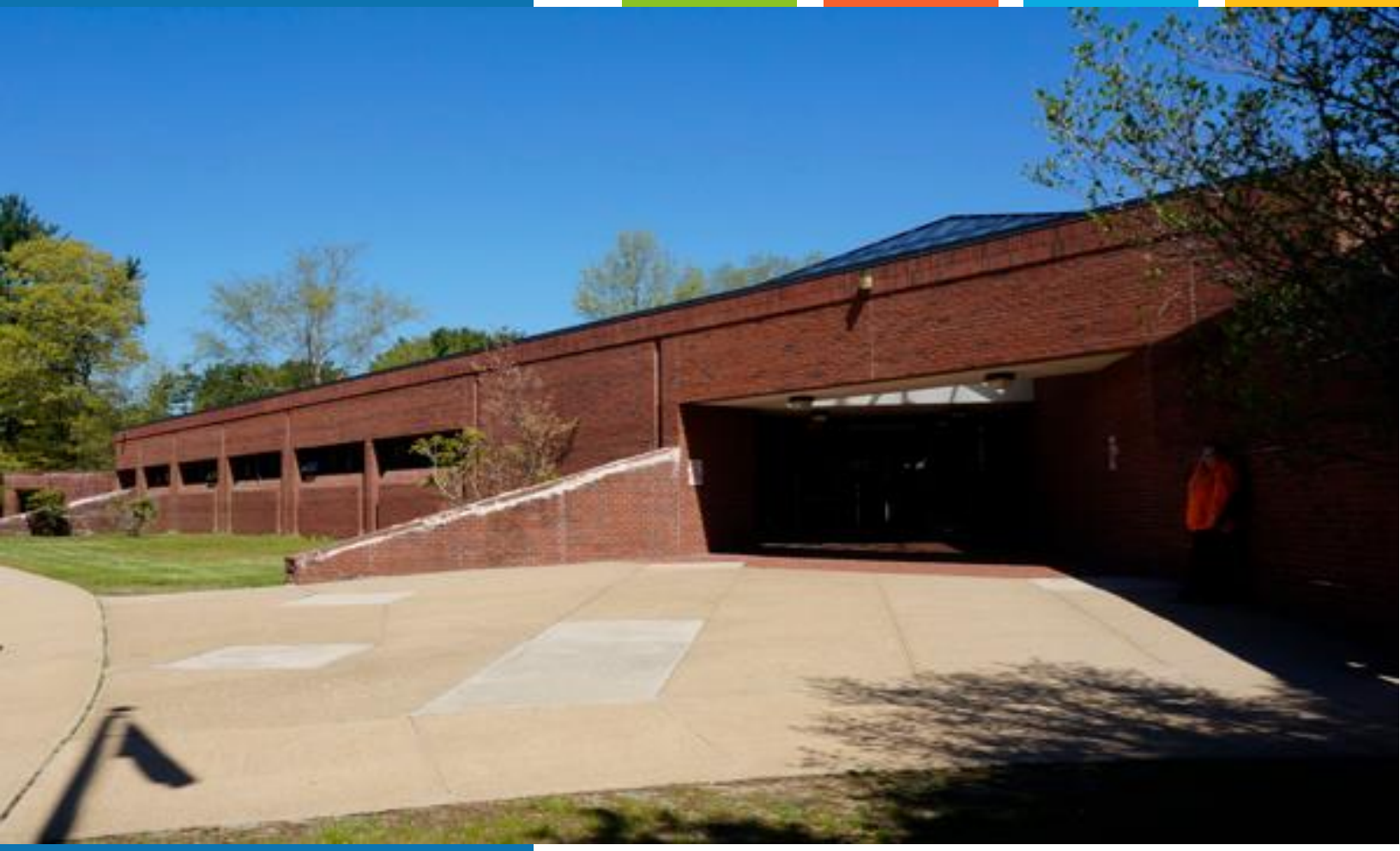

Wareham District Court
Wareham, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

June 14, 2022

Tighe&Bond

100% Recyclable

Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Wareham District Courthouse on May 6th, 2021. While on site we inspected the air handling equipment located in the mechanical rooms and toured the facility to determine if the spaces generally matched usages noted on the architectural plans. Tighe & Bond was provided with mechanical design plans from 1975 and a study of the building and site existing conditions from May 2020 by Kleinfelder. Our analysis is based on these drawings, the report, and our one day on site.

Site Visit Attendees:

- *Plymouth County:*
  - Mike Wholey - Courthouse Facilities Staff
  - Ken Stone – Diamond Mechanical (HVAC contractor)
- *Tighe & Bond*
  - Sean Pringle, PE, Project Mechanical Engineer
  - Matt Mancini, Staff Mechanical Engineer

1.1 Existing Ventilation System

The Wareham District Courthouse was constructed in 1975 and is approximately 25,000 square feet in size. Seven constant volume air handling units (AHU) provide ventilation air to the building.

All AHU's appeared to be from the original construction in 1975 and are in overall poor condition. The filters were very dirty and were bending in several units. Most of the heating and cooling coils were dirty, and several condensate trays had severe buildup. The chilled water control valves and associated piping at each unit are not insulated and the pipes were sweating and corroded. The hot water control valves are generally in fair condition. The internal fiberglass lining in most of the units is torn and falling apart. AH-2 and AH-4 have very loose and corroded covers resulting in significant air leakage. AH-4 also showed evidence of a coil repair in the middle of the coil. The freeze stat in AH-1 appears to have been recently replaced, but the unit appears to be an automatic reset type (instead of manual reset), and the sensing element was left coiled up (rather than being spread across the airstream).

Air handling units AH-1,2,3,4, and 6 each contain a mixing box, 2" MERV 13 filters, chilled water cooling coils, hot water heating coils, and a supply air fan. Each unit also has a remote return air fan and one or more duct mounted hot water reheat coils downstream of the supply fan for individual zone temperature control.

Air handling unit AH-5 is a 100% outdoor air unit, which provides ventilation air to the perimeter offices on the first floor. These areas are heated and cooled via floor-mounted fan coils, which do not provide any outdoor air. This unit contains 2" MERV 13 filters, a chilled water cooling coil, a hot water heating coil, a supply air fan, and a 2" MERV 13 filter. The freeze stat on this unit was set very low (0°F), likely to avoid nuisance trips. This is far too low to provide any freeze protection.

Air handling unit AH-7 serves the lockup areas and contains a mixing box, 2" MERV 13 filters, a hot water heating coil, and a supply air fan. It also has a remote return air fan. AH-7 does not have a cooling coil.

The toilet exhaust ducts from the cells are connected to the return air fan for this unit. Note that while this design approach may have been acceptable or approved at the time of the original installation, this approach does not comply with current code. Exhaust from cells or toilet rooms is not permitted to be recirculated, whether the space is occupied or not.

It appears that AH-7 is designed to operate at 100% outdoor air during occupied periods, and 0% outdoor air (100% return air) during unoccupied periods, as there is no auxiliary heating in the lockup area. This approach is concerning, as any misalignment in the dampers or misunderstanding of the intended operation would result in toilet exhaust air being recirculated. This has already occurred, as staff indicated that they operate this unit at 0% outdoor air 24 hours a day during the summer months to avoid pressurization and condensation issues between the lockup areas and the remainder of building. We found that the toilet exhaust ducts had been capped in four out of the six cells, apparently as part of a recent plumbing upgrade (the ducts were in conflict with the new piping). Staff indicated that at 100% outdoor air, the excess supply of warm, humid air from the lockup area flows into areas of the building with air conditioning, causing moisture to condense on the walls and floors. This is likely a direct result of the reduced return/exhaust airflow.

