

SECTION 230993 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish equipment, devices, switches, contacts, services, and programming necessary for a complete and safe installation as required to implement the sequence of operation for the new central chiller, boiler plants and air-handling equipment.
 - B. All control set points, alarm set points, schedules and parameters shall be adjustable from the system front end.
 - C. All temperature, pressure and flow variables shall be trended. The Owner shall determine trend period and length of archived data period and give to the Control Contactor to program during start-up and commissioning. All trend parameters shall have the ability to be adjustable by Owner.
 - D. All memory chips in all controllers shall have 72 hours of volatile memory backup in 1st tier controllers and 6 months for 2nd tier controllers.
 - E. Runtime for all pumps and fans shall be monitored individually and reset after 1,000,000 hours of runtime.
 - F. The BAS shall utilize adaptive control algorithms to directly control the chilled water and hot water systems. Optimum start shall be utilized to provide efficient temperature control of the building systems for morning warm-up/cool down modes prior to scheduled occupied time periods.
 - G. The BAS shall utilize the following ambient room temperatures (adjustable) as heating and cooling design set points:
 - 1. Heating Occupied: 70 deg F (adj.) plus or minus 2 deg F.
 - 2. Heating Unoccupied: 60 deg F (adj.)
 - 3. Cooling Occupied: 74 deg F (adj.) plus or minus 2 deg F.
 - 4. Cooling Unoccupied: 80 deg F (adj.)
 - H. The BAS shall utilize the following for Vestibule HVAC Equipment Operation: Specific to controls for HVAC equipment located in Vestibules, the heating section must turn off when the outdoor ambient temperature is above 45 deg F. Heating Occupied and Unoccupied setpoint shall be no higher than 60 deg F. If applicable, cooling occupied and unoccupied setpoint shall be no lower than 85 deg F.
- #### **1.2 RELATED SECTIONS**
- A. See Division 23 Section "HVAC Instrumentation and Control" and individual equipment specifications for control equipment and devices, coordination requirements between equipment manufacturer and BAS installing contractor and for submittal requirements.

1.3 DEFINITIONS

- A. BAS – Building Automatic System

1.4 CENTRAL BOILER PLANT CONTROL SEQUENCES

A. General

1. Provide an H-O-A switch for each constant speed pump or valve motor. In "Hand" position, the pumps shall be manually started/stopped locally from the starters. In "Auto" position, the pumps shall be under control of Building Automation System (BAS) and start/stop remotely in accordance with the control sequence. Motor operated valves shall be capable of indicating valve positions at BAS.
2. Provide a Local/Remote switch at the variable frequency drive for each variable speed pump. In "Local" position, the drive speed shall be manually adjustable at the variable frequency drive. In "Remote" position, the drive speed shall be automatically adjusted by the BAS.
3. Emergency Stop / Carbon Monoxide Shutdown: Upon activation of the emergency break-glass alarm or Carbon Monoxide Sensors the boilers shall be shutdown and the gas solenoid valves placed in the closed position. An alarm shall be activated at the BAS and Fire Alarm Panel.

B. BAS System Setup:

1. Provide a software command "System Enable" to activate/deactivate the BAS control sequence based on outside air temperature or a call for "reheat" during the cooling months.
2. Provide software enable to activate/deactivate individual boilers and hot water pumps. In "enable" mode, the equipment will be under the control of BAS based on the normal control sequence. In "Manual" mode the equipment will be started or stopped locally at the equipment starter. All safety interlocks shall remain in effect in the manual mode.
3. Assign start/stop sequence for individual boilers and hot water pumps. The sequence shall modulate and sequence the boilers in parallel to respond to system load. Boilers shall be staged to meet the building heating demand most efficiently.
4. Set the demand limiting for individual boilers.
5. The hot water system shall be designed for a fully "automated" operation as described in the sections below.

1.5 HEATING HOT WATER SYSTEM

A. General:

1. Refer to paragraph 1.4.A.1 above.

2. Boiler Plant Control:

- a. Boiler plant shall be enabled by the boiler control panel based on an adjustable outdoor air temperature set-point of 60 deg F or via manual enable via the BAS.
- b. The boiler manufacturer's controls shall adjust boiler output automatically to maintain the leaving hot water supply temperature at set-point. Hot water supply temperature set-point may be adjusted remotely from BAS.
- c. When the heating demand exceeds the capacity of the operating boiler as determined by the boiler plant control panel, additional boiler(s) shall be sequenced in parallel to respond to system demand.
- d. The hot water supply temperature shall be reset based on the following schedule:

OA TEMPERATURE	HW SUPPLY TEMPERATURE
10 deg F	150 deg F
20 deg F	140 deg F
30 deg F	135 deg F
40 deg F	130 deg F
50 deg F	125 deg F
60 deg F	120 deg F

*At OA temperatures above 60 deg F, the plant shall be de-energized unless overridden by the Owner via the BAS or for dehumidification.

- e. Boiler Isolation valve shall be open when the boiler it is associated with (B-X) is commanded on by the boiler plant control panel. A delay timer shall be configured to keep the valve open for a period of 2 minutes after a boiler is commanded off by the plant controller. The control valve shall be normally open and be provided by the boiler manufacturer.
- f. On a rise in outdoor air temperature above the outside air set-point plus a differential temperature and there is no command for dehumidification, the boiler plant control panel shall disable the boiler plant. The boiler(s) shall stop first and after a time delay of one minute (adjustable) the hot water pump shall stop.
- g. The BAS shall poll the existing building room temperature sensors based on programming by the BAS contractor and provide feedback to boiler plant controller to reduce overheating within the building.
- h. Adaptive algorithms must continuously re-evaluate and dynamically adjust boiler sequencing set-points based on variations in hot water temperature set-point and hot water loop differential and flow in order to assure optimum energy efficiency.

3. Hot Water Pumping (VFD Control):

- a. The hot water pump system shall consist of a primary pump and a stand-by pump, which shall be alternated on a programmed schedule (adjustable). One pump shall run continuously during normal operation (occupied heating mode).
- b. The hot water pump system shall be enabled based on outside air temperature, 60 deg F adjustable and shall start and stop in concert with the hot water boiler control system.
- c. In the event of a non-start of the primary pump as sensed by a current transducer on the pump motor, the control system shall automatically switch to the stand-by pump and generate an alarm signal to the BAS system.

