Roxbury Trial Court
Roxbury, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

February 25, 2022

Tighe&Bond

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Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Roxbury Trial Court on October 28, 2020. While on site we inspected the air handling equipment located in the mechanical room and on the roof and toured the facility to determine if the spaces generally matched usages noted on the architectural plans.

Site Visit Attendees:

- *Office of Court Management:*
  - Jeff Daru, Manager of Court Facilities
  - Bertrand Djoutsa, Courthouse Facilities Staff
- *Tighe & Bond*
  - Sean Pringle, PE, Mechanical Engineer
  - Caitlin DeWolfe, Staff Engineer

1.1 Existing Ventilation System

The Roxbury Trial Court is a three story building constructed in 1971 with major renovations in 1993, and is approximately 71,000 square feet in size. Four air handling units (AHU) and three rooftop air handling units (RTU) provide ventilation air to the building.

The four AHU's in the penthouse mechanical room each have a preheat hot water coil, chilled water coil, reheat hot water coil, and supply fan, as well as return and outside air dampers. Each AHU has an associated external return air fan and exhaust air damper. The AHU's are generally in poor condition. The return air fans are in fair condition. The AHU's are original to the building. In 1993, the preheat coils were added to the AHU and control improvements were made to convert the AHU's from constant volume to variable air volume (VAV) operation. On AHU's 2 and 3, the condensate drains have rusted through, which are an integral part of the metal enclosure. Fabricated trays have been set under the units to contain the condensate leakage, but do not address air leakage. The reheat coils are in very poor condition and appear to be original. The damper actuators are generally in good condition, and the dampers are in fair condition.

RTU-1 was installed in 1993 and was added to serve the lobby and other new areas along the northwest façade. The RTU has a preheat hot water coil, chilled water coil, supply fan, as well as return and outdoor air dampers. RTU-1 is in good condition and no issues were noted.

RTU-2 and RTU-3 were replaced in 2010 and serve the lockup areas on the third floor with 100% outdoor air. Each unit has a DX cooling coil, DX hot gas reheat coil, supply fan, and an indirect natural gas furnace. The units appear to be in very good condition.

Four, 2 MMBH, hot water boilers provide hot water to air handlers and perimeter radiation. A single 325 ton, water cooled chiller provides chilled water to all air handlers and RTU-1.

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	19,300	1,930	2" MERV 8	Poor
AHU-2	25,600	2,560	2" MERV 8	Poor
AHU-3	23,200	2,320	2" MERV 8	Poor
AHU-4	13,200	1,320	2" MERV 8	Poor
RTU-1	16,000	1,600	4" MERV 8	Good
RTU-2	3,600	3,600	2" MERV 8	Good
RTU-3	3,600	3,600	2" MERV 8	Good

All areas except the lockup area are served by (VAV) systems. Supply air is regulated to each zone by VAV boxes. The VAV boxes do not have reheat. The controls, and possibly the boxes themselves were upgraded in 2012. VAV boxes typically operate between a maximum and minimum position. The minimum position prevents the VAV box damper from fully closing, which allows continuous airflow to the space when occupied, which is a code requirement for ventilation purposes. The 2012 control drawings indicate VAV minimum airflows as 0 CFM. Unless this has been revised, supply air may not always be provided during occupied periods. The working condition of these boxes is also unknown.

The lockup areas are provided with 100% outside air supply from RTU's 2 and 3. Supply air is provided both into the cells directly and into the corridors Air is exhausted from the cells through the toilet exhausts.

While touring the lockup areas, it was noted that the exhaust airflow in the cells was inconsistent from cell to cell. The airflow in cells closest to the exhaust fan was relatively high, while the airflow in cells further away was barely detectable using tissue paper. We were able to access the service corridor running along the backs of the cells and found that there are no balancing dampers on the exhaust ductwork serving most cells. Only a few cells nearest the entrance to the service corridor had balancing dampers. The 1994 indicate that these should be on every exhaust branch.

During the visit, several restrooms were checked for the presence of exhaust airflow. No exhaust airflow was observed in the third-floor bathroom locker rooms (rooms 344,345, and 352).

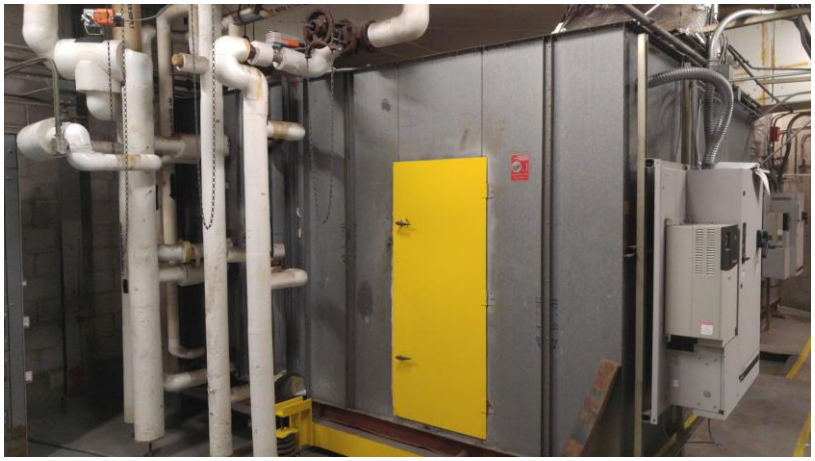

Photo 1 – Representative Air Handler

Photo 2 – Representative RTU

1.2 Existing Control System

The Courthouse has an Automated Logic building management control system (BMS). The BMS monitors and controls the existing boilers, chiller, AHU's, RTU's, VAV's, perimeter heat, and exhaust fans. The current BMS and AHU controls were upgraded in 2012. While onsite, Tighe & Bond was able to observe various control system screens and setpoints and discussed the operation with staff. In addition to typical controls, we understand that the system provides the following key features for the AHU's:

1. AHU units:
    a. Economizer mode – 100% outdoor air
    b. Safeties and alarms, including freeze stats

c. AHU-level Demand Controlled Ventilation (DCV) – varies the outside air percentage from a minimum to a maximum limit in response to CO2 concentrations in various spaces within the building.

d. Zone-level DCV – increases the zone VAV supply air volume in response to CO2 concentrations in specific occupied spaces (Courtrooms only)

e. Zone occupancy sensors (Courtrooms only)

f. Outdoor air flow stations

2. RTU-1
    a. Economizer mode – 100% outdoor air
    b. Safeties and alarms, including freeze stats
    c. Outdoor air flow station
3. RTU-2 and RTU-3
    a. 100% outside air units
    b. Hot gas reheat humidity control
    c. Zone level hot water reheat (constant volume) control

Section 2
Recommendations

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

2.1 Filtration Efficiency Recommendations

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

RF-1: *Replace MERV-8 filters with MERV-13 filters.*

The TAB Contractor and/or Engineer shall verify that the air handlers can accommodate a MERV-13 filter.

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

RF-3a: *Connect the pressure sensor to the BMS system.*

2.2 Testing & Balancing Recommendations

The air handling units are 50 years old, RTU-1 is 28 years old, and RTU's 2 and 3 are 11 years old. It is unknown to Tighe & Bond when the last time the units were tested and balanced. Also, the code requirements to determine the outside air flow rates that were used to design the original system were different than the 2015 International Mechanical Code (IMC) and current ASHRAE Standard 62.1 requirements.

We recommend the following testing and balancing measures be implemented:

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

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

TABLE 2
Recommended Air Handler O.A. Flow Rates

Unit	Original Supply Airflow (CFM)	Original Design Min. O.A. (CFM)	Current Code Min. O.A. Requirements (CFM)	Recommended Minimum O.A. (CFM)
AHU-1	19,300 (15,000)**	1,930	1,800*	1,900
AHU-2	25,600 (17,000)**	2,560	1,900*	2,600
AHU-3	23,200 (15,000) **	2,320	4,200*	4,200*
AHU-4	13,200	1,320	1,650*	1,700*
RTU-1	16,000	1,600	900	1,600
RTU-2	3,600	3,600	3,000**	3,000**
RTU-3	3,600	3,600	3,600	3,600

*After reducing occupancies in rooms listed below.
**Estimated connected load based on 1993 drawings.
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 recommend increasing the outdoor air on AHU-3 and 4 to the quantities shown. Based on the original coil capacities in the 1968 drawings, the coils have adequate heating and cooling capacity for the airflows shown. The preheat coil added in 1993 provides additional heating capacity. However, there is some risk of cold spots as the outdoor air percentage will be much higher under low supply flow conditions, when most VAV boxes are at minimum airflow.

There is a discrepancy on the 1993 drawings for AHU's 1-3. The total connected airflow of the VAV's for each system (15,000, 17,000, and 15,000 CFM respectively) is significantly less than the design supply airflow indicated in the schedules and Table 2 above. The airflows in the 1993 schedules appear to be slightly less than the maximum airflow of the AHU's as originally installed in 1971, reflecting the added restriction of the VAV system and reheat coil.

Based on this analysis using the 1993 drawings, several break and conference rooms were identified as being under ventilated. These low supply air flows in these rooms were driving the requirement for significantly higher outdoor air rates, based on the IMC outdoor airflow calculation. Table 3 shows the recommended maximum occupancy of these rooms. The airflows in Table 2 assume that these occupancy reductions are implemented.

TABLE 3
Recommended Occupancy Reductions of Specific Rooms

Room	2015 IMC Permitted Occupancy (# of People)	Recommended Occupancy (# of People)
Break Room 107	30	15
Conference Room 220	7	4
Conference Room 223	7	4
Conference Room 224	7	4
Conference Room 314	9	3
Break Room 316	10	6
Break Room 354-358	11	5
Conference Room 369	16	8

*These occupancies are the maximum occupancies recommended for normal use under full building occupancy.

The average airflow rate per person is shown below in Table 4. These values are based on the original design supply airflow rate and the recommended outdoor air flow rates shown in Table 3 above. The airflow rate per person assumes a diversity factor of 70%, meaning the maximum number of occupants assumed to be in all zones at all times equates to 70% of the code required occupancy.

TABLE 4
Average Airflow Rate per Person

	All spaces	***Courtrooms***	***Non-Courtroom Spaces***
Total Occupancy (People)	664	394	270
Total Supply Air (CFM/Person)	123	38	250
Outdoor Air (CFM/Person)	28	7	58

The airflow rate per person for each Courtroom and the Jury Pool Room is shown below in Table 5. These values are based on full occupancy without taking diversity into account, the original design supply airflow rate, and the recommended outdoor airflow rate. The airflow rate per person assumes the full supply airflow is being delivered to the room. At times when the supply airflow is reduced due to the space temperature being satisfied, the airflow rate per person will also be reduced.