Linked return and outdoor air dampers control the fresh air to each unit. Each unit also has an associated exhaust air damper within the ductwork. The dampers we were able to observe appear to be functioning and are in fair condition, although most of the exhaust dampers were inaccessible during our visit due to their locations in the ductwork. The pneumatic actuators for these dampers are old and likely original, but they appear to be in fair condition.

Ultraviolet germicidal irradiation (UVGI) lamps had been recently mounted in the supply air ductwork of several units, but they were not yet wired.

We were able to observe several of the reheat coils through access doors and found that they were partially blocked with insulation fiber and paper jacketing from upstream lined ductwork and AHU liner.

The lounge and law library are each served by ceiling-mounted fan coils. Each fan coil contains filters, a chilled water cooling coil, a hot water heating coil, and a supply fan. On the return duct to each fan coil, there is a small branch duct connected to a roof gravity vent for fresh air. We were not aware of these units at the time of the visit, and as a result we have not directly observed the units. The summary above is based on staff feedback and information on the 1975 plans after the units were noticed by Tighe & Bond during a detailed review of the plans following the visit. Based on photographs provided by staff, the units are in poor condition and use 1" mesh filters. According to staff, the fans run continuously.

According to the drawings provided to Tighe & Bond, there are 13 fans tagged as "EF" serving the building. However, EF-1,2,3,4,6, and 7 are associated with air handlers and function as return fans. Fans EF-5, 5a, and 5b are general exhaust fans associated with AHU-5. The remaining four fans, EF-8 through 11, serve toilet rooms. All toilet exhaust fans were running at the time of our visit.

As noted above, the lockup area is designed to be exhausted with the return fan EF-7. However, this fan currently returns air from the holding cells back into the associated air handling unit (AH-7). Each holding area was originally designed with a supply and exhaust register. The design exhaust airflow in each cell is the same as the supply airflow, so that the cells are neutrally pressurized. As noted above, four of the six cells had blocked exhaust ducts.

A 5.6 million BTU/h hot water boiler plant provides hot water to the air handlers, perimeter radiation, perimeter and ceiling fan coils, and duct mounted reheat coils. A 70 ton, water cooled chiller located in the basement mechanical room provides chilled water to the air handlers and fan coils.

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

TABLE 1
Existing Air Handling Units

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Filters	Condition
AH-1	4,150	2,050	2" MERV 13	Poor
AH-2	3,100	1,500	2" MERV 13	Poor
AH-3	2,500	1,250	2" MERV 13	Poor
AH-4	8,450	3,700	2" MERV 13	Poor
AH-5	1,310	1,310	2" MERV 13	Poor
AH-6	3,200	800	2" MERV 13	Poor
AH-7	2,000	2,000	2" MERV 13	Poor
Fan Coil B (Lounge)	400	200	1" Mesh	Poor
Fan Coil E (Library)	675	200	1" Mesh	Poor

It appears that two private offices were recently added in the area previously identified as "Garage 105." We were not aware of that these rooms were additions at the time of the visit and did not observe the spaces at that time. However, the May 2020 existing conditions report by Kleinfelder identified these areas as not having any mechanical ventilation.

Photo 1 – Representative Air Handler

Photo 2 – Capped Exhaust Duct Serving Holding Areas

Photo 3 – Deteriorated Duct Liner and Blocked Reheat Coils.

Photo 4 – Improperly Installed Freeze Stat Element

1.2 Existing Control System

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

Section 2
Recommendations

Below is a list of recommendations for the Wareham District Courthouse. Please refer to the "Overview of Recommendations" report for further explanation and requirements of the stated recommendations.

2.1 Filtration Efficiency Recommendations

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

We recommend the following measures be implemented for the existing air handling units:

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

This applies to the AHU's only.

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

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

Alarm setpoints for each bank of filters should be reviewed, to ensure they are consistent with the filter manufacturer's recommendation.

2.2 Testing & Balancing Recommendations

The air handling units are approximately 46 years old and it is unknown to Tighe & Bond when the last time the units were tested and balanced. Also, the code requirements to determine the outdoor air flow rates that were used to design the original system may be different than the 2015 International Mechanical Code (IMC) and current ASHRAE Standard 62.1 requirements.

We recommend the following testing and balancing measures be implemented:

RTB-1: *Test and balance air handling unit supply air and minimum outdoor air flow rates.*

We recommend testing and balancing the outdoor air flow rates for all air handling units to the recommended minimum O.A. rates listed in Table 2.

TABLE 2
Recommended Air Handler O.A. Flow Rates

Unit	Original Design Supply Airflow (CFM)	Original Design Min. O.A. (CFM)	Current Code Min. O.A. Requirements (CFM)	Recommended Minimum O.A. (CFM)
AH-1	4,150	2,050	660	**2,050**
AH-2	3,100	1,500	800	**1,500**
AH-3	2,500	1,250	500	**1,250**
AH-4	8,450	3,700	460	**3,700**
AH-5	1,310	1,310	680	**1,310**
AH-6	3,200	800	280	**800**
AH-7	2,000	2,000	360	**2,000**
Fan Coil B (Lounge)	400	200	100	**200**
Fan Coil E (Library)	675	200	150	**200**

Note: Although the ASHRAE Position Document on Infectious Aerosols recommends using the latest published standards and codes as a baseline for minimum ventilation, the mechanical code in effect at the time the HVAC systems were designed and constructed is what governs the required outdoor air flowrate for the HVAC equipment, if there have been no additions, renovations, alterations or changes in occupancy to the building. The 2015 International Mechanical Code does not prevent the continued use of existing systems.

During the pandemic, we recommend maintaining the outdoor airflows at the original designed values where they exceed the code minimums calculated by Tighe & Bond. Supplying more outdoor than required by code will provide better indoor air quality.

The average airflow rate per person is shown below in Table 3. These values are based on the original full design supply airflow rate and the recommended outdoor airflow rates shown in Table 2. The airflow rate per person assumes a diversity factor of 70%, meaning the maximum number of occupants assumed to be in all zones at all times equates to 70% of the code required occupancy.

TABLE 3
Average Airflow Rate per Person

	All spaces	***Courtrooms***	***Non-Courtroom Spaces***
Total Occupancy (People)	354	232	122
Total Supply Air (CFM/Person)	73	38	140
Outdoor Air (CFM/Person)	37	19	71

The airflow rate per person for each Courtroom and the Jury Pool Room is shown below in Table 4. These values are based on full occupancy without taking diversity into account, the original full design supply airflow rate, and the recommended outdoor airflow rate. The airflow rate per person assumes the full supply airflow is being delivered to the room.

TABLE 4
Airflow Rate per Person (Full Occupancy)

		Total Air		*Outdoor Air*	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outdoor Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Jury Pool Room 110	19	200	11	100	5
First Session Courtroom	112	3,880	35	1,920	17
Second Session Courtroom	135	2,750	20	1,360	10
Juvenile Session Courtroom	85	2,150	25	1,060	12

Note: Courtroom occupant density is based on 70 people/1,000 square feet, per the 2015 International Mechanical Code

The airflow rate per person for each Courtroom and the Jury Pool Room, based on a reduced occupancy schedule determined by the Office of Court Management, is shown below in Table 4a. The airflow rate per person assumes the full supply airflow is being delivered to the room.

