LET'S CONNECT

EXPERIENCE: COMMISSIONING

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consulting engineers

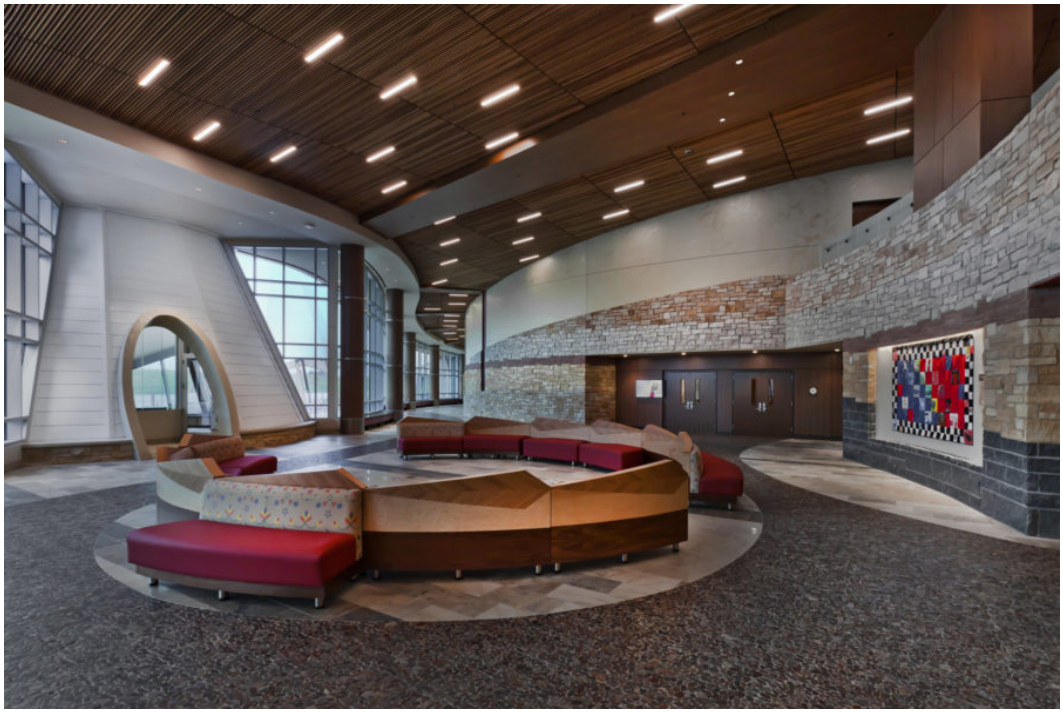
Case Study: Community & Cultural Center

INTRODUCTION:

The building design and construction started in 2016. Construction was completed in the fall / winter of 2018 and the commissioning occurring winter 2018 through spring 2019.

BUILDING INFORMATION:

Building Owner: not disclosed
Building Location: not disclosed
Building Type: not disclosed
Building Size: 84,176 sf (gross) / 78,118 sf (net)



BUILDING DESCRIPTION:

The building equipment included multiple AHUs with a mix of multi-zone VAV and constant volume units. All AHUs have an economizer and employ active building pressure control. A 100% OA make-up air unit is used for the kitchen hood and was interlocked with a hood exhaust fan which was to be operated when the grill was in service. The building was served by a heating hot water system and chilled water cooling.

This project is comprised of the following spaces:

- Galleries
- Activity Areas
- Exhibit areas
- Kitchen / Dining area
- Mechanical / Electrical
- Offices
- Library / Gift Shop
- Public Restrooms

Each AHU was tested independently prior to occupancy with minimal issues discovered. Most were resolved during testing by the control's programmer. Post occupancy with full building pressurization occurring, the following issues arose. When an individual system is functionally tested by itself, it may pass, but when tested as a whole with all other building systems in operation, it may fail. System integration is key.

Issue 1:
The design of the kitchen MUA unit was to be a fixed 100% speed when in operation. During the TAB process the flows were set to the design numbers corresponding to supply and exhaust fans to provide proper ventilation. The functional testing documents were written against the sequence of operations and the system was functionally tested and passed.

During occupancy it was noted that any time the grill — which was open to the dining area — was used, the smoke bypassed the capture hood. Even though the systems were fully functionally tested and balanced per the design documents, the hood could not capture 100% of the smoke. The original thought was that the MAU and associated exhaust was not balanced properly. To correct the issue, the facility maintenance team reduced the speed of the MAU.

During the investigation of the issue, in addition to the capture hood not containing the grill exhaust, it was noted that the building pressures were not being maintained properly.

We tested various scenarios and found that the unit serving the activity areas (AHU-1) and the galleries' (AHU-4) units were influencing the way the hood was operating. What was found was that the MAU needs to be operated at the as-found 50% speed, and what was changed was the minimum fan speeds for AHU-1 SF and RF. Below are the as found and changes made.

