VENTILATION ASSESSMENT REPORT

Mansfield Qualters Middle School

Abstract

This report summarizes the findings from a walk-through completed at the Qualters Middle School in Mansfield, MA, by RISE Engineering.
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Introduction

The primary purpose of this report is to review the ventilation systems within the Mansfield Qualters Middle School. A review of the heating, ventilation and air conditioning distribution systems was implemented through a site visit to the school on September 4, 2020 (Greg Sine). A return visit was performed on September 18, 2020 (Hossam Mahmoud) to inspect the recently installed Building Management System (BMS). HVAC controls were reviewed and documented while on site. Additional information was provided by the Town in the form of mechanical plans. The review is intended to determine if there are proper systems and design configurations in place to provide appropriate air flow rates per the building code and current ASHRAE COVID-19 recommendations. A 20% inspection of representative portions of the building ventilation systems is provided.

Executive Summary

RISE Engineering inspected a 20% sample of classrooms with unit ventilators (UV) to determine ability to provide supply and exhaust air flow. UV filter condition, outside air (OA) damper position, UV fan speed settings, exhaust systems, and room volume/occupancy were noted. Additionally, RISE reviewed existing HVAC equipment conditions, OA damper position, damper operation, and filter condition, as well as inspected exhaust fan condition/operation status.

After the on-site assessment of the Mansfield Qualters Middle School HVAC equipment, they were deemed to be in an overall good condition. Almost 50% of the UV's featured new MERV 8 filters. RISE understands that the HVAC units were in the process of upgrading to the recommended high efficiency MERV 13 filters where possible. Most of the HVAC units controls inspected were not functioning properly during the initial site visit, however that was predominantly due to the active installation of a new energy management system (EMS). RISE visited the site a second time on September 13th to review the new EMS. The new EMS was functioning and controlling the HVAC units properly. Inspected classrooms have the ability to deliver an acceptable amount of outside air to the room, however there were several classrooms observed that did not have an active means of exhaust. Code recommends balanced supply and exhaust flow to ensure maximum efficiency in distributing OA throughout the space in question. Additionally, the exhaust fan for the Nurse Room was not in operation at the time of the inspection. This is a critical area and needs to be addressed.

RISE has been communicating any issues noted with the Mansfield Facilities Department, and understands that the issues are being promptly addressed.

Please note that once the COVID-19 virus is fully eliminated as a health hazard, a return to normal, code required ventilation rates is advisable for occupant comfort and energy efficiency.

Recommendations

1- Address deficiencies noted on Classroom Inspection Summary table promptly (Table 1), in addition to ensuring that exhaust fan which services Nursing Area and all classrooms are placed into operation and repaired/replaced if necessary.
2- Provide the maximum fresh air allowed while maintaining recommended indoor conditions
3- Try to maintain 40% to 60% relative humidity during occupied hours within the building to reduce COVID-19 impact when possible.
4- Run inlet fresh air and exhaust systems within the building two hour prior to opening and one hour after dismissal of students each weekday.
5- Where possible replace filters with MERV 13 rated filters.
6- All supply & exhausts fans should be run continuously on at all times when the building is occupied.
7- Change air filters at two-month intervals during the COVID-19 pandemic to minimize pressure drop and mitigate possible air flow issues.
8- Constant review of control systems and HVAC system operation is recommended.
9- Demand control ventilation CO_2 set point should be set at a maximum of 750 PPM.
10- Label windows to remain closed during classroom occupancy where the supply and exhaust flow rates are acceptable as it impacts the ventilation efficiency of the system.
11- Please review the ASHRAE Startup checklist for HVAC Systems Prior to Occupancy in the Appendix of this report for additional guidance.
12- Ensure that the BMS is properly activating each of the exhaust fans during occupied hours.

Next Steps

RISE Engineering stands ready and able to oversee the necessary changes and to revisit the site after improvements have been made to conduct some additional functional tests as a separate phase two of this project to ensure the issues have been adequately addressed.