TABLE 4a
Airflow Rate per Person (Reduced Occupancy)

		Total Air		*Outdoor Air*	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outdoor Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Jury Pool Room 110	9	200	22	100	11
First Session Courtroom	25	3,880	150	1,920	77
Second Session Courtroom	23	2,750	120	1,360	59
Juvenile Session Courtroom	18	2,150	120	1,060	59

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

RTB-2: *Rebalance system return air flow rate.*

We recommend testing and balancing the return fan airflow rates to ensure the correct quantity of return air is being delivered to the air handler.

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

If the airflow to each space has not been recently tested, we recommend testing the airflow rates in the holding cells (after repairs noted in Section 2.7.1 are completed), control room, courtrooms, jury pool room, and other densely occupied areas as a minimum. These systems are very old, and the airflow rate delivered to and returned from these spaces may not match the original design intent.

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

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

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

2.3 Equipment Maintenance & Upgrades

We recommend the following equipment maintenance and upgrades:

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

Replace dampers and actuators that are not functioning properly.

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

RE-5: *Confirm the existing freeze stat is working correctly on each air handling unit.*

Any automatic reset freeze stats should be replaced with manual reset freeze stats.

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.*

We assume this can be implemented by adjusting the existing timeclocks. Note that because the fans currently only operate when there is a heating of cooling call present, the benefit of this flush sequence is limited unless the fans are also set to run continuously. Refer to Section 2.7.2.

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

Confirm any existing thermostatic economizers are operational and correctly set and calibrated.

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. Refer to the "Overview of Recommendations" document for further guidance on installing portable HEPA filters.

Due to the lack of ventilation in the lockup area, we recommend the use of portable HEPA filters or similar air purification approaches if these areas are to be occupied in the near term, until the current repairs noted in Section 2.7.1 are completed. For security reasons, the HEPA filters will likely need to be located in the corridors just outdoor of the cells. While all spaces benefit from additional air filtration, this measure is likely not necessary for single occupant offices, and therefore we do not recommend portable HEPA filters for the two unventilated offices on the first floor.

2.6 Humidity Control

Installing duct mounted or portable humidifiers can help maintain the relative humidity levels recommended by ASHRAE. The feasibility of adding active humidification is determined by the building envelope. Buildings that were not designed to operate with active humidification can potentially be damaged due to a lack of a vapor barrier, adequate insulation, and air tightness.

Duct mounted humidifiers must be engineered, integrated into the building control system, tested, and commissioned. They are available in many configurations but require substantial maintenance and additional controls. They also run the risk of adversely affecting IAQ from growing microorganisms, or leaking water through poorly sealed ductwork damaging insulation and ceilings. Portable humidifiers are easier to install and require less maintenance, but still have the potential to damage the building envelope.

While active humidification is not recommended as a whole building solution due to high installation costs, operational costs, potential to damage the building envelope and adversely affect poor IAQ, it may be warranted as a temporary solution in some areas.

2.7 Other Recommendations

Consider implementing measures 2.7.4 through 2.7.6 as a single project. This approach would likely reduce overall cost and provide a more coherent installation.

2.7.1 Repair Lockup Ventilation Systems

The lockup area is not currently receiving any ventilation, and toilet exhaust from the cells is being recirculated during occupied periods. The underlying issues that have led to this operational approach need to be resolved before the existing system can be used for ventilation.

The first issue is exhaust airflow in the cells. To resolve this, the four lockup vents that have been blocked should be repaired. New security registers should be installed, and the demolished ductwork repaired in the wet walls.

Once the ducts are repaired, the issue of pressurization should be addressed. The supply airflow in each cell should be reduced to 75 CFM each, so that each cell is negatively pressurized relative to the corridors. According to the 1975 schedules, the AH-7 supply air is 200 CFM higher than the return/exhaust airflow. Given the pressurization and moisture issues the building has been experiencing with this system, we recommend balancing the lockup area to be slightly negative relative nearby corridors with air conditioning, and slightly positive or neutral relative to the outdoors.

Finally, the automatic dampers and actuators should be repaired and adjusted so that the return dampers fully close during occupied periods. The controls should be checked to ensure that the system only recirculates during unoccupied periods. This would restore the original design intent. However, as noted in Section 1.1, this mode of operation would not comply with current code.

In the long term, we strongly recommend adding perimeter heat to the lockup areas and eliminating the return connection to AH-7. Also consider adding cooling to AH-7, so there is no longer a risk of pressurization issues between areas with and without air conditioning.

2.7.2 Add Ventilation to All Occupied Areas

Two offices spaces on the first floor do not have any mechanical ventilation. Consider adding additional distribution ductwork or another type of ventilation system to serve these areas.

2.7.3 Run Supply Fans Continuously During Occupied Hours

All air handling units and floor mounted fan coils were set to run the fan in "auto" mode, which runs the supply fan only when the unit is actively heating or cooling. This should be changed on each of the systems to run the supply fans continuously in occupied mode, to supply ventilation air to the spaces. Note that this may cause comfort issues because supply air temperature can fluctuate as the heating and cooling is staged on and off, and the systems may not have been designed to operate like this originally. This will likely require modifying the control wiring for the AHU's.

2.7.4 Replace Air Handling Units & Return Fans

Indoor air handling units have a life expectancy of 35-45 years. The air handlers are approximately 46 years old and are in poor condition. Consider replacing these units in the near term. Replacing the return and general exhaust fans should also occur in conjunction with the replacement of the air handling units. They should be sized correctly to provide an overall positive building pressure to reduce infiltration.

This recommendation is generally an energy saving measure and does not necessarily improve the indoor air quality of the building. However, this would help to resolve many of the maintenance and operational issues identified in this report and the Kleinfelder report.

2.7.5 Install a Building Management System

We recommend replacing the pneumatic control system and all control devices with a Building Management System to control and monitor all HVAC equipment. Pneumatic air systems are antiquated and do not offer the same benefits as a BMS.

This recommendation is an energy saving and maintenance measure and does not affect the indoor air quality of the building. However, a BMS does give insight into how the system is operating. Items like filter status and outdoor air damper position can be easily viewed and system alarms can be generated to prompt corrective actions.

2.7.6 Convert Chilled and Hot Water Systems to Variable Flow

The hot and chilled water pumps are constant flow systems. Constant flow pumps circulate the same volume of water to air handling units regardless of whether the water is required or not. If air handlers do not require this water, the three-way valves serving the air handler coils bypass the coil, which allows the water to return back to the chiller or boiler plant. We recommend investigating the possibility of converting these systems to variable flow. The three-way air handler valves would have to be replaced with two-way valves, as well as any other three-way valves that are in the system. Variable frequency drives (VFD) may be able to be connected to the existing hot and chilled water pumps, allowing the pumps to vary the flow rate to match the demand.

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

Section 3
Testing & Balancing Results

Milharmer Associates visited the Wareham District Courthouse on April 13th, 2022 to test the airflow rates of the air handling units and the exhaust fans. The balancing report also contains the water flow rate testing results of the air handler hot water coils. The chilled water system was not operational during the time of testing, therefore chilled water coil flow rates were not tested. A summary of the tested airflow and water flow rates versus the design airflow rates are shown below in Tables 5, 6, 7 and 8. The full testing and balancing report is attached.

