Hingham District Court
Hingham, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

November 29, 2021

Tighe&Bond

100% Recyclable

Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Hingham District Courthouse on January 28, 2020. While on site we inspected the air handling equipment located in the mechanical rooms and on the roof and toured the facility to determine if the spaces generally matched usages noted on the architectural plans.

Site Visit Attendees:

- *Plymouth County*
  - *Jay Pinkham, Courthouse Facilities Staff*

- *Tighe & Bond*
  - *Sean Pringle, PE, Mechanical Engineer*
  - *Tim Bill, Staff Mechanical Engineer*

1.1 Existing Ventilation System

The Hingham District Courthouse was originally constructed in 1938. An addition was added in 1973, more than doubling the size of the courthouse to approximately 30,000 square feet in size.

The original building is largely unchanged since the original 1938 installation. There is no operable mechanical ventilation within the original building. Most rooms have steam radiators. The two courtrooms also have unit ventilators (UV). The outdoor air openings for the unit ventilators serving the two courtrooms are covered with plexiglass on the exterior. The outdoor air dampers appear to have rusted away completely, and the units are not currently operable. The restrooms, courtrooms, and several other locations have exhaust air openings, but the openings rely on natural draft as there is no exhaust fan in the ductwork. The perimeter rooms all have relatively large operable windows. A steam boiler provides heat to this area independent from the addition.

In the 1973 addition, ventilation is provided by a single constant airflow air handling unit, AHU-1. In perimeter rooms, outdoor air is provided through fan coil units.

AHU-1 contains a mixing section with return and outdoor air dampers, 2” MERV 10 filters, a chilled water cooling coil, and a supply fan. A dedicated return fan operates in conjunction with the air handling unit. Each zone has a hot water reheat coil in the supply ductwork to that zone. The AHU is in fair condition. The pneumatic damper actuator is disconnected, although the return and outdoor dampers appear functional. The outdoor air damper was manually set to approximately 20% open. According to staff, a UVGI lamp was installed in the fan section of the AHU in December of 2020.

AHU-2 appears to have been added recently to serve a new office area in the basement. This area was previously used for facilities storage. This unit is a residential/light commercial type unit and contains a 1” pleated filter, DX cooling coil, and supply fan. A 6” outdoor air duct provides outdoor air into the return air ductwork. According to staff, the supply fan operates continuously. A UVGI lamp was installed in the supply fan section at the same time as AHU-1.

The fan coils contain separate hot and chilled water coils with pneumatic valve actuators, and small permanent outdoor air openings without dampers. There are no air filters installed in the fan coils, and as a result, the coils were fairly dirty. According to staff, the fans operate continuously. Overall, the units are in poor condition.

The lockup area is served by an exhaust fan that was not operational at the time of the visit. Supply air is provided into the open area outside the cells and exhausted through exhaust grilles in the individual cells.

A pair of 700 MBH hot water boilers provide hot water to the fan coils, reheat coils, and perimeter radiation. A split chiller with an air cooled condenser provides chilled water to the air handler.

While touring the facility, we noted that a storage room in the basement was being used as a break room. This room did not have any mechanical ventilation.

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

TABLE 1
Existing Air Handling Units

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Filters	Condition
AHU-1	18,000	3,600	2" MERV 10	Fair
AHU-2*	Unknown (1,400 est)	Unknown	1" Pleated (MERV unknown)	Fair
FC-1 (Typical)	300	75	None	Poor
FC-2 (Typical)	400	100	None	Poor
FC-3 (Typical)	500	125	None	Poor
3rd Session UV's	Unknown	Unknown	None	Inoperable
4th Session UV's	Unknown	Unknown	None	Inoperable

*Supply Airflow estimated based on equipment nameplate cooling capacity, assuming 400 CFM/Ton.

Photo 1 – AHU-1 Air Handler

Photo 2 – Fan Coil with Cover Removed

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. While it appears the temperature controls for the AHU and fan coils are operational, the outdoor air dampers for AHU-1 are not connected and can only be moved manually.

Section 2
Recommendations

Below is a list of recommendations that we propose for the Hingham District Courthouse. Please refer to the "Master Recommendation List" for further explanation and requirements of the stated recommendations.

As noted in Section 1, the original building areas and the storage area being used as a break room in the addition do not have any means of mechanical ventilation. Building areas without adequate ventilation and filtration significantly increase the risk of spreading viruses like COVID-19, especially areas with high occupant density and where people occupy the same space for relatively long periods of time. Consider significantly reducing occupancy or relocating occupants to other areas with adequate ventilation.

2.1 Filtration Efficiency Recommendations

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

RF-1a: *Replace MERV-10 filters with MERV-13 filters.*

We recommend installing MERV-13 filters in AHU's 1 and 2 if supply airflows can be maintained.