System Repair Progress Update

On September 18th, Hossam Mahmoud of RISE Engineering performed an inspection of the new BMS system installed at Mansfield Qualters Middle School and observed that 80% of the total EF's for the facility had been restored to operation and no longer displaying a fault code in the BMS. The new BMS was also observed to control the position of the OA dampers on UV's, and the UV OA damper settings had been updated to 50% open during occupied hours. The HV dampers have been commanded 50% open. RISE has compiled a deficiencies list of some of the end devices and shared it to the school to be maintained. RISE understand that the school facilities department is actively working on addressing the deficiencies.

As of the writing of this report, RISE understands that all but 2 EF's at the facility have been restored to operation. Additionally, RISE understands that a "purge" feature will be integrated into the new BMS,

which will put all systems into occupied mode, opens all OA dampers to 100% on both HVAC systems and UV's, and turns on all exhaust fans.

Building Summary

Building Use

The 135,000 square feet, two story school is located at in Mansfield, Massachusetts. The facility is used as the middle school for the Town of Mansfield, MA. The current structure was built in 1953, and renovated in 1998.

Operations Schedule

There is a recently installed Stellar Niagara direct digital control (DDC) building management system (BMS). RISE Engineering reviewed the various screens in the Graphic User Interface (GUI). The system appears to be in good working condition and properly controlling equipment. The Universal Heating Unoccupied Setback temperature is 58°F. The Universal Heating Occupied temperature is 68°F. Demand Control Ventilation (DCV) CO_2 levels are set to 750 PPM.

Building Occupancy

The school plans to reopen in October with the students attending on Monday and Tuesday. On Wednesday, the school will be open for staff only. On Thursday and Friday, the school will be open for the students. The Town plans on keeping a six feet distance between students and requiring students wear masks. There is an average of twelve students being considered in each classroom.

HVAC Equipment

There are two Weil-McLain hydronic natural gas-fired boilers, 4,113 MBH and 4,474 MBH respectively, installed at the site. The heating distribution system consists of air handling units (AHU), roof top units (RTU), heating ventilators (HV), convectors, and cabinet unit heaters (CUH) for the hallways, cafeteria, library, auditorium, boiler room, gym, and girl's locker room. There are heating unit ventilators (UV) in each classroom, with the exception of the modular wing. Exhaust ventilation for classrooms is in the form of ceiling or mounted exhaust grilles connected through ductwork to rooftop exhaust fans, or cabinet mounted through the wall exhaust fans in classrooms serviced by older style UV's.

Effective ventilation during the primary months of heating or cooling are best provided by mechanical ventilation. Mechanical ventilation, as defined by the MA building code, takes the form of fresh outdoor air (OA) brought in and conditioned (heated or cooled) and exhaust air (EA) ventilation being sent out.

For each OA and EA air streams, the code refers to specific rates of cubic feet of air per minute (cfm) for each particular use classification within the building.

Ventilation Systems Assessment

Common Areas

Inspection Methods:

20% of the accessible HVAC equipment was inspected visually. The units' operation, damper position and filter was inspected.

Results from Initial Site Visit:

AHU 1 (Library Offices): Not in operation at time of inspection. The OA damper was at a 0% open position. The unit has an older MERV 8 filter which will be getting replaced with a new MERV 13 filter. Controls in process of being updated.

HV 3 (Boiler Room): This is a dedicated system for providing makeup air to the boilers. It was not in operation at the time of the inspection. The OA damper was at a 100% open position.

HV 1 (Auditorium): In operation at time of inspection. The OA damper was at a 0% open position. The unit has an older MERV 8 filter which will be getting replaced with a new MERV 13 filter. It is suggested to adjust the OA damper linkage so minimum position is 10% open. Controls in process of being updated.

HV 2 (Auditorium): In operation at time of inspection. The OA damper was at a 100% open position. The unit has an older MERV 8 filter which will be getting replaced with a new MERV 13 filter. Controls in process of being updated.

HV 4 (Gym): Contractor working on this unit at time of inspection, installing new controls, not in operation. The OA damper was at a 20% open position. This unit has new MERV 13 filters

HV 5 (Gym): Contractor working on this unit at time of inspection, installing new controls, not in operation. The OA damper was at a 0% open position. There was no filter present on this unit

HV 6 (Girls Locker Room): Contractor working on this unit at time of inspection, installing new controls, not in operation. The OA damper was at a 100% open position. The unit has an older MERV 8 filter which will be getting replaced with a new MERV 13 filter.

