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2255 Sheppard Ave. East • Suite E-331
Toronto • ON • M2J4Y1
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Memorandum

MEMO No.: M - 001

To:	Jelena Vulovic-Basic	Project No.:	21021
Company:	University of Toronto	Project Name:	U of T Classroom Study
From:	Andrew Pratt	Email:	jelena.vulovic.basic@utoronto.ca
Date:	March 10, 2021	No of Pages:	4
Re:	Ventilation Rates for Classrooms		

Distribution:

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Message

1.0 Air Change Rates for Classrooms

1. There is no definitive recommendation for the appropriate air change rate required to mitigate Covid 19 spread in Classrooms and the recommendations for air flows have been changing as the pandemic continues. The following memo identifies some of the recommendations that have been made.

Organization	Service	Space Type	Recommendation	Comment
CSA Z317.2	Health Care	Examination Room / Offices / Patient Rooms	Minimum of 6 Total ACH and 2 Outside Air ACH	CSA Z317.2 identifies the requirements for healthcare which should be more stringent than an education environment.
ASHRAE	Health Care	Alternate Care Sites (Non Covid Emergency Surge Facilities)	Minimum 2 ACH outdoor air and 2 ACH total air. For larger rooms they are recommending 2.5 total ACH. https://www.ashrae.org/technical-resources/healthcare-faq	For non covid health care spaces that are built for surge applications ASHRAE's minimum ACH rates are very low.

ASHRAE 62	Education	Lecture Hall	O/A = 7.5 cfm/person plus 0.06 cfm per square feet.	Minimum outside air rates for all spaces should not be less than those identified in ASHRAE 62.
Washington State Department Of Health	Health Care		Portable HEPA air cleaners can supplement ventilation… The equivalent of at least the equivalent of 5-6 air changes per hour is recommended. https://docs.google.com/spreadsheets/d/1NEhk1IEdbEi_b3wa6gI_zNs8uBJjlSS-86d4b7bW098/edit#gid=1836861232	Harvard – Boulder Colorado University has created an air change rate calculator. It can be accessed at the link indicated. They indicate that 6 air changes is ideal.
Rhode Island Department of Health	Health Care		At least 4 ACH	
EPA	Education	Lecture Hall	Recommends ventilation system comply with ASHRAE 62 requirements.	
Triatek	Health Care	Isolation Room preparedness for Covid 19 Patients.	At least 6 ACH	Recommending 6 ACH for spaces where Covid patients are expected.
Boston University	Education	Classrooms	Covid 19 Response: Offices, Classrooms 3 to 7 effective ACH Link can be found at http://www.bu.edu/cpo/files/2020/07/BU-HVAC-Guidance-7-28-20.pdf	Boston University has approximately 800 classrooms.
MIT Safety Guideline for Indoor Airborne Transmission of Covid 19.	Education	Classrooms	Link can be found at https://cheme.mit.edu/wp-content/uploads/2021/01/COVID-19_Indoor_Safety_Guideline_v6.xlsx	Two Professors at MIT (John Bush and Martin Byzant) created this spreadsheet to calculate the recommended occupancy and exposure time taking

				into account the volume of the space, infection rate and filtration efficiency.

2.0 Filtration

1. ASHRAE (Building Readiness Document) recommends that Building Owners improve the efficiency of filters within air handling units. ASHRAE recommends mechanical filter efficiency be at least Merv 13 to help mitigate the transmission of infectious aerosols.
2. If increasing the filters to Merv 13 would result in more than a 5% drop in air flow from the existing condition, unit discharge temperatures do not drop too low or the airflow is less than recommended CFM / ton then the filter upgrade may not be possible with Merv 13 filters. For these applications ASHRAE is recommending that the filters be replaced with the highest Merv rating possible and to consider in room portable HEPA filters.
3. Filter efficiency is estimated to be as follows for Merv 13 filters. The filter drop nuclei value is included in the equivalent air change rate calculation used to determine the length of time required for flushing and the equivalent air change rate.

Merv Rating	E1% (0.3um to 1um)	E2% (1 um to 3 um)	E3% (3 um to 10 um)	Filter Droplet Nuclei Efficiency
13	66.3%	92.4%	97.8	89.93%

4. Refer to the ASHRAE Covid technical reports for recommended maintenance and inspection of filter systems.

3.0 Flushing Prior to and After Occupancy During Pandemic

1. ASHRAE has issued a recommendation in their Building Readiness document that was issued in early February indicating the following:

   .1 Recommends that the building be flushed pre and post occupancy for a duration sufficient to reduce concentration of airborne infectious particles by 95%. For a well mixed space, this would require a total of 3 air exchanges of Outside air or 3 Equivalent air exchanges (includes filtration) prior to occupancy and after occupancy. This is not an air change rate but a requirement to replace the total amount of air in the space 3 times prior to occupancy.

   .2 ASHRAE has provided an Equivalent Air Change Rate calculation which utilizes the O/A, R/A and Total Air Change rates, Droplet Nuclei Filtration at the air handling unit, air cleaner filter efficiency and the zone air distribution effectiveness.

.3 This calculation can also be used to determine the equivalent total air change rates for the space.

.4 Depending on the equivalent air change rate the total time required to complete the 3 Air Exchanges can be calculated.

4.0 ASHRAE Recommendation Outside Air

1. ASHRAE's is recommending the following:

.1 Building Operators should confirm that their systems are providing outside air flow rates that comply with the requirements of ASHRAE 62 for outside air when the building is occupied.

.2 Where an existing building has a lower outside air flow rate than current ASHRAE 62 requirements portable HEPA filter units should be provided to supplement the air change rate for the room to ensure that there is a minimum of 6 equivalent air changes per hour.

.3 Where mechanical ventilation is not available openable windows should be utilized to increase the amount of outside air in conjunction with portable HEPA air filtration units.

.1 When operable windows are utilized the occupancy within the classroom should be modified based on the number of windows that are able to be opened while maintaining thermal comfort. The more windows that can be opened the higher the occupancy.

.2 The amount of time that the space is required to be flushed pre and post occupancy is dependent on the number of windows that can be opened.

.4 In order to occupy a space during the pandemic we recommend that a minimum amount of outside air be provided to each room that is being occupied by either mechanical or natural ventilation.

5.0 Recommendation

1. The majority of the publications issued for Covid preparedness are indicating that total air change rates of approximately 6 ACH are appropriate for spaces that will be occupied during the pandemic.

2. The total air change rates should be used in conjunction with:

.1 Appropriate pre and post flushing of 3 total air exchanges.
.2 Outside air flow rates that meet current ASHRAE 62 requirements and where the outside air flow rates are less than current ASHRAE 62 requirements portable HEPA filter units should be provided to provide a minimum of 6 equivalent air changes per hour.
.3 Where mechanical ventilation is not possible the maximum number of operable windows that can be opened while maintaining thermal comfort should be opened and portable HEPA air cleaners capable of providing an equivalent 6 air changes per hour should be installed in the room. The maximum occupancy of the classroom should be adjusted depending on the number of windows that can be opened.

.4 Turning off the Demand Control Ventilation systems which reduce outside air volumes below ASHRAE 62 design air volumes during part occupied modes.

Yours very truly,

CROSSEY ENGINEERING LTD.

Andrew Pratt, P. Eng.