# BARNSTABLE DISTRICT COURT
# HVAC SYSTEM EVALUATION SUMMARY

Visited October 15, 2020. While on site, inspected the air handling equipment located in mechanical rooms and occupied areas and toured the facility to determine if the spaces generally matched usages noted on the architectural plans. The Barnstable District Courthouse was constructed in 1970 and is approximately 44,000 square feet in size. Five constant volume air handling units (AHU) and 49 unit ventilators (UV) provide ventilation air to the building. In 2003, upgraded controls and dampers were added to AHU's 1-4, the four original air handlers.

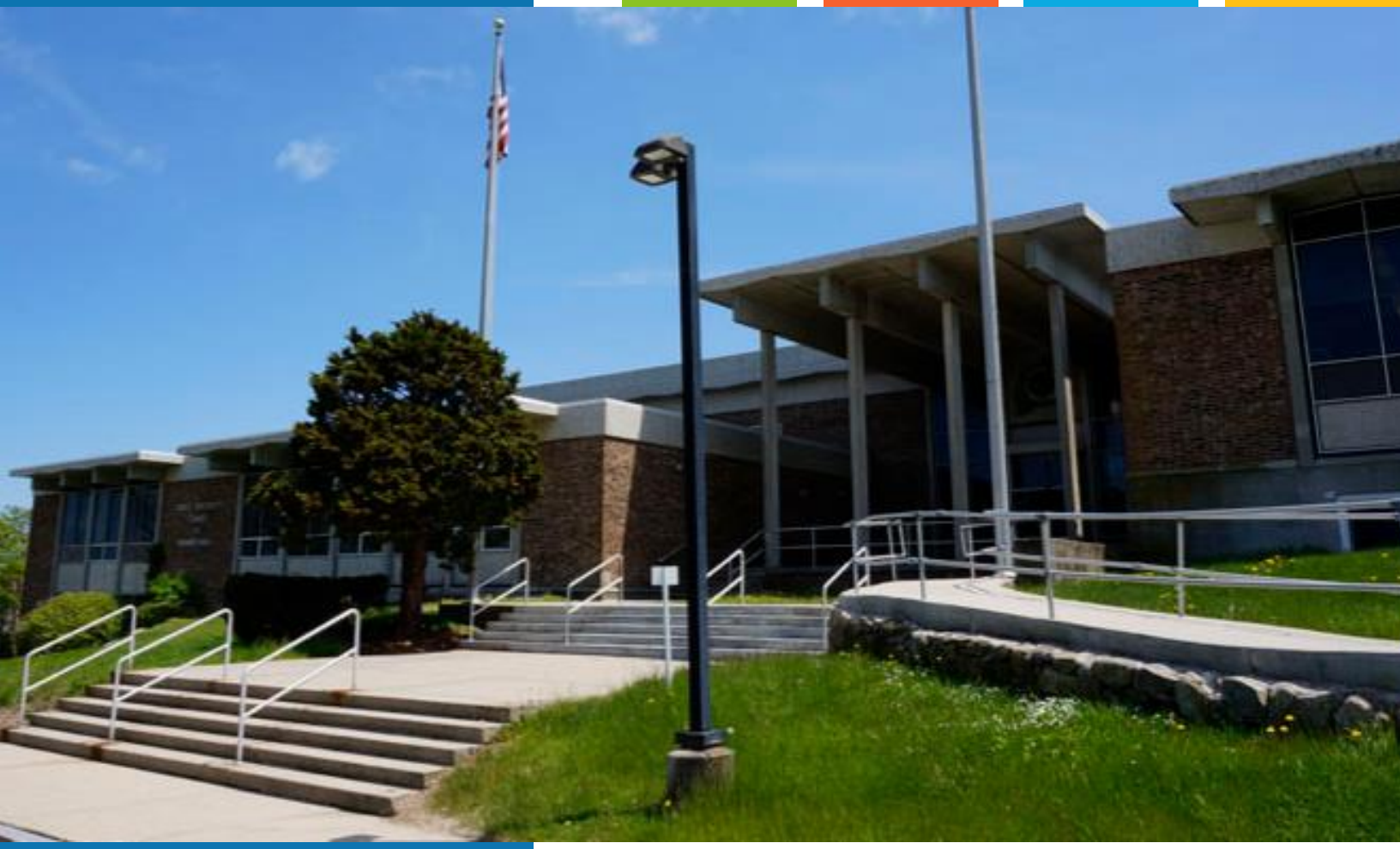
## 1.0 Airflow Rate per Person (Reduced Occupancy)

| | | *Total Air* | | *Outdoor Air* | |
|---|---|---|---|---|---|
| *Courtroom* | *Total People (Reduced Occupancy)* | *Supply Airflow (CFM)* | *Airflow Rate (CFM/Person)* | *Outside Airflow (CFM)* | *Airflow Rate (CFM/Person)* |
| Jury Pool Room | 12 | 700 | 58 | 154 | 13 |
| Civil Courtroom | 6 | 1,340 | 223 | 400 | 67 |
| Juvenile Courtroom | 9 | 1,160 | 129 | 500 | 56 |
| Courtroom 1 | 33 | 8,400 | 255 | 4,200 | 127 |
| Courtroom 2 | 13 | 3,500 | 269 | 1,000 | 77 |
| Courtroom 3 | 13 | 3,500 | 269 | 1,000 | 77 |

## 2.0 Recommendations

| Section | Recommendation/Finding | Action |
|---|---|---|
| **2.1** | **Filtration Efficiency** | |
| RF-1 | Replace filters with MERV 13 | In-progress |
| RF-3 | Install a differential pressure sensor across the filter banks | In-progress |
| RF-3a | Connect the pressure sensors to the BMS system and/or 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 minimum under non-peak conditions | In-progress |
| RTB-5 | Consider rebalancing all air inlets and outlets | In-progress |
| RTB-6 | Test and balance all air handler chilled and hot water coils | 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-7 | Test the existing air handler control valves and actuators for proper operation | In-progress |

| | | |
|---|---|---|
| 2.4 | Control System | |
| RC-1 | Implement a pre and post-occupancy flush sequence | In-progress |
| RC-3 | Install controls required to introduce outside air beyond the minimum requirement in a stepped approach | 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.* | In-progress |
| 2.6 | Humidity Control | |
| | No actionable items listed – suggestion of installing portable humidifiers | On-going |
| 2.7 | Other Recommendations | |
| 2.7.1 | Repair unit ventilators | In-progress |
| 2.7.2 | Replaced toilet exhaust fans | In-progress |
| 2.7.3 | Replace air handling units #1-4 | Deferred – included in 5 year Capital Plan |
| 2.7.4 | Add demand-controlled ventilation to select unit ventilators | In-progress |



