



SALEM PROBATE & FAMILY COURT HVAC SYSTEM EVALUATION SUMMARY

Visited April 30, 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 Salem Probate and Family Courthouse was constructed in 1895 and is approximately 77,000 square feet in size. This Courthouse underwent a major renovation in 2014 including the installation of a new mechanical system.

1.0 Airflow Rate per Person (Reduced Occupancy)

Courtroom	Total People	Total Air		Outdoor Air	
		Supply Airflow (CFM)	Airflow Rate (CFM/Person)	Outside Airflow (CFM)	Airflow Rate (CFM/Person)
Courtroom 1 (2013)	22	3,050	138	969	44
Courtroom 2 (2026)	16	1,700	106	680	43
Courtroom 3 (2028)	18	1,700	94	680	38
Courtroom 4 (2035)	25	3,200	128	1,280	51
Hearing Room (2001)	7	660	94	264	38
Hearing Room (2037)	7	550	78	220	31

2.0 Recommendations

Section	Recommendation/Finding	Action
2.1	Filtration Efficiency	
RF-1	Replace filters with MERV 13	Complete
RF-3a	Connect the pressure sensor to a local alarm in the boiler room	In-progress
2.2	Testing and Balancing	
RTB-1	Test and rebalance air handling unit supply air and minimum outside air flow rates	In-progress
RTB-2	Rebalance system return air flow rate	In-progress
RTB-6	Test and balance all air handler chilled and hot water coils	In-progress
2.3	Equipment Maintenance and Upgrades	
RE-1	Test existing air handling system dampers and actuators for proper operation	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 and post-occupancy flush sequence	In-progress
RC-2	Install controls required to introduce outside air beyond the minimum requirements	In-progress

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RC-4	Confirm the economizer control sequence is operational	In-progress
RC-5	Disable demand control ventilation sequences if they exist	NA

2.5 Additional Filtration and Air Cleaning

RFC-1	Install portable HEPA filters in high traffic areas – <i>if courthouse is to operate at a high occupancy (i.e. 50% occupancy or greater), install portable HEPA filters in high traffic areas.</i>	Complete
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2.6 Humidity Control

	No actionable items listed	N/A
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**Salem Probate & Family Court
Salem, MA**

**HVAC SYSTEM
EVALUATIONS
COVID-19**

Office of Court Management

April 30, 2021

Section 1

Existing Conditions & Site Observations

Tighe & Bond visited the Salem Probate and Family Courthouse on March 2, 2021. While on site we viewed 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:*
 - Norman Eldredge, Courthouse Facilities Staff
- *Tighe & Bond*
 - Ryan Ablondi, Mechanical Engineer
 - Matt Mancini, Staff Mechanical Engineer

1.1 Existing Ventilation System

The Salem Probate and Family Courthouse was constructed in 1895 and is approximately 77,000 square feet in size. This Courthouse underwent a major renovation in 2014 including the installation of a new mechanical system. Ventilation air is provided by four variable air volume (VAV) air handling units. AHU-1 serves the basement level office space, AHU-2 serves all levels of the North wing of the building including Courtroom 4, AHU-3 serves the second floor including courtrooms 1, 2, and 3 and AHU-4 serves the first floor. Each unit contains a VFD controlled supply and return fan, chilled water cooling coils, hot water heating coils, 2" MERV 13 pre filter, and a 4" MERV 13 final filter. All air handling units were installed during the 2014 renovation and they appear to be in great condition. The dampers and actuators appear to be in very good condition, and the heating and cooling coils are clean. The hot and chilled water control valves and actuators also appear to be in very good condition. Supply air is distributed from each air handler to VAV boxes, which control the airflow to each zone.

According to the drawings provided to Tighe & Bond, there are 13 exhaust fans serving the building. Four fans serve toilet rooms, one fan serves the lockup area and the remaining 8 serve mechanical spaces. At the time of our site visit one exhaust fan (EF-7) serving the public restrooms on the basement level was not running due to reduced occupancy in the Courthouse. The restrooms being served by EF-7 are currently not being used by anyone and that exhaust system has been turned off. All other toilet exhaust fans and lockup exhaust fan were all running at the time of our site visit.

A pair of Fulton gas-fired hydronic boilers, rated at 1.84 million BTU/hr each, provide hot water to the air handlers, VAV reheat coils and perimeter finned tube radiation. A 200 ton, air cooled chiller located on the roof provides chilled water to all air handlers. There is also an air cooled VRF system which serves the electrical rooms and data closets.

