# BARNSTABLE PROBATE & FAMILY COURT
# HVAC SYSTEM EVALUATION SUMMARY

Visited October 15, 2020. While on site, inspected the air handling equipment located in mechanical rooms and on the roof, and toured the occupied areas of the facility to determine if the spaces generally matched usages noted on the architectural plans. The Barnstable Probate and Family Courthouse was constructed in 1956 with a major addition and renovation in 1988. The Courthouse is approximately 29,000 square feet in size.

Airflow Rate per Person (Reduced Occupancy)

| | | *Total Air* | | *Outdoor Air* | |
|---|---|---|---|---|---|
| *Courtroom* | *Total People (Reduced Occupancy)* | *Supply Airflow (CFM)* | *Airflow Rate (CFM/Person)* | *Outside Airflow (CFM)* | *Airflow Rate (CFM/Person)* |
| Courtroom 1 | 20 | 2,400 (est.) | 120 | 620 | 31 |
| Courtroom 2 | 17 | 2,000 | 141 | 400 | 24 |

## 1.0 Recommendations

| Section | Recommendation/Finding | Action |
|---|---|---|
| 2.1 | **Filtration Efficiency** | |
| RF-1 | Replace filters with MERV 13 | Complete |
| RF-3 | Install a differential pressure sensor across the filter banks | Deferred |
| RF-3a | Connect the pressure sensors to the BMS system and/or local alarm | Deferred |
| 2.2 | **Testing and Balancing** | |
| RTB-1 | Test and rebalance air handling unit supply air and minimum outside air flow rates | Complete |
| RTB-3 | Increase outside air flow rate beyond minimum under non-peak conditions | Complete |
| RTB-5 | Consider rebalancing all air inlets and outlets | N/A |
| RTB-6 | Test and balance all air handler chilled and hort water coils | N/A |
| 2.3 | **Equipment Maintenance and Upgrades** | |
| RE-1 | Test existing air handling system dampers and actuators for proper operation | Complete |
| RE-2 | Clean air handler coils and drain pans | Complete |
| RE-7 | Test the existing air handler control valves and actuators for proper operation | Complete |
| RE-7 | Test the existing air handler control valves and actuators for proper operation | Complete |
| 2.4 | **Control System** | |
| RC-1 | Implement a pre and post-occupancy flush sequence | Complete |
| RC-3 | Install controls required to introduce outside air beyond the minimum requirement in a stepped approach | Complete |
| RC-4 | Confirm the economizer control sequence is operational | Complete |

| | | |
|---|---|---|
| 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** | |
| | No actionable items listed – Portable humidifiers can help maintain the relative humidity levels recommended by ASHRAE | On-going |
| 2.7 | **Other Recommendations** | |
| 2.7.1 | Run ventilation fans continuously during occupied hours | On-going |
| 2.7.2 | Add ventilation to all occupied areas | Deferred |
| 2.7.3 | Replace toilet exhaust fans | Complete |
| 2.7.4 | Provide exhaust for all toilet rooms | In progress |
| 2.7.5 | Replace AHU-1, RTU-2, and RTU-4 | Deferred |
| 2.7.6 | Add heat to RTUs 4-6 | Deferred |


**Barnstable Probate & Family Court**
**Barnstable, MA**

# HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

January 13, 2021

Tighe&Bond

100% Recyclable

# Section 1
# Existing Conditions & Site Observations

Tighe & Bond visited the Barnstable Probate and Family Courthouse on October 15, 2020. While on site we inspected the air handling equipment located in mechanical rooms and on the roof, and toured the occupied areas of the facility to determine if the spaces generally matched usages noted on the architectural plans.

Site Visit Attendees:

- *Office of Court Management:*
  - Don Reynolds, Facilities Director, County of Barnstable
  - Tom Butler, Courthouse Facilities Staff
  - Keith Bernier, Courthouse Facilities Staff
  - Adam Alati, Courthouse Facilities Staff
- *Tighe & Bond*
  - Sean Pringle PE, Mechanical Engineer
  - Christina Wu, Staff Engineer

## 1.1 Existing Ventilation System

The Barnstable Probate and Family Courthouse was constructed in 1956 with a major addition and renovation in 1988. The Courthouse is approximately 29,000 square feet in size. One air constant volume air handling unit (AHU) and six constant volume rooftop air handling units (RTU) provide ventilation air to the building.

