FENTON JUDICIAL CENTER
HVAC SYSTEM EVALUATION SUMMARY

Visited February 4, 2021. While on site, inspected the air handling equipment located in the mechanical rooms and toured the facility to determine if the spaces generally matched usages noted on the architectural plans. The Fenton Judicial Center was constructed in 1998 and is approximately 156,000 square feet in size. Six variable air volume (VAV) air handling units (AHU) provide ventilation air to the building.

1.0 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	10	2,000	200	802	80
Courtroom 1	23	3,040	132	1,151	50
Courtroom 2	17	6,200	365	2,777	163
Courtroom 3	20	5,760	288	2,741	137
Courtroom 4	28	7,070	253	3,102	111
Courtroom 5	19	3,360	177	1,436	76
Courtroom 6	14	2,680	191	1,222	87
Courtroom 7	14	2,680	191	1,222	87
Courtroom 8	20	3,240	162	1,398	70
Courtroom 9	17	3,240	191	1,398	82
Courtroom 10	20	4,920	246	2,271	114

2.0 Recommendations

Section	Recommendation/Finding	Action
2.1	**Filtration Efficiency**	
RF-3	Install a differential pressure sensor with a display across the filter bank	Complete
2.2	**Testing and Balancing**	
RTB-1	Test and rebalance air handling unit supply air and minimum outside air flow rates	Complete
RTB-4	Test and balance VAV box flow rates	N/A
RTB-5	Test and balance all air inlets and outlets	N/A
RTB-6	Test and balance all air handler chilled and hot water coils	Complete
2.3	**Equipment Maintenance and Upgrades**	
RE-1	Test existing air handling system dampers and actuators for proper operation	Complete
RE-2	Clean air handler coils	Complete
RE-4	Inspect VAV boxes and controllers	Complete
RE-5	Confirm the existing freeze stat is working correctly on each air handling unit	Complete
RE-7	Test the existing air handler control valves and actuators for proper operation	Complete

2.4	Control System	
RC-1	Implement a pre-occupancy flush sequence	In-progress
RC-4	Confirm the economizer control sequence is operational	Complete
RC-5	Disable demand control ventilation sequences	N/A
2.5	Additional Filtration and Air Cleaning	
RFC-1	Install portable HEPA filters in high traffic areas – *if courthouse is to operate at a high occupancy (i.e. 50-75% or greater), install portable HEPA filters in high traffic areas.*	In-progress
2.6	Humidity Control	
	No actionable items listed – continuous monitoring for seasonal changes	On-going
2.7	Other Recommendations	
2.7.1	Repair or replace holding cell and toilet exhaust fans	Complete
2.7.2	Add ventilation to employee break area	In-progress
2.7.3	Fix air handler smoke damper	In-progress
2.7.4	Improve enrichment air control logic	In-progress

Fenton Judicial Center
Lawrence, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

March 24, 2021

Tighe&Bond

100% Recyclable

Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the Fenton Judicial Center in Lawrence, MA on February 4, 2021. While on site we inspected the air handling equipment located in the mechanical rooms and toured the facility to determine if the spaces generally matched usages noted on the architectural plans.

Site Visit Attendees:

- *Office of Court Management:*
  - Greg McMahan, Regional Facilities Manager
  - Rick Croswell, Courthouse Facilities Staff
  - Jose Ayalan, Courthouse Facilities Staff

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

1.1 Existing Ventilation System

The Fenton Judicial Center was constructed in 1998 and is approximately 156,000 square feet in size. Six variable air volume (VAV) air handling units (AHU) provide ventilation air to the building. Each unit contains a supply fan, chilled water cooling coils, hot water heating coils, and a single stage 12" MERV 14 filter. Five dedicated return fans serve AHU's 1-5. All six units serve the building through a common supply and return duct system. AHU's 1-5 operate with variable airflow and approximately 25% outdoor air. AHU-6 operates with constant airflow and is a 100 percent outdoor air unit. Supply air is distributed to each zone via VAV boxes. The AHU's are from the original building construction in 1997 and are generally in good condition.

