

REVISONS

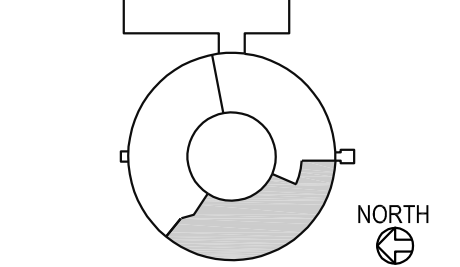
HVAC Replacement and Deferred
Maintenance - Phase 3

CROOKED LAKE
ELEMENTARY SCHOOL
Anoka-Hennepin Schools I.S.D. No. 11
2939 Bunker Lake Blvd NW
Andover, MN 55304

SIGNATURE / SEAL
I hereby certify that this plan, specification, or
report was prepared by me or under my direct
supervision and that I am a duly licensed
Professional Engineer under the laws of the
State of Minnesota.

SIGNATURE
Elavene Parkos, PE
October 27, 2021
TYPED OR PRINTED NAME
October 27, 2021
DATE

KEY PLAN



DRAWN BY
GEG

CHECKED BY
BJP

ISSUED FOR
CONSTRUCTION DOCUMENTS

ISSUE DATE
OCTOBER 27, 2021

SHEET NAME

MECHANICAL
CONTROL DIAGRAMS

ATSR PROJECT NO.
19039.2

REVISION NO.