AHU-1 is located in the basement boiler room and serves the land court offices in the basement. The unit has a hot water coil, chilled water coil, hot water reheat coil, supply fan, as well as return and outside air dampers. This unit is in poor condition. The hot water coil was dirty, and the unit did not appear to be providing any outdoor air at the time of the visit based on the position of the outdoor air damper.

The RTU's have DX cooling, supply fan, as well as return, outside, and relief air dampers. There is no heating within the RTU's. The conditions vary from poor to good condition, as some appear to have been replaced at different times. The RTU fans do not operate continuously, and cycle in response to cooling needs in the spaces served. In heating mode, RTU's 1-3 run continuously to serve the multiple zones with individual hot water heating coils in the ductwork. RTU's 4-6 are single zone systems and only provide cooling, cycling the fan in response to cooling demands. Heat is provided in these areas via hot water baseboard around the perimeter. The newer RTU's (1,3,5, and 6) include economizer controls and have 3 position outdoor air dampers. The oldest RTU's (2 and 4) have fixed outdoor air dampers.

Two 780 MBH (input) hot water boilers provide hot water to the AHU, duct-mounted heating coils, and perimeter baseboard heaters. A 60 ton air-cooled chiller provides cooling to the AHU's and ducted fan coils. Staff commented that the chiller is too large for the connected load and they have operational issues as a result. Prior to the 1988 addition, the chiller also served chilled water coils in several rooftop units which are now packaged AC units.

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 |
|---|---|---|---|---|
| AHU-1 | Unknown (3,700 est) | Unknown | 2" MERV 11 | Poor |
| RTU-1 | 5,000 | 1,000 | 2" Mesh | Good |
| RTU-2 | 5,760 | 1,150 | 2" MERV 11 | Fair |
| RTU-3 | 2,700 | 540 | 2" MERV 11 | Good |
| RTU-4 | Unknown (3,000 est) | Unknown | 2" MERV 11 | Fair |
| RTU-5 | Unknown (4,000 est) | Unknown | 2" MERV 11 | Fair |
| RTU-6 | Unknown (2,000 est) | Unknown | 2" MERV 11 | Fair |


Photo 1 – Representative Rooftop Air Handler

Photo 2 – Air handler AHU-1

At the time of the visit, the toilet exhaust fan serving the judge's lobby for Courtroom 1 was not operational. The judge's lobby restroom for Courtroom 2, and the first-floor staff restrooms did not have any toilet exhaust vents.

In the basement, there is an office area that is currently unoccupied. It is heated and cooled by a large concealed ducted fan coil. There is also perimeter baseboard heat serving this space. However, there is no source of ventilation air for the space. Staff indicated that there are plans to reuse this area.

In the first floor, there is an office area that is under construction, but currently unoccupied. Heating and cooling is provided by wall-mounted heat pump units that appear to have been recently added as part of the project. There is no source of ventilation air for the space.

The first floor Registry of Deeds and lobby areas do not have any source of ventilation air. Several concealed ducted fan coils provide cooling to these areas, but do not provide outdoor air. Heat is provided in these areas via hot water baseboard.

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 perimeter rooms generally have large windows with small operable sashes at the top and bottom of the window.

The available drawings for this building were limited. The duct system and specifications for RTU's 1-3 were available as part of the 1988 design documents. AHU-1 was originally designed to serve the photography lab in the basement. We were able to estimate the total supply airflow for this unit based on the sum of airflow values at supply outlets on

ductwork drawings, but no other data was available. Because the estimated airflows are based on use as a photography lab, they may not be accurate based on the current office use. Based on the exhaust rate from the photography lab hoods, the unit was likely originally used for 100% outdoor air operation. We were not provided with any drawings indicating the capacities or duct routing for RTU's 4-6. Staff advised us of the areas each unit serves. Any airflows indicated in this report for these units and areas are estimates. Further engineering review is recommended. Refer to recommendation RTB-5.