According to staff, AHU-1 cannot be shut off when the other units are running, or the fan will spin backwards, and air will enter the unit from the supply duct. This may indicate a stuck smoke damper in the supply ductwork, allowing airflow back through the unit while the unit. Half of the outdoor air damper on AHU-2 was closed at the time of the visit. The pneumatic actuator pressure was significantly lower than the other actuators, possibly indicating a leak or control issue. In all of the units, it appeared that the original filter differential pressure transducers had been removed and left on the floor of the unit to accommodate the 12" filters. The AHU's were originally designed to use a 2" prefilter and 10" final filter.

Approximately 10,000 CFM of the AHU-6 supply air is sent to the common supply air system. The remaining 15,000 CFM is routed through a booster fan (BF-1) with a hot water and electric reheat coil. The supply air from this is distributed throughout the building as "enrichment air" through pneumatically operated dampers. According to staff, the electric reheat coil is disconnected and no longer operates.

The main AHU supply air system serves a combination of traditional VAV boxes as well as fan powered VAV boxes. Many of the traditional VAV boxes have a minimum airflow of 0 CFM per the design drawings. While some have enrichment air circuits that provide the minimum required outdoor air to each zone, many do not. Code requires that ventilation

be continuous during occupied periods. In these spaces, the code required ventilation is not being provided when the airflow is zero or very low.

Of the ten toilet and holding cell exhaust fans, six were not operating at the time of the visit (EF's-8, 9, 12, 13, 14, and 16). In most of these, the motors were spinning but the belts had failed. According to staff, these are checked twice a year and were all repaired in the fall. Given the number that had failed, this may indicate that belt tensioning and alignment procedures are not adequate, or the that bearings are worn and impeding proper tensioning and alignment.

In the lock-up area, supply air from the AHU's is delivered to the corridors and into each cell. Air is exhausted from each cell via several exhaust fans.

An eight million BTU/h hot water boiler plant provides hot water to air handlers, radiation, and VAV reheat coils. A pair of 250 ton, water cooled chiller located in the mechanical room provides chilled water to all air handlers.

While onsite, we observed a basement storage room that had been converted to a break room. This area did not have any means of ventilation.

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

TABLE 1
Existing Air Handling Units

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Filters	Condition
AHU-1	28,120	7,500	12" MERV 14	Good
AHU-2	28,120	7,500	12" MERV 14	Good
AHU-3	28,120	7,500	12" MERV 14	Good
AHU-4	28,120	7,500	12" MERV 14	Good
AHU-5	28,120	7,500	12" MERV 14	Good
AHU-6	25,000	25,000	12" MERV 14	Good

Photo 1 – Representative Air Handler

1.2 Existing Control System

The existing control system is a relatively sophisticated electronic BMS system with electronic sensors in AHU's and other major equipment, and pneumatic actuators. The fan powered VAV boxes utilize pneumatic actuators with electronic controls and are visible from the BMS central controller. The traditional VAV boxes and associated thermostats and perimeter heating devices are fully pneumatic, with no electronic controls or visibility from the BMS. While fairly sophisticated and capable, both the BMS system and the pneumatic controls are obsolete. There is currently a project in the design phase to replace all pneumatic systems with electronic controls and update the BMS system.

The existing pneumatic controls for the "enrichment air" dampers attached to the VAV systems function as a rudimentary occupancy detection / demand controlled ventilation (DCV) system and prevent overcooling. The enrichment air dampers will close if the space temperature falls more than three degrees below the setpoint, which will generally happen when the space is unoccupied or very lightly occupied. At all other times, the enrichment air dampers are open.

