Massachusetts Probation Service Training and Operations Center

Clinton, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

June 14, 2022

Tighe&Bond

Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Massachusetts Probation Service Training and Operations Center (MTOC) in Clinton on April 28, 2021. While on site we inspected the air distribution systems visible in the space and toured the facility to determine if the spaces generally matched usages noted on the architectural plans. We were unable to secure permission from the property manager to access the roof but were able to see some rooftop units from windows on the upper floor.

Site Visit Attendees:

- *MTOC:*
    - Dianne Fasano, Deputy Commissioner
    - Daniel Pires, Electronic Monitoring Manager
    - Patricia Gavin, Training Manager
- *Tighe & Bond:*
    - Todd R. Holland, PE, Senior Mechanical Engineer
    - Matthew P. Mancini, Staff Mechanical Engineer

1.1 Existing Ventilation System

The MTOC facility is a two-story historic mill building, renovated in 2019, and approximately 23,600 square feet in size. Eight constant volume packaged rooftop units (RTUs) cool, heat, and provide ventilation air to the building. Each unit contains a supply fan, direct expansion (DX) refrigerant cooling coil, and a gas-fired furnace. According to the property manager, filters were recently replaced and upgraded to MERV-11.

Photo 1 – Representative Rooftop Unit (RTU-1, note gas supply not connected)

These units were existing prior to the 2019 renovation and appear to be 10-15 years old. We were unable to access these units for a better inspection, to determine whether they were running, and if the outdoor air dampers are operational. One RTU, which serves the single-story training department, does not have its gas heat connected. This area of the building was heated this winter by portable electric resistance heaters. There are 10 RTUs on the roof, but two have no distribution ductwork on the plans and are most likely serving areas on the lower level that are not leased by the Trial Courts.

The distribution ductwork was all replaced during the 2019 renovation, using a bypass VAV design. Each single-zone constant volume RTU serves two or three sub-zones with control dampers controlled by individual temperature sensors located in the space. A bypass damper in the supply trunk, controlled by static pressure, redirects the conditioned air directly into the return ducts when one or more zone dampers are closed. This allows a constant volume unit to serve VAV distribution, but without the energy savings normally associated with VAV systems. It appears that the zone dampers are set to close fully, so that zones will not receive mechanical ventilation when not calling for heating or cooling.

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)	Pre/Final Filters	Condition
RTU-1	3,000	300	MERV-11*	Unknown
RTU-2	4,000	400	MERV-11*	Unknown
RTU-3	2,000	200	MERV-11*	Unknown
RTU-4	4,000	400	MERV-11*	Unknown
RTU-5	-------------------------- (not used) --------------------------			
RTU-6	4,000	400	MERV-11*	Unknown
RTU-7	5,000	500	MERV-11*	Unknown
RTU-8	5,000	500	MERV-11*	Unknown
RTU-9	-------------------------- (not used) --------------------------			
RTU-10	2,400	240	MERV-11*	Unknown

*According to property manager

According to the plans, there are three toilet exhaust fans that were installed during the 2019 renovation. We were able to verify some airflow from exhaust grilles in toilet rooms on the first floor, but there was zero airflow detected in the toilet rooms, locker rooms, and shower rooms on the second floor.

The 2019 design drawings show for the RTUs to be replaced with new variable air volume (VAV) units with variable speed fans, but this was not part of the actual project. The design drawings also call for carbon dioxide (CO_2) sensors in each room over 300 sq. ft., used to control exhaust fans that serve the spaces. We were unable to verify that these sensors or fans were installed in any of the large training rooms. Carbon monoxide (CO) sensors were also specified, one or more for every 3,000 sq. ft., but we were unable to locate these. The testing, adjusting, and balancing (TAB) report provided by the property manager also notes the absence of CO sensors.

Photo 3 – Zone Dampers in Fully Open and Fully Closed Positions

1.2 Existing Control System

Each RTU is controlled by Honeywell TrueZONE bypass VAV system, which consists of a zoning panel, thermostats, zone dampers, a pressure relief damper, and a discharge air temperature sensor. It is a simple, low-cost system usually used for residential or light commercial applications.