TABLE 5
Airflow Rate per Person (Full Occupancy)

		Total Air		Outdoor Air	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outside Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Jury Pool Room	20	1,200	60	120	6
First Session	162	6,000	37	770	5
Second Session	69	1,500	22	430	6
Third Session	69	1,500	22	430	6
Fourth Session	69	1,500	22	430	6
Fifth Session	69	1,500	22	430	6
Sixth Session	105	3,000	29	390	4

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

The airflow rate per person for each Courtroom and the Jury Pool Room, based on a reduced occupancy schedule determined by the Office of Court Management, is shown below in Table 5a. The airflow rate per person assumes the full supply airflow is being delivered to the room. At times when the supply airflow is reduced due to the space temperature being satisfied, the airflow rate per person will also be reduced.

TABLE 5a
Airflow Rate per Person (Reduced Occupancy)

		Total Air		Outdoor Air	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outside Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Jury Pool Room	7	1,200	171	120	17
First Session	30	6,000	200	770	26
Second Session	16	1,500	94	430	27
Third Session	15	1,500	100	430	29
Fourth Session	15	1,500	100	430	29
Fifth Session	16	1,500	94	430	27
Sixth Session	15	3,000	200	390	26

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.*

We recommend increasing the outdoor air flow rate in AHU's and RTU-1 beyond the recommended outdoor air flow rates in a stepped approach by up to 30% beyond the recommended outdoor air flow rates under non-peak conditions. We do not believe this would cause a threat of coil to freeze based on the total percentage of outside air vs. the total amount of outside air, however cold spots on the coil may develop due to poor mixing. This may cause nuisance freeze stat trips via the existing freeze stat.

Note that this measure does not apply to RTU's 2 and 3, as they supply 100% outdoor air to the lockup areas.

RTB-4: *Test and balance VAV box flow rates.*

Note that no VAV minimum airflows are identified in the 1993 drawings or 2012 control documents. As part of this effort, minimum airflows for each space should be established. These values should be established by an engineer, to ensure the code required ventilation rates can be maintained at the minimum airflow.

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

Lockup areas
The lockup area ventilation strategy is based on maintaining a slight negative airflow in the cells relative to the corridors in the lockup area. If any exhaust grilles have been accidently closed or if the supply air flow is too high in these areas, the likelihood of cross contamination from one cell to another increases.

We observed that a large portion of the exhaust ducts serving the cells are without volume dampers, and the airflows are inconsistent in the cells. Balancing dampers will need to be added in these areas prior to balancing.

Whole building
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 chiller and boiler plants are maintaining the correct supply water temperatures.

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

Testing and balancing the air handler hot and chilled water coils will help ensure the coils are receiving the proper water flow rates. 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-4: *Inspect VAV boxes and controllers.*

VAV boxes regulate the supply air delivered to each space. 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. Consider cleaning airflow stations and reheat coils and changing dirty filters in the fan powered

VAV boxes. Any boxes not delivering the expected airflow rates should be rebalanced or replaced.

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.*

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

The existing BMS appears sophisticated enough to implement this type of sequence.

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

RC-5: *Disable demand control ventilation sequences.*

This measure applies to AHU's 1-4. Note that the VAV-level DCV sequences for the courtrooms should be left operational as this maintains adequate airflow in these spaces.

2.5 Additional Filtration and Air Cleaning

We recommend the installation of the following air cleaning devices:

RFC-1: *Install portable HEPA filters.*

If the Courthouse is to operate at a high capacity (i.e. 50% occupancy or greater), we recommend installing portable HEPA filters in high traffic areas, such as entrance lobbies. They should also be considered for Courtrooms, depending on the occupancy of the room and how much noise is generated from the filters. The noise levels will vary depending on the manufacturer.

2.6 Humidity Control

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

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

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

2.7 Other Recommendations

2.7.1 Replace Toilet Exhaust Fans

We recommend replacing any failed toilet exhaust fans. At the time of the visit, the toilet exhaust fan serving the third floor locker rooms was not functioning.

2.7.2 Replace Air Handling Units #1-4

These air handlers are original to the building and have exceeded their expected service life. While the dampers and controls have been upgraded, the enclosures, coils, and fans have not. Consider replacing these units in the next three to five years.

2.7.3 Improve Conference and Break Room Ventilation

Consider increasing VAV minimum airflow and adding either zone level DCV or electric reheat to the VAV's serving the conference and break rooms identified as being under ventilated. These spaces are generally interior rooms that are at risk of overcooling if DCV or reheat is not used. In some cases, the VAV maximum airflow will also need to be increased. Developing comprehensive design documents for these improvements is beyond the scope of this assessment.

Section 3
Testing & Balancing Results

Wings Testing & Balancing Co., Inc. visited the Roxbury Trial Court on April 23, 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.

On February 7, 2022 Wings returned to retest the AHU's and exhaust fans, as well as test the hot and chilled water flow rates. The hot water flow rates were unable to be tested due to inadequate straight piping lengths (and no balancing devices), and the chilled water was shut down for the winter.

TABLE 6
Air Handler Testing & Balancing Results

	Design			Actual		
Unit	Total Supply Fan Airflow (CFM)	Recommended Outdoor Airflow (CFM)	Return Airflow (CFM)	Supply Fan Airflow (CFM)	Outdoor Airflow (CFM)	Return Airflow (CFM)
AHU-1	19,300 (15,000)*	1,900	17,400	15,190	1,897	13,293
AHU-2	25,600 (17,000)*	2,600	23,000	17,145	2,645	14,501
AHU-3	23,200 (15,000) *	4,200	19,000	15,500	Inoperable Ret. Fan	Inoperable Ret. Fan
AHU-4	13,200	1,700	11,500	12,587	1,713	10,875
RTU-1	16,000	1,600	14,400	15,004	1,565	13,442
RTU-2	3,600 (3,000)*	3,000	0	3,886	3,886	0
RTU-3	3,600	3,600	0	3,622	3,622	0

*Estimated connected load of VAV boxes, based on 1993 drawings.

