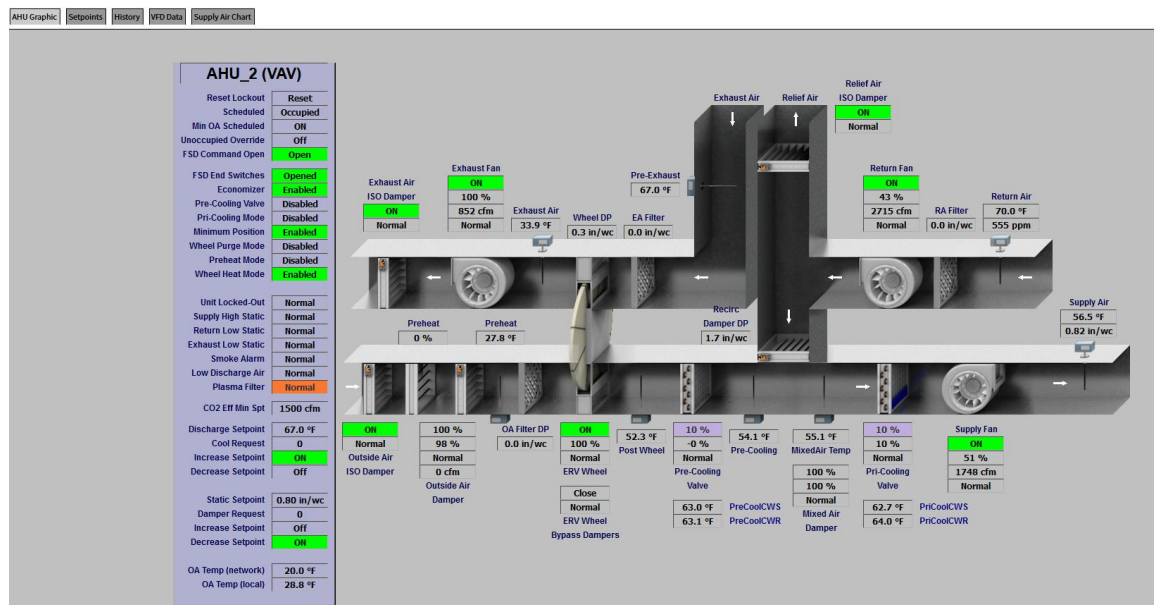


MMN Building AHU 2 January Report



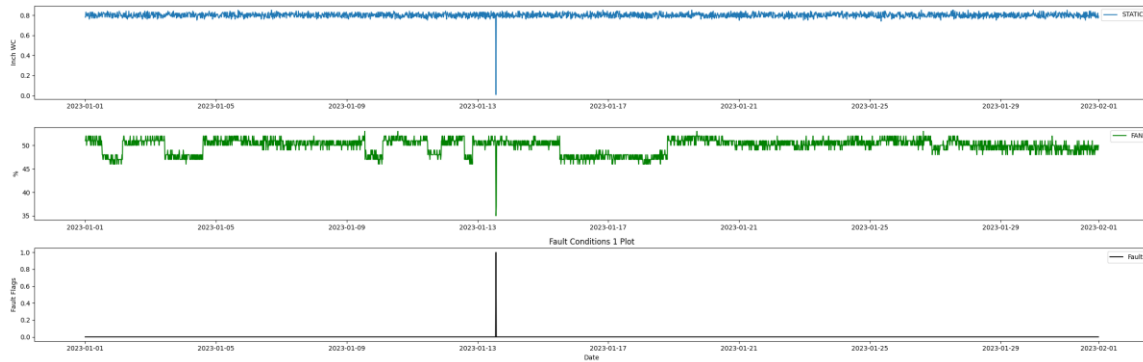
- Verify chiller plant doesn't run during Wintertime what's noticed on AHU 4 it appears mechanical cooling is running where the difference is between the mix and supply temperatures.
- Recommend removing all operator overrides from the BAS.
- As with other AHU's in this building verify how they are supposed to ventilate the issue with OS #6 appears common across all AHUs.