Section 2
Recommendations

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

As noted in section 1, the basement break room is unventilated. 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 AHU's were recently upgraded with single stage 12" MERV 14 filters. It is likely that the existing equipment can accommodate the static pressure drop of the new filters. The use of MERV 14 filtration meets the ASHRAE recommendations for filtration during the pandemic. We recommend maintaining the current level of filtration. However, we recommend that a testing and balancing Contractor test and document the airflow and static pressure profile of all RTU's, as outlined in recommendation RF-1 in the Overview of Recommendations document.

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

The existing differential pressure sensors that have been disconnected should be reinstalled. If they no longer fit the new 12" deep filters, they should be modified to fit if possible, or replaced.

2.2 Testing & Balancing Recommendations

The air handling units are approximately 23 years old and it is unknown to Tighe & Bond when the last time the units were tested and balanced. Also, the code requirements to determine the outside air flow rates that were used to design the original system may be different than the 2015 International Mechanical Code (IMC) and current ASHRAE Standard 62.1 requirements.

We recommend the following testing and balancing measures be implemented:

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

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

TABLE 2
Recommended Air Handler O.A. Flow Rates

Unit	Original Supply Airflow (CFM)	Original Design Min. O.A. (CFM)	Current Code Min. O.A. Requirements (CFM)	Recommended Minimum O.A. (CFM)
AHU-1	28,120	7,500	1,300	7,500
AHU-2	28,120	7,500	1,300	7,500
AHU-3	28,120	7,500	1,300	7,500
AHU-4	28,120	7,500	1,300	7,500
AHU-5	28,120	7,500	1,300	7,500
AHU-6	25,000	25,000	25,000	25,000

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.

The calculated outdoor air requirements below assume AHU's 1-6 are all operating simultaneously. Assuming AHU-6 operates continuously at full airflow as designed, the code required combined minimum outdoor provided by AHU's 1-5 airflow is 7,000 CFM across all operating units.

In the original design drawings, many VAV boxes indicated a minimum outdoor airflow of 0 CFM and did not have any enrichment air. To be able to calculate the O.A. requirements for each space and the system overall, the minimum ventilation rate cannot be zero. For the purposes of this calculation, where the minimum ventilation requirements were not being met with enrichment air, we assumed that VAV minimum airflows were set to 30% of the maximum airflow for most spaces and 40% for VAV's serving break rooms.

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

Our ventilation air analysis discovered that while the exhaust airflow in the lockup areas appears adequate as a whole, the supply and ventilation airflow rates are inconsistent from cell to cell. We recommend reviewing and adjusting the supply air and enrichment air flows in the lockup area as part of the planned controls upgrade.

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)	1,520	1,100	420
Total Supply Air (CFM/Person)	110	31	320
Outdoor Air (CFM/Person)	41	17	110

The airflow rate per person for each Courtroom and the Jury Pool Room is shown below in Table 4. These values are based on full occupancy without taking diversity into account, the original full design supply airflow rate, and the recommended outdoor airflow rate. The airflow rate per person assumes the full supply airflow is being delivered to the room. 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)*
Jury Pool Room	33	2,000	61	802	24
Courtroom 1	86	3,040	35	1,151	13
Courtroom 2	184	6,200	34	2,777	15
Courtroom 3	124	5,760	46	2,741	22
Courtroom 4	159	7,070	44	3,102	20
Courtroom 5	104	3,360	32	1,436	14
Courtroom 6	70	2,680	38	1,222	17
Courtroom 7	71	2,680	38	1,222	17
Courtroom 8	103	3,240	31	1,398	14
Courtroom 9	103	3,240	31	1,398	14
Courtroom 10	108	4,920	46	2,271	21

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)
Jury Pool Room	10	2,000	200	802	80
Courtroom 1	23	3,040	132	1,151	50
Courtroom 2	17	6,200	365	2,777	163
Courtroom 3	20	5,760	288	2,741	137
Courtroom 4	28	7,070	253	3,102	111
Courtroom 5	19	3,360	177	1,436	76
Courtroom 6	14	2,680	191	1,222	87
Courtroom 7	14	2,680	191	1,222	87
Courtroom 8	20	3,240	162	1,398	70
Courtroom 9	17	3,240	191	1,398	82
Courtroom 10	20	4,920	246	2,271	114

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

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

We recommend testing and balancing the existing VAV boxes to ensure each space is being supplied the proper quantity of air. As the pneumatic controls will be replaced soon, this may not be practical. However, this should be included in the commissioning of the planned control upgrades.