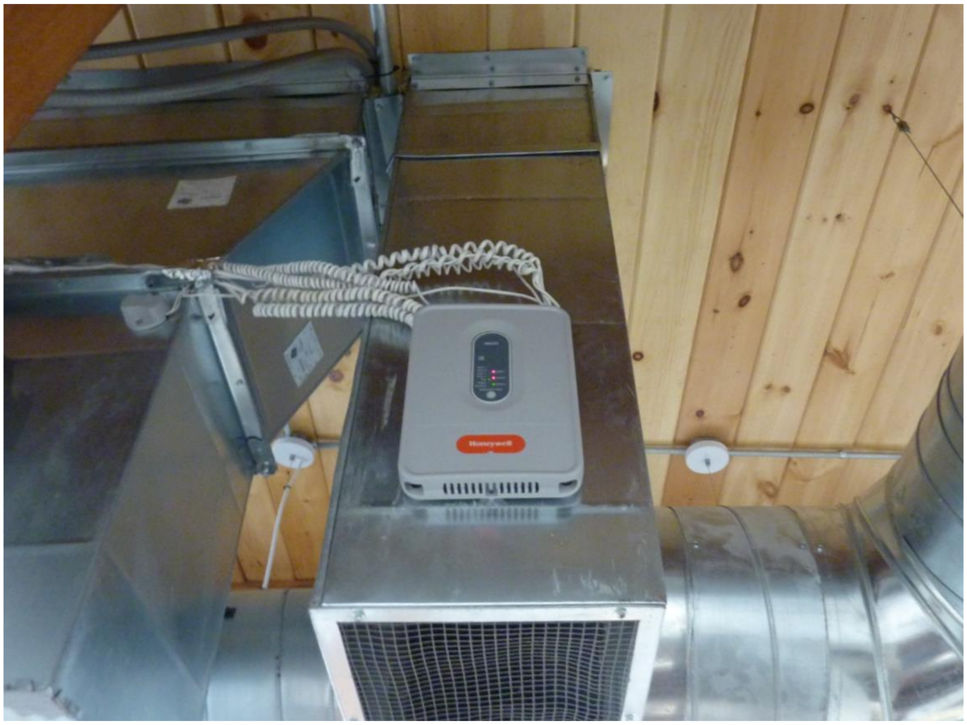

Photo 4 – Bypass VAV System Controller

Zone thermostats control temperature setpoints, fan operation, and unit start/stop with seven-day schedules. We noted all thermostats had the fan set to “auto” mode, which shuts down the supply fan and mechanical ventilation when space temperatures are satisfied. MTOC personnel noted that schedules have been overridden for occupied mode 24/7.

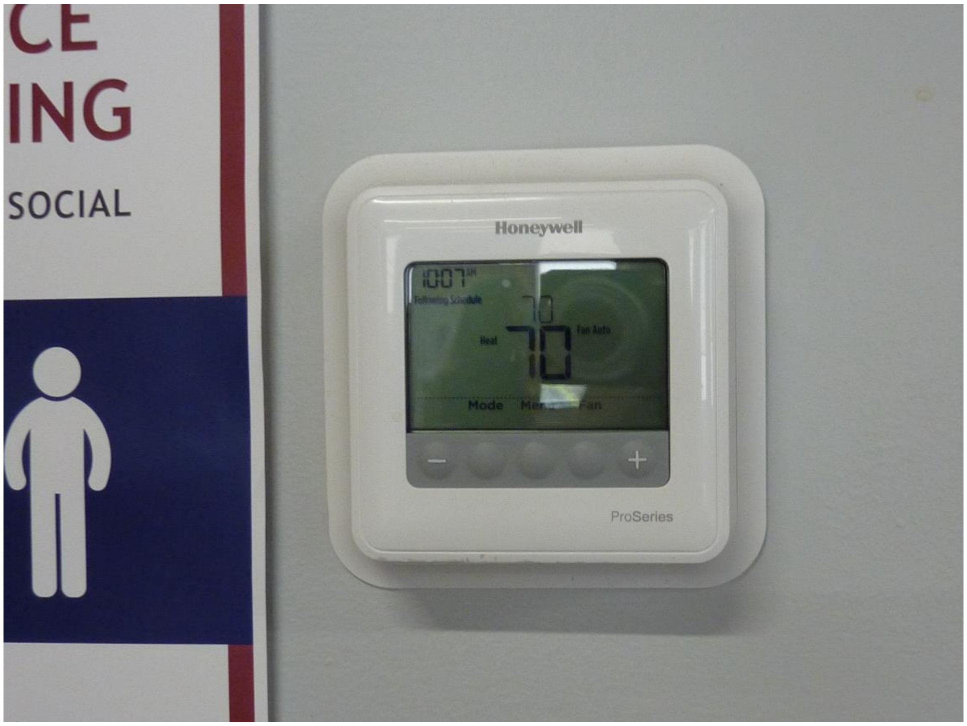

Photo 5 – Representative Zone Thermostat

We are not aware of any demand control ventilation sequences in use at this courthouse, although design documents call for CO_2 sensors in larger meeting rooms.

Section 2 Recommendations

Below is a list of recommendations for the MTOC facility. Please refer to the "Master Recommendation List" for further explanation and requirements of the stated recommendations.

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

The filters in the air handlers were already upgraded with 2" MERV-11 filters. While these are an improvement over more typical MERV-8 filters, MERV-13 is the minimum recommended by ASHRAE during the pandemic.

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

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

The TAB Contractor and/or Engineer shall verify that the RTUs can accommodate MERV-13 filters per Appendix A in the overview of recommendations report. Filter racks should be inspected and adjusted to ensure that filters fit tightly and that end spacers are in place to minimize filter bypass.