Fault Condition One Report

Fault condition one of ASHRAE Guideline 36 is related to flagging poor performance of a AHU variable supply fan attempting to control to a duct pressure setpoint. Fault condition equation as defined by ASHRAE:

FC#1	Equation	$DSP < DSPSP - \epsilon DSP$ AND $VFDSPD \geq 99\% - \epsilon VFDSPD$	Applies to OS#1 through OS#5
	Description	Duct static pressure too low with fan at full speed	
	Possible Diagnosis	<ul style="list-style-type: none">• Problem with VFD• Mechanical problem with fan• Fan undersized• SAT set point too high (too much zone demand)	

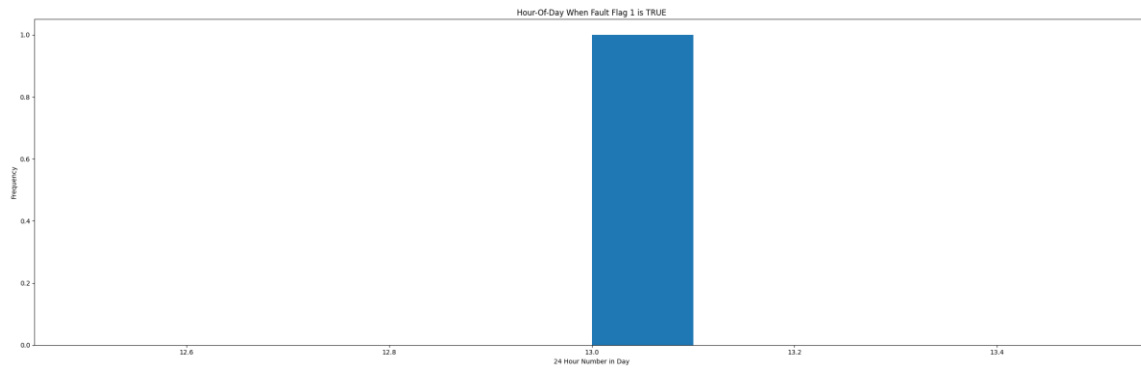
Dataset Plot



Dataset Statistics

- Total time in days calculated in dataset: 30.99
- Total time in hours calculated in dataset: 743.75
- Total time in hours for when fault flag is True: 0.25
- Percent of time in the dataset when the fault flag is True: 0.03%
- Percent of time in the dataset when the fault flag is False: 99.97%
- Calculated motor runtime in hours based off of VFD signal > zero: 743.75
- This fan system appears to run 24/7 consider implementing occupancy schedules to reduce building fuel use through HVAC

Time-of-day Histogram Plots



- Average duct system pressure for when in fault condition (fan VFD speed > 95%): 0.01"WC

Summary Statistics filtered for when the AHU is running

VFD Speed

- count 2976.00000
mean 49.87164
std 1.53535
min 35.00000
25% 49.00000
50% 50.00000
75% 51.00000
max 53.00000
Name: AHU2_SaFanSpeedAO_value, dtype: float64

Duct Pressure

- count 2976.000000
mean 0.800380
std 0.024714
min 0.010000
25% 0.780000
50% 0.800000
75% 0.820000
max 0.850000
Name: AHU2_SaStatic_value, dtype: float64

Duct Pressure Setpoint

- count 2.976000e+03
mean 8.000000e-01
std 1.110410e-16
min 8.000000e-01

25% 8.000000e-01
50% 8.000000e-01
75% 8.000000e-01
max 8.000000e-01
Name: duct_static_setpoint, dtype: float64

Suggestions based on data analysis

- The percent True metric that represents the amount of time for when the fault flag is True is low indicating the fan appears to generate good duct static pressure
- No duct static pressure setpoint reset detected consider implementing a reset strategy to save AHU fan energy

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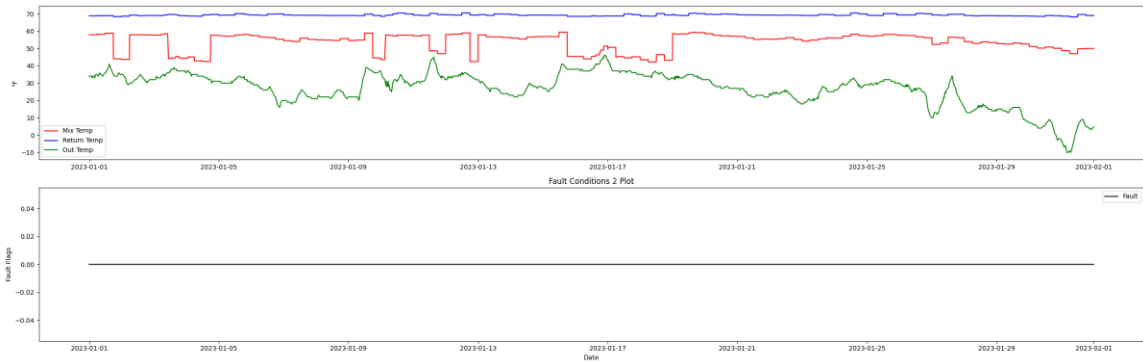
Fault Condition Two Report