TABLE 7
Exhaust Fan Testing & Balancing Results

Unit	Serving	Design Exhaust Airflow (CFM)	Actual Exhaust Airflow (CFM)
EF-1	Lockup	6,300	1,885
REF-1	Toilets	1,200	1,179
REF-2	Toilets	960	888
NREF-4	Toilets	1,550	1,401

Typical balancing tolerances for air systems is ±10% of the design airflow. In VAV systems, airflow issues may reside in downstream VAV boxes resulting in a total supply airflow reading at the air handler higher or lower than the designed value. Further investigation is required to determine the cause of a low airflow reading at the air handling unit.

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

1. Except for AHU-3, all AHU's and RTU's are performing within the acceptable supply and outdoor airflow range, based on the connected VAV devices indicated in the 1993 design drawings.
2. The supply airflow of AHU-3 is within the acceptable airflow range. However, the return fan RAF-3 is not operating properly, and as a result the return and outdoor airflow could not be properly balanced. The VFD for RAF-3 should be replaced before the unit is retested.
3. When the air handlers were tested, the airflow for each VAV box was set to 100% of the design airflow in the BMS. Many of the VAV's did not report achieving the design airflow. Refer to pages 8 and 9 of the balancing report for specific VAV's. It is possible that some VAV airflow stations are clogged, causing the VAV to operate at a very high airflow, even when it is reporting a very low or zero airflow. Conversely, the low airflow reading may be correct, and the VAV actuator or damper could be stuck, preventing the damper from opening fully. Given the number of inaccurate readings, we recommend that all VAV's be recalibrated and in some cases replaced. At minimum, the VAV's that did not report the commanded airflow should be investigated and repaired.
4. The filters in all units are were MERV-13 at the time of the tests. Based on the VFD speeds and measured motor loads during the tests, these filters do not appear to be impacting the airflow of the units.
5. RTU-2 is operating well above the connected load, but close to the design airflow. This should be adjusted when the lockup area is rebalanced (see RTB-5).
6. REF-1, and REF-2, and NREF-1 are performing within the acceptable airflow range.
7. EF-1 is operating far below the design airflow. The pneumatic actuator serving EF-1 is stuck in the closed position and needs to be fixed or replaced. The fan should then be retested. It's possible the fan may need to be replaced.

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.

WING'S TESTING & BALANCING CO., INC.

Roxbury Municipal Court
HVAC Ventilation Study
Revisit February 2022

* * * *

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

February 7th, 2022

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WING'S TESTING & BALANCING CO., INC.

February 7th, 2022

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

Re: Roxbury Municipal Court HVAC Ventilation Study – Revisit February 2022

Dear Jason,

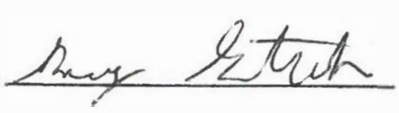
Wing's has completed the return visit for the above referenced location. The results are as follows:

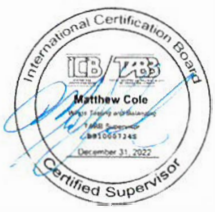
- AHUs 1 through 4, RTU-1 and Exhaust fans were tested.
- There was no clear straight run of piping available to test the hot water.
- The chilled water loop is off for the season.
- RAF-3 only operates in hand mode at 32.8Hz and does not operate in auto. This VFD should be fixed or replaced.
- RAF-2's VFD is still not replaced. It worked on 4/23/21 but was burnt on 2/7/22.
- The pneumatic actuator on the discharge side of EF-1 is not functioning and is stuck in the closed position. This should be fixed or replaced.

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
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SUPPLY FAN REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	2/3/22
AREA SERVED:	Various	**TECH:**	BS

FAN DATA

	AHU-1		RAF-1		AHU-2	
FAN NUMBER						
LOCATION	Penthouse		Penthouse		Penthouse	
AREA SERVED	Court Room #1		AHU-1		Probation	
MANUFACTURER	Buffalo Forge		Buffalo Forge		Buffalo Forge	
MODEL OR SIZE	250 PCH		850		320 PCH	
	DESIGN	**ACTUAL**	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**
TOTAL CFM	15,000	15,190	ND	12,772 (2)	17,000	17,145
RETURN AIR	13,100	13,293	---	---	14,400	14,501
OUTSIDE AIR	1900	1897	---	---	2600	2645
DISCH. STATIC	---	2.77''	---	+0.22"	---	+1.54''
SUCTION STATIC	---	-1.13''	---	-0.44"	---	-0.57''
TOTAL STATIC	NA	3.47''	NA	0.66	NA	1.85''
FAN RPM	NA	1186	NA	338	NA	761
PULLEY O.D.	11" x 1 15/16"		12" x 1 3/16"		15 1/2" x 2 5/16"	
ESP	2.47		---		1.85	
VFD SPEED	46Hz		53 Hz		36Hz	
O.A.D.MIN POS	23%		---		5%	

MOTOR DATA

MANUFACTURER	Lincoln		Marathon		Lincoln	
MODEL OR FR.	224 T		184 T		326 T	
HORSEPOWER	40	40	5	5	50	50
MOTOR RPM	1765	1765	1755	1755	1765	1765
VOLTAGE / PH.	230/3	230/3	230/3	230/3	230/3	230/3
AMPS LEG 1	118	61.9	6.0	5.4	141	56.4
AMPS LEG 2	---	61.1	---	5.5	---	55.5
AMPS LEG 3	---	69.6	---	5.5	---	54.3
SHEAVE O.D.	10" x 2 1/8"		5 1/2" x 1 1/8"		11 1/2" x 2 1/8"	
BELTS - QUANTITY / SIZE	3/B124		2/BX126		3/B154	
SHEAVE POSITION	100% Open		100% Closed		Fixed	
BHP			4.6			

REMARKS

(2) RAF-1 tested isolated to itself.

