JOHN ADAMS COURT
HVAC SYSTEM EVALUATION SUMMARY

Tighe & Bond visited the John Adams Courthouse on April 22, 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. The John Adams Courthouse was constructed in 1893 and is approximately 245,000 square feet in size. In 2004 the courthouse went through a major renovation which included a complete HVAC system replacement. There are twenty-eight air handling units (AHUs) serving the building, all in good condition. All AHUs, with the exception of AHU-12 have MERV 13 filters with BMS dirty filter alarms, hot water heating coils with face & bypass dampers, chilled water-cooling coils and a supply fan. AHU-12 is a Variable Air Volume (VAV) AHU dedicated to the Seven Justice Courtroom which has a return fan, MERV-13 filters, hot water coil, chilled water coil and supply fan. Twenty-two of the remaining air handling units are constant volume, 100% outdoor air units providing conditioned ventilation air to fan coil units (FCUs) and individual rooms. Four of the units are constant volume, mixed air units serving 4th & 5th floor Libraries. AHU-23 is a constant volume, mixed air unit serving the Special Collections room.

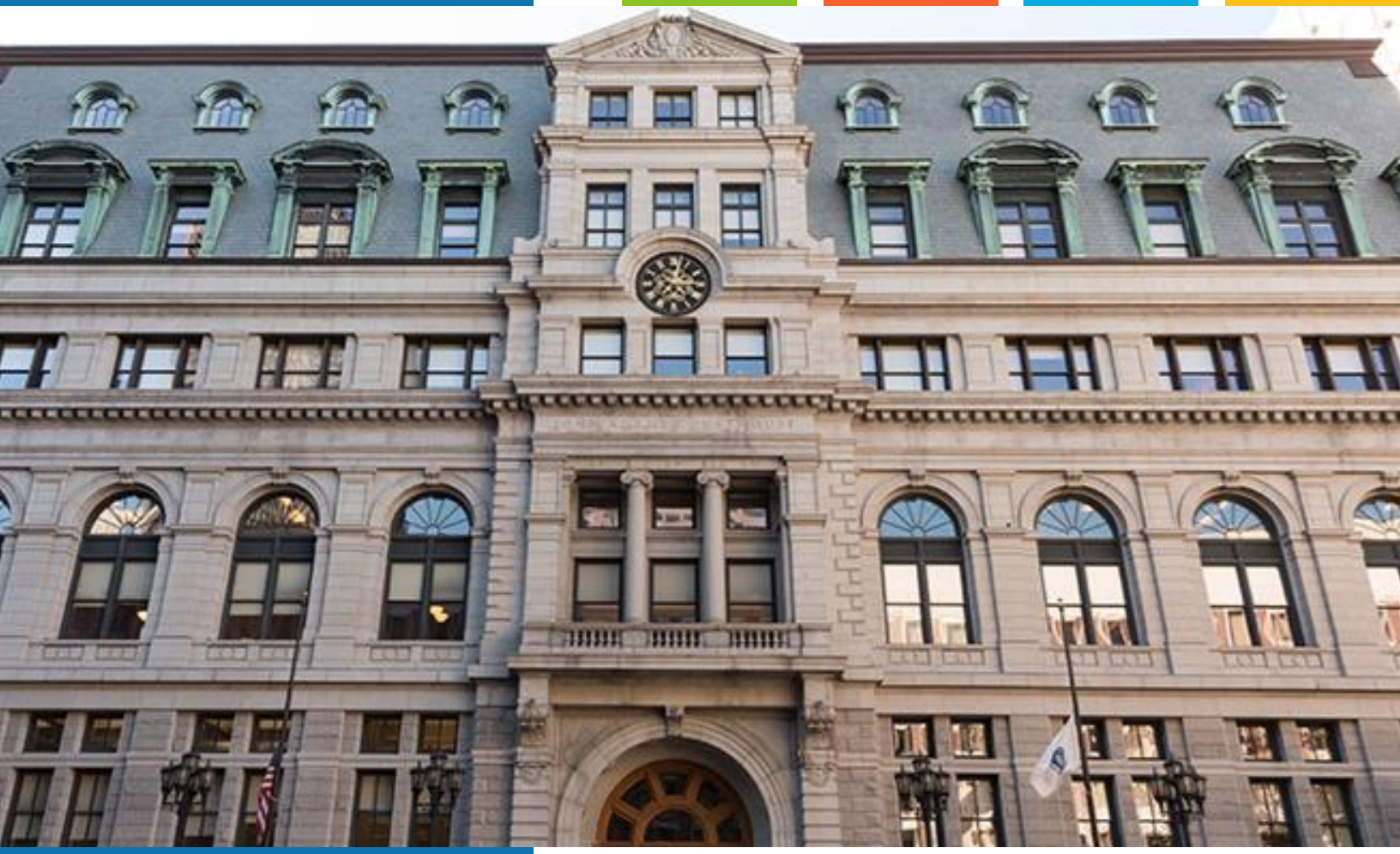
1.0 Airflow Rate per Person (Reduced Occupancy)