## 1.2 Existing Control System

The Courthouse does not have a building-wide control system. The AHU has local DDC controls and time clocks. All RTU's, radiant heat, and supplemental heating and cooling utilize local thermostats and electronic controls, without any functioning time clocks. According to staff, toilet exhaust fans are turned on manually each day.

# Section 2
# Recommendations

Below is a list of recommendations that we propose for the Barnstable Probate and Family 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.*

We recommend replacing the filters in the AHU and RTU's with MERV 13 filters. The TAB Contractor and Engineer shall verify that the existing AHU and RTU's can accommodate MERV-13 filters. Replace filters in AHU and RTU's with 2" MERV 13 filters.

For the fan coils providing supplementary cooling, consider the use of 1" pleated MERV 13 filters. The use of MERV ratings than the typical MERV 8 in these units may reduce the supply airflow and will require replacement at a higher frequency. The TAB Contractor shall verify that the existing fan coil airflows are not significantly reduced with the addition of MERV-13 filters.

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

This recommendation applies to AHU-1 and the RTU's.

**RF-3a:** *Connect the pressure sensor to the BMS system and/or a local alarm.*

As there is no BMS, provide a local alarm. For the RTU's, provide a local alarm in area that will be noticed by staff.

## 2.2 Testing & Balancing Recommendations

AHU-1 is approximately 65 years old and the RTU's are of unknown age. The RTU's have been replaced as they failed. 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 likely different than the 2015 International Mechanical Code (IMC) and current ASHRAE Standard 62.1 requirements.

The ASHRAE climatic data for outdoor air conditions in Barnstable states a summer design condition of 84.0°F/73.5°F DB/WB and a winter condition of 9.6°F. We were not able to find the intended capacity, supply or outdoor airflow for RTU's 4-6 in the available design documents. The supply airflow for AHU-1 is based on the 1956 drawings when the space was used as a photography lab, which may not be accurate based on the current use.

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) | Design O.A. (CFM) | Current Code Min. O.A. Requirements (CFM) | Recommended Minimum O.A. (CFM) |
|---|---|---|---|---|
| AHU-1** | 3,700 | Unknown | 650 | 900 |
| RTU-1 | 5,000 | 1,000 | 380 | 1,000 |
| RTU-2 | 5,760 | 1,150 | 700 | 1,150 |
| RTU-3 | 2,700 | 540 | 480 | 540 |
| RTU-4* | Unknown (3,000 est.) | Unknown | 780 | 780 |
| RTU-5* | Unknown (4,000 est.) | Unknown | 160 | 400 |
| RTU-6* | Unknown (2,000 est.) | Unknown | 210 | 250 |

*Supply Airflow estimated based on equipment nameplate cooling capacity, assuming 400 CFM/Ton.
**Supply airflow based on 1956 documents when space was used as a photography lab.

For AHU-1 and RTU's 4, 5, and 6, we are recommending outdoor airflow rates above the code minimum ventilation rate to provide adequate makeup air for the toilet exhausts and to maintain a positive pressure in the space. Because the supply airflows in individual spaces are not known, the calculated and recommended outdoor air requirements are approximate. Further engineering review is recommended. Refer to recommendation RTB-5.

The discrepancies between the calculated code required ventilation rates and the design ventilation rates are likely due to variations in assumptions in the expected occupant concentration, airflow per person, calculation methodology, and makeup and pressurization requirements. We recommend maintaining the outdoor airflows at the original designed values where they are known and exceed the code minimums calculated by Tighe & Bond.

The average airflow rate per person is shown below in Table 3. These values are based on the original design or estimated supply airflow rate and the recommended outdoor air flow rates shown in Table 2 above. Only the areas with ventilation are shown. Areas without ventilation are not included. 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) | 227 | 113 | 114 |
| Total Supply Air (CFM/Person) | 116 | 39 | 190 |
| Outdoor Air (CFM/Person) | 22 | 9 | 35 |

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 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 continuously.

**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)* |
| Courtroom 1 | 96 | 2,400 (est.) | 25 | 620 | 6 |
| Courtroom 2 | 65 | 2,000 | 37 | 400 | 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 the full supply airflow is being delivered to the room continuously.