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

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.

2.2 Testing & Balancing Recommendations

The air handling systems were tested and balanced by Air Solutions & Balancing, LLC, in August 2019. These values are listed below in Table 2a. It is unknown to Tighe & Bond whether the design ventilation and minimum outdoor air rates meet the 2015 International Mechanical Code (IMC) and current ASHRAE Standard 62.1 requirements, because it appears that only one of the systems was tested for outdoor airflow.

The report was incomplete and very confusing, with some obvious mistakes in nomenclature that made it very difficult to follow. Some of the measured supply airflows are well outside the accepted tolerance of ±10%, but these may be errors in nomenclature. We have presented these numbers in Table 2a, but do not recommend relying on them.

TABLE 2a
Air Handler Testing & Balancing Results

	Design			Actual		
Unit	Original Supply Airflow (CFM)	Original Design Min. O.A. (CFM)	Original Return Airflow (CFM)	Supply Airflow (CFM)	Outdoor Airflow (CFM)	Return Airflow (CFM)
RTU-1	3,000	300	2,700	1,804	No reading	No reading
RTU-2	4,000	400	3,600	3,143	No reading	No reading
RTU-3	2,000	200	1,800	2,382	No reading	No reading
RTU-4	4,000	400	3,600	3,359	No reading	No reading
RTU-6	4,000	400	3,600	3,962	No reading	No reading
RTU-7	5,000	500	4,500	4,758	No reading	No reading
RTU-8	5,000	500	4,500	3,265	No reading	No reading
RTU-10	2,400	240	2,160	2,625	243	2,382

We recommend the following testing and balancing measures be implemented:

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

We recommend testing and balancing the supply and outdoor airflow rates for all rooftop units to the original supply and recommended minimum O.A. rates listed in Table 2b.

TABLE 2b
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)
RTU-1	3,000	300	547	**550**
RTU-2	4,000	400	736	**750**
RTU-3	2,000	200	380	**380**
RTU-4	4,000	400	558	**600**
RTU-6	4,000	400	732	**732**
RTU-7	5,000	500	571	**600**
RTU-8	5,000	500	854	**860**
RTU-10	2,400	240	442	**450**

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.

We based our ventilation calculations on minimum zone damper positions of 50% for classrooms, conference rooms, and break rooms, and 40% for offices and other areas in order to determine the minimum airflow rates in each space. The minimum airflow rates delivered to each space affects the quantity of code required ventilation air. These values should be reviewed with the original design engineer, as they will affect the minimum OA values if changed. The controls are presently set up to close these zone dampers fully when space temperatures are satisfied, which also cuts off ventilation. Measure RTB-4 recommends testing zone damper airflows, and a recommendation to reset the zone minimum airflows is included in Section 2.7.

According to our calculations, none of the existing air handling systems were designed to deliver code-required ventilation levels, as the design documents list 10% OA for all units. We recommend increasing the outdoor air beyond the original design. If the existing units have the same capacities as those in the design documents, it appears the cooling and heating capacities should be able to provide leaving air conditions similar to the original design under peak outdoor air conditions, assuming these capacities have not degraded significantly over time. Supply air temperatures during the heating and cooling season should be monitored to ensure they are not dropping below design values. Note that the gas furnace heating capacities are based on the "Permit Set" of HVAC drawings that show the rooftop units being replaced in 2019. These units were not replaced as part of that renovation, and Tighe & Bond was unable to access the roof to verify nameplate information during our site visit. These values may change if the actual heating capacities can be provided.

This measure includes balancing the total supply airflow through each unit, and the values shown as "Original Supply Airflow (CFM)" in Tables 2a and 2b are from the Packaged Rooftop Unit Schedule in the HVAC drawings. There are several units where the sum of the airflows through the diffusers and zone dampers do not add up those listed values, shown in Table 2c. The total system airflows for RTU-3, RTU-4, RTU-6, and RTU-10 fall significantly short of the scheduled supply airflow. We also recommend reviewing these airflows with the original design engineer.

TABLE 2c
Discrepancy in Supply Airflow from Design Documents

Unit	Scheduled Supply Airflow (CFM)	Measured Supply Airflow (CFM)	Difference
RTU-1	3,000	2,960	-1%
RTU-2	4,000	3,880	-3%
RTU-3	**2,000**	**1,660**	**-17%**
RTU-4	**4,000**	**3,040**	**-24%**
RTU-6	**4,000**	**2,100**	**-48%**
RTU-7	5,000	5,090	+2%
RTU-8	5,000	4,690	-6%
RTU-10	**2,400**	**1,920**	**-20%**

Our ventilation air analysis discovered that many spaces were not receiving the correct quantity of outdoor air based on today's code requirements at full occupancy. Our calculations showed that the quantity of outdoor air required per code would result in a significant increase in outdoor air for some rooftop units, increasing the load on the heating and cooling coils. In several cases these loads appear to exceed the capacity of the units. We recommend temporarily reducing the occupancy of the spaces that are not receiving the code required ventilation air. Table 3 lists the spaces that would require a reduced occupancy. The recommended outdoor air flow rates listed in Table 2 reflect the outdoor air requirements based on a reduced occupancy shown in Table 3.

