National TAB

Project Summary

Purpose and Background
The purpose of the visit to Gerbes 124 in Columbia MO was to perform airflow testing on the main AHU for the store. The store has had issues in the past with comfort particularly with humidity control throughout the store. The existing compressors were failing and are in the process of being replaced. Kroger also stated there is significant vibration at the AHU and supply duct. The testing was to be performed to ensure that there is proper airflow to the system and rule it out as a cause for compressor failure and performance issues. A survey was performed in 2012 on this store by National TAB and was referenced during the testing for comparison's sake.

The Carrier AHU is an old existing unit and there is limited data available. No original design drawings were available. Adil spoke with Carrier and they indicated the evaporator coil is 60 tons. For typical Kroger design this would be between 350-400 CFM target (21,000 CFM to 24,000 CFM). The existing compressors were one 20 ton and one 30 ton. They are being replaced with two 30 ton compressors. A manual was found online for a similar model number unit which indicates that the acceptable range of airflow is between 23,000 CFM to 37,000 CFM with 30,000 CFM being the nominal flow. Recommend that Carrier is contacted to confirm exactly what the airflow for this unit should be.

The AHU is located within a mechanical room. The AHU return is not ducted and pulls from the room itself. There is a return air tunnel that pulls from the cases and also a return air duct that pulls from the sales floor. Air was felt coming out of both ducts and the duct to the sales floor was verified to be fully open with no restrictions. There is a louver on the side of the building that is roughly 14 feet directly above the AHU return opening. This louver has a manual damper that brings in outside air to the AHU. There is a door to the mechanical room that remains closed. The unit was inspected and filters were clean, the belt was tight, and the blower was clean. The blower did have some corrosion/peeling paint but it did not appear to be affecting the overall performance yet.

Initial Findings and Testing Results
Upon arrival spoke with the Kroger facility manager, Adil, who said that prior to arrival the blower wheel and coils were cleaned. He also found that both the return air damper for the sales floor duct and the outside air damper were closed. He opened the return air damper fully and opened up the outside air damper about 50%. It's possible that this was impacting performance of the unit. Adil mentioned that they keep the humidity setpoint in the store at 50% because if they increase it any higher the doors to their freezers start to sweat. The AHU blower did not originally have a VFD installed but he added one recently. His technician for the store said that when the frequency was set to 50Hz, the breaker for the AHU tripped and the motor was very hot to the touch. While on site, he found that there was a burnt and loose wire connected at the VFD. They replaced this and the AHU motor was observed to operating OK and not tripping off. It should be noted though that the motor is old and may not be compatible with a VFD. The motor should be Inverter Duty which it does not appear to be. Information found online states that one requirement is the insulation rating should be at least F Class, but the motor is only B class. Recommend looking into this.

The AHU was initially running found running at 60Hz. Adil indicated that they run the unit at a constant speed. The initial airflow was measured two different ways. First the flow was measured by traversing the return air opening of the AHU and multiplying by the free area. The average velocity was 679 FPM and the free area was 55.4 SF. Airflow measured this way was 37,628 CFM. Compared readings for reference with the mechanical room door open and closed and there was no significant change in flow. A static pressure was measured at the door for reference as 0.19" wc. A second airflow was measured via traverse in the main supply duct on the sales floor. It is a 95x32 duct and the average velocity was 1733 FPM at 0.40" wc. This is an airflow of 36,970 CFM. Reviewed the preivous report from 10 years ago and airflow at that time was 35,000 CFM. So, there is a high confidence in the airflow of 36,970 CFM.

The fan was slowed down to 40 Hz and the airflow was traversed again at the supply duct as 25,317 CFM at 0.16" wc and 457 FPM velocity. Prior to slowing down there was significant vibration noted at the supply

duct. After slowing down the vibration decreased significantly. It appears the cause for this vibration is the small duct size at the discharge of the AHU where air is the most turbulent. The duct at the connection to the AHU is not accessible for direct measurement, but on the duct is written 43"x36.75". That duct size would require 3400 FPM at 37,000 CFM and 2300 FPM at 25,000 CFM both of which are very high. Rule of thumb on systems of this size is 1000-1200 FPM. The duct then expands to 96x50 where it passes through the wall above the cooler, and then transitions to 96x32. These two duct sizes are acceptable. It was confirmed that at the connection of the AHU there is a flexible connector for vibration isolation. The vibration seems to be worst where the duct is secured to and passes through the wall. Vibration was not noted down stream at all. If further reduction is required an additional flexible connector prior to duct entering wall is recommended.

