITS SHALL BE ENERGIZED. DURING OCCUPIED MODE THE SUPPLY FAN SHALL RUN CONTINUOUSLY. THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL OPEN TO THE MINIMUM POSITION AND THE RETURN DAMPER SHALL BE OPEN. A TEMPERATURE SENSOR LOCATED IN THE SUPPLY AIR DUCTWORK SHALL BE ARRANGED TO MODULATE GAS HEAT AS REQUIRED TO MAINTAIN A CONSTANT DISCHARGE AIR TEMPERATURE. D. <u>ECONOMIZER OPERATION</u>: ON A CALL FOR COOLING WHEN THE AMBIENT OUTDOOR AIR CONDITIONS PERMIT (AS DETERMINED BY DIFFERENTIAL ENTHALPY CONTROLS) THE UNIT CONTROLS SHALL MODULATE THE OUTSIDE AIR, RELIEF AIR AND RETURN AS REQUIRED TO PROVIDE "FREE COOLING" AND MAINTAIN DISCHARGE SET-POINT. DURING ECONOMIZER OPERATION THE DX COOLING AND GAS HEATING SHALL NOT BE OPERATIONAL. CONTROL ACTION SHALL BE THAT AN INCREASE IN SUPPLY AIR TEMPERATURE WILL CAUSE THE OUTSIDE AIR AND RELIEF AIR DAMPERS TO MODULATE TOWARDS THE OPEN POSITION AND THE RETURN AIR DAMPER TO MODULATE TOWARDS THE CLOSED POSITION. A DROP IN TEMPERATURE BELOW SET-POINT WILL CAUSE THE REVERSE TO OCCUR. WHEN THE OUTSIDE AIR AND RELIEF AIR DAMPER OPEN TO FULL POSITION AND A FURTHER CALL FOR COOLING OCCURS THE DX COOLING SYSTEM SHALL OPERATE. WHEN AMBIENT AIR CONDITIONS ARE NO LONGER SUITABLE FOR ECONOMIZER OPERATION THE UNIT CONTROLS SHALL REVERT TO NORMAL OPERATION. MORNING WARM-UP OPERATION: THE UNIT SHALL START AND OPERATE FOR A PREDETERMINED PERIOD AS PROGRAMMED INTO THE UNIT CONTROLLER. DURING THIS CYCLE, THE JTSIDE AIR AND RELIEF AIR DAMPER SHALL BE CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. THE GAS HEATING SHALL MODULATE TO MAINTAIN SET—POINT. WHEN ZONE TEMPERATURES ARE WITHIN 2 DEGREES OF SET-POINT THE UNIT SHALL OPERATE IN OCCUPIED MODE. MORNING COOL-DOWN OPERATION: UNIT SHALL START AND OPERATE FOR A PREDETERMINED PERIOD AS PROGRAMMED INTO THE UNIT CONTROLLER. DURING THIS CYCLE, THE OUTSIDE AIR AND RELIEF AIR DAMPER SHALL BE CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. DX COOLING SHALL CYCLE TO MAINTAIN SET-POINT. WHEN ZONE TEMPERATURES ARE WITHIN 2 DEGREES OF SET-POINT THE UNIT SHALL OPERATE IN OCCUPIED MODE. UNOCCUPIED OPERATION: UNIT SUPPLY FAN, GAS HEATING AND DX COOLING SHALL CYCLE AS REQUIRED ON A CALL FOR HEATING OR COOLING. DURING THIS MODE, THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL BE FULL CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. H. LIMIT CONTROLS: PROVIDE HIGH/LOW LIMIT CONTROL SENSORS IN THE SUPPLY FAN DISCHARGE ARRANGED TO OVERRIDE TEMPERATURE CONTROLS AND PREVENT DISCHARGE TEMPERATURE FROM DROPPING BELOW 50 DEGREES F OR RISING ABOVE 110 DEGREES F (ADJUSTABLE). MISCELLANEOUS: WHENEVER THE UNITS ARE SHUT-DOWN THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL BE CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. UNIT SHALL SHUT—DOWN UPON DETECTION OF SMOKE AS SENSED BY DUCT MOUNTED SMOKE DETECTOR. PROVIDE A FIRESTAT MOUNTED IN THE SUPPLY AIR DUCTWORK ARRANGED TO SHUT-DOWN THE UNIT WHEN SUPPLY AIR TEMPERATURE EXCEEDS 140° (ADJUSTABLE). FIRESTAT SHALL BE MANUALLY RESET TYPE. 10. <u>DUCTLESS SPLIT SYSTEM CEILING CASSETTE UNIT AND HEAT PUMP (AC-1 AND HP-1)</u>: A. SYSTEM SHALL BE OPERATED THROUGH A FACTORY PROVIDED WIRED REMOTE CONTROLLER, CAPABLE OF PROVIDING SET-POINT ADJUSTMENTS AND ALL PROGRAMMING FOR CONTROL SEQUENCES. THE SYSTEM SHALL CYCLE ON/OFF AS REQUIRED TO MAINTAIN SPACE SET-POINT. THE FACTORY INSTALLED CONTROLS SHALL BE CONFIGURED SUCH THAT A LEAK DETECTOR MOUNTED IN THE INDOOR UNIT DRAIN PAN SHALL BE ARRANGED TO SHUT-DOWN THE SYSTEM WHEN WATER IS DETECTED. 