Quincy District Court
Quincy, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

January 14, 2022

Tighe&Bond

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Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Quincy District Courthouse on October 22, 2020. 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. Tighe & Bond revisited the site on December 20, 2021 to determine what unit S-1 and S-4 are serving. While on site, we received basement mechanical plans and were able to complete ventilation calculations of the basement area.

Site Visit Attendees:

- *Office of Court Management:*
  - Mike Ostman, Courthouse Facilities Staff
- *Tighe & Bond*
  - Jason R. Urso PE, Mechanical Engineer

1.1 Existing Ventilation System

The Quincy District Courthouse was constructed in 1972 and is approximately 36,000 square feet in size. Four constant volume air handling units (S-1 through S-4) supply air to the building. They mostly serve interior spaces and some limited spaces located along the perimeter. Air handlers S-1, S-2, and S-3 contain a supply fan, chilled water cooling coil, hot water heating coil, and a 2" MERV 10 filter. The court expressed to Tighe & Bond that since the initial site visit, the filters have been upgraded to MERV 13. A dedicated return fan serves each air handling unit. A duct mounted hot water reheat coil serves each zone. Air handler S-4 is hung from the ceiling in the basement mechanical room and contains a refrigerant (DX) cooling coil and no heat. We were not able to open this air handler while on site to inspect the filters, coils, or dampers.

The air handling units appear to be from the original construction in 1972 and are in poor condition. The outdoor air dampers and actuators are in fair to poor condition, and the outdoor air damper in S-1 and S-2 appeared to be closed or mostly closed during our site visit. The heating and cooling coils are dirty. The 3-way hot and chilled water control valves and actuators are in fair condition. S-1 serves most of the basement, S-2 serves the first floor, and S-3 serves the second floor. S-4 serves three small offices in the old vault space. S-4 does not provide any outdoor air to the spaces served.

There are also fan coil units located in the offices located around the perimeter of the building. According to the design drawings, only fan coil units FC-2 and FC-2A were designed to provide outdoor air, however fan coil units FC-3 and FC-3A are also located in perimeter offices. Most perimeter spaces are not supplied with air from the main air handlers and our understanding is none of the fan coil units are providing outdoor air. For example, the Jury Pool room is served by a fan coil unit and supply air is not provided by the existing air handling units.

According to the 1970 design drawings, there are four toilet exhaust fans and one fan (EX-6) serving the cells.

Two Lochinvar, one million BTU/hr (input) each, hot water boilers provide hot water to air handlers, radiation, convectors, fan coil units, cabinet unit heaters, and duct mounted reheat coils. A Carrier, Model 30HR160 chiller provides chilled water to air handlers S-1, S-2, and S-3.

During a second site visit on December 20, 2021, courthouse staff made Tighe & Bond aware of an archive room that is regularly occupied located on the lower level of the parking garage next to the courthouse. The space is constructed of a single layer of CMU with no vapor barrier. There is a single unit heater in the space and no ventilation, mechanical or natural, provided to the space. This space is not suitable for occupancy, considering there is no ventilation air, and is likely not suitable as an archive space for documents.

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)	Pre/Final Filters	Condition
S-1	10,000	3,750	2" MERV 13	Poor
S-2	11,000	4,150	2" MERV 13	Poor
S-3	12,750	4,800	2" MERV 13	Poor
S-4	1,050	0	Unknown	Poor

Photo 1 – Representative Air Handler

1.2 Existing Control System

A pneumatic system controls the existing HVAC air handling equipment. It is an old, obsolete system and appears to be original. We did not see any evidence or components of a Building Management System (BMS) during our site visit. We are not aware of any demand control ventilation sequences in use at this courthouse.

Section 2
Recommendations

Below is a list of recommendations for the Quincy 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: *Replace filters with MERV-13 filters.*

The TAB Contractor and/or Engineer shall verify that the air handlers can accommodate a MERV-13 filter per Appendix A in the overview of recommendations report. Filter racks should be inspected and adjusted 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.*

RF-3a: *Connect the pressure sensor to a local alarm.*

Maximum differential pressure should be set per manufacturer's recommendation based on air velocity to ensure filters are within their service lives. Typically this is not more than 1.0" w.g.

2.2 Testing & Balancing Recommendations

The air handling units are approximately 50 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 outside 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 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)
S-1	10,000	3,750	1,350	**3,750**
S-2	11,000	4,150	1,600	**4,150**
S-3	12,750	4,800	2,100	**4,800**
S-4	1,050	0	100	**100**

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.