- d. If after the switch to the stand-by pump is made and the stand-by pump's current transducer senses a non-start of the pump, the BAS control system shall generate an alarm signal and the primary pump shall continue to operate.
 - e. The VFD shall receive its input from the loop header differential pressure transmitter/sensors and will adjust output. The VFD shall be programmed as to not reduce system flow below 60%.
 - f. In Primary pumping system, the primary pump shall run on an adjustable time delay with boiler fire to allow loop heat to dissipate.
 - g. Provide flow meters and temperature probes on the hot water secondary piping as per control diagrams. Utilize the hot water flow meter and hot water temperature sensors to provide a BTU energy use output. Trend this output in 5-minute intervals.
4. Boiler Plant Unoccupied Control
- a. When the boiler plant is set to unoccupied mode and the outdoor air temperature is above 38 deg F (adj), boilers and pumps shall be disabled.
 - b. When the boiler plant is in unoccupied mode and the outdoor air temperature is below 38 deg F (adj), boiler plants and pumps will be enabled and the supply water temperature setpoint shall be 120 deg F (adj) to circulate water to the building for freeze protection.
 - c. When the boiler plant is in unoccupied mode and the outdoor air temperature is below 38 deg and there is a call for heating in the building, boiler plants and pumps will be enabled and the supply water temperature setpoint shall be set per the occupied heating setpoints per the OA reset schedule.
5. Make-up Water:
- a. Make-up water flow to the boiler system shall be monitored by the BAS through a flow totalizer.
6. Safety Shutdown and Alarms: Upon the following conditions, boiler(s) shall shut down automatically in accordance with the normal shutdown sequence and an alarm shall be indicated at the BAS front-end workstation and alert the maintenance personnel via email. Scope noted below is by the Package #3 Contractor unless otherwise noted.
- a. Plant Emergency Break-Glass Alarm: Upon activation of the plant emergency break-glass switches/push buttons as noted on the electrical documents the boilers shall be shut down and an alarm shall be indicated.
 - b. Manufacturer Standard Safety Alarm: If boiler manufacturer's standard safety controls are violated, a common alarm shall be indicated.
 - c. Boiler Failure Alarm: If boiler(s) fail to fire after pre-programmed sequence and require a manual reset, an alarm shall be indicated.
 - d. Pump/VFD Failure Alarm: If pump(s) or associated VFD(s) fail to operate after pre-programmed sequence and require a manual reset, an alarm shall be indicated.
 - e. HW Loop Low Temperature Alarm: If outside air temperature is less than that scheduled in the OA Reset Schedule above and the HWS temperature is less than the HWS set-point by 5 deg F (adjustable), then an alarm shall be indicated.
 - f. Make-Up Water Alarm: Upon a total flow of more than 5 gallons (adjustable) of make-up water, an alarm shall be indicated.

- g. Building Ambient Temperature Alarm: If the space temperature in unoccupied mode drops below 63 deg F in a typically occupied space (i.e. classroom) then an alarm shall be indicated.
 - h. Natural Gas Leak Detection Alarm: Upon sensing of a natural gas leak by the natural gas leak detection system, the Boilers shall be shutdown and an alarm indicated.
7. Points to be monitored and displayed on BAS:
- a. Boiler Status (ON/OFF).
 - b. Boiler Operating Parameters via Boiler Control Panel (by Condensing Boiler Manufacturer) including but not limited to, sequencing, staging, runtime, % of full load, electrical power consumption in kWh, Boiler entering and leaving water temperatures in deg F.
 - c. Outside Ambient Temperature in deg F.
 - d. Hot Water Supply Header Set-point in deg F.
 - e. Hot Water Header Supply and Return Temperature in deg F.
 - f. Hot Water Loop Pump; Primary and Stand-by:
 - 1) Command and Status (ON/OFF),
 - 2) Runtime in hours,
 - 3) VFD Control and Pump Speed in Hz,
 - 4) General Alarm,
 - 5) Electrical Power Consumption.
 - g. Boiler Pump; One per Boiler:
 - 1) Command and Status (ON/OFF),
 - 2) Runtime in hours,
 - 3) General Alarm,
 - 4) Electrical Power Consumption.
 - h. Hot Water Loop Flow in GPM.
 - i. Make-up Water Flow Totalizer in GPM.
 - j. Boiler Room ambient temperature in deg F.
 - k. Loop Differential Pressure setpoint and reading in PSID.
 - l. Natural gas consumption via flowmeter in CFH.
 - m. Safety Shutdown and Alarms as indicated above.

1.6 VARIABLE AIR VOLUME ROOFTOP UNITS WITH ENERGY RECOVERY SECTION

- A. General: Rooftop Units (RTU) shall be controlled as follows:
- 1. Rooftop Units shall be controlled as Variable Air Volume, Discharge Air Temperature Setpoint Control with a Room Reference Temperature.
- B. The unit shall run based upon an operator adjustable schedule. The unit shall not run during:
- 1. High Static Shutdown: The unit shall shut down and generate an alarm upon receiving a high static shutdown signal.
 - 2. Return Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a return air smoke detector status activation.