**Barnstable District Court**
**Barnstable, MA**

# HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

April 6, 2021

Tighe&Bond

100% Recyclable

# Section 1
# Existing Conditions & Site Observations

Tighe & Bond visited the Barnstable District Courthouse on October 15, 2020. While on site we inspected the air handling equipment located in mechanical rooms and occupied areas and toured 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 District Courthouse was constructed in 1970 and is approximately 44,000 square feet in size. Five constant volume air handling units (AHU) and 49 unit ventilators (UV) provide ventilation air to the building. The AHU's serve the first and second levels and interior zones on the third and fourth levels, while the UV's serve the perimeter areas on the third and fourth levels and select rooms on the first and second levels.

In 2003, upgraded controls and dampers were added to AHU's 1-4, the four original air handlers. Return air fans and return air ductwork were added as part of this work. In addition, a fifth air handler (AHU-5) was added to serve Courtrooms 2 and 3.

AHU's 1-4 have a hot water coil, chilled water coil, hot water reheat coil, supply fan, as well as return and outside air dampers. Each AHU has an associated external return air fan and exhaust air damper. The air handling units are generally in fair condition. Several of the coils were dirty, and the coils were showing some signs of corrosion. It does not appear that the coils were replaced as part of the 2003 upgrades.

AHU-5 has a chilled water coil, hot water coil, supply fan, as well as return and outside air dampers. The chilled water coil is in the first position to allow the unit to provide active dehumidification. The AHU has an associated external exhaust fan and damper. The unit is in good condition.

A small AHU, (designated here as AHU-LL) serves recently added office areas in what was previously part of the first floor mechanical room in the lower level. This AHU has a chilled water coil, hot water coil, supply fan, and a fixed position outdoor air damper. The unit is in good condition.

The unit ventilators have separate hot and chilled water coils fed through a four-pipe hot and chilled water distribution system, and are generally in good condition. According to the design drawings, they were mostly replaced in kind in 2003, with very minor changes. Notably, one of three UV's was removed from courtrooms 2 and 3, presumably due to the

addition of AHU-5. According to staff, most units are operational, but there are a few that have failed in areas such as the courtrooms and lobbies where there are more than one unit serving the space.

Two 650 MBH hot water boilers provide hot water to the air handlers, unit ventilators, corridor fan coils, and perimeter radiators. A dedicated 400 MBH summer boiler provides hot water to the AHU reheat coils and hot water coil in AHU-5 for reheat during active dehumidification operation via a separate hot water loop. A pair of air-cooled chillers located on grade provide chilled water to the air handlers, unit ventilators, and corridor fan coils.

Table 1 summarizes the air handling units' designed airflow rates where available, 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 | 3,750 | Unknown | 2" MERV 8 | Fair |
| AHU-2 | 4,300 | Unknown | 2" MERV 8 | Fair |
| AHU-3 | 5,000 | Unknown | 2" MERV 8 | Fair |
| AHU-4 | 4,000 | Unknown | 2" MERV 8 | Fair |
| AHU-5 | 3,000 | Unknown | 2" MERV 8 | Good |
| AHU-LL | 700 (est.) | Unknown | 1" MERV 8 | Good |
| Unit Ventilators | 200-1,200 (Varies) | 25-50% of Supply (Varies) | 1" MERV 8 | Fair |

N/S: Not Specified

Photo 1 – Representative Air Handler

Photo 2 – Representative Unit Ventilator

At the time of the visit, all toilet exhaust fans except for EF-11 appeared to be functioning.

The "County Use" and "District Attorney" areas on the second level appear to have been significantly remodeled since the original design. The drawings provided to Tighe & Bond show this as "unassigned space." Based on the register locations, it does not appear that the supply ductwork has been modified. All areas except for room 208 appear to have supply vents. Room 208 is designated as storage on the plans but appears to be used as an office currently. As part of the 2003 work, significant return air ductwork was added. Based on the original design airflows through each diffuser, the office areas appear to be adequately ventilated for the current use, except for room 208.

The Civil Courtroom on the second level in this area may be under-ventilated for the ASHRAE standard of 70 people per 1,000 square feet. Based on the original space airflows, the current supply airflow rate of 1,340 cfm provides the code-required ventilation for 89 people.

Similarly, a large portion of the original boiler room has been converted to occupied spaces, and new ductwork was added to serve these areas. Based on feedback from staff, this area is fed from AHU-LL, a small air handler located in the boiler room, added to serve this load. We were not provided with any drawings indicating the capacities, duct routing, or airflows for areas served by AHU-LL. Any airflows indicated in this report for this unit are estimated. Further engineering review is recommended, as discussed in RTB-5.

## 1.2 Existing Control System

The Courthouse has a Trane building management control system (BMS). It is tied to the existing boiler, chiller, AHU's, UV's, radiant heat, and exhaust fans. While onsite, Tighe & Bond was able to observe various control system screens and setpoints. In addition to typical controls, we understand that the system provides the following key features:

1. AHU's 1-5:
    a. Economizer mode – 100% outdoor air.
    b. Safeties and alarms, including freeze stats.
    c. Active dehumidification using hot water reheat in summer, controlling to a target space humidity.
2. Unit Ventilators:

a. The control drawings indicate that the fans shall run continuously during occupied periods. The bulk of the UV's operate in this fashion.
b. On approximately ten UV's, the fans cycle in response to heating and cooling demand during occupied periods. The sequence has been modified as the control valves in these units have failed open. With the modified sequence, the fan is used to regulate heating and cooling, which results in interruptions to the delivery of outdoor ventilation air. The international mechanical code requires ventilation air to be provided continuously during occupied periods.

# Section 2
# Recommendations

Below is a list of recommendations that we propose for the Barnstable 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 MERV-8 filters with MERV-13 filters.*

We recommend replacing the filters in the air handling units and unit ventilators with MERV 13 filters. The TAB Contractor and Engineer shall verify that the existing AHU's and UV's fans can accommodate the additional pressure drop associated with MERV-13 filters. We recommend replacing filters in AHU's and UV's with 2" and 1" MERV 13 filters, respectively.