RTU 1 (Kitchen/Cafe): In operation at time of inspection. The unit has an older MERV 8 filter which will be getting replaced with a new MERV 13 filter. The OA damper was at a 50% open position.

Picture 1: New Controls HV 6

Picture 2: HV2 OA Damper open

Findings/Updates:

The HVAC equipment inspected was generally found to be in good condition. It is recommended to upgrade all of the units to new MERV 13 filters as well as confirm that OA dampers on each piece of HVAC equipment respond to commands from the new EMS system which is currently being installed. The units' minimum outside air damper were found to vary from 0% to 10%. It is recommended that all units supply fan run at 100% continuous speed while the building is occupied. The OA dampers on each piece of HVAC equipment should be set to at least 50% minimum position during occupied hours based on original OA design. Demand control ventilation CO2 set point should be set to 750PPM on all HVAC units. **As of the writing of this report, it has been confirmed that the OA dampers for the HV systems have been commanded to the 50% open position during occupied hours in the new BMS system.**

Roof Exhaust Fans

Testing Methods:

EFs that were accessible were inspected visually on the roof. The Building Management System (BMS) was unable to be accessed to verify operation and condition at the initial inspection, as the school was is in the process of upgrading their BMS system.

Results from Initial Site Visit:

At the initial site visit, RISE observed 30 EF's on the roof, of which 77% were not in operation. The Mansfield Facilities Department informed RISE at the time of the inspection that they were actively working to restore all EF's to operable condition.

Findings/Updates:

It is imperative to ensure that the EF's servicing the Nurse's Room and Classrooms are operational. It is also suggested that all exhaust fans be verified to have the proper size (length and width) belt, and that all are fully functional. The second course of action would be to look for and correct any poor duct work transitions which create excessive pressure drop for the fan motors to overcome. It was also noted that the restrooms had exhaust inlets, but the EF's servicing them were not in operation. The below pictures show examples of the roof mounted fans. **As of the writing of this report, all but 2 EF's (95% of total) have been restored to full operation.**

Picture 3: Inoperable EF

Picture 4: Inoperable EF's, no power

Classrooms

Testing Methods:

20% of total Classrooms with Unit Ventilators (UV) present were inspected at the time of the site visit. Each UV was inspected to determine fan speed setting, OA damper position/condition, and filter condition. In addition, each classroom was inspected to ensure there is a means of exhaust present as per IMC and ASHRAE recommendations.

Initial Results:

Room #	UV Fan Speed	UV OA Damper % Open	Replace Filter (y/n)	Exhaust Present (y/n)	Additional Comments
108	Low	10%	y	y	Exhaust inlet present but EF not in operation
104	High	0%	n	y	Exhaust inlet present but EF not in operation
106	Low	0%	n	y	Exhaust inlet present but EF not in operation, fan control knob broken
142	Med	0%	y	y	
131	Med	0%	y	y	Exhaust inlet present but EF not in operation
113	Med	10%	y	y	Exhaust inlet present but EF not in operation, repair OA damper linkage
117	High	10%	n	y	Exhaust inlet present but EF not in operation, repair OA damper linkage
118	Low	10%	n	y	Exhaust inlet present but EF not in operation, loose damper linkage
209	Low	10%	n	y	Exhaust inlet present but EF not in operation
223	Low	0%	n	y	Bent linkage
236	Low	10%	y	y	

Table 1: Initial Classroom Inspection Summary

Classroom served by UV's:

Classrooms served by UV's were found to have a generally acceptable supply and exhaust distribution with UV SA/OA diffuser on the window side of the class, and one exhaust vent on the door side of the room. All of the classrooms inspected had exhaust registers present in them, but not all of the EF's servicing these classrooms were in operation at the time of the inspection.

