

PFLUGERVILLE ISD WINDERMERE ES 2024 HVAC AND CONTROL SYSTEM REPLACEMENT

PROJECT SCOPE OF WORK

&

*REQUIRED SEQUENCES OF OPERATION
AND CONTROL POINTS*

For the following facilities:

Windermere ES



806 W Main, Box 39
Atlanta, TX 75551
(512) 417 4989
Texas Registered Engineering Firm F-4882

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Chris Carter, P.E.
State of Texas #142639

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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 replace the existing Novar DDC system. Unless noted otherwise, this includes replacement of:
 - A. All existing Novar controllers throughout the facility
 - B. All existing control system wiring throughout the facility
 - C. All existing valve and damper actuators (including replacement of any remaining pneumatic actuators with new electronic actuators)
 - D. All existing sensors (temperature, pressure, humidity, CO2, etc.)
- 2) Replace the hot water and/or chilled water control valves where applicable for air handling units to be replaced as part of the concurrent HVAC renovation project. Refer to HVAC equipment schedules for chilled water and hot water pipe size and flow requirements. All other existing control valves are to remain and be re-used.
- 3) Existing air flow control dampers are to remain and be re-used, unless integrated within HVAC equipment replaced as part of the concurrent HVAC renovation project. Air dampers integrated within HVAC equipment shall be provided by the equipment manufacturer. Any duct-mounted air dampers added as part of the concurrent HVAC renovation project shall be provided by the mechanical contractor.
- 4) Provide proportional modulating actuators for all dampers/valves (including those on VAV terminal units) listed as an "AO" point type on the point lists.
- 5) Existing duct smoke detectors are to remain and be re-used except where new detectors are provided with new equipment as part of the concurrent HVAC renovation project. Duct smoke detectors shall be directly interlocked with the associated system's fan motor starter/VFD or emergency stop contactor for automatic shutdown. An alarm signal shall be sent to the BAS indicating that an emergency shutdown has occurred (i.e. a "fan failure" alarm or discharge air temperature alarm).
- 6) All motor starters and variable frequency drives are existing to remain and be re-used, unless specified to be replaced with the associated HVAC unit as part of the concurrent HVAC renovation. The Controls Contractor will be responsible for re-programming VFDs to accept new signals.
- 7) 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.
- 8) Any other existing control components including control valves, actuators, sensors, etc. that the District chooses to retain shall remain property of the District and shall be returned to the District immediately after removal for spare parts inventory. Any control components that the District does not wish to retain or recycle will be property of the Contractor

- 9) Refer to project drawing floor plans for locations of known equipment and existing building controllers.
- 10) 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.
- 11) Existing equipment such as building exhaust fans which are specified on the equipment list to be interlocked with HVAC units, light switches, wall switches, etc. may or may not be hardwire interlocked with these components already. The Contractor shall install or remove hardwire interlocks as required so the equipment operates as specified on the equipment list and control sequences at the completion of the project.
- 12) Conduit for controls wiring:
 - A) Replace existing control wiring conduit exposed to weather for all outdoor HVAC systems that are being replaced.
 - B) All other control wiring conduit (indoor and outdoor) may be re-used whenever possible, unless existing conduit is damaged, not water-tight (exterior locations), or does not meet specification requirements.
- 13) Re-use existing equipment-mounted controller enclosure panels where available. New controllers may be installed inside the controls section of rooftop units. Provide new wall-mounted controller enclosure panels in mechanical rooms if existing panels are undersized, in poor condition, or not available. New enclosures are not required for HVAC equipment controllers located above-ceiling (e.g. VAV terminal units, AHUs) if existing enclosures are not provided.
- 14) Existing wall-mounted zone thermostats may be installed in locations which do not comply with ADA accessibility standards. All new thermostats with push-button overrides or other occupant-adjustable controls will need to be relocated as necessary to comply with ADA mounting height requirements and project specifications.
- 15) Provide the networking equipment needed to interface the new BAS with the existing District DDC server. New operator workstations or servers should not be required to operate the new BAS.
- 16) Drain pan float switches, where required, shall be provided and installed by the Mechanical Contractor. Float switches will directly shut off the associated unit and will not interface with the BAS.
- 17) Refer to project specification section "Building Automation Systems", control point lists and control sequences of operation for additional control system renovation requirements.

1-B. GENERAL SOFTWARE NOTES

- 1) All equipment and systems of the types specified in the following sections are to be controlled by the new DDC Building Automation System (BAS) according to the sequence of operation specified on the equipment list. An estimate of the control points for each equipment type is provided in the following sections, 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 (whether listed on these points lists or not) to operate equipment per the applicable sequences as described in the following sections.
- 2) 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 BAS.
- 3) 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.
- 4) All control inputs, outputs, and setpoints shall be available for data-logging within User-defined parameters through the BAS interface's built-in trend log program.
- 5) All setpoints, delays, alarm parameters, PID settings, etc. defined by the BAS 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.
- 5) The BAS 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

- 6) Refer to the Building Automation System specification section in the Project Manual for additional control system requirements.



1-C. PRELIMINARY SCHEDULES

The recommended schedules for each zone type / equipment type are listed below. Refer to the equipment list for recommended schedule assignments per unit. All schedules and schedule assignments shall be modifiable by the User.

ELEMENTARY SCHOOLS	
Classrooms	6:45 AM - 3:30 PM, M-F
Corridors	7:00 AM - 2:30 PM, M-F
Administration	6:45 AM - 4:00 PM, M-F
Library	6:30 AM - 3:30 PM, M-F
Kitchen	6:00 AM - 2:00 PM, M-F
Cafeteria	6:30 AM - 6:30 PM, M-F
Gymnasium	6:45 AM - 6:30 PM, M-F
Make-Up Air	7:45 AM - 2:30 PM, M-F
DHW Circ Pumps	6:00 AM - 6:00 PM, M-F

MIDDLE SCHOOL	
Classrooms	6:30 AM - 4:45 PM, M-F
Corridors	7:00 AM - 3:30 PM, M-F
Administration	7:00 AM - 4:30 PM, M-F
Library	6:30 AM - 4:00 PM, M-F
Kitchen	6:00 AM - 3:30 PM, M-F
Cafeteria	6:30 AM - 4:45 PM, M-F
Gymnasium	6:30 AM - 4:30 PM, M-F
Locker Rooms	7:00 AM - 4:30 PM, M-F
Music Rooms	6:30 AM - 4:30 PM, M-F
Make-Up Air	8:25 AM - 3:30 PM, M-F
Chilled Water System	5:30 AM - 5:00 PM, M-F
Heating Water System	5:30 AM - 5:00 PM, M-F
DHW Circ Pumps	6:00 AM - 6:00 PM, M-F

HIGH SCHOOL	
Classrooms	7:30 AM - 5:30 PM, M-F
Corridors	8:00 AM - 4:30 PM, M-F
Administration	7:30 AM - 4:30 PM, M-F
Library	7:30 AM - 5:00 PM, M-F
Kitchen	6:00 AM - 3:30 PM, M-F
Cafeteria	7:30 AM - 5:30 PM, M-F
Gymnasium	7:30 AM - 5:30 PM, M-F
Locker Rooms	8:00 AM - 5:30 PM, M-F
Music Rooms	7:30 AM - 5:30 PM, M-F
Auditorium	7:30 AM - 5:30 PM, M-F
Weight Room	7:30 AM - 5:30 PM, M-F
Field House	7:30 AM - 5:30 PM, M-F
Make-Up Air	9:30 AM - 4:30 PM, M-F
Heating Water System	6:30 AM - 6:00 PM, M-F
DHW Circ Pumps	6:00 AM - 6:00 PM, M-F
Credit Union	7:30 AM - 4:30 PM, M-F
Exterior Lights	7:00 PM - 7:00 AM, M-Sun
Parking Lights	7:00 PM - 11:30 PM, M-F
	5:30 AM - 7:00 AM, M-F

2. LIST OF EQUIPMENT TO BE CONTROLLED PER SITE

A. WINDERMERE ES

WINDERMERE ELEMENTARY SCHOOL - NEW CONTROL SEQUENCE ASSIGNMENTS

Central Plant Equipment

TAG	SERVICE	CONTROL SEQUENCE	3-PHASE MOTOR	SCHEDULE
CH-1	Chilled Water System	4 : Air-Cooled Chillers	Yes	CHW SYSTEM
CH-2	Chilled Water System	4 : Air-Cooled Chillers	Yes	CHW SYSTEM
CHWP-1	Chilled Water System	5 : Variable Volume CHW Pumps	Yes	CHW SYSTEM
CHWP-2	Chilled Water System	5 : Variable Volume CHW Pumps	Yes	CHW SYSTEM
B-1	Hot Water System	6 : Natural Gas Boilers	-	HW SYSTEM
HWP-1	Hot Water System	7 : Variable Volume HW Pumps	Yes	HW SYSTEM
HWP-2	Hot Water System	7 : Variable Volume HW Pumps	Yes	HW SYSTEM
GWH-1	Domestic HW	20: Domestic Water Heaters	-	Domestic HW System

Air Handling Units

TAG	SERVICE	CONTROL SEQUENCE	CO2 DCV	3-PHASE MOTOR	ECONOMIZER	SCHEDULE
AHU-1	Kitchen	9 : CV Single Zone AHU	-	Yes	-	KITCHEN
AHU-2	Cafeteria	9 : CV Single Zone AHU	Yes	Yes	Yes	CAFETERIA
AHU-3	Custodial (Cafeteria)	9 : CV Single Zone AHU	Yes	Yes	Yes	CLASSROOMS
AHU-4	Lobby	9 : CV Single Zone AHU	-	Yes	-	CORRIDORS
AHU-5	West Wing Classrooms	8 : VAV Central Station AHU	Yes	Yes	Yes	By Req. from Zone
AHU-6	East Wing Classrooms	8 : VAV Central Station AHU	Yes	Yes	Yes	By Req. from Zone
AHU-7	Coach Office / Storage	10 : Fan Coil Unit	-	-	-	GYMNASIUM