Because AHU-2 is a residential type unit, it may not be able to maintain supply airflows with the added restriction of a MERV-13 filter. If airflow cannot be maintained, install a filter with the highest possible MERV rating while maintaining airflow.

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

See recommendation 2.7.3 for fan coil filter recommendations.

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

This recommendation applies to the AHU's only.

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

As there is no BMS, provide a local alarm. Provide a local alarm in area that will be noticed by staff.

2.2 Testing & Balancing Recommendations

The air handling equipment in the addition is approximately 45 years old and it is unknown to Tighe & Bond when the last time the units were tested and balanced. Also, the code requirements to determine the outside air flow rates that were used to design the original system may be different than the 2015 International Mechanical Code (IMC) and current ASHRAE Standard 62.1 requirements.

We recommend the following testing and balancing measures be implemented:

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

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

TABLE 2
Recommended Air Handler O.A. Flow Rates

Unit	Original Supply Airflow (CFM)	Original Design Min. O.A. (CFM)	Current Code Min. O.A. Requirements (CFM)	Recommended Minimum O.A. (CFM)
AHU-1	18,000	3,600	2,900	3,600
AHU-2	Unknown (1,400 est)	Unknown	110	150
FC-1 (Typical)	300	75	Varies	75
FC-2 (Typical)	400	100	Varies	100
FC-3 (Typical)	500	125	Varies	125

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.

*Supply Airflow estimated based on equipment nameplate cooling capacity, assuming 400 CFM/Ton.

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. Note that in all areas served by the fan coil units, the calculated outdoor air requirements based on the current code was less than the original design values.

For AHU-2, where the original design outdoor airflow is unknown, it appears the cooling coils should be able to provide adequate leaving air conditions under peak outdoor air conditions with the recommended outdoor air quantity, assuming the coils are clean, and performance has not degraded over time. Supply air temperatures during the heating and cooling season should be monitored to ensure the outdoor air does not cause comfort issues.

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. Only the areas with operable mechanical ventilation are included in the averages.

TABLE 3
Average Airflow Rate per Person

	All spaces	*Courtrooms*	*Non-Courtroom Spaces*
Total Occupancy (People)	279	164	116
Total Supply Air (CFM/Person)	93	37	170
Outdoor Air (CFM/Person)	19	7	36

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. Note that the unit ventilators serving the third and fourth session courtrooms three and are inoperable and of unknown capacity. No ventilation is provided in these courtrooms

TABLE 4
Airflow Rate per Person (Full Occupancy)

		Total Air		*Outdoor Air*	
Courtroom	*Total People*	*Supply Airflow (CFM)*	*Airflow Rate (CFM/Person)*	*Outside Airflow (CFM)*	*Airflow Rate (CFM/Person)*
First Session	150	3,840	26	768	5
Second Session	84	2,260	27	452	5
Third Session	82	0	0	0	0
Fourth Session	44	0	0	0	0

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.

TABLE 4a
Airflow Rate per Person (Reduced Occupancy)

		Total Air		Outdoor Air	
Courtroom	Total People	Supply Airflow (CFM)	Airflow Rate (CFM/Person)	Outside Airflow (CFM)	Airflow Rate (CFM/Person)
First Session	33	3,840	116	768	23
Second Session	19	2,260	119	452	24
Third Session*	16	0	0	0	0
Fourth Session*	9	0	0	0	0

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

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

This measure applies to AHU-1. Due to the age of the unit, the ability of the coil to maintain the supply air temperature is uncertain. We recommend increasing the outdoor air flow rate by only 10% beyond the recommended outdoor air flow rates during non-peak outdoor air conditions. We do not believe this would cause a threat of a potential coil to freeze given the amount of outside air as a percentage of total supply air, however cold spots on the coil may develop due to poor mixing. This may cause nuisance freeze stat trips via the existing freeze stat.

RTB-4: *Test and balance all air inlets and outlets.*

Considering the age of the systems, we recommend rebalancing all air inlets and outlets throughout the building. 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-5: *Test and balance all hot and chilled water coils.*

Testing and balancing the air handler chilled water coil, hot water reheat coils, and fan coil hot and chilled water coils will help ensure the coil is receiving the proper water flow rate. 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. At the time of the visit, the pneumatic damper actuator for AHU-1 was not operational.

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

RE-5: *Confirm the existing freeze stat is working correctly on AHU-1.*

2.4 Control System Recommendations

We recommend the following for the control system:

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

This measure applies to AHU-1. Additional controls will be required to implement this

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

This measure applies to AHU-1. The existing control system does not appear to be sophisticated enough to implement this type of sequence. Additional controls and sensors will be required. The louver serving AHU-1 appears to be suitable for up to 100% outdoor air.

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.