3. Fire Smoke Damper Detection: The unit shall shut down and generator and alarm upon receiving a fire smoke damper detector status activation.
- C. RTU Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.
- D. Occupied Mode
 1. The supply fan shall operate continuously.
 2. The VFD shall modulate to maintain the duct static pressure.
 3. The DX Cooling Section, Hot Gas Reheat Section and economizer dampers shall modulate in sequence to maintain the cooling discharge air temperature and relative humidity setpoints.
 4. Heating Section shall operate if cooling section is off to meet the unit discharge air temperature setpoint.
 5. The outdoor air damper shall be set to its minimum position and shall track the exhaust air or building pressure input as required to maintain the differential pressure.
- E. Unoccupied Mode / Night Setback
 1. The supply fan shall be off.
 2. The outdoor air damper shall be closed and return air damper open.
 3. Cooling and Heating Systems shall remain off unless unoccupied room temperatures are exceeded. If exceeded, unit shall function in a recirculation mode until space temperature setpoints are within range.
- F. Morning Warm-Up Heating Mode
 1. The supply fan shall operate continuously.
 2. The VFD shall modulate to maintain the duct static pressure.
 3. The outdoor air damper shall be closed and DX Cooling off.
 4. The return air damper shall be fully open, and the Gas Heating Section valve shall modulate to maintain maximum heating discharge air temperature set point.
 5. All VAV / FPB terminal units will be open until the set-point criterion is satisfied and the RTU returns to the occupied or unoccupied mode.
- G. Supply Fan Control
 1. The supply fan shall operate continuous (occupied cooling/heating mode or night set back/morning warm up heating mode) unless shutdown on safeties.
 2. The supply fan shall be off when:
 - a. The AHU is in unoccupied mode.
 - b. The mixed air low limit is tripped.
 - c. Fan status indicates a failure (after a 2 minute delay).
 3. Low limit and fan failure require a manual reset.
 4. Provide alarms for:
 - a. Supply Fan Failure: Commanded on, but the status is off.
 - b. Supply Fan in Hand: Commanded off, but the status is on.

- c. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

H. Supply Fan VFD Control

1. When the supply fan is on the variable frequency drive will slowly ramp up (adjustable) and modulate to maintain the proper discharge duct static pressure setpoint. The speed shall not drop below 30% (adj.). The static pressure setpoint shall be reset based on zone cooling requirements.
 - a. The initial duct static pressure setpoint shall be 1.5in H2O (adj.).
 - b. As cooling demand increases, the setpoint shall incrementally reset up to a maximum of 1.8in H2O (adj.).
 - c. As cooling demand decreases, the setpoint shall incrementally reset down to a minimum of 1.3in H2O (adj.).
2. Alarms shall be generated for:
 - a. High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
 - b. Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
 - c. Supply Fan VFD Fault.

I. Economizer Control

1. When the outdoor air temperature is less than the changeover set point, the comparative enthalpy economizer shall be enacted. The outside air damper shall modulate the air flow between the minimum required outdoor air flow set point and the fully open position to maintain the discharge air temperature at the cooling discharge air temperature set point.
2. If the mixed air temperature is less than 45 deg F (adj) the damper shall be modulate to minimum position.
3. The mixed air sensor shall be located between the heating coil and the cooling coil.
4. If the outdoor airflow is modulated below the minimum requirement, an alarm shall be sent to the BAS indicating a minimum ventilation flow failure.
5. A manual reset mixed air low limit shall turn disable the supply fan when the sensing element is below its set point.
6. The outdoor air damper shall be controlled to maintain the required minimum outdoor airflow if the economizer function is disabled, or the discharge air temperature sensor has failed.
7. If the RTU is the morning warm-up mode or the supply fan is off, the outdoor air damper shall be closed.
8. If the mixed air temperature sensor has failed, the outdoor air damper shall be closed, and an alarm shall be sent to the BAS indicating a mixed air sensor failure and a minimum ventilation flow failure.
9. The economizer damper shall close if the freezestat is on.

J. Dampers

1. The outside and exhaust air dampers shall close, and the return air damper shall open when the unit is off. If Optimal Start Up is available, the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

2. Minimum Outside Air Ventilation - Fixed Percentage: The outside air dampers shall maintain a minimum adjustable position during building occupied hours and be closed during unoccupied hours.

K. Gas Heating Section

1. The natural gas heating valve shall modulate to maintain the heating discharge air temperature (adj.).
2. The natural gas heating valve shall modulate to maintain discharge air temperature at the night setback / morning warm-up discharge air heating set point.
3. The natural gas heating valve shall be closed if the cooling valve is open.
4. The heating discharge air temperature setpoint may be reset based on space, return, OAT or via network inputs. A linear relationship between the discharge air temperature and the reset variable will function between the minimum and maximum discharge air temperature setpoints.
5. Alarms shall be generated for:
 - a. Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.

L. Cooling System Controls

1. The DX Cooling System shall modulate to maintain room setpoint by adjusting discharge air temperature at the discharge air cooling set point of 55 deg F (adj.) 365 days per year. The supply air temperature setpoint shall be optimized by maintaining a supply air temperature setpoint reset based on the zone cooling and heating requirements. As cooling demand increases, the setpoint shall be incrementally reset down to a minimum = of 52 deg. F (adj.). As cooling demand decreases, and if the outside air temperature is below 40 deg. F (adj.), the setpoint shall be incrementally reset up to a maximum of 65 deg F.
2. If the economizer function is enabled and the outdoor air damper is not fully opened, the DX Cooling shall be disabled.
3. The DX Cooling shall be disabled if the RTU is in the heating mode, the supply fan is off, or the discharge air temperature sensor has failed.
4. Humidity Control via Hot Gas Reheat: The unit shall be provided with fully modulating hot gas reheat coil and appurtenances. The dehumidification sequence shall reference the leaving coil temperature and the discharge air temperature (DAT) sensor. During dehumidification, the refrigeration circuit controls the compressor(s) to maintain the leaving coil temperature setpoint and the reheat coil is controlled to maintain the supply air reheat setpoint. The supply air reheat setpoint changes based on the whether there is a call for both cooling and dehumidification or a call for dehumidification only. When a call for both cooling and dehumidification is made the reheat setpoint is set as the cooling DAT setpoint. During a call for dehumidification only the reheat setpoint is reset in a linear manner between two endpoints referred to as the min and max reheat setpoints (adj.). This reset is based on the cooling and heating setpoints for the rooftop unit. This logic will send warmer supply air when the space is approaching the heating changeover setpoint and cooler supply air when the space is approaching cooling changeover setpoint. This logic prevents unnecessary fluctuations between cooling and heating states. The dehumidification will be enabled based on the relative humidity in the return duct or space rises above the dehumidification setpoint of 65% RH (adj.)
5. Alarms shall be generated for:

- a. High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.
- b. CHW Freeze Protection Pump Failure: Commanded on, but the status is off.
- c. CHW Freeze Protection Pump in Hand: Commanded off, but the status is on.

