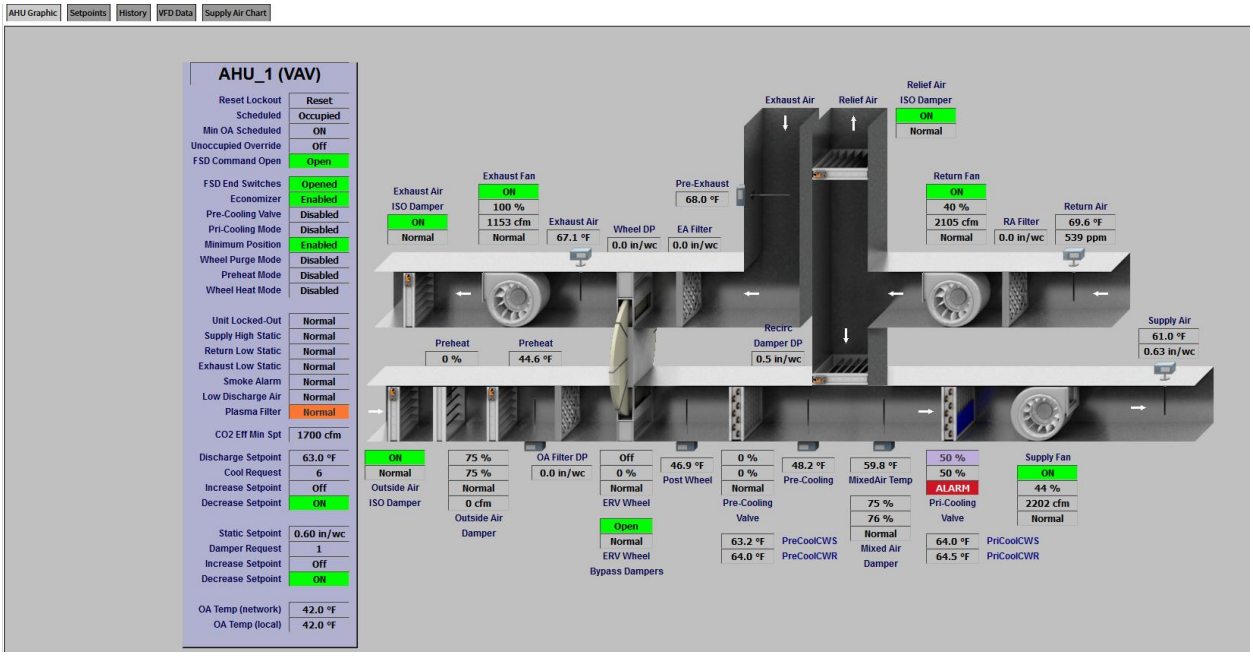
MMN Building AHU 1 January Report



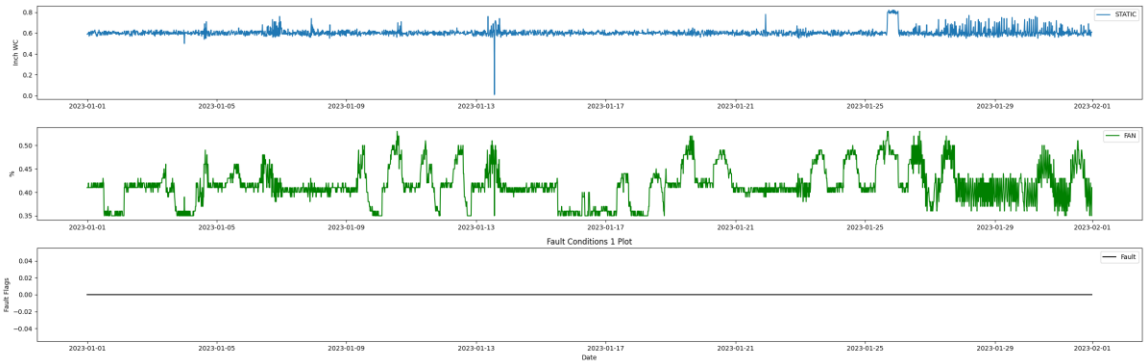
- Recommend removing all operator overrides
- Fault condition #2 some hunting when weather gets cold
- Fault condition #8 is good that the mix and supply should be equal
- Fault condition #6 should be true it's just the AHU doesn't have heating coil. Something looks off as this fault attempts to compare the calculated outdoor air fraction Vs a calculation expressed in percent of the AHU total air flow (this AHU has a supply fan AFMS) divided by the outdoor air ventilation setpoint which I got off the design schedules. Either this AHU operates much like a DOAS during non-economizing conditions, or the AHU is way under ventilating per design OA.