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

SUPPLY FAN REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	2/3/22
AREA SERVED:	Various	**TECH:**	BS

FAN DATA

FAN NUMBER	RAF-2		AHU-3		RAF-3 (3)	
LOCATION	Penthouse		Penthouse		Penthouse	
AREA SERVED	AHU-2		AHU-1		Probation	
MANUFACTURER	Buffalo Forge		Buffalo Forge		Buffalo Forge	
MODEL OR SIZE	NA		320 PCH		NA	
	DESIGN	**ACTUAL**	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**
TOTAL CFM	ND	12,246 (2,1)	15,000	15,472	ND	6911
RETURN AIR	---	---	10,800	(3)	ND	---
OUTSIDE AIR	---	---	4200	(3)	ND	---
DISCH. STATIC	---	+0.44"	---	+3.07''	---	+0.16''
SUCTION STATIC	---	-0.62"	---	-1.05''	---	-0.20''
TOTAL STATIC	NA	---	NA	4.12''	NA	0.36''
FAN RPM	NA	---	NA	1068	NA	292
PULLEY O.D.	15 1/2" x 1 15/16"		13 1/2" x 2 3/16"		18 1/2" x 1 15/16"	
ESP	---		3.82		---	
VFD SPEED	60 Hz		52Hz		32.8Hz	
O.A.D.MIN POS	---		25%		---	

MOTOR DATA

MANUFACTURER	Dayton		Lincoln		Marathon	
MODEL OR FR.	215 T		324 T		213 T	
HORSEPOWER	10	10	40	40	7.5	7.5
MOTOR RPM	1770	1770	1765	1765	1765	1765
VOLTAGE / PH.	230/3	230/3	230/3	230/3	230/3	230/3
AMPS LEG 1	25.8	9.1	118	67.2	23.0	---
AMPS LEG 2	---	9.2	---	66.3	---	---
AMPS LEG 3	---	9.3	---	67.1	---	---
SHEAVE O.D.	6" x 1 3/8"		9 1/2" x 2 1/8"		6" x 1 1/8"	
BELTS - QUANTITY / SIZE	2/BX136		3/5VX1500		2/B144	
SHEAVE POSITION	100% Open		100% Open		50% Open	
BHP	3.6		NA		NA	

REMARKS

(1) RAF-2 has a VFD that is not functional and needs to be replaced as of 2/3/22.

(2) RAF-2 tested isolated to itself. On first visit 4/23/21.

(3) RF only runs in he hand position on the VFD at 38Hz. Drive needs to be fixed or replaced.

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

SUPPLY FAN REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	2/3/22
AREA SERVED:	Various	**TECH:**	BS

FAN DATA						
FAN NUMBER	AHU-4		RAF-4			
LOCATION	Penthouse		Penthouse			
AREA SERVED	Court Room 6		AHU-4			
MANUFACTURER	Buffalo Forge		Buffalo Forge			
MODEL OR SIZE	170 PCH		660			
	DESIGN	**ACTUAL**	**DESIGN**	**ACTUAL**		
TOTAL CFM	13,200	12,587	ND	11,005		
RETURN AIR	11,500	10,875	---	---		
OUTSIDE AIR	1700	1713	---	---		
DISCH. STATIC	---	+3.22''	---	+0.76"		
SUCTION STATIC	---	-1.57''	---	-0.86"		
TOTAL STATIC	NA	4.79''	NA	1.62"		
FAN RPM	NA	1636	NA	944		
PULLEY O.D.	9" x 1 5/8"		11" x 1 5/8"			
ESP	4.0		---			
VFD SPEED	51Hz		52 Hz			
O.A.D.MIN POS	20%		---			

MOTOR DATA						
MANUFACTURER	Lincoln		Marathon			
MODEL OR FR.	286 T		184 T			
HORSEPOWER	30	30	5	5		
MOTOR RPM	1770	1770	1740	1740		
VOLTAGE / PH.	230/3	230/3	230/3	230/3		
AMPS LEG 1	86.0	61.2	14.8	14.5		
AMPS LEG 2	---	59.4	---	14.6		
AMPS LEG 3	---	61.1	---	14.8		
SHEAVE O.D.	10" x 1 7/8"		6" x 1 1/8"			
BELTS - QUANTITY / SIZE	4/B124		2/B112			
SHEAVE POSITION	100% Open		100% Closed			
BHP	NA		4.9			

REMARKS

(2) RAF-4 tested isolated to itself.

(3) RF only runs in he hand position on the VFD at 3.8Hz. Drive needs to be fixed or replaced.