Due to the lack of ventilation in the original portion of the building, we recommend the use of portable HEPA filters or similar air purification approaches if the areas below are to be occupied in the near term, until adequate ventilation is added to the building. While all spaces benefit from additional air filtration, this measure is likely not necessary for single occupant offices.

- First Floor:
  - Third Session Courtroom
  - Lobby
  - Corridor (if the public is allowed to congregate in corridor)
- Second Floor
  - Juvenile Court Area
  - Corridor (if the public is allowed to congregate in corridor)
  - Fourth Session Courtroom

2.6 Other Recommendations

2.6.1 Repair or Replace Toilet Exhaust Fan

The exhaust fan serving the holding cells and several restrooms was not operating at the time of the visit. We recommend repairing or replacing this fan.

2.6.2 Add Ventilation to Employee Break Area

As noted above, staff were using an unventilated storage area as a break room at the time of the visit. If this area will continue to be used as a break room, we recommend adding ventilation to this space. This could be accomplished with a standalone AHU or fan coil with outside air, or possibly by adding ductwork from the existing AHU-1 distribution. Additional engineering design support is required to determine the best solution.

2.6.3 Add filters to Fan Coils

At the time of the visit, the fan coils did not have filters in place. This eliminates the benefit of the circulating air and will cause the coils to become dirty more quickly. We recommend installing 1" pleated filters in these units, with the highest MERV rating possible without compromising airflow (likely MERV 8 to 11). The filter brackets may need to be repaired or replaced to implement this measure.

2.6.4 Inspect Reheat Coils and Controls

The reheat coils regulate the supply air temperature delivered to each space. At a minimum, we recommend adjusting the thermostats and verifying that the supply air temperature changes in response to the thermostat setpoint. Consider cleaning the reheat coils. Any reheat coils not providing the required temperature control should be repaired or replaced.

2.6.5 Mechanical Ventilation Feasibility Study

The original 1936 Courthouse building is not mechanically ventilated. Operable windows do exist, and natural ventilation is allowable per code. However, in reality windows are typically not opened during cold or hot outdoor air temperatures, limiting the benefit. We recommend a study of the Courthouse to determine the feasibility of installing mechanical ventilation systems for all occupied spaces.

2.6.6 Install a Building Management System

We recommend replacing the pneumatic control system with a modern building management system to control and monitor HVAC equipment. Pneumatic air systems are antiquated and do not offer the same benefits as a BMS. This recommendation is primarily an energy saving and maintenance measure and does not affect the indoor air quality of the building, although it will allow ventilation control and scheduling measures to be more easily implemented.

If possible, installing a BMS should be implemented at the same time as measure 2.7.7 and 2.7.8 below as a single project.

2.6.7 Replace AHU-1 and Convert the Air Distribution System to Variable Air Volume (VAV)

Indoor air handling units have a life expectancy of 35-45 years. AHU-1 is approximately 45 years old and is at the end of its useful life. Consider replacing this unit in the next 5 years.

The current constant volume arrangement is inefficient and may cause humidity and thermal comfort issues in the building. The use of a VAV system would allow the air handlers to provide a discharge air temperature of 55°F during the summer, resulting in better control of space humidity. At each zone, the quantity of air delivered can be varied to accommodate the cooling or heating needs of the space for more precise temperature control and improved comfort. As part of this project, the existing duct arrangement and airflows should be reviewed, and revisions made where necessary to accommodate current space uses and floor plans. At minimum, each reheat coil will need to be replaced with a VAV box and reheat coil.

As part of this project, additional energy saving measures could be explored including the use of energy recovery from the toilet exhaust air to preheat incoming outdoor air, and demand-controlled ventilation (post COVID-19) to adjust the supply of outdoor air to each space in response to actual occupancy.

The conversion of the existing duct system to VAV will require an invasive construction project in occupied areas. Due to the constraints of modifying an existing building, this project will be challenging and require relocating personnel.

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

2.6.8 Replace Fan Coil Units

We recommend replacing the fan coil units within the next five years. The average life of a fan coil unit is approximately 25-35 years. The fan coil units appear to be original and are 45 years old and in poor condition, exceeding their expected useful life. This recommendation is primarily an energy saving measure and does not increase the indoor air quality of the building.

Section 3
Testing & Balancing Results

Milharmer Associates visited the Hingham District Courthouse on May 5 and 6, 2021 to test the airflow rates of the air handling units and the exhaust fans. A summary of the tested airflow rates versus the design airflow rates are shown below in Tables 5 and 6. The full testing and balancing report is attached.