**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)* |
| Courtroom 1 | 20 | 2,400 (est.) | 120 | 620 | 31 |
| Courtroom 2 | 17 | 2,000 | 141 | 400 | 24 |

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

We recommend increasing the outdoor air flow rate in AHU-1 beyond the recommended outdoor air flow rates in a stepped approach by up to 10% beyond the recommended outdoor air flow rates under non-peak conditions. We do not believe this would cause a threat of coil to freeze based on the total percentage of

outside air vs. the total amount of outside air, however cold spots on the coil may develop due to poor mixing.

With the current equipment and lack of a central BMS, we do not recommend this approach for the RTU's.

Refer to the control system upgrades section for the required controls to implement this strategy for the AHU's.

**RTB-5:** *Consider rebalancing all air inlets and outlets.*

Original 1956 Areas:
We were not provided with any design documents showing the ductwork in these areas, and according to staff, they are not available. We were provided with some ductwork drawings showing airflows for the AHU-1 area, but this is likely no longer accurate. If design documents showing the required airflows and ductwork are not available, the required airflows should be established by an engineer and rebalanced to provide appropriate air volumes based on loads, and the code required ventilation rates for each space.

Whole building or spaces with airflow/temperature issues
If the Courthouse experiences regular cooling and heating comfort complaints, we recommend exploring rebalancing all air inlets and outlets throughout the building. Prior to rebalancing the building, we recommend verifying the chiller and boiler plants are maintaining the correct supply water temperatures.

**RTB-6**: *Test and balance AHU chilled and hot water coils.*

Testing and balancing the air handler hot and chilled water coils, and duct mounted hot 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.*

Several coils were visibly dirty at the time of the site visit.

**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.*

Time clocks will need to be added to control the RTU's and exhaust fans for this measure to be implemented. Consider adding a single electronic timer to control all devices from a single location in the Courthouse. According to staff, the controls for AHU-1 already include a time clock.

**RC-3:** *Install controls required to introduce outside air beyond the minimum requirements.*

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

AHU-1 appears to have the ability to economize, and several RTU's (1, 3, 5, and 6) have built-in economizer controls. Ensure the controls are calibrated and correctly configured, and outside air dampers can open fully.

## 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 handle 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 RTU systems where the fans cycle in response to thermal demand, we strongly recommend running the supply fans continuously during occupied hours, to provide mechanical ventilation at all times, as code requires. Implementing this strategy may cause comfort issues. 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. During the winter, RTU's without heating coils in the ductwork will supply air below room temperature. Further system analysis and improvements are required to execute this recommendation.

Consider 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 or occupancy schedule function. Depending on the current wiring, new control wiring may be required between the thermostats and RTU's.

## 2.7.2 Add Ventilation to All Occupied Areas

The lobby and Registry of Deeds areas on the first floor do not have any mechanical ventilation. Consider adding a ventilation system to serve these areas. If the area is currently adequately heated and cooled, consider the use of a dedicated outdoor air system (DOAS) to serve this space.

According to staff, there are plans to use the unoccupied areas in the basement and first floor in the future. We also recommend adding code-required ventilation to these areas prior to occupancy.

## 2.7.3 Replace Toilet Exhaust Fans

We recommend replacing any failed toilet exhaust fans. At the time of the visit, the toilet exhaust fan serving the judge's lobby restroom for Courtroom 1 was not functional.

## 2.7.4 Provide Exhaust for All Toilet Rooms

Add exhaust fans and ductwork to the judge's lobby restroom for Courtroom 2 and the first-floor restrooms.

## 2.7.5 Replace AHU-1, RTU-2, and RTU-4

AHU-1 appears to be original to the building. RTU's 2 and 4 are the oldest rooftop units. They have fixed outdoor air dampers, which do not allow for economizer function or shutting off outdoor air during unoccupied periods. Consider replacing these units within the next 5 years.

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

### 2.7.6 Add Heat to RTU's 4-6

RTU's 4-6 do not provide heating. As mentioned in 2.7.1, occupants may feel cold with the low supply air temperature in the winter without heat to temper supply air. Provide duct mounted heating coils or replace the RTU with a unit that provides gas or hot water heating. If gas heat is used, the furnace should be a modulating type, to mitigate fluctuations in the supply air temperature.

This recommendation is a comfort and 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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