VAV Terminal Units

TAG	SERVICE	CONTROL SEQUENCE	3-PHASE MOTOR	SCHEDULE	MAX / MIN CFM
VAV-C112	RM 112	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C111	RM 111	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C109	RM 109	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C108RR	RESTROOMS	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C CORR	CORRIDOR	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C104	RM 104	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C116	RM 116	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C146	CORRIDOR	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C119	RM 119	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C121	RM 121	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C125	RM 125	17 : Fan-Powered Terminal w/ HW Heat	-	CORRIDORS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C126	RM 126	17 : Fan-Powered Terminal w/ HW Heat	-	CORRIDORS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C127	RM 127	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-100HC	CORRIDOR	17 : Fan-Powered Terminal w/ HW Heat	-	CORRIDORS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B102	RM 102	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B103	RM 103	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B104	RM 104	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B105	RM 105	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-101HC	CORRIDOR	17 : Fan-Powered Terminal w/ HW Heat	-	CORRIDORS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C103	RM 103	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B109	RM 109	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B108	RM 108	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B107	RM 107	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B106	RM 106	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B111	RM 111	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B112	RM 112	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV B113	RM 113	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B114	RM 114	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV B110	CORRIDOR	17 : Fan-Powered Terminal w/ HW Heat	-	CORRIDORS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B115	RM 115	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B116	RM 116	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B117	RM 117	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-B118	RM 118	17 : Fan-Powered Terminal w/ HW Heat	-	CORRIDORS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C140	RM 140	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C139	RM 139	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C138	RM 138	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C135RR	RR C135	17 : Fan-Powered Terminal w/ HW Heat	-	RESTROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C132	RM 132	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C147	400 Hall	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C141	RM 141	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C142	RM 142	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C143	RM 143	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C144	RM 144	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS
VAV-C145	RM 145	17 : Fan-Powered Terminal w/ HW Heat	-	CLASSROOMS	SEE NEW EQUIP. SCHEDULE ON PLANS

Packaged Rooftop Units

TAG	SERVICE	CONTROL SEQUENCE	3-PHASE MOTOR	CO2 DCV	DEHUMIDIFICATION	ECONOMIZER	SCHEDULE
RTU-1	Admin Interior	12 : DX RTU w/ NG Heat - Constant OA	Yes	-	-	-	ADMINISTRATION
RTU-2	Admin Exterior	12 : DX RTU w/ NG Heat - Constant OA	Yes	-	-	-	ADMINISTRATION
RTU-3	South Corridor	12 : DX RTU w/ NG Heat - Constant OA	Yes	-	-	-	CORRIDORS
PU-1	Gymnasium	13 : DX RTU w/ NG Heat - Variable OA	Yes	Yes	Yes w/ HGRH	Yes, Enthalpy	GYMNASIUM

Area Relief Dampers

TAG	SERVICE	CONTROL SEQUENCE
RAH-1	AHU-2	23 : Area Relief Dampers
RAH-2	AHU-3	23 : Area Relief Dampers
RAH-3	AHU-1	23 : Area Relief Dampers
RAH-4	AHU-6	23 : Area Relief Dampers
RAH-5	AHU-6	23 : Area Relief Dampers
RAH-6	AHU-5	23 : Area Relief Dampers
RAH-7	AHU-5	23 : Area Relief Dampers

Fans

TAG	SERVICE	CONTROL SEQUENCE	3-PHASE MOTOR	SCHEDULE
EF-1	Janitor Office	X : Interlock w/ AHU-2	-	N/A
EF-4	Dishwasher Hood	Existing Interlock w/ Dishwasher	-	N/A
EF-5	Wash Area	X : Interlock w/ AHU-1	-	N/A
EF-6	Kitchen Toilet & Storage	X : Interlock w/ AHU-1	-	N/A
EF-7	Gym Area Student RR	X : Interlock w/ RTU-1	-	N/A
EF-8	Nurse Toilet	X : Interlock w/ RTU-1	-	N/A
EF-9	N.E. Student RR	X : Interlock w/ AHU-6	-	N/A
EF-10	Room 209 Toilet	Existing Interlock w/ Light Switch	-	N/A
EF-11	S.E. Student RR	X : Interlock w/ AHU-6	-	N/A
EF-12	Book Storage	X : Interlock w/ RTU-1	-	N/A
EF-13	Janitor Closet	Continuous Operation	-	N/A
EF-1K	Kitchen Hood	Existing Kitchen Hood Switch	Yes	N/A
SF-1K	Kitchen Hood	Existing Kitchen Hood Switch	Yes	N/A

Unit Heaters

TAG	SERVICE	CONTROL SEQUENCE	3-PHASE MOTOR	SCHEDULE
UH-5	Main Mechanical Room	18 : Unit Heater - Nat Gas	-	No Schedule

Domestic Hot Water Circulation Pumps

TAG	SERVICE	CONTROL SEQUENCE	SCHEDULE
CP-1A, 1B	WH-1 Kitchen	20 : Domestic Water Heaters	DHW CIRC. PUMPS

Kitchen Freezer/Cooler

TAG	SERVICE	CONTROL SEQUENCE
FREEZER	Kitchen	21 : Kitchen Frzr/Clr Temp Monitoring
COOLER	Kitchen	21 : Kitchen Frzr/Clr Temp Monitoring

3. FACILITY MONITORING AND REFERENCES

- 1) Outside Air Conditions:
 - a. The BAS shall monitor the outside air temperature and humidity and calculate the outside air enthalpy on a continual basis. These values shall be made available to the system at all times.
 - 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 BAS 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 BAS 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 BAS to de-energize all 3-phase HVAC equipment (refer to equipment list). 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 BAS 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.
- 5) Solar PV System Meter:
 - a. The BAS shall monitor and record the power output (kW) of the existing solar photo-voltaic system 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 main PV system disconnect.

- b. The BAS shall calculate and record the total energy produced (kWh) by the solar PV system daily, monthly, and annual basis, as well as display the building energy use and energy cost offset by the solar PV system.
- c. Alarms shall be generated as follows:
 - i. Solar Power Signal Failure: No solar power meter pulse signal detected.

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 (kW) (1)		X			X
Solar Power Pulse Meter (kW)		X			X
Building Power Phase Failure		X			
Fire Alarm		X			
Totals	2	4	0	0	
	6				

Adjustable Control Settings (At Minimum)	Initial Setting
Electricity Consumption Billing Rate Avg. (\$/kWh)	Not set
Electricity Demand Billing Rate Avg. (\$/kW)	Not set

NOTES:

- 1) Provide power monitoring meters and BAS points for each electrical service account to the building:
 - Administration - 1 electrical service
 - Northwest ES - 1 electrical service
 - Support Services - 1 electrical service

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
Energy Consumption Offset by Solar (kWh) - Year
Energy Consumption Offset by Solar (kWh) - Month
Energy Consumption Offset by Solar (kWh) - Day
Energy Cost Offset by Solar (\$) - Year
Energy Cost Offset by Solar (\$) - Month
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



4. AIR-COOLED CHILLERS

1) Run Conditions:

- a. The chillers shall be enabled to run by a User-defined enable/disable time schedule.
- b. After being enabled by the time schedule, the chillers and chilled water pumps shall stop if no chilled water coils have requested cooling for a period of 1 hour (adj.). The chiller and chilled water pumps shall re-start if 1 (adj.) or more chilled water coils request cooling AND the chiller is still enabled by the time schedule.
- c. To prevent short cycling, the chillers shall run for and be off for a minimum period of 15 minutes each (adj.), unless shutdown on safeties.
- d. Each chiller shall run subject to its own internal safeties and controls. A BACNET control interface shall be provided by the chiller manufacturer to allow the BAS to monitor and/or control chiller status and functions remotely. When a chiller is in alarm, a chiller alarm shall be displayed at the HMI.
- e. Alarms shall be provided as follows:
 - i. Chiller Failure: The chiller status is off 2 minutes (adj.) after being commanded on.
 - ii. Chiller Running in Hand: The chiller status is on 2 minutes (adj.) after being commanded off.
 - iii. Chiller Runtime Exceeded: Status runtime exceeds a User definable limit.
 - iv. Manual Reset / Auto Reset Chiller Alarm: Chiller is reporting an internal alarm.

2) Chiller Isolation Valves:

- a. Each chiller isolation valve shall open anytime the associated chiller is called to run. The chiller isolation valves shall open prior to the chiller being enabled and shall close only after the chiller is disabled. The chiller isolation valves shall therefore have a User-adjustable delay on stop. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.
- b. All chiller isolation valves shall open whenever the chilled water pumps are called to run for freeze protection.

3) Chiller Start / Stop Sequence

- a. When the chilled water system is activated, the BAS will open the lead chiller's isolation valve and start the lead chilled water pump. Once chilled water flow has been proven by the lead chiller flow switch, the chiller will start and maintain the leaving water temperature at setpoint by its own internal controls.
- b. The chillers shall have a User-adjustable delay on start. The delay shall prevent the chillers from starting until 5 minutes (adj.) after the pumps have been commanded to start.
- c. If the lead chiller fails to start, the BAS shall activate the Chiller Failure alarm and attempt to start the lag chiller in the same manner as the lead chiller.
- d. When the chilled water system is deactivated, the BAS will stop the chillers. After the chillers have been commanded off for 5 minutes (adj.) and the chiller status is proven off, the BAS will stop the chilled water pumps. After the chilled water pumps have been commanded off for 5 minutes (adj.) and the pump status is proven off, the chiller isolation valves will close.
- e. Alarms shall be provided as follows:
 - i. Chilled Water Flow Failure: No flow is detected 30 seconds (adj.) after the chiller is commanded to run.

4) Chiller Lead/Lag Sequence

- a. After the lead chiller and chilled water pump have started, the lag chiller and chilled water pump shall be commanded to start if either of the following conditions are met:
 - i. The load on the lead chiller is greater than 85% (adj.) of its capacity.
 - ii. OR the chiller leaving water temperature is more than 2°F (adj.) above the setpoint temperature for 15 minutes (adj.).

