BROOKLINE MUNICIPAL COURT
HVAC SYSTEM EVALUATION SUMMARY

Visited October 28, 2020. While on site we inspected the air handling equipment located in the ceilings, attic, and on the roof and toured the facility to determine if the spaces generally matched usages noted on the architechral plans. The courthouse was constructed in 1941 with significant improvements in 2005, and is approximately 15,700 square feet in size. Eight indoor air handling units (AHU) and one rooftop handling unit (RTU) provide ventilation air to the building. A field fabricated 100% outdoor air system provides makeup air to the lockup areas.

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)*
Small Courtroom	9	1,500	33	270	6
Main Courtroom	117	2,400	104	680	30

2.0 Recommendations

Section	Recommendation/Finding	Action
2.1	**Filtration Efficiency**	
RF-1	Replace filters with MERV 13	Can only support MERV-10
RF-3	Install a differential pressure sensor across the filter banks	In Progress
RF-3a	Connect the pressure sensor to a local alarm	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-3	Increase outside air flow rate beyond the minimum under non-peak conditions	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
2.4	**Control System**	
RC-1	Implement a pre and post-occupancy flush sequence	In Progress
RC-2	Install controls required to introduce outside air beyond the minimum requirements under non-peak conditions	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 in high traffic areas – *if courthouse is to operate at a high occupancy (i.e. 50-75% or greater), install portable HEPA filters in high traffic areas.*	Complete

2.6	Humidity Control	On-going
2.7	Other Recommendations	
2.7.1	Run ventilation fans continuously during occupied hours	Complete
2.7.2	Provide exhaust for all toilet rooms	Complete
2.7.3	Add ventilation to all occupied areas	Deferred
2.7.4	Add heat to AHUs	N/A
2.7.5	Add economizer controls to AHUs	Complete

Brookline District Court
Brookline, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

May 23, 2021

Tighe&Bond

100% Recyclable

Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Brookline District Court on October 28, 2020. While on site we inspected the air handling equipment located in the ceilings, attic, and on the roof and toured the facility to determine if the spaces generally matched usages noted on the architectural plans.

Site Visit Attendees:

- *Office of Court Management:*
  - Mike Ostman, Norfolk County Facilities Staff
  - John Koch, Norfolk County Facilities Staff
- *Tighe & Bond*
  - Sean Pringle, PE, Mechanical Engineer
  - Caitlin DeWolfe, Staff Engineer

1.1 Existing Ventilation System

The Brookline District Court is a three story building (including basement) constructed in 1941 with significant HVAC improvements in 2005, and is approximately 15,700 square feet in size. Eight indoor air handling units (AHU) and one rooftop air handling unit (RTU) provide ventilation air to the building. A field fabricated 100% outdoor air system provides makeup air to the lockup areas. All air handling equipment appears to be from the 2005 renovations.

AC's 1-7 are light commercial / residential style constant volume air handlers. Each unit has a DX cooling coil, supply fan, and an outside air duct with an on/off motorized damper. The AHU's do not provide heat. Heating in the areas served is provided by steam perimeter radiators. The AHU's are currently configured to cycle the fan on/off with calls for cooling, and do not operate in the heating season. The AHU's do not have an economizer function. The AHU's are generally in good condition.

AC's 9-10 are wall mounted split heat pump units that serve stair and mechanical areas. These units do not provide any ventilation.

AC-11 is a ceiling mounted split heat pump system serving office B1 in the lockup area providing heating and cooling. The unit is configured to provide outdoor air through a small fresh air duct and is in good condition.

RTU-1 is a constant volume unit in good condition. The RTU has a DX cooling coil, supply fan, as well as return, outside, and relief air dampers. There is no heating within the RTU. The unit has onboard economizer controls and a power exhaust. Heating in the area served is provided by steam perimeter radiators. The RTU is also configured to cycle the fan on/off with calls for cooling, and does not operate in the heating season.

There are three exhaust fans. EF-1, which is a general relief exhaust, was not running at the time of the visit. According to staff, the fan is too loud, and the occupants complain when it is running. The toilet exhaust fan TEF-1 was running, and most restrooms

appeared to have exhaust airflow. However, the basement men's restrooms did not appear to have any exhaust airflow at the time of the visit. The cause should be investigated.

The lockup area is supplied by a duct mounted supply fan (SF-1), steam coil, and DX cooling coil. Air is supplied into the corridor and exhausted through both the cells and corridor via a dedicated exhaust fan (EF-2). Due to the ceiling location, we were not able to closely inspect the coils. There did not appear to be any air filter protecting the coils. Both the supply and exhaust fans were observed to be working at the time of the visit.

