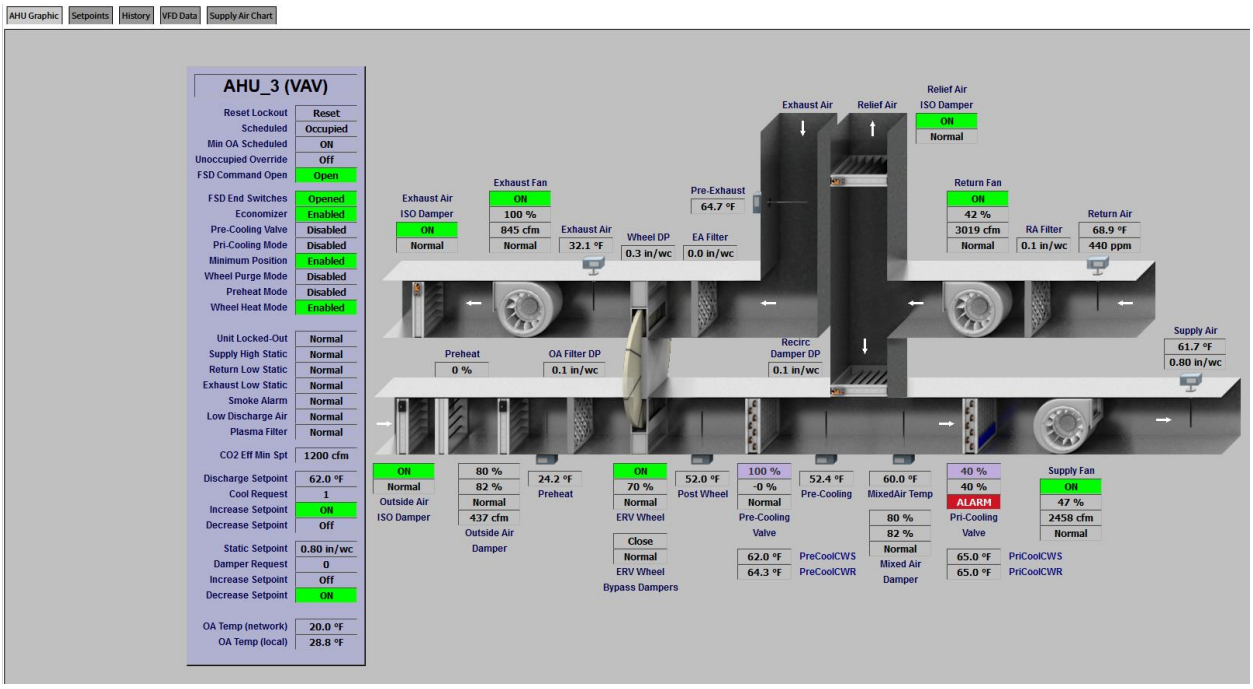
MMN Building AHU 3 January Report



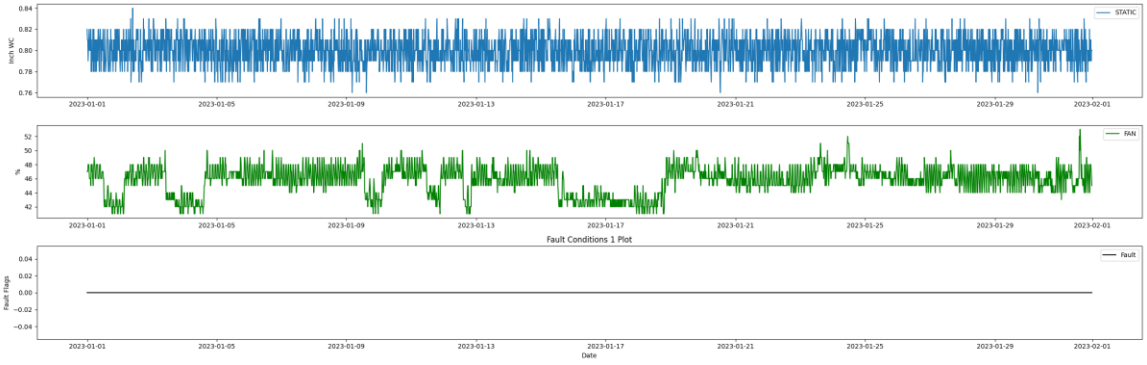
- Recommend removing all operator overrides for cooling coils
- Fault condition #2 very similar to AHU 1
- Fault condition #8 very similar to AHU 1 but better control. Its unclear if the adjustments shown in the data charts are from operator override setpoints or automated discharge air setpoints.
- Fault condition #6 very similar to AHU 1 I think a deeper brief dive could be worth looking at on how these AHU's by design are supposed to ventilating the building and make up air for exhaust systems. Fault six would be True if this AHU had a heating coil that the calculated OA fraction isn't within a tolerance of the design OA requirements.