M. Return Fan VFD Control (Same for Return / Exhaust Fan)

- 1. The return fan shall run whenever the supply fan runs. If the supply fan is disabled on alarm, then the return fan shall be disabled.
- 2. Alarms shall be generated for:
 - a. Return Fan Failure: Commanded on, but the status is off.
 - b. Return Fan in Hand: Commanded off, but the status is on.
 - c. Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
 - d. Return Fan VFD Fault.
- 3. The return fan VFD shall modulate to maintain building static pressure or airflow differential as measured by the airflow stations. The controller shall measure building static pressure and modulate the return fan VFD speed to maintain a building static pressure setpoint of 0.05in H2O (adj.). The return fan VFD speed shall not drop below 20% (adj.). Outdoor air damper tracking is also an acceptable means of controlling the return/exhaust fan.
- 4. Alarms shall be generated for:
 - a. High Building Static Pressure: If the building air static pressure is 25% (adj.) greater than setpoint.
 - b. Low Building Static Pressure: If the building air static pressure is 25% (adj.) less than setpoint.

N. Filter Monitor

- 1. Prefilter Differential Pressure Monitor: The controller shall monitor the differential pressure across the prefilter.
- 2. Alarms shall be provided as follows:
 - a. Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
- 3. Final Filter Differential Pressure Monitor: The controller shall monitor the differential pressure across the final filter.
- 4. Alarms shall be provided as follows:
 - a. Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

O. Return Air Temperature

1. The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).
2. Alarms shall be provided as follows:
 - a. High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 - b. Low Return Air Temp: If the return air temperature is less than 45°F (adj.).

P. Supply Air Temperature

1. The controller shall monitor the supply air temperature.
2. Alarms shall be provided as follows:
 - a. High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
 - b. Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

Q. Return Air Humidity

1. The controller shall monitor the return air humidity and use as required for economizer control.
2. Alarms shall be provided as follows:
 - a. High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
 - b. Low Return Air Humidity: If the return air humidity is less than 35% (adj.).

R. Energy Recovery Section

1. The controller shall operate the energy recovery section in accordance with the manufacturer's pre-programmed sequences including start/stop/jog, speed control and freeze protection.
2. Economizer Mode: During economizer mode, the heat wheel shall be deactivated.
3. Cooling Mode: During cooling mode, the heat wheel shall be activated.
4. Heating Mode: During heating mode, the heat wheel shall be activated.
5. Morning Warm-up Mode: During morning warm-up mode, the heat wheel shall be deactivated.
6. Alarms shall be provided as follows:
 - a. Fan Failure: Commanded on, but the status is off.
 - b. Fan in Hand: Commanded off, but the status is on.
 - c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).
 - d. Damper: If the damper does not match its commanded position, an alarm will be provided at the BAS.
 - e. Wheel Failure: If the wheel rotation sensor does not sense rotation, an alarm will be provided at the BAS.

S. Demand Controlled Ventilation

1. When in the occupied mode, the controller shall measure the return air CO2 levels and modulate the outside air dampers open on rising CO2 concentrations, overriding normal damper operation to maintain a CO2 setpoint of 800 ppm (adj.).

T. Freezestat

1. A two-pole freezestat shall be installed as shown on the flow diagram. One set of contacts is wired in series with the unit duct smoke detector for fan shutdown (by others). A second set of contacts closes when the device is tripped, sending an alarm signal to the control panel. In case of fan shut down, O.A. damper will fully close, RA damper will fully open, control valve will be fully open to the coil.

U. Humidity

1. Supply Air, Return / Exhaust Air Humidity shall be monitored and alarmed if relative humidity is higher than 65% RH.

V. Post-Fire Smoke Purge (IBC 403.4.7)

1. To comply with IBC 403.4.7 Post-Fire Smoke Purge requirements, the BMS Contractor and Fire Alarm Contractor shall coordinate to provide the following:
2. The “Post-Fire Smoke Purge” sequence shall be accessible via the BMS Owner User Interface and via the Fire Fighter’s Control Panel in the Fire Command Center (FCC).
3. The sequence shall be activated for “Post-Fire Smoke Purge” by manually enabling the Rooftop Unit(s) via switch at the FCC Control Panel. This panel shall also have the ability to open/close the fire-smoke damper actuators and monitor their position by floor. The sequence is as follows.
 - a. Main “Smoke Removal System” Mode is activated at the FCC Smoke Control Panel via key-operated switch.
 - 1) The allows the Office Floor RTU “Smoke Purge” sequence to be enabled.
 - b. Office Floor RTU “Smoke Purge” Switch is activated at the FCC Control Panel via “on/off” switch (on per floor).
 - 1) Main “Smoke Purge System” key switch must be “ON” in order for any floor to commence smoke purge mode.
 - 2) The RTU heat recovery wheel will be disabled.
 - 3) The RTU Supply and Exhaust fan shall be indexed to “Occupied” mode to maintain duct static pressure as described in Occupied mode sequence.
 - 4) The RTU Supply and Exhaust dampers indexed to “Occupied” mode.
 - 5) The Active floor’s fire-smoke dampers (supply and return/exhaust) shall be commanded open 100% and proven open via end switch. If the damper’s smoke detector is in alarm and preventing damper from opening an alert shall be sent to the BMS and the operator will have to manually open the damper from the FCC Control Panel.
 - 6) Active floor’s RTU and associated VAV boxes primary air valve shall open 100% regardless of their programmed maximum position.
 - 7) RTU supply and exhaust fan shall operate in occupied mode / economizer with 100% OA and full powered exhaust.
 - c. Main “Smoke Purge System” Switch is de-activated at the FCC Control Panel via key-operated switch.
 - 1) The RTU shall revert back to Normal, Occupied Mode of Operation.