TABLE 5
Air Handler 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	18,000	3,600	14,400	12,050	Unknown	12,002
AHU-2	Unknown	150	Unknown	Not Tested	Not Tested	Not Tested
FCU Type 1	300	75	225	None Tested	None Tested	None Tested
FCU Type 2	400	100	300	None Tested	None Tested	None Tested
FCU Type 3	500	125	375	None Tested	None Tested	None Tested

TABLE 6
Exhaust & Return Fan Testing & Balancing Results

Unit	Serving	Design Return/Exhaust Airflow (CFM)	Actual Return/Exhaust Airflow (CFM)
RA-1	AC-1	18,000	12,002
EF-1	Toilet	340	131
EF-2	Toilet	360	150
EF-3	Toilet	200	87
EF-4	Toilet	100	112
EF-5	Toilet	100	122
EF-6	Courtroom Relief	3,000	Inoperable
EF-7	Lockup / Toilet	700	Inoperable
EF-9	Toilet	320	140

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

1. AHU-1 is performing at 66% of the design airflow.
    a. Increasing the fan speed to meet the design airflow is not possible without doubling the motor size. The cause of the low airflows should be investigated.
    b. The pressure drop through the ductwork is relatively high. This suggests that dirty reheat coils or ductwork may be contributing to the low airflow. The supply ductwork and reheat coils should be inspected and cleaned if necessary.
    c. The outdoor air damper was not operating in sync with the return air damper. The linkage between the two should be adjusted to restore proper operation.
2. RA-1 is operating 66% below design airflow.
    a. Once AHU-1 airflow is restored, the airflow through RA-1 can likely be adjusted to meet the design airflow with a sheave adjustment.
    b. The associated relief air damper has been disconnected and the percentage of return air and outdoor air flowing to AHU-1 cannot be accurately tested. The damper and/or damper controls should be repaired to restore proper operation.
3. AHU-2 and FCU-1, 2, & 3 were not tested during this visit.
    a. AHU-2 should be tested as part of any future balancing activities.

   b. Select FCU's that provide outdoor air should be tested as part of any future balancing activities.
4. Exhaust fans EF-4 and EF-5 were operating at 110% and 120% of the design airflow, respectively.
5. Exhaust fans EF-1, 2, 3, 9, & 10 are operating between 40 and 50 percent of the design airflow. The cause of the low airflows should be investigated.
6. EF-6, 7, & 8 were inoperable at the time of the visit and should be repaired or replaced.
7. According to the balancer, dust buildup was visible on most of the exhaust registers and in the ductwork.
   a. We recommend having the duct systems and coils professionally cleaned. At minimum, this should include all of the return and exhaust ducts. If the supply ducts do not have any visible accumulation, it may be possible to omit cleaning the entire supply duct system. However, the reheat coils should still be inspected and cleaned as noted above.

Disclaimer

Tighe and Bond cannot in anyway guarantee the effectiveness of the proposed recommendations to reduce the presence or transmission of viral infection. Our scope of work is intended to inform the Office of Court Management on recommendations for best practices based on the guidelines published by ASHRAE and the CDC. Please note that these recommendations are measures that may help reduce the risk of airborne exposure to COVID-19 but cannot eliminate the exposure or the threat of the virus. Implementing the proposed recommendations will not guarantee the safety of building occupants. Tighe & Bond will not be held responsible should building occupants contract the virus. The Office of Court Management should refer to other guidelines, published by the CDC and other governing entities, such as social distancing, wearing face masks, cleaning and disinfecting surfaces, etc. to help reduce the risk of exposure of COVID-19 to building occupants.

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MILHARMER ASSOCIATES, INC.
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TEST AND BALANCE REPORT

Project: **Hingham District Court**
Hingham, MA

Project No.: **21-208** **Project Date:** **5/6/2021**

MECHANICAL CONTRACTOR
Tighe & Bond

3384

A N.E.B.B. Certified Company

Project:	Hingham District Court		
Address:	Hingham, MA		
Date:	5/6/2021	**Project No.**	21-208

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:	Hingham District Court		
Address:	Hingham, MA		
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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	8-20-20	8-20-21
2	Shortridge Flow Hood	8-20-20	8-20-21
3	Ampmeter	8-20-20	8-20-21
4	Tachometer	8-20-20	8-20-21
5	Airflow Anemometer	8-20-20	8-20-21
6	Digital Thermometers	8-20-20	8-20-21
7	Shortridge Water Meter	8-20-20	8-20-21
8	Sound Meter	8-20-20	8-20-21
9	Vibration Meter	8-20-20	8-20-21

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:	Hingham District Court		
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REPORT SUMMARY

AC-1:	Overall the A/C unit is in good condition.
	1. OA damper position is not in parrallel with the position of return.
	The linkage may need to be adjusted.
	Ex: While unit was at 100% OA, the return damper was at 50%.
	2. The discharge static of unit is high (+2.08).
	There are zone's with reheats that could possibly have dirty coils resulting
	in low airflow.
	3. The unit is 33% below design airflow and will need a sheave change to increase.
RA-1:	Fan is in good condition.
	1. The linkage on the damper at the exhaust side of plenum has been
	disconnected. Damper is approximately 10% open. Without this
	working properly, there is no accurate way to test percentage of OA/Return
	to AC-1.
	3. The unit is 33% below design airflow and will need a sheave change to increase.
EF-6, 7 & 8	Fans will not run and need to be serviced.