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	$DSP < DSPSP - \varepsilon DSP$ **AND** $VFDSPD \geq 99\% - \varepsilon VFDSPD$	**Applies to OS#1 through OS#5**
	Description	Duct static pressure too low with fan at full speed	
	Possible Diagnosis	• 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: 0.0
- 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

VFD Speed

- count 2976.000000
  mean 45.793683
  std 1.983065

min 41.000000
25% 45.000000
50% 46.000000
75% 47.000000
max 53.000000
Name: AHU3_SaFanSpeedAO_value, dtype: float64

Duct Pressure

- count 2976.000000
  mean 0.799795
  std 0.014494
  min 0.760000
  25% 0.790000
  50% 0.800000
  75% 0.810000
  max 0.840000
  Name: AHU3_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 inidicating 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

Report generated: Mon Feb 27 13:10:49 2023

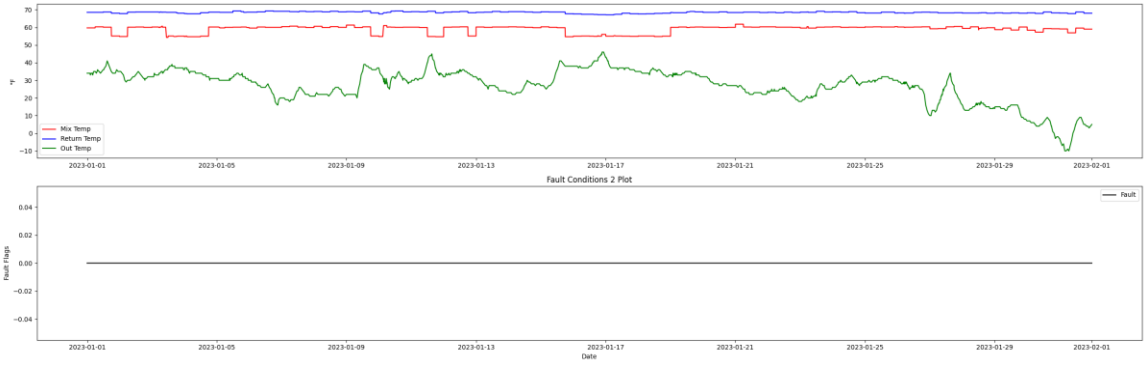
Fault Condition Two Report

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 comparision 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**	$MATavg + \varepsilon MAT < \min[(RATavg - \varepsilon RAT), (OATavg - \varepsilon OAT)]$	**Applies to OS#1 through OS#5**
	Description	MAT too low; should be between OAT and RAT	
	Possible Diagnosis	• 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 58.964500
  std 2.090303
  min 54.300000
  25% 59.200000
  50% 60.000000
  75% 60.200000
  max 61.800000
  Name: AHU3_MATemp, dtype: float64

Return Temp

- count 1369.000000
  mean 68.408400
  std 0.455484
  min 67.100000
  25% 68.100000
  50% 68.500000
  75% 68.700000
  max 69.300000
  Name: AHU3_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

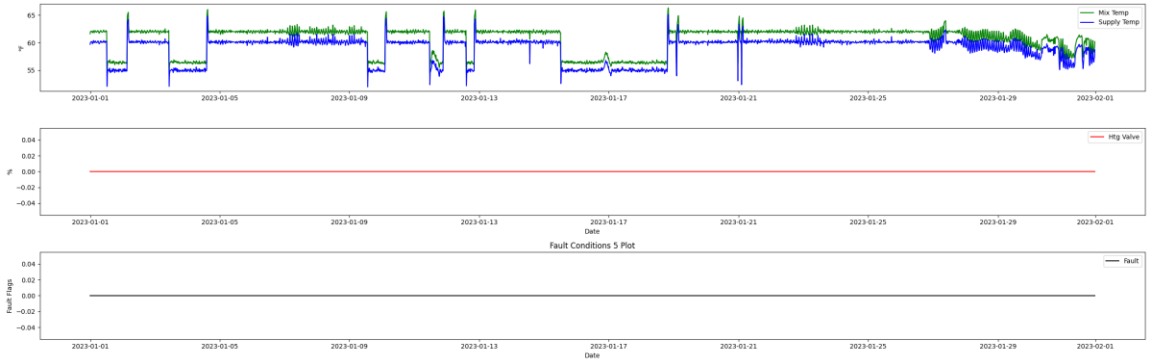
Report generated: Mon Feb 27 13:19:38 2023

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**	$SATavg + \varepsilon SAT \leq MATavg - \varepsilon MAT + \Delta TSF$	**Applies to OS#1** (heating mode)
	Description	SAT too low; should be higher than MAT	
	Possible Diagnosis	• 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 60.679032
  std 2.304560
  min 53.900000
  25% 60.200000
  50% 61.900000
  75% 62.000000
  max 66.300000
  Name: AHU3_DAT, dtype: float64

Supply Temp

- count 2976.000000
  mean 58.919892
  std 2.169782
  min 52.000000
  25% 58.400000
  50% 60.000000
  75% 60.200000
  max 65.100000
  Name: AHU3_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 inidicating the AHU temperature sensors are within calibration