		Total Air		*Outdoor Air*	
Courtroom	*Total People*	*Supply Airflow (CFM)*	*Airflow Rate (CFM/Person)*	*Outside Airflow (CFM)*	*Airflow Rate (CFM/Person)*
Seven Justice Courtroom	42	5,445	130	3,940	94
Single Justice Courtroom	19	3,760	198	1,000	53
Panel Courtroom 3-201	19	4,240	223	1,000	53
Panel Courtroom 3-101	13	4,240	326	1,000	77

2.0 Recommendations

Section	Recommendation/Finding	Action
2.1	**Filtration Efficiency**	
RF-1	Replace filters with a MERV 13 filter	Complete
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-4	Test and balance air inlets and outlets	In-progress
RTB-5	Test and balance all air inlets and outlets	In-progress
RTB-6	Test and balance all air handler and fan coil unit 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	In-progress
RE-2	Clean air handler coils and drain pans	Complete

RE-4	Test the existing air handler control valves and actuators for proper operation	In-progress
RE-7	Test the existing air handler control valves and actuators for proper operation	In-progress
2.4	Control System	
RC-1	Implement a pre-occupancy flush sequence	Complete
RC-4	Confirm the economizer control sequence is operational	Complete
RC-5	Disable demand control ventilation sequences	In-progress
2.5	Additional Filtration and Air Cleaning	
RFC-1	Install portable HEPA filters -– *if courthouse is to operate at a high occupancy (i.e. 50% or greater), install portable HEPA filters in high traffic areas.*	Complete
2.6	Humidity Control	
	No actionable items listed – continuous monitoring for seasonal changes	In-progress
2.7	Other Recommendations	
2.7.1	Maximum Occupancy for Single Justice Courtroom and Jury Pool	N/A
2.7.2	Program Lead / Lag Schedule for Cooling Towers	Complete
2.7.3	Insulate AHU-12 OA Duct	In-progress



John Adams Courthouse
Boston, MA

HVAC SYSTEM EVALUATIONS COVID-19

Office of Court Management

June 4, 2021

Tighe&Bond

100% Recyclable

Section 1
Existing Conditions & Site Observations

Tighe & Bond visited the John Adams Courthouse on April 22, 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:*
  - Jose Ramos, Courthouse Facilities Staff
- *Tighe & Bond*
  - Ryan Ablondi, Senior Mechanical Engineer
  - Tim Bill, Staff Mechanical Engineer

1.1 Existing Ventilation System

The John Adams Courthouse was constructed in 1893 and is approximately 245,000 square feet in size. In 2004 the courthouse went through a major renovation which included a complete HVAC system replacement. There are twenty-eight air handling units (AHUs) serving the building, all in good condition. All AHUs, with the exception of AHU-12 have MERV 13 filters with BMS dirty filter alarms, hot water heating coils with face & bypass dampers, chilled water cooling coils and a supply fan. AHU-12 is a Variable Air Volume (VAV) AHU dedicated to the Seven Justice Courtroom which has a return fan, MERV-13 filters, hot water coil, chilled water coil and supply fan. Twenty-two of the remaining air handling units are constant volume, 100% outdoor air units providing conditioned ventilation air to fan coil units (FCUs) and individual rooms. Four of the units are constant volume, mixed air units serving 4th & 5th floor Libraries. AHU-23 is a constant volume, mixed air unit serving the Special Collections room.