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.

The average airflow rate per person for spaces served by all air handling units 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. This table does not include Juvenile Small Claims Court in the basement, since we do not have airflow data for this space. This table also does not include all spaces served by fan coil units.

TABLE 3
Average Airflow Rate per Person

	All spaces	***Courtrooms***	***Non-Courtroom Spaces***
Total Occupancy (People)	445	253	193
Total Supply Air (CFM/Person)	102	46	175
Outdoor Air (CFM/Person)	29	17	44

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.

TABLE 4
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 Pool	17	400	24	100	6
Arraignment Courtroom 131	132	3,680	28	1,388	11
Courtroom Jury A	56	1,800	32	678	12
Courtroom Jury B	56	1,800	32	678	12
Courtroom No. 2	56	1,800	32	678	12
Courtroom No. 3	29	1,200	41	452	16
Courtroom No. 4	32	1,260	39	474	15

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.

TABLE 4a
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 Pool	7	400	57	100	14
Arraignment Courtroom 131	26	3,680	142	1,388	53
Courtroom Jury A	16	1,800	113	678	42
Courtroom Jury B	15	1,800	120	678	45
Courtroom No. 2	15	1,800	120	678	45
Courtroom No. 3	7	1,200	171	452	65
Courtroom No. 4	8	1,260	158	474	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 testing and balancing the return fan airflow rate to ensure the correct quantity of return air is being delivered to the air handler.

RTB-5: *Test and balance all air inlets and outlets.*

If the airflow to each space has not been recently tested, we recommend testing the airflow rates in the holding cells, control room, Courtrooms, Jury Pool room, and other densely occupied areas as a minimum. These systems are very old and the airflow rate currently delivered to and returned from these spaces may not match the original design intent.

If other areas within the Courthouse experience regular cooling and heating comfort complaints this may be an indication of a lack of airflow to the space. We recommend testing and balancing the air inlets and outlets serving those spaces to the designed values. Prior to rebalancing the building, we recommend verifying the boiler and chilled water plants are maintaining the correct supply water temperature. Incorrect supply water temperature may contribute to temperature control complaints instead of a lack of airflow.

RTB-6: *Test and balance all air handler chilled and hot water coils.*

Testing and balancing the air handler hot and chilled water coils will help ensure the coils are receiving the proper water flow rates. Due to the age of the coils, the coils may not perform as required to properly temper the supply air. Coils become fouled over time, which degrades the performance.

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-5: *Install freeze stat or confirm the existing freeze stat is working correctly on each air handling unit.*

RE-7: *Test the existing air handler control valves and actuators for proper operation.*

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.*

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 Replace Air Handling Units & Return Fans

Indoor air handling units have a life expectancy of 35-45 years. The air handlers are approximately 49 years old and are in poor condition. Consider replacing these units as soon as possible to avoid the risk of failure. If one of the air handling units fails unexpectedly, it will result in significant portions of the building being unventilated, heated, or cooled. Replacing the return fans should also occur in conjunction with the replacement of the air handling units and should be sized correctly to provide an overall positive building pressure to reduce infiltration.

We recommend replacing air handler S-4 with a new air handler that can provide ventilation air if the space served by S-4 is to be used as office space. There is an outdoor air intake plenum in the same mechanical room that can be modified to provide outdoor air to S-4.

According to facility staff, the zones along the exterior of the building are not mechanically ventilated. We recommend investigating if ductwork can be extended from the existing systems to serve these areas when the air handlers are replaced.

We also recommend considering converting the air systems from constant air flow to variable airflow. The duct mounted hot water reheat coils would have to be replaced with variable air volume boxes. This will increase comfort control for each zone and also help save energy. This recommendation is an energy saving measure and does not increase the indoor air quality of the building, assuming the air handling units are operating correctly.

2.7.2 Install a Building Management System

We recommend installing a Building Management System to control and monitor HVAC equipment when the air handling units are replaced. This recommendation is an energy saving and maintenance measure and does not affect the indoor air quality of the building.