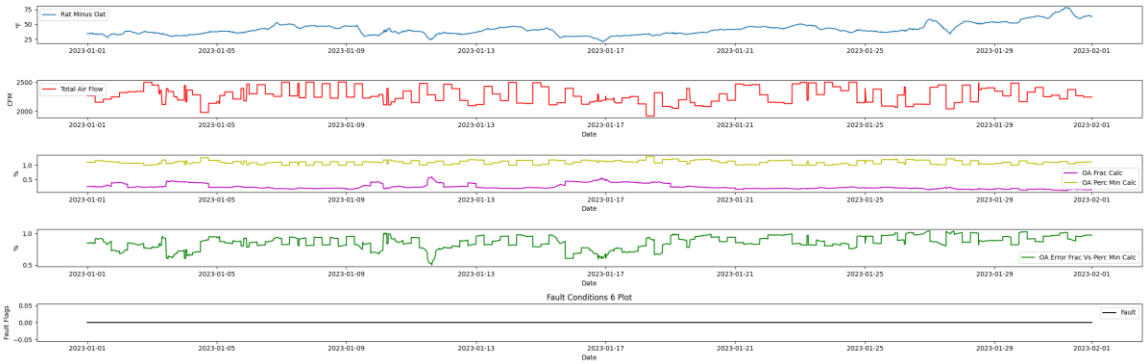
Report generated: Mon Feb 27 13:12:11 2023

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 to 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**	$\|RATavg - OATavg\| \geq \Delta Tmin$ **AND** $\|\%OA - \%OAmin\| > \varepsilon F$	**Applies to OS#1 and OS#4**
	Description	OA fraction too low or too high; should equal %OAmin	
	Possible Diagnosis	• RAT sensor error • MAT sensor error • OAT sensor error • Leaking or stuck economizer damper or actuator	

Dataset Plot



Dataset Statistics

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- 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 58.964500
  std 2.090303
  min 54.300000
  25% 59.200000
  50% 60.000000
  75% 60.200000
  max 61.800000
  Name: AHU3_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 68.408400
  std 0.455484
  min 67.100000
  25% 68.100000
  50% 68.500000
  75% 68.700000
  max 69.300000
  Name: AHU3_RATemp_value, dtype: float64

Total Air Flow

- count 1369.000000
  mean 2260.740687
  std 141.207012
  min 1916.000000
  25% 2148.000000
  50% 2252.000000
  75% 2388.000000

max 2500.000000
Name: AHU3_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 inidicating the sensors are within calibration

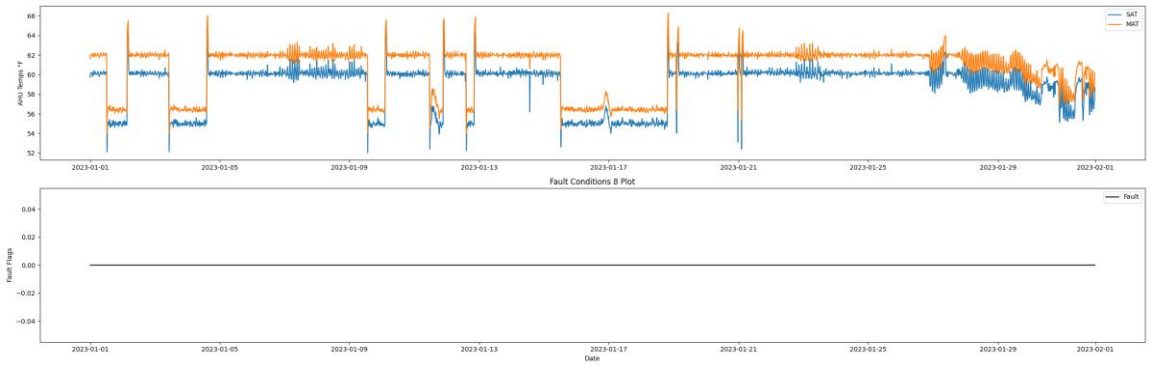
Report generated: Mon Feb 27 13:14:43 2023

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**	$\lvert SATavg - \Delta TSF - MATavg \rvert > \sqrt{\varepsilon SAT^2 + \varepsilon MAT^2}$	**Applies to OS#2**
	Description	SAT and MAT should be approximately equal	
	Possible Diagnosis	• SAT sensor error • MAT sensor error • Cooling-coil valve leaking or stuck open • Heating-coil valve leaking or stuck open	

Dataset Plot



Dataset Statistics

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- 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 58.919892
  std 2.169782
  min 52.000000

25% 58.400000
50% 60.000000
75% 60.200000
max 65.100000
Name: AHU3_MATemp, dtype: float64

Mix Air Temp

- count 2976.000000
  mean 60.679032
  std 2.304560
  min 53.900000
  25% 60.200000
  50% 61.900000
  75% 62.000000
  max 66.300000
  Name: AHU3_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 inidicating the AHU components are within calibration for this fault equation Ok.

Report generated: Mon Feb 27 13:15:53 2023