TABLE 5
Air Handler Airflow 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)**
AH-1	4,150	2,050	2,100	3,815	2,106	1,709
AH-2	3,100	1,500	1,600	1,708	578	1,130
AH-3	2,500	1,250	1,250	2,354	1,108	1,246
AH-4	8,450	3,700	4,750	5,459	3,273	2,186
AH-5	1,310	1,310	N/A	1,422	1,422	N/A
AH-6	3,200	800	2,400	2,659	821	1,838
AH-7	2,000	2,000	0	1,521	0	1,521
FCU-B	400	200	200	0	0	0
FCU-E	675	200	475	275	105	170

TABLE 6
Return Fan Testing & Balancing Results

Unit	Serving	Design Return Airflow (CFM)	Actual Return Airflow (CFM)
EF-1	AH-1	3,735	3,325
EF-2	AH-2	2,790	1,130
EF-3	AH-3	2,250	2,151
EF-4	AH-4	4,750	2,706
EF-6	AH-6	2,880	2,375
EF-7	AH-7	1,800	1,644

Note that although these fans have "EF" identifiers, they are return fans, located in the return air ductwork.

TABLE 8
Exhaust Fan Testing & Balancing Results

Unit	Serving	Design Exhaust Airflow (CFM)	Actual Exhaust Airflow (CFM)
EF-5	AH-5	420	Not Tested
EF-5a	AH-5	300	Not Tested
EF-5b	AH-5	230	Not Tested
EF-8	Restrooms	300	275
EF-9	Restrooms	460	417
EF-10	Restrooms	320	328
EF-11	Restrooms	210	191

TABLE 7
Air Handler Waterflow Testing & Balancing Results

	Design Hot Water Flow Rate (GPM)	Actual Hot Water Flow Rate (GPM)
AH-1	9	0
AH-2	7	0
AH-3	6	6.8
AH-4	18.3	17.1
AH-5	10	9.4
AH-6	2	2.4
AH-7	15	15.3

The typical balancing tolerance for air and water systems is ±10% of the design flow.

In reviewing the airflow report data, the following should be noted:

1. AH-2, AH-4, AH-6 and their associated return fans EF-2, EF-4 and EF-6 are all well below the design airflow. Increasing the fan speed to meet the design airflow is not possible with the existing motors unless airflow resistance in the system can be reduced.
    a. We recommend checking and cleaning the AHU coils and changing the filters.
    b. We also recommend cleaning the associated reheat coils and supply and return openings to ensure they are not causing an additional airflow restriction. In our initial evaluation we observed several partially blocked reheat coils.
    c. After cleaning, the units should be retested, and the sheaves should be adjusted if needed to meet the design airflow.
2. AH-7 is operating well below the design airflow. The balancing contractor noted that AH-7 has a broken outdoor air damper linkage and so the unit is not receiving any outdoor airflow, even though this system is intended to operate at 100% outdoor airflow. The AHU is currently recirculating return air from EF-7 which should all be exhausted to the outdoors. The holding cells being served by AH-7 are not receiving any outdoor airflow, and are not being exhausted, neither of which is permitted by the mechanical code.
    a. Refer to recommendation 2.7.1 for recommended short and long term corrective actions to provide proper operation of AH-7 and the ventilation and exhaust to the areas served.
    b. After the system is restored to proper operation, the system should be rebalanced, including all inlets and outlets, and the sheaves should be adjusted if needed to meet the design airflow.

3. Fan coil FCU-B is not operational and needs to be repaired or replaced, and FCU-E is operating well below the design airflow.
    a. These units should be cleaned and repaired, or replaced.
    b. After the units are operating properly, they should be retested, and rebalanced if possible.
4. All toilet exhaust fans are operating within the typical 10% design tolerance.
5. The relief exhaust fans for AH-5 were not tested. We recommend testing these fans as part of any future testing and balancing activities.
6. The balancing contractor noted that the hot water coils for AH-1 and AH-2 appear to be air bound (or clogged) and are not receiving any hot water flow.
    a. We recommend investigating why these coils are not receiving any hot water flow and repairing as necessary.

Disclaimer

Tighe and Bond cannot in any way 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.

MILHARMER ASSOCIATES, INC.
534 New State Highway, Route 44, Suite 3
Raynham, MA 02767
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TEST AND BALANCE REPORT

Project: **Wareham District Court**
Wareham, MA

Project No.: **22-180** **Project Date:** **4/13/2022**

MECHANICAL CONTRACTOR
Tighe & Bond

3384

A N.E.B.B. Certified Company

Project:	Wareham District Court		
Address:	Wareham, MA		
Date:	4/13/2022	**Project No.**	22-180

CERTIFICATION

Submitted & Certified by:

Milharmer Associates, Inc.

Certification No.: ***3384*** Certification Expiration Date: **3-31-23**

The data presented in this Report is a record of system measurements and final adjustments that have been obtained in accordance with the current edition of the ***N.E.B.B. Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.*** Any variances from design quantities which exceed N.E.B.B. tolerances, are noted in the Test-Adjust-Balance Report Project Summary.

N.E.B.B. Qualified TAB Supervisor Name: **Scott F. Miller**

N.E.B.B. Qualified TAB Supervisor Signature:_____

Certification

SCOTT F. MILLER

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL STATUS IN THE FOLLOWING DISCIPLINE

Testing, Adjusting and Balancing of Environmental Systems

This Certificate, as well as individual affiliation with a NEBB Certified Firm and associated NEBB Certification Stamp are REQUIRED to provide a NEBB Certified Report. Participation in the NEBB Quality Assurance Program requires the Certificant be affiliated with a NEBB Certified Firm

CP-23541

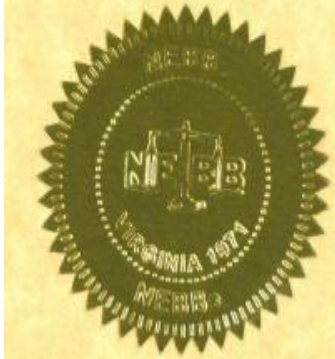
NEBB Certification Number

March 31, 2023

Expiration Date

NEBB President

NEBB President-Elect



Firm Certification

MILHARMER ASSOCIATES, INC.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED STATUS IN THE FOLLOWING DISCIPLINE

Testing, Adjusting and Balancing of Environmental Systems

3384

NEBB Certification Number

March 31, 2023

Expiration Date

NEBB President

NEBB President-Elect

Project:	Wareham District Court		
Address:	Wareham, MA		
Date:	4/13/2022	**Project No.**	22-180

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Project:	Wareham District Court		
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INSTRUMENT SHEET

The following is a list of Instruments owned and operated by Milharmer Associates, Inc. and used on this project.

Instrument ID Number	Instrument	Calibration Date	Calibration Due Date
1	ADM-870 Digital Multimeter	8-20-21	8-20-22
2	Shortridge Flow Hood	8-20-21	8-20-22
3	Ampmeter	8-20-21	8-20-22
4	Tachometer	8-20-21	8-20-22
5	Airflow Anemometer	8-20-21	8-20-22
6	Digital Thermometers	8-20-21	8-20-22
7	Shortridge Water Meter	8-20-21	8-20-22
8	Sound Meter	8-20-21	8-20-22
9	Vibration Meter	8-20-21	8-20-22

Please Note: Instruments are tested annually at the M.A.I. Lab. and sent back to the factory if deviation exceeds manufacturing tolerance.