The use of higher MERV ratings in unit ventilators may reduce the supply airflow and will require replacement at a higher frequency. It is recommended that a testing and balancing contractor confirm the supply airflow can be maintained and adjust the outdoor air flow as recommended in RTB-1. Since this type of UV generally has poor filter fitment and uses the removeable cover as a sealing surface, consider adding gasketing to the UV cover and sides of the filter tray.

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

This is only recommended for the AHU's.

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

## 2.2 Testing & Balancing Recommendations

AHU's 1-4 are approximately 50 years old, and AHU-5 and the unit ventilators are approximately 17 years old. 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.

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. The original design drawings do not indicate the intended outdoor air percentage for the AHU's, only the heating and cooling capacities and total airflow. Based on the design heating and cooling capacities of the equipment, we verified that the recommended outdoor air percentage would allow a supply air temperature of 90-95°F in heating and 56-58°F (cooling) to be maintained, assuming the coils are operating at full capacity and performance hasn't degraded over time.

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 | 3,750 | Unknown | 700 | 1,200 |
| AHU-2 | 4,300 | Unknown | 700 | 1,200 |
| AHU-3 | 5,000 | Unknown | 860 | 900 |
| AHU-4 | 4,000 | Unknown | 1100 | 1,200 |
| AHU-5 | 3,000 | 0* | 0* | 0* |
| AHU-LL | 700 (est.) | Unknown | 150 | 150 |

*Courtrooms served by AHU-5 receive outdoor air from the in the UV's in the space

For AHU's 1,2, and 4 we are recommending outdoor airflow rates above the code minimum ventilation rate to provide adequate makeup air for the toilet exhausts and to maintain appropriate levels of space pressurization. Because there is some uncertainty in estimating the outdoor air capacity of the equipment and given the age of the coils, we recommend that facilities staff monitor supply air temps during periods of high heating and cooling demand to confirm that the recommended O.A. airflows do not result in loss of temperature control.

The original outdoor air ventilation rates for the unit ventilators are relatively high compared to the current code requirements. We recommend testing and balancing the outdoor air flow rates for all unit ventilators to the recommended minimum O.A. rates listed in Table 3.

The discrepancies in the calculated ventilation rates for the UV's are likely due to variations in assumptions in the expected occupant concentration, airflow per person, and calculation methodology. We recommend maintaining the UV outdoor airflows at the original designed values, as these exceed the code minimums calculated by Tighe & Bond and will likely result in improved indoor air quality (IAQ).

**TABLE 3**
Recommended Unit Ventilator 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) |
|---|---|---|---|---|
| **1st Level** | | | | |
| Judge's Chamber 117 | 200 | 50 | 12 | 50 |
| Juvenile Court Room 116 | 1,160 | 500 | 304 | 500 |
| Police Room 116 | 400 | 100 | 30 | 100 |
| **2nd Level** | | | | |
| Jury Pool 202* | 400 | 100 | 92 | 100 |
| **3rd Level** | | | | |
| Judge's Chamber 323 | 2,000 | 500 | 56 | 500 |
| Officer Room 316 | 600 | 300 | 81 | 300 |
| Secretary 317 | 400 | 100 | 23 | 100 |
| Main Lobby 354 | 9,600 | 2,400 | 215 | 2,400 |
| Assistant Clerk 312 | 400 | 100 | 15 | 100 |
| Clerk of Courts | 1,200 | 300 | 17 | 300 |
| Assistant Clerk 310 | 800 | 150 | 15 | 150 |
| Waiting 301 | 760 | 200 | 40 | 200 |
| Clerk of Courts Open Office 302 | 2,760 | 700 | 117 | 700 |
| Courtroom 1 | 8,400 | 4,200 | 1,013 | 4,200 |
| Conference 314 | 400 | 100 | 62 | 100 |

**TABLE 3**
Recommended Unit Ventilator O.A. Flow Rates

| | | | | |
|---|---|---|---|---|
| **4th Level** | | | | |
| Courtroom 2* | 2,000 | 1,000 | 381 | 1,000 |
| Jury Room 410 | 1,200 | 600 | 92 | 600 |
| Courtroom 3* | 2,000 | 1,000 | 386 | 1,000 |
| Jury Room 412 | 1,200 | 600 | 67 | 600 |
| Judge's Chamber 404 | 760 | 150 | 25 | 150 |
| Judge's Chamber 417 | 760 | 150 | 26 | 150 |
| Probation General Office 419/433 | 3,160 | 800 | 130 | 800 |
| Probation Office 432 | 400 | 100 | 12 | 100 |
| Probation Office 431 | 200 | 50 | 12 | 50 |
| Probation 430 | 400 | 100 | 12 | 100 |
| Assistant Probation Officer 429 | 400 | 100 | 12 | 100 |
| Chief Probation Officer 429 | 760 | 150 | 25 | 150 |
| Probation Office 425 | 400 | 100 | 41 | 100 |
| Probation Office 424 | 400 | 100 | 25 | 100 |

*These areas also receive some additional ventilation from AHU's.
The UV's are assumed to be the primary source of outdoor air in these areas.

The average airflow rate per person is shown below in Table 4. These values are based on the original design supply airflow rate and the recommended outdoor air flow rates shown in Table 2 and 3 above. 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) | 592 | 312 | 280 |
| Total Supply Air (CFM/Person) | 110 | 48 | 170 |
| Outdoor Air (CFM/Person) | 34 | 22 | 46 |

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 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 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 Pool Room | 15 | 700 | 47 | 154 | 10 |
| Civil Courtroom | 125 | 1,340 | 11 | 400 | 3 |
| Juvenile Courtroom | 52 | 1,160 | 22 | 500 | 10 |
| Courtroom 1 | 173 | 8,400 | 49 | 4,200 | 24 |
| Courtroom 2 | 65 | 3,500 | 54 | 1,000 | 15 |
| Courtroom 3 | 66 | 3,500 | 53 | 1,000 | 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 5a. The airflow rate per person assumes the full supply airflow is being delivered to the room.

**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 Pool Room | 12 | 700 | 58 | 154 | 13 |
| Civil Courtroom | 6 | 1,340 | 223 | 400 | 67 |
| Juvenile Courtroom | 9 | 1,160 | 129 | 500 | 56 |
| Courtroom 1 | 33 | 8,400 | 255 | 4,200 | 127 |
| Courtroom 2 | 13 | 3,500 | 269 | 1,000 | 77 |
| Courtroom 3 | 13 | 3,500 | 269 | 1,000 | 77 |

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

We recommend increasing the outdoor air flow rate in AHU's only beyond the recommended outdoor air flow rates in a stepped approach by up to 30% 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.