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

SUPPLY FAN REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	2/7/22
AREA SERVED:	Various	**TECH:**	BS

FAN DATA

FAN NUMBER	RTU-2		RTU-3		RTU-1	
LOCATION	Roof		Roof		Roof	
AREA SERVED	Lock Up		Lock Up			
MANUFACTURER	Valent		Valent		NA	
MODEL OR SIZE	VPR-210-18A		VPR-210-18A		NA	
	DESIGN	**ACTUAL**	**DESIGN**	**ACTUAL**	**DESIGN**	**ACTUAL**
TOTAL CFM	3600	3886	3600	3622	16,000	15,004
RETURN AIR	0	0	0	0	14,400	13,439
OUTSIDE AIR	3600	3886	3600	3627	1600	1565
DISCH. STATIC	---	+1.42"	---	+1.13"	---	+1.03''
SUCTION STATIC	---	-0.60"	---	-0.58"	---	-0.72''
TOTAL STATIC	NA	2.02"	NA	1.72"	---	1.75''
FAN RPM	NA	1187	NA	944	---	1580
PULLEY O.D.	DD		DD		6.5'' x 1 11/16''	
ESP	1.57		1.25		1.29	
VFD SPEED	57 Hz		51.6 Hz		60Hz	
O.A.D.MIN POS	100%		100%		25%	

MOTOR DATA

MANUFACTURER	Baldor		Baldor		Lincoln	
MODEL OR FR.	182 T		182 T		284T	
HORSEPOWER	3	3	3	3	25	25
MOTOR RPM	1765	1765	1765	1765	1775	1775
VOLTAGE / PH.	230/3	230/3	230/3	230/3	230/3	
AMPS LEG 1	8.4	6.9	8.4	5.9	66.0	
AMPS LEG 2	---	6.8	---	6.1	---	
AMPS LEG 3	---	7.0	---	6..0	---	
SHEAVE O.D.	DD		DD		6.0'' x 1 7/8''	
BELTS - QUANTITY / SIZE	DD		DD		31BX79	
SHEAVE POSITION	DD		DD		Fixed	
BHP	2.5		2.1			
C to C					31.0	

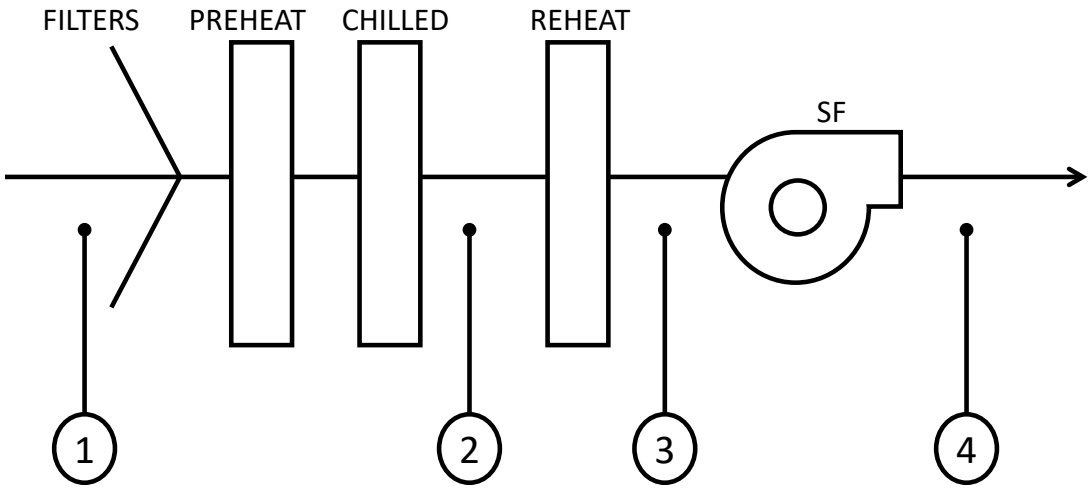
REMARKS

(3) RF only runs in he hand position on the VFD at 38Hz. Drive needs to be fixed or replaced.

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

SYSTEM STATIC PRESSURE PROFILE

PROJECT:	Roxbury Municipal Court	**DATE:**	2/2/22
SYSTEM/AREA:	AHUs	**TECH:**	BS



STATIC PRESSURE READINGS "wc

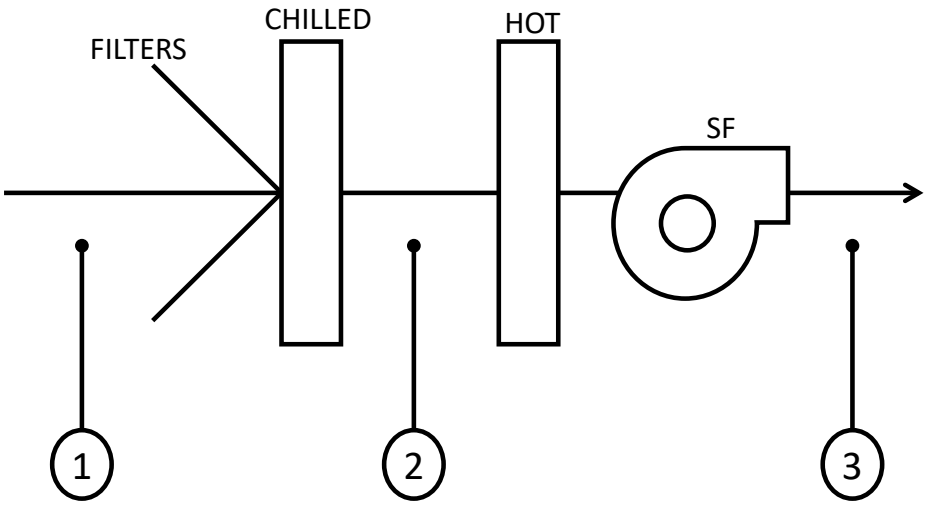
POS. (+) / NEG.(-)	1	2	3	4	5	6	7	8	NOTES
AHU-1	-0.70''	-1.07''	-1.13''	+2.77					
AHU-2	-0.31''	-0.53''	-0.57''	+1.54''					
AHU-3	-0.75''	-0.81''	-1.05''	+3.07''					
AHU-4	-0.78''	-1.41''	-1.57''	+3.22''					