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			Applies to
	Equation	DSP < DSPSP – εDSP **AND** VFDSPD ≥ 99% – εVFDSPD	**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
- Fan systems appear 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 0.414452
  std 0.037828
  min 0.350000
  25% 0.400000
  50% 0.410000
  75% 0.430000
  max 0.530000
  Name: AHU1_SaFanSpeedAO_value, dtype: float64

Duct Pressure

- count 2976.000000
  mean 0.604573
  std 0.033982
  min 0.010000
  25% 0.590000
  50% 0.600000
  75% 0.610000
  max 0.820000
  Name: AHU1_SaStatic_value, dtype: float64

Duct Pressure Setpoint

- count 2.976000e+03
  mean 6.000000e-01
  std 1.110410e-16
  min 6.000000e-01
  25% 6.000000e-01
  50% 6.000000e-01
  75% 6.000000e-01
  max 6.000000e-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: Thu Feb 23 12:51:59 2023

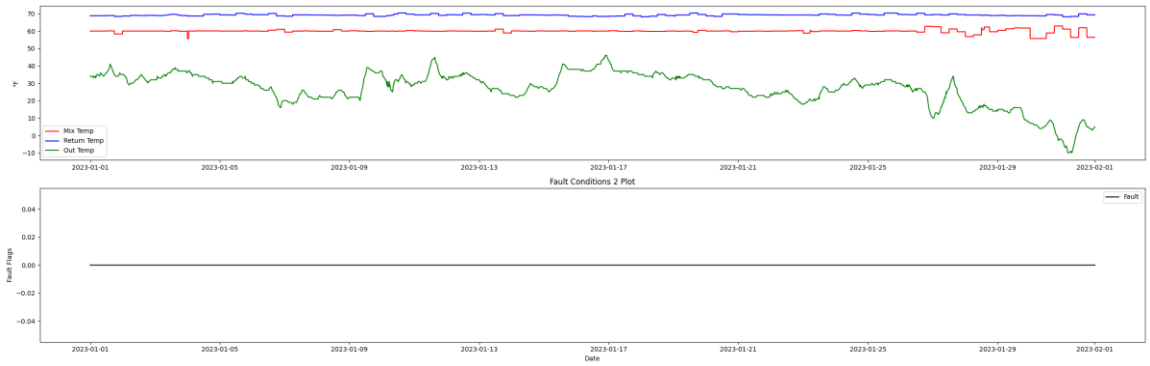
Fault Condition Two Report

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
- Fan systems appear 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 59.961286
  std 0.930167
  min 55.600000
  25% 59.900000
  50% 60.000000
  75% 60.100000
  max 62.900000
  Name: AHU1_MATemp, dtype: float64

Return Temp

- count 1369.000000
  mean 69.230825
  std 0.494176
  min 68.200000
  25% 68.900000
  50% 69.200000
  75% 69.500000
  max 70.400000
  Name: AHU1_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