A 1.6 million Btu/h boiler plant provides steam for the perimeter heating throughout the building. Each AHU is served by a dedicated DX condensing unit located on the roof.

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

TABLE 1
Existing Air Handling Units

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Filters	Condition
AC-1	2,000	360	1" MERV 8	Good
AC-2	2,000	240	1" MERV 8	Good
AC-3	1,200	160	1" MERV 8	Good
AC-4	2,000	240	1" MERV 8	Good
AC-5	1,600	200	1" MERV 8	Good
AC-6	1,000	120	1" MERV 8	Good
AC-7	800	100	1" MERV 8	Good
AC-11	450	40	Unknown	Good
RTU-1	2,400	480	2" MERV 8	Good
SF-1	400	400	Unknown	Good

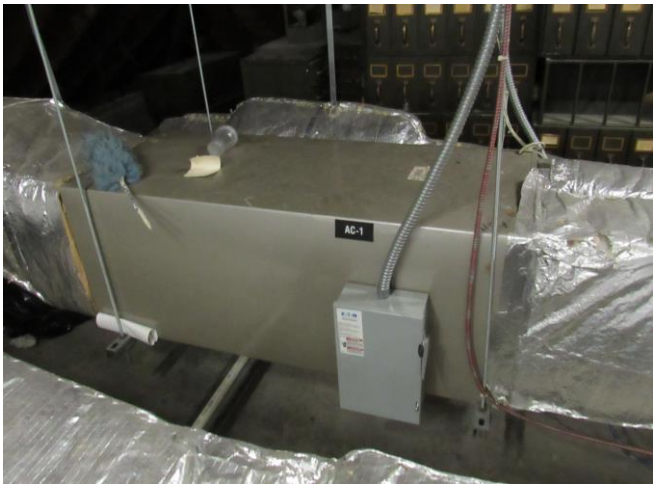

Photo 1 – Representative Air Handler

Photo 2 – RTU-1

Aside from the lockup area, the occupied areas in the basement do not have any source of ventilation air. Although the first floor lobby is ventilated, there is no ventilation in the second floor corridor area outside the courtrooms. Building areas without ventilation significantly increase the risk of spreading viruses like COVID-19, especially areas with high occupant density and where people occupy the same space for relatively long periods of time. Consider significantly reducing occupancy or relocating occupants to other areas with adequate ventilation. The windows in the perimeter basement rooms are relatively large with operable sashes.

1.2 Existing Control System

The Courthouse does not have a building-wide control system or building management system (BMS). The AHU's, RTU, and perimeter heating operate with local thermostats. A localized Automated Logic DDC controller and external time clock enable the exhaust fans and lockup area ventilation.

Section 2
Recommendations

Below is a list of recommendations that we propose for the Brookline District Court. 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 1" and 2" MERV-8 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. Replace filters in AHU's and RTU's with 2" and 1" MERV 13 filters, respectively.

For AC-11, we recommend using the highest performance filter available. Mitsubishi offers a MERV 10 filter for this type of unit.

RF-3: *Install a differential pressure sensor with a display across the filter bank.*

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

As there is no centralized control system or BMS, provide a local alarm. For the AHU's and RTU, provide a local alarm in an area that will be noticed by staff.

2.2 Testing & Balancing Recommendations

The air handling units are approximately 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 outside air flow rates that were used to design the original system were 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 rebalance 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	2,000	360	320	360
AC-2	2,000	240	90	240
AC-3	1,200	160	50	160
AC-4	2,000	240	140	240
AC-5	1,600	200	100	200
AC-6	1,000	120	80	120
AC-7	800	100	50	100
AC-11	450	40	20	40
RTU-1	2,400	480	680	680
SF-1	400	400	N/A	400

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.

As noted in section 1.1, since the all units aside from AC-11 and SF-1 currently operate only when a call for cooling is present, no ventilation is currently provided during the winter months or moderate weather.

We believe the outdoor air for RTU-1 can safely be increased to 680 CFM with the current operation. This will likely reduce comfort on extremely cold days.

If the controls are modified to operate in "fan on" (see Section 2.7.1), the outdoor airflow for RTU-1 may need to be kept at the current rate of 480 CFM to maintain reasonable supply air temperatures on very cold days. While less than the airflow required by the current code, any winter ventilation would be an improvement over current winter operation without any ventilation air.

The average airflow rate per person is shown below in Table 3. These values are based on the original design supply airflow rate and the recommended outdoor air flow 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. The airflow rate per person assumes supply air is being delivered to all rooms.

