

HVAC CONTROL SYSTEM PROJECT MANUAL

SCOPE OF WORK • SEQUENCES OF OPERATION • CONTROL POINTS

For:

**Pflugerville ISD
Provan Opportunity Center
Control System Replacement Project**

Facilities:

Provan Opportunity Center



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1-A. GENERAL HARDWARE NOTES

- 1) Provide a new, complete, Direct Digital Control (DDC) system per the project specifications, control point lists, sequences of operation, and drawings to control all equipment identified on the Equipment Lists in this project manual for each building. If a building is noted to have an existing control system on the equipment list, the existing control system shall be completely removed and replaced with new components. Unless noted otherwise, this includes:
 - A) Replacement of all existing control system controllers and relays throughout the facility.
 - B) Replacement of all existing control system wiring throughout the facility, also including the 18-gauge control wiring between each split system indoor and outdoor unit.
 - C) Replacement of all existing control valves and valve actuators.
 - D) Replacement of all existing air damper actuators which interface directly with the control system (i.e. do not replace damper actuators inside equipment such as packaged rooftop units which are operated by the equipment manufacturer's controls). Existing air dampers will not be replaced unless they are found to be inoperable or damaged; such instances shall be brought to the attention of the Engineer and Owner for consideration of replacement.
 - E) Replacement of all existing sensors (temperature, pressure, humidity, CO2, etc.) which interface with the control system (i.e. do not replace factory-installed sensors integrated into equipment which are monitored by the equipment manufacturer's controls).
 - F) Replacement of all wall-mounted enclosures for control system controllers.
- 2) Provide proportional modulating actuators for all dampers/valves listed as an analog "AO" point type on the point lists (including those on VAV terminal units).
- 3) Existing duct smoke detectors are to remain and be re-used. Duct smoke detectors shall be directly interlocked with the associated system's fan motor starter/VFD or emergency stop contactor for automatic shutdown. The control system shall display an alarm indicating that an emergency shutdown has occurred (i.e. a "fan failure" alarm or discharge air temperature alarm).
- 4) All existing motor starters and variable frequency drives are to remain and be re-used. The Controls Contractor will be responsible for re-programming VFDs to accept new signals.
- 5) All existing Novar controllers and devices are to remain property of the District and shall be returned to the District immediately after removal for spare parts inventory.
- 6) Any other existing control components including control valves, actuators, sensors, etc. that the Owner chooses to retain shall remain property of the Owner and shall be returned to the Owner immediately after removal for spare parts inventory. Any control components that the Owner does not wish to retain or recycle will be property of the Contractor
- 7) HVAC systems serving portable buildings and other small, remote buildings shall be provided with wireless controls, or shall access the control network through a wireless router to communicate with the nearest permanent main building controller. All remote HVAC systems shall be seamlessly controlled by the main building automation system. A separate control system shall not be allowed.

- 8) Control Wiring and Conduit:
- A) Completely remove all existing control wiring from the building. If the existing control wiring cannot be removed in certain locations due to inaccessibility, the accessible ends of the wiring shall be cut back as far as possible away from equipment.
 - B) All control wiring shall be new continuous cable between connection points of equipment, controllers, sensors, etc. Spliced wires will not be permitted.
 - C) Existing control wiring conduit (if present) may be re-used unless existing conduit is damaged or corroded, is not water-tight (exterior locations), or does not meet specification requirements.
 - D) Replace all existing flexible conduit for control wiring at connections to equipment located outdoors. If flexible conduit length exceeds 5 feet, provide new metal conduit to within 5 feet of the equipment connection.
 - E) Provide EMT or rigid metal conduit for all indoor control wiring, with the following exceptions:
 - a. Flexible conduit may be used within 5 feet of equipment connection point.
 - b. Conduit is not required for control wiring routed above ceilings or inside walls.
 - c. Control wiring in mechanical, electrical, telephone and data rooms with exposed structure may be installed without raceway where routed horizontally, tight to ceiling structure. Provide metal conduit drops down from the ceiling level to equipment or devices.
 - d. Architectural raceway may be used in occupied spaces where control wiring must be routed on a wall surface to zone sensors.
 - F) Refer to "Building Automation Systems" specification for additional control wiring installation requirements.
- 9) New controllers for packaged rooftop units may be installed inside the controls section of the rooftop unit. Controller enclosures are not required for HVAC equipment located above finished ceilings (e.g. VAV terminal units, split system AHUs).
- 10) All thermostats with push-button overrides or other occupant-adjustable controls will need to be located to comply with ADA mounting height requirements and project specifications.
- 11) Provide networking equipment required to interface the new control system with the Owner's existing network server. New operator workstations or servers should not be required to operate the new control system.
- 12) Refer to project specification section 25 00 00 "Building Automation Systems", as well as the control point lists and control sequences of operation in this project manual for additional control system renovation requirements.