- d. Office Floor RTU “Smoke Purge” Switch is de-activated at the FCC Control Panel via “on/off” switch (one per floor).
 - 1) The RTU shall revert back to Normal, Occupied Mode of Operation.
- W. Safety Shutdown and Alarms: Upon the following conditions, rooftop unit(s) shall shut down automatically in accordance with the normal shutdown sequence and an alarm shall be indicated at the DDCS front-end workstation and alert the maintenance personnel via email:
 - a. Low Temperature Alarm.
 - b. Fan Alarm (Supply and Exhaust).
 - c. Manufacturer Standard Alarms.
 - d. Duct Smoke Detector Alarm.
 - e. Ventilation Alarm.
 - f. Fire/Smoke Purge Alarm.
- X. Points to be monitored and displayed at DDCS:
 - a. System Start, Stop, Status.
 - b. Room Temperature in deg F.
 - c. Room Humidity in % RH.
 - d. Room CO2 in ppm.
 - e. Room CO2 differential in ppm.
 - f. Ambient Outside Air Temperature in deg F.
 - g. Ambient Outside Air enthalpy in lb/hr.
 - h. Supply Air Temperature in deg F.
 - i. Supply Air Relative Humidity in %RH.
 - j. Supply Air Static Pressure in inches of WC.
 - k. Cooling Coil Discharge Air Temperature in deg F.
 - l. Return Air Temperature in deg F.
 - m. Return Air Relative Humidity in %RH.
 - n. Return Air CO2 in ppm.
 - o. Outside Air Temperature in deg F.
 - p. Outside Air Relative Humidity in %RH.
 - q. Outside Air CO2 in ppm.
 - r. Mixed Air Temperature in deg F.
 - s. Exhaust Air Temperature in deg F.
 - t. Exhaust Air Humidity in %RH.
 - u. Supply Fan (Start/Stop and Status).
 - v. Supply Fan VFD speed in Hz.
 - w. Return Fan (Start/Stop and Status).
 - x. Return Fan VFD speed in Hz.
 - y. Exhaust Fan (Start/Stop and Status).
 - z. Exhaust Damper (Status and Modulation).
 - aa. Outside Air Damper (Status and Modulation).
 - bb. Return Air Damper (Status and Modulation).
 - cc. DX Cooling (Status and Start/Stop).
 - dd. Hot Gas Reheat Coil (Status and Valve Position).
 - ee. Gas Fired Heat Exchanger (Status and Modulation).
 - ff. Filter Differential Pressure in inches of WC.
 - gg. Supply airflow in CFM.
 - hh. Return airflow in CFM.

- ii. Outside airflow in CFM.
- jj. Exhaust airflow in CFM.
- kk. Energy Recovery Wheel (Start/Stop and Status).
- ll. Unit in Smoke Purge Mode (Status).
- mm. Safety Shutdown and Alarms as indicated above.

1.7 SINGLE DUCT, VARIABLE AIR VOLUME TERMINAL UNIT (VAV)

A. Occupied Mode

1. On a rise in space temperature, the unit will modulate to provide maximum cooling airflow. As space temperature decreases, the box will modulate down to its minimum airflow.
2. For boxes with reheat, as the space temperature continues to fall to the heating set point, the terminal will modulate to its heating airflow. At this point, the hot water heating valve will be controlled as follows:
 - a. Proportional Hot Water – Below the heating set point, the hot water valve will modulate as required to maintain the active heating set point.
3. Occupant will have capability to adjust temperature and override unoccupied mode utilizing push button on wall-mounted thermostat.
4. Ventilation Control (Fixed):
 - a. When the unit is unoccupied mode, the ventilation airflow setpoint will be zero.
 - b. When the unit is in occupied mode, the ventilation airflow setpoint will equal the design outdoor airflow (see VAV Schedule).
5. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:
 - a. Occupied Mode: The unit shall maintain temperature setpoints as noted in 1.1.G.
 - b. Unoccupied Mode: The unit shall maintain temperature setpoints as noted in 1.1.G.
6. Alarms shall be provided as follows:
 - a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
 - c. Space Sensor Failure: If there is a fault with the operation of the zone sensor an alarm will be annunciated at the BAS. Space sensor failure will cause the VAV to drive the damper to minimum air flow if the VAV is in the occupied mode, or drive it closed if the VAV is in the unoccupied mode.
7. Discharge Air Temperature: The controller shall monitor the discharge air temperature.
 - a. Alarms shall be provided as follows:

- 1) High Discharge Air Temp: If the discharge air temperature is greater than 130°F (adj.).
- 2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

B. Unoccupied Mode

1. During unoccupied mode, the primary air valve will remain fully closed. Unit will be commanded to its heating or cooling mode if temperatures fall outside of the unoccupied temperature parameters.

C. Points to be monitored and displayed at BAS:

- a. System On, Off and Status.
- b. Room Temperature in deg F.
- c. Room Relative Humidity in % RH.
- d. Primary Airflow in CFM.
- e. Primary Air Damper Position (Open/Close).
- f. Discharge Air Temperature in deg F.
- g. Heating Valve Position in % Open.
- h. Safety Shutdown and Alarms as indicated above.

1.8 SERIES, FAN-POWERED BOXES (FPB)

A. Occupied Mode

1. On a rise in space temperature, the unit will modulate to provide maximum cooling airflow. As space temperature decreases, the box will modulate down to its minimum airflow. Terminal fan will operate continuously and vary the flow based on whether the unit is in heating or cooling mode.
2. For boxes with reheat, as the space temperature continues to fall to the heating set point, the terminal will modulate to its heating airflow. At this point, the hot water heating valve will be controlled as follows:
 - a. Proportional Hot Water – Below the heating set point, the hot water valve will modulate as required to maintain the active heating set point.
3. Occupant will have capability to adjust temperature and override unoccupied mode utilizing push button on wall-mounted thermostat.
4. Ventilation Control (Fixed):
 - a. When the unit is in unoccupied mode, the ventilation airflow setpoint will be zero.
 - b. When the unit is in occupied mode, the ventilation airflow setpoint will equal the design outdoor airflow (see Fan Powered Box Schedule).
 - c. The current ventilation airflow setpoint will be communicated to the BAS for control of the system outdoor-air intake.
5. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:

- a. Occupied Mode: The unit shall maintain temperature setpoints as noted in 1.1.G.
 - b. Unoccupied Mode: The unit shall maintain temperature setpoints as noted in 1.1.G.
6. Alarms shall be provided as follows:
- a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
 - c. Space Sensor Failure: If there is a fault with the operation of the zone sensor an alarm will be annunciated at the BAS. Space sensor failure will cause the VAV to drive the damper to minimum air flow if the VAV is in the occupied mode, or drive it closed if the VAV is in the unoccupied mode.
 - d. Duct Smoke Detector Shutdown for applicable units. Upon sensing smoke in the return airstream the unit shall shutdown and alarm at the BAS and fire alarm system.
7. Discharge Air Temperature: The controller shall monitor the discharge air temperature.
- a. Alarms shall be provided as follows:
 - 1) High Discharge Air Temp: If the discharge air temperature is greater than 130°F (adj.).
 - 2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).
8. Perimeter Heating Coil Valve (Where Applicable): The controller shall measure the zone temperature and modulate the perimeter heating coil valve open on dropping temperature to maintain its heating setpoint. If the perimeter heating does not satisfy the zone temperature requirement, then the VAV reheat shall become active.

B. Unoccupied Mode

- 1. During unoccupied mode, the primary air valve will remain fully closed. Unit will be commanded to its heating or cooling mode if temperatures fall outside of the unoccupied temperature parameters.

C. Points to be monitored and displayed at BAS:

- a. System On, Off and Status.
- b. Room Temperature in deg F.
- c. Room Relative Humidity in % RH.
- d. Room Carbon Dioxide in PPM.
- e. Primary Airflow in CFM.
- f. Primary Air Damper Position (Open/Close).
- g. Discharge Air Temperature in deg F.
- h. Fan On, Off and Status.
- i. Heating Valve Position in % Open.
- j. Filter Replacement Timer.
- k. Duct Detector Status (where applicable.)
- l. Safety Shutdown and Alarms as indicated above.

1.9 EXHAUST FAN - ON/OFF

- A. General: Applies to all general exhaust fans that operate via the building occupancy schedule and/or interlocked with a specific piece of equipment.
- B. Run Conditions - Interlocked: The fan(s) shall be interlocked to run whenever the HVAC equipment or damper is energized as noted on the contract documents unless shutdown on safeties.
- C. Fan: The fan shall have a user definable (adj.) minimum runtime.
- D. Exhaust Air Damper:
 - 1. The exhaust air damper shall open anytime the unit runs and shall close anytime the unit stops. The exhaust air damper shall close 30 sec (adj.) after the fan stops.
 - 2. Alarms shall be provided as follows:
 - a. Damper Failure: Commanded open, but the status is closed.
 - b. Damper in Hand: Commanded closed, but the status is open.
- E. Damper Status: The fan shall be enabled after the damper status has proven.
 - 1. Alarms shall be provided as follows:
 - a. Damper Failure: Commanded open, but the status is closed.
 - b. Damper in Hand: Commanded closed, but the status is open.
- F. Fan Status: The controller shall monitor the fan status.
 - 1. Alarms shall be provided as follows:
 - a. Fan Failure: Commanded on, but the status is off.
 - b. Fan in Hand: Commanded off, but the status is on.
 - c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).
- G. Points to be monitored and displayed at BAS:
 - a. System On, Off and Status.
 - b. Motor Operated Damper Position (Open/Close).
 - c. Safety Shutdown and Alarms as indicated above.

1.10 EXHAUST FAN – HEAT REJECTION TYPE

- A. General: Applies to Mechanical Room Ventilation, Fire Pump Ventilation and other “heat rejection” applications as indicated on the contract documents.
- B. Run Conditions - Continuous:
 - 1. The unit shall be continuously enabled to maintain a zone temperature cooling setpoint of 85°F (adj.).

2. Alarms shall be provided as follows: High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - C. Fan: The fan shall run anytime the zone temperature rises above cooling setpoint, unless shutdown on safeties. The fan shall also run in the even of the CO sensor alarming.
 - D. Exhaust Air Damper: The exhaust air damper shall open anytime the unit runs and shall close anytime the unit stops. The exhaust air damper shall close 30 sec (adj.) after the fan stops.
 - E. Ventilation Air Damper: The ventilation air damper shall be hard-wired interlock with the exhaust fan and exhaust air damper and shall prove open prior to fan operating.
 - F. Damper Status: The fan shall be enabled after the damper status has proven.
 1. Alarms shall be provided as follows:
 - a. Damper Failure: Commanded open, but the status is closed.
 - b. Damper in Hand: Commanded closed, but the status is open.
 - G. Fan Status: The controller shall monitor the fan status.
 1. Alarms shall be provided as follows:
 - a. Fan Failure: Commanded on, but the status is off.
 - b. Fan in Hand: Commanded off, but the status is on.
 - c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).
 - H. Points to be monitored and displayed at BAS:
 - a. System On, Off and Status.
 - b. Room Temperature in deg F.
 - c. Exhaust Air Motor Operated Damper Position (Open/Close).
 - d. Ventilation Air Motor Operated Damper Position (Open/Close).
 - e. Safety Shutdown and Alarms as indicated above.
- 1.11 STAIRWELL PRESSURIZATION FANS
- A. General: Stairwell pressurization fan controllers shall be UUKL compliant and installed on an isolated network. Controllers shall be installed in NEMA3R enclosures on the roof next to VFDs.
 - B. All controllers and associated installation/wiring associated with stair pressurization shall be UUKL compliant.
 - C. Stair Pressurization Sequence:
 1. Field DDCS controller shall control SPF-# for pressurization of respective Stair.

