West Roxbury Municipal Court
Jamaica Plain, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

December 14, 2021

Section 1
Existing Conditions and Site Observations

Tighe & Bond visited the West Roxbury Division Boston Municipal Court on September 17, 2020. While on site, we inspected the air handling units and toured the occupied portions of the building to determine if the spaces generally matched usage noted on the architectural plans.

Site Visit Attendees:

- Office of Court Management:
  - Joao Fonseca, Courthouse Facilities Staff
- Tighe & Bond:
  - Sean Pringle, PE, Project Mechanical Engineer
  - Caitlin DeWolfe, Staff Engineer

1.1 Existing Ventilation System

The West Roxbury Courthouse is a three-story building, constructed in 1925 with a major renovation in 1993, with a floor area of approximately 54,000 gross square feet. The HVAC system includes 5 air handling units (AHU), and one rooftop unit (RTU), with the AHU's located on the ground floor and the RTU located on the southern roof.

All air handlers have a hot water coil, chilled water coil, supply fan, return air and outside air dampers. Each AHU has an associated external return air fan and exhaust air damper. The air handling units are in fair condition. We observed that several of the freeze stats do not adequately cover the hot water coil, which could result in coil freezing.

RTU-1 has natural gas heating, DX cooling, a supply and return fan, as well as return, outside, and exhaust air dampers. The RTU is in poor condition. The unit did not have a trap on the cooling coil condensate drain, and the tray was flooded at the time of the visit.

All AHU's and the RTU are constant airflow and appear to be the original units from the 1993 renovation. The controls are not original, and were upgraded around 2012 according to staff, including replacing actuators. Most exhaust dampers could not be inspected because they were within ductwork, and not visible.

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

TABLE 1
Existing Air Handlers

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Filters	Condition
AHU-1	5,800	1,160	2" MERV 8	Fair
AHU-2	5,500	1,100	2" MERV 8	Fair
AHU-3	4,200	840	2" MERV 8	Fair
AHU-4	4,200	840	2" MERV 8	Fair
AHU-5	11,000	2,200	2" MERV 8	Fair
RTU-1	22,000	5,500	2" MERV 8	Poor

Chilled water is provided by a single 80 ton water cooled chiller. Hot water is provided from four, 375 MBH (input) modular boilers. In areas along the building perimeter, finned tube radiation is provided for additional heating.

While all air handling equipment are constant airflow units, the equipment serving the non-courtroom areas (AHU-1, AHU-5, and RTU-1) utilize bypass valves and variable air volume (VAV) terminal units without reheat to control the airflow to the individual zones. VAV boxes typically operate between a maximum and minimum position. Minimum values were not indicated on the design drawings. The working condition of these boxes is unknown.

AHU's 1 and 5 each have two bypass air valves and serve VAV distribution. They are depicted on the AHU control screen, but there doesn't appear to be any control functions associated with the dampers. In conversations with the staff, they stated they were not sure if the bypass valves were still operational. They also noted that VAV's are very loud when closed, which could indicate a high duct static pressure as a result of closed bypass valves.

The ground floor lockup area is provided with mixed supply air through AHU-1 via a VAV box set to a constant airflow and supplied into the corridors. Air is exhausted from the cells through the toilet exhaust ductwork. During the walkthrough, it was noted that one supply air grille (westernmost corner) in the lockup area corridor did not have any airflow. This grille is not shown on the 1993 drawings, so it is possible it was installed in error and balanced to zero airflow.

A row of offices was added along the front (north) portion of the building, in an area that was once an open corridor / lobby area. We were not provided with design documents for these areas. All the new offices appear to have functioning supply and return grilles. It is possible that they have adequate ventilation, as the single offices represent a lighter use than the original open lobby area, however this should be confirmed. Based on the routing of the original ductwork, these areas are served by AHU-5, and the existing duct system serving the lobby was modified to serve the new areas.

As part of the renovation above, a large hearing room was also added in the northernmost corner of the second floor out several smaller rooms. Supply and return vents were

observed in the space that roughly correspond to the original openings shown on the plans. Depending on the original use of this space and available airflow through the ductwork, this room may not have adequate ventilation. Based on the original space airflows, this room may be under-ventilated for its current use. The current ventilation rate of 475 cfm provides the code-required ventilation for 15 people at a supply airflow rate of 32 cfm/person.