Picture 5: Typical Bathroom Exhaust

Picture 6: Typical Exhaust

Picture 7: Typical Classroom UV

Picture 8: Broken Fan Control Rm 106

Picture 9: Filter requiring replacement Rm 108

Findings/Updates:

All classrooms inspected had a means of supplying OA through the existing UV's. It is recommended to check all UV's at the facility to ensure proper operation, set UV fan speed to high, replace filters as needed and ideally upgrade to MERV 13 if they fit the equipment, set OA minimum damper position to 10%, ensure OA damper responds to commands from BMS, and command OA damper to maximum open position where acceptable space conditions can be maintained during occupied hours. This is defined as maintaining a relative humidity of 40-60% and space temperature of 70-72°F, while providing adequate ventilation per 2015 IMC Standards. Updated Results are shown below in Table 2. **As of the writing of this report, OA dampers on UV's have been commanded to the 50% open position during occupied hours in the new BMS System.**

Room #	UV Fan Speed	UV OA Damper % Open	Replace Filter (y/n)	Exhaust Present (y/n)	Additional Comments
108	High	50%	n	y	
104	High	50%	n	y	
106	High	50%	n	y	
142	High	50%	n	y	
131	High	50%	n	y	
113	High	50%	n	y	
117	High	50%	n	y	
118	High	50%	n	y	
209	High	50%	n	y	
223	High	50%	n	y	
236	High	50%	n	y	

Table 2: Updated Classroom Inspection Summary

Picture 10: Rm 131 Updated OA Damper Position

Picture 11: Rm 223 Updated OA Damper Position

At a minimum, OA damper should be between 35-50% open during occupied hours based on the original OA design. Please refer to the original building schedule to determine the exact OA position needed for each UV type. This will also provide an opportunity to make any necessary repairs to each UV at the facility, as it was noted that some UV's had damaged linkages and fan speed control switches. In case the unit was not able to maintain indoor conditions, due to the age of the unit, please refer to the ventilation rates table in the appendix and use the existing post-COVID occupancy rate to calculate the minimum OA flowrate needed. It is also suggested to perform an interior cleaning of each UV while they are open for inspection, maintenance. Of note, 45% of filters inspected were more than 6 months old. Cleaning the inside of the UV cabinets will help prolong UV filter life. At the initial inspection, it was observed that 45% of UV's inspected had OA damper 0% open, the remainder were approximately 10% open.

Careful attention should be paid to ensuring that all classrooms have a means of exhaust, and that all rooftop exhaust fans are restored to an operable state. This will ensure that the fresh supply of outside air can reach each classroom in the most efficient manner as per code recommendations. All classrooms identified at the inspection had a means of exhaust.

ASHRAE and the CDC has generally recommended bringing more fresh air than design when conditions permit while maintaining indoor environment conditions. This should be done mechanically where possible by increasing the OA intake if the HVAC and control system allows it. It should be noted that opening windows is not a recommended way of increasing ventilation except on temporary basis in specific cases. Opening windows usually leads to short cycling the air, and not allowing the air to travel properly across the room and eventually decrease the exhaust capability and ventilation efficiency. Rooms and doors should be closed to allow the isolation of the Classroom HVAC system and for proper air cycle.

Nursing Area

Testing Methods: Supply Air (SA) and Exhaust Air (EA) were visually inspected for operation

Initial Results:

Nurse Room is served by a unit ventilator w/ OA and a dedicated exhaust system. The UV is controlled by a dedicated thermostat. There is a steam radiator present which is not in operation, as well as a mini-split AC unit, and operable windows in the Main Nurse Office. There are supply duct registers present, but these are disconnected from the HVAC system and abandoned in place. The nursing area is broken up into 8 smaller rooms:

- Isolation Room
- Exam Room 1
- Exam Room 2
- Main Nurse Office
- Foyer
- Bathroom 1
- Bathroom 2
- Storage

Heat and OA is supplied to these rooms by the UV. Each of these rooms has its own exhaust outlet(s), however the EF servicing this area was not in operation at the time of the inspection. This was confirmed visually when inspecting the EF's on the rooftop, the EF located above the Nursing Area was not running. It is recommended to add a means of supplying conditioned outside air directly to the Isolation Room, as this room only has exhaust present.

