CAMBRIDGE/MALDEN DISTRICT COURT
HVAC SYSTEM EVALUATION SUMMARY

Visited February 23, 2021. While on site, inspected the air handling equipment located in the mechanical rooms and toured the facility to determine if the spaces generally matched usage noted on the architectural plans. The Cambridge/Malden District Courthouse went through a major renovation in 2008 in which the mechanical systems were replaced. The building is approximately 65,000 square feet in size. Ventilation air is provided to the building by two larger variable air volume (VAV) air handling units (RTU-5 & 6) which serve the majority of the building while four smaller VAV Air Handling Units (RTU-1,2,3 & 4) provide ventilation air to each of the three courtrooms and the large corridor outside the courtrooms.

1.0 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 Room 1107	16	1,800	113	780	49
Courtroom 1 1212	31	4,990	161	1,550	50
Courtroom 2 1208	26	3,000	115	1,082	42
Courtroom 3 1200	26	3,960	152	1,037	40

2.0 Recommendations

Section	Recommendation/Finding	Action
2.1	**Filtration Efficiency**	
RF-1	Replace filters with a MERV 13 filter	Complete
RF-3	Install a differential pressure sensor (switch) across the filter banks	In-progress
2.2	**Testing and Balancing**	
RTB-1	Test and rebalance air handling unit supply air and minimum outside air flow rates	In-progress
RTB-4	Test and balance VAV box flow rates	In-progress
2.3	**Equipment Maintenance and Upgrades**	
RE-1	Test existing air handling system dampers and actuators for proper operation	In-progress
RE-2	Clean air handler coils and drain pans	In-progress
RE-4	Inspect VAV boxes and controllers	In-progress
2.4	**Control System**	
RC-1	Implement a pre-occupancy flush sequence	In-progress
RC-4	Confirm the economizer control sequence is operational	In-progress
2.5	**Additional Filtration and Air Cleaning**	
RFC-1	Install portable HEPA filters -– *if courthouse is to operate at a high occupancy (i.e. 50% or greater), install portable HEPA filters in high traffic areas.*	In-progress

2.6	Humidity Control	
	No actionable items listed – continuous monitoring for seasonal changes	On-going
2.7	Other Recommendations	
2.7.1	Inspect/repair RTU-6 supply fan	In-progress
2.7.2	Repair RTU-6 condensate trap	In-progress
2.7.3	Install a Building Management System (BMS)	In-progress

Cambridge/Malden District Courts
Medford, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

April 8, 2021

Tighe&Bond

100% Recyclable

Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Cambridge/Malden District Courts on February 23, 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:*
  - Bruce Toby, Courthouse Facilities Staff
- *Tighe & Bond*
  - Jason Urso, PE, Senior Mechanical Engineer
  - Ryan Ablondi, Senior Mechanical Engineer
  - Matt Mancini, Staff Mechanical Engineer

1.1 Existing Ventilation System

The Cambridge/Malden District Courts went through a major renovation in 2008 in which the mechanical systems were replaced. The building is approximately 65,000 square feet in size. Ventilation air is provided to the building by two larger variable air volume (VAV) air handling units (RTU-5 & 6) which serve the majority of the building while four smaller VAV Air Handling Units (RTU-1,2,3 & 4) provide ventilation air to each of the three courtrooms and the large corridor outside the courtrooms. Finally, an energy recovery unit (ERU-1) provides ventilation air to Holding Area. Each unit contains a supply fan, refrigerant (DX) cooling coils, gas-fired furnace and a 2" MERV 13 pre filter.

The two larger units and the ERU were installed as part of a renovation to the building in 2008 and are in good condition, however, the fans in RTU-6 makes a loud noise and the PVC cooling coil condensate drain piping has broken off. The four smaller units serving the Courtrooms and corridor were existing and relocated during the 2008 renovation. Tighe & Bond is unsure of their exact age, but we estimate that they were manufactured ~2005 based on information found on unit nameplates. ASHRAE data indicates that the median useful life expectancy for Rooftop Units like these are 15 Years, however, these unit appear to be in good condition and with proper maintenance, likely have several years of useful life remaining.

Each air handler, with the exception of the ERU, is a variable air volume (VAV) unit, where VAV boxes regulate the airflow into zones throughout the building. According to the plans, there are seven toilet exhaust fans, which are in good condition. All toilet exhaust fans were running during the time of our site visit.

According to the drawings provided to Tighe & Bond, there are eight exhaust fans serving the building. Seven fans serve toilet rooms and one fan serves the sally port area. The toilet exhaust fans and sally port exhaust fan were all running at the time of our site visit.

The lockup area is served by an Energy Recovery Unit which provides 50% outside air to all spaces in the holding area and exhaust 50% of the air from the space. Each holding area is negatively pressurized.

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

TABLE 1
Existing Air Handling Units

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Filters	Condition
ERU-1	3,250	1,650	MERV-13	Good
RTU-1	4,110 100 (Est, based on diffuser totals)	Unknown	MERV-13	Good
RTU-2	3,050 (Est, based on diffuser totals)	Unknown	MERV-13	Good
RTU-3	4,000 (Est, based on diffuser totals)	Unknown	MERV-13	Good
RTU-4	5,000 (Est, based on diffuser totals)	Unknown	MERV-13	Good
RTU-5	18,800	5,000	MERV-13	Good
RTU-6	18,000	5,000	MERV-13	Good

Photo 1 – Representative Air Handler

1.2 Existing Control System

The Cambridge/Malden District Courts does not have a Building Management System (BMS) for controlling the mechanical systems. All the mechanical equipment is controlled using local controls. All the Rooftop AHU's have integral airside economizer controls. All existing controls are electronic, there are no pneumatics in the building.