On the architectural plans provided and used during the site visit, most room names and descriptions were illegible. Because of this, the original intended uses are inferred from the current use and space layout. It is possible some spaces with modified uses were not identified during the visit.

Photo 1 – Representative Air Handler

Photo 2 – RTU-1 Rooftop Air Handler.

1.2 Existing Control System

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

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

2. AHU-1, AHU-5, and RTU-1
    a. Control of bypass valves to allow VAV operation. The functionality of AHU-1 and AHU-5 bypass valves is unknown.

Staff informed us that the AHU's have been set to operate in occupied mode 24/7, possibly including maintaining occupied temperatures.

Section 2
Recommendations

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

2.1 Filtration Efficiency Recommendations

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

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

The TAB Contractor and Engineer shall verify that the existing air handlers can accommodate MERV-13 filters. Replace filters in AHU's and RTU's with MERV 13 filters.

RF-3: *Install a differential pressure sensor (switch) across the filter banks.*

RF-3b: *Pressure sensor (switch) shall have a display and be connected to the BMS system.*

2.2 Testing & Balancing Recommendations

The air handlers are approximately 27 years old and it is unknown to Tighe & Bond when the last time this units were tested and balanced to the proper airflow. Also, the code required outside air flow rates that were used to design the system in 1993 are different than the 2015 IMC and ASHRAE Standard 62.1 requirements.

We recommend the following measures:

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

We recommend rebalancing the air handlers to the recommended minimum O.A. values shown in Table 2. After rebalancing, the spaces should be monitored during peak heating and cooling conditions to confirm space temperature can be maintained.

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	5,800	1,160	1,400	1,400
AHU-2	5,500	1,100	880	1,100
AHU-3	4,200	840	690	840
AHU-4	4,200	840	690	840
AHU-5	11,000	2,200	2,000	2,200
RTU-1	22,000	5,500	4,400	5,500

We recommend the outside air flow rate for AHU-1 be increased to 1,400 CFM. While this AHU is scheduled for 5,800 CFM, the ductwork on the design drawings only shows 4,800 CFM of distribution. If this is correct, it is likely that the reduced airflow will allow the outside air to be increased without affecting the ability of the coils to maintain the target supply air temperature.

We also recommend that the AHU-1 supply air flow be rebalanced to match the connected distribution of 4,800 CFM, or the sum of the currently connected VAV boxes. The excess AHU airflow capacity does not benefit the spaces and results in a excess flow of unused bypass air.

For the remaining AHU's and RTU, it appears that the original design supply and outdoor airflows are adequate. Where the outside airflows calculated by Tighe & Bond are less than the original design values, we recommend using the original designed values, as these exceed the calculated code minimums and will likely result in improved indoor air quality (IAQ).

The airflow rate per person is shown below in Table 3. These values are based on the recommended outdoor airflow and the original design supply airflow rates shown in Table 2 above. The airflow rate per person also 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)	430	216	214
Total Supply Air (CFM/Person)	120	65	180
Outdoor Air (CFM/Person)	28	14	42

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 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 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)*
West Courtroom	120	5,500	46	1,100	9
Center Courtroom	95	4,200	45	840	9
East Courtroom	94	4,200	44	840	9

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

The airflow rate per person for each Courtroom and the Jury Pool Room, based on a reduced occupancy schedule determined by the Office of Court Management, is shown below in Table 4a. The airflow rate per person assumes the full supply airflow is being delivered to the room. 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 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)*
West Courtroom	34	5,500	162	1,100	32
Center Courtroom	26	4,200	162	840	32
East Courtroom	24	4,200	168	840	34

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

We recommend increasing the outdoor air flow rate 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.

Refer to the control system upgrades section for the required controls to implement this strategy.

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

Note that no minimum airflows are identified on the design documents. As part of this effort, minimum airflows should be established. These should be established to maintain the code required ventilation rates at the minimum airflow.

RTB-5: *Consider rebalancing all air inlets and outlets.*

New offices and hearing room in former lobby area
If test and balance reports are not available for these areas, we recommend rebalancing the airflows for these areas. If design documents showing the required airflows are not available, the required airflows should be established by an engineer and rebalanced to provide the code required ventilation rates for each space.