Picture 10: Nursing Area UV

Findings/Updates:

The Exhaust Fan which serves this area was noted as not being in operation at the time of the inspection. It is imperative to remedy this issue. **As of the writing of this report, it has been noted that this EF has been restored to operation.** The recommended total turnover air rate for the Nurse's area is between 4 to 6 air changes per hour with a minimum of 2 air changes per hour representing fresh outside air. It is also suggested to add a means of supplying conditioned outside air directly to the isolation room to ensure comfort of patients. The nurse room should always operate under negative pressure to eliminate the risk of contaminated air leaving the space.

The rate of ventilation air flow for health areas of schools does not have a specific category in the IMC code. The ASHRAE Standard 170 and associated guides address the ventilation recommendations for such applications. The Appendix of this report has a chart excerpt for ventilation guidelines for health areas.

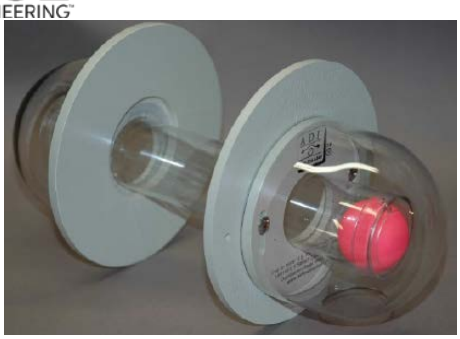
Health and Nurses areas deserve a special level of attention given they are potentially where a COVID-19 building occupant will be. Here are some of the ASHRAE recommendations for such areas:

- Establish physical barrier in waiting room for screening
- Require face mask and hand sanitation from a sanitizer dispenser
- Increase ventilation rate to six ACH of clean air
- Create at least one isolation exam room in waiting area (can be temporary)
- Add non-woven fabrics for seating
- Use laminate or solid surface casework to improve cleaning
- Remove carpet for flooring

Isolation rooms – Follow ANSI/ASHRAE/ASHE Standard 170

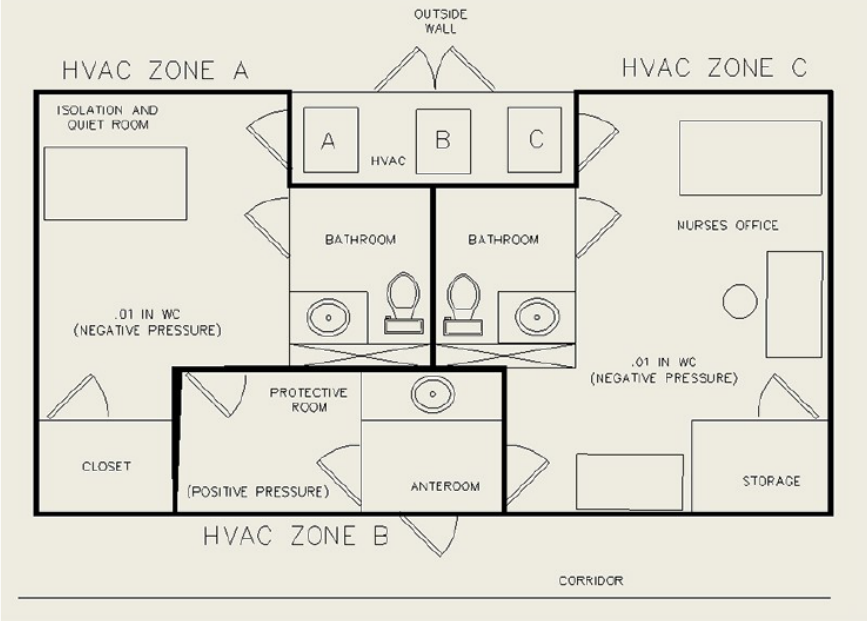
- Negative Pressure to 0.01 inches of water
- Twelve air changes (HEPA recirculation allowed)
- All air exhausted to outdoors (exhaust grill above exam table)
- Provide minimum of two isolation rooms (conduct risk assessment)
- Dedicated HVAC capable of 100% OA
- Anteroom/Protective Equipment Room
- Normal non-isolation nurse's office can become the iso-room

- Include Biohazard waste storage in anteroom and iso-room for PPE



The picture to the left shows an easily visible means to determine the pressure status of an isolation patient room. The device is mounted in the partition wall of the room to the corridor. The ball moves as the pressure moves from negative to positive (such as the door is opened and closed or an HVAC equipment malfunction) to remind those in care of the sick to maintain a negative pressure in the room so the patient's breathing is contained within the room's exhaust system instead of being transferred to an adjacent area.