The lag chiller and lag chilled water pump will be started and controlled in the same manner as the lead chiller.
- b. When both chillers are running, the lag chiller and chilled water pump shall be commanded to stop if all of the following conditions are met:
 - i. The combined load on the chillers is less than 80% (adj.) of the capacity of a single chiller.

- ii. AND the building chilled water supply temperature has been at setpoint for 15 minutes (adj.).
 - c. The designated lead chiller shall rotate upon one of the following conditions (User-selectable):
 - i. Manually through a software switch.
 - ii. If chiller runtime (adj.) is exceeded.
 - iii. Daily, weekly, or monthly.
- 5) Chiller Monitoring: The BAS shall monitor the loading of the chillers including the current percent of full-load capacity and amperage. The BAS shall also monitor the on/off status of each compressor.
- 6) Chilled Water Temperature Monitoring:
 - a. The entering water temperature and leaving water temperature of each chiller shall be monitored.
 - b. The building chilled water supply and return temperatures shall be monitored.
 - c. Alarms shall be provided as follows:
 - i. Low Chiller Leaving Water Temp: The chiller leaving water temperature is less than 38°F (adj.) while the chiller is running. Disable the chiller until the alarm is manually reset. Continue to run the chilled water pump until the leaving water temperature rises above 40°F (adj.).
 - ii. High Chiller Leaving Water Temp: The chiller leaving water temperature is greater than 55°F (adj.) for 15 minutes (adj.) while the chiller is running.
 - iii. Low Chilled Water Supply Temp: The temperature of the chilled water supply to the building is less than 38°F (adj.) while the chiller is running. Disable the chiller until the alarm is manually reset. The chilled water pump shall continue to run until the leaving water temperature rises above 40°F (adj.).
 - iv. High Chilled Water Supply Temp: The temperature of the chilled water supply to the building is greater than 55°F (adj.) for 15 minutes (adj.) while the chiller is running.
- 7) Chilled Water Supply Temperature Setpoint Reset: The chilled water supply temperature setpoint shall be allowed to reset based on a correlation to the outside ambient temperature. The chilled water supply temperature setpoint shall

incrementally increase from a minimum setpoint of 42°F (adj.) at 80°F (adj.) OAT, up to a maximum of 48°F (adj.) at 40°F (adj.) OAT.

Air-Cooled Chiller Points Summary

Typical of Each Chiller

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Chiller Leaving Water Temp.	X				X
Chiller Entering Water Temp.	X				X
CHW Supply Temp Setpoint			X		X
Building CHWS Temperature	X				X
Building CHWR Temperature	X				X
Chilled Water Flow Status		X			X
Chiller Iso. Valve Open/Close				X	X
Chiller Enable/Disable				X	X
Chiller % Full Load	X				X
Chiller Amps	X				X
Compressor 1 Status		X			X
Compressor 2 Status		X			X
Compressor 3 Status		X			X
Compressor 4 Status		X			X
Manual Reset Alarm		X			
Auto Reset Alarm		X			
Totals	6	7	1	2	
	16				

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

Alarms
High Chiller Leaving Water Temperature
Low Chiller Leaving Water Temperature
High Chilled Water Supply Temperature (Building)
Low Chilled Water Supply Temperature (Building)
Chiller Failure
Chiller Running in Hand
Chiller Runtime Exceeded
Chilled Water Flow Failure
Chiller Manual Reset Internal Alarm
Chiller Auto Reset Internal Alarm

Adjustable Control Settings (At Minimum)	Initial Setting
Enabled/Disabled Scheduling	SEE SCHEDULES
Chilled Water Supply Temperature Setpoint	42°F
CHW Supply Temperature Setpoint Reset Settings	SEE SEQUENCE
Chiller Start Delay Time	5 minutes
Chiller Stop Delay Time	0 minutes
Chiller Isolation Valve Open Delay Time	0 minutes
Chiller Isolation Valve Close Delay Time	5 minutes
Minimum Chiller Run Time / Off-Time	15 minutes
No. of Clg Requests Required to Maintain Operation	1
Chiller Plant Stop Delay Upon Zero Cooling Requests	1 hour
Lead Chiller Selection Settings	Daily Rotation
OAT Lockout	Not set
Chiller Enable/Disable Override	AUTO
Chiller Isolation Valve Open/Close Override	AUTO



5. VARIABLE VOLUME CHILLED WATER PUMPS

- 1) Run Conditions:
 - a. Each chilled water pump shall be controlled to run anytime its associated chiller is called to run.
 - b. Both pumps shall run for freeze protection anytime the outside air temperature is less than 38°F (adj.).
 - c. Alarms shall be provided as follows:
 - i. Pump Failure: The pump status is off 2 minutes (adj.) after being commanded on.
 - ii. Pump Running in Hand: The pump status is on 2 minutes (adj.) after being commanded off.
 - iii. Pump Runtime Exceeded: Status runtime exceeds a User-definable limit.
 - iv. Pump VFD Fault: Pump VFD is reporting an error.
- 2) Chilled Water Pump Start / Stop Sequence
 - a. When the chilled water system is activated, the BAS will open the lead chiller's isolation valve and start the lead chilled water pump.
 - b. If the lead pump fails to start, the BAS shall activate the Pump Failure alarm and attempt to start the lag pump.
 - c. The pumps shall have a User-adjustable delay on stop. The pumps shall continue to run for 5 minutes (adj.) after the chillers have been commanded off and the chiller status is proven off.
- 3) Chilled Water Pump Lead/Lag Operation:
 - a. The designated lead pump shall rotate upon one of the following conditions (User-selectable):
 - i. Manually through a software switch.
 - ii. If pump runtime (adj.) is exceeded.
 - iii. Daily, weekly, or monthly.

4) Chilled Water Pump Speed Control

- a. The BAS shall monitor the chilled water system differential pressure sensor, mounted on the building chilled water supply and return lines, 2/3 the distance of the longest piping run. The BAS shall adjust the chilled water pump VFD speed to maintain the chilled water system differential pressure at 12 psi (adj.). The pump VFD shall be controlled to operate between a maximum speed of 60 Hz (adj.) and a minimum speed of 20 Hz (adj.). The differential pressure setpoints and pump speeds shall be field-adjusted during the commissioning period to meet the requirements of actual field conditions.
- b. The differential pressure setpoint shall be reset using a trim and respond algorithm based on cooling coil valve positions throughout the facility as follows:
 - i. If 2 (adj.) or more chilled water coil valves are at a position of 100%, the differential pressure setpoint shall incrementally increase until all valves are at a position of 90% open (adj.) or less, up to a maximum differential pressure of 12 psi (adj.)
 - iii. If all chilled water coil valves are at a position of 80% open (adj.) or less, the differential pressure setpoint shall incrementally decrease until one or more valves reach a position of 90% open (adj.), down to a minimum differential pressure of 5 psi (adj.).
- c. Alarms shall be provided as follows:
 - i. High System Differential Pressure: The chilled water system differential pressure is 25% (adj.) greater than setpoint.
 - ii. Low System Differential Pressure: The chilled water system differential pressure is 25% (adj.) less than setpoint.

5) Pump Differential Pressure Monitoring:

- a. The BAS shall monitor the differential pressure between the pump suction and discharge.
- b. Alarms shall be provided as follows:
 - i. High Pump Differential Pressure: The pump differential pressure is greater than a User-definable amount.

Variable Volume CHW Loop Pump Points Summary

Typical of Each CHW Pump

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
System Differential Pressure	X				X
Pump Differential Pressure	X				X
Pump Start/Stop				X	X
Pump VFD Speed			X		X
Pump Amps / Run Status	X				X
Pump VFD Fault		X			X
Totals	3	1	1	1	
	6				

Adjustable Control Settings (At Minimum)	Initial Setting
Enabled/Disabled Scheduling	Chiller Interlock
System Differential Pressure Setpoint	12 PSI
Differential Pressure Setpoint Reset Settings	SEE SEQUENCE
Maximum Pump VFD Speed	60 Hz
Minimum Pump VFD Speed	20 Hz
Start Delay Time	0 minutes
Stop Delay Time	5 minutes
Minimum Run Time / Off-Time	Not set
Lead Pump Selection Settings	Daily Rotation
Freeze Protection Enable	Below 38°F
Pump Enable/Disable Override	AUTO

Additional Settings and Statuses to Show on Graphic
Current Differential Pressure Setpoint
Current Schedule Status (Enabled or Disabled)
Active Program Overrides
Active Alarms

Alarms
High System Differential Pressure
Low System Differential Pressure
High Pump Differential Pressure
Pump Failure
Pump Running in Hand
Pump VFD Fault
Pump Runtime Exceeded



6. NATURAL GAS BOILERS

- 1) Run Conditions:
 - a. The boilers shall be enabled to run by a User-defined enable/disable time schedule. The boilers shall also have an outside ambient temperature lockout preventing them from operating while the outside temperature is greater than 65°F (adj.)
 - b. The boilers shall be enabled for freeze protection whenever the outside ambient temperature is less than 38°F (adj.).
 - c. To prevent short cycling, the boilers shall run for and be off for a minimum period of 15 minutes each (adj.), unless shutdown on safeties.
 - d. The boilers shall run subject to their own internal safeties and controls.
 - e. Alarms shall be provided as follows:
 - i. Boiler Failure: The boiler status is off 2 minutes (adj.) after being commanded on.
 - ii. Boiler Running in Hand: The boiler status is on 2 minutes (adj.) after being commanded off.
 - iii. Boiler Runtime Exceeded: Status runtime exceeds a User-definable limit.
 - iv. Boiler Alarm: Boiler is reporting an internal alarm.
- 2) Boiler Start / Stop Sequence
 - a. When the hot water system is activated, the BAS will start the system hot water pump. Once hot water flow has been proven by the lead boiler flow switch, the lead boiler will start. The boiler will operate according to its own internal controls to maintain the system hot water supply temperature at setpoint. If additional heating capacity is required to meet the hot water supply temperature setpoint, the lag boiler will start and operate simultaneously with the lead boiler.
 - b. The designated lead boiler shall rotate upon one of the following conditions (User-selectable):
 - i. Manually through a software switch.
 - ii. If boiler runtime (adj.) is exceeded.