There are hundreds of FCUs throughout the courthouse, all of which have chilled water coils and hot water coils, with the exception of FCU-35 serving the security office on the ground floor which is a cooling only unit. The several FCUs we inspected during the walkthrough were in good condition. The fan coil units are a mix of ceiling hung units and cabinet style units installed below windows. All of them have standard ½", non-MERV rated filters. This is a concern because the fan coil units are recirculating air within the space, however the fan coil units are not rated for the pressure drop of a MERV-13 filter and installing them may put undue strain on the fan motors.

Cooling is provided to the AHUs and FCUs from a 950 ton chiller plant consisting of two 475 ton centrifugal water cooled chillers. Heat rejection for the chiller plant is provided by two cooling towers, each with two cells located on the roof. There is a 175 ton free-cool heat exchanger to provide free cooling in winter. The cooling towers are piped so that CT-1 & 2 serve the chiller when in mechanical cooling and CT-3 & 4 are dedicated to the free-cool heat exchanger.

Hot water is provided to the building by seven 1,615 MBH modular boilers, each with a dedicated circulator pump. The boilers and associated circulator pumps are staged by local heat timer controls. HW is distributed throughout the building by two 1,100 gpm variable speed pumps.

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)	Filters	Condition
AHU-1	1,045	1,045	MERV 13	Good
AHU-2	2,565	2,565	MERV 13	Good
AHU-3	1,495	1,495	MERV 13	Good
AHU-4	2,305	2,305	MERV 13	Good
AHU-5	3,300	3,300	MERV 13	Good
AHU-6	1,355	1,355	MERV 13	Good
AHU-7	710	710	MERV 13	Good
AHU-8	1,435	1,435	MERV 13	Good
AHU-9	2,005	2,005	MERV 13	Good
AHU-10	4,030	4,030	MERV 13	Good
AHU-11	1,655	1,655	MERV 13	Good
AHU-12	5,400	3,940	MERV 13	Good
AHU-14	1,650	1,650	MERV 13	Good
AHU-15	1,765	1,765	MERV 13	Good
AHU-16	1,890	1,890	MERV 13	Good
AHU-17	1,325	1,325	MERV 13	Good
AHU-18	1,130	1,130	MERV 13	Good
AHU-19	3,380	3,380	MERV 13	Good
AHU-20	3,485	3,485	MERV 13	Good
AHU-21	2,415	2,415	MERV 13	Good
AHU-22	2,095	2,095	MERV 13	Good
AHU-23	1,700	100	MERV 13	Good
AHU-26	6,750	1,500	MERV 13	Good
AHU-27	4,240	1,500	MERV 13	Good
AHU-28	4,250	1,750	MERV 13	Good

AHU-30	740	740	MERV 13	Good
AHU-31	3,015	3,015	MERV 13	Good
AHU-32	4,000	1,500	MERV 13	Good

Photo 1 – Representative Air Handler

1.2 Existing Control System

The HVAC equipment is controlled by a Trane Building Management System (BMS) which was installed as part of the 2004 renovation. Air handlers, exhaust fans, boilers, chillers, pumps, etc… are all tied into the system. AHU-12 serving the Seven Justice Courtroom operates with a demand control ventilation (DCV) sequence of operation, where outdoor ventilation air is reduced when the space is not fully occupied.

Section 2
Recommendations

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

2.1 Filtration Efficiency Recommendations

The filters in the air handlers were already upgraded with 2" MERV 13 filters. The use of 2" MERV 13 meets the minimum ASHRAE recommendations for filtration during the pandemic. We recommend that a testing and balancing contractor test and document the airflow and static pressure profile of all air handlers, as outlined in recommendation RF-1 in the Overview of Recommendations document. This will help determine if the equipment can accommodate the increase in system static pressure associated with the addition of the MERV 13 filters.