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REPORT SUMMARY

AIR HANDLING UNITS

UNIT	SUPPLY	RETURN	OUTSIDE AIR
AC-1	12,050 CFM	12,002 CFM	**

FANS

UNIT	EXHAUST
EF-1	131 CFM
EF-2	150 CFM
EF-3	87 CFM
EF-4	112 CFM
EF-5	122 CFM
EF-6	**
EF-7	**
EF-8	**
EF-9	140 CFM
EF-10	209 CFM

** SEE REPORT SUMMARY

Project: Hingham District Court
Address: Hingham, MA
Date: 5/6/2021 **Project No.** 21-208

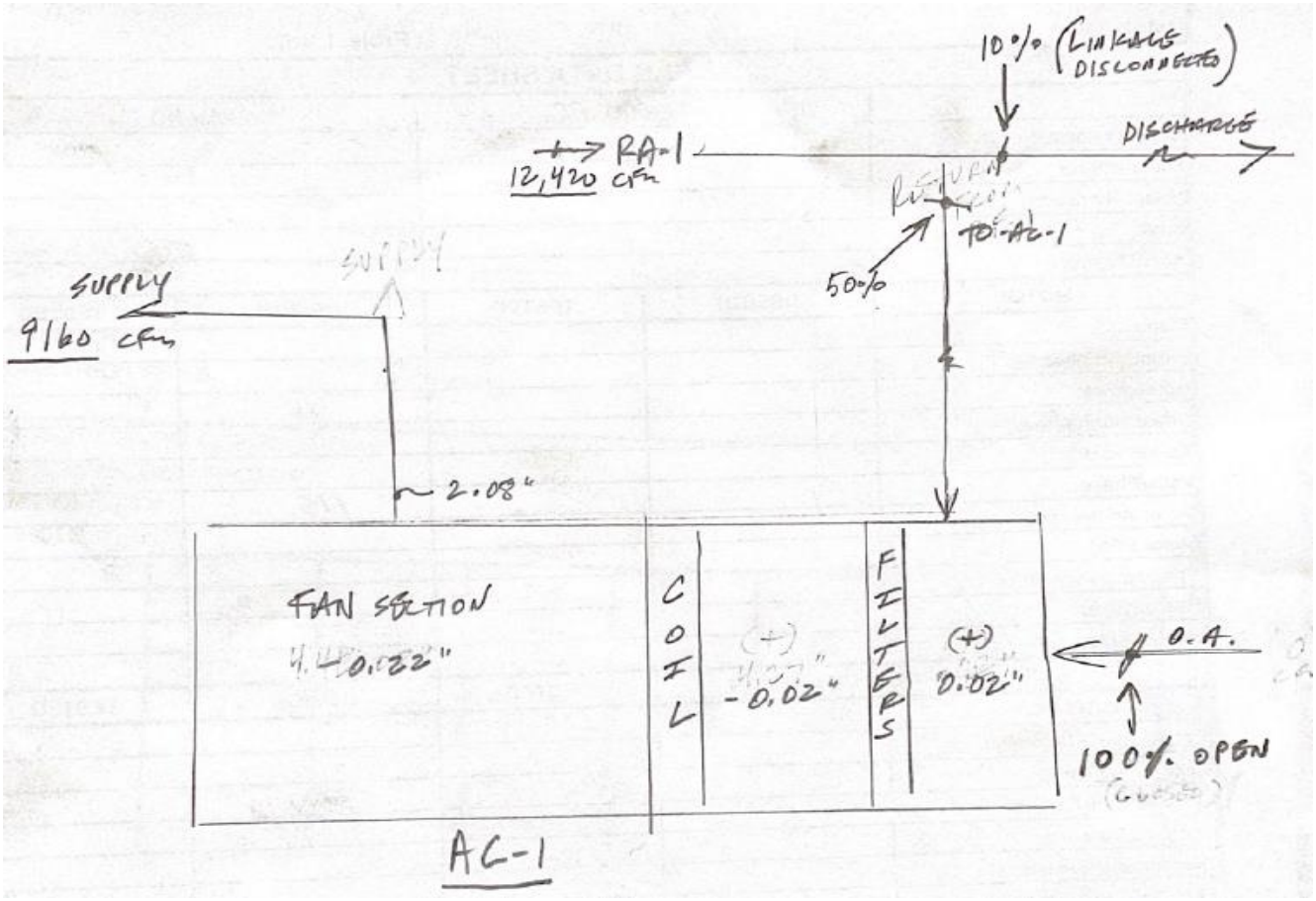
FAN DATA SHEET

	FAN NO. AC-1		FAN NO. RF-1	
Serves / Location:	Core Areas	Mech Room	Core Area	Mech Room
Manufacturer:	TRANE		TRANE	
Model Number:	L-35		81	
Size:	NL		NL	
Serial Number:	K4F262532		K4E261772	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	GE MOTORS	NL	CENTURY
Frame Number:	NL	213T	NL	184T
Horsepower:	NL	7.5	NL	5
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.15	NL	1.15
Volts/Phase:	208/3	208	208/3	208
Motor Amperage:	19.6	14.2/14/14.2	13	9.3/9.1/9.5
Motor RPM:	1750	1750	1755	1755
Speeds:	NL	1	NL	1
Heater Size:	NL	NA	NL	NA
Heater Amps.:	NL	NA	NL	NA
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:	18000	12050		
Return Air CFM:			18000	12002
Exhaust Air CFM:				
Outside Air CFM:	3600	**		
Suction Pressure:	NL	0.22	NL	-0.49
Discharge Pressure:	NL	2.08	NL	1.09
Fan Static Pressure:	NL	2.3	NL	1.58
External Pressure:	NL	NA	NL	NA
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	734	819	NL	608
Motor Drive:	NL	2BK80	NL	2VP55
Motor Size/Bore:	NL	1 1/4"	NL	1"
Fan Drive:	NL	2BK160	NL	2BK160
Fan Size/Bore:	NL	1 3/8	NL	2 1/8"
Belt Size / Number:	NL	BX95/2	NL	B150/2
Shafts C-C:	NL	30 1/8"	NL	60"
Turns Open:	NL	1	NL	1

Comments: **** Outside air cannot be set until SA/RA/OA damper linkages are repaired.**

Project:	Hingham District Court		
Address:	Hingham, MA		
Date:	5/6/2021	**Project No.**	21-208