TABLE 3
Recommended Occupancy During COVID-19 Pandemic

Room & Associated AHU	***2015 IMC Permitted Occupancy (# of People)***	***Recommended Occupancy (# of People)***
RTU-1		
Conference Room 111	23	**16**
Staff Support Kitchen 113	14	**5**
RTU-2		
Training/Conf. Room 122A	48	**28**

Break Room 411	34	**15**
RTU-4		
Staff Lounge 220	8	**4**
RTU-6		
Computer Classroom 124	28	**14**
RTU-8		
Training/Conf. Room 122B	56	**14**
Training Room 129	38	**9**
RTU-10		
Classroom 2 202	20	**6**
Classroom 3 201	26	**7**

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)	259	0	259
Total Supply Air (CFM/Person)	98	N/A	98
Outdoor Air (CFM/Person)	19	N/A	19

There are no courtrooms or jury pool rooms at the MTOC facility in Clinton. Table 4, which in other reports shows airflow rate per person at full occupancy, and Table 4a, which shows airflow rate per person at reduced occupancy, are not included in this report.

RTB-4: *Test and balance zone damper flow rates.*

We recommend testing and balancing the zone dampers to ensure each space is being supplied the proper quantity of air. The recommended minimum outdoor air values should be recalculated if the zone airflows differ significantly from design.

RTB-6: *Test and balance all packaged rooftop unit cooling coils and gas furnaces.*

Testing and balancing the rooftop units will help ensure they are delivering the required cooling and heating capacities. Confirm that the refrigerant systems are operating correctly to ensure the DX coils are receiving full refrigerant flow. Due to the age of the coils and heat exchangers, they may not perform as required to properly temper the supply air. Coils and heat exchangers 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 packaged rooftop unit dampers and actuators for proper operation*.

Replace dampers and actuators that are not functioning properly.

RE-2: *Clean packaged rooftop unit coils and drain pans.*

RE-4: *Inspect zone dampers, bypass dampers, and controllers.*

Zone dampers regulate the supply air delivered to each space, and bypass dampers regulate the supply air short-circuited to the return duct when zone temperatures are satisfied. At a minimum, we recommend cycling the damper positions and testing the airflow to verify the maximum and minimum airflow rates are being delivered as designed. Any dampers not delivering the expected airflow rates should be rebalanced or replaced.

2.4 Control System Recommendations

We recommend the following for the control system:

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

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

We could not confirm if these units contain an economizer sequence. If they do, they should be tested to ensure they are working properly.

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 training facility is to operate at a high capacity (i.e. 50% occupancy or greater), we recommend installing portable HEPA filters in high-occupancy areas. They should also be considered for classrooms, training rooms, and break rooms as listed below. The number of units used in each space will depend on the occupancy of the room and how much noise is generated from the filters. The noise levels will vary depending on the manufacturer.

- Conference Rm. 102
- Conference Rm. 111
- Staff Kitchen 113
- Training Rm. 122A
- Training Rm. 122B
- Computer Class 124
- Training Rm. 129
- Classroom 3 201
- Classroom 2 202
- Staff Lounge 220

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

2.7.1 Reset Zone Damper Minimum Airflow Stops

We recommend setting the minimum positions for all zone dampers based on required ventilation rates. The controls appear to be presently set up to close zone dampers fully when space temperatures are satisfied, which also cuts off ventilation air to the spaces. We based our ventilation calculations on minimum zone damper positions of 50% for classrooms, conference rooms, and break rooms, and 40% for offices and other areas. Minimum zone damper positions were not specified on the design documents.

2.7.2 Run Supply Fans Continuously During Occupied Hours

All units 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 or cooling is staged on and off, and the systems may not have been designed to operate like this originally.

2.7.3 Replace Packaged Rooftop Units

Light commercial-grade packaged rooftop units have a life expectancy of 10-15 years. These units were existing prior to the 2019 renovation and appear to be at the end of their service lives. This is based on a visual assessment from a distance, as we were unable to access the roof for a better inspection. Consider replacing these units in the next 1-2 years.

True VAV units that have variable-speed fans and air-source heat pumps could provide significant energy savings, a significant reduction in noise, increased comfort, and use MERV-13 filters. The replacement units should be specified with capacities sufficient to handle the proper amount of ventilation air for all spaces, under full occupancy.

2.7.4 Install a Building Management System

We recommend replacing the existing residential/light commercial controls with a Building Management System to control and monitor HVAC equipment. This recommendation is an energy saving and maintenance measure and does may affect the indoor air quality of the building.

