East Brookfield District Court
East Brookfield, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

July 15, 2022

Tighe&Bond

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Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the East Brookfield District Courthouse on February 17, 2021. While on site we inspected the air handling equipment located in the mechanical rooms and toured the facility to determine if the spaces generally matched usages noted on the architectural plans.

Site Visit Attendees:

- *Office of Court Management:*
  - Courthouse Facilities Staff
- *Tighe & Bond*
  - Todd Holland, PE, Senior Mechanical Engineer
  - Ryan Ablondi, Senior Mechanical Engineer

1.1 Existing Ventilation System

The East Brookfield District Courthouse was constructed in 1992 and is approximately 44,000 square feet in size. There are four variable air volume (VAV) air handling units that provide ventilation air to the occupied portion of the building. These are replacement units, installed in 2019, and are in new condition including all dampers, valves, and controls.

Photo 1 – Typical air handling unit

AC-1 and AC-2 have integral return fans, mixed air dampers capable of full economizer, MERV-13 filters, a direct expansion (DX) cooling coil, gas-fired furnace, and supply fan in a draw-through configuration. AC-3 and AC-4 have dedicated return fans that are

external to the unit. These units also have full airside economizer capability. The units include a supply fan in a blow-through configuration, MERV-13 filters, DX cooling coil, and gas-fired furnace. Each of the four packaged DX air handling units has an air-cooled condenser mounted on the roof of the building. Supply air is distributed to each zone via VAV boxes, which were also replaced in 2019.

The ductwork serving these systems and all the occupied areas is original to the 1992 construction. The supply ductwork is 100% internally lined with fiberglass and is reported to be in poor condition according to a 2020 report. The report suggest that the liner has detached from the walls and may be restricting airflow. Filter fabric has been placed over the supply diffusers to address indoor air quality (IAQ) concerns from loose fibers in the supply air stream.

Photo 2 – Linear slot diffuser with filter fabric

Photo 3 – Typical ceiling diffuser with filter fabric

Additionally, there are three smaller split systems, AC-5, AC-6 and AC-7. These units serve the archive storage spaces in the building's lower level and basement. These are split DX units with hot water heating coils. Each unit has a dedicated air-cooled condenser mounted on the roof. Each of the three units has a dedicated wall-mounted humidifier with dispersion tube in the supply air ductwork. Outdoor air is ducted to the inlet of each of these units. These units are original to the 1992 construction and are operational but in poor condition and at the end of their useful life.

Hot water for preheat coils in AC-5, AC-6, and AC-7, unit heaters, and perimeter radiation is provided by two gas-fired boilers located in the boiler room on the lower level. These boilers, unit heaters, and perimeter radiation all appear to be original to the 1992 construction of the building and are in fair condition. The boilers may be approaching the end of their useful lives, but may last for another 10-15 years.

According to the plans, there are 25 exhaust fans serving various areas, including the holding cells and toilet rooms. We were able to verify that rooftop exhaust fans were operating as commanded by the building management system (BMS) during our site visit.

Table 1 summarizes the air handling units' designed airflow rates, the MERV rating of the installed filters, and the observed condition.

TABLE 1
Existing Air Handling Units

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Pre/Final Filters	Condition
AC-1	12,100	3,035*	MERV-13	New
AC-2	11,640	1,518*	MERV-13	New
AC-3	4,300	1,336*	MERV-13	New
AC-4	7,700	1,563*	MERV-13	New
AC-5	2,000	Unknown	Unknown	Poor
AC-6	2,000	Unknown	Unknown	Poor
AC-7	2,000	Unknown	Unknown	Poor

* Design minimum OA value from Testing and Balancing Report dated 01/25/2020. Air flow values shown in table are actual balanced values which are slightly higher than design values listed in report.

1.2 Existing Control System

As part of the building upgrade project completed in 2020, a new building management system (BMS) was installed by Schneider Electric to control the new air handing units (AC-1, AC-2, AC-3, and AC-4) and associated VAV boxes. The new BMS was also tied into the existing building systems including the hydronic hot water system and AC-5, AC-6, and AC-7.