- iii. Daily, weekly, or monthly.
 - c. The boilers shall have a User-adjustable delay on start. The delay shall prevent the boilers from starting until 5 minutes (adj.) after the pump has been commanded to start.
 - d. When the hot water system is deactivated, the BAS will disable the boilers. After the boilers have been commanded off for 5 minutes (adj.) and the boiler status is proven off, the BAS will stop the hot water pump.
 - e. Alarms shall be provided as follows:
 - i. Hot Water Flow Failure: No flow is detected 30 seconds (adj.) after the boiler is commanded to run.
- 4) Boiler Monitoring: The BAS shall monitor the output percent or stage of each boiler.
- 5) Hot Water Temperature Monitoring:
- a. The entering water temperature and leaving water temperature of each boiler shall be monitored.
 - b. Alarms shall be provided as follows:
 - i. Low Boiler Leaving Water Temp: The boiler leaving water temperature is less than 100°F (adj.) for 15 minutes (adj.) while the boiler is running.
 - ii. High Boiler Leaving Water Temp: The boiler leaving water temperature is greater than 200°F (adj.) while the boiler is running. Disable the boiler until the alarm is manually reset. Continue to run the hot water pump until the hot water temperature drops below 180°F (adj.).
- 6) Hot Water Supply Temperature Setpoint Reset: The hot water supply temperature setpoint shall be allowed to reset based on a correlation to the outside ambient temperature. The hot water supply temperature setpoint shall incrementally increase from a minimum setpoint of 140°F (adj.) at 65°F (adj.) OAT, up to a maximum of 180°F (adj.) at 40°F (adj.) OAT.

Natural Gas Boiler Points Summary

Typical of Each Boiler

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Boiler Leaving Water Temp.	X				X
Boiler Entering Water Temp.	X				X
HW Supply Temp Setpoint			X		X
Building HWS Temperature	X				X
Building HWR Temperature	X				X
Hot Water Flow Status		X			X
Boiler Enable/Disable				X	X
Burner Output %	X				X
Boiler Alarm Status		X			
Totals	5	2	1	1	
	9				

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

Alarms
High Boiler Leaving Water Temperature
Low Boiler Leaving Water Temperature
Boiler Failure
Boiler Running in Hand
Boiler Runtime Exceeded
Hot Water Flow Failure
Boiler Internal Alarm

Adjustable Control Settings (At Minimum)	Initial Setting
Enabled/Disabled Scheduling	SEE SCHEDULES
Hot Water Supply Temperature Setpoint	180°F
HW Supply Temperature Setpoint Reset Settings	SEE SEQUENCE
Boiler Start Delay Time	5 minutes
Boiler Stop Delay Time	0 minutes
Minimum Boiler Run Time / Off-Time	15 minutes
Lead Boiler Selection Settings	Daily Rotation
Outside Ambient Temperature Lockout	Above 65°F
Freeze Protection Enable	Below 38°F
Boiler Enable/Disable Override	AUTO



7. VARIABLE VOLUME HOT WATER SYSTEM PUMPS

- 1) Run Conditions:
 - a. The hot water system pump shall be controlled to run anytime a boiler is called to run.
 - b. The pump shall run for freeze protection anytime the outside air temperature is less than 38°F (adj.).
 - c. Alarms shall be provided as follows:
 - i. Pump Failure: The pump status is off 2 minutes (adj.) after being commanded on.
 - ii. Pump Running in Hand: The pump status is on 2 minutes (adj.) after being commanded off.
 - iii. Pump Runtime Exceeded: Status runtime exceeds a User-definable limit.
 - iv. Pump VFD Fault: Pump VFD is reporting an error.
- 2) Hot Water Pump Start / Stop Sequence
 - a. When the hot water system is activated, the BAS will start the lead hot water pump.
 - b. If the lead pump fails to start, the BAS shall activate the Pump Failure Alarm and attempt to start the lag pump.
 - c. The pumps shall have a User-adjustable delay on stop. The pumps shall continue to run for 5 minutes (adj.) after the boiler has been commanded off and the boiler status is proven off.
- 3) Hot Water Pump Lead/Lag Operation
 - a. The designated lead pump shall rotate upon one of the following conditions (User-selectable):
 - i. Manually through a software switch.
 - ii. If boiler runtime (adj.) is exceeded.
 - iii. Daily, weekly, or monthly.

4) Hot Water Pump Speed Control

- a. The BAS shall monitor the hot water system differential pressure sensor, mounted on the building hot water supply and return lines, 2/3 the distance of the longest piping run. The BAS shall adjust the hot water pump VFD speed to maintain the hot water system differential pressure at 12 psi (adj.). The pump VFD shall be controlled to operate between a maximum speed of 60 Hz (adj.) and a minimum speed of 20 Hz (adj.). The differential pressure setpoints and pump speeds shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
- b. The differential pressure setpoint shall be reset based on hot water coil valve positions.
 - i. If 2 (adj.) or more hot water coil valves are at a position of 100%, the differential pressure setpoint shall incrementally increase until all valves are at a position of 90% open (adj.) or less, up to a maximum differential pressure of 12 psi (adj.)
 - iii. If all hot water coil valves are at a position of 80% open (adj.) or less, the differential pressure setpoint shall incrementally decrease until one or more valves reach a position of 90% open (adj.), down to a minimum differential pressure of 5 psi (adj.).
- c. Alarms shall be provided as follows:
 - i. High System Differential Pressure: The hot water system differential pressure is 25% (adj.) greater than setpoint.
 - ii. Low System Differential Pressure: The hot water system differential pressure is 25% (adj.) less than setpoint.

5) Pump Differential Pressure Monitoring:

- a. The BAS shall monitor the differential pressure between the pump suction and discharge.
- b. Alarms shall be provided as follows:
 - i. High Pump Differential Pressure: The pump differential pressure is greater than a User-definable amount.

Variable Volume HW System Pump Points Summary

Typical of Each HW Plant

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
System Differential Pressure	X				X
Pump 1 Differential Pressure	X				X
Pump 2 Differential Pressure	X				X
Pump Select Switch				X	X
Pump Start/Stop				X	X
Pump VFD Speed			X		X
Pump Amps / Run Status	X				X
Pump VFD Fault		X			X
Totals	4	1	1	2	
	8				

Adjustable Control Settings (At Minimum)	Initial Setting
Enabled/Disabled Scheduling	Boiler Interlock
System Differential Pressure Setpoint	12 PSI
Differential Pressure Setpoint Reset Settings	SEE SEQUENCE
Maximum Pump VFD Speed	60 Hz
Minimum Pump VFD Speed	20 Hz
Start Delay Time	0 minutes
Stop Delay Time	5 minutes
Minimum Run Time / Off-Time	Not set
Lead Pump Selection Settings	Daily Rotation
Freeze Protection Enable	Below 38°F
Pump Enable/Disable Override	AUTO

Additional Settings and Statuses to Show on Graphic
Current Differential Pressure Setpoint
Current Schedule Status (Enabled or Disabled)
Active Program Overrides
Active Alarms

Alarms
High System Differential Pressure
Low System Differential Pressure
High Pump Differential Pressure
Pump Failure
Pump Running in Hand
Pump VFD Fault
Pump Runtime Exceeded



8. VARIABLE AIR VOLUME CENTRAL STATION AIR HANDLING UNITS

- 1) Run Conditions
 - a. The AHU shall be enabled to run by a User-defined occupied/unoccupied time schedule, or when any zone associated with the AHU is in occupied mode.
 - b. The AHU 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 AHU 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. 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.
- 2) Supply Air Temperature Setpoint Reset:
 - a. The BAS shall monitor the supply air temperature and shall reset the supply air temperature setpoint based on the outside ambient temperature. The supply air temperature setpoint 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 temperature setpoint shall be 52°F (adj.).
 - ii. When the outside ambient temperature is 55°F (adj.) and below, the supply air temperature setpoint shall be 55°F (adj.).
- 3) Cooling Coil Valve:

- a. The BAS shall measure the supply air temperature and adjust the cooling coil valve position to maintain the supply air temperature setpoint.
 - b. Cooling shall be enabled whenever the supply fan status is on AND the heating coil valve is at 0% open position.
 - c. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).
 - d. The cooling coil valve shall be opened to 50% (adj.) whenever the freeze-stat (if present) status is tripped, regardless of the supply fan or heating coil valve status.
- 4) Heating Coil Valve:
- a. The BAS shall measure the supply air temperature and adjust the heating coil valve position to maintain the supply air temperature setpoint.
 - b. Heating shall be enabled when the supply fan status is on AND the cooling coil valve is at 0% open position.
 - c. Heating shall be disabled when the outside ambient temperature is above 70°F (adj.).
 - d. The heating coil valve shall be enabled to open and provide heating whenever the freeze-stat (if present) status is tripped, regardless of the supply fan or cooling coil valve status.
- 5) AHU Start/Stop Sequence
- a. When the AHU 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 valves to open 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 supply air fan, and fully close the outside air damper, return air damper, chilled water valve, and hot water valve.
- 6) 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 VAV terminal unit damper positions.
 - i. If 2 (adj.) or more VAV terminal unit dampers are at a position of 100%, the duct static pressure setpoint shall incrementally increase until all VAV 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 VAV dampers are at a position of 80% open (adj.) or less, the duct static pressure setpoint shall incrementally decrease until one or more VAV 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 AHU until the alarm is manually reset.
 - ii. Low Duct Static Pressure: The supply air static pressure is 25% (adj.) less than setpoint.

7) Carbon Dioxide (CO2) Demand-Controlled Ventilation:

- a. The BAS shall monitor the return air CO2 concentration and use it as a reference to control the volume of outside air supplied to the system. While the AHU is operating in occupied mode, the BAS shall adjust the position of the outside air damper between the design ventilation position and fully closed position to maintain a maximum return air CO2 concentration of 1000 PPM (adj.).
- b. Alarms shall be provided as follows:
 - i. High CO2 Concentration: The return air CO2 concentration is greater than 1200 PPM (adj.) for 15 minutes (adj.) while in the AHU is running and the outside air damper is commanded open.

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 AHU will provide the BAS with 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.).

Variable Air Volume Central Station AHU Points Summary

Typical of Each VAV Central Station AHU

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Supply Air Temperature	X				X
Return Air Temperature	X				X
Mixed Air Temperature	X				X
Return Air Relative Humidity	X				X
Return Air CO2 Concentration	X				X
Supply Duct Static Pressure	X				X
Supply Fan Start/Stop				X	X
Supply Fan VFD Speed			X		X
Supply Fan Amps / Run Status	X				X
Supply Fan VFD Fault		X			X
Cooling Valve Control			X		X
Heating Valve Control			X		X
Outside Air Damper Control			X		X
Return Air Damper Control			X		X
Building Static Pressure	X				X
Relief Air Damper Control			X		X
Freezestat Trip Status		X			X
Totals	8	2	6	1	
	17				

Additional Settings and Statuses to Show on Graphic
Current Supply Air Temperature Setpoint
Current Duct Static Pressure Setpoint
Current Schedule Status (Occupied or Unoccupied)
Economizer Mode Status
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 Duct Static Pressure
Low Duct Static Pressure
High Building Pressure
Supply Fan Failure
Supply Fan Running in Hand
Supply Fan Runtime Exceeded
Supply Fan VFD Fault
Freezestat Trip

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
Number of Occupied Zones Required to Enable	1 zone
Number of Unoccupied Zones Required to Enable	2 zones
Supply Air Temperature Setpoint & Reset Settings	SEE SEQUENCE
Occupied Maximum CO2 PPM Setpoint	1000 PPM
Economizer High Limit OA Dry Bulb Temperature	70°F
Economizer High Limit OA Enthalpy	28 BTU/LB
Economizer Low Limit OA Dry Bulb Temperature	40°F
Building Static Pressure Setpoint	0.1" WC
Outside Air Damper Delay at Start-Up	30 minutes
Outside Air Damper Design Ventilation Position (1)	15%
Duct Static Pressure Setpoint	1" WC
Duct Static Pressure Setpoint Reset Settings	SEE SEQUENCE
Maximum Supply Fan VFD Speed	60 Hz
Minimum Supply Fan VFD Speed	15 Hz
Minimum Fan Runtime/Off-Time	15 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F
Cooling Enable/Disable Override	AUTO
Heating Enable/Disable Override	AUTO
Outside Air Damper Position Override	AUTO
Return Air Damper Position Override	AUTO
Supply Fan Enable/Disable Override	AUTO

NOTES:

- 1) Test and Balance to set the outside air damper design ventilation position to achieve design outside air volume.



9. CONSTANT VOLUME SINGLE ZONE AIR HANDLING UNITS

1) Run Conditions

- a. The AHU shall be enabled to run by a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the AHU shall operate continuously to maintain a 74°F (adj.) zone cooling setpoint and a 68°F (adj.) zone heating setpoint.
 - ii. In unoccupied mode (night setback) the AHU shall cycle on and off as needed to maintain an 85°F (adj.) zone cooling setpoint and a 55°F (adj.) zone heating setpoint. To prevent short-cycling the AHU fan shall run for and be off for a minimum period of 15 minutes each (adj.).
- b. The supply fan shall run anytime the AHU is commanded to run, unless shutdown on safeties.
- c. 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. Freeze-Stat Trip: The unit shall shut down and generate an alarm upon receiving a freeze-stat trip status.
 - v. High Zone Temp: The zone temperature is greater than the cooling setpoint by 5°F (adj.) after the AHU has been commanded to run for 30 minutes (adj.).
 - vi. Low Zone Temp: The zone temperature is less than the heating setpoint by 5°F (adj.) after the AHU has been commanded to run for 30 minutes (adj.).

2) Cooling Control:

- a. When the zone air temperature is above the zone cooling setpoint, the BAS shall adjust the cooling coil valve position to maintain the zone air temperature at the zone cooling setpoint.

- b. Cooling shall be enabled whenever the supply fan status is on AND the heating coil valve is at 0% open position.
 - c. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).
 - d. The cooling coil valve shall be opened to 50% (adj.) whenever the freeze-stat (if present) status is tripped, regardless of the supply fan or heating coil valve status.
- 3) Heating Control:
 - a. When the zone air temperature is below the zone heating setpoint, the BAS shall adjust the heating coil valve position to maintain the zone air temperature at the zone heating setpoint.
 - b. Heating shall be enabled whenever the supply fan status is on AND the cooling coil valve is at 0% open position.
 - c. Heating shall be disabled whenever the outside ambient temperature is above 70°F (adj.).
 - d. The heating coil valve shall be enabled to open and provide heating whenever the freeze-stat (if present) status is tripped, regardless of the supply fan or cooling coil valve status.
- 4) AHU Start/Stop Sequence
 - a. When the AHU 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 valves to open as required to meet the zone 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 design ventilation volume position.
 - b. When the AHU is called to stop, the BAS shall stop the supply air fan, and fully close the outside air damper, return air damper, chilled water valve, and hot water valve.
- 5) Carbon Dioxide (CO2) Demand-Controlled Ventilation (only when CO2 DCV is specified on the Equipment List):
 - a. The BAS shall monitor the return air CO2 concentration and use it as a reference to control the volume of outside air supplied to the system. While the AHU is operating in occupied mode, the BAS shall adjust the position of the outside air damper between the design ventilation position and fully closed position to maintain a maximum return air CO2 concentration of 1000 PPM (adj.).

- b. Alarms shall be provided as follows:
 - i. High CO2 Concentration: The return air CO2 concentration is greater than 1200 PPM (adj.) for 15 minutes (adj.) while in the AHU is running and the outside air damper is commanded open.
- 6) Economizer Operation (only when Economizer is specified on the Equipment List):
- a. When the outside air temperature is between 70°F and 50°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 AHU will provide the BAS with 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.). Disable economizer mode and return the outside air damper to the minimum ventilation position.
- 7) Temperature and Humidity:
- a. The BAS shall monitor the return air temperature, mixed air temperature, supply air temperature, and zone relative humidity.
 - b. Alarms shall be provided as follows:
 - i. High Zone Relative Humidity: The zone 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.).



Constant Volume Single Zone AHU Points Summary

Typical of Each CV Single Zone AHU

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Supply Air Temperature	X				X
Return Air Temperature	X				X
Mixed Air Temperature	X				X
Zone Relative Humidity	X				X
Zone CO2 Concentration (1)	X				X
Supply Fan Start/Stop				X	X
Supply Fan Run Status		X			X
Cooling Valve Control			X		X
Heating Valve Control			X		X
Outside Air Damper Control			X		X
Return Air Damper Control			X		X
Building Static Pressure (2)	X				X
Relief Air Damper Control (2)			X		X
Freezestat Trip Status		X			X
Totals	7	2	5	1	
	15				

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

Alarms
High Zone Temperature
Low Zone Temperature
High Supply Air Temperature
Low Supply Air Temperature
High Zone Relative Humidity
High Zone CO2 Concentration (1)
High Building Pressure (2)
Supply Fan Failure
Supply Fan Running in Hand
Supply Fan Runtime Exceeded
Freezestat Trip

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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
Occupied Maximum CO2 PPM Setpoint (1)	1000 PPM
Economizer High Limit OA Dry Bulb Temperature (2)	70°F
Economizer High Limit OA Enthalpy (2)	28 BTU/LB
Economizer Low Limit OA Dry Bulb Temperature (2)	50°F
Building Static Pressure Setpoint (2)	0.1" WC
Outside Air Damper Delay at Start-Up	30 minutes
Minimum Fan Runtime/Off-Time	15 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F
Cooling Enable/Disable Override	AUTO
Heating Enable/Disable Override	AUTO
Outside Air Damper Position Override	AUTO
Return Air Damper Position Override	AUTO
Supply Fan Enable/Disable Override	AUTO

NOTES:

- 1) When CO2 DCV specified on the equipment list.
- 2) When Economizer specified on the equipment list.



10. FAN COIL UNITS

1) Run Conditions

- a. The system shall be enabled to run by a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the system shall operate continuously 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 allowed for cooling.
 - ii. In unoccupied mode (night setback) the system 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 fan shall run for and be off for a minimum period of 10 minutes each (adj.).
- b. The supply fan shall run anytime the system is commanded to run, unless shutdown on safeties.
- c. 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 FCU has been commanded to run for 30 minutes (adj.).
 - v. Low Zone Temp: The zone temperature is less than the heating setpoint by 5°F (adj.) after the FCU has been commanded to run for 30 minutes (adj.).

2) Cooling Control:

- a. When the zone air temperature is above the zone cooling setpoint, the BAS shall adjust the cooling coil valve position to maintain the zone air temperature at the zone cooling setpoint.

- b. Cooling shall be enabled whenever the supply fan status is on AND the heating coil valve is at 0% open position.
 - c. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).
- 3) Heating Control:
 - a. When the zone air temperature is below the zone heating setpoint, the BAS shall adjust the heating coil valve position to maintain the zone air temperature at the zone heating setpoint.
 - b. Heating shall be enabled whenever the supply fan status is on AND the cooling coil valve is at 0% open position.
 - c. Heating shall be disabled whenever the outside ambient temperature is above 70°F (adj.).
- 4) Fan Coil Unit Start/Stop Sequence
 - a. When the system is called to run, the BAS shall command the supply fan to run and enable cooling or heating as required to meet the zone air temperature setpoint.
 - b. When the system is called to stop, the BAS shall stop the supply air fan and disable cooling and heating.
- 5) Temperature Monitoring:
 - a. The BAS shall monitor the return 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 split system until the alarm is manually reset.
 - ii. Low Supply Air Temp: The supply air temperature is less than 40°F (adj.). Disable the split system until the alarm is manually reset.