We do not recommend increasing the outside air flow rate in areas served by UV's. The outside air flow rate is already significantly above code minimum, and the current dampers and controls do not have the ability to modulate outdoor air.

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.*

<u>New office areas in lower mechanical room space</u>
If test and balance reports are not available for these areas, we recommend rebalancing the airflows for these areas. If design documents showing the required airflows are not available, the required airflows should be established by an engineer and rebalanced to provide the code required ventilation rates for each space.

<u>County use and District Attorney areas</u>
Our analysis is based on the airflows from the original design documents. If the registers have not been rebalanced as part of the renovations in this area, the civil courtroom is under ventilated. Room 208 currently does not have any ventilation. Rebalancing by slightly reducing the office airflow, increasing the courtroom airflow, and adding a branch to serve room 208 is recommended. If design documents showing revised airflows from the renovations are not available, the required airflows should be established by an engineer and rebalanced to provide the code required ventilation rates for each space.

<u>Whole building or spaces with airflow/temperature issues</u>
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 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 and can accommodate the outdoor air volumes recommended in RTB-1. 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*.

Repair or 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.

Repair or replace valves and actuators that are not functioning properly.

## 2.4 Control System Recommendations

We recommend the following for the control system:

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

**RC-3:** *Install controls required to introduce outside air beyond the minimum requirement in a stepped approach.*

**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 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 Repair Unit Ventilators

Repair unit ventilators that are not operational. Replace actuators in units where the actuators have failed open. Once repairs are made, reestablish the control sequence to allow the fans to operate continuously during occupied periods.

### 2.7.2 Replace Toilet Exhaust Fans

We recommend replacing any failed toilet exhaust fans. At the time of the visit, the toilet exhaust fan EF-11 was not functioning.

### 2.7.3 Replace Air Handling Units #1-4

These air handlers appear to be original to the building. While the dampers and controls have been upgraded, the enclosures, coils, and fans have not. Consider replacing these units in the next 5 years.

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

### 2.7.4 Add Demand-Controlled Ventilation to Select Unit Ventilators

After the COVID-19 emergency has passed, consider adding demand-controlled ventilation (DCV) to unit ventilators serving courtrooms, conference rooms, and open offices. The outdoor airflow rates are relatively high and the use of DCV can reduce operating costs while maintaining comfort and providing the higher outdoor airflow rates when required. This measure will require the installation of CO2 sensors in the spaces and new modulating damper actuators and controls in the UV's. The exhaust fans serving these areas will also require added speed or sequencing controls to manage the building pressure with varying outdoor air.

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

# Section 3
# Testing & Balancing Results

Wing's Testing & Balancing C., Inc. visited the Barnstable District Courthouse on January 22, 2021 to test the airflow rates of the air handling units, unit ventilators, and exhaust fans. A summary of the tested airflow rates versus the design airflow rates are shown below in Tables 6, 7, and 8. The full testing and balancing report is attached.

**TABLE 6**
Air Handler Testing & Balancing Results

| | Design | | | Actual | | |
|---|---|---|---|---|---|---|
| Unit | Total Supply Fan Airflow (CFM) | Recommended Outdoor Airflow (CFM) | Return Airflow (CFM) | Supply Fan Airflow (CFM) | Outdoor Airflow (CFM) | Return Airflow (CFM) |
| AHU-1 | 3,750 | 1,200 | 2,550 | 2,193 | 689 | 1,504 |
| AHU-2 | 4,300 | 1,200 | 3,100 | 4,441 | 1,216 | 3,225 |
| AHU-3 | 5,000 | 900 | 4,100 | 4,492 | 320 | 4,172 |
| AHU-4 | 4,000 | 1,200 | 2,800 | 3,923 | 1,165 | 2,758 |
| AHU-5 | 3,000 | 0 | 3,000 | 2,179 | 0 | 2,179 |
| AHU-LL | 700 (est.) | 150 | 550 | - | - | - |

**TABLE 7**
Unit Ventilator Testing & Balancing Results

| | Design | | | Actual | | |
|---|---|---|---|---|---|---|
| Unit | Total Supply Fan Airflow (CFM) | Recommended Outdoor Airflow (CFM) | Return Airflow (CFM) | Supply Fan Airflow (CFM) | Outdoor Airflow (CFM) | Return Airflow (CFM) |
| FCU-1 | 200 | 50 | 150 | 200 | 0 | NT |
| FCU-3 | 760 | 300 | 460 | 569 | 63 | 506 |
| FCU-5 | 400 | 100 | 300 | 470 | 38 | 432 |
| FCU-23 | 760 | 150 | 610 | 566 | 229 | 337 |
| FCU-32 | 1,000 | 500 | 500 | 452 | 48 | 404 |
| FCU-39 | 1,200 | 300 | 900 | 907 | 121 | 786 |
| FCU-46 | 1,250 | 600 | 600 | 1,045 | 381 | 664 |
| FCU-48 | 1,000 | 250 | 250 | 0 | 0 | 0 |

NT: Not Tested

**TABLE 8**
Exhaust Fan Testing & Balancing Results

| Unit | Serving | Design Return/Exhaust Airflow (CFM) | Actual Return/Exhaust Airflow (CFM) |
|---|---|---|---|
| EF-3 | Main Courtroom, | 4,310 | 2,901 |
| EF-5 | Restrooms and Holding | 1,830 | 1,850 |

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

1. Air Handling Equipment:
    a. AHU-1 is operating well below the design airflow range. The unit is operating at about 60% of design capacity and the motor sheave is seized and could not be fully closed to adjust the fan speed. Based on the motor current measurements at 60% airflow, acceptable airflow cannot be attained with the existing two horsepower motor. We recommend additional investigations into the cause of the low airflow.
    b. The AHU-3 outdoor air actuator is not working. The outdoor air flowrate is 30% of design capacity. The actuator should be replaced or repaired to allow the correct outdoor airflow. The total airflow is 90% of design, at the lower limit of acceptable airflow. Based on the motor current measurements at 90% airflow, it is likely that airflow could be improved by changing the pulleys.
    c. AHU-5 is operating at 73% of design capacity. Based on the motor current measurements at 73% airflow, acceptable airflow cannot be attained with the existing two horsepower motor. We recommend additional investigations into the cause of the low airflow.
    d. AHU-LL was not operational at the time of balancing and could not be tested. The power may not be connected at the breaker panel.
2. Unit Ventilators:
    a. The unit ventilator outdoor air dampers positions are a fixed control point and could not be adjusted by the maintenance staff during balancing.
    b. FCU-48 was not operational at the time of balancing and could not be tested.
    c. The supply airflows for the unit ventilators that were tested were inconsistent and varied from 50-125% of the design airflow. Most units were below the design airflow.
    d. The outdoor airflows for the unit ventilators that were tested were inconsistent, and generally well below the design airflow.