2.7.5 Repair or Replace Toilet and Locker Room Exhaust Fans

We recommend repairing or replacing all exhaust fans that are not working or are not exhausting the proper airflow rate.

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.

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Section 3
Testing & Balancing Results

Wing's Testing and Balancing Co. visited the Massachusetts Probation Service Training and Operations Center (MTOC) in Clinton on March 8 - 14, 2022 to test the airflow rates of the air handling units and the exhaust fans. A summary of the tested airflow and water flow 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 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)**
RTU-1	3,000	550	2,450	2,889	559	2,330
RTU-2	4,000	750	3,250	**3,260**	**654**	**2,606**
RTU-3	2,000	380	1,620	1,860	410	1,450
RTU-4	4,000	400	3,600	4,329	412	3,917
RTU-6	4,000	400	3,600	**1,510**	**154**	**1,356**
RTU-7	5,000	600	4,400	**4,276**	**515**	**3,761**
RTU-8	5,000	860	4,140	**2,751**	**459**	**2,292**
RTU-10	2,400	450	1,950	**1,224**	**228**	**996**

TABLE 6
Exhaust Fan Testing & Balancing Results

Unit	Serving	Design Exhaust Airflow (CFM)	Actual Exhaust Airflow (CFM)
EF-1	Restrooms	120	**190**
EF-2	Restrooms	120	**191**

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. On the first day of testing, none of the outdoor air dampers were operational. A technician fixed these on day two and rewired the controls.

2. Toilet exhaust fans EF-1 and EF-2 are not performing within acceptable range. While we would normally recommend rebalancing these fans to their design airflow rates, the excess exhaust flow is relatively small and should not affect zone or building pressurization.

3. There continues to be confusion with rooftop unit numbering and the actual design airflow values. The balancing report used the numbering convention from the roof plan and the new labels on the RTUs, which may not match the schedules.

    a. Before implementing any of the recommendations below, Tighe & Bond believes it is imperative to verify the design airflow rates. This may be able to be accomplished if we request selection data from the manufacturer based on nameplate data, however the manufacture may not have records of these units. We can then cross reference this with the discharge duct dimensions provided in the balancing report.

    b. Note that the recommendations below are provided conditionally, pending verification of design airflows.

4. Three out of eight rooftop air handling units are providing acceptable supply airflow; the remainder are performing well below the acceptable airflow range. Measured airflow rates outside of the 10% tolerance are shown in **boldface** in Tables 5 and 6.

5. RTU-2, RTU-7, and RTU-10 are operating well below the specified tolerance for their design airflow rates. The balancing contractor noted that these units will require a sheave change in order to bring the unit up to the design airflow rates. We recommend changing the supply fan sheaves for these units and rebalancing them to their design airflow rates.

6. RTU-6 is operating more than 60% below its design airflow rates. The balancing contractor noted that this unit has a 1.5-HP motor and the motors for the other units are 3-HP. Further, the unit is scheduled to have a 2-HP motor in the design drawings. We recommend replacing the motor and rebalancing to the design airflow rates.

WING'S TESTING & BALANCING CO., INC.

Massachusetts Probation Services

Training and Operations Center HVAC / Fresh Air Ventilation Survey

* * * *

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

March 14th, 2022

WING'S TESTING & BALANCING CO., INC.

March 14th, 2022

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

Re: Massachusetts Probation Services TOC / HVAC Fresh Air Ventilation Survey

Dear Jason,

Wing's has completed the HVAC Fresh Air Ventilation Survey for the above referenced location. The results are as follows:

Initial observations:

- On the first day of testing, units were unable to be kept on during testing and none of the outside air louvers were functional.
- On the second day, the client provided our team with a field tech that was extremely helpful.
  - The tech fixed every outside air louver and rewired the controls.
- The numbering of these units is questionable as some units tested nowhere near design.
  - Our team based the numbering off the roof print (and the new labels on them).

Testing observations:

- RTU-2 needs a sheave change to meet design.
- RTU-6 is only supplying 1510 CFM out of a design of 4000 CFM.
- RTU-7 needs a sheave change to get within design CFM.
- RTU-10 needs a sheave change to get within design CFM.

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

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

Barry Stratos
Certified TABB Technician
CT SM-2 License 6386
MA SM-2 13595

SUPPLY FAN REPORT

PROJECT:	Massachusetts Probation Services Training and Operations Center	**DATE:** 3/8/22
AREA SERVED:	RTUs	**TECH:** BS