Temporary isolation rooms during a pandemic should have the proper pressure and physical division from waiting and other health areas. See the ASHRAE suggested layout here which can be modified as needed to fit the site conditions.



In these times of the COVID-19 virus, ventilation rates of in excess of the building code are advisable to the extent that the ventilation system is capable of efficiently displacing and removing the stale air to

provide a whole structure air turnover rate. The following is advice from the American Society of Heating, Refrigeration and Air Conditioning Engineers:

ASHRAE's statement on operation of heating, ventilating, and air-conditioning systems to reduce SARS-CoV-2/COVID-19 transmission: *Ventilation and filtration provided by heating, ventilating, and air-conditioning systems can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air. Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. In general, disabling of heating,*

ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus.

HVAC filters, along with other strategies, help to reduce virus transmission while removing other air contaminants that may have health effects.

Once the COVID-19 virus is fully eliminated as a health hazard, a return to normal, code required, ventilation rates is advisable for occupant comfort and energy efficiency.

The supply and return grilles should be placed to obtain good air turnover and mixing of air. Air turnover is defined as the number of times the total mixed indoor air is moved throughout the space within an hour. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) recommends a 4 to 6 air turnover rate for many of the functional common spaces in this type of facility.

Disclaimer

Recommendations made in this report are based on engineering estimates and a test sampling of the ventilation equipment. It is recommended that you contact the engineer who prepared your report to answer any of your questions.

This report and analysis are based upon cursory observations of the visible and apparent conditions and is not intended to serve as a comprehensive evaluation of all aspects of the distribution system and equipment. Although care has been taken in the performance of these observations, RISE Engineering (and/or its representatives) make no representations regarding latent, unobserved, or concealed defects which may exist and no warranty or guarantee is expressed or implied. This report is made only in the best exercise of our ability and judgment.

RISE Engineering assumes no responsibility for the safety of the facilities mechanical or electrical distribution system and equipment and their compliance with all applicable federal, state and local requirements and shall not be liable under any legal or equitable theory for any claims for direct, indirect, consequential or other damages of any nature, including, but not limited to damages for personal injury, property damage, or lost profits connected with the performance of these services.

Conclusions within this report are based on estimates of the age and normal working life of various items of equipment. Air flow testing was done to sample various types of systems and is not necessarily representative of the remainder of the systems. Predictions of life expectancy and the balance of life remaining are necessarily based on opinion. It is essential to understand that actual conditions can alter the remaining life of any item. The previous use/misuse, irregularity of servicing, faulty manufacture, unfavorable conditions, acts of God, and unforeseen circumstances make it impossible to state precisely when each item would require replacement. The client herein should be aware that certain components may function consistent with their purpose at the time of our observations, but due to their nature are subject to deterioration without notice.

Estimates of Construction Cost, if any, prepared by the Engineer, represent the Engineer's best judgment as a design professional familiar with the construction industry. However, it is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment; over the Contractor's methods of determining bid prices; or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from the estimate.

Appendix

VENTILATION

TABLE 403.3.1.1
MINIMUM VENTILATION RATES

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT² [a]	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT² [a]	EXHAUST AIRFLOW RATE CFM/FT² [a]
Education				
Art classroom[g]	20	10	0.18	0.7
Auditoriums	150	5	0.06	—
Classrooms (ages 5-8)	25	10	0.12	—
Classrooms (age 9 plus)	35	10	0.12	—
Computer lab	25	10	0.12	—
Corridors (see public spaces)	—	—	—	—
Day care (through age 4)	25	10	0.18	—
Lecture classroom	65	7.5	0.06	—
Lecture hall (fixed seats)	150	7.5	0.06	—
Locker/dressing rooms[g]	—	—	—	0.25
Media center	25	10	0.12	—
Multiuse assembly	100	7.5	0.06	—
Music/theater/dance	35	10	0.06	—
Science laboratories[g]	25	10	0.18	1.0
Smoking lounges[b]	70	60	—	—
Sports locker rooms[g]	—	—	—	0.5
Wood/metal shops[g]	20	10	0.18	0.5

The above chart was excerpted from IMC 2015 with Feb. 2019 updates.