   e. Based on the inconsistent results, we recommend the coils be cleaned, actuators repaired and adjusted, motors replaced, and any other operational issues fixed prior to retesting.
3. Filtration:
   a. AHU's 1-5: Based on the relatively low static pressure drop over the filters relative to the total static pressure of the supply fans, it appears that the use of MERV-13 filters would not substantially affect the supply airflow. In AHU's 1, 3, and 5, issues causing low airflow should be resolved before upgrading the filters.
   b. AHU-LL: This unit was not operational at the time of the test. We cannot make any recommendations regarding the ability of the unit to accommodate MERV 13 filters at this time.
   c. Unit Ventilators: Differential pressures across the filters were not recorded during testing. The supply and outdoor airflows were very inconsistent across the units tested. Additional data after adjustments are made to improve the airflows is required before making any recommendations regarding the ability of the unit ventilators to accommodate MERV 13 filters.
4. Exhaust Fans:
   a. EF-3 is operating at 68% of design capacity.
   b. The motor for EF-7 has failed. The motor or entire fan should be replaced as necessary.

# 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.

J:\M\M1671 Comm. of MA Court System\011 - COVID-19 Courthouse Evaluations\Report_Evaluation\Draft Reports\Barnstable District\Barnstable District - Draft.docx

WING'S TESTING & BALANCING CO., INC.

# Barnstable District Courthouse
# HVAC/Ventilation Survey

* * * *

Tighe & Bond
Attn: Jason Urso
53 Southampton Road
Westfield, MA 01085

January 22, 2021

94 North Branford Road • Suite One • Branford, CT 06405
(203) 481-4988 • Fax (203) 488-5634 • wings@wingstesting.com
SM-1 License #6803
www.wingstesting.com

WING'S TESTING & BALANCING CO., INC.

January 22, 2021

Tighe & Bond
Attn: Jason Urso
53 Southampton Road
Westfield, MA 01085

Re: Barnstable District Courthouse/HVAC Ventilation Survey

Dear Jason,

We have completed our survey for the above referenced project. Through our testing we found that the motor sheave on AHU-1 is seized and unable to be fully closed. On all AHU's the outside air louvers are partially clogged.

- The outside air actuator for AHU-3 is not functional.
- The outside air dampers on the FCU's are a fixed point and are not able to be controlled by the maintenance crew.
- There was no access to the duct work for Exhaust Fans 2 and 12 to get totals on.
- EF-7 has a burned out motor.
- FCU-48 is not operational.
- AHU-LL is not operational.
    - This unit looks like it was wired to a breaker panel, but breakers were never installed for it. An electrician should investigate this.

This report includes Brake Horsepower (BHP) calculations. When a motor has a VFD, we take the amperage measurements from there. When we calculate from volts and amps, it means there has to be a nameplate on the motor. Many times, these are missing or illegible. If BHP is not listed for an individual motor, this is because we do not have enough information to calculate it. It should be noted that that the older a motor is, the less likely it is to follow the affinity laws for BHP- since the efficiency degrades over time. We have used accepted constants for efficiency and the power factor, which should result in fairly close calculations, but are not as accurate for older motors.

Barnstable District Court
January 22, 2021

The following pages are your record of current operating conditions. If you have any questions, or if we can be of further service, please do not hesitate to call.

Very truly yours,
**Wing's Testing & Balancing Co., Inc.**
*ICB Certified Contractor for:*
TABB—Commissioning—Fire/Life Safety L1&L2—Sound & Vibration

**Barry Stratos**
Certified TABB Technician BB996928T


# SUPPLY FAN REPORT

| | |
|---|---|
| **PROJECT:** Barnstable District Courthouse | **DATE:** 1/11/21 |
| **AREA SERVED:** Various | **TECH:** BS |

| **FAN DATA** | | | | | | |
|---|---|---|---|---|---|---|
| FAN NUMBER | AHU-1 | | AHU-2 | | AHU-3 | |
| LOCATION | Basement | | Vault | | Law Library | |
| AREA SERVED | --- | | --- | | --- | |
| MANUFACTURER | Trane | | Trane | | Trane | |
| MODEL OR SIZE | L-8 | | L-10 | | L-12 | |
| | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** |
| TOTAL CFM | 3750 | 2193 | 4300 | 4441 | 5000 | 4492 |
| RETURN AIR | 2550 | 1504 | 3100 | 3225 | 4100 | 4172 |
| OUTSIDE AIR | 1200 | 689 | 1200 | 1216 | 900 | 320 (1) |
| DISCH. STATIC | --- | +0.30" | --- | +0.45" | --- | +0.46" |
| SUCTION STATIC | --- | -0.71" | --- | -0.95" | --- | -0.68" |
| TOTAL STATIC | --- | 1.01 | --- | 1.50 | --- | 1.14 |
| FAN RPM | --- | 726 | --- | 776 | --- | 708 |
| PULLEY O.D. | 9.0" x 1 3/16" | | 11.0" x 1" | | 13.0" x 7/8" | |
| ESP | 0.23 | | 0.45 | | 0.67 | |
| VFD SPEED | No VFD | | No VFD | | No VFD | |
| O.A.D. MIN POS | 40% | | 50% | | --- | |
| **MOTOR DATA** | | | | | | |
| MANUFACTURER | Emerson | | Reliance | | ODP Motors | |
| MODEL OR FR. | 145TC | | 145T | | 182T | |
| HORSEPOWER | 2.0 | 2.0 | 2.0 | 2.0 | 3 | 3 |
| MOTOR RPM | 1740 | 1740 | 1730 | 1730 | 1725 | 1725 |
| VOLTAGE / PH. | 208/3 | 208/3 | 208/3 | 208/3 | 208/3 | 208/3 |
| AMPS LEG 1 | 6.0 | 4.0 | 7.8 | 7.7 | 9.4 | 6.7 |
| AMPS LEG 2 | --- | 4.5 | --- | 7.3 | --- | 6.8 |
| AMPS LEG 3 | --- | 3.9 | --- | 7.5 | --- | 6.9 |
| SHEAVE O.D. | 4 1/2" x 7/8" | | 5 1/2" x 7/8" | | 6.0" x 1 1/8" | |
| BELTS - QTY / SIZE | 1/4L570 | | 1/Ax65 | | 1/Ax71 | |
| SHEAVE POSITION | 100% Open | | 75% Closed | | Fixed | |
| BHP | 1.4 | | 1.9 | | 2.2 | |
| FILTERS | | | | | | |

**REMARKS**

(1) The outside air actuator is not functional

NA-Not Available
ND-No Design DD-Direct Drive

# SUPPLY FAN REPORT

| | |
|---|---|
| **PROJECT:** Barnstable District Courthouse | **DATE:** 1/12/21 |
| **AREA SERVED:** Various | **TECH:** BS |

| FAN DATA | | | | | | |
|---|---|---|---|---|---|---|
| FAN NUMBER | AHU-4 | | AHU-5 | | AHU-LL | |
| LOCATION | 2nd Fl Mech Rm | | 4th Fl Mech Rm | | Boiler Room | |
| AREA SERVED | --- | | --- | | Basement Offices | |
| MANUFACTURER | Trane | | Trane | | First Co. | |
| MODEL OR SIZE | L-10 | | LPCAF06D1D | | 8MB-3HH | |
| | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** |
| TOTAL CFM | 4000 | 3923 | 3000 | 2179 | 700 | (1) |
| RETURN AIR | 2800 | --- | 3000 | 2179 | 550 | --- |
| OUTSIDE AIR | 1200 | 1165 | 0 | 0 | 150 | --- |
| DISCH. STATIC | --- | +0.45" | --- | +0.19" | --- | --- |
| SUCTION STATIC | --- | -0.64" | --- | -0.81" | --- | --- |
| TOTAL STATIC | --- | 1.09 | --- | 1.00 | --- | --- |
| FAN RPM | --- | 741 | --- | 803 | --- | --- |
| PULLEY O.D. | 12.0" x 7/8" | | 8.0" x 3/4" | | DD | |
| ESP | 0.58 | | 0.65 | | --- | |
| VFD SPEED | No VFD | | No VFD | | No VFD | |
| O.A.D. MIN POS | 45% | | NA | | NA | |
| **MOTOR DATA** | | | | | | |
| MANUFACTURER | Dayton | | Baldor | | NA | |
| MODEL OR FR. | 145T | | 145T | | NA | |
| HORSEPOWER | 2 | 2 | 2 | 2 | 1/5 | 1/5 |
| MOTOR RPM | 1740 | 1740 | 1725 | 1725 | 1075 | 1075 |
| VOLTAGE / PH. | 208/3 | 208/3 | 208/3 | 208/3 | 120/1 | 120/1 |
| AMPS LEG 1 | 6.14 | 4.4 | 5.0 | 3.2 | 5.1 | --- |
| AMPS LEG 2 | --- | 4.4 | --- | 3.2 | --- | --- |
| AMPS LEG 3 | --- | 4.4 | --- | 3.2 | --- | --- |
| SHEAVE O.D. | 5 1/2" x 7/8" | | 3 3/4" x 5/8" | | DD | |
| BELTS - QTY / SIZE | 1/Ax66 | | 1/Ax46 | | DD | |
| SHEAVE POSITION | 100% Closed | | 100% Closed | | DD | |
| BHP | 1.43 | | 1.28 | | --- | |
| FILTERS | | | | | | |

**REMARKS**

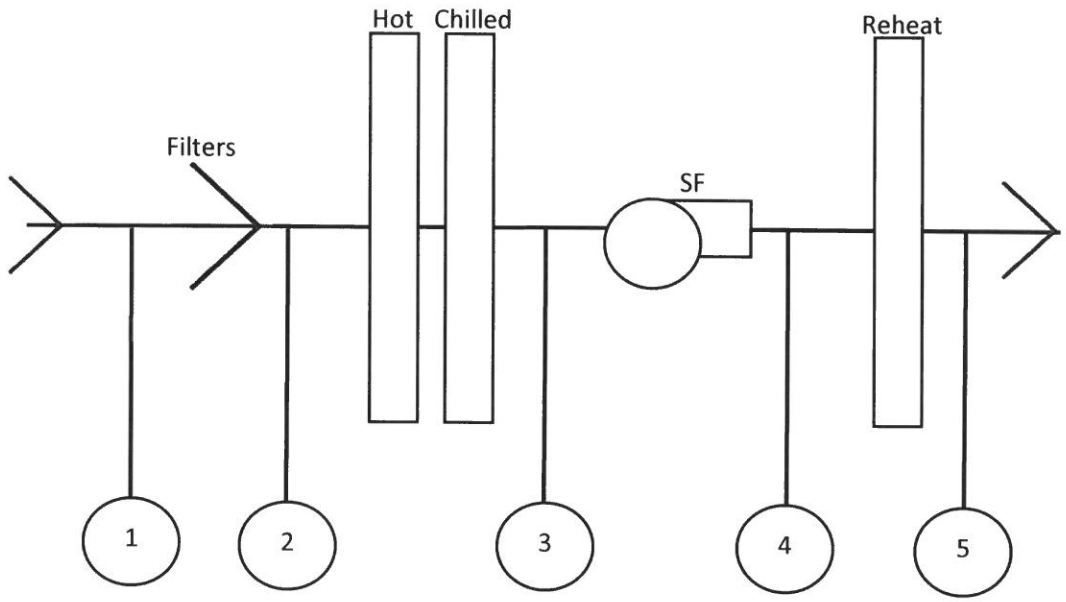
(1) Unit does not operate. Not wired into the breaker panel.