Fan Coil Unit Points Summary

Typical of Each Fan Coil Unit

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Supply Air Temperature	X				X
Return Air Temperature	X				X
Supply Fan Start/Stop				X	X
Supply Fan Run Status		X			X
Cooling Valve Control			X		X
Heating Valve Control			X		X
Totals	3	1	2	1	
	7				

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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 Offset (Drift)	+/-1.5°F
Minimum Fan Run Time / Off-Time	10 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F
Cooling Enable/Disable Override	AUTO
Heating Enable/Disable Override	AUTO
Supply Fan Enable/Disable Override	AUTO

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

Alarms
High Zone Temperature
Low Zone Temperature
High Supply Air Temperature
Low Supply Air Temperature
Supply Fan Failure
Supply Fan Running in Hand
Supply Fan Runtime Exceeded

11. CONSTANT AIR VOLUME ENERGY RECOVERY VENTILATOR

1) Run Conditions

- a. The ERV shall be enabled to run according to a User-defined enable/disable time schedule.
- b. When indoor zones served by the ERV are in unoccupied mode, night setback or morning start-up, the ERV will stay OFF and the associated dampers will remain closed.
- c. The ERV's supply fan, exhaust fan and energy recovery wheel shall run anytime the ERV is commanded to run, unless shut down on safeties.
- d. The ERV's outside air damper shall open whenever the supply fan is commanded to run, and shall close whenever the supply fan is commanded to stop.

2) ERV Status Monitoring

- a. The BAS shall monitor the status of the following ERV components:
 - i. Supply fan and exhaust fan on/off status.
 - ii. Energy recovery wheel rotation status.
- b. Alarms shall be provided as follows:
 - i. Supply/Exhaust Fan Failure: The fan status is off 2 minutes (adj.) after the ERV is commanded to run.
 - ii. Supply/Exhaust Fan in Hand: The fan status is on 2 minutes (adj.) after the ERV is commanded off.
 - iii. Supply/Exhaust Fan Runtime Exceeded: Status runtime exceeds a User-definable limit.

3) Temperature and Humidity Monitoring

- a. The BAS shall monitor ERV supply air temperature, supply air humidity, outside air temperature, return air temperature and return air humidity.
- b. Alarms shall be provided as follows:
 - i. High Supply Air Temp: The supply air temperature is greater than 85°F (adj.) after the ERV has been commanded to run for 15 minutes (adj.).

- ii. Low Supply Air Temp: The supply air temperature is less than 55°F (adj.) after the ERV has been commanded to run for 15 minutes (adj.).
 - iii. High Supply Air Relative Humidity: The supply air relative humidity is greater than 60% (adj.) for 15 minutes (adj.) while the ERV is running.
 - iv. High Return Air Relative Humidity: The return air relative humidity is greater than 65% (adj.) for 15 minutes (adj.) while the ERV is running.
- 4) Carbon Dioxide (CO2) Demand-Controlled Ventilation (only when CO2 DCV is specified on the Equipment List)
 - a. While enabled by the time schedule, the ERV shall be commanded to run when the zone CO2 concentration exceeds 1000 PPM (adj.), and shall be commanded off when the zone CO2 concentration falls below 800 PPM (adj.).
 - b. Alarms shall be provided as follows:
 - i. High CO2 Concentration: The zone CO2 concentration is greater than 1200 PPM (adj.) for 15 minutes (adj.) while in the ERV is running and the outside air damper is commanded open.

Constant Air Volume ERV Points Summary

Typical of Each CV ERV

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Supply Air Temperature	X				X
Return Air Temperature	X				X
Outside Air Temperature	X				X
Supply Air Relative Humidity	X				X
Return Air Relative Humidity	X				X
Zone CO2 Concentration (1)	X				X
Supply Fan Start/Stop				X	X
Exhaust Fan Start/Stop				X	X
Energy Wheel Start/Stop				X	X
Supply Fan Run Status		X			X
Exhaust Fan Run Status		X			X
Energy Wheel Run Status		X			X
Outside Air Damper Open/Close				X	X
Totals	6	3	0	4	
	13				

Adjustable Control Settings (At Minimum)	Initial Setting
ERV Enabled/Disabled Scheduling	SEE SCHEDULES
Occupied Maximum CO2 PPM Setpoint (1)	1000 PPM
Shut-Off CO2 PPM Setpoint (1)	800 PPM
ERV Enable/Disable 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 Supply Air Relative Humidity
High Return Air Relative Humidity
High Zone CO2 Concentration (1)
Supply/Exhaust Fan Failure
Supply/Exhaust Fan Running in Hand
Supply/Exhaust Fan Runtime Exceeded

NOTES:

1) When CO2 DCV specified on the equipment list.



12. DX PACKAGED ROOFTOP UNITS - CONSTANT OA (NAT GAS OR ELECTRIC HEAT)

1) Run Conditions

- a. The RTU shall be enabled to run by a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the RTU shall operate continuously 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 10 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.
- c. The supply fan shall run anytime the RTU is commanded to run, unless shutdown on safeties.
- d. 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 30 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 30 minutes (adj.).

2) Cooling Control:

- a. When the zone air temperature is above the zone cooling setpoint, the BAS shall control the system compressors on or off to maintain the zone air temperature at the zone cooling setpoint. If the system is equipped with two stages of cooling, the second stage will activate if the zone air temperature has been 1.5°F (adj.) above setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
 - b. Cooling shall be enabled whenever the supply fan status is on AND heating is not active.
 - c. To prevent short-cycling, the compressors shall have a minimum on and off time of 3 minutes (adj.)
 - d. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).
- 3) Heating Control:
- a. When the zone air temperature is below the zone heating setpoint, the BAS shall adjust the heating output to maintain the zone air temperature at the zone heating setpoint. If the system is equipped with two stages of heating, the second stage will activate if the zone air temperature has been 1.5°F (adj.) below setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
 - b. Heating shall be enabled whenever the supply fan status is on AND the cooling compressors are off.
 - c. 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 cooling or heating as required to meet the zone 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 design ventilation volume position.
 - b. When the RTU is called to stop, the BAS shall stop the supply air fan, fully close the outside air damper and return air damper, and disable cooling and heating.
- 5) Temperature Monitoring:

- a. The BAS shall monitor the return air temperature, 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 (when specified on the equipment list):
- a. The BAS shall monitor the zone air relative humidity. If the relative humidity exceeds 60% (adj.) the unit will be forced into dehumidification mode until the zone air relative humidity falls below 50% (adj.).
 - b. If the RTU is equipped with a hot-gas reheat coil and factory-installed dehumidification controller, the factory controller shall be allowed to operate the cooling coil and hot-gas reheat coil in tandem to dehumidify the supply air until the zone relative humidity falls below 50% (adj.). A status point shall be provided on the BAS to indicate whenever the hot-gas reheat coil and dehumidification mode is active.
 - c. If the RTU is not equipped with factory-installed dehumidification mode controls and hot gas reheat, the BAS shall instead force the unit into maximum cooling until the zone air relative humidity falls below 50% (adj.). During dehumidification operation, the BAS shall also enable heating and adjust the heating output to maintain the zone air temperature at the current setpoint.
 - d. Alarms shall be provided as follows:
 - i. High Zone Relative Humidity: The zone air relative humidity is greater than 60% (adj.) for 15 minutes (adj.) while the RTU is running.

DX Packaged RTU (Constant OA) Points Summary

Typical of Each DX RTU with Constant Outside Air

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Occupant Override		X			
Supply Air Temperature	X				X
Return Air Temperature	X				X
Mixed Air Temperature	X				X
Zone Relative Humidity (2)	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
Hot-Gas Reheat Coil Status (3)		X			X
Outside Air Damper Open/Close				X	X
Return Air Damper Open/Close				X	X
Totals	5	3	0	7	
	15				

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

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

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.

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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
Second Stage Cooling Differential from Setpoint	+1.5°F for 2 minutes
Second Stage Heating Differential from Setpoint	-1.5°F for 2 minutes
Maximum Relative Humidity Setpoint (2)	60%
Dehumidification Setpoint (2)	50%
Minimum Fan Run Time / Off-Time	10 minutes
Minimum Compressor Runtime/Off-Time	3 minutes
Outside Air Damper Delay at Start-Up	30 minutes
Occupancy Override Run Time	30 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F
Cooling Enable/Disable Override	AUTO
Heating Enable/Disable Override	AUTO
Outside Air Damper Open/Close Override	AUTO
Return Air Damper Open/Close Override	AUTO
Supply Fan Enable/Disable Override	AUTO



13. DX PACKAGED ROOFTOP UNITS - VARIABLE OA (NAT GAS OR ELECTRIC HEAT)

1) Run Conditions

- a. The RTU shall be enabled to run by a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the RTU shall operate continuously 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 10 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.
- c. The supply fan shall run anytime the RTU is commanded to run, unless shutdown on safeties.
- d. 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 30 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 30 minutes (adj.).

2) Cooling Control:



- a. When the zone air temperature is above the zone cooling setpoint, the BAS shall control the system compressors on or off to maintain the zone air temperature at the zone cooling setpoint. If the system is equipped with two stages of cooling, the second stage will activate if the zone air temperature has been 1.5°F (adj.) above setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
 - b. Cooling shall be enabled whenever the supply fan status is on AND heating is not active.
 - c. To prevent short-cycling, the compressors shall have a minimum on and off time of 3 minutes (adj.)
 - d. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).
- 3) Heating Control:
- a. When the zone air temperature is below the zone heating setpoint, the BAS shall adjust the heating output to maintain the zone air temperature at the zone heating setpoint. If the system is equipped with two stages of heating, the second stage will activate if the zone air temperature has been 1.5°F (adj.) below setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
 - b. Heating shall be enabled whenever the supply fan status is on AND the cooling compressors are off.
 - c. 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 cooling or heating as required to meet the zone 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 design ventilation volume position.
 - b. When the RTU is called to stop, the BAS shall stop the supply air fan, fully close the outside air damper and return air damper, and disable cooling and heating.
- 5) Temperature Monitoring:

- a. The BAS shall monitor the return air temperature, 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 (when specified on the equipment list):
- a. The BAS shall monitor the zone air relative humidity. If the relative humidity exceeds 60% (adj.) the unit will be forced into dehumidification mode until the zone air relative humidity falls below 50% (adj.).
 - b. If the RTU is equipped with a hot-gas reheat coil and factory-installed dehumidification controller, the factory controller shall be allowed to operate the cooling coil and hot-gas reheat coil in tandem to dehumidify the supply air until the zone relative humidity falls below 50% (adj.). A status point shall be provided on the BAS to indicate whenever the hot-gas reheat coil and dehumidification mode is active.
 - c. If the RTU is not equipped with factory-installed dehumidification mode controls and hot gas reheat, the BAS shall instead force the unit into maximum cooling until the zone air relative humidity falls below 50% (adj.). During dehumidification operation, the BAS shall also enable heating and adjust the heating output to maintain the zone air temperature at the current setpoint.
 - d. Alarms shall be provided as follows:
 - i. High Zone Relative Humidity: The zone air relative humidity is greater than 60% (adj.) for 15 minutes (adj.) while the RTU is running.
- 7) Carbon Dioxide (CO2) Demand-Controlled Ventilation (when specified on the equipment list):
- a. The BAS shall monitor the zone air CO2 concentration and use it as a reference to control the volume of outside air supplied by the RTU. While the RTU is operating in occupied mode, the BAS shall adjust the position of the outside air damper between the design ventilation position and fully closed position to maintain a maximum zone air CO2 concentration of 1000 PPM (adj.).
 - b. 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 in the RTU is running and the outside air damper is commanded open.
- 8) Economizer Operation (when specified on the equipment list):
 - 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.