The below chart was excerpted from the ASHRAE HVAC Design Manual for Hospitals and Clinics

Table F-1. Comparison of Engineering Best (For table notes see

Function Space	Pressure Relationship to Adjacent Areas (a) (2)			Minimum Air Changes of Outdoor Air per Hour (b) (3)			Minimum Total Air Changes per Hour (c) (4) (5)		
	Manual	Handbook	AIA (1)	Manual	Handbook	AIA (1)	Manual	Handbook	AIA (1)
Patient Room	—	±	—	2	2	2	6	4	6 (16)
Toilet Room (g)	N	N	In	Optional	Optional	—	10	10	10
Intensive Care		P	—		2	—		6	—
Newborn Nursery Suite	—	—	—	2	—	2	6	—	6
Protective Isolation (i)		P	—		2	—		15	—
Infectious Isolation (h)		±	—		2	—		6	—
Protective Environment Room (11), (17)	P	—	Out	2	—	2	12	—	12
Airborne Infection Isolation Room (11), (18)	N	—	In	2	—	2	12	—	12
Isolation Alcove or Anteroom (17), (18)	P/N	±	In/Out	2	2	—	10	10	10
Labor/Delivery/Recovery		—	—		—	2		—	6 (16)
Labor/Delivery/Recovery/Postpartum		—	—		—	2		—	6 (16)
Labor/Delivery/Recovery/Postpartum (LDRP) (16)	—	E	—	2	2	—	6	4	—
Patient Corridor	—	E	—	2	2	—	4	4	2
Public Corridor	N			2			2		

Practice with *AIA Guidelines and *ASHRAE Handbook*** **pages 240-244 of Appendix F.)**

All Air Exhausted Directly to Outdoors (6)			Air Recirculated Within Room Units (d) (7)			Relative Humidity (8) (%)			Design Temperature (9) (°F/°C)			Proposed Comments
Manual	Handbook	AIA (1)	Manual	Handbook	AIA (1)	Manual	Handbook	AIA (1)	Manual	Handbook	AIA (1)	
—	Optional	—	—	Optional	—	30-60	30 (winter), 50 (summer)	—	70-75	75	70-75 (21-24)	B3
Yes	Yes	Yes	No	No	—	—		—	—		—	C3
	Optional	—		No	—		30-60	—		75-80	—	
—	—	—	No	—	No	30-60		30-60	72-78		72-78 (22-26)	C2
	Yes	—		Optional	—			—			—	
	Yes	—		No	—		30 (winter), 50 (summer)	—		75	—	
—	—	—	No	—	No	—		—	70-75		75 (24)	C2
Yes	—	Yes (15)	No	—	No	—		—	70-75		75 (24)	C2
Yes	Yes	Yes	No	No	No	—		—	—		—	D1
	—	—		—	—			—			70-75 (21-24)	
	—	—		—	—			—			70-75 (21-24)	
—	Optional	—	—	Optional	—	30-60	30 (winter), 50 (summer)	—	70-75	75	—	A2
—	Optional	—	—	Optional	—	—		—	—		—	D2
—			—			—			—			

ASHRAE Checklist No. 2: Startup Checklist for HVAC Systems Prior to Occupancy

☐ Maintain proper indoor air temperature and humidity to maintain human comfort, reduce potential for spread of airborne pathogens and limit potential for mold growth in building structure and finishes (refer to ASHRAE Standard 55, recommended temperature ranges of 68-78 degrees F dry bulb depending on operating condition and other factors, recommend limiting maximum RH to 60%). Consider consulting with a local professional engineer to determine appropriate minimum RH levels based on local climate conditions, type of construction and age of the building under consideration. Recommend minimum RH of 40% if appropriate for building. Consider the addition of humidification equipment only when reviewed by a design professional to verify minimum RH set points will not adversely impact building or occupants by contributing to condensation and possible biological growth in building envelope. Trend and monitor temperature and humidity levels in each space to the extent possible and within the capability of BAS, portable data loggers and handheld instruments.