The four new air handling units have CO_2 sensors installed in the return air ducts which are used for a demand control ventilation (DCV) sequence. DCV will increase ventilation air if measured CO_2 levels in the return air duct rise above the 800 ppm setpoint. This DCV sequence calls for an alarm to be activated on the BMS and will provide increased ventilation air until the CO_2 level in the return air drops to 200 ppm.

The four new air handling units also have full airside economizer controls, which means they are capable of handling 100% outdoor air when ambient conditions allow.

The three existing air handling units serving the archival storage areas of the building have minimum outside air dampers which are interlocked with the fan and open whenever the fan is enabled.

Section 2
Recommendations

Below is a list of recommendations that we propose for the East Brookfield District Courthouse. Please refer to the "Master Recommendation List" for further explanation and requirements of the stated recommendations.

2.1 Filtration Efficiency Recommendations

We recommend the following measures be implemented for the existing air handling units:

RF-1: *MERV-13 filters.*

We recommend the continued use of MERV-13 filters which meet the ASHRAE minimum recommendation. Existing filters should be checked to ensure they are within their service lives and installed properly. The filter racks should be inspected to ensure that filters fit tightly and that end spacers are in place to minimize filter bypass.

RF-3: *Check differential pressure sensors across the filter banks.*

There are existing differential pressure switches installed for each bank of filters in each of the air handlers. We recommend reviewing the location of the pressure taps and the resulting pressure readings.

RF-3a: *Check the pressure sensors' alarms on the BMS system.*

Alarm setpoints for each bank of filters should be reviewed, to ensure they are consistent with the filter manufacturer's recommendation.

2.2 Testing & Balancing Recommendations

Air handling units AC-1, AC-2, AC-3, and AC-4 and their associated terminal devices are approximately one year old and balancing work was performed in January of 2020. The testing, adjusting, and balancing (TAB) report produced by Precision Air Testing and Balancing, Inc., dated February 2020, indicates that all airflows were within acceptable limits.

It should be noted that during the work to replace these units in 2019, it was discovered that the duct liner in the ductwork throughout the building has become detached and the ducts appeared to be in poor condition. A ductwork remediation study was performed by Habeeb & Associates and a report dated October 2020 details these deficiencies with the ductwork. The report also presents several solutions including complete replacement of the ductwork throughout the building. Typically we recommend adjusting all airflow rates to recommended levels but, given that the building was recently balanced and extensive work is planned to remedy the duct issues, Tighe & Bond recommends performing the more comprehensive TAB work (measures RTB-2 and RTB-4) after the duct remediation work is complete.

However, we do recommend adjusting the minimum outdoor air damper positions (RTB-1) in the near term, as the positions we observed during the site visit seemed to be significantly lower than expected.

RTB-1: *Test and balance air handling unit supply air and minimum outside air flow rates.*

We recommend testing and balancing the outdoor air flow rates for all air handling units to the recommended minimum O.A. rates listed in Table 2.

TABLE 2
Recommended Air Handler O.A. Flow Rates

Unit	Original Supply Airflow (CFM)	Original Design Min. O.A. (CFM)	Current Code Min. O.A. Requirements (CFM)	Recommended Minimum O.A. (CFM)
AC-1	12,100	3,035*	3,770	3,800
AC-2	11,640	1,518*	3,093	3,100
AC-3	4,300	1,336*	1,485	1,500
AC-4	7,700	1,563*	2,990	2,990
AC-5	2,000	Unknown	147	200
AC-6	2,000	Unknown	147	200
AC-7	2,000	Unknown	147	200

* Design minimum OA value from Testing and Balancing Report dated 01/25/2020. Air flow values shown in table are actual balanced values which are slightly higher than design values listed in report.

Note: Although the ASHRAE Position Document on Infectious Aerosols recommends using the latest published standards and codes as a baseline for minimum ventilation, the mechanical code in effect at the time the HVAC systems were designed and constructed is what governs the required outdoor air flowrate for the HVAC equipment, if there have been no additions, renovations, alterations or changes in occupancy to the building. The 2015 International Mechanical Code does not prevent the continued use of existing systems.