REMARKS

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

SYSTEM STATIC PRESSURE PROFILE

PROJECT:	Roxbury Municipal Court	**DATE:**	2/7/22
SYSTEM/AREA:	RTUs	**TECH:**	BS



STATIC PRESSURE READINGS "wc

POS. (+) / NEG.(-)	1	2	3	4	5	6	7	8	NOTES
RTU-1	-0.26''	-0.72''	+1.03''						
RTU-2	-0.15''	-0.60''	+1.42''						
RTU-3	-0.12''	-0.58''	+1.13''						

REMARKS

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

EXHAUST FAN REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	2/7/22
AREA SERVED:	Various	**TECH:**	BS

FAN DATA

FAN NUMBER		EF-1 (2,4)	NREF-04	REF-1	REF-2
LOCATION		Penthouse	Roof	Roof	Roof
AREA SERVED		Lock Up	Restrooms	Restrooms	Restrooms
MANUFACTURER		Buffalo Forge	Greenheck	Davidson Fan	Davidson Fan
MODEL OR SIZE		600	NA	22CA	19CA
TOTAL CFM	**DESIGN**	7415	1550	1200	960
	ACTUAL	1194	1401	1179	888
FAN RPM	**DESIGN**	ND	NA	NA	NA
	ACTUAL	1039	966	711	910
PULLEY	**O.D.**	11 1/2" x 1 5/8"	5'' x 3/4	8.0'' x 3/4''	5.0'' x 3/4''
SERVICE		1.15	1.25	1.25	1.25

MOTOR DATA

MANUFACTURER		Leeson	Marathon	Marathon	Magnatech
MODEL NUMBER		184 T	56	NA	BA56
MOTOR HP	**DESIGN**	5	1/2	1/2	1/2
	ACTUAL	5	1/2	1/2	1/2
MOTOR RPM		1740	1725	1725	1725
VOLTAGE/PHASE		200/3	115/1	208/1	208/1
MOTOR AMPS	**DESIGN**	13.0	1.1	4.4	1.8
	ACT. LEG 1	3.7	---		
	ACT. LEG 2	3.6	1.0	4.1	1.6
	ACT. LEG 3	3.6	---		
SHEAVE		5 1/4" x 1 1/8"	3 1/4" x 5/8"	3.0'' x 5/8	3.75'' x 5/8
BELTS - QUANTITY/SIZE		2/5VX1120	1/4L230	1/4L32OR	1/4L240
SHEAVE POSITION		100% Closed	50% Closed	100% Closed	100% Open
C to C				6.5	5.5

REMARKS

(2) Fan is tagged EF-1 in the penthouse, but it's EF-7 on the mechanical room.

(4) The pneumatic actuator on the discharge side of this fan is closed and not functioning.

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

AIR DEVICE REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	2/7/22
SYSTEM / AREA:	Various	**TECH:**	BS

				DESIGN		TEST		FINAL		
LOCATION	**NO.**	**SIZE**	**A K**	**FPM**	**CFM**	**FPM**	**CFM**	**FPM**	**CFM**	**NOTES**
REF-1										
Men's 1st Floor	1	6''x6''	0.25	---	ND	444	111			
Women's 1st Floor	2	6''x6''	0.25	---	ND	421	105			
Jury 200A	3	6''x6''	0.25	---	ND	446	112			
Jury 200B	4	6''x6''	0.25	---	ND	595	149			
Jury 202A	5	6''x6''	0.25	---	ND	559	140			
Jury 202B	6	6''x6''	0.25	---	ND	628	157			
Women's 316A	7	6''x6''	0.25	---	ND	1032	258			
Men's 316B	8	6''x6''	0.25	---	ND	588	147			
					1200		1179			
REF-2										
Men's 3rd Floor	1	10''x6''	0.30	---	ND	1004	301			
Women's 3rd Floor	2	10''x6''	0.30	---	ND	888	266			
Janitor's 3rd Floor	3	8''x4''	0.16	---	ND	594	95			
Sup. Restroom 2nd Fl	4	10''x6''	0.35	---	ND	645	226			
					960		888			
NREF-04										
Men's 3rd Floor	1	10''x10''	0.50	---	ND	609	305			
Women's 3rd Floor	2	6''x6''	0.18	---	ND	1206	217			
Men's 2nd Floor	3	10''x10''	0.50	---	ND	357	179			
Women's 2nd Floor	4	10''x10''	0.50	---	ND	407	204			
Men's 1st Floor	5	6''x6''	0.18	---	ND	342	62			
Men's 1st Floor	6	6''x6''	0.18	---	ND	272	49			
Women's 1st Floor	7	10''x10''	0.50	---	ND	324	162			
Women's 1st Floor	8	10''x10''	0.50	---	ND	445	223			
					1550		1401			

REMARKS

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

BMS GRAPHIC REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	4/23/21
SYSTEM / AREA:	Various	**TECH:**	BS