11. VARIABLE AIR VOLUME GAS FIRED PACKAGED ROOFTOP UNITS (RTU-3 AND RTU-5): A. GENERAL: UNIT SHALL BE PROVIDED WITH, AND OPERATED THROUGH, A 24-7 PROGRAMMABLE THERMOSTAT WITH NIGHT SET-BACK AND UNIT MOUNTED CONTROLS CAPABLE OF PROVIDING AUTOMATIC OPERATION, SET-POINT ADJUSTMENT AND ALL SEQUENCES INDICATED BELOW. SUMMER OCCUPIED OPERATION: UPON START-UP, THE CONTROL CIRCUITS SHALL BE ENERGIZED. DURING OCCUPIED MODE THE SUPPLY FAN SHALL RUN CONTINUOUSLY. THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL OPEN TO THE MINIMUM POSITION AND THE RETURN DAMPER SHALL BE OPEN. A TEMPERATURE SENSOR LOCATED IN THE SUPPLY AIR DUCTWORK SHALL BE ARRANGED TO CYCLE DX COOLING ON/OFF IN STAGES AS REQUIRED TO MAINTAIN A CONSTANT DISCHARGE SET-POINT. WINTER OCCUPIED OPERATION: UPON START-UP, THE CONTROL CIRCUITS SHALL BE ENERGIZED. DURING OCCUPIED MODE THE SUPPLY FAN SHALL RUN CONTINUOUSLY. THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL OPEN TO THE MINIMUM POSITION AND THE RETURN DAMPER SHALL BE OPEN. A TEMPERATURE SENSOR LOCATED IN THE SUPPLY AIR DUCTWORK SHALL BE ARRANGED TO MODULATE GAS HEAT AS REQUIRED TO MAINTAIN A CONSTANT DISCHARGE AIR TEMPERATURE D. <u>ECONOMIZER OPERATION</u>: ON A CALL FOR COOLING WHEN THE AMBIENT OUTDOOR AIR CONDITIONS PERMIT (AS DETERMINED BY DIFFERENTIAL ENTHALPY CONTROLS) THE UNIT CONTROLS SHALL MODULATE THE OUTSIDE AIR, RELIEF AIR AND RETURN AS REQUIRED TO PROVIDE "FREE COOLING" AND MAINTAIN DISCHARGE SET-POINT. DURING ECONOMIZER OPERATION THE DX COOLING AND GAS HEATING SHALL NOT BE OPERATIONAL. CONTROL ACTION SHALL BE THAT AN INCREASE IN SUPPLY AIR TEMPERATURE WILL CAUSE THE OUTSIDE AIR AND RELIEF AIR DAMPERS TO MODULATE TOWARDS THE OPEN POSITION AND THE RETURN AIR DAMPER TO MODULATE TOWARDS THE CLOSED POSITION. A DROP IN TEMPERATURE BELOW SET-POINT WILL CAUSE THE REVERSE TO OCCUR. WHEN THE OUTSIDE AIR AND RELIEF AIR DAMPER OPEN TO FULL POSITION AND A FURTHER CALL FOR COOLING OCCURS THE DX COOLING SYSTEM SHALL OPERATE. WHEN AMBIENT AIR CONDITIONS ARE NO LONGER SUITABLE FOR ECONOMIZER OPERATION THE UNIT CONTROLS SHALL REVERT TO NORMAL OPERATION. MORNING WARM-UP OPERATION: THE UNIT SHALL START AND OPERATE FOR A PREDETERMINED PERIOD AS PROGRAMMED INTO THE UNIT CONTROLLER. DURING THIS CYCLE. THE OUTSIDE AIR AND RELIEF AIR DAMPER SHALL BE CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. THE GAS HEATING SHALL MODULATE TO MAINTAIN SET-POINT. VARIABLE AIR VOLUME BOXES SHALL BE OPEN. WHEN ZONE TEMPERATURES ARE WITHIN 2 DEGREES OF SET-POINT THE UNIT SHALL OPERATE IN OCCUPIED MODE. MORNING COOL-DOWN OPERATION: UNIT SHALL START AND OPERATE FOR A PREDETERMINED PERIOD AS PROGRAMMED INTO THE UNIT CONTROLLER. DURING THIS CYCLE, THE OUTSIDE AIR AND RELIEF AIR DAMPER SHALL BE CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. DX COOLING SHALL CYCLE TO MAINTAIN SET-POINT. VARIABLE AIR VOLUME BOXES SHALL BE OPEN. WHEN ZONE TEMPERATURES ARE WITHIN 2 DEGREES OF SET-POINT THE UNIT SHALL