DX Packaged RTU (Variable OA) Points Summary

Typical of Each DX RTU with Variable Outside Air

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Occupant Override		X			
Supply Air Temperature	X				X
Return Air Temperature	X				X
Mixed Air Temperature	X				X
Zone Relative Humidity (2)	X				X
Zone CO2 Concentration (3)	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
Hot-Gas Reheat Coil Status (4)		X			X
Outside Air Damper Position			X		X
Return Air Damper Position			X		X
Totals	6	3	2	5	
	16				

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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
Second Stage Cooling Differential from Setpoint	+1.5°F for 2 minutes
Second Stage Heating Differential from Setpoint	-1.5°F for 2 minutes
Maximum Relative Humidity Setpoint (2)	60%
Dehumidification Setpoint (2)	50%
Occupied Maximum CO2 PPM Setpoint (3)	1000 PPM
Economizer High Limit OA Dry Bulb Temperature (5)	70°F
Economizer High Limit OA Enthalpy (5)	28 BTU/LB
Economizer Low Limit OA Dry Bulb Temperature (5)	40°F
Outside Air Damper Design Ventilation Position (6)	15%
Minimum Fan Run Time / Off-Time	10 minutes
Minimum Compressor Runtime/Off-Time	3 minutes
Outside Air Damper Delay at Start-Up	30 minutes
Occupancy Override Run Time	30 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F
Cooling Enable/Disable Override	AUTO
Heating Enable/Disable Override	AUTO
Outside Air Damper Open/Close Override	AUTO
Return Air Damper Open/Close Override	AUTO
Supply Fan Enable/Disable Override	AUTO

Additional Settings and Statuses to Show on Graphic
Current Zone Temperature Setpoint
Current Schedule Status (Occupied or Unoccupied)
Occupancy Override Status
Economizer Mode Status (5)
Active Program Overrides
Active Alarms

Alarms
High Zone Temperature
Low Zone Temperature
High Supply Air Temperature
Low Supply Air Temperature
High Zone Relative Humidity (2)
High Zone CO2 Concentration (3)
Supply Fan Failure
Supply Fan Running in Hand
Supply Fan Runtime Exceeded

NOTES:

- 1) Verify number of heat/cool stages per unit
- 2) When dehumidification specified on the equipment list.
- 3) When CO2 DCV specified on the equipment list.
- 4) Only for units with a hot-gas reheat coil.
- 5) When economizer specified on the equipment list
- 6) Test and Balance to set the outside air damper design ventilation position to achieve design outside air volume.



14. DX SPLIT SYSTEMS (NAT GAS OR ELECTRIC HEAT)

1) Run Conditions

- a. The system shall be enabled to run by a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the system shall operate continuously 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 system 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 AHU fan shall run for and be off for a minimum period of 10 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.
- c. The supply fan shall run anytime the system is commanded to run, unless shutdown on safeties.
- d. 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 AHU has been commanded to run for 30 minutes (adj.).
 - v. Low Zone Temp: The zone temperature is less than the heating setpoint by 5°F (adj.) after the AHU has been commanded to run for 30 minutes (adj.).

2) Cooling Control:

- a. When the zone air temperature is above the zone cooling setpoint, the BAS shall control the system compressors on or off to maintain the zone air temperature at the zone cooling setpoint. If the system is equipped with two stages of cooling, the second stage will activate if the zone air temperature has been 1.5°F (adj.) above setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
 - b. Cooling shall be enabled whenever the supply fan status is on AND heating is not active.
 - c. To prevent short-cycling, the compressors shall have a minimum on and off time of 3 minutes (adj.)
 - d. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).
- 3) Heating Control:
- a. When the zone air temperature is below the zone heating setpoint, the BAS shall adjust the heating output to maintain the zone air temperature at the zone heating setpoint. If the system is equipped with two stages of heating, the second stage will activate if the zone air temperature has been 1.5°F (adj.) below setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
 - b. Heating shall be enabled whenever the supply fan status is on AND the cooling compressors are off.
 - c. Heating shall be disabled whenever the outside ambient temperature is above 70°F (adj.).
- 4) Split System Start/Stop Sequence
- a. When the system is called to run, the BAS shall command the supply fan to run and enable cooling or heating as required to meet the zone air temperature setpoint.
 - b. When the system is called to stop, the BAS shall stop the supply air fan and disable cooling and heating.
- 5) Temperature Monitoring:
- a. The BAS shall monitor the entering (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 split system until the alarm is manually reset.
 - ii. Low Supply Air Temp: The supply air temperature is less than 40°F (adj.). Disable the split system until the alarm is manually reset.
- 6) Dehumidification (when specified on the equipment list):
 - a. The BAS shall monitor the zone air relative humidity. If the relative humidity exceeds 60% (adj.) the unit will shall be forced into dehumidification mode, if present, until the zone air relative humidity falls below 50% (adj.).
 - b. If the split system does not have a built-in dehumidification mode, the BAS shall force the unit into maximum cooling until the zone air relative humidity falls below 50% (adj.). During dehumidification operation, the BAS shall also enable heating and adjust the heating output to maintain the zone air temperature at the current setpoint.
 - c. Alarms shall be provided as follows:
 - i. High Zone Relative Humidity: The zone air relative humidity is greater than 60% (adj.) for 15 minutes (adj.) while the AHU is running.

DX Split System (NG or Electric Heat) Points Summary

Typical of Each DX Split System with Nat Gas or Electric Heat

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Occupant Override		X			
Supply Air Temperature	X				X
Entering Air Temperature	X				X
Zone Relative Humidity (2)	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
Totals	4	2	0	5	
	11				

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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
Second Stage Cooling Differential from Setpoint	+1.5°F for 2 minutes
Second Stage Heating Differential from Setpoint	-1.5°F for 2 minutes
Maximum Relative Humidity Setpoint (2)	60%
Dehumidification Setpoint (2)	50%
Minimum Fan Run Time / Off-Time	10 minutes
Minimum Compressor Runtime/Off-Time	3 minutes
Occupancy Override Run Time	30 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F
Cooling Enable/Disable Override	AUTO
Heating Enable/Disable Override	AUTO
Supply Fan Enable/Disable Override	AUTO

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

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

NOTES:

- 1) Verify number of heat/cool stages per unit
- 2) When dehumidification specified on the equipment list.



15. DX SPLIT SYSTEM HEAT PUMPS

1) Run Conditions

- a. The system shall be enabled to run by a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the system shall operate continuously 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 system 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 AHU fan shall run for and be off for a minimum period of 10 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.
- c. The supply fan shall run anytime the system is commanded to run, unless shutdown on safeties.
- d. 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 AHU has been commanded to run for 30 minutes (adj.).
 - v. Low Zone Temp: The zone temperature is less than the heating setpoint by 5°F (adj.) after the AHU has been commanded to run for 30 minutes (adj.).

2) Cooling Control:

- a. When the zone air temperature is above the zone cooling setpoint, the BAS shall control the system compressors on or off to maintain the zone air temperature at the zone cooling setpoint. If the system is equipped with two stages of cooling, the second stage will activate if the zone air temperature has been 1.5°F (adj.) above setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
- b. Cooling shall be enabled whenever the supply fan status is on AND heating is not active.
- c. To prevent short-cycling, the compressors shall have a minimum on and off time of 3 minutes (adj.)
- d. Cooling shall be disabled whenever the outside ambient temperature is below 40°F (adj.).

3) Heating Control:

- a. When the zone air temperature is below the zone heating setpoint, the BAS operate the system with the reversing valve in heating mode and stage the compressors on or off to maintain the zone air temperature at the heating setpoint. If the system is equipped with two stages of heating, the second stage will activate if the zone air temperature has been 1.5°F (adj.) below setpoint for more than 2 minutes (adj.), and will deactivate once the zone air temperature returns to setpoint. Alternatively, a PID feedback control loop may be used to control staging.
- b. The supplementary electric heat strip (if present) shall be enabled if the zone temperature remains 2°F (adj.) or more below setpoint for 5 minutes (adj.) while the system is in heating mode. The BAS will cycle the electric heat on and off as needed to maintain the zone air temperature at the heating setpoint.
- b. Heating shall be enabled whenever the supply fan status is on AND cooling is not active.
- c. Heating shall be disabled whenever the outside ambient temperature is above 70°F (adj.).

4) Split System Start/Stop Sequence

- a. When the system is called to run, the BAS shall command the supply fan to run and enable cooling or heating as required to meet the zone air temperature setpoint.
- b. When the system is called to stop, the BAS shall stop the supply air fan and disable cooling and heating.

- 5) Temperature Monitoring:
- a. The BAS shall monitor the entering (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 split system until the alarm is manually reset.
 - ii. Low Supply Air Temp: The supply air temperature is less than 40°F (adj.). Disable the split system until the alarm is manually reset.