Note that the minimum VAV airflow for many areas was identified as zero on the design documents. As part of the controls upgrade project, non-zero minimum VAV airflows should be established. These should be established by an engineer to maintain the code required ventilation rates to all areas at the minimum VAV airflow.

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

Spaces with airflow/temperature issues
If specific areas within the Courthouse experiences 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, we recommend verifying the boiler and chilled water plants are maintaining the correct supply water temperature. Incorrect supply water temperature may be contributing to the temperature control complaints instead of a lack of airflow.

Whole building
As part of the planned control systems upgrade, we recommend testing and balancing all inlets and outlets, in addition to the VAV boxes, to ensure each space is being supplied the proper quantity of air.

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. A portion of the outdoor air damper on AHU-2 was closed at the time of the visit.

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 adjusting the thermostat to cycle the damper positions and confirming the airflow varies in response to the thermostat. Consider cleaning the boxes and reheat coils and changing dirty filters in the fan powered VAV boxes. Any boxes not responding the thermostat changes should be rebalanced or replaced.

As the pneumatic controls operating the VAV's will be replaced soon, this may not be cost effective. However, this should be included in the commissioning of the planned control upgrades.

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

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

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

Consider manually disabling the enrichment damper actuators and setting the dampers to be fully open. This will allow outdoor air to flow continuously through this system during occupied periods. This is a fairly involved task and may not be practical as there are approximately 200 enrichment dampers throughout the building. While this will increase ventilation airflow to spaces, this measure will also increase the risk of overcooling, potentially causing comfort issues.

As part of the controls upgrade, we recommend adding a control feature to allow the enrichment dampers to be overridden open through the BMS.

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 Repair or Replace Holding Cell and Toilet Exhaust Fans

We recommend repairing or replacing the holding cell and toilet exhaust fans that are not working or are not exhausting the proper airflow rate. It appears that many of the fans are relatively small and according to staff they have had chronic issues with belt failures. For larger fans, consider having the motors professionally aligned and bearings checked. For smaller belt driven fans, consider replacing these with equivalent direct drive ECM fans to reduce maintenance requirements.

2.7.2 Add Ventilation to Employee Break Area

Staff were using an unventilated storage area as a break room at the time of the visit. If this area will continue to be used as a break room, we recommend adding ventilation to this space. This could likely be accomplished by adding ductwork from the existing supply air distribution.

2.7.3 Fix Air Handler Smoke Damper

The staff mentioned that AHU-1 could not be turned off while the system was operating, or the fans would begin to rotate backwards. This is most likely due to the smoke damper not closing properly. The damper should be repaired to allow for this unit to be cycled off when not needed or for service. This recommendation is primarily a maintenance measure and does not directly increase the indoor air quality of the building.

2.7.4 Improve Enrichment Air Control Logic

As noted in Section 1.1, the existing pneumatic controls for the "enrichment air" dampers provide rudimentary occupancy detection / DCV system and prevent overcooling. Because this system relies on low temperature as an indirect indicator of occupancy, there is some risk that enrichment air dampers will shut off during occupied periods, and there will be no ventilation air provided to the zone. We recommend installing CO2 sensors in the occupied spaces that use enrichment air and modulating the enrichment dampers and the VAV's in response to CO2 concentrations. This should be incorporated into and the planned controls upgrade and in conjunction with establishing new VAV minimum airflows.

Disclaimer

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

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