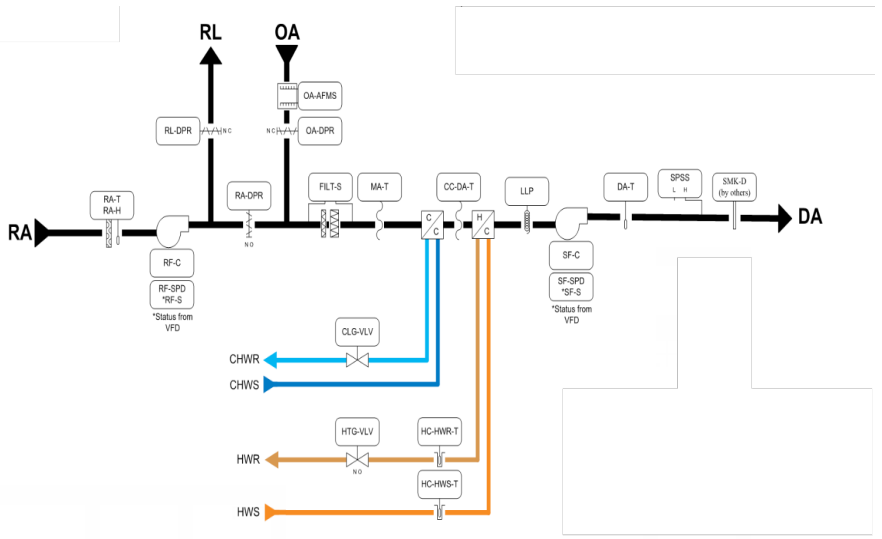
Lowering the minimum speed of the fans enabled them to modulate down further when in lower demand situations. The offset allows the fans to maintain the differential when trying to maintain building pressures. The final test was run with AHU-1 operating in economizer mode, bringing in @13K cfm of OA to simulate the POG requiring full cooling, which was when the complaints seemed to be the most common.

AHU-1 VAV unit

As-found conditions	*Changes*
SF min speed 55%	30%
RF min speed 55%	30%
Offset 20%	no change

AHU-4 VAV unit

As-found conditions	*Changes*
SF min speed 50%	40%
RF min speed 40%	no change
Offset 0%	no change



As indicated above, with the AHU fans preset at a minimum speed, the space pressures could not be maintained, which caused the smoke being produced during grilling to mitigate throughout the dining area and into the adjacent spaces.

While investigating the building pressure issue in the dining area, it was discovered that the outdoor pressure reference tube serving AHU-3 and AHU-4 was disconnected at the brass barb fitting going through the exterior wall and was pinched behind the black acoustic insulation. After reconnecting the tubing, the building pressure control returned to normal.

Issue 2:
During functional testing, the Outdoor Air damper (OAD) and Return Air Damper (RAD) would modulate inversely during economizer mode as designed, but the relief damper would remain at a position to maintain building pressure. What is happening while in this condition is that RAD is closing as the OAD is opening and the relief damper is at a position to maintain building pressure. With the RAD closing the return fan is still trying to maintain the offset from the supply fan and caused the return air section of the AHU to pressurize. This occurred until the building pressure loop caught up to the increase in building pressure.

The programming and loop tuning for the building pressure control loop is typically slow to prevent hunting of the fans and over- or under-pressurizing the building, 15-30 min reaction times from COV is common.

The following lines are from a SOO for building pressure and economizer control:

Return Fan Speed Control:

- *Air balancing contractor will determine through the TAB process the return fan speed offset from the supply fan speed required to achieve a building static pressure of +.03"wc. It is assumed that balancer will start with a 10% offset and will adjust from there to achieve the actual offset.*
- *The return fan will modulate to track the supply fan speed minus the constant offset.*

Building Pressure Control:

- *The relief air damper will modulate between minimum and maximum position to maintain a building pressure of +.03"wc*

Economizer Operation:

- *The outdoor air damper will be closed, and the return air damper will be open when in unoccupied mode or in start-up mode*
- *Return Air/Outdoor air damper will modulate to the minimum outdoor airflow CFM setpoint (adj.).*
- *The economizer will remain at minimum position when OA enthalpy exceeds RA enthalpy.*
- *The economizer will remain at minimum position when heating coil control valve is more than 0% open.*
- *When OA enthalpy is less than RA enthalpy, the economizer will modulate to maintain the supply air temperature. The relief air damper will be modulating to maintain the building static pressure setpoint.*
- *When the economizer is fully open and the supply air temperature is still above the calculated setpoint, cooling will be enabled.*

If programmed as written, the system would operate in a typical AHU. The issue with this system as installed and programmed was that the return fan tracks the supply fan and the relief air damper was only modulating based on building pressure. This was not considered when writing the SOO for economizer mode or programming the BAS.

To remedy this issue, the relief damper was modulated with the OAD any time the system went into economizer. This prevented over-pressurizing the spaces and the return air section of the AHU.

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