STATIC PRESSURE PROFILE



Project: Hingham District Court
Address: Hingham, MA
Date: 5/6/2021 **Project No.** 21-208

TRAVERSE DATA

SYSTEM: AC-1 Supply
TRAVERSE NUMBER : T1
TRAVERSE LOCATION: Mech Room

DUCT SIZE (ROUND)		" DIAMETER			Sq Ft =	0.00
DUCT SIZE (RECT.)	60	" WIDTH x	24	" DEPTH	Sq Ft =	10.00

AIR DENSITY DATA

STATIC PRESS @ CL:	2.16	InWg.	DESIGN CFM =	18000
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	11980
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**12050**

AIR DENSITY RATIO CORRECTION = 1.01
SCFM CORRECTION FACTOR 1.01
ACTUAL DENSITY 0.075

TEST HOLE	1	2	3	4	5	6	7
A	1490	1424	1325	816	890	888	
B	1584	1503	1313	917	997	892	
C	1581	1453	1288	990	933	974	
D	1542	1408	1262	1003	824	929	
E	1463	1360	1340	1226	1252	1073	
F							
G							
H							
I							

NO. OF READINGS = 30 AVERAGE FPM = 1198

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Brian Murphy

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

SYSTEM: RF-1 TRAVERSE NUMBER : T1
Return TRAVERSE LOCATION: Mech Room

DUCT SIZE (ROUND)		" DIAMETER			Sq Ft =	0.00
DUCT SIZE (RECT.)	36	" WIDTH x	36	" DEPTH	Sq Ft =	9.00

AIR DENSITY DATA

STATIC PRESS @ CL:	0.14	InWg.	DESIGN CFM =	18000
DUCT AIR TEMP :	70	Deg F	ACTUAL CFM =	11991
BAROMETRIC PRESS :	29.92	In Hg.	SCFM=	**12002**

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	1262	1729	1610	1797	1730	1289	
B	1757	1790	1735	1713	1723	1207	
C	1550	1608	1737	1565	1487	1046	
D	1475	1197	1145	1078	1305	1004	
E	1356	1119	1041	960	872	718	
F	1234	1077	853	1762	653	781	
G							
H							
I							

NO. OF READINGS = 36 AVERAGE FPM = 1332

J							
K							
L							
M							
N							
O							
P							
Q							
R							

TECHNICIAN: Brian Murphy

Project: Hingham District Court
Address: Hingham, MA
Date: 5/6/2021 **Project No.** 21-208