SHEET NUMBER

M10.1

AIR HANDLING UNIT - VAV INTERNAL HEAT RECOVERY DOAS UNIT

SEQUENCE

- Fan shall start and stop following the occupancy schedule as defined by the BAS.
- Variable speed drive shall be used to: soft start fan, balance fan (set max airflow) and control for occupancy volume control
- Amp Draw for fan status to be monitored through the VFD by the BAS.
- Points shall be monitored by the BAS.
- On fan startup, VFD shall gradually ramp up to half speed. After 5 minute delay begin pre-occupancy warm-up or cool down mode, see below for warm-up sequences.
- When pre-occupancy mode is complete, unit shall switch to occupied-standby mode
- When unit has multiple fans operating in parallel and the VFD amp draw of any VFD is more than 10% different from the others then send a fan failure alarm.
- A command fail alarm shall be sent to the BAS any time the fan command and status don't match for 60 seconds (adjustable).
- Variable speed drive shall modulate to maintain duct static pressure setpoint at static pressure sensor located 2/3 distance down the longest supply run or where determined by the BAS contractor and approved by the Engineer.
- The duct static pressure setpoint shall be optimally reset based on zone airflow request and meeting airflow and space temperature requirements. The static pressure set-point shall be reset using Trim & Respond logic within the range 0.15" w.g (adjustable) to 1.3" w.g (adjustable). When the supply fan is off, the set-point shall be 0.5" w.g. While the fan is proven on, every two minutes, trim the set-point by 0.4" w.g., if there are more than two zone pressure requests. If there are more than two zone pressure requests, respond by increasing the set-point by 0.08" w.g (adjustable).
- The exhaust fan shall modulate speed based on space static pressure to maintain a positive 0.05"wc positive pressure.
- A duct static pressure at the discharge of the unit that exceeds the high limit setpoint shall send high static alarm and shut unit down.
- Airflow measuring stations shall indicate outdoor and supply fan air flow for trending.
- Piezo ring airflow measuring station shall measure supply airflow for each fan at the ERU for trending.
- Outdoor Air and By-pass damper control by CO2: The BAS shall monitor the space mounted CO2 sensors and shall control to the highest space CO2. The Outdoor air quantity shall modulate between a minimum (20%) Outdoor Air (OA) and maximum Outdoor of 100% based on a scale of 500 ppm to 1200 ppm of CO2. The Return Air By-Pass damper shall modulate with the outdoor air damper to return the remainder of the required supply air back to the system.
- Heating Mode (partial recovery): If the Outdoor Air (OA) and Mixed Air (MA) temperature is below discharge air set point, the energy wheel shall start at low speed until discharge air supply temperature is satisfied. If the mixed air temperature (MA) rises above set-point, the wheel speed should be reduced to maintain the mixed air temperature set-point. On further call for heat unit shall switch to "Heating Mode (full recovery)" and heating control valve shall modulate to maintain setpoint. EMS shall monitor energy wheel speed for trend data.
- Heating Mode (full recovery): If the Outdoor Air (OA) and Mixed Air (MA) temperature is below discharge air set point, the energy wheel shall be operated at full speed and heating control valve shall modulate to maintain setpoint of discharge air supply temperature. If the mixed air temperature (MA) rises above the discharge air set-point, the unit shall go back to partial recovery mode. EMS shall monitor energy wheel speed for trend data.
- Economizer mode (economizer plus partial cooling): If OA temperature is greater than unit discharge air temperature set-point and the OA enthalpy is less than RA enthalpy the energy wheel shall be off. Cooling control valve shall modulate to meet discharge air temperature setpoint.
- Economizer mode (free cooling): If OA temperature is less than the discharge air temperature set-point the outdoor air and exhaust air dampers shall be fully open, wheel return by-pass damper closed and energy wheel shall be off. The cooling coil and heating coil control valves shall be closed. If the mixed air temperature starts to drop below the unit discharge air temperature by more than 3 degrees F, modulate the heating coil to maintain discharge air temperature.
- Cooling Mode (full recovery, and cooling): If Outdoor air enthalpy is greater than the return air enthalpy; The Outdoor air and Exhaust air dampers shall be fully open, the energy wheel shall be at full speed, the cooling coil control valve shall modulate to maintain discharge air temperature set-point. As outdoor air enthalpy becomes less than the return air enthalpy, switch to "economizer mode with partial cooling".
- The discharge air temperature setpoint shall be reset (between 55F and 95F) by the space below its heating setpoint.
- During unoccupied mode the heating valve will cycle as needed and the wheel by-pass damper shall open with the air handler to meet set-back temperature.
- Heating coil valve operator shall be spring return to fail open.
- During the unoccupied mode the heating coil shall cycle open to maintain a 40 to 50F. at the mixed air chamber.
- When return air humidity rises to 55% RH, initiate Dehumidification mode until R.A humidity drops to 50% RH. During dehumidification mode, the cooling coil discharge temperature shall be set to 50 degrees and the EMS shall send a 0 to 10 vdc signal to the hotgas reheat coil valve at the condenser to meet the unit discharge temperature setpoint (55 to 65 Deg F adjustable).
- EMS shall cycle the hotgas reheat coil valve to 100% once each hour of DX operation.
- During unoccupied mode or when the fan is off the cooling control valve shall be closed.
- Frost control mode: If OA temp drops below the manufacturers required temperature for frost control (-3 deg F adjustable) the wheel speed shall be at minimum.
- Low temperature Alarm: If unit discharge air temperature drops below 40 deg. F., shut OA & EA ops, open recirc dpr, open heating control valve. On further drop to 35 deg. F., shut of fans & send low temp alarm operators remote site.