DX Split System Heat Pump Points Summary

Typical of Each DX Split System Heat Pump

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Occupant Override		X			
Supply Air Temperature	X				X
Entering Air Temperature	X				X
Supply Fan Start/Stop				X	X
Supply Fan Run Status		X			X
Cooling/Heating Stage 1				X	X
Cooling/Heating Stage 2 (1)				X	X
Auxiliary Heat				X	X
Reversing Valve Control				X	X
Totals	3	2	0	5	
	10				

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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
Second Stage Cooling Differential from Setpoint	+1.5°F for 2 minutes
Second Stage Heating Differential from Setpoint	-1.5°F for 2 minutes
Auxiliary Heating Enable Setpoint Differential	>2°F for 5 minutes
Minimum Fan Run Time / Off-Time	10 minutes
Minimum Compressor Runtime/Off-Time	3 minutes
Occupancy Override Run Time	30 minutes
Cooling OAT Lockout	Below 40°F
Heating OAT Lockout	Above 70°F
Cooling Enable/Disable Override	AUTO
Heating Enable/Disable Override	AUTO
Supply Fan Enable/Disable Override	AUTO

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

Alarms
High Zone Temperature
Low Zone Temperature
High Supply Air Temperature
Low Supply Air Temperature
Supply Fan Failure
Supply Fan Running in Hand
Supply Fan Runtime Exceeded

NOTES:

1) Verify number of heat/cool stages per unit



17. VAV PARALLEL FAN-POWERED TERMINAL UNITS (HOT WATER REHEAT)

- 1) Run Conditions
 - a. Each terminal unit shall be managed by a User-defined occupied/unoccupied time schedule with the following settings:
 - i. In occupied mode the terminal unit shall maintain a 74°F (adj.) zone cooling setpoint and a 68°F (adj.) zone heating setpoint.
 - ii. In unoccupied mode (night setback) the terminal unit shall maintain an 85°F (adj.) zone cooling setpoint and a 55°F (adj.) zone heating setpoint.
 - b. Alarms shall be provided as follows:
 - i. High Zone Temperature: The zone temperature is greater than the cooling setpoint by 5°F (adj.) after the central AHU has been commanded to run for 30 minutes (adj.).
 - ii. Low Zone Temperature: The zone temperature is less than the heating setpoint by 5°F (adj.) after the central AHU has been commanded to run for 30 minutes (adj.).
- 2) Airflow and Heating Control:
 - a. The BAS shall measure the primary air flow through the terminal unit and control the terminal unit damper and heating to maintain the zone temperature setpoint as follows:
 - i. When the zone temperature is greater than the cooling setpoint, the terminal unit damper shall be controlled to increase or decrease the primary cold air flow as needed to satisfy the zone temperature setpoint. The air flow shall be variable between a minimum cooling airflow setpoint (adj.) and a maximum cooling airflow setpoint (adj.).
 - ii. When the zone temperature is between the cooling setpoint and the heating setpoint, the terminal unit damper shall be controlled to maintain the minimum airflow setpoint (adj.) for ventilation.
 - iii. When the zone temperature is less than the heating setpoint, the heating coil and fan shall be enabled. The terminal unit damper shall remain at the minimum airflow position (adj.) for ventilation. The BAS shall control the hot water coil valve position to maintain the zone temperature at the heating setpoint.

- b. Heating shall be disabled whenever the outside ambient temperature is above 70°F (adj.).
- c. Alarms shall be provided as follows:
 - i. High Primary Airflow: The measured air flow is 25% (adj.) greater than the airflow setpoint.
 - ii. Low Primary Airflow: The measured air flow is 25% (adj.) less than the airflow setpoint.

3) Fan Control:

- a. The fan shall run only while the terminal unit is operating in heating mode. The terminal unit damper shall close completely before the fan starts to prevent air from the AHU from causing the fan to spin backward. The terminal unit damper will return to automatic control after the fan starts.
- b. To prevent short-cycling the fan shall run for and be off for a minimum period of 15 minutes each (adj.).
- c. Alarms shall be provided as follows:
 - i. Fan Failure: The fan status is off 2 minutes (adj.) after being commanded on.
 - ii. Fan Running in Hand: The fan status is on 2 minutes (adj.) after being commanded off.
 - iii. Fan Runtime Exceeded: Status runtime exceeds a User-definable limit.

4) Discharge Air Temperature:

- a. The BAS shall monitor the terminal unit's discharge air temperature.
- b. Alarms shall be provided as follows:
 - i. High Discharge Air Temperature: The discharge air temperature is greater than 120°F (adj.). Disable the terminal unit until the alarm is manually reset.
 - ii. Low Discharge Air Temperature: The discharge air temperature is less than 45°F (adj.).

VAV Fan-Powered Terminal Unit (HW Reheat) Points Summary

Typical of Each VAV Fan-Powered Terminal Unit with HW Reheat

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature	X				X
Discharge Air Temperature	X				X
Primary Air Flow	X				X
Damper Control			X		X
Heating Valve Control			X		X
Fan Start/Stop				X	X
Fan Run Status		X			X
Totals	3	1	2	1	
	7				

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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
Minimum Fan Runtime/Off-Time	15 minutes
Maximum Cooling Airflow Setpoint	SEE EQUIP. LIST
Minimum Cooling Airflow Setpoint	SEE EQUIP. LIST
Maximum Heating Airflow Setpoint	SEE EQUIP. LIST
Minimum Heating Airflow Setpoint	SEE EQUIP. LIST
Heating OAT Lockout	70°F
Damper Position Override	AUTO
Heating Enable/Disable Override	AUTO
Fan Enable/Disable Override	AUTO

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

Alarms
High Zone Temperature
Low Zone Temperature
High Discharge Air Temperature
Low Discharge Air Temperature
High Primary Airflow
Low Primary Airflow
Fan Failure
Fan Running in Hand
Fan Runtime Exceeded

18. UNIT HEATERS

- 1) Run Conditions
 - a. The unit heater is locally controlled by an existing wall-mounted thermostat, and operates only when the zone temperature falls below the thermostat temperature setpoint.
 - b. The BAS shall monitor the zone temperature. Alarms shall be provided as follows:
 - i. Low Zone Temperature: The zone temperature is less than 40°F (adj.).

Unit Heater Points Summary

Typical of Each Unit Heater

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
Zone Temperature Alarm Setpoint	40°F

Alarms
Low Zone Temperature

19. EXHAUST FANS

1) Run Conditions

- a. For exhaust air fans specified with “BAS Enable/Disable Control” on the equipment list: fans shall be enabled to run by a User-defined enabled/disabled time schedule.
- b. Alarms shall be provided as follows (only for fans controlled by the BAS):
 - 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 Exhaust Fan under BAS Control

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
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
Fan Enable/Disable Override	AUTO

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

20. DOMESTIC WATER HEATERS

- 1) Run Conditions: Domestic hot water heater circulation pumps shall be enabled to run by a User-defined occupied/unoccupied time schedule.

Domestic HW Heater Points Summary

Typical of Each Water Heater with Circulation Pump

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Enable / Disable Circ Pump				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
Enabled/Disabled Scheduling	SEE SCHEDULES
Circ Pump Enable/Disable Override	AUTO

21. KITCHEN COOLER AND FREEZER TEMPERATURE MONITORING

- 1) Temperature Monitoring: The BAS shall monitor the temperatures of the kitchen's walk-in cooler and freezer.
 - a. Alarms shall be provided as follows
 - i. High Cooler Temperature: The temperature of the cooler is greater than 40°F (adj.) for more than 5 minutes (adj.).
 - ii. Low Cooler Temperature: The temperature of the cooler is less than 30°F (adj.) for more than 5 minutes (adj.).
 - iii. High Freezer Temperature: The temperature of the freezer is greater than 10°F (adj.) for more than 5 minutes (adj.).
 - iv. Low Freezer Temperature: The temperature of the freezer is less than -10°F (adj.) for more than 5 minutes (adj.).

Kitchen Cooler/Freezer Monitoring Points Summary

Typical of Each School Kitchen

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Cooler Temperature	X				X
Freezer Temperature	X				X
Totals	2	0	0	0	
	2				

Adjustable Control Settings (At Minimum)	Initial Setting
Temperature Tolerance Settings for Alarm	SEE SEQUENCE

Additional Settings and Statuses to Show on Graphic
Active Alarms

Alarms
High Cooler Temperature
Low Cooler Temperature
High Freezer Temperature
Low Freezer Temperature

23. AREA RELIEF DAMPERS

- 1) Building Static Pressure Control: A static pressure sensor located in the designated area will provide the BAS with a building static pressure feedback. The BAS will adjust the position of the area's motorized relief air damper(s) to maintain the building static pressure at 0.1" w.g. (adj.) at all times.
 - a. 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.
 - ii. Low Building Static Pressure: The building static pressure is less than 0.0" w.g. (adj.) for 5 minutes.

Area Relief Damper Points Summary

Typical of Each Designated Area

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Static Pressure	X				X
Relief Air Damper Control (1)			X		X
Totals	1	0	1	0	
	2				

Adjustable Control Settings (At Minimum)	Initial Setting
Building Static Pressure Setpoint	0.1" WC
High Pressure Alarm Setpoint	0.25" WC for 5 minutes
Low Pressure Alarm Setpoint	0.0" WC for 5 minutes

Additional Settings and Statuses to Show on Graphic
Active Alarms

Alarms
High Building Static Pressure
Low Building Static Pressure

NOTES:

- 1) Some areas have multiple relief air dampers; control all in unison.

Point Name	Point Type				Show on Graphic
	AI	DI	AO	DO	
Zone Temperature Setpoint			X		X
Zone Temperature	X				X
Occupant Override		X			
Supply Air Temperature	X				X
HVAC System Enable/Disable				X	X
Totals	2	1	1	1	
	5				

Adjustable Control Settings (At Minimum)	Initial Setting
Occupied/Unoccupied Mode Scheduling	SEE SCHEDULES
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
Occupancy Override Run Time	30 minutes
Minimum Run Time / Off-Time	10 minutes
HVAC System Enable/Disable Override	AUTO

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

Alarms
High Zone Temperature
Low Zone Temperature
High Supply Air Temperature
Low Supply Air Temperature