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

TABLE 1
Existing Air Handling Units

Unit	Original Design Airflow (CFM)	Original Design Min. O.A. (CFM)	Pre/Final Filters	Condition
AHU-1	7,500	3,000	2" MERV-13, 4" MERV-13	Very Good
AHU-2	10,000	3,600	2" MERV-13, 4" MERV-13	Very Good
AHU-3	17,000	5,400	2" MERV-13, 4" MERV-13	Very Good
AHU-4	12,000	4,200	2" MERV-13, 4" MERV-13	Very Good



Photo 1 – Representative Air Handler

1.2 Existing Control System

The HVAC equipment is controlled by a Building Management System (BMS). Air handlers, exhaust fans, boilers, chillers, and pumps are all tied into the system. All Air handlers operate under a demand control ventilation (DCV) sequence of operation, where outdoor ventilation air is increased when CO2 levels rise above setpoint based upon CO2 sensors

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located within the return air duct and densely occupied zones. Each AHU has also been equipped with a full outside air economizer section.

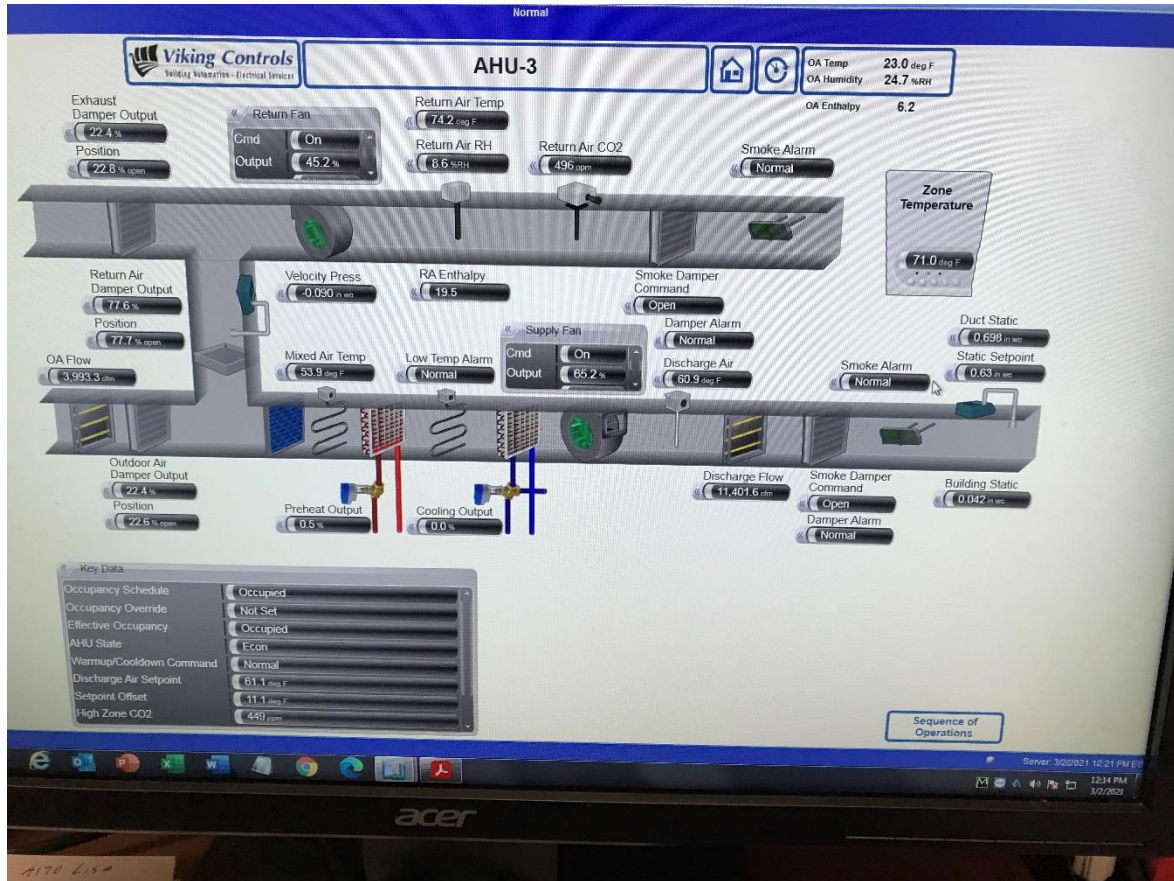


Photo 2 – Representative BMS Screen

Section 2

Recommendations

Below is a list of recommendations for the Salem Probate and Family 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: *MERV-13 Filters.*

We recommend the continued use of MERV-13 pre and final filters as they meet ASHRAE's minimum recommended MERV rating. The existing pre and final filters should be checked to ensure that they are within their recommended service life, and that they have been installed correctly. Filter racks should be inspected and adjusted to ensure that filters fit tightly and that end spacers are in place to minimize filter bypass.