TABLE 3
Average Airflow Rate per Person

	All spaces	*Courtrooms*	*Non-Courtroom Spaces*
Total Occupancy (People)	148	113	34
Total Supply Air (CFM/Person)	94	34	290
Outdoor Air (CFM/Person)	17	8	46

The airflow rate per person for each Courtroom is shown below in Table 4. These values are based on full occupancy without taking diversity into account, the original design supply airflow rate, and the recommended outdoor airflow rate. The airflow rate per person assumes supply air 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)*
Small Courtroom	45	1,500	33	270	6
Main Courtroom	117	2,400	21	680	6

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, 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 supply air 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)*
Small Courtroom	9	1,500	167	270	30
Main Courtroom	23	2,400	104	680	30

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

RTB-3: *Increase outside air flow rate beyond the minimum under non-peak conditions*

At minimum, this would require added controls and changing the outdoor air dampers from on/off to modulating. The available increase in outdoor air will be limited by the existing outdoor air ductwork, louvers and soffit openings.

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.*

2.4 Control System Recommendations

We recommend the following for the control system:

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

RC-2: *Install controls required to introduce outside air beyond the minimum requirements under non-peak conditions.*

For the AHU's, this would require a new control system and replacement of outdoor air dampers actuators at minimum. It is possible that RTU-1 can be field retrofitted to operate with variable outdoor airflow, but this should be confirmed with the manufacturer.

Prior to implementing this control strategy, the TAB Contractor should verify the quantity of outside air the outdoor air louvers can accommodate without exceeding an intake air velocity of 450 feet/minute (FPM). Exceeding this air velocity through an intake air louver may result in rain or snow entering the louver.

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

This applies to RTU-1 only.

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 using duct mounted humidification or portable humidifiers 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. We are not aware if this building was constructed to accommodate a humidification system.

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 Run Ventilation Fans Continuously During Occupied Hours

For the AHU and RTU systems where the fans cycle in response to cooling demand, we strongly recommend running the supply fans continuously during occupied hours in all seasons, to provide mechanical ventilation at all times as code requires. Implementing this strategy may cause comfort issues, especially in systems with a high outdoor air percentage. When the fan continuously runs, the cooling coils will turn on and off based on the space temperature. Comfort issues may arise if the existing units do not have multiple stages of cooling that would otherwise handle load fluctuations better. In the winter, no heat is available to temper the supply air as these systems provide cooling only.

With the recommended outdoor airflows in Table 2, the supply air temperature on a design winter day (8.5°F) will generally be around 60°F, except for RTU-1 which will be about 53°F with the recommended increase in outdoor air. These low supply air temperatures have the potential to create comfort issues on winter days. Further system analysis and improvements are required to execute this recommendation.

Consider also adding a single electronic time clock to control AHU's, RTU's, and exhaust fans from a single location in the Courthouse to simplify scheduling and operation. Alternately, the existing programmable thermostats serving the RTU's could be replaced with new thermostats that include a programmable fan function. Depending on the current wiring, new control wiring may be required between the thermostats and RTU's.

2.7.2 Provide Exhaust for All Toilet Rooms

Investigate the lack of exhaust airflow in the basement restrooms. Add exhaust fans and/or ductwork to provide the code-required exhaust to these restrooms.

2.7.3 Add Ventilation to All Occupied Areas

Several office areas in the basement level do not have any ventilation. Consider adding a ventilation system to serve these areas. If the area is currently adequately heated and cooled, consider the user of a small energy recovery ventilator (ERV) or dedicated outdoor air system (DOAS) to serve these spaces.

2.7.4 Add Heat to AHU's

The RTU and AHU's do not heat the supply air. As mentioned in section 2.7.1, occupants may feel cold with the low supply air temperature in the winter without heat to the temper supply air. Consider providing duct mounted heating coils or replace the AC unit and condenser with a split air source heat pump system to provide heating and cooling with the refrigerant coil. As the building is heated by steam, the routing and installation of duct

mounted steam coils or the addition of a steam to hot water heat exchanger and hot water distribution may be an involved and intrusive project. Electric heating coils or replacing the AHU's with equipment that provides both heating and cooling may be more practical solutions. Further analysis and design efforts are required to execute this recommendation.

This recommendation is a comfort and energy saving measure and does not affect the indoor air quality of the building, however this measure will allow the ventilation air to be provided at all times with less space temperature discomfort.

2.7.5 Add Economizer Controls to AHU's

The AHU's have small outdoor air ducts and louvers, which can only provide limited outdoor air. There is currently an on/off motorized damper in the outdoor air duct, but no return air damper. Consider increasing the outdoor air duct and louver / intake opening size to provide 100% outdoor air when outdoor conditions are favorable. This would also require new actuators and dampers in the return air ducts for each unit, as well as standalone or DDC type economizer controls. Further analysis and design efforts are required to execute this recommendation.

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

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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