FAN DATA

FAN NUMBER	RTU-1		RTU-2		RTU-3	
LOCATION	Roof		Roof		Roof	
AREA SERVED	Offices		Training + Break		Entry, 101, 102, 103	
MANUFACTURER	Daikin		Daikin		Daikin	
MODEL OR SIZE	DCG1502103B		DCG1502103B		DCG1502103B	
	DESIGN	**ACTUAL**	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**
TOTAL CFM	3000	2889	4000	3260 (1)	2000	1860
RETURN AIR	2450	2330	3250	2606	1620	1450
OUTSIDE AIR	550	559	750	654	380	410
DISCH. STATIC	---	+0.30"	---	+0.48"	---	+0.73"
SUCTION STATIC	---	-0.75"	---	-1.21"	---	-0.33"
TOTAL STATIC	---	1.05"	---	1.69"	---	1.06"
FAN RPM	NA	1144	NA	873	NA	786
PULLEY O.D.	5.5" x 1"		7.25" x 1"		7.5" x 1"	
ESP	0.63		1.21		0.85	
VFD SPEED	No VFD		No VFD		No VFD	
O.A.D.MIN POS	35%		30%		30%	

MOTOR DATA

MANUFACTURER		US Motors		US Motors		US Motors	
MODEL OR FR.		NA		NA		NA	
HORSEPOWER		3	3	2	2	2	2
MOTOR RPM		1725	1725	1745	1745	1725	1725
VOLTAGE / PH.		208/3	208/3	208/3	208/3	208/3	208/3
AMPS	**LEG 1**	9.0	6.4	7.6	5.4	7.6	4.6
	LEG 2	---	6.5	---	5.4	---	4.7
	LEG 3	---	6.4	---	5.4	---	4.7
SHEAVE O.D.		3.75" x 7/8"		3.75" x 7/8"		3.75" x 7/8"	
BELTS - QUANTITY / SIZE		1/AX48		1/AX51		1/AX51	
SHEAVE POSITION		Fully open		Fully closed		3/4 closed	
C to C		18.5		18.5		18.0	

REMARKS

(1) This unit needs a sheave change in order to meet design CFM.

NA Not Available | **ND** No Design | **DD** Direct Drive | **N/R** No Requirement

SUPPLY FAN REPORT

PROJECT: Massachusetts Probation Services Training and Operations Center **DATE:** 3/10/22

AREA SERVED: RTUs **TECH:** BS

FAN DATA						
FAN NUMBER	RTU-4		RTU-6		RTU-7	
LOCATION	Roof		Roof		Roof	
AREA SERVED	Staff Lounge		Computer 124		Elmo (ASU)	
MANUFACTURER	Daikin		Daikin		Daikin	
MODEL OR SIZE	DCG1502103B		DCG1502103B		DCG1502103B	
	DESIGN	**ACTUAL**	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**
TOTAL CFM	4000	4329	4000	1510 (3)	5000	4276 (1)
RETURN AIR	3600	3917	3600	1356	4400	3761
OUTSIDE AIR	400	412	400	154	600	515
DISCH. STATIC	---	+0.43"	---	+0.47"	---	+0.68"
SUCTION STATIC	---	-0.78"	---	-0.61"	---	-1.14"
TOTAL STATIC	---	1.21"	---	1.14"	---	1.82"
FAN RPM	NA	966	NA	732	NA	971
PULLEY O.D.	6.5" x 1"		7.0" x 1"		6.5" x 1"	
ESP	0.73		0.73		1.24	
VFD SPEED	No VFD		No VFD		No VFD	
O.A.D.MIN POS	35%		18%		9%	

MOTOR DATA							
MANUFACTURER		US Motors		US Motors		US Motors	
MODEL OR FR.		NA		NA		NA	
HORSEPOWER		3	3	1 1/2	1 1/2	3	3
MOTOR RPM		1725	1725	1745	1745	1725	1725
VOLTAGE / PH.		208/3	208/3	208/3	208/3	230/3	230/3
AMPS	**LEG 1**	9.0	8.4	4.8	3.5	9.0	8.3
	LEG 2	---	8.5	---	3.5	---	8.3
	LEG 3	---	8.5	---	3.5	---	8.4
SHEAVE O.D.		3.75" x 7/8"		4.0" x 7/8" (2)		3.75" x 7/8"	
BELTS - QUANTITY / SIZE		1/A x 49		1/A x 51		1/A x 49	
SHEAVE POSITION		Fully open		Fully open		Fully open	
C to C		18.5		18.5		17.5	

REMARKS

(1) A sheave change is required to get this unit within design CFM.
(2) Motor sheave seized and unable to move.
(3) This unit has a 1 1/2 HP motor. All other units of the same design have 3 HP motors.