OPTIMUM START - WARM UP MODE

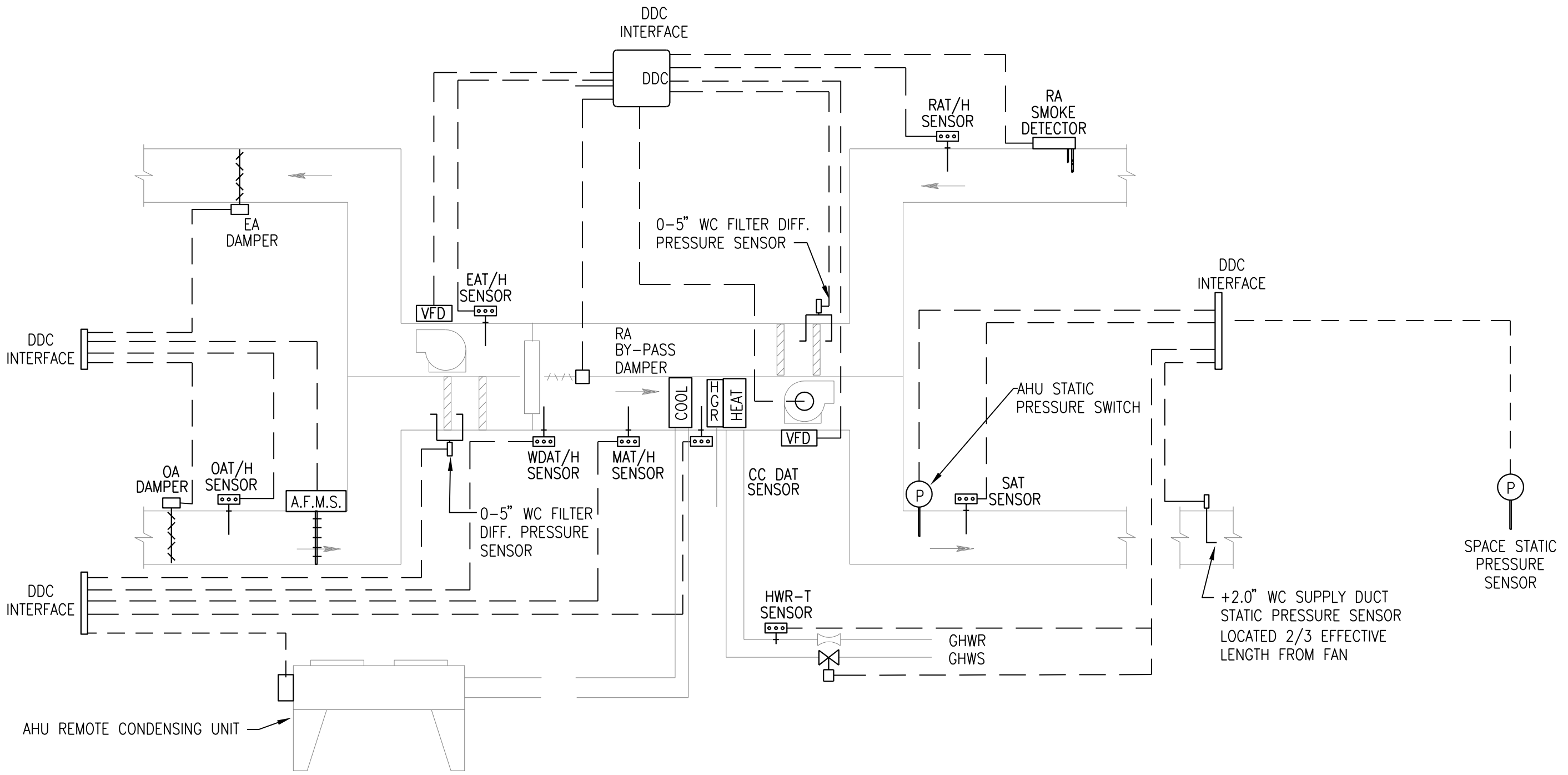
- Warm-up will be based on the return air temperature. Sequence will be used if the return air temperature is below 63 F. (adjustable).
- Prior to beginning occupied mode, the discharge temperature shall be increased (95F max., adj.) until the return air temperature rises above 68F. (adjustable). Outside air damper shall be fully closed. ERW By-pass return air damper shall be fully open.
- An adaptive optimal start algorithm shall be used to minimize the energy required and warm-up time during the unoccupied period, necessary to achieve zone occupied temperature setpoints by the of the scheduled occupied period.
- Upon completion of the warm-up cycle the unit shall commence normal occupied operation. If the cycle has not been completed prior to scheduled occupancy, unit shall commence normal occupied operation.