RF-3a: *Check the pressure sensor alarms on the BMS.*

Differential pressure sensors with displays have already been installed within each AHU but they do not have the ability to tie into the BMS. We recommend installing differential pressure switches across each filter bank and providing a dirty filter alarm to the BMS.

2.2 Testing & Balancing Recommendations

The air handling units are approximately 7 years old and have not been tested or balanced since they were installed. 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	7,500	3,000	3,832	3,900
AHU-2	10,000	3,600	3,794	3,800
AHU-3	17,000	5,400	5,345	5,400
AHU-4	12,000	4,200	4,108	4,200

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.

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

TABLE 3
Recommended Occupancy During COVID-19 Pandemic

Room & Associated AHU	2015 IMC Permitted Occupancy (# of People)	Recommended Occupancy (# of People)
AHU-2		
Kitchenette M104	5	4
Staff Break Room 1030	10	3*
Courtroom 4 2035	152	75
Hearing Room 2037	16	14
Conference Room 2034	8	5
Conference Room 2035	8	4
AHU-3		
Detainee Holding 2016 & 2017	7	5*
Courtroom 1 2013	144	75
Courtroom 2 2026	96	40
Courtroom 3 2028	96	40
Hearing Room 2001	23	17
Conference Room 2023	6	4
Conference Room 2025	10	8
Conference Room 2012	6	4
Conference Room 2031	5	4
Conference Room 2030	5	4

* It is also recommended that the minimum supply airflow rate from the VAV box serving this room be raised to 100 CFM along with the reduced occupancy.

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 (as with AHU-3 and AHU-4).

Where we recommend increasing the outdoor air beyond the original design (as with AHU-1 and AHU-2) it appears the cooling and heating coils should be able to provide leaving air conditions similar to the original design under peak outdoor air conditions, assuming the coils are clean, and their performance has not degraded significantly over time. Supply air temperatures during the heating and cooling season should be monitored to ensure they are not dropping below design values. If the supply air temperature does drop below design values, the outdoor airflow rate should be reduced, but not below the originally designed outdoor air flow rates.

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 Salem Probate and Family Courthouse HVAC System Evaluation
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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

	<i>All spaces</i>	<i>Courtrooms</i>	<i>Non-Courtroom Spaces</i>
Total Occupancy (People)	670	342	328
Total Supply Air (CFM/Person)	69	28	112
Outdoor Air (CFM/Person)	26	10	43

The airflow rate per person for each Courtroom and Hearing 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)

<i>Courtroom</i>	<i>Total People</i>	<i>Total Air</i>		<i>Outdoor Air</i>	
		<i>Supply Airflow (CFM)</i>	<i>Airflow Rate (CFM/Person)</i>	<i>Outside Airflow (CFM)</i>	<i>Airflow Rate (CFM/Person)</i>
Courtroom 1 (2013)	144	3,050	21	969	7
Courtroom 2 (2026)	96	1,700	18	680	7
Courtroom 3 (2028)	96	1,700	18	680	7
Courtroom 4 (2035)	152	3,200	21	1,280	8
Hearing Room (2001)	23	660	29	264	11
Hearing Room (2037)	16	550	34	220	14

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 Hearing 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)

Courtroom	Total People	Total Air		Outdoor Air	
		Supply Airflow (CFM)	Airflow Rate (CFM/Person)	Outside Airflow (CFM)	Airflow Rate (CFM/Person)
Courtroom 1 (2013)	22	3,050	138	969	44
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Hearing Room (2037)	7	550	78	220	31

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

RTB-2: *Rebalance system return air flow rate.*

We recommend testing and balancing the return fan airflow rate to ensure the correct quantity of return air is being delivered to the air handler.

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-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.*

We recommend implementing a sequence that starts all air handlers and exhaust fans each day before the building enters its occupied mode, and allows it to run for a period of time following occupancy. The start and stop times should be early and late enough to allow for a minimum of three complete air changes of ventilation air before and after the building is normally occupied. The systems should also be run in occupied mode while cleaning staff are in the building.

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

The existing BMS appears to be sophisticated enough to implement this type of sequence, however new control sequences must be defined.

Prior to implementing this control strategy, the TAB Contractor should verify the quantity of outside air the outdoor air louvers can accommodate without exceeding an intake air velocity of 450 feet/minute (FPM). Exceeding this air velocity through an intake air louver may result in rain or snow entering the louver.

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

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

During the COVID-19 pandemic, we recommend disabling any DCV sequences that may reduce the quantity of outdoor ventilation air into occupied 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 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.

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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