Fault condition two and three of ASHRAE Guideline 36 is related to flagging mixing air temperatures of the AHU that are out of acceptable ranges. Fault condition 2 flags mixing air temperatures that are too low and fault condition 3 flags mixing temperatures that are too high when in comparison to return and outside air data. The mixing air temperatures in theory should always be in between the return and outside air temperatures ranges. Fault condition two equation as defined by ASHRAE:

Snip of ASHRAE Fault Condition 2

FC#2 (omit if no MAT sensor)	Equation	$MAT_{avg} + \epsilon_{MAT} < \min[(RAT_{avg} - \epsilon_{RAT}), (OAT_{avg} - \epsilon_{OAT})]$	Applies to OS#1 through OS#5
	Description	MAT too low; should be between OAT and RAT	
	Possible Diagnosis	<ul style="list-style-type: none">• RAT sensor error• MAT sensor error• OAT sensor error	

Dataset Plot



Dataset Statistics

- Total time in days calculated in dataset: 31.0
- Total time in hours calculated in dataset: 743.8833333333333
- Total time in hours for when fault flag is True: 0.0
- Percent of time in the dataset when the fault flag is True: 0.0%
- Percent of time in the dataset when the fault flag is False: 100.0%
- Calculated motor runtime in hours based off of VFD signal > zero: 743.88
- This fan system appears to run 24/7 consider implementing occupancy schedules to reduce building fuel use through HVAC
- No faults were found in this given dataset for the equation defined by ASHRAE.

Summary Statistics filtered for when the AHU is running

Mix Temp

- count 1369.000000
mean 53.897955
std 4.999242
min 42.200000
25% 52.300000
50% 56.100000
75% 57.600000
max 59.400000
Name: AHU2_MATemp, dtype: float64

Return Temp

- count 1369.000000
mean 69.257633
std 0.471934
min 68.200000
25% 69.000000
50% 69.200000
75% 69.500000
max 70.500000
Name: AHU2_RATemp_value, dtype: float64

Outside Temp

- count 1369.000000
mean 27.661432
std 8.729501
min -10.000000
25% 23.000000
50% 30.000000
75% 34.000000
max 46.000000
Name: HourlyDryBulbTemp, dtype: float64

Suggestions based on data analysis

- The percent True of time in fault condition 2 is high indicating the AHU temperature temp sensors are out of calibration

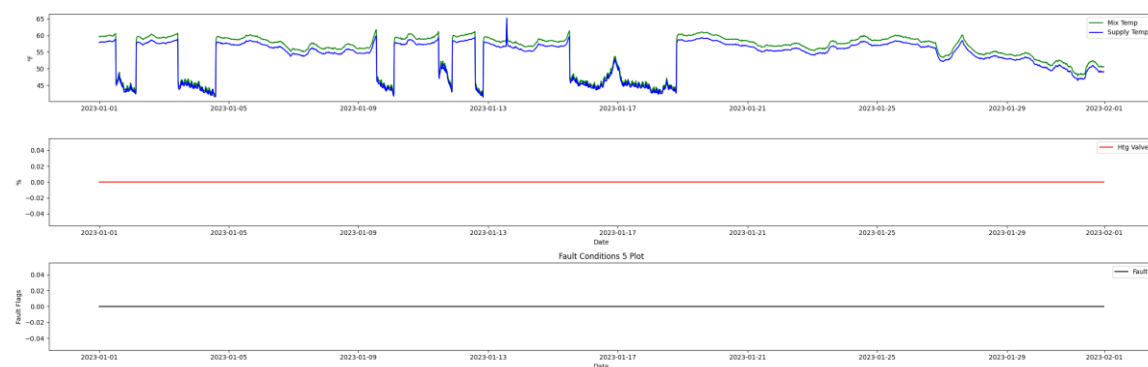
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Fault Condition Five Report

Fault condition five of ASHRAE Guideline 36 is (an AHU heating mode or winter time conditions only fault equation) related to flagging supply air temperatures that are out of acceptable ranges based on the mix air temperature and an assumption for heat created by the AHU supply fan in the air stream. Fault condition five equation as defined by ASHRAE:

FC#5 (omit if no MAT sensor)	Equation	$SAT_{avg} + \epsilon SAT \leq MAT_{avg} - \epsilon MAT + \Delta T_{SF}$	Applies to OS#1 (heating mode)
	Description	SAT too low; should be higher than MAT	
	Possible Diagnosis	<ul style="list-style-type: none">• SAT sensor error• MAT sensor error• Cooling-coil valve leaking or stuck open• Heating-coil valve stuck closed or actuator failure• Fouled or undersized heating coil• HW temperature too low or HW unavailable• Gas or electric heat unavailable• DX cooling stuck ON	

Dataset Plot



Dataset Statistics

- Total time in days calculated in dataset: 30.99
- Total time in hours calculated in dataset: 743.75
- Total time in hours for when fault flag is True: 0.0
- Percent of time in the dataset when the fault flag is True: 0.0%
- Percent of time in the dataset when the fault flag is False: 100.0%
- Calculated motor runtime in hours based off of VFD signal > zero: 743.75
- This fan system appears to run 24/7 consider implementing occupancy schedules to reduce building fuel use through HVAC
- No faults were found in this given dataset for the equation defined by ASHRAE.

Summary Statistics filtered for when the AHU is running

Mix Temp

- count 2976.000000
 - mean 54.983367
 - std 5.383913
 - min 42.000000
 - 25% 52.000000
 - 50% 57.100000
 - 75% 59.000000
 - max 65.300000
- Name: AHU2_DAT, dtype: float64

Supply Temp

- count 2976.000000
 - mean 53.624093
 - std 5.034585
 - min 41.400000
 - 25% 50.500000
 - 50% 55.600000
 - 75% 57.400000
 - max 65.000000
- Name: AHU2_MATemp, dtype: float64

Suggestions based on data analysis

- The percent True metric that represents the amount of time for when the fault flag is True is low indicating the AHU temperature sensors are within calibration

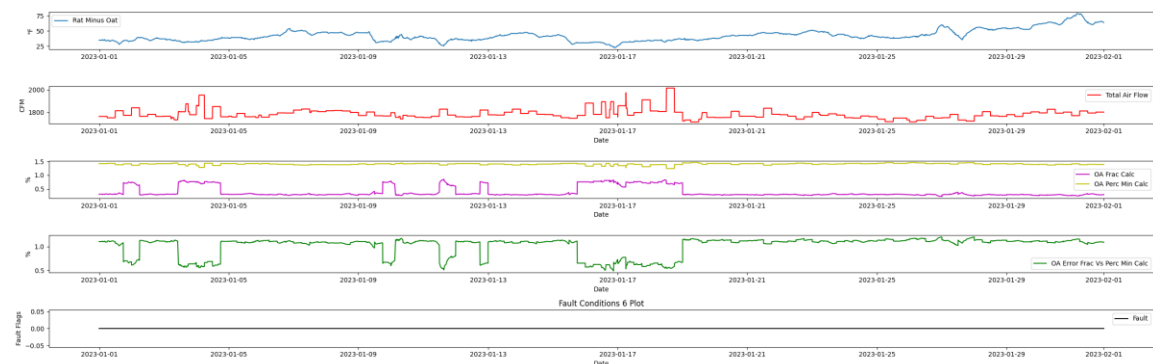
Report generated: Mon Feb 27 13:37:13 2023

Fault Condition Six Report

Fault condition six of ASHRAE Guideline 36 is an attempt at verifying that AHU design minimum outside air is close to the calculated outside air fraction through the outside, mix, and return air temperature sensors. A fault will get flagged in an AHU heating or mechanical cooling mode only if the calculated OA fraction is too low or too high as compared to percent Min calculation which is the AHU total air flow divided by the design minimum outdoor air expressed as a percent. Fault condition six equation as defined by ASHRAE:

FC#6	Equation	$ RAT_{avg} - OAT_{avg} \geq \Delta T_{min}$ AND $ \%OA - \%OA_{min} > \epsilon F$	Applies to OS#1 and OS#4
	Description	OA fraction too low or too high; should equal $\%OA_{min}$	
	Possible Diagnosis	<ul style="list-style-type: none">• RAT sensor error• MAT sensor error• OAT sensor error• Leaking or stuck economizer damper or actuator	

Dataset Plot



Dataset Statistics

- Total time in days calculated in dataset: 31.0
- Total time in hours calculated in dataset: 743.8833333333333
- Total time in hours for when fault flag is True: 0.0
- Percent of time in the dataset when the fault flag is True: 0.0%
- Percent of time in the dataset when the fault flag is False: 100.0%
- Calculated motor runtime in hours based off of VFD signal > zero: 743.88
- This fan system appears to run 24/7 consider implementing occupancy schedules to reduce building fuel use through HVAC
- No faults were found in this given dataset for the equation defined by ASHRAE.