OPTIMUM START - COOLING

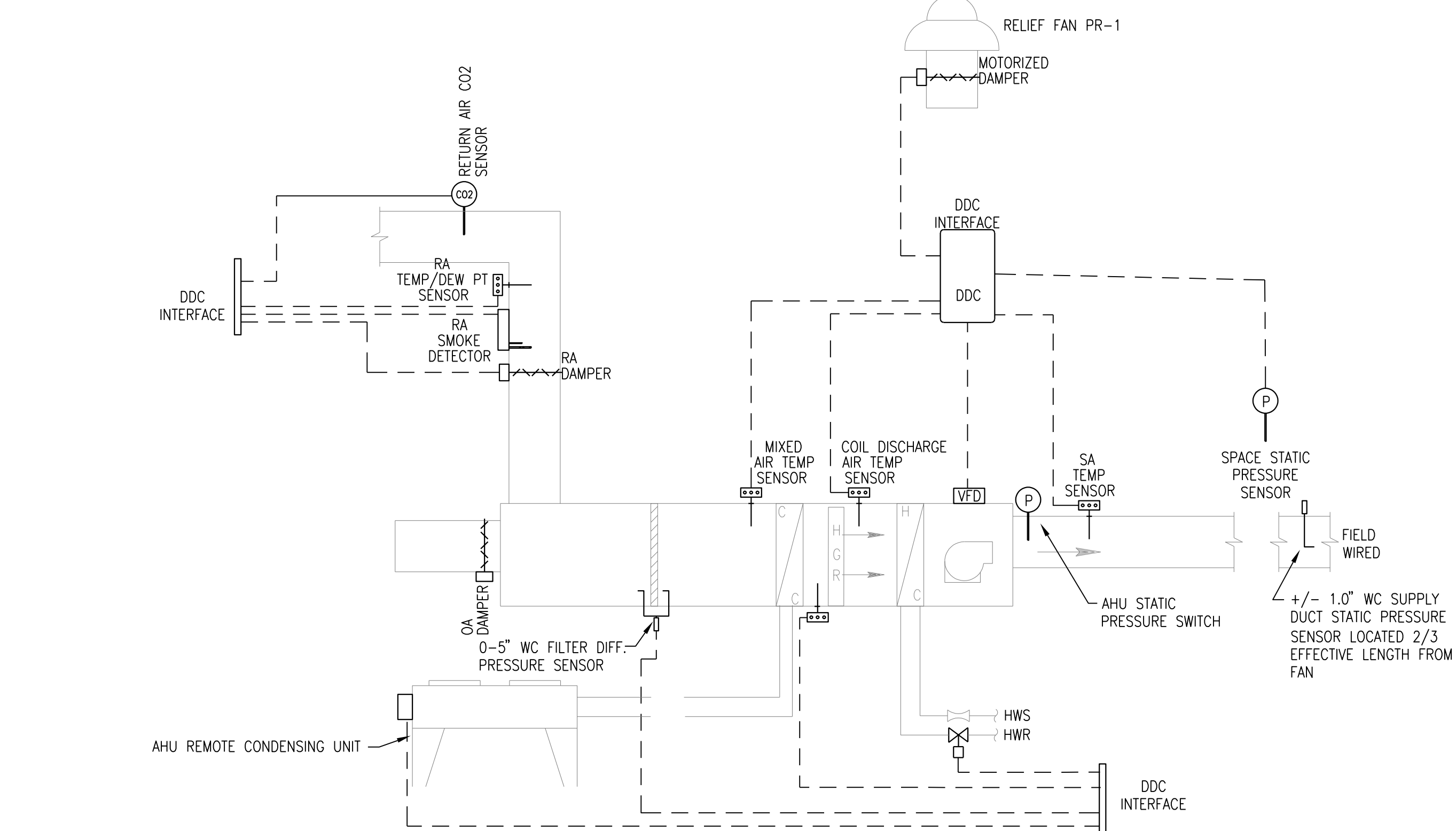
- Cool-down will be based on the return air temperature. Sequence will be used if the return air temperature is above 76 Deg F. (adjustable).
- Prior to beginning occupied mode, the discharge temperature shall be lowered (55F min., adj.) until the return air temperature falls below 76F. (adjustable). Outside air damper shall be fully closed. ERW By-pass return air damper shall be fully open.
- An adaptive optimal start algorithm shall be used to minimize the energy required and cool-down time during the unoccupied period, necessary to achieve zone occupied temperature setpoints by the of the scheduled occupied period.
- Upon completion of the cool-down cycle the unit shall commence normal occupied operation. If the cycle has not been completed prior to scheduled occupancy, unit shall commence normal occupied operation.
- An adaptive optimal start algorithm shall be used to minimize the energy required and cool-down time during the unoccupied period, necessary to achieve zone occupied temperature setpoints by the of the scheduled occupied period.
- Upon completion of the cool-down cycle the unit shall commence normal occupied operation. If the cycle has not been completed prior to scheduled occupancy, unit shall commence normal occupied operation.