Our ventilation air analysis discovered that many spaces were not receiving the correct quantity of outdoor air based on today's code requirements at full occupancy. Our calculations showed that the quantity of outdoor air required per code would result in a significant increase in outdoor air for some air handlers, increasing the load on the heating and cooling coils. These loads appear to exceed the capacity of the units. We recommend temporarily reducing the occupancy of the spaces that are not receiving the code required ventilation air. Table 3 lists the spaces that would require a reduced occupancy. The recommended outdoor air flow rates listed in Table 2 reflect the outdoor air requirements based on a reduced occupancy shown in Table 3.

TABLE 3
Recommended Occupancy During COVID-19 Pandemic

Room & Associated AHU	***2015 IMC Permitted Occupancy (# of People)***	***Recommended Occupancy (# of People)***
AC-1		
Jury Deliberation Room 247	12	4
Conference Room 221	7	5
Conference Room 252	8	4
AC-3		
Conference Room 105	12	9
Staff Room 106	8	6
Office Conference Room 109	6	4
Office Conference Room 110	5	3
AC-4		
Small Courtroom 117	108	68
Conference Room 112	7	4
Jury Assembly 113	30	16
Conference Room 140	7	2

During the pandemic, we recommend maintaining the outdoor airflows at the original designed values where they exceed the code minimums calculated by Tighe & Bond. Supplying more outdoor than required by code will provide better indoor air quality.

Where we recommend increasing the outdoor air beyond the original design, it appears the cooling and heating coils should be able to provide leaving air conditions similar to the original design under peak outdoor air conditions, assuming the coils are clean and their performance has not degraded significantly over time. Supply air temperatures during the heating and cooling season should be monitored to ensure they are not dropping below design values. If the supply air temperature does drop below design values, the outdoor airflow rate should be reduced, but not below the originally designed outdoor air flow rates.

Where we do not recommend increasing outdoor air to the current code requirements, it appears the cooling and/or heating coils cannot maintain the proper leaving air temperature under peak outdoor air conditions.

The average airflow rate per person is shown below in Table 4. These values are based on the original full design supply airflow rate and the recommended outdoor airflow rates shown in Table 2. The airflow rate per person assumes a diversity factor of 70%, meaning the maximum number of occupants assumed to be in all zones at all times equates to 70% of the code required occupancy.

TABLE 4
Average Airflow Rate per Person

	All spaces	***Courtrooms***	***Non-Courtroom Spaces***
Total Occupancy (People)	396	183	213
Total Supply Air (CFM/Person)	90	41	133
Outdoor Air (CFM/Person)	29	14	42

The airflow rate per person for each Courtroom and the Jury Pool Room is shown below in Table 5. These values are based on full occupancy without taking diversity into account, the original full design supply airflow rate, and the recommended outdoor airflow rate. The airflow rate per person assumes the full supply airflow is being delivered to the room. At times when the supply airflow is reduced due to the space temperature being satisfied, the airflow rate per person will also be reduced.

TABLE 5
Airflow Rate per Person (Full Occupancy)

		Total Air		***Outdoor Air***	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outside Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Jury Assembly 113	30	560	19	244	8
Small Courtroom 117	108	2,100	19	916	9
Main Courtroom 218	154	5,400	35	1,696	11

Note: Courtroom occupant density is based on 70 people/1,000 square feet, per the 2015 International Mechanical Code

The airflow rate per person for each Courtroom and the Jury Pool Room, based on a reduced occupancy schedule determined by the Office of Court Management, is shown below in Table 5a. The airflow rate per person assumes the full supply airflow is being delivered to the room. At times when the supply airflow is reduced due to the space temperature being satisfied, the airflow rate per person will also be reduced.

TABLE 5a
Airflow Rate per Person (Reduced Occupancy)

		Total Air		Outdoor Air	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outside Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Jury Assembly 113	8	560	70	244	31
Small Courtroom 117	19	2,100	111	916	48
Main Courtroom 218	29	5,400	186	1,696	59

Note: If occupancy is further reduced, the airflow rate per person will increase, assuming full airflow is being delivered to the space.

RTB-2: *Rebalance system return air flow rate.*

We recommend rebalancing the return fan airflow rate to ensure the correct quantity of return air is being delivered to the air handler.