FAN DATA SHEET

	FAN NO. EF-1		FAN NO. EF-2	
Serves / Location:	Toilet	Roof	Toilet	Roof
Manufacturer:	TWIN CITY		TWIN CITY	
Model Number:	DCRD070B2		DCRD120B	
Size:	NL		NL	
Serial Number:	K17-00000255233		L17-0000237591	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	CF	NL	CF
Frame Number:	NL	48	NL	48
Horsepower:	NL	1/8	NL	1/15
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	NA	NL	NA
Volts/Phase:	115/1	115	115/3	115
Motor Amperage:	1.7	NA	0.8	NA
Motor RPM:	NL	NA	NL	NA
Speeds:	NL	NA	NL	NA
Heater Size:	NL	NA	NL	NA
Heater Amps.:	NL	NA	NL	NA
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:				
Return Air CFM:				
Exhaust Air CFM:	360	131	340	150
Outside Air CFM:				
Suction Pressure:				
Discharge Pressure:				
Fan Static Pressure:				
External Pressure:				
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Motor Drive:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Motor Size/Bore:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Fan Drive:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Fan Size/Bore:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Belt Size / Number:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Shafts C-C:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Turns Open:	NL	DIRECT DRIVE	NL	DIRECT DRIVE

Comments:

Project: Hingham District Court
Address: Hingham, MA
Date: 5/6/2021 **Project No.** 21-208

AIR DISTRIBUTION

SYSTEM: EXHAUST FANS AS NOTED.

SUPPLY [ ] RETURN [ ] EXHAUST [X]

ROOM OR LOCATION	UNIT NUMBER	UNIT SIZE	AREAxK FACTOR	DESIGN FT/MIN	TEST FT/MIN	DESIGN CFM	TESTED CFM
	EF-1						
Men	1	6X4	FH	NA	NA	180	85
Women	2	6X4	FH	NA	NA	180	46
					TOTALS:	360	131
	EF-2						
Men	1	4X8	FH	NA	NA	120	58
Women	2	4X8	FH	NA	NA	120	42
Women	3	4X8	FH	NA	NA	100	50
					TOTALS:	340	150

Comments:

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

	FAN NO. EF-3		FAN NO. EF-4	
Serves / Location:	Toilet	Roof	Toilet	Roof
Manufacturer:	TWIN CITY		TWIN CITY	
Model Number:	DCRD090B2		DCRD0070B2	
Size:	NL		NL	
Serial Number:	L17-000000232413		K17-000000235234	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	CF	NL	CF
Frame Number:	NL	48	NL	48
Horsepower:	NL	1/8	NL	1/8
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1	NL	1
Volts/Phase:	115	NA	115	NA
Motor Amperage:	1.7	NA	1.7	NA
Motor RPM:	1350	NA	1350	NA
Speeds:	NL	NA	NL	NA
Heater Size:	NL	NA	NL	NA
Heater Amps.:	NL	NA	NL	NA
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:				
Return Air CFM:				
Exhaust Air CFM:	100	87	100	112
Outside Air CFM:				
Suction Pressure:				
Discharge Pressure:				
Fan Static Pressure:				
External Pressure:				
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Motor Drive:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Motor Size/Bore:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Fan Drive:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Fan Size/Bore:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Belt Size / Number:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Shafts C-C:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Turns Open:	NL	DIRECT DRIVE	NL	DIRECT DRIVE

Comments:

Project: Hingham District Court
Address: Hingham, MA
Date: 5/6/2021 **Project No.** 21-208

AIR DISTRIBUTION

SYSTEM: EXHAUST FANS AS NOTED.

SUPPLY [ ] RETURN [ ] EXHAUST [X]

ROOM OR LOCATION	UNIT NUMBER	UNIT SIZE	AREAxK FACTOR	DESIGN FT/MIN	TEST FT/MIN	DESIGN CFM	TESTED CFM
	EF-3						
Janitor	1	8X4	FH	NA	NA	100	87

Comments:

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

	FAN NO. EF-5		FAN NO. EF-6	
Serves / Location:	Toilet	Roof	Toilet	Roof
Manufacturer:	TWIN CITY		TWIN CITY	
Model Number:	DCRD095B2		DCRD300D	
Size:	NL		NL	
Serial Number:	K17-000000236713		L17-0000000237567	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	CF	NL	US MOTOR
Frame Number:	NL	48	NL	56
Horsepower:	NL	1/8	NL	1/2
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	NA	NL	1.15
Volts/Phase:	115	NA	208/3	NA
Motor Amperage:	1.7	NA	1.8	NA
Motor RPM:	NL	NA	1725	NA
Speeds:	NL	NA	NL	NA
Heater Size:	NL	NA	NL	NA
Heater Amps.:	NL	NA	NL	NA
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:				
Return Air CFM:				
Exhaust Air CFM:	100	122	3000	*1
Outside Air CFM:				
Suction Pressure:				
Discharge Pressure:				
Fan Static Pressure:				
External Pressure:				
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	NL	DIRECT DRIVE	NL	NA
Motor Drive:	NL	DIRECT DRIVE	NL	1VP30
Motor Size/Bore:	NL	DIRECT DRIVE	NL	5/8
Fan Drive:	NL	DIRECT DRIVE	NL	AK114
Fan Size/Bore:	NL	DIRECT DRIVE	NL	1 1/8"
Belt Size / Number:	NL	DIRECT DRIVE	NL	4L420/1
Shafts C-C:	NL	DIRECT DRIVE	NL	10"
Turns Open:	NL	DIRECT DRIVE	NL	3