Whole building or spaces with airflow/temperature issues
If the Courthouse experiences regular cooling and heating comfort complaints, we recommend exploring rebalancing all air inlets and outlets throughout the building. Prior to rebalancing the building, we recommend verifying the chiller and boiler plants are maintaining the correct supply water temperatures.

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

Testing and balancing the air handler hot and chilled water coils will help ensure the coils are receiving the proper water flow rates.

2.3 Equipment Maintenance & Upgrades

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

Replace dampers and actuators that are not functioning.

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

While most air handler coils were in good condition, several showed some signs of corrosion or buildup. These should be cleaned to ensure the airflow and heating/cooling capacity can be maintained. In addition, the RTU-1 drain pan was in poor condition due to the lack of a condensate trap.

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. Staff indicated that these older VAV boxes have been problematic, which may be in part due to poor operation of the bypass air valves. Consider cleaning airflow stations. Any boxes not delivering the expected airflow rates should be rebalanced.

2.4 Control System

We recommend the following control system strategies be implemented into the existing control system:

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

It is our understanding based on conversations with staff that the building is currently being operated in an occupied mode 24/7, possibly including using daytime occupied temperature setpoints. This exceeds the three air change flush sequence recommended by ASHRAE. If the current strategy is continued, it is recommended that the nighttime temperature setpoints be used instead of the daytime setpoints to reduce energy costs.

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

RC-4: *Confirm Economizer control sequence is operational.*

2.5 Additional Filtration and Air Cleaning

We recommend the installation of the following air cleaning devices:

RFC-1: *Install portable HEPA filters.*

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

2.6 Humidity Control

Installing duct mounted or portable humidifiers can help maintain the relative humidity levels recommended by ASHRAE. The feasibility of 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 Make AHU Adjustments to Reduce Air Leakage

Adjust the filter tray filler, door seals, and door hardware to reduce air leakage. In some units it was noted that the there was a small gap in the filter tray around the filters. These fitment issues cause untreated outside air to be drawn into the AHU supply air system and will clog and damage coils over time.

2.7.2 Add a Condensate Trap to the RTU-1 Condensate Piping

The addition of a trap allows water to drain out of the condensate pan and, prevents stagnant water from accumulating in the cooling coil tray, and reduces unfiltered air leakage into the supply air stream.

2.7.3 Adjust Freeze Stats

Adjust the freeze stats to provide better coverage over the protected coils. Freeze stats should provide at least some coverage over every square foot of coil. Where existing freeze stats are not long enough to provide adequate coverage, provide new freeze stats with longer elements.

2.7.4 Replace RTU-1

While operational, RTU-1 is in poor condition, and at the end of its expected useful life. It should be replaced within the next three to five years. The indoor AHU's may have another five to ten years of useful life.

2.7.5 Add VFD's to Supply and Return Air Fans for AHU-1, AHU-5, and RTU-1

These constant airflow air handlers use bypass air valves instead of a variable frequency drive (VFD) to manage airflows to the VAV terminals. As a result, a significant amount of outside air is conditioned, but is never delivered to the space and is instead exhausted when it is bypassed. This design also uses significantly more fan energy than a variable flow air handler. With the current arrangement, implementing any increased outside air scheme with these air handlers will be more costly than a typical system. It appears that the units already incorporate static pressure control, so adding VFD's and modifying programming may be the only change required. The bypass valves may still be necessary (at a much lower airflow) to maintain minimum air flow for heating and cooling operation. Also consider the addition of airflow stations on the outside air ductwork if space allows, to allow the outside air flow to be controlled more precisely.

If VFD's are not added to these units, at minimum the controls and operation of the bypass valves should be reviewed to ensure they working properly, which may reduce the complaints of noisy VAV boxes.

Section 3
Testing & Balancing Results

Wings Testing and Balancing visited the West Roxbury Division Boston Municipal Court on April 8, 2021 to test the airflow rates of the air handling units and the exhaust fans.

On May 21, 2021 Wings returned to the courthouse to test the airflow of exhaust fan EF-1 which was inoperable during the original visit.