Summary Statistics filtered for when the AHU is running

Mix Temp

- count 1369.000000
mean 53.897955
std 4.999242
min 42.200000
25% 52.300000
50% 56.100000
75% 57.600000
max 59.400000
Name: AHU2_MATemp, dtype: float64

Outside Temp

- count 1369.000000
mean 27.661432
std 8.729501
min -10.000000
25% 23.000000
50% 30.000000
75% 34.000000
max 46.000000
Name: HourlyDryBulbTemp, dtype: float64

Return Temp

- count 1369.000000
mean 69.257633
std 0.471934
min 68.200000
25% 69.000000
50% 69.200000
75% 69.500000
max 70.500000
Name: AHU2_RATemp_value, dtype: float64

Total Air Flow

- count 1369.000000
mean 1781.176771
std 41.475537
min 1716.000000
25% 1757.000000
50% 1772.000000
75% 1800.000000

max 2014.000000

Name: AHU2_SaFanFlow_value, dtype: float64

Suggestions based on data analysis

- The percent True metric that represents the amount of time for when the fault flag is True is low indicating the sensors are within calibration

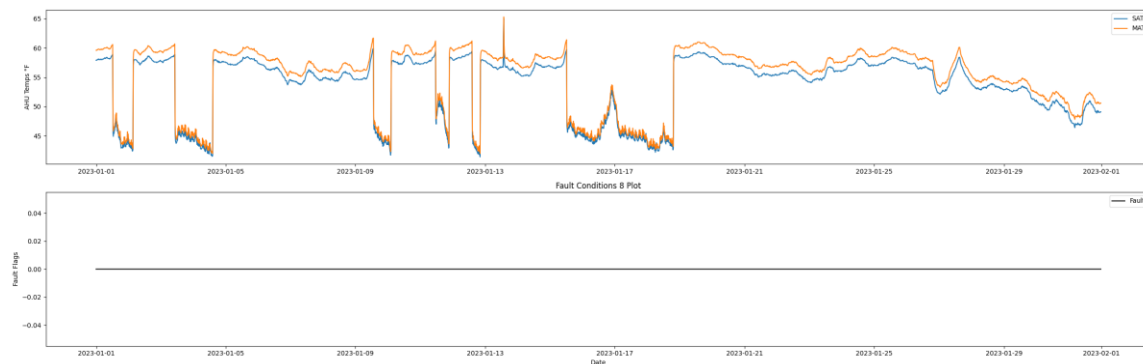
Report generated: Mon Feb 27 13:37:59 2023

Fault Condition Eight Report

Fault condition Eight of ASHRAE Guideline 36 is an AHU economizer free cooling mode only with an attempt at flagging conditions when the AHU mixing air temperature the supply air temperature are not approximately equal. Fault condition eight equation as defined by ASHRAE:

FC#8 (omit if no MAT sensor)	Equation	$ SAT_{avg} - MAT_{avg} > \sqrt{\epsilon SAT^2 + \epsilon MAT^2}$	Applies to OS#2
	Description	SAT and MAT should be approximately equal	
	Possible Diagnosis	<ul style="list-style-type: none">SAT sensor errorMAT sensor errorCooling-coil valve leaking or stuck openHeating-coil valve leaking or stuck open	

Dataset Plot



Dataset Statistics

- Total time in days calculated in dataset: 30.99
- Total time in hours calculated in dataset: 743.75
- Total time in hours for when fault flag is True: 0.0
- Percent of time in the dataset when the fault flag is True: 0.0%
- Percent of time in the dataset when the fault flag is False: 100.0%
- Calculated motor runtime in hours based off of VFD signal > zero: 743.75
- This fan system appears to run 24/7 consider implementing occupancy schedules to reduce building fuel use through HVAC
- No faults were found in this given dataset for the equation defined by ASHRAE.

Summary Statistics filtered for when the AHU is running

Supply Air Temp

- count 2976.000000
- mean 53.624093
- std 5.034585

min 41.400000
25% 50.500000
50% 55.600000
75% 57.400000
max 65.000000
Name: AHU2_MATemp, dtype: float64

Mix Air Temp

- count 2976.000000
mean 54.983367
std 5.383913
min 42.000000
25% 52.000000
50% 57.100000
75% 59.000000
max 65.300000
Name: AHU2_DAT, dtype: float64

Suggestions based on data analysis

- The percent True metric that represents the amount of time for when the fault flag is True is low indicating the AHU components are within calibration for this fault equation Ok.

Report generated: Mon Feb 27 13:40:18 2023