2. The supply fan VFDs communicate with the BAS system, allowing the operator to view and adjust selected parameters through the BAS system. Start/stop and speed control signal are hard-wired to the VFD.
 3. System Disabled:
 - a. The Supply fan stops and damper D-# closes.
 4. System Enabled Sequence:
 - a. The Fire Alarm system energizes fire control module and engages DDCS field controller. DDCS shall then close a contact in the VFD to energize actuator, opening damper D-1. Damper end switch DES-1 closes to start the supply fan at minimum speed. Differential pressure switch reports the fan status back to the DDCS. Current sensor SF-S verifies fan operation and enables fan speed control. Stairwell pressure is sensed at STAIRx-P1. The setpoint will be +0.17"wg (adj.). Field DDCS Controller will ramp-up speed control signal SF-O until setpoint is achieved and then modulate the speed signal to maintain setpoint. When the fire alarm system de-energizes control module FIREONx, the supply fan will stop, and its outdoor air damper D-1 will close.
 - b. Note: The local field DDCS controller on roof, mounted next to SPF VFD, shall receive input from fire alarm panel to activate. Local field controller and VFD shall be on emergency power. All low voltage power required to run and activate stairwell pressurization system, including differential pressure sensor, shall derive from roof DDC panel as this panel shall be on emergency power.
- D. Damper Status: The fan shall be enabled after the damper status has proven.
1. Alarms shall be provided as follows:
 - a. Damper Failure: Commanded open, but the status is closed.
 - b. Damper in Hand: Commanded closed, but the status is open.
- E. Fan Status: The controller shall monitor the fan status.
1. Alarms shall be provided as follows:
 - a. Fan Failure: Commanded on, but the status is off.
 - b. Fan in Hand: Commanded off, but the status is on.
 - c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).
- F. Points to be monitored and displayed at BAS:
- a. System On, Off and Status.
 - b. Fan On, Off and Status.
 - c. Motor Operated Damper Command and Position (Open/Close).
 - d. Stairwell Pressure Sensor(s) reading in inches of w.c.
 - e. VFD Fault.
 - f. Safety Shutdown and Alarms as indicated above.

1.12 PARKING GARAGE EXHAUST / VENTILATION SYSTEM

- A. General: BMS Contractor shall provide a Control Panel that combines the Honeywell E-Point Garage CO/NO2 Control Panel and associated sensors to monitor and control the garage ventilation system (EF-1-1 and 1-2, VFDs and associated motor operated dampers) in addition to interlocking and controlling the transfer fans (EF-1-8; typical) as indicated on the plan. Outside air is being provided naturally via openings in the garage to the exterior.
 - 1. Provide Carbon Monoxide and Nitrogen Dioxide sensors for every 5,000 SF of required coverage.
 - 2. During periods of occupancy the system shall provide the minimum required ventilation flow rate.
 - 3. On a detection of Carbon Monoxide and/or Nitrogen Dioxide above 25 ppm the exhaust fan(s) shall go to their maximum speed.
 - 4. System shall be available regardless of occupancy.
- B. Damper Status: The fan shall be enabled after the damper status has proven.
 - 1. Alarms shall be provided as follows:
 - a. Damper Failure: Commanded open, but the status is closed.
 - b. Damper in Hand: Commanded closed, but the status is open.
- C. Fan Status: The controller shall monitor the fan status.
 - 1. Alarms shall be provided as follows:
 - a. Fan Failure: Commanded on, but the status is off.
 - b. Fan in Hand: Commanded off, but the status is on.
 - c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).
- D. Points to be monitored and displayed at BAS:
 - a. System On, Off and Status.
 - b. Fan On, Off and Status.
 - c. Motor Operated Damper Command and Position (Open/Close).
 - d. CO/NO2 Sensor(s) reading in ppm.
 - e. Fan VFD Fault.
 - f. Honeywell E-Point Garage Control Panel Alarm.
 - g. CO/NO2 Sensor(s) high ppm reading or alarm.
 - h. Safety Shutdown and Alarms as indicated above.

1.13 UNIT HEATER AND CABINET UNIT HEATER – HOT WATER

- A. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:
 - 1. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adj.).

2. Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F (adj.).
 - B. Alarms shall be provided as follows:
 1. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
 - C. Zone Unoccupied Override:
 1. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
 - D. Fan:
 1. The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.
 - E. Heating Coil Valve:
 1. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
 - F. The heating shall be enabled whenever:
 1. Outside air temperature is less than 65°F (adj.).
 2. AND the zone temperature is below heating setpoint.
 3. AND the fan is on.
 - G. Points to be monitored and displayed at BAS:
 - a. Room Temperature in deg F.
 - b. Unit Heater (Enable/Disable).
 - c. Valve Position (Open/Close).
 - d. Fan Status (On/Off)
 - e. Safety Shutdown and Alarms as indicated above.
- 1.14 UNIT HEATER – ELECTRIC (STAND-ALONE)
- A. Run Conditions – Stand Alone:
 1. The unit shall run according to the local thermostat setpoint:
 - a. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adj.).
 - b. Unoccupied Mode: Same as occupied.
 - B. Fan:

1. The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.

C. Heating (Electric):

1. The unit controller shall measure the zone temperature and stage the heating to maintain its heating setpoint.

1.15 SPLIT SYSTEM AIR CONDITIONING UNITS (COOLING ONLY)

A. Occupied Mode

1. Unit shall operate to maintain room ambient set point based on unitary controller's programmed algorithms. Evaporator and condensing unit shall be hard-wired interlocked for operation. Split system shall be integrated into the BAS. Additional Temperature and Humidity sensor shall be provided to provide room information for monitoring and provide alarms.
2. Run Conditions – The unit shall run according to a user definable time schedule in the following modes:
 - a. Occupied Mode: The unit shall maintain temperature setpoint of 75 deg F.
 - b. Unoccupied Mode: Same as Occupied Mode.
3. Alarms shall be provided as follows:
 - a. Unit Failure: Commanded on, but the status is off.
 - b. High Ambient Temp: If the room ambient temperature is greater than 85°F (adj.).
 - c. High Humidity: If the room ambient relative humidity is greater than 65%RH (adj.).
 - d. Condensate Overflow Alarm: If condensate overflow is detected, alarm shall be made at the front end and unit shall be de-energized.

B. Unoccupied Mode

1. Same as Occupied Mode.

C. Points to be monitored and displayed at BAS:

- a. System On, Off and Status.
- b. Room Temperature in deg F.
- c. Room Humidity in % RH.
- d. Fan Status (On, Off).
- e. Fan speed (Low, Medium, High).
- f. Safety Shutdown and Alarms as indicated above.

1.16 COMPUTER ROOM AIR-CONDITIONING UNITS

A. Occupied Mode

1. Unit shall operate to maintain room ambient set point for temperature and humidity based on unitary controller's programmed algorithms. Evaporator and condensing unit shall be hard-wired interlocked for operation. Computer Room Air-Conditioning Units shall be integrated into the BAS and all available points mapped into the system.
 2. Run Conditions – The unit shall run according to a user definable time schedule in the following modes:
 - a. Occupied Mode: The unit shall maintain temperature setpoint of 70 deg F and 50% RH.
 - b. Unoccupied Mode: Same as Occupied Mode.
 3. Alarms shall be provided as follows:
 - a. Unit Failure: Commanded on, but the status is off.
 - b. High Ambient Temp: If the room ambient temperature is greater than 85°F (adj.).
 - c. High Humidity: If the room ambient relative humidity is greater than 65%RH (adj.).
 - d. Condensate Overflow Alarm: If condensate overflow is detected, alarm shall be made at the front end and unit shall be de-energized.
- B. Unoccupied Mode
1. Same as Occupied Mode.
- C. Points to be monitored and displayed at BAS:
- a. System On, Off and Status.
 - b. Room Temperature in deg F.
 - c. Room Humidity in % RH.
 - d. Available BACnet Points via integration.
 - e. Safety Shutdown and Alarms as indicated above.

1.17 SPLIT SYSTEM AIR CONDITIONING UNITS (VRF HEAT PUMP SYSTEM)

- A. Occupied Mode
1. Unit shall operate to maintain room ambient set point based on unitary controller's programmed algorithms. Evaporator(s) and condensing unit(s) shall be hard-wired interlocked for operation and communication. The system shall be integrated into the BAS for monitoring, scheduling, and control.
 2. Run Conditions – The unit shall run according to a user definable time schedule in the following modes:
 - a. Occupied Mode: The unit shall maintain temperature setpoints as noted in 1.1.G.
 - b. Unoccupied Mode: The unit shall maintain temperature setpoints as noted in 1.1.G.
 3. Alarms shall be provided as follows:
 - a. Unit Failure: Commanded on, but the status is off.
 - b. Manufacturer's standard alarms.
 - c. High Ambient Temp: If the room ambient temperature is greater than 85°F (adj.).

- d. High Humidity: If the room ambient relative humidity is greater than 65%RH (adj.).
- e. Condensate Overflow Alarm: If condensate overflow is detected, alarm shall be made at the front end and unit shall be de-energized.

B. Unoccupied Mode

- 1. Same as Occupied Mode.

C. Points to be monitored and displayed at BAS:

- a. Evaporator Fan On, Off and Status.
- b. Evaporator Fan Speed (Low, Medium, High).
- c. Condensing Unit On, Off, Status.
- d. Room Temperature in deg F.
- e. Room Humidity in % RH.
- f. Discharge Air Temperature in deg F.
- g. System Cooling or Heating Mode.
- h. Safety Shutdown and Alarms as indicated above.

1.18 MISCELLANEOUS MONITORING

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show on Graphic
Emergency Generator POR			x						x		x
Emergency Generator Alarm			x						x	x	x
ATS Status			x						x		x
Domestic Water Heater Supply Temperature	x								x		x
Elevator Machine Room Space Temperature	x								x		X
Elevator Sump Pit (High Level Alarm)			x							x	x

1.19 INDICATIONS AND SAFETY

- A. Operator Station Display: Indicate on operator workstation display terminal system operating status and parameters listed in this section.
 - 1. DDC system graphic.
 - 2. DDC system status, on-off.

3. Outdoor-air temperature.
 4. Time and time schedule.
- B. Duct Detectors: A duct smoke detector shall be furnished by the electrical contractor and installed in the ductwork by the mechanical contractor. The electrical contractor shall provide wiring from the duct smoke detector to the associated unit's motor starter and to the building fire alarm system. Whenever products of combustion are sensed, the unit's fans will shutdown. O.A. damper will fully close, RA damper will fully open. Mechanical refrigeration or gas furnace whichever is in operation will be de-energized. Where indicated on the drawings, the mechanical contractor shall provide wiring from an additional set of contacts from the duct smoke detector to the HVAC unit's control panel to indicate a fire alarm condition and for secondary shutdown.
- C. Fire Alarm Interlock/Coordination: Where indicated on the drawings, the electrical contractor shall provide wiring from the building's fire alarm system to a set of contacts at the HVAC unit's control panel to indicate a fire alarm condition and for secondary shutdown.
- D. Freezestat: A two-pole freezestat shall be installed on the leaving side of all heating coils. One set of contacts is wired in series with the unit duct smoke detector for fan shutdown. A second set of contacts closes when the device is tripped, sending an alarm signal to the control panel. In case of fan shut down, O.A. damper will fully close, RA damper will fully open, control valve will be fully open to the coil.
- E. Motor Starters: All safety devices shall be wired so they stop the motor with the hand-off-auto switch in the hand as well as the auto position.
- F. Condensate Drain Pan Float Switches: A two-pole float switch shall be installed on the condensate drain pans on all units with cooling coils. One set of contacts is wired in series with the unit duct smoke detector for fan shutdown. A second set of contacts closes when the high water level is detected in the drain pan, sending an alarm signal to the control panel. In addition, for all horizontal suspended units with cooling coils, a leak detector shall be provided in an auxiliary drain pan and shall also be wired in series with the unit duct smoke detector for fan shutdown and shall send an alarm signal to the control panel.
- G. Carbon Monoxide / CH₄ / NO₂ Shutdown: Upon activation of the Carbon Monoxide or CH₄ sensor or NO₂ sensor as sensed by the local panel, the respective equipment shall be shutdown unless otherwise noted on the contract drawings. An alarm shall be initiated at the BAS.
- H. Heating Control Valves: At ambient temperatures, less than 40 deg F, hot water heating control valves shall be commanded to force flow through their respective heating coil.
- 1.20 SPARE I/O POINTS
- A. Provide analog and digital inputs and outputs on the BAS as required to achieve the above sequence of operation plus 20% for analog points and 20% for digital points. Submit point list for approval.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993