NA-Not Available
ND-No Design DD-Direct Drive

# SYSTEM STATIC PRESSURE PROFILE

**PROJECT:** Barnstable District Courthouse | **DATE:** 1/12/21

**SYSTEM/AREA SERV:** Various | **TECH:** BS




**STATIC PRESSURE READINGS "wc**

| POS. (+ ) / NEG.(-) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | NOTES |
|---|---|---|---|---|---|---|---|---|
| AHU-1 | -0.11" | -0.17" | -0.71" | +0.30" | +0.12" | | | |
| AHU-2 | -0.17" | -0.26" | -0.95" | +0.45" | +0.28" | | | |
| AHU-3 | -0.35" | -0.45" | -0.68" | +0.46" | +0.32" | | | |
| AHU-4 | -0.29" | -0.38" | -0.64" | +0.45" | +0.29" | | | |
| AHU-5 | -0.46" | -0.55" | -0.81" | +0.19" | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**REMARKS**

# SUPPLY FAN REPORT

| | |
|---|---|
| **PROJECT:** Barnstable District Courthouse | **DATE:** 1/12/21 |
| **AREA SERVED:** Various | **TECH:** BS |

| **FAN DATA** | | | | | | |
|---|---|---|---|---|---|---|
| FAN NUMBER | FCU-1 | | FCH-3 | | FCU-5 | |
| LOCATION | Judges Chamber | | Juvenile Court | | 2nd Fl Jury | |
| AREA SERVED | Judges Chamber | | Juvenile Court | | 2nd Fl Jury | |
| MANUFACTURER | Trane | | Trane | | Trane | |
| MODEL OR SIZE | FCBB02 | | VUV-750 | | FCBB04 | |
| | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** |
| TOTAL CFM | 200 | 200 | 760 | 569 | 400 | 470 |
| RETURN AIR | 150 | --- | 460 | 506 | 300 | 432 |
| OUTSIDE AIR | 50 | (1,2) | 300 | 63 (2) | 100 | 38 (2) |
| DISCH. STATIC | --- | --- | --- | --- | --- | --- |
| SUCTION STATIC | --- | --- | --- | --- | --- | --- |
| TOTAL STATIC | --- | --- | --- | --- | --- | --- |
| FAN RPM | --- | --- | --- | --- | --- | --- |
| PULLEY O.D. | DD | | DD | | DD | |
| ESP | --- | | --- | | --- | |
| VFD SPEED | No VFD | | No VFD | | No VFD | |
| O.A.D. MIN POS | NA | | NA | | NA | |
| **MOTOR DATA** | | | | | | |
| MANUFACTURER | AO Smith | | AO Smith | | AO Smith | |
| MODEL OR FR. | NA | | NA | | NA | |
| HORSEPOWER | 1/30 | 1/30 | 0.17 | 0.17 | 0.12 | 0.12 |
| MOTOR RPM | 980 | 980 | 1075 | 1075 | 925 | 925 |
| VOLTAGE / PH. | 120/1 | 120/1 | 120/1 | 120/1 | 120/1 | 120/1 |
| AMPS LEG 1 | 0.6 | 0.5 | 2.2 | --- | 1.4 | 1.2 |
| AMPS LEG 2 | --- | --- | --- | 1.6 | --- | --- |
| AMPS LEG 3 | --- | --- | --- | --- | --- | --- |
| SHEAVE O.D. | DD | | DD | | DD | |
| BELTS - QTY / SIZE | DD | | DD | | DD | |
| SHEAVE POSITION | DD | | DD | | DD | |
| BHP | | | | | --- | |
| FILTERS | | | | | | |

**REMARKS**

(1) Outside air damper not functional
(2) Outside air dampers not able to be controlled
NA-Not Available
ND-No Design DD-Direct Drive

# SUPPLY FAN REPORT

| | |
|---|---|
| **PROJECT:** Barnstable District Courthouse | **DATE:** 1/12/21 |
| **AREA SERVED:** Various | **TECH:** BS |

| **FAN DATA** | | | | | | |
|---|---|---|---|---|---|---|
| FAN NUMBER | FCU-23 | | FCU-32 | | FCU-39 | |
| LOCATION | 4th Fl Judge | | 3rd Session Court | | Entry/Lobby | |
| AREA SERVED | 4th Fl Judge | | 3rd Session Court | | Entry/Lobby | |
| MANUFACTURER | Trane | | Trane | | Trane | |
| MODEL OR SIZE | VUV-750 | | VUV-1000 | | VUV-1250 | |
| | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** |
| TOTAL CFM | 760 | 566 | 1000 | 452 | 1200 | 907 |
| RETURN AIR | 610 | 337 | 500 | 404 | 900 | 786 |
| OUTSIDE AIR | 150 | 229 (1) | 500 | 48 (1) | 300 | 121 |
| DISCH. STATIC | --- | --- | --- | --- | --- | --- |
| SUCTION STATIC | --- | --- | --- | --- | --- | --- |
| TOTAL STATIC | --- | --- | --- | --- | --- | --- |
| FAN RPM | --- | --- | --- | --- | --- | --- |
| PULLEY O.D. | DD | | DD | | DD | |
| ESP | --- | | --- | | --- | |
| VFD SPEED | No VFD | | No VFD | | No VFD | |
| O.A.D. MIN POS | NA | | NA | | NA | |
| **MOTOR DATA** | | | | | | |
| MANUFACTURER | AO Smith | | AO Smith | | AO Smith | |
| MODEL OR FR. | NA | | NA | | NA | |
| HORSEPOWER | 0.17 | 0.17 | 0.17 | 0.17 | 1/4 | 1/4 |
| MOTOR RPM | 1075 | 1075 | 1075 | 1075 | 1075 | 1075 |
| VOLTAGE / PH. | 120/1 | 120/1 | 120/1 | 120/1 | 120/1 | 120/1 |
| AMPS LEG 1 | 2.2 | --- | 2.2 | 1.4 | 2.8 | --- |
| AMPS LEG 2 | --- | 1.6 | --- | --- | --- | 2.2 |
| AMPS LEG 3 | --- | --- | --- | --- | --- | --- |
| SHEAVE O.D. | DD | | DD | | DD | |
| BELTS - QTY / SIZE | DD | | DD | | DD | |
| SHEAVE POSITION | DD | | DD | | DD | |
| BHP | | | | | | |
| FILTERS | | | | | | |

**REMARKS**

(1) Outside air dampers not able to be controlled

NA-Not Available
ND-No Design DD-Direct Drive

# SUPPLY FAN REPORT

| | | | | | | |
|---|---|---|---|---|---|---|
| **PROJECT:** Barnstable District Courthouse | | | | **DATE:** 1/12/21 | | |
| **AREA SERVED:** Various | | | | **TECH:** BS | | |
| **FAN DATA** | | | | | | |
| FAN NUMBER | FCU-46 | | FCU-48 | | | |
| LOCATION | Main Court | | 1st Session Judge | | | |
| AREA SERVED | Main Court | | 1st Session Judge | | | |
| MANUFACTURER | Trane | | Trane | | | |
| MODEL OR SIZE | VUV-1250 | | VUV-1000 | | | |
| | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** |
| TOTAL CFM | 1250 | 1045 | 1000 | (1) | | |
| RETURN AIR | 650 | 664 | 750 | --- | | |
| OUTSIDE AIR | 600 | 381 (2) | 250 | (2) | | |
| DISCH. STATIC | --- | --- | --- | --- | | |
| SUCTION STATIC | --- | --- | --- | --- | --- | |
| TOTAL STATIC | --- | --- | --- | --- | --- | |
| FAN RPM | --- | --- | --- | --- | | |
| PULLEY O.D. | DD | | DD | | | |
| ESP | --- | | --- | | | |
| VFD SPEED | No VFD | | No VFD | | | |
| O.A.D. MIN POS | NA | | NA | | | |
| **MOTOR DATA** | | | | | | |
| MANUFACTURER | AO Smith | | AO Smith | | | |
| MODEL OR FR. | NA | | NA | | | |
| HORSEPOWER | 1/4 | 1/4 | 1/4 | 1/4 | | |
| MOTOR RPM | 1075 | 1075 | 1075 | 1075 | | |
| VOLTAGE / PH. | 120/1 | 120/1 | 120/1 | 120/1 | | |
| AMPS LEG 1 | 2.8 | 2.2 | --- | --- | | |
| AMPS LEG 2 | --- | --- | --- | --- | --- | |
| AMPS LEG 3 | --- | --- | --- | --- | --- | |
| SHEAVE O.D. | DD | | DD | | | |
| BELTS - QTY / SIZE | DD | | DD | | | |
| SHEAVE POSITION | DD | | DD | | | |
| BHP | | | | | | |
| FILTERS | | | | | | |

**REMARKS**

(1) Unit not operational
(2) Outside air dampers not able to be controlled
NA-Not Available
ND-No Design DD-Direct Drive

# VELOCITY PRESSURE READINGS

**PROJECT:** Barnstable District Courthouse | **DATE:** 1/12/21

**AREA SERVED:** Various | **TECH:** BS

| TRAVERSE LOCATIONS | DUCT SIZE " | AREA SQ.FT. | DESIGN | | CENTERLINE STATIC PRES." | TEST | | NOTES |
|---|---|---|---|---|---|---|---|---|
| | | | FPM | CFM | | FPM | CFM | |
| | | | | | | | | |
| **AHU-1** | | | | | | | | |
| Supply | 46" x 12" | 3.83 | 979 | 3750 | +0.10 | 572 | 2193 | |
| OA | 49" x 25" | 8.51 | 141 | 1200 | w/velgrid | 81 | 689 | |
| | | | | | | | | |
| **AHU-2** | | | | | | | | |
| Supply | 55" x 12" | 4.58 | 939 | 4300 | +0.27 | 969 | 4441 | |
| OA | 44" x 23" | 7.03 | 171 | 1200 | w/velgrid | 173 | 1216 | |
| | | | | | | | | |
| **AHU-3** | | | | | | | | |
| Supply | 48" x 12" | 4.0 | 1250 | 5000 | +0.32 | 1123 | 4492 | |
| OA | 57" x 24 1/2" | 9.7 | 93 | 900 | w/velgrid | 33 | 320 | |
| | | | | | | | | |
| **AHU-4** | | | | | | | | |
| Supply | 12" x 52" | 4.33 | 924 | 4000 | +0.29 | 906 | 3923 | |
| OA | 43" x 25" | 7.47 | 161 | 1200 | w/velgrid | 156 | 1165 | |
| | | | | | | | | |
| **AHU-5** | | | | | | | | |
| Total | 14" x 14" | 1.36 | 2206 | 3000 | +0.17 | 1601 | 2179 | |
| | | | | | | | | |
| **EF-3** | | | | | | | | |
| Total | 64" x 12" | 5.33 | 809 | 4310 | -0.54 | 544 | 2901 | |
| | | | | | | | | |
| **EF-5** | | | | | | | | |
| Supply | 20" x 70" | 2.78 | 658 | 1830 | -0.42 | 666 | 1850 | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**REMARKS**

# EXHAUST FAN REPORT

**PROJECT:** Barnstable District Courthouse | **DATE:** 1/21/21

**AREA SERVED:** Various | **TECH:** BS

| FAN DATA | | | | | | |
|---|---|---|---|---|---|---|
| FAN NUMBER | | EF-3 | EF-5 | | | |
| LOCATION | | Attic | Roof | | | |
| AREA SERVED | | Main Courtroom | Rest Rm &Det | | | |
| MANUFACTURER | | Penn Ventilator | Greenheck | | | |
| MODEL OR SIZE | | NA | GB-161 | | | |
| TOTAL CFM | DESIGN | 4310 | 1830 | | | |
| | ACTUAL | 2901 | 1850 | | | |
| FAN RPM | DESIGN | 1725 | 1725 | | | |
| | ACTUAL | NA | 5 1/2" x 3/4" | | | |
| PULLEY | O.D. | 1.15 | 1.15 | | | |
| SERVICE | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **MOTOR DATA** | | | | | | |
| MANUFACTURER | | Marathon | Fasco | | | |
| MODEL NUMBER | | 56 | --- | | | |
| MOTOR HP | DESIGN | 1 | 1/4 | | | |
| | ACTUAL | 1 | 1/4 | | | |
| MOTOR RPM | | 1725 | 1725 | | | |
| VOLTAGE/PHASE | | 208/3 | 115/1 | | | |
| MOTOR AMPS | DESIGN | 3.4 | 4.1 | | | |
| | ACT. LEG 1 | 2.4 | --- | | | |
| | ACT. LEG 2 | 2.4 | --- | | | |
| | ACT. LEG 3 | 2.4 | 3.8 | | | |
| SHEAVE | | 3 3/4" x 5/8" | --- | | | |
| BELTS-QTY/SIZE | | NA | 2 3/4" x 5/8" | | | |
| SHEAVE POSITION | | 75% Closed | --- | | | |
| BHP | | | | | | |
| | | | | | | |
| | | | | | | |

**REMARKS**