NA Not Available | **ND** No Design | **DD** Direct Drive | **N/R** No Requirement

SUPPLY FAN REPORT

PROJECT:	Massachusetts Probation Services Training and Operations Center				**DATE:** 3/11/22	
AREA SERVED:	RTUs				**TECH:** BS	
FAN DATA						
FAN NUMBER	RTU-8		RTU-10			
LOCATION	Roof		Roof			
AREA SERVED	Training Area		Classrooms 2+3			
MANUFACTURER	Daikin		Daikin			
MODEL OR SIZE	DCG1202103B		DCG0721403B			
	DESIGN	**ACTUAL**	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**
TOTAL CFM	5000	2751	2400	1224 (1)		
RETURN AIR	4140	2292	1950	996		
OUTSIDE AIR	860	459	450	228		
DISCH. STATIC	---	+0.94"	---	+0.17"		
SUCTION STATIC	---	-0.95"	---	-0.42"		
TOTAL STATIC	---	1.89"	---	0.59"		
FAN RPM	NA	954	NA	863		
PULLEY O.D.	6.5" x 1"		7.5" x 1"			
ESP	1.39		0.39			
VFD SPEED	No VFD		No VFD			
O.A.D.MIN POS	20%		45%			
MOTOR DATA						
MANUFACTURER	US Motors		US Motors			
MODEL OR FR.	NA		NA			
HORSEPOWER	2	2	1 1/2	1 1/2		
MOTOR RPM	1725	1725	1745	1745		
VOLTAGE / PH.	208/3	208/3	208/3	208/3		
AMPS LEG 1	7.8	6.7	4.8	3.1		
AMPS LEG 2	---	6.7	---	2.8	---	
AMPS LEG 3	---	6.7	---	3.2	---	
SHEAVE O.D.	3.75" x 7/8"		3.75" x 7/8"			
BELTS - QUANTITY / SIZE	1/A x 51		1/A x 52			
SHEAVE POSITION	Fully closed		1/2 Open			
C to C	18.5		19.0			

REMARKS

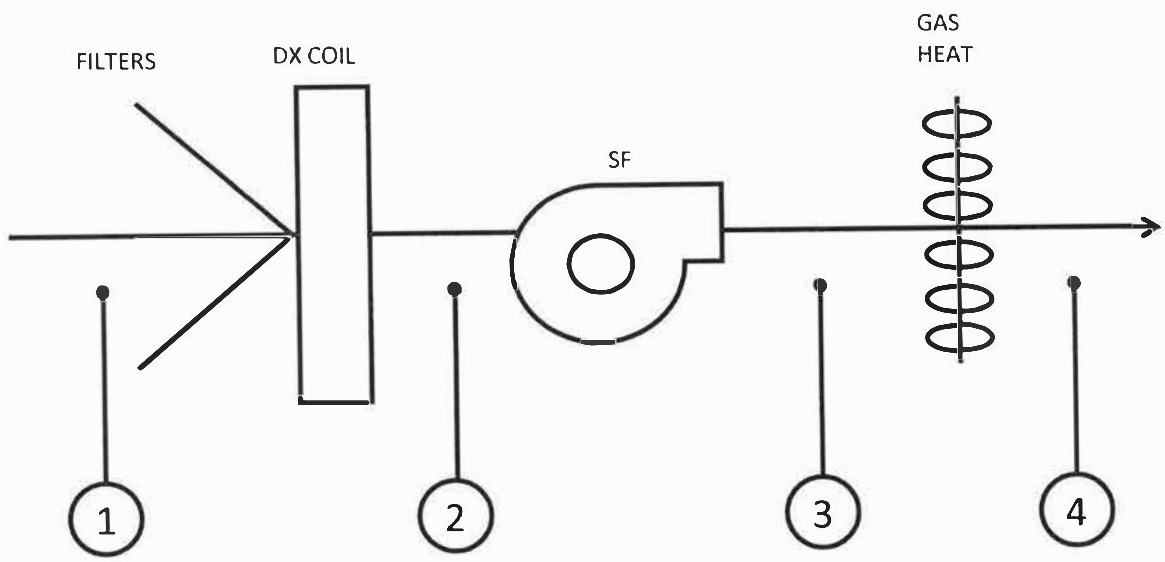
(1) A sheave change is required to get this unit closer to design.

NA Not Available | **ND** No Design | **DD** Direct Drive | **N/R** No Requirement

SYSTEM STATIC PRESSURE PROFILE

PROJECT: Massachusetts Probation Services Training and Operations Center | **DATE:** 3/14/22

SYSTEM/AREA: RTUs | **TECH:** BS



UNIT	1	2	3	4	5	6	7	8	NOTES
RTU-1	-0.35"	-0.75"	+0.30"	+0.28"					
RTU-2	-0.76"	-1.21"	+0.48"	+0.45"					
RTU-3	-0.15"	-0.33"	+0.73"	+0.70"					
RTU-4	-0.43"	-0.78"	+0.32"	+0.30"					
RTU-6	-0.29"	-0.67"	+0.47"	+0.44"					
RTU-7	-0.59"	-1.14"	+0.68"	+0.65"					
RTU-8	-0.48"	-0.95"	+0.94"	+0.91"					
RTU-10	-0.24"	-0.42"	+0.17"	+0.15"					

REMARKS

NA Not Available | **ND** No Design | **DD** Direct Drive | **N/R** No Requirement

VELOCITY PRESSURE READINGS

PROJECT:	Massachusetts Probation Services Training and Operations Center							**DATE:** 3/10/22
AREA SERVED:	RTUs							**TECH:** BS
TRAVERSE LOCATIONS	**DUCT SIZE "**	**AREA SQ.FT.**	**DESIGN FPM**	**DESIGN CFM**	**CENT. STAT. PRESS."**	**TEST FPM**	**TEST CFM**	**NOTES**
RTU-1								
Total	28" x 21"	4.08	---	3000	w/ Velgrid	708	2889	
O.A.	28" x 21"	4.08	---	550	w/ Velgrid	137	559	
Return	---	---	---	2450	Calculated	---	2330	
RTU-2								
Total	34" x 12"	2.83	---	4000	w/ Velgrid	1152	3260	
O.A.	34" x 12"	2.83	---	750	w/ Velgrid	231	654	
Return	---	---	---	3250	Calculated	---	2606	
RTU-3								
Total	34" x 12"	2.83	---	2000	w/ Velgrid	657	1860	
O.A.	34" x 12"	2.83	---	380	w/ Velgrid	145	410	
Return	---	---	---	1620	Calculated	---	1450	
RTU-4								
Total	28" x 21"	4.08	---	4000	w/ Velgrid	1061	4329	
O.A.	28" x 21"	4.08	---	400	w/ Velgrid	101	412	
Return	---	---	---	3600	Calculated	---	3917	
RTU-6								
Total	26" x 12"	2.16	---	4000	w/ Velgrid	699	1510	
O.A.	26" x 12"	2.16	---	400	w/ Velgrid	77	154	
Return	---	---	---	3600	Calculated	---	1356	
RTU-7								
Total	28" x 21"	4.08	---	5000	w/ Velgrid	1048	4276	
O.A.	28" x 21"	4.08	---	600	w/ Velgrid	126	514	
Return	---	---	---	4400	Calculated	---	3762	
RTU-8								
Total	36" x 12"	3.0	---	5000	w/ Velgrid	917	2751	
O.A.	36" x 12"	3.0	---	860	w/ Velgrid	153	459	
Return	---	---	---	4140	Calculated	---	2292	
RTU-10								
Total	36" x 12"	3.0	---	2400	w/ Velgrid	408	1224	
O.A.	36" x 12"	3.0	---	450	w/ Velgrid	76	228	
Return	---	---	---	1950	Calculated	---	996	

REMARKS

NA Not Available | **ND** No Design | **DD** Direct Drive | **N/R** No Requirement

EXHAUST FAN REPORT

PROJECT: Massachusetts Probation Services Training and Operations Center **DATE:** 3/14/22
AREA SERVED: EFs **TECH:** BS

FAN DATA					
FAN NUMBER		EF-1	EF-2		
LOCATION		Roof	Roof		
AREA SERVED		Restrooms	Restrooms		
MANUFACTURER		Twin City	Twin City		
MODEL OR SIZE		DCRD070B1	DCR090B1		
TOTAL CFM	**DESIGN**	ND	ND		
	ACTUAL	190	191		
FAN RPM	**DESIGN**	DD	DD		
	ACTUAL	DD	DD		
PULLEY	**O.D.**	DD	DD		
SERVICE		1.0	1.0		
MOTOR DATA					
MANUFACTURER		GW Industries	Twin City		
MODEL NUMBER		48	48		
MOTOR HP	**DESIGN**	1/8	1/8		
	ACTUAL	1/8	1/8		
MOTOR RPM	**DESIGN**	1650	1650		
	ACTUAL	1650	1650		
VOLTAGE/PHASE	**DESIGN**	115/1	115/1		
	ACTUAL	115/1	115/1		
MOTOR AMPS	**DESIGN**	1.7	1.7		
	ACT. LEG 1	1.6	1.6		
	ACT. LEG 2	---	---		
	ACT. LEG 3	---	---		
SHEAVE		DD	DD		
BELTS - QUANTITY/SIZE		DD	DD		
SHEAVE POSITION		DD	DD		

REMARKS

NA Not Available | **ND** No Design | **DD** Direct Drive | **N/R** No Requirement

AIR DEVICE REPORT

PROJECT: Massachusetts Probation Services Training and Operations Center **DATE:** 3/14/22
SYSTEM / AREA: EFs **TECH:** BS

LOCATION	NO.	SIZE	A K	DESIGN FPM	DESIGN CFM	TEST FPM	TEST CFM	FINAL FPM	FINAL CFM	NOTES
EF-1										
1st Fl Men's Rm	1	8" x 8"	FH	---	ND	---	73			
1st Fl Women's Rm	2	8" x 8"	FH	---	ND	---	111			
							184			
EF-2										
1st Fl Men's Rm	1	8" x 8"	FH	---	ND	---	95			
1st Fl Women's Rm	2	8" x 8"	FH	---	ND	---	95			
							190			

REMARKS

NA Not Available | **ND** No Design | **DD** Direct Drive | **N/R** No Requirement