1-B. GENERAL SOFTWARE NOTES

- 1) All equipment identified on the following pages is to be controlled by the new control system according to the sequence of operation specified for each.
- 2) An estimate of the required control points for each sequence of operation is provided in this project manual, but additional points and logic may be required so that the system functions as intended. The controls contractor's bid shall include all necessary control points and logic to operate equipment per the sequence of operation.
- 3) The term "User" in this document shall refer to the Building Owner/Operator, or any individual assigned with the system access permissions required to modify parameters such as setpoints, schedules, and overrides within the control system.
- 4) The User shall be able to define and assign a weekly time schedule to any equipment which is provided with enable/disable control or occupied/unoccupied mode control. The scheduling program shall also enable the User to assign temporary event or holiday schedules which are active for a defined period of calendar days, with the option to save the schedule for future use and automatically repeat the schedule for recurring events.
- 5) All control inputs, outputs, and setpoints shall be available for data-logging within User-defined parameters through the control system interface.
- 6) All setpoints, delays, alarm parameters, PID settings, etc. defined in the control system shall be adjustable by the User. The minimum required User-adjustable settings are noted as "(adj.)" in the sequence of operation for each equipment type.
- 7) All control outputs shall be provided with User-adjustable override or lockout controls.
- 8) The control system interface shall display status and setpoint values in the following default units unless otherwise noted:

Temperature: °F
Relative Humidity: %RH
Enthalpy: BTU/LB
CO2 Concentration: PPM
Static Pressure (Air): INCHES W.C.
Water Pressure: PSI
VFD Speed: Hz
Valve and Damper Positions: % OPEN
Air Flow: CFM
Water Flow: GPM

2-A. LIST OF EQUIPMENT TO BE CONTROLLED PER EACH FACILITY

A. PROVAN OPPORTUNITY CENTER

PROVAN OPPORTUNITY CENTER

Existing Control System: Novar Controls

Scope: Fully remove existing control system and replace with new system to control or monitor the following equipment per the noted sequence of operation for each.

Facility Monitoring

TAG	SERVICE	CONTROL SEQUENCE
	Outside Air Temperature and Humidity	3 : Facility Monitoring and References
	Utility Power Pulse Meter	3 : Facility Monitoring and References
	Phase Failure Monitoring	3 : Facility Monitoring and References
	Fire Alarm System Monitoring	3 : Facility Monitoring and References

Fans

TAG	SERVICE	CONTROL SEQUENCE	CONTROL TYPE	INTERLOCK WITH
EF-1	Admin RRS	7: Exhaust Fans	INTERLOCK	RTU-1A
EF-2	Student Restrooms	7: Exhaust Fans	INTERLOCK	RTUMZ-2

Note: Other exhaust fans not listed (EF-3, EF-4, EF-5, EF-6, EF-7, EF-8) are controlled by other existing means, and will not be connected to the building control system.

DX Packaged Rooftop Units

TAG	SERVICE	CONTROL SEQUENCE	HEAT TYPE	FAN MODE	OA SUPPLY	OA DAMPER	CO2 DCV	DEHUMIDIFICATION	ECONOMIZER
RTU-1A	Administration	5: DX Packaged Rooftop Unit	GAS	CYCLE	DIRECT OA	2-POSITION	NO	HOT GAS REHEAT	NO
RTU-2A	Administration	5: DX Packaged Rooftop Unit	GAS	CYCLE	DIRECT OA	2-POSITION	NO	HOT GAS REHEAT	YES
RTU-3A	Administration	5: DX Packaged Rooftop Unit	GAS	CYCLE	DIRECT OA	2-POSITION	NO	HOT GAS REHEAT	YES
RTU-4A	Administration	5: DX Packaged Rooftop Unit	GAS	CYCLE	DIRECT OA	2-POSITION	NO	HOT GAS REHEAT	YES
RTU-5A	Dining	5: DX Packaged Rooftop Unit	GAS	CYCLE	DIRECT OA	2-POSITION	NO	HOT GAS REHEAT	YES
RTU-SCI-1 (NEW)	Science Lab	5: DX Packaged Rooftop Unit	GAS	CYCLE	DIRECT OA	2-POSITION	NO	HOT GAS REHEAT	NO
RTU-SCI-2 (NEW)	Science Lab	5: DX Packaged Rooftop Unit	GAS	CYCLE	DIRECT OA	2-POSITION	NO	HOT GAS REHEAT	NO

Multi-Zone Packaged Rooftop Units

TAG	SERVICE	CONTROL SEQUENCE	# of Zones	CONTROL LEVEL	CO2 DCV
RTUMZ-1	Classrooms	6: Multi-Zone Packaged Rooftop Unit	6 (FORMERLY 10)	ENABLE/DISABLE	NO
RTUMZ-2	Classrooms	6: Multi-Zone Packaged Rooftop Unit	11	ENABLE/DISABLE	NO

Portable Building DX Packaged Wall Units

TAG	SERVICE	CONTROL SEQUENCE
PWU-P1-A	Classroom P5	Z1 : Portable Building Packaged Unit
PWU-P1-B	Classroom P6	Z1 : Portable Building Packaged Unit

3. FACILITY MONITORING AND REFERENCES

- 1) Outside Air Conditions:
 - a. The control system shall monitor the outside air temperature and humidity, and calculate the outside air enthalpy on a continual basis. These values will be representative of the current outdoor air conditions at the building location and shall be made available to other equipment control sequences where required
 - b. Alarms shall be generated as follows:
 - i. Outdoor Sensor Failure: Sensor reading indicates shorted or disconnected sensor. In the event of a sensor failure, an alternate outside air conditions status from the district control network shall be made available to the system without interruption to control sequences.
- 2) Building Power Pulse Meter:
 - a. The control system shall monitor and record the building power (kW) on a continual basis, and display the maximum power recorded on a daily, monthly, and annual basis. Provide and install a new digital pulse meter at the building main power service entrance for this function.
 - b. The control system shall calculate and record building energy consumption (kWh) on a daily, monthly, and annual basis.
 - c. Alarms shall be generated as follows:
 - i. Building Power Signal Failure: No building power meter pulse signal detected.
- 3) Phase Failure Monitoring: A phase failure relay will notify the control system to de-energize all 3-phase HVAC equipment. Provide and install a control panel with UPS, relay and controller for this function.
- 4) Fire Alarm: Upon activation of the building fire alarm, the control system shall receive a signal from the Fire Alarm Control Panel. All air-moving HVAC systems (with the exception of exhaust fans) shall automatically shut down until the Fire Alarm is manually re-set.

Facility Monitoring and References Points Summary

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Outside Air Temperature	X				X
Outside Air Humidity	X				X
Building Power Pulse Meter		X			X
Solar Power Pulse Meter		X			X
Building Power Phase Failure		X			X
Fire Alarm		X			X
Totals	2	4	0	0	
	6				

Adjustable Control Settings (At Minimum)	Initial Setting

NOTES:

Additional Settings and Statuses to Show on Graphic
Outside Air Enthalpy (Btu/lb)
Building Consumption (kWh) - Year
Building Consumption (kWh) - Month
Building Consumption (kWh) - Day
Building Power Max. (kW) - Year
Building Power Max. (kW) - Month
Building Power Max. (kW) - Day
Solar Production (kWh) - Year
Solar Production (kWh) - Month
Solar Production (kWh) - Day
Solar Power Max. (kW) - Year
Solar Power Max. (kW) - Month
Solar Power Max. (kW) - Day
Active Alarms

Alarms
Outside Air Temperature Sensor Failure
Outside Air Humidity Sensor Failure
Building Power Signal Failure
Solar Power Signal Failure
Phase Failure
Fire Alarm

5. DX PACKAGED ROOFTOP UNITS

1) Run Conditions

- a. The control system shall command the Packaged Rooftop Unit (RTU) to run according to a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the RTU fan shall operate continuously or shall cycle on and off (***refer to equipment list***) while cooling and heating is controlled to maintain a 74°F (adj.) zone cooling setpoint and a 68°F (adj.) zone heating setpoint, with a +/-1.5°F (adj.) offset.
 - ii. In unoccupied mode (night setback) the RTU shall cycle on and off as needed to maintain an 85°F (adj.) zone cooling setpoint and a 55°F (adj.) zone heating setpoint, with a +/-1.5°F (adj.) offset. To prevent short-cycling the RTU fan shall run for and be off for a minimum period of 5 minutes each (adj.).
- b. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the system into occupied mode for 30 minutes (adj.). At the expiration of this time, control of the system shall automatically return to the schedule.
- a. For systems with “**Dual T-Stat**” specified on the equipment list: provide two temperature sensors in the area(s) served and calculate the average of the two temperatures for control. Refer to the floorplan drawings for temperature sensor locations.
- d. The supply fan shall run anytime the RTU is commanded to run, unless shutdown on safeties. The fan on/off status shall be monitored by the control system.
- e. Alarms shall be provided as follows:
 - i. Supply Fan Failure: The fan status is off 2 minutes (adj.) after being commanded on.
 - ii. Supply Fan in Hand: The fan status is on 2 minutes (adj.) after being commanded off.
 - iii. Supply Fan Runtime Exceeded: Status runtime exceeds a User-definable limit.
 - iv. High Zone Temp: The zone temperature is greater than the cooling setpoint by 5°F (adj.) after the RTU has been commanded to run for 60 minutes (adj.).

- v. Low Zone Temp: The zone temperature is less than the heating setpoint by 5°F (adj.) after the RTU has been commanded to run for 60 minutes (adj.).

2) RTU Start/Stop Sequence

- a. When the RTU is called to run, the control system will command the supply fan to run and enable cooling or heating as required to meet the zone temperature setpoint.
- b. If the RTU has a motorized outside air damper, the control system shall open the damper to the design ventilation position during occupied mode operation only. The outside air damper shall remain closed during unoccupied mode.
- c. When the RTU is called to stop, the control system shall stop the supply air fan, fully close the outside air damper (if present), and disable cooling and heating.

3) Cooling Control:

- a. When the zone temperature is above the zone cooling setpoint, the control system shall activate or deactivate compressor stages as required to maintain the zone temperature at the cooling setpoint.
- b. To prevent short-cycling, the compressors shall have a minimum on and off time of 2 minutes (adj.)
- c. Cooling shall be disabled if the supply fan status is OFF.
- d. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).

4) Heating Control:

- a. When the zone temperature is below the zone heating setpoint, the control system shall activate or deactivate heater stages as required to maintain the zone temperature at the heating setpoint.
- b. Heating shall be disabled if the supply fan status is OFF.
- c. Heating shall be disabled whenever the outside ambient temperature is above 70°F (adj.).

5) Temperature Monitoring:

- a. The control system shall monitor the RTU mixed air temperature and supply air temperature.

- b. Alarms shall be provided as follows:
 - i. High Supply Air Temp: The supply air temperature is greater than 120°F (adj.). Disable the RTU until the alarm is manually reset.
 - ii. Low Supply Air Temp: The supply air temperature is less than 40°F (adj.). Disable the RTU until the alarm is manually reset.

6) Dehumidification:

- a. For RTUs with **“Hot Gas Reheat”** dehumidification specified on the equipment list:
 - i. The RTU is equipped with a hot-gas reheat coil and factory-installed dehumidification controller.
 - ii. If the zone relative humidity exceeds 60% (adj.) while in occupied mode or unoccupied mode, the system shall be forced into dehumidification operation.
 - iii. The factory-installed controller will operate the cooling coil and hot-gas reheat coil in tandem to dehumidify the supply air until the zone relative humidity falls below 55% (adj.) while maintaining the zone temperature at the occupied cooling setpoint. A status indicator shall be provided on the control system graphic to indicate whenever the hot-gas reheat dehumidification mode is active.
- b. For RTUs with **“Cycle Max Cool”** dehumidification specified on the equipment list:
 - i. The RTU does not have factory-installed dehumidification controls.
 - ii. If the zone relative humidity exceeds 65% (adj.) while in occupied mode or unoccupied mode, the system shall be forced into dehumidification operation:
 - 1. The control system shall force the RTU into maximum cooling for a period of 15 minutes (adj.) with the outside air damper (if present) fully closed. If possible, control the fan to first stage/low speed. The maximum cooling period shall be stopped early if the zone temperature falls below 68°F (adj.) to prevent overcooling.
 - 2. Next, the system will enter a warm-up period, activating heat if necessary until the zone temperature equals or exceeds the occupied cooling setpoint. There shall also be a time delay to ensure the warm-up period lasts for a minimum of 5 minutes (adj.) before allowing the dehumidification cycle to repeat.

3. If the zone relative humidity is above the maximum setpoint after the warm-up period, the maximum cooling dehumidification cycle will repeat.
 4. If the zone relative humidity is below the maximum setpoint after the warm-up period, the system will return to normal occupied or unoccupied mode per the time schedule.
 - b. For all RTUs specified to have dehumidification, provide a relative humidity sensor located in the zone served and the following alarms:
 - i. High Zone Relative Humidity: The zone air relative humidity is greater than 65% (adj.).
- 7) Carbon Dioxide (CO2) Demand-Controlled Ventilation (**if “CO2 DCV” is specified on the equipment list**):
 - a. Provide a CO2 sensor located in the zone served. The control system shall monitor the zone CO2 concentration and use it as a reference to control outside the air volume.
 - b. While the RTU is operating in occupied mode, the 2-position outside air damper shall be opened or closed based on CO2:
 - i. The outside air damper shall open to the maximum design ventilation position at or above 1000 PPM (adj.).
 - ii. The outside air damper shall be fully closed at or below 800 PPM (adj.).
 - c. Alarms shall be provided as follows:
 - i. High Zone CO2 Concentration: The zone air CO2 concentration is greater than 1200 PPM (adj.) for 15 minutes (adj.) while the system is running in occupied mode and the outside air damper is commanded open.

DX Packaged RTU Points Summary

Typical of Each

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature (6)	X				X
Occupant Override		X			X
Zone Relative Humidity (2)	X				X
Zone CO2 Concentration (5)	X				X
Supply Air Temperature	X				X
Mixed Air Temperature	X				X
Supply Fan Start/Stop				X	X
Supply Fan Run Status		X			X
Cooling Stage 1				X	X
Cooling Stage 2 (1)				X	X
Heating Stage 1				X	X
Heating Stage 2 (1)				X	X
HGRH Dehumidification On/Off (3)				X	X
Outside Air Damper Open/Close (4)				X	X
Totals	5	2	0	7	
	14				

Additional Settings and Statuses to Show on Graphic
Current Zone Temperature Setpoint
Current Schedule Status (Occupied or Unoccupied)
Dehumidification Mode Status (2)
Active Program Overrides
Active Alarms

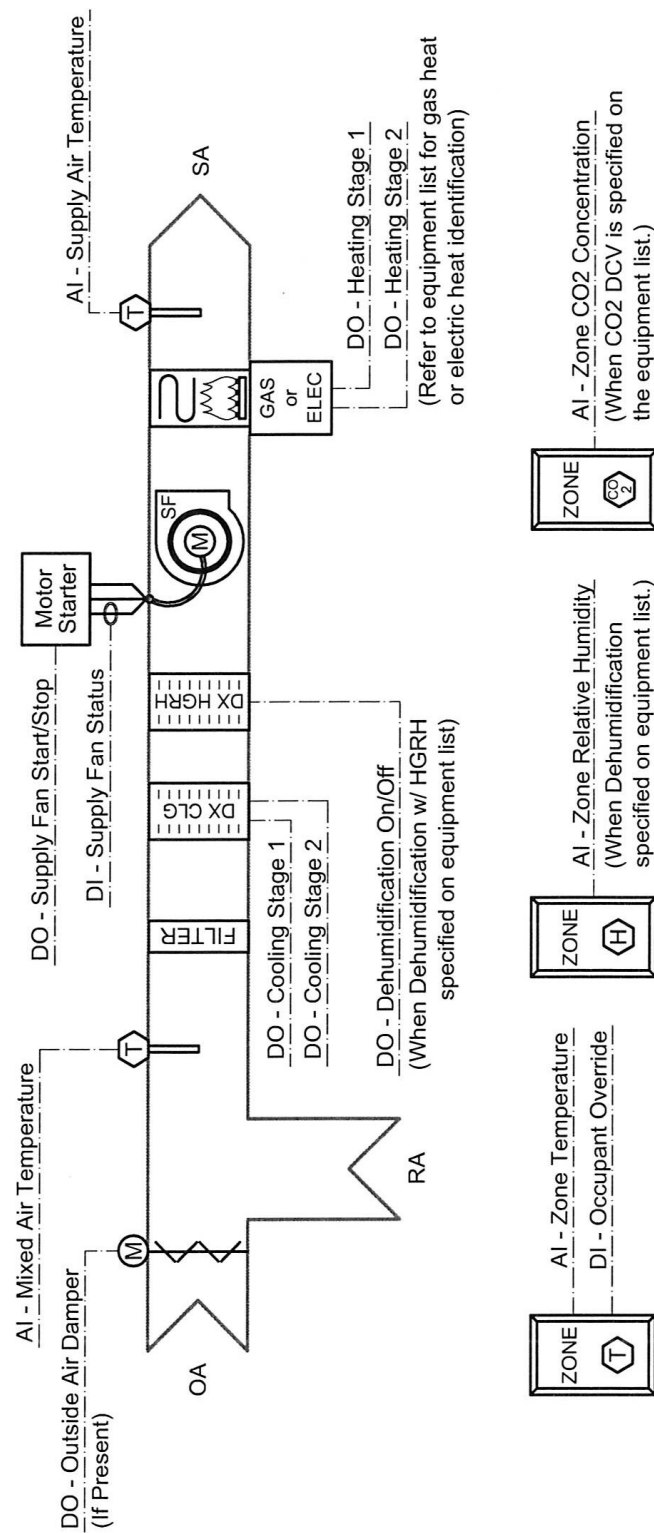
Alarms
Supply Fan Failure
Supply Fan Running in Hand
Supply Fan Runtime Exceeded
High Zone Temperature
Low Zone Temperature
High Supply Air Temperature
Low Supply Air Temperature
High Zone Relative Humidity (2)
High Zone CO2 Concentration (5)

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied Zone Temperature Cooling Setpoint	74°F
Occupied Zone Temperature Heating Setpoint	68°F
Unoccupied Zone Temperature Cooling Setpoint	85°F
Unoccupied Zone Temperature Heating Setpoint	55°F
Zone Temperature Cooling/Heating Offset (Drift)	+/-1.5°F
Maximum Relative Humidity Setpoint (2)	SEE SEQUENCE
Maximum CO2 Setpoint (5)	1000 PPM
Minimum CO2 Setpoint (5)	800 PPM
Minimum Fan Run Time / Off-Time	5 minutes
Minimum Compressor Runtime/Off-Time	2 minutes
Occupancy Override Run Time	30 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F

NOTES:

- 1) Verify number of heat/cool stages per unit
- 2) When dehumidification specified on the equipment list.
- 3) Only for units with a hot-gas reheat coil.
- 4) Provide control point if exist. motorized damper is present.
- 5) When CO2 DCV specified on the equipment list.
- 6) Provide two temperature sensors if "Dual T-Stat" is specified on the equipment list.

DX Packaged RTU Control Schematic



5. MULTI-ZONE PACKAGED ROOFTOP UNIT

1) Run Conditions

- a. The RTU shall be enabled to run by a User-defined occupied/unoccupied time schedule, or when any zone associated with the RTU is in occupied mode.
- b. The RTU shall be enabled to run whenever 2 (adj.) or more unoccupied zones call for heating or cooling.
- c. The supply fan shall run anytime the RTU is commanded to run, unless shutdown on safeties. To prevent short-cycling the supply fan shall run for and be off for a minimum period of 15 minutes each (adj.).
- d. Alarms shall be provided as follows:
 - i. Outside Air (OA) Fan Failure: The fan status is off 2 minutes (adj.) after being commanded on.
 - ii. OA Fan in Hand: The fan status is on 2 minutes (adj.) after being commanded off.
 - iii. OA Fan Runtime Exceeded: Status runtime exceeds a User-definable limit.
 - iv. OA Fan VFD Fault: Supply fan VFD is reporting an error.
 - v. Supply Fan Failure: The fan status is off 2 minutes (adj.) after being commanded on.
 - ii. Supply Fan in Hand: The fan status is on 2 minutes (adj.) after being commanded off.
 - iii. Supply Fan Runtime Exceeded: Status runtime exceeds a User-definable limit.
 - iv. Supply Fan VFD Fault: Supply fan VFD is reporting an error.
 - v. Freeze-Stat Trip: The unit shall shut down and generate an alarm upon receiving a freeze-stat trip status.
 - vi. Smoke Detector Trip: The unit shall shut down and generate an alarm upon receiving a supply or return air smoke detector trip status.

2) OA Cooling Coil:

- a. The BAS shall measure the OA Cooling Coil temperature and adjust the cooling output percent to maintain the OA cooling setpoint:
 - i. During occupied mode, the RTU shall supply outside air at a maximum temperature of 53.8°F (adj.) unless otherwise specified by a setpoint reset algorithm.
 - ii. During unoccupied mode, the RTU air damper is to be closed.
- b. OA Cooling shall be enabled whenever the system is in occupied mode, the OA fan status is ON and the natural gas heat is OFF.
- c. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).

3) Supply Air Cooling Coil:

- a. The BAS shall measure the supply air temperature temperature and adjust the cooling output percent to maintain the supply air cooling setpoint:
 - i. During occupied mode, the RTU shall supply outside air at a maximum temperature of 54°F (adj.) unless otherwise specified by a setpoint reset algorithm.
 - ii. During unoccupied mode, the RTU shall supply air at a maximum temperature of 60°F (adj.).
- b. Cooling shall be enabled whenever the supply fan status is ON and the natural gas heat is OFF.
- c. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).

4) Heating Control:

- a. When the zone temperature is below the zone heating setpoint, the control system shall activate or deactivate heater stages as required to maintain the zone temperature at the heating setpoint.
- b. Heating shall be disabled if the supply fan status is OFF.
- b. Heating shall be disabled whenever the outside ambient temperature is above 70°F (adj.).

4) RTU Start/Stop Sequence

- a. When the RTU is called to run, the BAS shall fully open the return air damper and fully close the outside air damper before starting the supply fan. The BAS will then command the supply fan to run and enable the cooling or heating sequence to operate as required to meet the supply air temperature setpoint. After the supply fan has been commanded to run for 30 minutes (adj.), the BAS shall open the outside air damper to the minimum ventilation position.
- b. When the AHU is called to stop, the BAS shall stop the heat sequence, stop the supply air fan, fully close the outside air damper and return air dampers, and de-energize the cooling sequence.

5) Supply Fan Speed Control:

- a. The BAS shall measure duct static pressure and adjust the supply fan VFD speed to maintain the duct static pressure at 1.0" w.g. (adj.). The fan VFD shall be controlled to operate between a maximum speed of 60 Hz (adj.) and a minimum speed of 15 Hz (adj.). The differential pressure setpoint and fan speed shall be field-adjusted during the commissioning period to meet the requirements of actual field conditions.
- b. The duct static pressure setpoint shall be reset based on zone damper positions.
 - i. If 2 (adj.) or more zone dampers are at a position of 100%, the duct static pressure setpoint shall incrementally increase until all zone dampers are at a position of 90% open (adj.) or less, up to a maximum duct static pressure of 1.5" w.g (adj.)
 - iii. If all zone dampers are at a position of 80% open (adj.) or less, the duct static pressure setpoint shall incrementally decrease until one or more zone dampers reach a position of 90% open (adj.), down to a minimum duct static pressure of 0.8" w.g. (adj.).
- c. Alarms shall be provided as follows:
 - i. High Duct Static Pressure: The duct static pressure is 25% (adj.) greater than setpoint. Disable the RTU until the alarm is manually reset.
 - ii. Low Duct Static Pressure: The supply air static pressure is 25% (adj.) less than setpoint.

6) Supply Air Temperature Setpoint Reset:

- a. The BAS shall monitor the supply air temperature and shall reset the supply air temperature setpoint for cooling based on the outside ambient temperature. The supply air temperature setpoint for cooling shall be incrementally increased as the outside ambient temperature decreases, within the following minimum and maximum bounds:
 - i. When the outside ambient temperature is 80°F (adj.) and above, the supply air cooling temperature setpoint shall be 53°F (adj.).
 - ii. When the outside ambient temperature is 55°F (adj.) and below, the supply air cooling temperature setpoint shall be 55°F (adj.).

7) Dehumidification:

- a. For RTUs with **“Hot Gas Reheat”** dehumidification specified on the equipment list:
 - i. The RTU is equipped with a hot-gas reheat coil and factory-installed dehumidification controller.
 - ii. If the zone relative humidity exceeds 60% (adj.) while in occupied mode or unoccupied mode, the system shall be forced into dehumidification operation.
 - iii. The factory-installed controller will operate the cooling coil and hot-gas reheat coil in tandem to dehumidify the supply air until the zone relative humidity falls below 55% (adj.) while maintaining the zone temperature at the occupied cooling setpoint. A status indicator shall be provided on the control system graphic to indicate whenever the hot-gas reheat dehumidification mode is active.

8) Economizer Operation:

- a. When the outside air temperature is between 70°F and 40°F (adj.) AND the outside air enthalpy is 28 Btu/lb (adj.) or less, the BAS shall enable economizer mode.
- b. While economizer mode is enabled, the outside air damper will open fully and the return air damper will close fully. Economizer mode shall have priority over CO2 Demand-Controlled Ventilation (if present) to override outside air damper control fully open even if ventilation is not required to meet the CO2 setpoint.
- c. A static pressure sensor located in the area served by the RTU will provide the BAS with a building static pressure feedback. The BAS will adjust the position of

the area's relief air damper to maintain the building static pressure at 0.1" w.g. (adj.) at all times.

d. Alarms shall be provided as follows:

- i. High Building Static Pressure: The building static pressure is greater than 0.25" w.g. (adj.) for 5 minutes (adj.). Disable economizer mode and return the outside air damper to the minimum ventilation position.

9) Temperature and Humidity:

a. The BAS shall monitor the return air temperature, return air humidity, mixed air temperature and supply air temperature.

b. Alarms shall be provided as follows:

- i. High Return Air Humidity: The return air relative humidity is greater than 65% (adj.).
- ii. High Supply Air Temp: The supply air temperature is greater than 120°F (adj.). Disable the AHU until the alarm is manually reset.
- iii. Low Supply Air Temp: The supply air temperature is less than 45°F (adj.).

MZ PACKAGED ROOFTOP UNIT INNOVENT

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temp Setpoint (1 per zone)			X		X
Zone Temp (1 per zone)	X				X
Building Static Pressure	X				X
Occupied/Unoccupied Mode				X	X
Alarm Status		X			X
Supply Air Temperature	X				X
MZ Damper Position (1 per zone)	X				X
Heating Output %	X				X
Supply Fan VFD Speed Setpoint			X		X
Supply Fan VFD Speed	X				X
Supply Fan Run Status		X			X
HGRH Output %	X				X
Cooling Coil LAT	X				X
Cooling Coil Compressor Run Status		X			X
Cooling Coil Output %	X				X
Return Air Temperature	X				X
Return Air Relative Humidity	X				X
RA Damper %	X				X
RA Dirty Filter Switch			X		X
OA Fan VFD Speed Setpoint			X		X
OA Fan VFD Speed	X				X
OA Fan Run Status		X			X
Outside Air Flow (AFMS)	X				X
Outside Air Temperature	X				X
Outside Air Humidity	X				X
Outside Air Damper %	X				X
Outside Air Damper Setpoint			X		X
OA Dirty Filter Switch			X		X
OA Cooling Coil %	X				X
OA Cooling Coil LAT	X				X
Exhaust Air Flow (AFMS)	X				X
Totals	20	4	6	1	
	31				

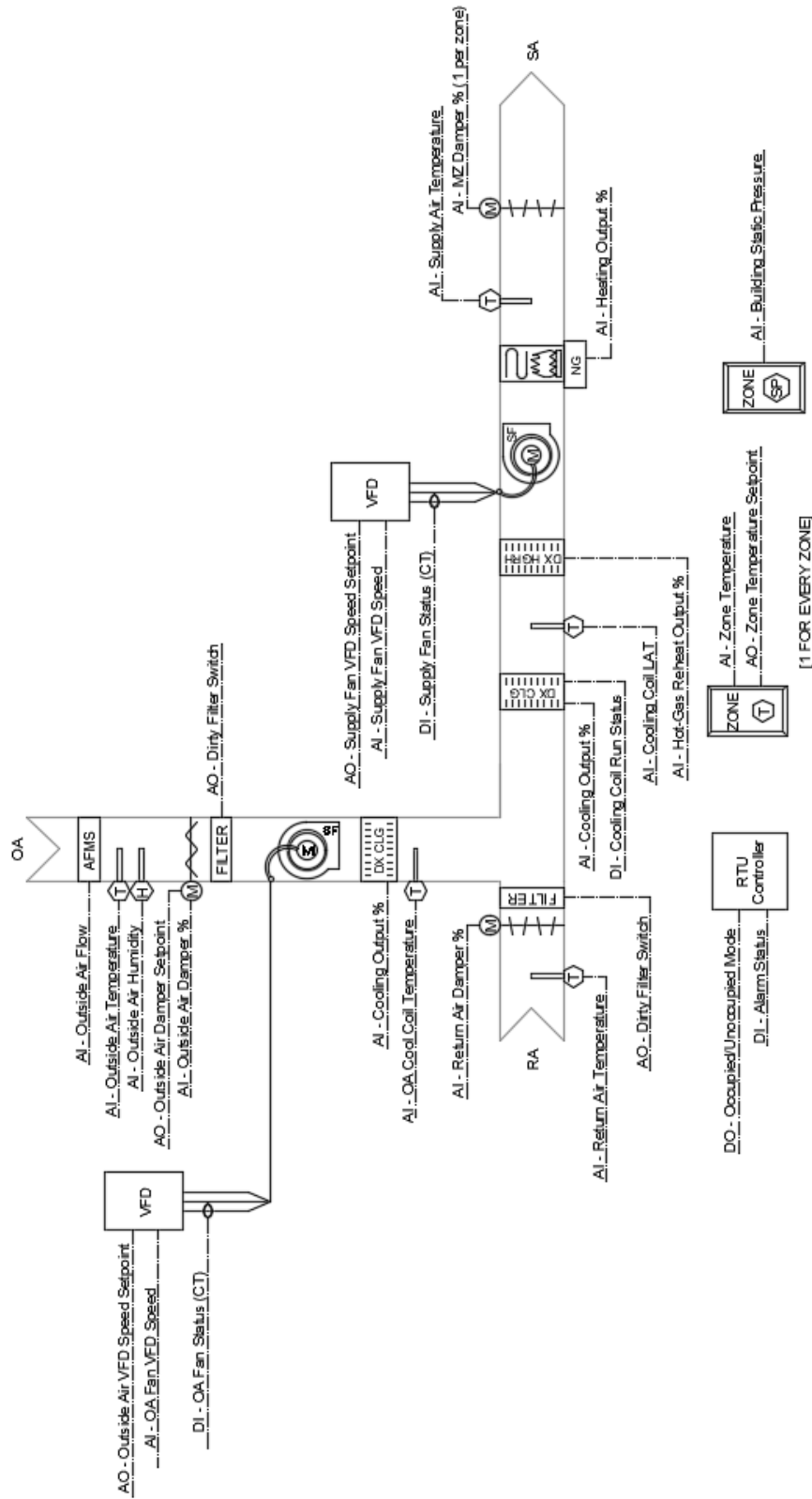
Adjustable Control Settings (At Minimum)	Initial Setting
MZRTU Enabled/Disabled Scheduling	SEE SCHEDULES
Supply Air Temperature Cooling Setpoint	70°F
Supply Air Temperature Heating Setpoint	65°F
Constant Fan Speed Override	AUTO

Additional Settings and Statuses to Show on Graphic
Outside Air Humidity (Site)
Active Program Overrides
Active Alarms

Alarms
High Supply Air Temperature
Low Supply Air Temperature
High Return Air Relative Humidity
High Return Air CO2 Concentration
High Zone Static Pressure
Low Zone Static Pressure
Supply/Exhaust Fan Failure
Supply/Exhaust Fan Running in Hand
Supply/Exhaust Fan Runtime Exceeded
MZRTU Internal Alarm

NOTES:

- 1) If system has multiple compressors; provide a run status for each. Field verify number of compressors in each MZRTU.



01 MZ PACKAGED ROOFTOP UNIT INNOVENT

Scale: None

7. EXHAUST FANS

1) Run Conditions

- a. For exhaust air fans specified on the Equipment List to have **“Scheduled”** control:
 - i. Exhaust fan shall be enabled by the control system to run according to a User-defined enabled/disabled time schedule.
- b. For exhaust air fans specified on the Equipment List to have **“Interlock”** control:
 - i. Whenever the specified HVAC unit is commanded to run in occupied mode, the interlocked exhaust fan shall also be commanded to run.
 - ii. The exhaust fan shall remain off when the zone is in unoccupied mode.
- c. Alarms shall be provided as follows:
 - i. Fan Failure: The fan status is off 2 minutes (adj.) after being commanded on.
 - ii. Fan in Hand: The fan status is on 2 minutes (adj.) after being commanded off.

Exhaust Fan Points Summary

Typical of Each

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Fan Start/Stop				X	X
Fan Run Status		X			X
Totals	0	1	0	1	
	2				

Adjustable Control Settings (At Minimum)	Initial Setting

Additional Settings and Statuses to Show on Graphic
Current Schedule Status (Occupied or Unoccupied)
Active Program Overrides
Active Alarms

Alarms
Fan Failure
Fan Running in Hand

9. ZONE TEMPERATURE MONITORING

- 1) Temperature Monitoring: The control system shall monitor the temperature of the specified zone.
 - a. Alarms shall be provided as follows
 - i. High Zone Temperature (Electrical and Computer Rooms): The temperature of the zone is greater than 95°F (adj.) for more than 5 minutes (adj.).
 - ii. Low Zone Temperature (Mechanical Rooms): The temperature of the zone is less than 35°F (adj.) for more than 5 minutes (adj.).

Zone Temperature Monitoring Points Summary

Typical of Each

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Totals	1	0	0	0	
	1				

Additional Settings and Statuses to Show on Graphic
Active Alarms

Adjustable Control Settings (At Minimum)	Initial Setting
High Zone Temperature Alarm Setpoint	> 95°F for 5 minutes
Low Zone Temperature Alarm Setpoint	< 35°F for 5 minutes

Alarms
High Zone Temperature
Low Zone Temperature

10. OUTDOOR LIGHTING CONTROL

- 1) Operating Conditions: Outdoor lighting shall be controlled by a User-defined occupied/unoccupied time schedule.

Outdoor Lighting Points Summary

Typical of Each School with Outdoor Lighting Controls

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Lighting Zone On / Off				X	X
Totals	0	0	0	1	
	1				

Additional Settings and Statuses to Show on Graphic
Active Program Overrides

Adjustable Control Settings (At Minimum)	Initial Setting