Technician:

SYMBOL SHEET

AHU	Air Handling Unit	HEATER O.L.	Thermal Overload
AC or ACU	Air Conditioner Unit		Protection For Motors
ACCU	Air Cooled Condensing Unit		Located at Starter Motor
ADJ P.D.	Adjusted Pitch Diameter		
AMP	Amperage	HEPA	High Efficiency Particulate
AVG	Average		Arrestance
A.D.	Air Density	HOA	Hand/Off/Auto Switch
		H.P.	Horsepower
B.H.P.	Brake Horsepower	HPS	High Pressure Steam
		HRC	Heat (Recovery or Recliam) Coil
CFM	Cubic Feet Per Minute	HVAC	Heating, Ventilation and
CH	Chiller		Air Conditioning
CHWR	Chilled Water Return	HWR	Hot Water Return or
CHW or CHWS	Chilled Water Supply		Heating Water Return
CT	Cooling Tower	HWS	Hot Water Supply or
CWR	Condenser Water Return		Heating Water Supply
CW or CWS	Condenser Water Supply	HX	Heat Exchanger
DB	Dry Bulb	I.D.	Inside Diameter
D.D.	Direct Drive		
DIA	Diameter	LAT	Leaving Air Temperature
		L.D.	Linear Supply Diffuser
EAT	Entering Air Temperature	LPS	Low Pressure Steam
EDC	Electric Duct Coil	L.T.	Light Troffer
EDH	Electric Duct Heater	LWT	Leaving Water Temperature
EF	Exhaust Fan		
EMS	Energy Mgt System	MAU/MUA	Make Up Air Unit
EWT	Entering Water Temperature	MBH	1,000 BTU's per Hour
FCU	Fan Coil Unit	N.A.	Not Accessible
FH	Fume Hood	N/A	Not Applicable
F.L.A.	Full Load Amperage	N.I.	Not Installed
FPB	Fan Powered Box	N.L.	Not Listed
FPM	Feet Per Minute		
FT. HD.	Feet of Head		
GPM	Gallons Per Minute		

SYMBOL SHEET CONTINUED

O.D.	Outside Diameter	TAB	Testing, Adjusting, and Balancing
OA Min	Outside Air Minimum	TSP	Total Static Pressure
OAT	Outside Air Total	TP	Thermally Protected
PF	Power Factor	UH	Unit Heater
PHC	Preheat Coil		
PH	Phase(s)	V	Volts
PSI	Pounds Per Square Inch	VAV	Variable Air Volume
P.T.	Pitot Traverse	VD	Volume Damper
		VFD	Variable Frequency Drive
RA	Return Air	VP	Velocity Pressure
RF	Return Air Fan		
R.G.	Return Grille	W	Watts
RHC	Reheat Coil	WB	Wet Bulb
RPM	Revolutions per Minute	W.D.	Water Density
		W.G.	Water Guage
SA	Supply Air		
SAT	Supply Air Temperature	F	Degrees Fahrenheit
S.D.	Supply Diffuser		
SEF	Smoke Exhaust Fan	ΔP	Differential (Delta) Pressure or Pressure Drop
SF (AIR)	Supply Fan		
S.F.(Elect)	Service Factors		
SHC	Steam Heating Coil	ΔT	Differential (Delta) Temperature, Net Temperature Decrease or Increase
S.P. "W.C."	Static Pressure Measured in Inches of Water Column	#	PSI or Pounds Per Square Inch Decrease or Increase

Project:	Wareham District Court		
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REPORT SUMMARY

The following is the report for the Wareham District Court with the following comments:

1. AH-2 is running at 55% of design airflow. The unit can be sped up with a sheave change and when sped up, the outside air can be increased to design airflow.

2. AH-4 is running at 65% of design airflow. The unit can be sped up with a sheave change and when sped up, the outside air can be increased to design airflow.

3. AH-6 is running at 65% of design airflow. The unit can be sped up with a sheave change.

4. AH-7 has a broken outside air damper linkage that needs to be repaired before the unit can be balanced to design airflow.

5. Chilled Water was not running at the time of this visit and could not be tested.

6. The hot water coils for AH-1 and AH-2 appear to be air bound and are not getting any hot water flow.

Project:	Wareham District Court		
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REPORT SUMMARY

AIR HANDLING UNITS

UNIT	SUPPLY	RETURN	OUTSIDE AIR
AH-1	3,815 CFM	1,009 CFM	2,106 CFM
AH-2	1,708 CFM	1,130 CFM	578 CFM
AH-3	2,354 CFM	1,246 CFM	1,108 CFM
AH-4	5,459 CFM	2,186 CFM	3,273 CFM
AH-5	1,422 CFM	NA	1,422 CFM
AH-6	2,659 CFM	1,838 CFM	821 CFM
AH-7	1,521 CFM	See Summary	See Summary

UNIT	EXHAUST
EF-8	275 CFM
EF-9	417 CFM
EF-10	328 CFM
EF-11	191 CFM

Project: Wareham District Court
Address: Wareham, MA
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FAN DATA SHEET

	FAN NO. AH-1		FAN NO. EF-1	
Serves / Location:	1st Session Court Rm	Mech. Rm.	1st Session Court Rm	Mech. Rm.
Manufacturer:	McQuay		Twin City	
Model Number:	LCL-108CH		BCV	
Size:	NL		200	
Serial Number:	3FH00013		7613075-2	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	LINCOLN	NL	A.O. SMITH
Frame Number:	NL	184T	NL	H56
Horsepower:	5	5	3/4	3/4
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.15	NL	1.25
Volts/Phase:	230/460/3	212/3	200-230/460	211/3
Motor Amperage:	15.6/7.8	13.1	2.5-2.6/1.3	2.3
Motor RPM:	1745	NA	1725	NA
Speeds:	NL	BELT DRIVEN	NL	BELT DRIVEN
Heater Size:	NL	CB PROTECTED	NL	CB PROTECTED
Heater Amps.:	NL	CB PROTECTED	NL	CB PROTECTED
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	4150	3815		
Return Air CFM:			3735	3325
Exhaust Air CFM:				1616
Outside Air CFM:	2050	2106		
Suction Pressure:	NL	-0.17	NL	-0.31
Discharge Pressure:	NL	1.36	NL	0.25
Fan Static Pressure:	2.5	NA	NL	NA
External Pressure:	.8	1.53	0.5	0.56
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	1030	NA	1300	NA
Motor Drive:	NL	NA	NL	3
Motor Size/Bore:	NL	NA	NL	NA
Fan Drive:	NL	NA	NL	8"
Fan Size/Bore:	NL	NA	NL	1 1/2
Belt Size / Number:	NL	NA	NL	A48/1
Shafts C-C:	NL	NA	NL	16
Turns Open:	NL	NA	NL	5

Comments: ***** No access to sheave data without dismantling the unit.**

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TRAVERSE DATA

SYSTEM: AH-1 TRAVERSE NUMBER : S1
Supply TRAVERSE LOCATION: Mech. Rm.

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	24	" WIDTH x	28 " DEPTH	Sq Ft =	4.67

AIR DENSITY DATA

STATIC PRESS @ CL:	1.36	InWg.	DESIGN CFM =	NL
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	3438
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**3451**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	749	770	824	810	754	726	
B	798	785	765	752	739	731	
C	801	781	566	716	730	671	
D	640	720	767	714	766	604	
E							
F							
G							
H							
I							

NO. OF READINGS = 24 AVERAGE FPM = 737

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
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TRAVERSE DATA

SYSTEM: AH-1 TRAVERSE NUMBER : S2
Supply TRAVERSE LOCATION: Mech. Rm.

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	10	" WIDTH x	8 " DEPTH	Sq Ft =	0.56

AIR DENSITY DATA

STATIC PRESS @ CL:	0.33	InWg.	DESIGN CFM =	NL
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	364
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**364**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	623	637	647				
B	669	626	641				
C	701	685	665				
D							
E							
F							
G							
H							
I							

NO. OF READINGS = 9 AVERAGE FPM = 655

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
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TRAVERSE DATA

SYSTEM: AH-1, EF-1 TRAVERSE NUMBER : R1
Return TRAVERSE LOCATION: Mech. Rm.