Section 2
Recommendations

Below is a list of recommendations for the Cambridge/Malden District Courts. Please refer to the "Master Recommendation List" for further explanation and requirements of the stated recommendations.

2.1 Filtration Efficiency Recommendations

The filters in the air handlers were already upgraded with 2" MERV 13 filters. The use of 2" MERV 13 meets the minimum ASHRAE recommendations for filtration during the pandemic. We recommend that a testing and balancing contractor test and document the airflow and static pressure profile of all air handlers, as outlined in recommendation RF-1 in the Overview of Recommendations document. This will help determine if the equipment can accommodate the increase in system static pressure associated with the addition of the MERV 13 filters.

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, pending the testing and balancing results. 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: *Install a differential pressure sensor with a display across the filter bank.*

Currently the units do not appear to have DP sensors across the filter banks. We recommend installing them to monitor the filters.

2.2 Testing & Balancing Recommendations

The air handling units are approximately 13-15 years old and it is unknown to Tighe & Bond when the last time the units were tested and balanced. Also, the code requirements to determine the outdoor air flow rates that were used to design the original system may be different than the 2015 International Mechanical Code (IMC) and current ASHRAE Standard 62.1 requirements.

We recommend the following testing and balancing measures be implemented:

RTB-1: *Test and balance air handling unit supply air and minimum outdoor 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)
ERU-1	3,250	1,650	1,750	**1,750**
RTU-1	4,100 (Est, based on Diffuser Totals)	Unknown	916	**950**
RTU-2	3,050 (Est, based on Diffuser Totals)	Unknown	1,058	**1,100**
RTU-3	4,000 (Est, based on Diffuser Totals)	Unknown	1,039	**1,050**
RTU-4	5,000 (Est, based on Diffuser Totals)	Unknown	1,545	**1,550**
RTU-5	18,800	5,000	5,382	**5,400**
RTU-6	18,000	5,000	7,759	**7,800**

Notes:

1. 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.
2. Current Code Min. O.A. Requirements were calculated using assumed VAV minimum flow values as design minimums were not available on the renovation drawings.

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 suitable leaving air conditions 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.

The average airflow rate per person is shown below in Table 3. 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 3
Average Airflow Rate per Person

	All spaces	*Courtrooms*	*Non-Courtroom Spaces*
Total Occupancy (People)	686	314	372
Total Supply Air (CFM/Person)	82	38	119
Outdoor Air (CFM/Person)	29	14	41

The airflow rate per person for each Courtroom and the Jury Pool Room is shown below in Table 4. 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 4
Airflow Rate per Person (Full Occupancy)

		Total Air		*Outdoor Air*	
Courtroom	*Total People*	*Supply Airflow (CFM)*	*Airflow Rate (CFM/Person)*	*Outdoor Airflow (CFM)*	*Airflow Rate (CFM/Person)*
Jury Assembly Room 1107	18	1,800	100	780	43
Courtroom 1 1212	191	4,990	26	1,550	8
Courtroom 2 1208	129	3,000	23	1,082	8
Courtroom 3 1200	129	3,960	31	1,037	8

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 4a. 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 4a
Airflow Rate per Person (Reduced Occupancy)

		Total Air		Outdoor Air	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outdoor Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Jury Assembly Room 1107	16	1,800	113	780	49
Courtroom 1 1212	31	4,990	161	1,550	50
Courtroom 2 1208	26	3,000	115	1,082	42
Courtroom 3 1200	26	3,960	152	1,037	40

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

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 recommend the following equipment maintenance and upgrades:

RE-1: *Test existing air handling system dampers and actuators for proper operation*.

Replace dampers and actuators that are not functioning properly.

RE-2: *Clean air handler coils and drain pans.*

RE-4: *Inspect VAV boxes and controllers.*

VAV boxes regulate the supply air delivered to each space. At a minimum, we recommend cycling the damper positions and testing the airflow to verify the maximum and minimum airflow rates are being delivered as designed. Consider cleaning the airflow stations and changing dirty filters in the fan powered VAV boxes. Any boxes not delivering the expected airflow rates should be rebalanced or replaced.

2.4 Control System Recommendations

We recommend the following for the control system:

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

RC-4: *Confirm the economizer control sequence is operational.*

Replace control components, such as outdoor and return air temperature and/or humidity sensors, as required.

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.

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 Inspect / Repair RTU-6 Supply Fan

As mentioned above, the supply fan for RTU-6 makes a loud noise. We recommend inspecting the fan belts, sheaves and bearings to determine the source of the noise and repair / replace parts as necessary. This recommendation is a maintenance item and does not increase the indoor air quality of the building.

2.7.2 Repair RTU-6 Condensate Trap

As mentioned above, the PCV condensate trap piping has broken off the unit and air is being sucked into the unit downstream of the filters, through the condensate drainpipe. We recommend replacing it to prevent further unfiltered air from entering the unit.

2.7.3 Install a Building Management System (BMS)

We recommend installing a Building Management System to control all the Mechanical systems for the building. This recommendation is primarily an energy saving and maintenance measure and does not affect the indoor air quality of the building, although it will allow ventilation control and scheduling measures to be more easily implemented.

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.

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