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 filters which meet the ASHRAE minimum recommendation. Existing filters should be checked to ensure they are within their service lives and installed properly. The filter racks should be inspected to ensure that filters fit tightly and that end spacers are in place to minimize filter bypass.

2.2 Testing & Balancing Recommendations

The air handling units are approximately 17 years old and the units have not been tested and balanced since their installation. The code requirements to determine the outdoor 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 outdoor 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	1,045	1,045	504	**1,045**
AHU-2	2,565	2,565	1,373	**2,565**
AHU-3	1,495	1,495	818	**1,495**
AHU-4	2,305	2,305	2,180	**2,305**
AHU-5	3,300	3,300	1,439	**3,300**
AHU-6	1,355	1,355	756	**1,355**
AHU-7	710	710	389	**710**
AHU-8	1,435	1,435	1,370	**1,435**
AHU-9	2,005	2,005	1,234	**2,005**
AHU-10	4,030	4,030	1,894	**4,030**
AHU-11	1,655	1,655	817	**1,655**
AHU-12	5,400	3,940	1,628	**3,940**
AHU-14	1,650	1,650	925	**1,650**
AHU-15	1,765	1,765	1,410	**1,765**
AHU-16	1,890	1,890	1,163	**1,890**
AHU-17	1,325	1,325	615	**1,325**
AHU-18	1,130	1,130	680	**1,130**
AHU-19	3,380	3,380	1,528	**3,380**
AHU-20	3,485	3,485	1,413	**3,485**
AHU-21	2,415	2,415	1,697	**2,415**
AHU-22	2,095	2,095	1,351	**2,095**
AHU-23	1,700	100	141	**141**
AHU-26	6,750	1,500	1,053	**1,500**
AHU-27	4,240	1,500	884	**1,500**
AHU-28	4,250	1,750	719	**1,750**

AHU-30	740	740	225	**740**
AHU-31	3,015	3,015	1,464	**3,015**
AHU-32	4,000	1,500	681	**1,500**

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.

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.

Where we recommend increasing the outdoor air beyond the original design, 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.

Where we do not recommend increasing outdoor air to the current code requirements, it appears the cooling and/or heating coils cannot maintain the proper leaving air temperature under peak outdoor air conditions.

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.

TABLE 3
Average Airflow Rate per Person

	All spaces	***Courtrooms***	***Non-Courtroom Spaces***
Total Occupancy (People)	2,175	697	1,478
Total Supply Air (CFM/Person)	33	18	40
Outdoor Air (CFM/Person)	28	4	40

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. For the VAV system serving the Seven Justice Courtroom, when the supply airflow is reduced due to the space

temperature being satisfied, the airflow rate per person will also be reduced. The other courtrooms listed in Table 4 are constant volume systems.

TABLE 4
Airflow Rate per Person (Full Occupancy)

		Total Air		Outdoor Air	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outdoor Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Seven Justice Courtroom	286	5,445	19	3,940	14
Single Justice Courtroom	133	3,760	28	1,000	8
Panel Courtroom 3-201	139	4,240	31	1,000	7
Panel Courtroom 3-101	139	4,240	31	1,000	7

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. For the VAV system serving the Seven Justice Courtroom, when the supply airflow is reduced due to the space temperature being satisfied, the airflow rate per person will also be reduced. The other courtrooms listed in Table 4 are constant volume systems.

TABLE 4a
Airflow Rate per Person (Reduced Occupancy)

		Total Air		Outdoor Air	
Courtroom	***Total People***	***Supply Airflow (CFM)***	***Airflow Rate (CFM/Person)***	***Outdoor Airflow (CFM)***	***Airflow Rate (CFM/Person)***
Seven Justice Courtroom	42	5,445	130	3,940	94
Single Justice Courtroom	19	3,760	198	1,000	53
Panel Courtroom 3-201	19	4,240	223	1,000	53
Panel Courtroom 3-101	13	4,240	326	1,000	77

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 for AHU-12 to ensure the correct quantity of return air is being delivered to the air handler.