OPERATE IN OCCUPIED MODE. UNOCCUPIED OPERATION: UNIT SUPPLY FAN, GAS HEATING AND DX COOLING SHALL CYCLE AS REQUIRED ON A CALL FOR HEATING OR COOLING. DURING THIS MODE, THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL BE FULL CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. DURING UNOCCUPIED MODE VARIABLE AIR VOLUME BOXES SHALL BE OPEN. H. STATIC PRESSURE CONTROLS: PROVIDE A STATIC PRESSURE SENSOR LOCATED IN THE MAIN SUPPLY DUCT APPROXIMATELY TWO-THIRDS (3/3) DOWNSTREAM ALONG THE LONGEST RUN. CONTROLS SHALL BE ARRANGED TO MODULATE THE UNIT VARIABLE FREQUENCY DRIVE ON THE SUPPLY FAN TO MAINTAIN A CONSTANT STATIC PRESSURE. A RISE IN PRESSURE SHALL CAUSE THE VARIABLE FREQUENCY DRIVE TO REDUCE FAN SPEED. A DROP IN STATIC PRESSURE SHALL CAUSE THE REVERSE TO TAKE PLACE. LIMIT CONTROLS: PROVIDE HIGH/LOW LIMIT CONTROL SENSORS IN THE SUPPLY FAN DISCHARGE ARRANGED TO OVERRIDE TEMPERATURE CONTROLS AND PREVENT DISCHARGE TEMPERATURE FROM DROPPING BELOW 50 DEGREES F OR RISING ABOVE 110 DEGREES F (ADJUSTABLE). MISCELLANEOUS: WHENEVER THE UNITS ARE SHUT-DOWN THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL BE CLOSED AND THE RETURN AIR DAMPER SHALL BE FULL OPEN. UNIT SHALL SHUT-DOWN UPON DETECTION OF SMOKE AS SENSED BY DUCT MOUNTED SMOKE DETECTOR. PROVIDE A FIRESTAT MOUNTED IN THE SUPPLY AIR DUCTWORK ARRANGED TO SHUT-DOWN THE UNIT WHEN SUPPLY AIR TEMPERATURE EXCEEDS 140° (ADJUSTABLE). FIRESTAT SHALL BE MANUALLY RESET TYPE. 12. <u>VARIABLE AIR VOLUME BOXES:</u> A. IN OCCUPIED MODE THE SPACE SENSOR SHALL MODULATE THE VAV BOX DAMPER ASSEMBLY TO MAINTAIN SET-POINT. IN SUMMER MODE A RISE IN SPACE TEMPERATURE SHALL CAUSE THE VAV DAMPER TO MODULATE OPEN, AS THE SPACE APPROACHES SET-POINT, THE DAMPER SHALL MODULATE TO THE MINIMUM POSITION. IN THE WINTER MODE A DROP IN SPACE TEMPERATURE SHALL CAUSE THE VAV DAMPER TO MODULATE OPEN, AS THE SPACE APPROACHES SET-POINT, THE DAMPER SHALL MODULATE TO THE MINIMUM POSITION. THE DDC CONTROLLER IN THE ROOFTOP UNIT SHALL RESET THE SUPPLY AIR TEMPERATURE BASED ON SATISFYING THE VAV ZONE THAT IS EITHER FURTHEST FROM SET-POINT OR THE VAV ZONE THAT HAS THE HIGHEST AIR-FLOW WHILE MAINTAINING SET-POINT. WHEN THE ROOFTOP UNIT IS OPERATING IN THE UNOCCUPIED, MORNING COOL-DOWN OR MORNING WARM-UP MODE THE VAV BOXES SHALL REMAIN IN THE FULL OPEN D. FOR VAV-7 ONLY WITH ELECTRIC REHEAT COIL, UPON A FURTHER CALL FOR SPACE HEATING THE ELECTRIC REHEAT COIL SHALL BE ENERGIZED IN STAGES AS REQUIRED TO MAINTAIN SPACE TEMPERATURE SET-POINT. 13. AIR HANDLER UNIT AND HEAT PUMP (HVAC-1 AND HP-1): A. SYSTEM SHALL BE OPERATED THROUGH A FACTORY PROVIDED WIRED REMOTE CONTROLLER, CAPABLE OF PROVIDING SET-POINT ADJUSTMENTS AND ALL PROGRAMMING FOR CONTROL SEQUENCES. THE SYSTEM SHALL CYCLE ON/OFF AS REQUIRED TO MAINTAIN SPACE SET-POINT. THE FACTORY INSTALLED CONTROLS SHALL BE CONFIGURED SUCH THAT A LEAK DETECTOR MOUNTED IN THE INDOOR UNIT DRAIN PAN SHALL BE ARRANGED TO SHUT-DOWN THE SYSTEM WHEN WATER IS DETECTED B. WHENEVER THE SYSTEM IS OPERATING IN THE OCCUPIED MODE THE MOTORIZED OUTSIDE AIR INTAKE DAMPER SHALL BE OPEN. WHENEVER THE SYSTEM IS OPERATING IN THE UNOCCUPIED MODE THE MOTORIZED OUTSIDE AIR INTAKE DAMPER SHALL BE CLOSED.

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