				SETPOINT		BMS		FINAL		
LOCATION	**NO.**	**SIZE**	**A K**	**FPM**	**CFM**	**FPM**	**CFM**	**FPM**	**CFM**	**NOTES**
AC-1										
VAV-155	---	---	---	---	150	---	150			
VAV-156	---	---	---	---	350	---	352			
VAV-158	---	---	---	---	1000	---	998			
VAV-162	---	---	---	---	2000	---	1439			
VAV-165	---	---	---	---	400	---	404			
VAV-166	---	---	---	---	400	---	135			
VAV-167	---	---	---	---	400	---	374			
VAV-154	---	---	---	---	300	---	298			
VAV-223	---	---	---	---	800	---	647			
VAV-221	---	---	---	---	800	---	801			
VAV-224	---	---	---	---	800	---	461			
VAV-225	---	---	---	---	1000	---	412			
VAV-212	---	---	---	---	1500	---	567			
VAV-213	---	---	---	---	300	---	206			
AC-2										
Admin Lobby	---	---	---	---	2400	---	2460			
VAV-102	---	---	---	---	600	---	520			
VAV-104	---	---	---	---	150	---	0			
VAV-163	---	---	---	---	700	---	127			
VAV-183	---	---	---	---	350	---	248			
VAV-138D	---	---	---	---	900	---	900			
VAV-138C	---	---	---	---	900	---	900			
VAV-101	---	---	---	---	375	---	260			
VAV-105	---	---	---	---	300	---	300			
VAV-213	---	---	---	---	300	---	300			
VAV-212B	---	---	---	---	3000	---	170			
VAV-228	---	---	---	---	1100	---	600			
VAV-222A	---	---	---	---	1780	---	1640			
VAV-LOBBY	---	---	---	---	1850	---	1670			
VAV-332	---	---	---	---	150	---	150			
VAV-302	---	---	---	---	150	---	150			
VAV-301A	---	---	---	---	300	---	210			
VAV-319	---	---	---	---	200	---	200			
VAV-306A	---	---	---	---	300	---	115			
VAV-306B	---	---	---	---	300	---	209			
VAV-306C	---	---	---	---	300	---	240			
VAV-306D	---	---	---	---	300	---	260			
VAV-313A	---	---	---	---	2100	---	1240			

REMARKS

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

BMS GRAPHIC REPORT

PROJECT:	Roxbury Municipal Court	**DATE:**	4/23/21
SYSTEM / AREA:	Various	**TECH:**	BS

LOCATION	NO.	SIZE	A K	SETPOINT		BMS		FINAL		NOTES
				FPM	CFM	FPM	CFM	FPM	CFM	
AC-4										
VAV-152	---	---	---	---	300	---	235			
VAV-146	---	---	---	---	300	---	230			
VAV-151	---	---	---	---	300	---	200			
VAV-142	---	---	---	---	400	---	320			
VAV-141	---	---	---	---	400	---	260			
VAV-135	---	---	---	---	400	---	240			
VAV-134	---	---	---	---	300	---	170			
VAV-129	---	---	---	---	300	---	41			
VAV-128	---	---	---	---	350	---	170			
VAV-124	---	---	---	---	400	---	280			
VAV-123	---	---	---	---	500	---	170			
VAV-150	---	---	---	---	200	---	203			
VAV-133	---	---	---	---	300	---	170			
VAV-219	---	---	---	---	1000	---	120			
VAV-218	---	---	---	---	800	---	710			
VAV-217	---	---	---	---	800	---	540			
VAV-216	---	---	---	---	500	---	400			
VAV-204	---	---	---	---	1000	---	1000			
VAV-203	---	---	---	---	3000	---	2600			
VAV-322	---	---	---	---	400	---	40			

REMARKS

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

VELOCITY PRESSURE READINGS

PROJECT:	Roxbury Municipal Court					**DATE:**	2/3/22	
AREA SERVED:	Various					**TECH:**	BS	
TRAVERSE LOCATIONS	**DUCT SIZE "**	**AREA SQ.FT.**	**DESIGN**		**CENT. STAT. PRESS."**	**TEST**		**NOTES**
			FPM	**CFM**		**FPM**	**CFM**	
AHU-1 Total	32"Ø	5.58	---	15,000	+2.72''		15,190	(1)
AHU-1 Return	36" x 26"	9.0	---	13,109	-0.28''	1477	13,293	
AHU-1 OA	---	---	---	1900	Calculated	---	1897	
AHU-2 Total	36"Ø	7.065	---	17,000	+1.54''	2427	17,145	(1)
AHU-2 Return	42" x 36"	10.5	---	14,400	-0.28''	1381	14,501	
AHU-2 OA	---	---	---	2600	Calculated	---	2645	
AHU-3 Total	36''	7.065	---	15,000	+3.07''	2190	15,472	(2)
AHU-3 Return	---	---	---	10,800				(2)
AHU-3 O.A.	---	---	---	4200				(2)
AHU-4 Total	26"Ø	3.69	---	13,200	+2.87''	3411	12,587	(1)
AHU-4 Return	36" x 26"	6.5	---	11,500	-0.60''	1673	10,875	
AHU-4 OA	---	---	---	1700	Calculated	---	1713	
RTU-1 Total	35'' x 23''	5.59	---	1600	w/ Velgrid	2684	15,004	
RTU-1 O.A.	35'' x 23''	5.59	---	1600	w/ Velgrid	280	1565	
RTU-1 Return					Calculated		13,439	
RTU-2 Total	54" x 23.5"	8..81	---	3600	w/ Velgrid	441	3886	

RTU-3 Total	54" x 23.5"	8..81	---	3600	w/ Velgrid	411	3622	
RAF-1	36" x 36"	9.0	---	ND	-0.22''	1419	12,772	
RAF-2	42" x 36"	10.5	---	ND	+0.77''	1166	12,246	
RAF-3	70'' x 20''	9.72	---	ND	+0.16''	711	6911	(2)
RAF-4	36" x 26"	6.5	---	ND	+0.76''	1693	11,005	

REMARKS

(1) The total connected VAV load is less than total design.

(2) The VFD for RAF-3 is not functioning properly. It only runs in the hand position at 32.8 Hz. It does not allow any interaction in hand mode and switches itself back into hand when put in auto.

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