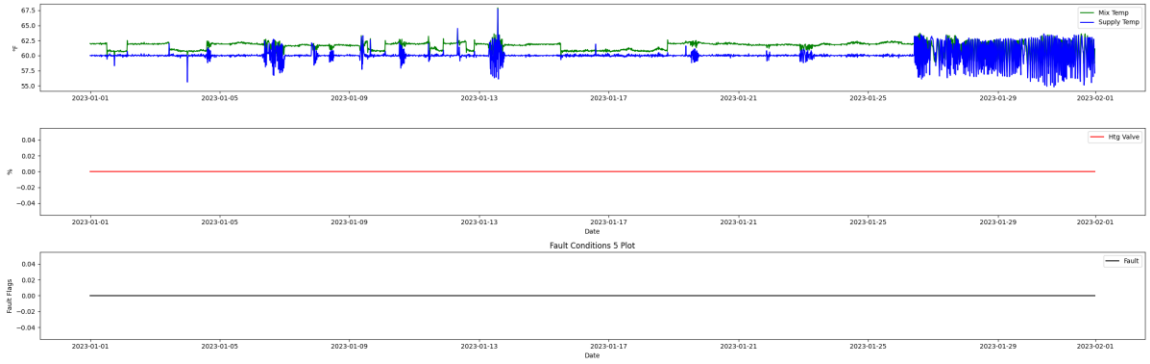
Report generated: Thu Feb 23 14:02:03 2023

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
- Fan systems appear 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 61.495430
  std 0.823666
  min 58.000000
  25% 60.900000
  50% 61.800000
  75% 62.000000
  max 67.900000
  Name: AHU1_DAT, dtype: float64

Supply Temp

- count 2976.000000
  mean 60.046438
  std 1.061346
  min 54.800000
  25% 59.900000
  50% 60.000000
  75% 60.100000
  max 67.700000
  Name: AHU1_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: Thu Feb 23 14:51:35 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

- 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 59.961286
  std 0.930167
  min 55.600000
  25% 59.900000
  50% 60.000000
  75% 60.100000
  max 62.900000
  Name: AHU1_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 69.230825
  std 0.494176
  min 68.200000
  25% 68.900000
  50% 69.200000
  75% 69.500000
  max 70.400000
  Name: AHU1_RATemp_value, dtype: float64

Total Air Flow

- count 1369.000000
  mean 1783.910884
  std 248.642624
  min 1470.000000
  25% 1621.000000
  50% 1684.000000
  75% 1828.000000

max 2416.000000
Name: AHU1_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

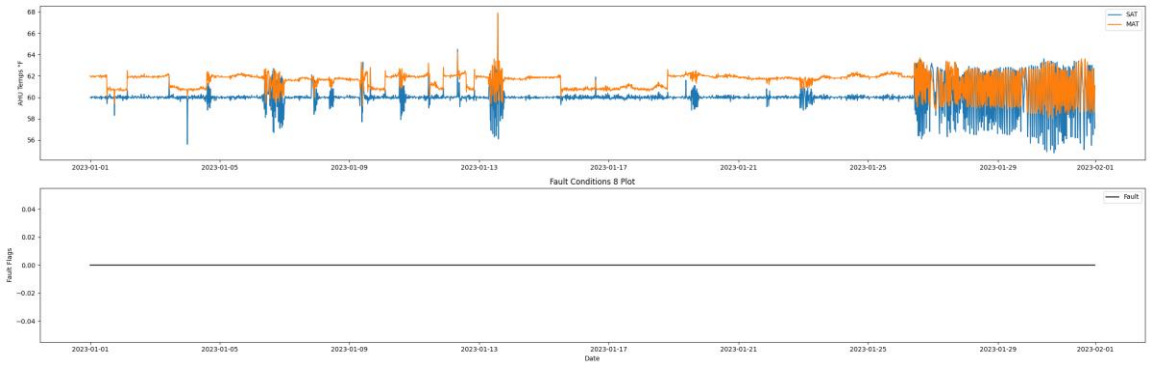
Report generated: Fri Feb 24 11:09:57 2023

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

- 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 60.046438
  std 1.061346
  min 54.800000

25% 59.900000
50% 60.000000
75% 60.100000
max 67.700000
Name: AHU1_MATemp, dtype: float64

Mix Air Temp

- count 2976.000000
  mean 61.495430
  std 0.823666
  min 58.000000
  25% 60.900000
  50% 61.800000
  75% 62.000000
  max 67.900000
  Name: AHU1_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: Fri Feb 24 11:57:35 2023