RTB-4: *Test and balance VAV box flow rates.*

We recommend testing and balancing the VAV boxes to ensure each space is being supplied the proper quantity of air.

2.3 Equipment Maintenance & Upgrades

We do not have any recommendations for equipment maintenance or upgrades at this time.

2.4 Control System Recommendations

We recommend the following for the control system:

RC-1: *Implement a pre-occupancy flush sequence.*

This sequence should start all air handlers and exhaust fans before the building is occupied, with the start time calculated to provide three air changes per hour (ACH) of ventilation air, or for two hours before people arrive.

RC-5: *Disable demand control ventilation sequences.*

For the duration of the COVID-19 pandemic, we recommend disabling any DCV sequences that may reduce the volume of outdoor air into spaces with reduced occupancy.

2.5 Additional Filtration and Air Cleaning

We recommend the installation of the following air cleaning devices:

RFC-1: *Install portable HEPA filters.*

If the Courthouse is to operate at a high capacity (i.e. 50% occupancy or greater), we recommend installing portable HEPA filters in high traffic areas, such as entrance lobbies. They should also be considered for courtrooms, depending on the occupancy of the room and how much noise is generated from the filters. The noise levels will vary depending on the manufacturer, and whether the fans are operated at the full speed setting.

2.6 Humidity Control

Installing duct mounted or portable humidifiers can help maintain the relative humidity levels recommended by ASHRAE. The feasibility of adding active humidification is determined by the building envelope. Buildings that were not designed to operate with active humidification can potentially be damaged due to a lack of a vapor barrier, adequate insulation, and air tightness.

Duct mounted humidifiers must be engineered, integrated into the building control system, tested, and commissioned. They are available in many configurations but require substantial maintenance and additional controls. They also run the risk of adversely affecting IAQ from growing microorganisms, or leaking water through poorly sealed ductwork damaging insulation and ceilings. Portable humidifiers are easier to install and require less maintenance, but still have the potential to damage the building envelope.

While active humidification is not recommended as a whole building solution due to high installation costs, operational costs, potential to damage the building envelope and adversely affect poor IAQ, it may be warranted as a temporary solution in some areas.

2.7 Other Recommendations

2.7.1 Modify Demand Control Ventilation Settings

As mentioned above, the four new air handling units have CO_2 sensors installed in the return air ducts which are used for a demand control ventilation (DCV) sequence. DCV will increase ventilation air if measured CO_2 levels in the return air duct rise above the 800 ppm setpoint. This DCV sequence calls for an alarm to be activated on the BMS and will provide increased ventilation air until the CO_2 level in the return air drops to 200 ppm. Typical outside air CO_2 levels are roughly 400 ppm, as such, a CO_2 level of 200 ppm is unattainable. Tighe & Bond recommends that, once normal operations resume, facilities staff review this lower limit setpoint of 200 ppm and adjust the setpoint to 500 ppm.

This recommendation is an energy saving measure and does not increase the indoor air quality of the building.

2.7.2 Replace AC-5, 6 & 7

AC-5, 6 & 7, serving the archive / storage areas, are in poor condition and at the end of their useful life. These units should be considered for replacement in the near future.

This recommendation does not increase the indoor air quality of the building.

Section 3
Testing & Balancing

The East Brookfield District Courthouse HVAC equipment was not tested under this contract. This site was tested and balanced in 2020 under a separate project with a different engineer.

Disclaimer

Tighe and Bond cannot in anyway guarantee the effectiveness of the proposed recommendations to reduce the presence or transmission of viral infection. Our scope of work is intended to inform the Office of Court Management on recommendations for best practices based on the guidelines published by ASHRAE and the CDC. Please note that these recommendations are measures that may help reduce the risk of airborne exposure to COVID-19 but cannot eliminate the exposure or the threat of the virus. Implementing the proposed recommendations will not guarantee the safety of building occupants. Tighe & Bond will not be held responsible should building occupants contract the virus. The Office of Court Management should refer to other guidelines, published by the CDC and other governing entities, such as social distancing, wearing face masks, cleaning and disinfecting surfaces, etc. to help reduce the risk of exposure of COVID-19 to building occupants.