2.7.3 Convert Chilled and Hot Water Systems to Variable Flow

The hot and chilled water pumps are constant flow systems. Constant flow pumps circulate the same volume of water to air handling units at all times, regardless of whether the water is required to meet heating and cooling demands or not. If air handlers do not require this water, the three-way valves serving the air handler coils bypass the coil and the water is pumped back to the chiller or boiler plant. We recommend considering converting the hot and chilled water systems to variable water flow systems when the air handlers are replaced. This recommendation is an energy saving measure and does not affect the indoor air quality of the building.

2.7.4 Replace Toilet & Holding Cell Exhaust Fans

Due to their age, we recommend replacing holding cell and toilet exhaust fans.

Section 3
Testing & Balancing Results

Wings Testing & Balancing Co., Inc. visited the Quincy District Courthouse on April 13, 2021 to test the airflow rates of the air handling units and the exhaust fans. A summary of the tested airflow rates versus the design airflow rates are shown below in Tables 5 and 6. The full testing and balancing report is attached.

TABLE 5
Air Handler & Fan Coil Unit Testing & Balancing Results

	Design			Actual		
Unit	Total Supply Fan Airflow (CFM)	Recommended Outdoor Airflow (CFM)	Return Fan Airflow (CFM)	Supply Fan Airflow (CFM)	Outdoor Airflow (CFM)	Return Fan Airflow (CFM)
S-1	10,000	3,750	6,250	9,119	3,693	5,426
S-2	11,000	4,150	6,850	10,390	4,167	6,223
S-3	12,750	4,800	7,950	12,071	4,791	7,280
S-4	1,050	Unknown	Unknown	968	0	968
FCU-1 (Court Magistrate)	300	0	300	232	0	232
FCU-2 (Assist. Clerk)	400	100	300	281	0	281
FCU-3 (Clerk's Office)	600	0	600	416	0	416
FCU-1A (Court 4 Jury)	300	0	300	202	0	202
FCU-2A (Jury Pool)	400	100	300	219	0	219
FCU-2B (Judges Lobby)	400	100	300	213	0	213

TABLE 6
Exhaust Fan Testing & Balancing Results

Unit	Serving	Design Return/Exhaust Airflow (CFM)	Actual Return/Exhaust Airflow (CFM)
EX-1	Basement	6,120	5,426

TABLE 6
Exhaust Fan Testing & Balancing Results

Unit	Serving	Design Return/Exhaust Airflow (CFM)	Actual Return/Exhaust Airflow (CFM)
EX-2	First Floor	11,620	9,765
EX-3	Second Floor	11,265	9,155
EF-5	Toilets	600	397
EF-6	Cells & Toilets	680	-
EF-7	First Floor Public Toilets	560	275
EF-8	First Floor Public Toilets	500	456
EF-10	Judge's Toilet	60	60

Typical balancing tolerances for air systems is ±10% of the design airflow. In reviewing the airflow report data, the following should be noted:

1. The total supply airflow for all air handling units, S-1 through S-4, are performing within the acceptable airflow range.

2. Air handler S-4 isn't providing any outdoor airThe fan belt is also cracked and needs replacing.

3. All air handlers contain MERV 8 filters. Based on the TAB results, it appears the filters in all units can be upgraded to MERV 13, however the airflow in unit S-2 may fall 10% below the acceptable airflow range when the filter is dirty. We recommend more frequent filter changes for air handler S-2.

   Tighe & Bond was informed that MERV 13 filters were installed in each air handling unit.

4. The supply airflow for all fan coil units are well below the acceptable range of ±10%. This may lead to inadequate cooling and heating.

5. The testing results confirms that the fan coil units that were tested are not providing any outdoor air. For example, fan coil unit FC-2A serves the Jury Pool Room and FC-2B serves the Judge's Lobby. The TAB report notes no outdoor air is being supplied by these units. According to the design drawings, these unit should be providing 100 CFM of outdoor air.

6. Return fans EX-1, EX-2, and EX-3 are returning air to their respective air handler within the acceptable airflow range, however are falling out of range compared to their designed full airflow capacity. We presume the fans were designed to fully exhaust the building if the air handlers were operating in an economizer mode, however we are not aware of functional economizer sequences existing. Further

investigation is required to determine why these fans were designed to the airflows noted in the design drawings.

7. Fan EX-2 is missing two belts.
8. Toilet exhaust fan EX-5 requires a sheave change to meet the designed airflow.
9. EX-6 is not operating and should be replaced. This fan serves the holding cells.
10. The motor bearings in fan EX-7 are failing and the fan should be replaced.

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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