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

We recommend testing and balancing the VAV boxes serving the Seven Justice Courtroom to ensure the space is being supplied the proper quantity of air.

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

If the airflow to each space has not been recently tested, we recommend testing the airflow rates in the holding cells, control room, Courtrooms, and other densely occupied areas as a minimum. These systems are very old, and the airflow rate

delivered to and returned from these spaces may not match the original design intent.

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 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.

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

Testing and balancing the AHU and FCU 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.

During the site walkthrough, Tighe & Bond witnessed the mixed air dampers for AHU-12 were not working properly. The BMS screen showed that the EA damper and the OA damper were commanded to 60% open and the RA damper was commanded to 40% open. When inspecting the AHU we found the EA damper 0% open, the RA damper only slightly open (did not seem like 40%) and the OA damper roughly 60% open as commanded. With this configuration, the RA fan was blowing against a mostly closed AHU section which can put added strain on the fan and motor and shorten the life of the fan.

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 the airflow stations and reheat coils. 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-occupancy flush sequence.*

This sequence should start all air handlers, fan coil units and exhaust fans before the building is occupied, with the start time calculated to provide three air changes per hour (ACH) of ventilation air, or for two hours before people arrive.

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

AHU-12, AHU-26 and AHU-27 are the only AHUs operating with an economizer sequence of operation.

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

AHU-12 is the only AHU with DCV sequence of operation.

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 Maximum Occupancy for Single Justice Courtroom and Jury Pool

During the site walk through, Tighe and Bond learned that the Court is looking into how to maximize ventilation in the Single Justice Courtroom 2-200 and the associated Conference Suite 2-100. The Single Justice Courtroom and some surrounding ancillary spaces are served by AHU-15 which is a 100% OA unit designed to supply 1,765 CFM of OA at 1.75 in w.c. ESP. The Conference Suite and some surrounding ancillary spaces are served by AHU-16 which is a 100% OA unit designed to supply 1,890 CFM of OA at 1.50 in w.c. ESP. With the current design OA flow of 1,000 CFM each, the Single Justice Courtroom and the Conference Suite can accommodate 137 people a piece.

We estimate that each AHU could handle a 25% increase in airflow to these space which can be achieved by rebalancing the system to reduce the flow to the ancillary spaces, but the occupancy of those spaces must also be reduced. By increasing the OA flow to the Single Justice Courtroom and Conference Suite to 1,250 CFM each, the spaces could each accommodate 177 people. We recommend further engineering to confirm how much additional airflow these air handlers can accommodate.

2.7.2 Program Lead / Lag Schedule for Cooling Towers

As mentioned in the Existing Ventilation Section Above, the cooling towers are being operated so that CT-1 & 2 serve the chiller when in mechanical cooling and CT-3 & 4 are dedicated to the free-cool heat exchanger. Because the chiller plant is in Mechanical cooling mode far more often than free-cool mode, CT-1 & CT-2 reached the end of their useful life much quicker than CT-3 & CT-4. As a result, CT-1 & CT-2 have recently been rebuilt with stainless steel hot water boxes and partition walls. CT-3 & 4 appear to be in relatively good condition, likely with several years of usable life remaining before a similar rebuild may be necessary.

The CW pumps in the plant are headered together with automatic control valves between the inlet and discharge of each pump. This piping arrangement allows for any of the three CW pumps to draw from either of the dual cell cooling towers.

We recommend working with your controls contractor to develop a Lead / Lag control sequence for the cooling towers to equalize the run time and prevent further uneven wear and tear on the cooling towers.

2.7.1 Insulate AHU-12 OA Duct

During the site walk through, Tighe & Bond noted that AHU-12 OA duct was not insulated. It appears the outside air duct has been mistaken for the exhaust duct and vice versa. Currently the exhaust air duct is insulated, and the outside air duct is not. Typically, the outside air duct is insulated because the cold air coming in during the winter can potentially lead to condensation building up on the ductwork. Currently there does not appear to be any evidence of water damage from condensation build up but we recommend insulating the OA duct for AHU-12.

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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