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	24	" WIDTH x	18 " DEPTH	Sq Ft =	3.00

AIR DENSITY DATA

STATIC PRESS @ CL:	0.07	InWg.	DESIGN CFM =	NL
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	3323
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**3325**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	1115	1007	1129	1185			
B	1023	1088	1143	1141			
C	1109	1044	1116	1163			
D	1117	1056	1177	1109			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 1108

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
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FAN DATA SHEET

	FAN NO. AH-2		FAN NO. EF-2	
Serves / Location:	2nd Session Court Rm	Mech. Rm.	2nd Session Court Rm	Mech. Rm.
Manufacturer:	McQuay		Twin City	
Model Number:	LSL-106CH		BCV	
Size:	NL		222	
Serial Number:	3FH00014		17813075-1	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	LINCOLN	NL	CENTURY
Frame Number:	NL	182T	NL	J56
Horsepower:	3	3	1/2	1/2
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.25	NL	1.25
Volts/Phase:	230/460/3	212/3	460/200-230	211/3
Motor Amperage:	7.8/3.9	6.3	1.0/1.8-2.0	1.3
Motor RPM:	1760	NA	1725	NA
Speeds:	NL	BELT DRIVEN	NL	BELT DRIVEN
Heater Size:	NL	CB PROTECTED	NL	CB PROTECTED
Heater Amps.:	NL	CB PROTECTED	NL	CB PROTECTED
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	3100	1708		
Return Air CFM:			2790	1130
Exhaust Air CFM:				
Outside Air CFM:	1500	578		
Suction Pressure:	NL	-0.17	NL	-0.1
Discharge Pressure:	NL	1.71	NL	0.18
Fan Static Pressure:	2.5	NA	NL	NA
External Pressure:	.8	1.88	0.5	0.28
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	1271	NA	1200	NA
Motor Drive:	NL	NA	NL	4
Motor Size/Bore:	NL	NA	NL	5/8
Fan Drive:	NL	NA	NL	8
Fan Size/Bore:	NL	NA	NL	1 1/2
Belt Size / Number:	NL	NA	NL	A47/1
Shafts C-C:	NL	NA	NL	17
Turns Open:	NL	NA	NL	5

Comments: ***** No access to sheave data without dismantling the unit.**

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TRAVERSE DATA

SYSTEM: AH-2 TRAVERSE NUMBER : S1
Supply TRAVERSE LOCATION: Mech. Rm.

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	24	" WIDTH x	22 " DEPTH	Sq Ft =	3.67

AIR DENSITY DATA

STATIC PRESS @ CL:	1.76	InWg.	DESIGN CFM =	3100
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	1708
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**1716**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	402	413	408	476			
B	537	478	411	447			
C	609	428	448	408			
D	628	522	485	353			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 466

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
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TRAVERSE DATA

SYSTEM: AH-2, EF-2 TRAVERSE NUMBER : R1
Return TRAVERSE LOCATION: Mech. Rm.

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	22	" WIDTH x	24 " DEPTH	Sq Ft =	3.67

AIR DENSITY DATA

STATIC PRESS @ CL:	-0.08	InWg.	DESIGN CFM =	2790
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	1130
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**1131**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	374	316	312	302			
B	345	309	331	240			
C	382	318	321	229			
D	334	338	225	257			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 308

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
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FAN DATA SHEET

	FAN NO. AH-3		FAN NO. EF-3	
Serves / Location:	Juvenile Court	Mech. G-4	Juvenile Court	Mech. G-4
Manufacturer:	McQuay		Twin City	
Model Number:	LSL-106CH		ASL	
Size:	NL		128	
Serial Number:	3FH00109		7613076-3	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	LINCOLN	NL	CENTURY
Frame Number:	NL	145T	NL	BA56
Horsepower:	2	2	1/2	1/2
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.15	NL	1.25
Volts/Phase:	200/400/3	211/3	200-208/3	211/3
Motor Amperage:	7.1/3.55	6.5	2.5-2.4	2.5
Motor RPM:	1720	1731	1725	NA
Speeds:	NL	BELT DRIVEN	NL	BELT DRIVEN
Heater Size:	NL	CB PROTECTED	NL	CB PROTECTED
Heater Amps.:	NL	CB PROTECTED	NL	CB PROTECTED
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	2500	2354		
Return Air CFM:			2250	2151
Exhaust Air CFM:				905
Outside Air CFM:	1250	1108		
Suction Pressure:	NL	0.05	NL	-0.62
Discharge Pressure:	NL	1.46	NL	0.13
Fan Static Pressure:	2.3	NA	NL	NA
External Pressure:	.9	1.51	0.5	0.75
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	1201	NA	677	NA
Motor Drive:	NL	4 3/4	NL	3 1/2
Motor Size/Bore:	NL	7/8	NL	NA
Fan Drive:	NL	6 1/2	NL	NA
Fan Size/Bore:	NL	1 1/8	NL	NA
Belt Size / Number:	NL	A50/1	NL	A53/1
Shafts C-C:	NL	17	NL	NA
Turns Open:	NL	1	NL	2

Comments:

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TRAVERSE DATA

SYSTEM: AH-3 Supply
TRAVERSE NUMBER : S1
TRAVERSE LOCATION: Basement Corridor

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	24	" WIDTH x	16 " DEPTH	Sq Ft =	2.67

AIR DENSITY DATA

STATIC PRESS @ CL:	1.23	InWg.	DESIGN CFM =	2500
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	2345
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**2354**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	803	939	809	865			
B	897	940	814	880			
C	855	924	856	906			
D	897	946	842	880			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 878

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

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TRAVERSE DATA

SYSTEM: AH-3 TRAVERSE NUMBER : R1
Return TRAVERSE LOCATION: Basement Corridor

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	24	" WIDTH x	16 " DEPTH	Sq Ft =	2.67

AIR DENSITY DATA

STATIC PRESS @ CL:	-0.52	InWg.	DESIGN CFM =	2250
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	2153
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**2151**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	643	764	965	890			
B	675	776	871	973			
C	636	801	871	833			
D	675	807	878	844			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 806

J							
K							
L							
M							
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O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

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TRAVERSE DATA

SYSTEM: AH-3 TRAVERSE NUMBER : OA1
Outside Air TRAVERSE LOCATION: Mech. G-4

DUCT SIZE (ROUND)		" DIAMETER			Sq Ft =	0.00
DUCT SIZE (RECT.)	42	" WIDTH x	12	" DEPTH	Sq Ft =	3.50

AIR DENSITY DATA

STATIC PRESS @ CL:	NA	InWg.	DESIGN CFM =	1250
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	1108
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**1108**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	135	119	464	350	286	470	192
B	299	69	458	274	336	585	332
C	198	114	459	222	202	632	450
D							
E							
F							
G							
H							
I							