The outside air could not be measured directly, so used a Temperature mix method to estimate as best as possible. The following temperatures were recorded:

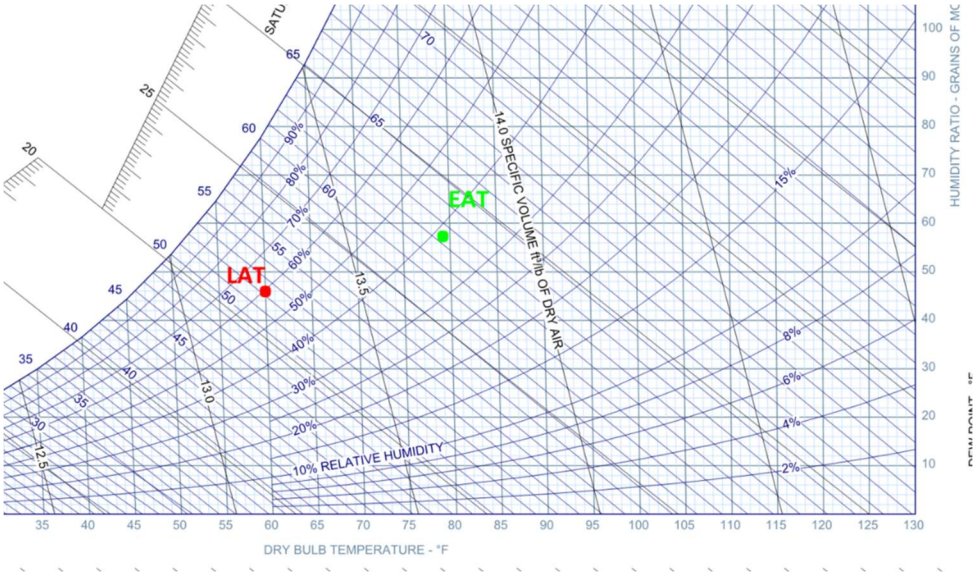
Outside air: 89.4F DB / 67.6F WB
Store Return air: 71.8F / 60.2F WB
Tunnel Temperature: 66.9F DB / 56.2F WB
Inside Mechanical Room: 73.8 F DB / 58.9 F WB
Temperature traverse at the AHU return opening: 78F avg

Based on these measurements it would be around a 37% ratio of outside air at the AHU. The louver is directly above the AHU around 16’ AFF and is air is dropping straight down towards the unit. The damper is approximately 40% open and needs to be closed to around 20%. But the damper is stuck and will not move. There is a pole used to try to knock it shut, but it won’t budge.

The compressor repair was completed after airflow had been balanced. However the techs noted that there were issues with the system still. Temperatures were taken during full cooling for reference:

Entering air = 79.2, 39% RH (28.44 Btu/lb)
Leaving air = 60F, 60% RH (21.85 Btu/lb)

Using a Btuh calculation (Btuh = 4.5 * CFM * Δ Enthalpy), 740,000 Btu’s are being removed by the coil. This is the equivalent of 60 tons which is what Carrier indicated the coil is rated for. Plotting the process on a psychrometric chart, it appears that possibly the air not reaching the saturation temperature due to how dry the entering air is. But it could also indicate the heat reclaim or electric heat strip was on during the test.



The space humidity is kept at a 50% setpoint and an offset is applied as well which drives the humidity down further. The actual RH in the space was measured as approximately 45%. This is a low setpoint and it is recommended that it be set higher if possible.

Final Findings and Recommendations:
Overall, airflow was found to be around 37,000 CFM initially and was reduced to 25,000 CFM which is a more typical airflow for a 60 ton unit. This reduction in airflow should help with dehumidifying the air since the air is moving more slowly across the coil. Temperatures and humidity were measured throughout the space and the unit is achieving both setpoints. Below are recommendations based on the findings:

1. Recommend consulting Carrier to determine the original airflow design for this AHU. The airflow was set to around 25,000 CFM but based on some manufacturer data found online this airflow may be on the low side even though it is within acceptable tolerances.
2. Recommend removing the humidity offset on the BMS controls so that the RH setpoint is more accurate. Adil stated that when the RH was set above 50% the coolers start to sweat. Once the compressors are fully functional recommend experimenting with setting this higher for better energy savings.
3. The outside air damper should be closed from it's current position of around 40% to 20%.
4. The vibration is much improved, but if it continues to be a nuisance, recommend installing another flexible connector on the supply duct in the mechanical room before the duct goes through the wall.
5. The blower motor that is currently installed may not be compatible with a VFD which could cause failure. Inverter duty motors are compatible with VFD's, however older motors can be compatible if they have certain specs. Some quick information found online indicates that one requirement is it must be NEMA Class F insulation or higher, and this motor was only Class B.
6. Appears based on graphing the temperatures and humidity that the heat reclaim or electric heat strip could be on. Possibly this was intentional but unknown to us when performing our tests. Recommend ensuring that this was intentional or if not verifying controls are set up correctly.