POINTS LEGEND

- AI = ANALOG INPUT SA = STATUS ALARM
AO = ANALOG OUTPUT TL = TREND LOG
DI = DIGITAL INPUT SP = SETPOINT
DO = DIGITAL OUTPUT SC = SCHEDULE
HA = HIGH ALARM IL = INTERLOCK
LA = LOW ALARM



1 M10.1 DEDICATED OUTDOOR AIR UNIT W/ HEAT/COOL & RECOVERY WHEEL ERU-3



2 M10.1 OFFICE RTU-4 SEE ALTERNATES

AIR HANDLING UNIT - VAV OFFICE - ALTERNATE

SEQUENCE

- Supply Fan shall start and stop following the occupancy schedule as defined by the BAS.
- Variable speed drive shall be used to: soft start fan, balance fan (set max airflow) and control for CO2/occupancy volume control
- Amp Draw for fan status to be monitored through the VFD by the BAS.
- Points shall be monitored by the BAS.
- On fan startup, VFD shall gradually ramp up to half speed. After 5 minute delay begin pre-occupancy mode
- When pre-occupancy mode is complete, unit shall switch to occupied mode; see below for warm up and cool down cycles.
- When unit has multiple fans operating in parallel and the VFD amp draw of any VFD is more than 10% different from the others then send a fan failure alarm.
- A command fail alarm shall be sent to the BAS any time the fan command and status don't match for 60 seconds (adjustable).
- A duct static pressure at the discharge of the unit that exceeds the high limit setpoint shall send high static alarm and shut unit down.
- Airflow measuring station shall indicate outside air flow for trending.
- During the occupied heating mode the heating control valve shall modulate to maintain the space temperature setpoint.
- If the space static pressure drops to negative, the outdoor air damper shall open from minimum position and modulate upwards to achieve a neutral pressure gain.
- The discharge air temperature setpoint shall be reset (between 55F and 65F) by the space below its heating setpoint.
- During unoccupied mode the heating valve will cycle as needed with the air handler to meet night set-back temperature.
- Heating coil valve operator shall be spring return to fail open.
- During the unoccupied mode the heating coil shall cycle open to maintain a 40 to 50F. at the mixed air chamber.
- In occupied cooling mode, the cooling coil control valve shall modulate to maintain 55 degree discharge air temp set-point.
- The unit discharge temperature shall be reset by the space thermostat and or return air humidity. Return air humidity setpoint to be 50% RH (adjustable)
- During dehumidification the cooling coil discharge temperature shall be set to 50 degrees and the heating coil valve shall modulate to meet the unit discharge temperature setpoint.
- During unoccupied mode or when the fan is off the dx cooling shall be off.
- Cooling Mode : If Outdoor air enthalpy is greater than the return air enthalpy; The Outdoor air and Exhaust air dampers shall be fully open, the DX cooling coil control shall modulate to maintain discharge air temperature set-point. As outdoor air enthalpy becomes less than the return air enthalpy, switch to "economizer mode with partial cooling".
- The discharge air temperature setpoint shall be reset (between 55F and 95F) by the space below its heating setpoint.
- During unoccupied mode the heating valve will cycle as needed with the air handler to meet set-back temperature.
- Heating coil valve operator shall be spring return to fail open.
- During the unoccupied mode the heating coil shall cycle open to maintain a 40 to 50F. at the mixed air chamber.
- When return air humidity rises to 55% RH, initiate Dehumidification mode until R.A humidity drops to 50% RH. During dehumidification mode, the cooling coil discharge temperature shall be set to 50 degrees and the EMS shall send a 0 to 10 vdc signal to the hotgas reheat coil valve at the condenser to meet the unit discharge temperature setpoint (55 to 65 Deg F adjustable).
- EMS shall cycle the hotgas reheat coil valve to 100% once each hour of DX operation.
- Economizer mode: Enthalpy sensors/controllers in the outside air and return air streams shall modulate outside air and return dampers between minimum outside airflow and 100% outdoor air setting to provide atmospheric cooling. Heating coil valve shall be closed. Dampers shall return to minimum outdoor air upon a continued rise in space temperature.
- Filter status shall be recorded daily when unit is in warm-up mode at full speed.