On October 11, 2021 Wings returned to the courthouse to change sheaves in AHU-1, 2, and 3 and remeasure the airflow of all AHU's. The sheave for EF-1 was changed and the airflow adjusted. EF-3 was rewired to the correct rotation. The chilled water system was off while Wings was on site. When the pumps were turned on to attempt to measure flows, there was air in the system, which prevented the use of ultrasonic measurement, and there are no circuit setters at the coils.

On November 5, 2021 Wings returned to the courthouse to adjust the outdoor air on AHU-1 to the correct value and measured hot water flows of each AHU. They also confirmed that the restroom registers exhibiting low airflow and associated with EF-2 had dampers in the 100% open position.

A summary of the tested air and water flow rates versus the design airflow rates are shown below in Tables 5, 6, and 7. 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	5,800	1,400	4,400	5,205	1,336	3,869
AHU-2	5,500	1,100	4,400	5,035	995	4,040
AHU-3	4,200	840	3,360	4,550	860	3,690
AHU-4	4,200	840	3,360	4,304	844	3,460
AHU-5	11,000	2,200	8,800	11,224	2,270	8,923
RTU-1	22,000	5,500	16,500	23,358	5,803	17,555

TABLE 6
Air Handler Waterflow Testing & Balancing Results

	Design		Actual	
Unit	Chilled Water Flow Rate (GPM)	Hot Water Flow Rate (GPM)	Chilled Water Flow Rate (GPM)	Hot Water Flow Rate (GPM)
AHU-1	39	23.4	N/T	18.1
AHU-2	37	22.2	N/T	25.9
AHU-3	28.3	17.0	N/T	15.9
AHU-4	28.3	17.0	N/T	17.3
AHU-5	74.4	44.6	N/T	35.8
RTU-1	N/A	N/A	N/A	N/A

N/A: Not Applicable N/T: Not Tested

TABLE 7
Exhaust Fan Testing & Balancing Results

Unit	Serving	Design Exhaust Airflow (CFM)	Actual Exhaust Airflow (CFM)
EF-1	SW Restrooms	2,075	1,929
EF-2	NE Restrooms	660	533
EF-3	SE Restrooms	1,125	1,115

Typical balancing tolerances for air systems is ±10% of the design airflow. In the VAV systems associated with AHU-1, AHU-5, and RTU-1, airflow issues may reside in downstream VAV boxes and bypass air dampers resulting in a total supply airflow reading at the air handler less than the designed value. Further investigation is required to determine the cause of a low or high airflow reading at the air handling unit.

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

1. AHU's 1, 2, 3, 4, and 5 are all performing within the acceptable airflow range.
2. RTU-1 is performing within the acceptable airflow range.
    a. The balancer noted that the outdoor air damper command did not match the position. The "15%" position on the BMS resulted in the damper being almost fully closed. This should be adjusted so the damper position matches the command (while maintaining the position established during balancing).

3. Exhaust fans EF-1 and EF-3 are performing within the acceptable airflow range.
4. EF-2 is operating at 80% of the design airflow.
    a. This airflow can likely be increased to 90% of design by changing the sheaves.
    b. The balancer measured very low airflows in the two restrooms serving the jury deliberation area, which are served by a relatively long duct branch. The balancer confirmed that the dampers for the underperforming area are set to be 100% open. This duct should be cleaned and inspected for leaks/breakage, and the airflows rechecked.
5. The balancer noted that the exhaust registers and ducts were dirty. Consider cleaning all exhaust ductwork.
6. The air handler chilled water coil flows could not be measured for the following reasons:
    a. The chilled water system was not operating on arrival.
    b. There were no balance valves serving the coils.
    c. When the system was turn on, there was evidence of significant amount of air in the piping. Air bound systems do not allow proper measurement of water flow rates with ultrasonic testing.
    d. At a follow-up visit, the balancer was still unable to get any readings with the ultrasonic meter, possibly due to surface rust and/or remaining air in the system.
7. The air handler hot water flows were all within plus or minus 20% of the design hot water flow.

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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WING'S TESTING & BALANCING CO., INC.

West Roxbury Municipal Court

HVAC/Ventilation Survey

REVISED

* * * *

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

November 5th, 2021

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WING'S TESTING & BALANCING CO., INC.