☐ Verify proper separation between outdoor air intakes and exhaust discharge outlets to prevent/limit re-entrainment of potentially contaminated exhaust air (generally minimum of 10-foot separation - comply with local code requirements).

☐ Consider having airflows and building pressurization measured/balanced by a qualified Testing, Adjusting and Balancing (TAB) service provider.

☐ Consider having airflows and system capacities reviewed by design professionals to determine if additional ventilation can be provided without adversely impacting equipment performance and building Indoor Environmental Quality (IEQ).

☐ Measure building pressure relative to the outdoors. Adjust building air flows to prevent negative
pressure differential.

☐ Verify coil velocities and coil and unit discharge air temperatures required to maintain desired indoor conditions and to avoid moisture carry over from cooling coils.

☐ Review outdoor airflow rates compared to the most current version of ASHRAE Standard 62.1 or current state-adopted code requirements.
<u>Filtration in all mechanical equipment:</u>

- Verify filters are installed correctly.

- Develop standards for frequency of filter replacement and type of filters to be utilized.

- Select filtration levels (MERV ratings) that are maximized for equipment capabilities, use MERV 13 if equipment allows, while assuring the pressure drop is less than the fans capability. See Filtration Upgrades.

If Demand-Controlled Ventilation (DCV) systems using Carbon Dioxide (CO2) sensors are installed, operate systems to maintain maximum CO2 concentrations of 800-1,000 Parts Per Million (ppm) in occupied spaces:

- Trend and monitor levels continuously if controls system is capable of doing so (use portable data
loggers and handheld instruments and document readings where needed to demonstrate compliance with District or Campus requirements).

- Consider adjusting to maximize outdoor air or disabling operation of DCV if it will not adversely impact operation of overall system (Temporary recommendation while operating under infectious Disease crisis).

- Perform initial air flush of all spaces prior to occupants re-entering building:

- Mechanical systems should operate in occupied mode for minimum period of one week prior to students returning (may be completed at same time as teachers start returning to building) while assuring the outside air dampers are open.

Domestic water systems shall be prepared for use:

- Systems should be flushed to remove potential contaminants from stagnant equipment, piping, fixtures, etc.

- Domestic cold-water systems should be flushed with all fixtures on a branch of piping opened simultaneously for a minimum period of five minutes – preferred approach is to have all building fixtures open at same time if possible – if not, care should be taken to ensure flow rate is adequate to flush piping mains and branch lines.

- Domestic hot water systems should be flushed with all fixtures on a branch of piping opened simultaneously for a minimum period of 15 minutes – preferred approach is to have all building fixtures open at same time if possible – if not, care should be taken to ensure flow rate is adequate to flush piping mains and branch lines.

- Reference ASHRAE Standard 188 and Guideline 12

Air Handling Units: Monthly

- Check for particulate accumulation on filters, replace filter as needed.
- Check ultraviolet lamp, replace bulbs as needed (if applicable).
- Check P-trap on drain pan.
- Check the control system and devices for evidence of improper operation.
- Check variable-frequency drive for proper operation.
- Check drain pans for cleanliness and proper slope.
- Verify control dampers operate properly.
- Confirm AHU is bringing in outdoor air and removing exhaust air as intended.
- Verify filters are installed correctly.
- Follow filter replacement policy.
- Review condition of cooling coils in air handling equipment – if issues with condensate drainage are identified or biological growth is identified, corrective action should be taken to clean or repair.

Roof Top Units: Monthly

- Check for particulate accumulation on outside air intake screens and filters. Replace filter as needed.
- Check ultraviolet lamp, replace bulbs as needed (if applicable).
- Check P-trap.
- Check drain pans for cleanliness and proper slope.
- Check the control system and devices for evidence of improper operation.
- Check variable frequency drive for proper operation.
- Check refrigerant system for leaks.
- Check for evidence of leaks on gas heat section heat-exchanger surfaces.
- For fans with belt drives, inspect belts and adjust as necessary. Verify control dampers operate properly.