NO. OF READINGS = 21 AVERAGE FPM = 316

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

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FAN DATA SHEET

	FAN NO. AH-4		FAN NO. EF-4	
Serves / Location:	Lobbies & Related Spaces / Mech G-4		Lobbies & Related Spaces / Mech G-4	
Manufacturer:	McQuay		Twin City	
Model Number:	LSL-214CH		BCV	
Size:	NL		300	
Serial Number:	3FH000110		7613075-3	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	BALDOR	NL	US MOTORS
Frame Number:	NL	213T	NL	116T
Horsepower:	7.5	7.5	2	2
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.15	NL	
Volts/Phase:	208-230/460/3	210/3	200/3	211/3
Motor Amperage:	21.7-20/10	15.4	7.4	6.1
Motor RPM:	1750	1757	1735	NA
Speeds:	NL	BELT DRIVEN	NL	BELT DRIVEN
Heater Size:	NL	CB PROTECTED	NL	CB PROTECTED
Heater Amps.:	NL	CB PROTECTED	NL	CB PROTECTED
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	8450	5459		
Return Air CFM:			4750	2706
Exhaust Air CFM:				520
Outside Air CFM:	3700	3273		
Suction Pressure:	NL	0.86	NL	-0.23
Discharge Pressure:	NL	0.8	NL	0.85
Fan Static Pressure:	2.3	NA	NL	NA
External Pressure:	0.75	1.66	0.75	1.08
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	1122	NA	1300	NA
Motor Drive:	NL	6"	NL	5 1/4
Motor Size/Bore:	NL	1 3/8	NL	5/8
Fan Drive:	NL	7"	NL	14
Fan Size/Bore:	NL	1 1/8	NL	2
Belt Size / Number:	NL	B66/2	NL	B63/1
Shafts C-C:	NL	26	NL	19
Turns Open:	NL	4	NL	4

Comments:

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-4 TRAVERSE NUMBER : S1
Supply TRAVERSE LOCATION: Maint. Office

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	34	" WIDTH x	22 " DEPTH	Sq Ft =	5.19

AIR DENSITY DATA

STATIC PRESS @ CL:	0.6	InWg.	DESIGN CFM =	8450
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	5459
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**5470**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	535	735	1209	1141	1223	1156	
B	789	815	1059	1341	1317	1271	
C	493	784	1112	1340	1294	1239	
D	388	860	1005	1364	1437	1351	
E	695	706	1147	1281	1382	1368	
F	203	908	960	1311	1305	1308	
G							
H							
I							

NO. OF READINGS = 36 AVERAGE FPM = 1051

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-4 TRAVERSE NUMBER : R1
Return TRAVERSE LOCATION: Maint. Office

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	34	" WIDTH x	22 " DEPTH	Sq Ft =	5.19

AIR DENSITY DATA

STATIC PRESS @ CL:	-0.11	InWg.	DESIGN CFM =	4750
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	2705
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**2706**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	418	463	412	457	620	514	
B	444	433	452	493	610	649	
C	480	475	433	509	543	638	
D	465	418	427	507	633	650	
E	493	444	497	531	671	638	
F	443	508	537	626	613	606	
G							
H							
I							

NO. OF READINGS = 36 AVERAGE FPM = 521

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-4 TRAVERSE NUMBER : E1
Exhaust TRAVERSE LOCATION: Maint. Office

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	32	" WIDTH x	20 " DEPTH	Sq Ft =	4.44

AIR DENSITY DATA

STATIC PRESS @ CL:	0.03	InWg.	DESIGN CFM =	1955
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	277
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**277**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	68	0	0	0	0	107	
B	0	0	0	0	0	88	
C	57	0	0	0	0	135	
D	104	198	197	144	126	272	
E							
F							
G							
H							
I							

NO. OF READINGS = 24 AVERAGE FPM = 62

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

FAN DATA SHEET

	FAN NO. AH-5		FAN NO.	
Serves / Location:	100% Fresh Air Unit	Mech. G-4		
Manufacturer:	McQuay			
Model Number:	LSL-103CH			
Size:	NL			
Serial Number:	3FH00111			
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	LINCOLN		
Frame Number:	NL	145T-85		
Horsepower:	2	2		
Brake Horsepower:	NL	NA		
Safety Factor:	NL	1.25		
Volts/Phase:	230/460/3	211/3		
Motor Amperage:	5.6/2.8	4.5		
Motor RPM:	1740	1741		
Speeds:	NL	BELT DRIVEN		
Heater Size:	NL	CB PROTECTED		
Heater Amps.:	NL	CB PROTECTED		
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	1310	1422		
Return Air CFM:				
Exhaust Air CFM:				
Outside Air CFM:	1310	1422		
Suction Pressure:	NL	-0.31		
Discharge Pressure:	NL	0.29		
Fan Static Pressure:	2.5	NA		
External Pressure:	0.75	0.6		
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	1723	NA		
Motor Drive:	NL	4 3/4		
Motor Size/Bore:	NL	7/8		
Fan Drive:	NL	4 1/2		
Fan Size/Bore:	NL	7/8		
Belt Size / Number:	NL	A50/1		
Shafts C-C:	NL	21		
Turns Open:	NL	0		

Comments:

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-5 TRAVERSE NUMBER : S1
Supply TRAVERSE LOCATION: Mech G-4

DUCT SIZE (ROUND)		" DIAMETER			Sq Ft =	0.00
DUCT SIZE (RECT.)	8	" WIDTH x	18	" DEPTH	Sq Ft =	1.00

AIR DENSITY DATA

STATIC PRESS @ CL:	0.42	InWg.	DESIGN CFM =	NL
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	700
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**701**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	651	647	805	729	754	699	
B	733	780	758	697	549	597	
C							
D							
E							
F							
G							
H							
I							

NO. OF READINGS = 12 AVERAGE FPM = 700

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-5 TRAVERSE NUMBER : S2
Supply TRAVERSE LOCATION: Mech G-4

DUCT SIZE (ROUND)		" DIAMETER			Sq Ft =	0.00
DUCT SIZE (RECT.)	8	" WIDTH x	18	" DEPTH	Sq Ft =	1.00

AIR DENSITY DATA

STATIC PRESS @ CL:	0.32	InWg.	DESIGN CFM =	NL
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	722
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**723**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	423	831	1025				
B	410	684	1061				
C	341	673	1053				
D							
E							
F							
G							
H							
I							

NO. OF READINGS = 9 AVERAGE FPM = 722

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

FAN DATA SHEET

	FAN NO. AH-6		FAN NO. EF-6	
Serves / Location:	Probation & Court Off.	Mech. G-4	Probation & Court Off.	Mech. G-4
Manufacturer:	McQuay		Twin City	
Model Number:	LSH-106CH		BCV	
Size:	NL		200	
Serial Number:	4FH00212		7513075-1	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	NA	NL	AO SMITH
Frame Number:	NL	NA	NL	LA56
Horsepower:	3	3	3/4	3/4
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	NA	NL	1.25
Volts/Phase:	208/460/3	210/3	460/200-230/3	211/3
Motor Amperage:	10.8/5.4	9.6	1.7/2.9-3.4	2.7
Motor RPM:	1755	1756	NL	NA
Speeds:	NL	BELT DRIVEN	NL	BELT DRIVEN
Heater Size:	NL	CB PROTECTED	NL	CB PROTECTED
Heater Amps.:	NL	CB PROTECTED	NL	CB PROTECTED
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	3200	2659		
Return Air CFM:			2880	2375
Exhaust Air CFM:				
Outside Air CFM:	800	821		
Suction Pressure:	NL	0.12	NL	-0.03
Discharge Pressure:	NL	0.62	NL	0.1
Fan Static Pressure:	2.4	NA	NL	NA
External Pressure:	0.75	0.74	0.75	0.13
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	1211	NA	1252	NA
Motor Drive:	NL	5 1/4	NL	3 3/4
Motor Size/Bore:	NL	15/16	NL	5/8
Fan Drive:	NL	7	NL	7
Fan Size/Bore:	NL	1 1/8	NL	1 3/8
Belt Size / Number:	NL	B55/1	NL	A43/1
Shafts C-C:	NL	20	NL	14 1/2
Turns Open:	NL	4	NL	4

Comments:

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-6 TRAVERSE NUMBER : S1
Supply TRAVERSE LOCATION: Mech G-4

DUCT SIZE (ROUND)		" DIAMETER			Sq Ft =	0.00
DUCT SIZE (RECT.)	22	" WIDTH x	22	" DEPTH	Sq Ft =	3.36

AIR DENSITY DATA

STATIC PRESS @ CL:	0.65	InWg.	DESIGN CFM =	3200
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	2653
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**2659**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	901	911	877	754			
B	803	856	725	776			
C	882	771	683	780			
D	759	686	681	783			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 789

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-6, EF-6 TRAVERSE NUMBER : R1
Return / Exhaust TRAVERSE LOCATION: Mech G-4

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	22	" WIDTH x	22 " DEPTH	Sq Ft =	3.36

AIR DENSITY DATA

STATIC PRESS @ CL:	-0.02	InWg.	DESIGN CFM =	2880
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	2372
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**2373**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	803	798	603	693			
B	788	670	663	638			
C	786	682	664	695			
D	798	684	686	641			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 706

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-6 TRAVERSE NUMBER : OA1
Outside Air TRAVERSE LOCATION: Mech G-4

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	20	" WIDTH x	24 " DEPTH	Sq Ft =	3.33

AIR DENSITY DATA

STATIC PRESS @ CL:	-0.19	InWg.	DESIGN CFM =	800
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	1208
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**1208**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	253	450	434	433			
B	215	411	413	409			
C	276	326	389	402			
D	265	282	418	424			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 363

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

FAN DATA SHEET

	FAN NO. AH-7		FAN NO. EF-7	
Serves / Location:	Cells	Mech. G-4	Cells	Mech. G-4
Manufacturer:	McQuay		Twin City	
Model Number:	NA		BCV	
Size:	NA		150	
Serial Number:	3FH00113		7613076-2	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	MARATHON	NL	DAYTON
Frame Number:	NL	56	NL	56
Horsepower:	3/4	3/4	1/2	1
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.25	NL	1.25
Volts/Phase:	208-230/460/3	211/3	208-230/460/3	211/3
Motor Amperage:	2.9-3.1/1.5	0.6	3.4-3.4/1.7	2.9
Motor RPM:	1725		NL	
Speeds:	NL	1 SPEED	NL	1 SPEED
Heater Size:	NL	CB PROTECTED	NL	CB PROTECTED
Heater Amps.:	NL	CB PROTECTED	NL	CB PROTECTED
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	2000	1521 *1		
Return Air CFM:			1800	1644
Exhaust Air CFM:			200	113
Outside Air CFM:	2000	0 *1		
Suction Pressure:	NL	0.38	NL	-0.36
Discharge Pressure:	NL	0.09	NL	0.31
Fan Static Pressure:	0.75	NA	NL	NA
External Pressure:	0.5	0.47	0.375	0.67
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	729	NA	1395	NA
Motor Drive:	NL	3 1/4	NL	3 5/8
Motor Size/Bore:	NL	NA	NL	5/8
Fan Drive:	NL	7 1/2	NL	AK45
Fan Size/Bore:	NL	NA	NL	1"
Belt Size / Number:	NL	A47/1	NL	A32/1
Shafts C-C:	NL	17 1/2	NL	10 1/2
Turns Open:	NL	0	NL	0

Comments: ***1 OA damper linkage is broken. AH-7 rotation is backwards.**

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-7 TRAVERSE NUMBER : R1
Return / Exhaust TRAVERSE LOCATION: Storage 1

DUCT SIZE (ROUND)		" DIAMETER		Sq Ft =	0.00
DUCT SIZE (RECT.)	16	" WIDTH x	16 " DEPTH	Sq Ft =	1.78

AIR DENSITY DATA

STATIC PRESS @ CL:	0.32	InWg.	DESIGN CFM =	1800
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	1644
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**1646**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	373	1337	1123	819			
B	1372	1579	1540	1609			
C	1017	702	634	656			
D	691	246	408	686			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 925

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

TRAVERSE DATA

SYSTEM: AH-7 Exhaust
TRAVERSE NUMBER : E1
TRAVERSE LOCATION: Storage 1

DUCT SIZE (ROUND)		" DIAMETER			Sq Ft =	0.00
DUCT SIZE (RECT.)	16	" WIDTH x	16	" DEPTH	Sq Ft =	1.78

AIR DENSITY DATA

STATIC PRESS @ CL:	-0.01	InWg.	DESIGN CFM =	200
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	113
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**113**

AIR DENSITY RATIO CORRECTION = 1.00
SCFM CORRECTION FACTOR 1.00
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	69	56	0	90			
B	57	-40	25	74			
C	69	49	73	95			
D	91	99	90	121			
E							
F							
G							
H							
I							

NO. OF READINGS = 16 AVERAGE FPM = 64

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Dan Abbett

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

AIR DISTRIBUTION

SYSTEM: FCU's
SUPPLY [X] RETURN [X] EXHAUST [ ]

ROOM OR LOCATION	UNIT NUMBER	UNIT SIZE	AREAxK FACTOR	DESIGN FT/MIN	TEST FT/MIN	DESIGN CFM	TESTED CFM
	FCU-B						
Lounge	1	12X12	FH	NA	NA	400	0 *1
	RETURN						
Lounge	1	12X12	FH	NA	NA	200	0 *1
	OUTSIDE AIR	NA	NA	NA	NA	200	0 *1
	FCU-E						
Library	1	12X12	FH	NA	NA	675	275
	RETURN						
Library	1	12X12	FH	NA	NA	475	105
	OUTSIDE AIR	NA	NA	NA	NA	200	170

Comments: *1 Doesn't run.

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

AIR DISTRIBUTION

SYSTEM: Existing Exhaust Fans

SUPPLY [ ] RETURN [ ] EXHAUST [X]

ROOM OR LOCATION	UNIT NUMBER	UNIT SIZE	AREAxK FACTOR	DESIGN FT/MIN	TEST FT/MIN	DESIGN CFM	TESTED CFM
	EF-8						
138	1	6X6	FH	NA	NA	150	136
139	2	6X6	FH	NA	NA	150	139
					TOTAL:	300	275
	EF-9						
121	1	6X6	FH	NA	NA	230	211
122	2	6X6	FH	NA	NA	230	206
					TOTAL:	460	417
	EF-10						
111	1	6X6	FH	NA	NA	160	149
112	2	6X6	FH	NA	NA	160	179
					TOTAL:	320	328
	EF-11						
C103	1	6X6	FH	NA	NA	105	97
C106	2	6X6	FH	NA	NA	105	94
					TOTAL:	210	191

Comments:

Project: Wareham District Court
Address: Wareham, MA
Date: 4/13/2022 **Project No.** 22-180

FLOW METERING DATA

SYSTEM: Hot Water

ROOM OR LOCATION	UNIT NUMBER	UNIT SIZE	EWT °F	LWT °F	DESIGN GPM	SET GPM	BALANCING VLV SET @
AH-1	1	1 1/4	69	55	9		*2
AH-2	2	1 1/4	69	68	7		*2
AH-3	3	3/4	152	133	6	6.8	*1
AH-4	4	1 1/2	148	94	18.3	17.1	*1
AH-5	5	1 1/4	149	102	10	9.4	*1
AH-6	6	3/4	143	117	2	2.4	*1
AH-7	7	1 1/2	143	105	15	15.3	*1

Comments: ** Chilled water is not in service at time of testing.
*1 No balancing valve, flow was measured with an ultrasonic meter.
*2 No flow. Pipes are bound, tried letting air out.