OPTIMUM START - WARM UP MODE

- Warm-up will be based on the return air temperature. Sequence will be used if the return air temperature is below 63 F. (adjustable).
- Prior to beginning occupied mode, the discharge temperature shall be increased (95F max., adj.) until the return air temperature rises above 68F. (adjustable). Fan and outside air damper full closed.
- An adaptive optimal start algorithm shall be used to minimize the energy required and warm-up time during the unoccupied period, necessary to achieve zone occupied temperature setpoints by the of the scheduled occupied period.
- Upon completion of the warm-up cycle the unit shall commence normal occupied operation. If the cycle has not been completed prior to scheduled occupancy, unit shall commence normal occupied operation.

OPTIMUM START - COOLING

- Cool-down will be based on the return air temperature. Sequence will be used if the return air temperature is above 76 Deg F. (adjustable).
- Prior to beginning occupied mode, the discharge temperature shall be lowered (55F min., adj.) until the return air temperature falls below 76F. (adjustable). Fan and outside air damper full closed.
- An adaptive optimal start algorithm shall be used to minimize the energy required and cool-down time during the unoccupied period, necessary to achieve zone occupied temperature setpoints by the of the scheduled occupied period.
- Upon completion of the cool-down cycle the unit shall commence normal occupied operation. If the cycle has not been completed prior to scheduled occupancy, unit shall commence normal occupied operation.

POINTS

POINTS	HARDWARE				SOFTWARE						
	AI	AO	DI	DO	HA	LA	SA	TL	SP	SC	IL
SS SUPPLY FAN			X	X				X	X		X
ACTIVE SETPOINT										X	
SUP FAN VFD AMPS	X							X	X		
SUP FAN SPEED	X										
EXHAUST FAN VFD AMPS	X							X	X		
EXHAUST FAN SPEED	X										
HEATING CONTROL VALVE	X										
RETURN AIR DAMPER	X								X		
OUTSIDE AIR DAMPER	X									X	
RETURN AIR HUMIDITY	X					X			X		
RETURN AIR TEMPERATURE	X							X	X		
WHEEL DISCH AIR TEMP/HUMID	X								X	X	
MIXED AIR TEMPERATURE	X								X	X	
COOLING COIL DISCHARGE AIR TEMP.	X								X	X	
UNIT DISCHARGE AIR TEMP.	X					X			X	X	
WHEEL D. A. T./HUMIDITY	X							X	X	X	
OUTDOOR AIR TEMP & HUMIDITY	X								X	X	
EXHAUST AIR TEMP & HUMIDITY	X								X	X	
SPACE TEMPERATURE & HUMIDITY	X	X								X	X
HIGH ZONE CO2	X	X								X	X
DUCT STATIC PRESSURE SETPOINT	X	X								X	X
DUCT STATIC PRESSURE " W.C.	X	X							X	X	X
OUTSIDE AIRFLOW CFM	X								X	X	X
SUPPLY/EXHAUST FANS AIRFLOW CFM	X								X	X	X
SS EXHAUST FAN	X	X	X	X	X	X	X	X	X	X	X
ACTIVE SETPOINT										X	
COOLING STAGING								X	X		
COOLING ENABLE/DISABLE								X	X		
DX COOLING SYSTEM STATUS	X	X							X	X	
DEHUMIDIFICATION SIGNAL	X	X								X	X
O.A. FILTER STAUS	X					X					
EXH FILTER STAUS	X					X					
WHEEL SPEED S.P.	X										
WHEEL SPEED STATUS	X									X	
HOT WATER RETURN TEMP	X									X	
STATIC PRESSURE SWITCH	X						X			X	X
SPACE STATIC PRESSURE	X							X	X	X	X

M10.1