November 5th, 2021

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

Re: West Roxbury Municipal Court/HVAC Ventilation Survey- **REVISED**

Dear Jason,

REVISED 5/11/2021:

Wing's has completed the revisit to West Roxbury District Court. We were unable to get any ultrasound readings on the chilled water. This is most likely due to rust coating the pipes under the insulation, and entrained air in the system. An attempt was made to wire brush and sand several of the pipes, but readings were still not working. Hot water readings were taken, and the outside air on unit 1 was set to design. We investigated the low flow to the last 2 grilles of EF-2 and found them to be 100% open.

10/11/2021:

Wing's has completed the post-remediation balancing from the HVAC ventilation survey. The results are as follows:

- We changed sheaves on the following vent motors:
  - AHU-1, AHU-2, AHU-3 and we retested air flow units static pressure profile as noted.
- The BMS shows 14 zone dampers on AHU-1, 17 ZD on AHU-5 and 38 ZD on RTU-1. There is no design or actual CFM showing on BMS, only status (open or closed).
  - We verified that all by-pass dampers are working properly as seen on attached screen shots.
- We changed the sheave on exhaust fan EF-1, fan was slowed down to 93% of design.
- We found that exhaust fan EF-3 had wrong rotation setting, motor was rewired by in house mechanic, fan is now performing at design flow.
- Air distribution readings were taken on EF-2 and EF-3 and noted on Air Device Sheets.
- The Chilled water system was found off when we were on site.
  - There are no circuit setters at the coils.
  - When the system was turned on, we heard obvious air in the piping.
    - We did not use the ultrasound meter at this point, since when air is present in the system, ultrasound meters cannot obtain measurements.

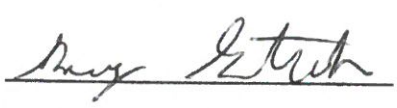
05/21/2021: We were informed after the initial report was submitted that EF-1 was fixed, and we were called back to retest. This report adds the test data for EF-1 serving the lock-up on the Exhaust Fan Report page, as well as the total flow on the Velocity Pressure Report page.

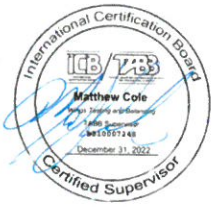
We have completed our HVAC/Fresh-Air survey for the above-mentioned project. Through our testing we found:

- Sheaves seized and unable to adjust on AHU's 1, 2, and 3.
- By-pass dampers for RF-1 are in question.
    - One has no actuator and the other has no access to confirm functionality.
    - When this fan is isolated to itself for testing, we get less air out of it.
- RTU-1 has no VFD.
    - A sheave change is required to achieve design.
    - Also, this unit is gas fired and has no water to it to be tested.

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

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





Barry Stratos
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HYDRONIC FLOW ELEMENTS

PROJECT:	West Roxbury District Court								**DATE:**	11/5/2021		
AREA SERVED:	Hot Water								**TECH:**	BS		
					DESIGN	**TEST I**			**FINAL**			
LOCATION	**NO.**	**ELEMENT**	**MFG.**	**SIZE**	**GPM**	**POS.**	**PR.DIF**	**GPM**	**POS.**	**PR.DIF**	**GPM**	**NOTES**
Hot Water												
	1	US	---	2.0	23.4	Open	---	18.1				
	2	US	---	2.0	22.2	Open	---	25.9				
	3	US	---	2.0	17.0	Open	---	15.9				
	4	US	---	2.0	17.0	Open	---	17.3				
	5	US	---	2.0	44.6	Open	---	35.8				

REMARKS

VELOCITY PRESSURE READINGS

PROJECT:	West Roxbury District Court					**DATE:**	11/5/2021	
AREA SERVED:	AHU-1					**TECH:**	BS	
TRAVERSE LOCATIONS	**DUCT SIZE "**	**AREA SQ.FT.**	**DESIGN**		**CENT. STAT. PRESS."**	**TEST**		**NOTES**
			FPM	**CFM**		**FPM**	**CFM**	
AHU-1 OA	20" x 26"	3.61	---	1400	-0.06"	370	1336	(1)

REMARKS