Comments: ***1 Fan is not running.**

Project: Hingham District Court
Address: Hingham, MA
Date: 5/6/2021 **Project No.** 21-208

FAN DATA SHEET

	FAN NO. EF-7		FAN NO. EF-8	
Serves / Location:	Court Offices	Boiler Mech.	Boiler Room	
Manufacturer:	NO TAG		NO TAG	
Model Number:				
Size:				
Serial Number:				
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	CENTURY	NL	CENTURY
Frame Number:	NL		NL	
Horsepower:	NL	1/6	NL	1/6
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.35	NL	1.35
Volts/Phase:	115		115	
Motor Amperage:	4.9		4.9	
Motor RPM:	1725		1725	
Speeds:	NL		NL	
Heater Size:	NL		NL	
Heater Amps.:	NL		NL	
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:				
Return Air CFM:				
Exhaust Air CFM:	700	*1	940	*1
Outside Air CFM:				
Suction Pressure:				
Discharge Pressure:				
Fan Static Pressure:				
External Pressure:				
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	NL	NO ACCESS	NL	NO ACCESS
Motor Drive:	NL	NO ACCESS	NL	NO ACCESS
Motor Size/Bore:	NL	NO ACCESS	NL	NO ACCESS
Fan Drive:	NL	NO ACCESS	NL	NO ACCESS
Fan Size/Bore:	NL	NO ACCESS	NL	NO ACCESS
Belt Size / Number:	NL	NO ACCESS	NL	NO ACCESS
Shafts C-C:	NL	NO ACCESS	NL	NO ACCESS
Turns Open:	NL	NO ACCESS	NL	NO ACCESS

Comments: ***1 Fan is not running.**

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

	FAN NO. EF-9		FAN NO. EF-10	
Serves / Location:	Toilet	Roof	Elec. Room	Roof
Manufacturer:	TWIN CITY		TWIN CITY	
Model Number:	DCRD120B		DCR-007032	
Size:	NL		NL	
Serial Number:	L17-0000237592		K17-000000235234	
MOTOR	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Manufacturer:	NL	GW INDUSTRY	NL	CF
Frame Number:	NL	48	NL	48
Horsepower:	NL	1/15	NL	1/8
Brake Horsepower:	NL	NA	NL	NA
Safety Factor:	NL	1.15	NL	1
Volts/Phase:	115/1	NA	115/1	NA
Motor Amperage:	0.8	NA	1.7	NA
Motor RPM:	860	NA	1350	NA
Speeds:	NL	NA	NL	NA
Heater Size:	NL	NA	NL	NA
Heater Amps.:	NL	NA	NL	NA
FAN	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Supply Air CFM:				
Return Air CFM:				
Exhaust Air CFM:	320	140	400	209
Outside Air CFM:				
Suction Pressure:				
Discharge Pressure:				
Fan Static Pressure:				
External Pressure:				
RPM	**DESIGN**	**TESTED**	**DESIGN**	**TESTED**
Fan RPM:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Motor Drive:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Motor Size/Bore:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Fan Drive:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Fan Size/Bore:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Belt Size / Number:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Shafts C-C:	NL	DIRECT DRIVE	NL	DIRECT DRIVE
Turns Open:	NL	DIRECT DRIVE	NL	DIRECT DRIVE

Comments:

Project: Hingham District Court
Address: Hingham, MA
Date: 5/6/2021 **Project No.** 21-208

AIR DISTRIBUTION

SYSTEM: EXHAUST FANS AS NOTED.

SUPPLY [ ] RETURN [ ] EXHAUST [X]

ROOM OR LOCATION	UNIT NUMBER	UNIT SIZE	AREAxK FACTOR	DESIGN FT/MIN	TEST FT/MIN	DESIGN CFM	TESTED CFM
	EF-9						
Men	1	8X4	FH	NA	NA	100	39
Janitor	2	8X4	FH	NA	NA	100	54
Bathroom		8X4	FH	NA	NA	100	47
					TOTALS:	300	140
	EF-10						
ELEC. RM.	3	12X12	FH	NA	NA	400	209

Comments: