

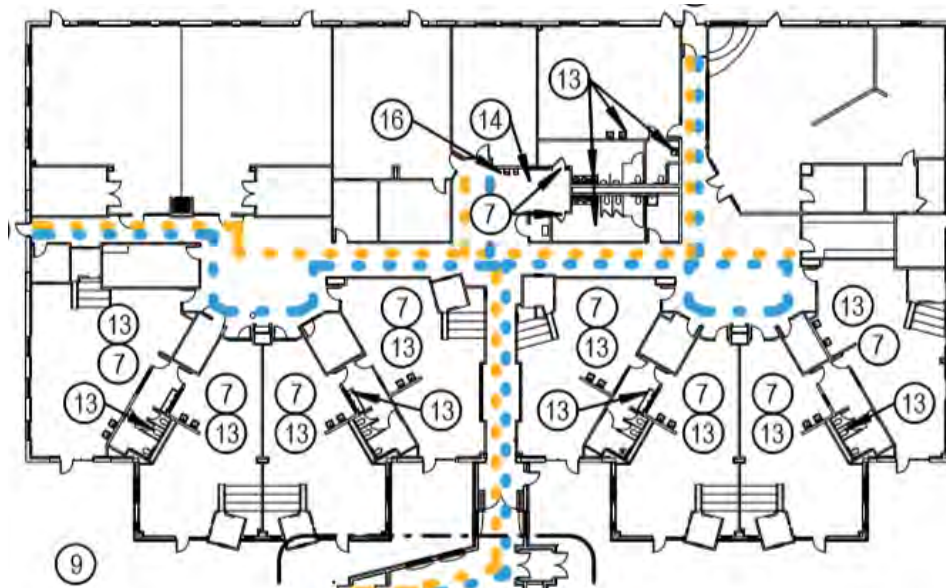
ANN ARBOR PUBLIC SCHOOLS  
LEAD. CARE. INSPIRE.



# Preparing School Buildings for a COVID Informed Return

*Emile Lauzzana, Executive Director, Capital Projects*  
*Bernerd Rice, Executive Director, Physical Properties*

*Presented to the Board of Education*  
*October 21, 2020*









# Presentation Overview

- **Types of COVID Transmission - Fomite, Droplet, and Aerosol**
- **Primary Risk Reduction Strategies**
  - **Managing Vacant School Buildings for a Safe Return**
    - Heating, Ventilating and Air Conditioning (HVAC) Systems
    - Water Quality
  - **Touch Surfaces and Social Distancing**
    - Cleaning and Sanitizing
    - Touchless Plumbing Conversion
    - Hand Washing / Sanitizing
    - Social Distance Preparations
  - **Air Quality Preparations**
    - Restroom Preparations
    - Ventilation and Filtration
    - Review of Additional Technologies
- **Expert Summary Guidance:**
  - Harvard School of Public Health
  - American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- **Next Steps and AAPS Recommendations**

# Types of COVID Transmission

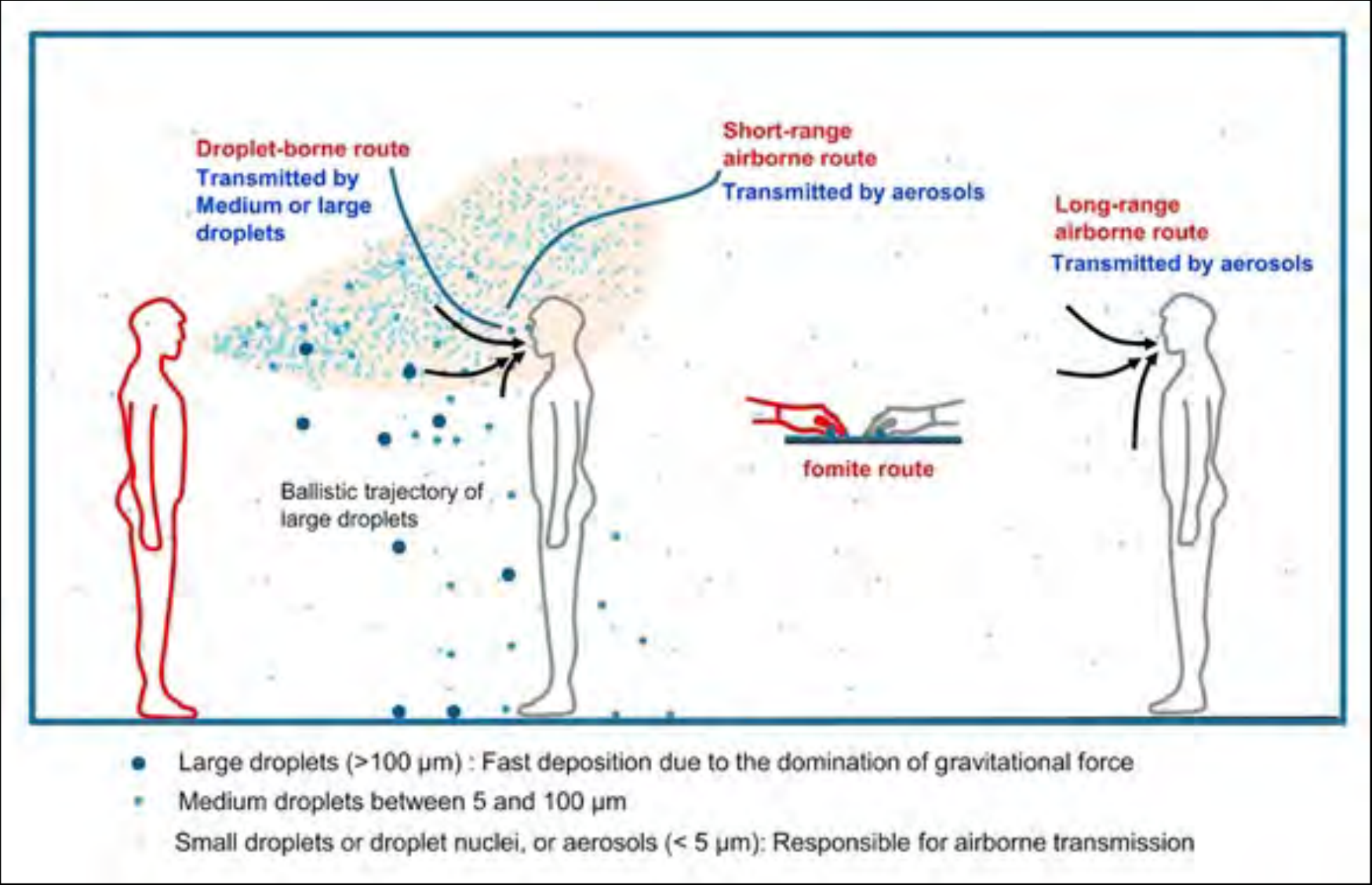
**CORONAVIRUS TRANSMISSION**

FOMITES	DROPLETS	AEROSOLS
		
<p><b>Fomites</b> are contaminated objects and surfaces that transmit coronavirus from your hands to your eyes, nose or mouth. Fomite spread is more likely on hard, non-porous materials like metals and plastics. Regular use of hand sanitizer and vigorous hand-washing can prevent fomite spread.</p>	<p><b>Droplets</b> are moist particles expelled from speaking, breathing, coughing and sneezing. They are considered to be the primary vector of COVID-19 infection. Virus-bearing droplets can spread coronavirus through your eyes, nose or mouth. Droplets do not remain airborne long: 6 feet of distance limits exposure, but masks covering the mouth and nose are the best prevention.</p>	<p><b>Aerosols</b> are tiny particulates that infected carriers exhale, especially when shouting, singing, or speaking. Aerosols are mostly inhaled as a means of transmitting the virus. Unlike droplets, aerosols can remain airborne for several hours, can travel further than 6 feet, and may accumulate, especially in poorly ventilated, closed spaces. Masks, worn snugly and properly, are extremely effective at containing aerosols. Remaining outdoors, where aerosols cannot accumulate, also prevents transmission</p>
 <p>Hand washing</p> <p>Hand sanitization</p>	 <p>Mask wearing</p> <p>Eye protection</p> <p>6'</p> <p>Social distancing</p> <p>Staying outdoors</p>	 <p>Mask wearing</p> <p>6'</p> <p>Social distancing</p> <p>Staying outdoors</p> <p>Ventilation</p>

Source: CDC / UMMC

Source: Centers for Disease Control (CDC)

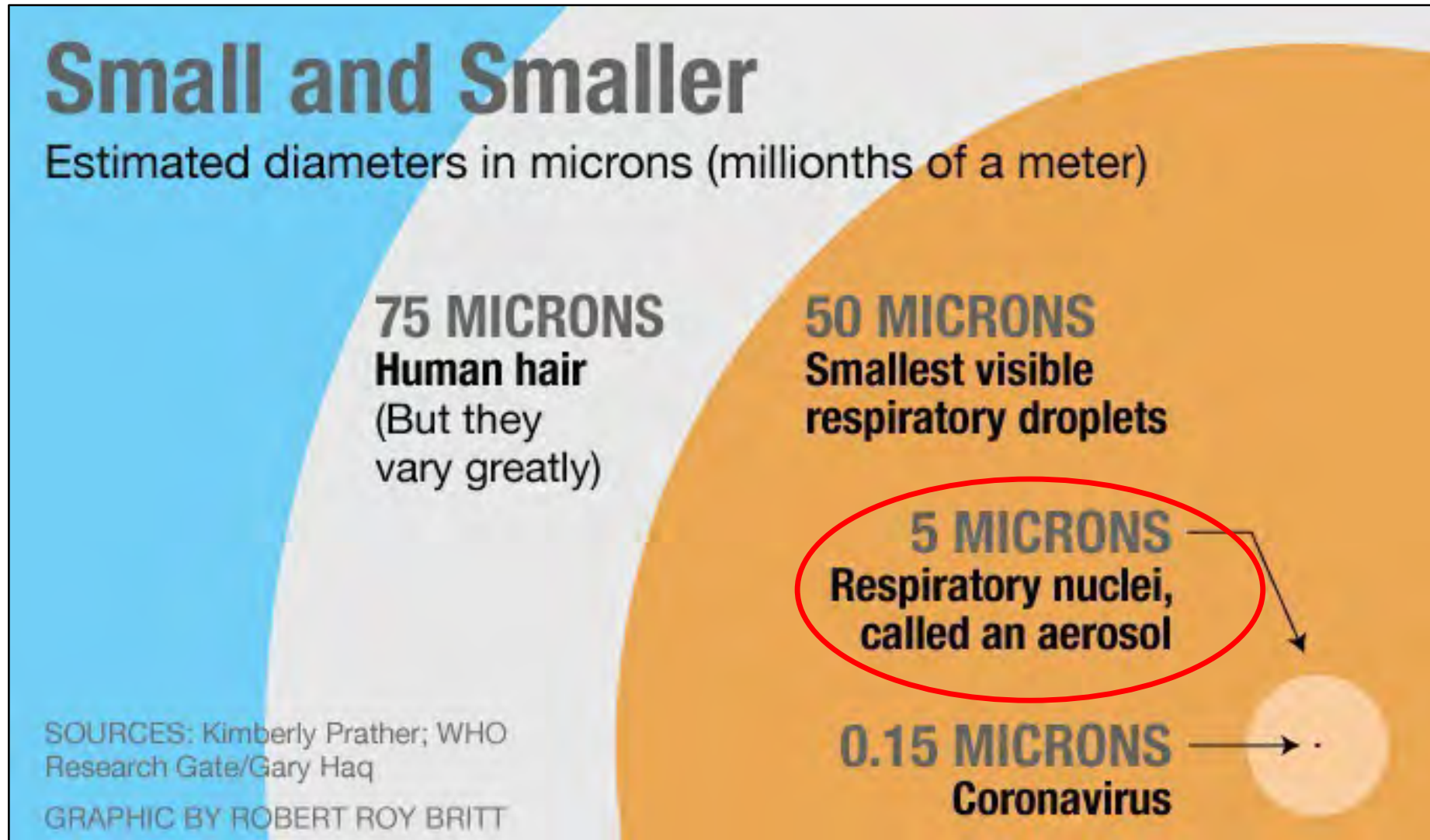
# Fomite, Droplet, and Aerosol Transmission



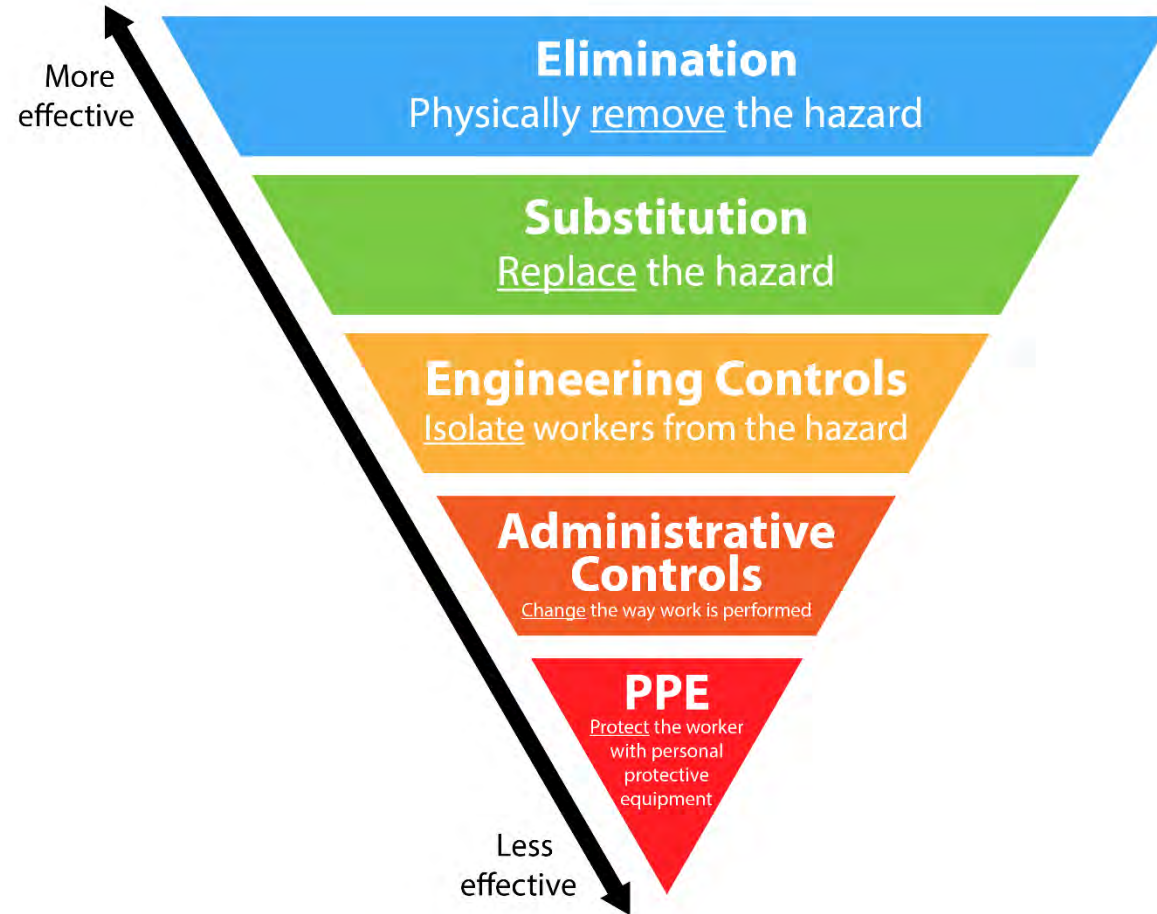
Source: <https://www.sciencedirect.com/science/article/pii/S0196655316305314>



# How Big is a Micron?



# Risk Reduction Strategies



CDC Hierarchy of Controls

# Primary Risk Reduction Strategies

## Tips for Reducing Risk of Getting COVID-19

### Things that Increase Risk

No Masks Worn

Crowded Place

Indoor Space

**HOT SPOT**

### Things that Decrease Risk

Masks Worn

6 Feet of Space Between People

Outdoor Space

**SAFE SPOT**

[www.cdc.gov/coronavirus](http://www.cdc.gov/coronavirus)

CS 319539 08/10/2020

Source: Centers for Disease Control (CDC)




# Risk Reduction Strategies


## SCHOOLS FOR HEALTH

Risk Reduction Strategies  
for Reopening Schools


June, 2020

COVID-19





**HARVARD T.H. CHAN**  
SCHOOL OF PUBLIC HEALTH



**HEALTHY BUILDINGS**  
FOR HEALTH | forhealth.org

**SCHOOLS FOR HEALTH**

Risk Reduction Strategies for Reopening Schools

### HEALTHY CLASSROOMS

- Wear masks
- Wash hands frequently
- Maximize physical distancing to protect individuals
- Maximize group distancing to slow transmission chains
- Disinfect objects between users

### HEALTHY BUILDINGS

- Increase outdoor air ventilation
- Filter indoor air
- Supplement with portable air cleaners
- Verify ventilation and filtration performance
- Consider advanced air quality techniques
- Use plexiglass as physical barrier
- Install no-contact infrastructure
- Keep surfaces clean
- Focus on bathroom hygiene



### HEALTHY ACTIVITIES

- Provide recess
- Modify physical education
- Reimagine music and theater classes
- Continue sports with enhanced controls
- Add structure to free time

### HEALTHY SCHEDULES

- Manage transition times and locations
- Make lunchtime safer
- Rethink transportation
- Modify attendance

### HEALTHY POLICIES

- Establish and reinforce a culture of health, safety, and shared responsibility
- Form a COVID-19 response team and plan
- Prioritize staying home when sick
- Promote viral testing and antibody testing
- Establish plans for when there is a case
- Support remote learning options
- De-densify school buildings
- Protect high-risk students and staff



# Risk Reduction Strategies



## RISK REDUCTION STRATEGIES

### HEALTHY CLASSROOMS

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# Managing Vacant School Buildings for a Safe Return



# Managing Vacant School Buildings for a Safe Return

## Heating Ventilating and Air Conditioning (HVAC) Systems

- While the buildings are unoccupied, HVAC systems are run at a minimum of two hours twice per week to keep them in good working order
- Increase filter changes to 3x per year and increase filter density where feasible
- Deep Clean and Commission all HVAC systems





# Managing Vacant School Buildings for a Safe Return

## Water Quality

- While buildings are unoccupied, **completely flush** the plumbing systems weekly to help prevent the growth of Legionella bacteria which can cause Legionnaires disease
- Complete the bi-annual **replacement of all drinking water filters**
- **Test all school buildings for Ecoli and Legionella**



# Preparing School Buildings for a Safe Return to In-Person Instruction

**SAFE  
RETURN  
2 LEARN**

# Cleaning and Sanitizing

- Frequently touched surfaces including light switches, doors, benches, bathrooms, will be cleaned every four hours with an EPA-approved disinfectant.
- Staff will wear appropriate personal protective equipment when cleaning.
- Custodial staff to regularly check and restock soap, hand sanitizer and paper towels.
- Hallway and classroom doors will be propped open to minimize touch surface contact where feasible
- Hand sanitizer will be provided in all occupied spaces and when arriving at school

## Touchpoints:





# Plumbing Systems - Fixture Modifications

- Remove all drinking fountain bubblers and cap openings
- Install water bottle fillers at locations of drinking fountain bubblers where feasible
- Begin transition to touchless restroom fixture operation for sinks, toilets, and urinals



# Plumbing Systems - Convert to Touchless Operation

Examples of Specified Touchless Fixtures for sinks, toilets and urinals:



# Health and Wellness Signage

AAPS has retained Stantec consulting architects and planners to develop informational signage and social distancing strategies. Signage will be placed throughout the schools including:

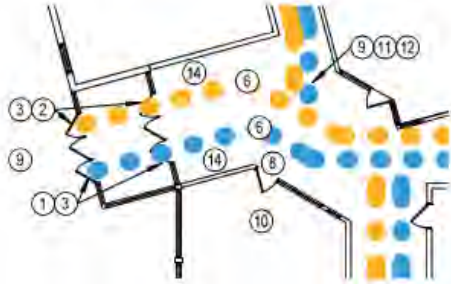
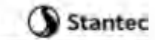
- “In-Only” and Exit-Only” door locations
- Social Distancing Reminders
- Self-Screening Reminders
- One-Way hallway and staircase traffic circulation - Walk on the right side only- “Stay in Your Lane”
- Maximum Occupancy for Elevators
- Maximum Occupancy for Restrooms
- Hand Washing Reminders in Restrooms



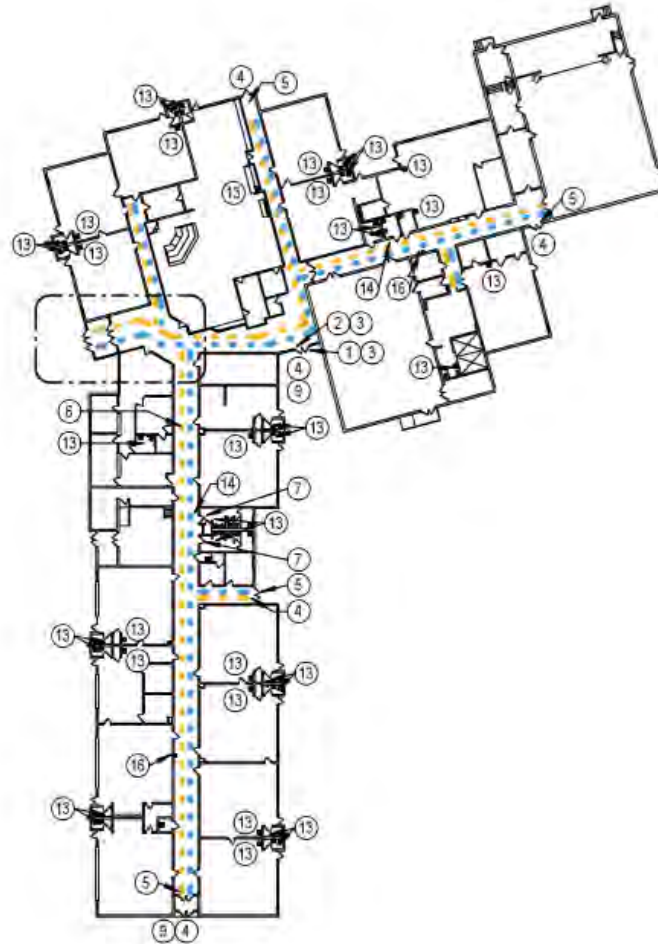


# Health and Wellness Signage - Typical Floor Plan

ANN ARBOR PUBLIC SCHOOLS



WELCOME LOBBY DETAIL



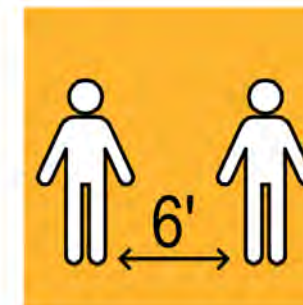
## SIGNAGE LEGEND

TYPE	QTY
① ENTER ONLY SIGN	3
② EXIT ONLY SIGN	3
③ DO NOT ENTER SIGN (ON BACKSIDE WHERE APPLIES)	6
④ ALL VISITORS USE MAIN ENTRY SIGN	5
⑤ EMERGENCY EXIT ONLY SIGN	4
⑥ CORRIDORS - SOCIAL DISTANCING FLOOR CLING DOTS- 'STAY IN YOUR LANE' - 2 COLORS - LOCATE OUTSIDE OF DOORS AND AT 15' OC MAX, TYP	50 Blue 50 Yellow
⑦ MAXIMUM OCCUPANCY SIGN	2
⑧ WELLNESS CHECK-IN LOCATION SIGN	1
⑨ ENTRANCE SCREENING POSTER	4
⑩ DRAPE-OFF EVERY OTHER CHAIR IN RECEPTION AREA	-
⑪ SOCIAL DISTANCING REMINDER SIGN	20
⑫ SELF SCREENING REMINDER SIGN	20
⑬ HAND WASHING AT SINKS SIGN	38
⑭ HAND SANITIZER STATION	4
⑮ ISOLATION ROOM LOCATION	1
⑯ DRINKING FOUNTAIN SOCIAL DISTANCING FLOOR CLING SET	2
⑰ STAIR SOCIAL DISTANCING FLOOR CLING SET	-

# Health and Wellness Signage - Overall Legend

## SIGNAGE LEGEND

TYPE	
①	ENTER ONLY SIGN
②	EXIT ONLY SIGN
③	DO NOT ENTER SIGN (ON BACKSIDE WHERE APPLIES)
④	ALL VISITORS USE MAIN ENTRY SIGN
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⑮	ISOLATION ROOM LOCATION
⑯	DRINKING FOUNTAIN SOCIAL DISTANCING FLOOR CLING SET
⑰	STAIR SOCIAL DISTANCING FLOOR CLING SET



# Health and Wellness Signage - Entry Poster

Posters will be placed outside of each school with entry requirement reminders. Entrance posters will be translated into multiple languages as needed.



## ANN ARBOR PUBLIC SCHOOLS BUILDING ENTRY PROCEDURES

### HOW ARE YOU FEELING?

PLEASE DO NOT ENTER IF YOU ARE EXPERIENCING ANY OF THESE SYMPTOMS:

	<input type="checkbox"/> Fever or chills	<input type="checkbox"/> Headache
	<input type="checkbox"/> Cough	<input type="checkbox"/> New loss of taste or smell
	<input type="checkbox"/> Shortness of breath or difficulty breathing	<input type="checkbox"/> Sore throat
	<input type="checkbox"/> Fatigue (very tired)	<input type="checkbox"/> Congestion or runny nose
	<input type="checkbox"/> Muscle or body aches	<input type="checkbox"/> Nausea or vomiting
		<input type="checkbox"/> Diarrhea

### VISITOR CHECK-IN



PROCEED TO WELLNESS CHECK-IN LOCATION

### STUDENT & STAFF CHECK-IN



COMPLETE THE COVID SCREENING APP PRIOR TO ARRIVAL

### COVID SAFETY REQUIREMENTS

			
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# Health and Wellness Signage - Entry and Exit

Entrances and Exits will be clearly labeled to promote In-Only and Exit-Only locations to minimize crossing circulation pathways.



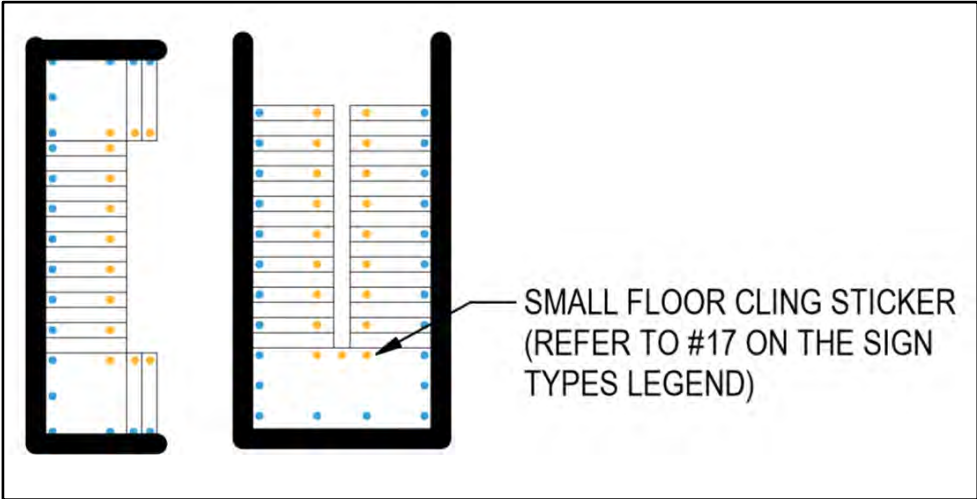
# Health and Wellness Signage - Hallway Circulation

Hallway Circulation floor dots will be installed in hallways to promote one-way hallway circulation.



# Health and Wellness Signage - Cue locations and Stairway Circulation

Social Distance floor dots will be installed in stairwells and potential cue locations such as water bottle filling stations, offices, cafeterias, etc.





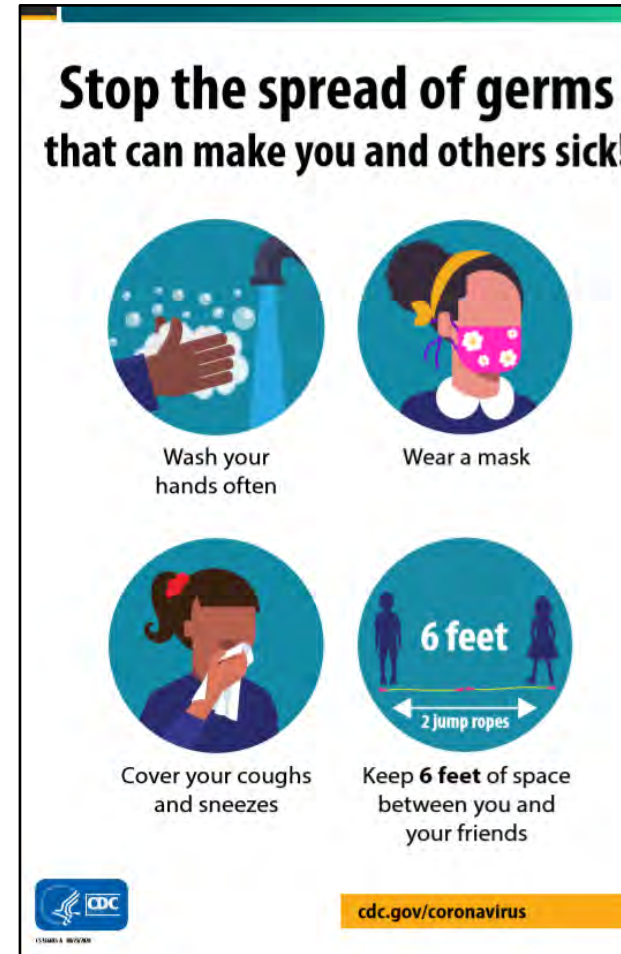
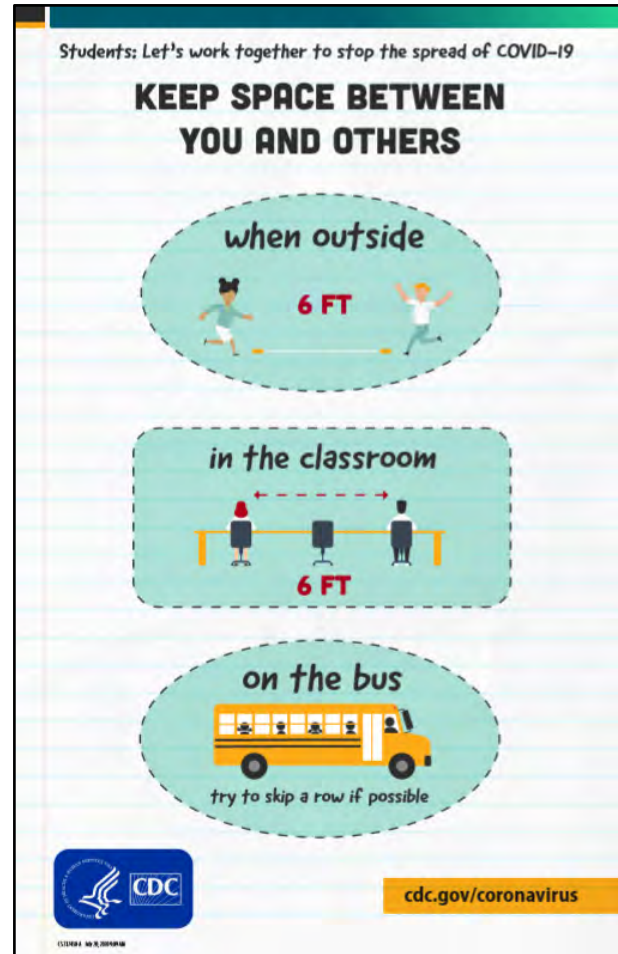
# Health and Wellness Signage - Maximum Occupancy

Maximum Occupancy will be designated for shared spaces such as restrooms, media centers, elevators, etc.



# Health and Wellness Signage - General Health Reminders

General health reminders and masking reminders will be posted throughout the schools.



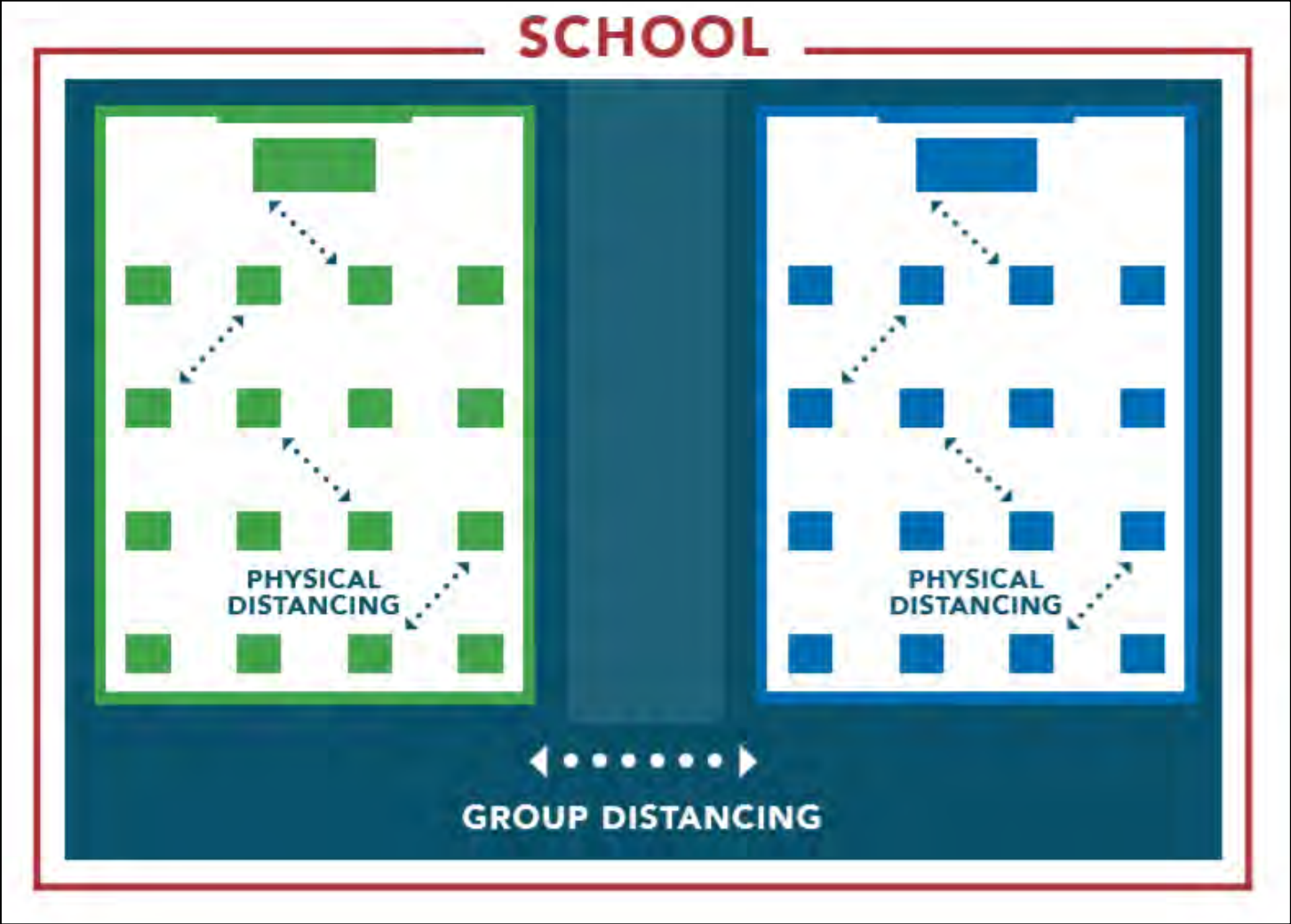
# Health and Wellness Signage - Hand Washing Reminders

Handwashing reminders will be posted at all sinks and restrooms.





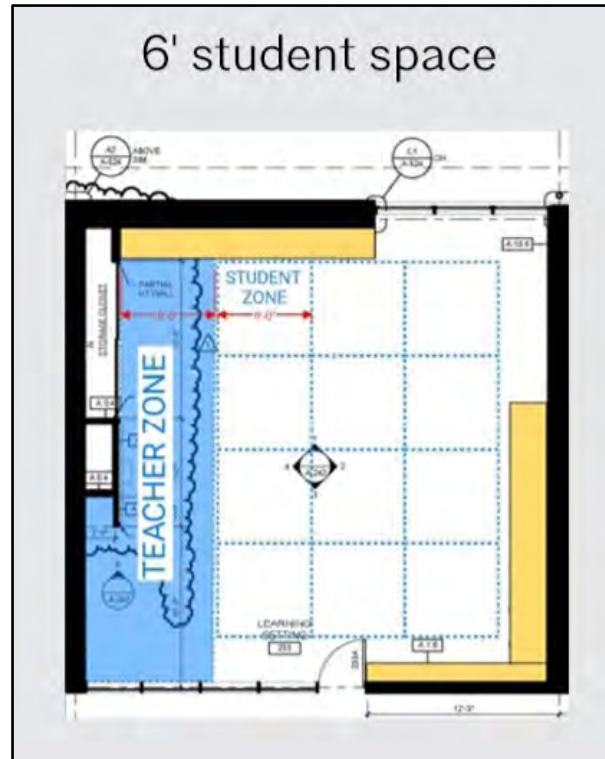
# Social Distancing Preparations - Physical Distance vs. Group Distance (Cohorts)





# Social Distancing Preparations - Classroom Layouts

Classroom, Offices and other occupied space will have furniture arranged to maximize social distancing. Unused furniture will be secured and labeled.



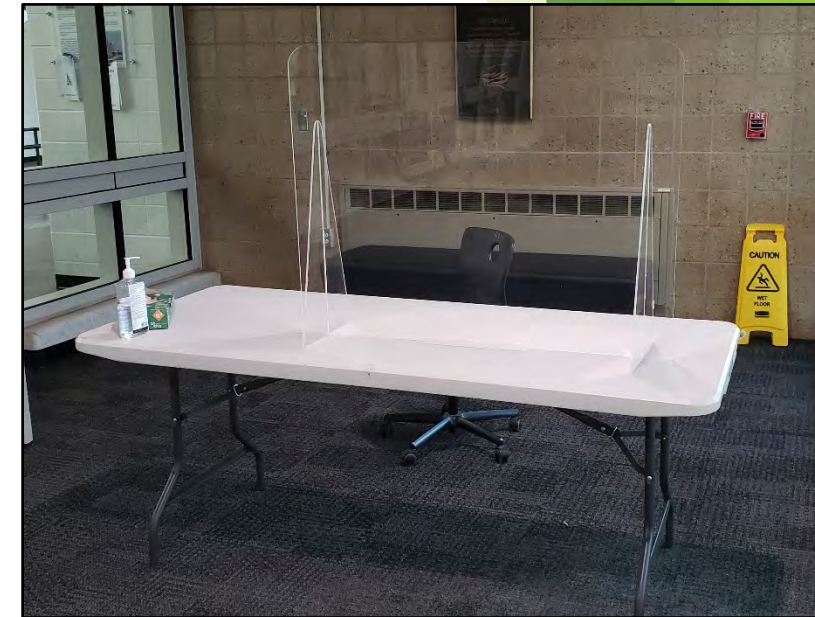
- **SAMPLE Classroom Layout** -*Stantec / American Institute of Architects*

# Social Distancing Preparations - Sneeze Guards

Sneeze Guards will be installed in all offices and other transaction locations where maintaining social distance is not feasible



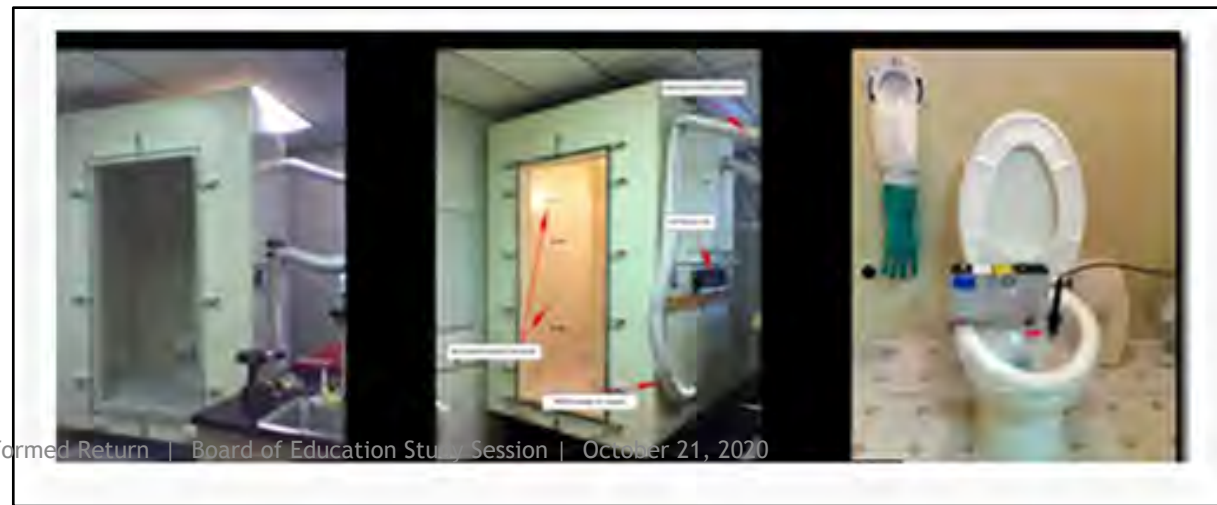
- Skyline High School



# Ventilation in Restrooms

Studies have shown that toilets and other restroom fixtures can be a risk of generating airborne droplets and droplet residues that could contribute to transmission of pathogens.

- Keep toilet room doors closed, even when not in use.
- Put the toilet seat lid down, if there is one, before flushing.
- Vent separately where possible (e.g. turn exhaust fan on if vented directly outdoors and run fan continuously).
- Keep bathroom windows closed if open windows could lead to re-entrainment of air into other parts of the building.
- Remove Forced Air Hand Dryers





# Heating Ventilating and Air Conditioning Systems (HVAC) - VENTILATION

AAPS has retained Fishbeck as consulting engineers to assist in maximizing the healthy operation of our school buildings' HVAC systems. The work has focused in several areas:

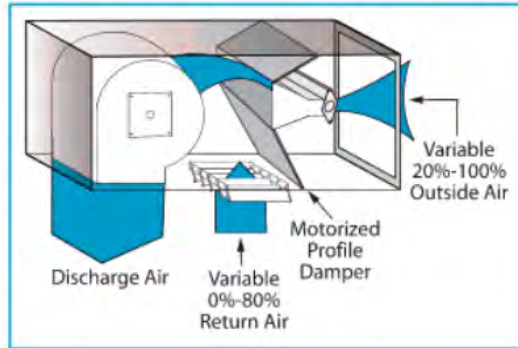
- Maximizing the provision of **fresh outside air**
- Maximizing the effectiveness of **air filtration systems**
- Developing algorithms for operating AAPS buildings in an **Enhanced Indoor Air Quality Mode** through the District's Building Automation System (BAS)





# Heating Ventilating and Air Conditioning Systems (HVAC)

## TYPICAL AIR SYSTEM CONFIGURATION



## ENHANCED INDOOR **AIR QUALITY** VENTILATION

- Review control system
- Modify sequences and setpoints to allow for an increase in outdoor air
- Implement emergency mode ventilation sequences



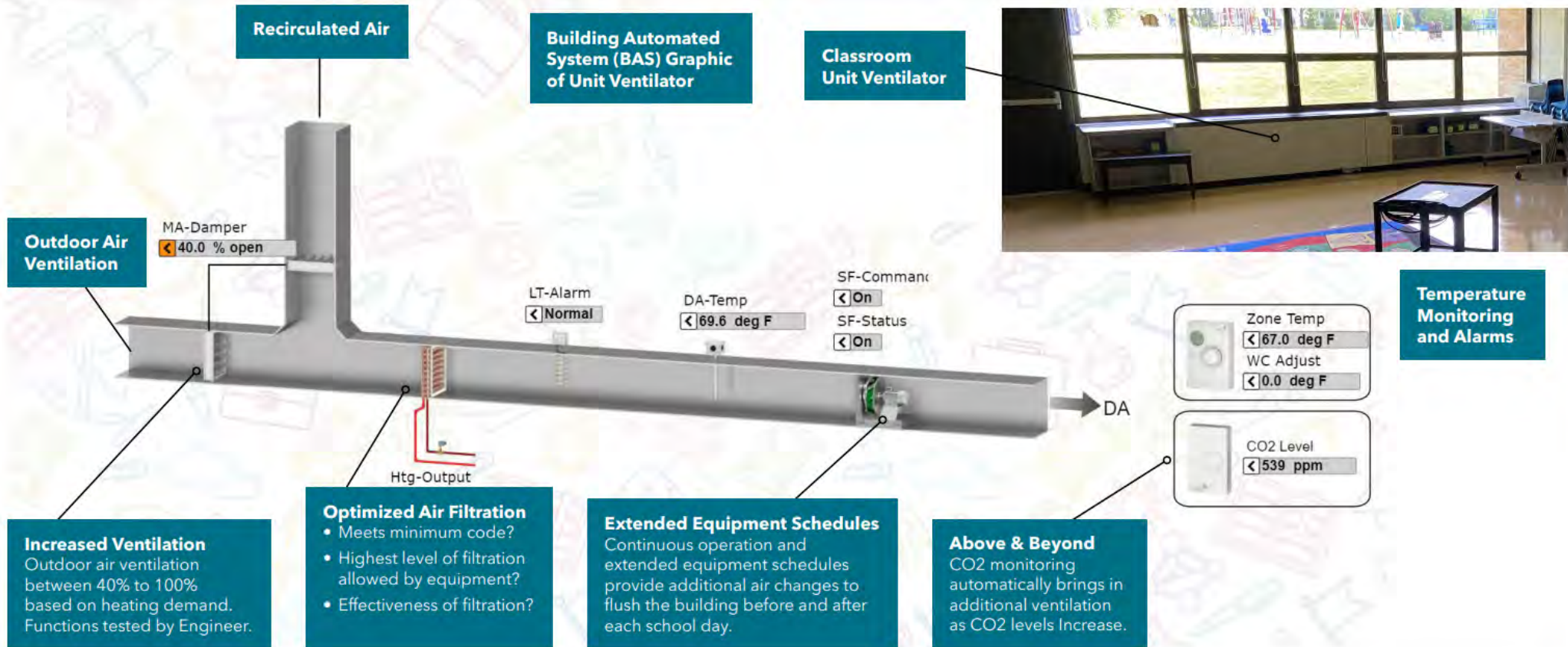
Images courtesy of UV Resources

fishbeck

# Heating Ventilating and Air Conditioning Systems (HVAC)

ENHANCED INDOOR  
**AIR QUALITY**

**MECHANICAL VERIFICATION AND TESTING  
ABBOT ELEMENTARY**

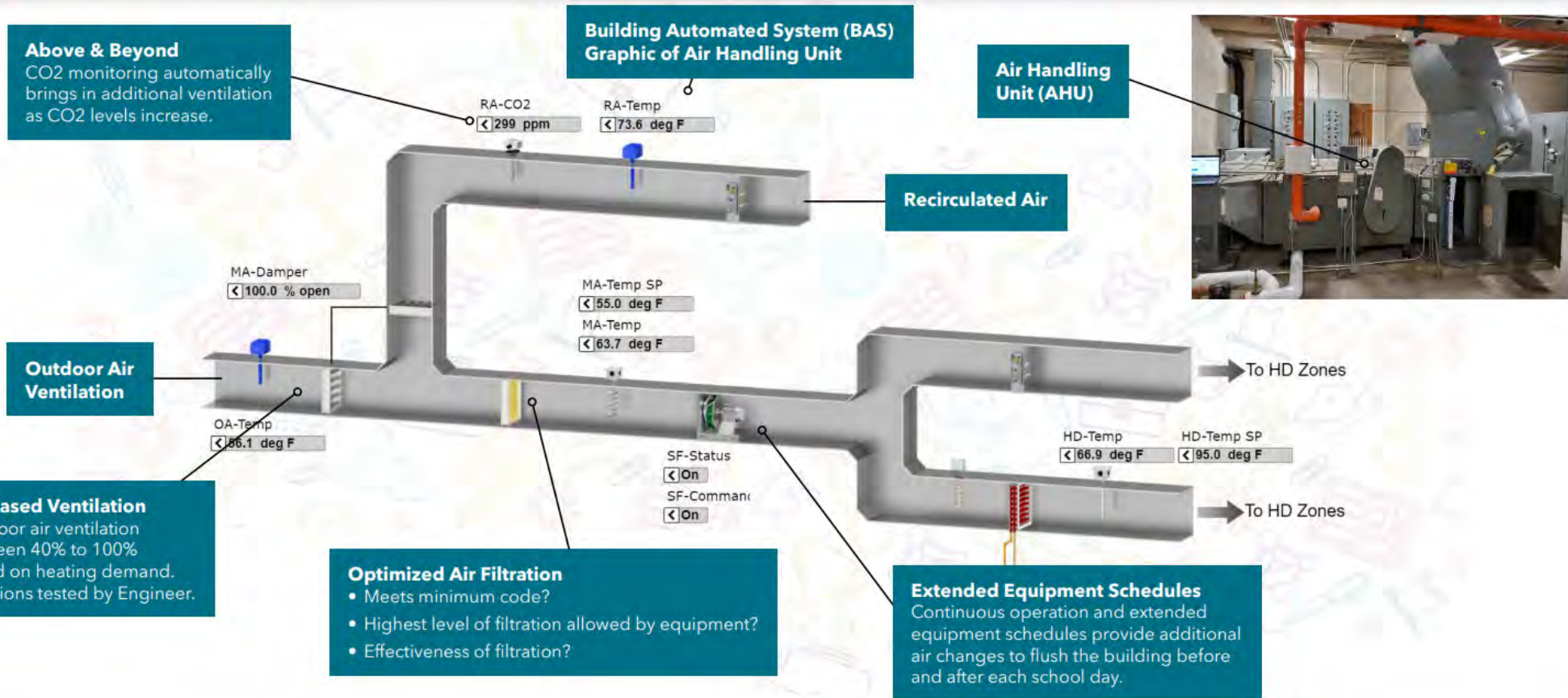




# Heating Ventilating and Air Conditioning Systems (HVAC)

## ENHANCED INDOOR AIR QUALITY

## MECHANICAL VERIFICATION AND TESTING CLAGUE MIDDLE SCHOOL



# Heating Ventilating and Air Conditioning Systems (HVAC)

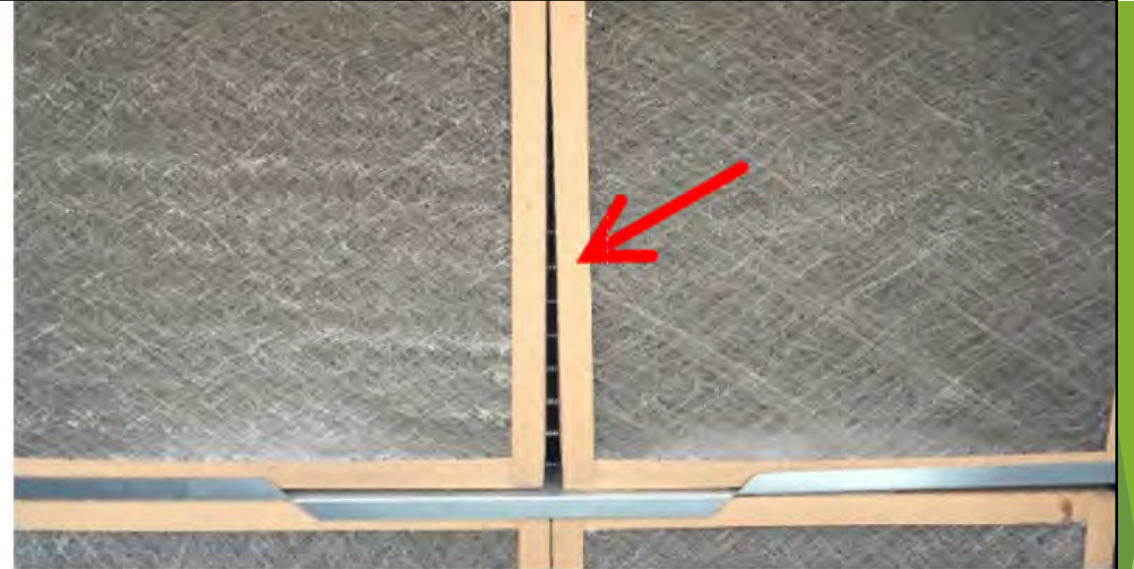
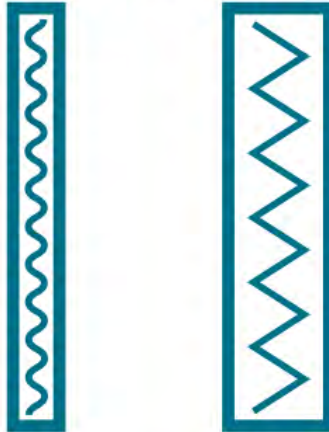
## ENHANCED INDOOR AIR QUALITY

### AIR FILTRATION

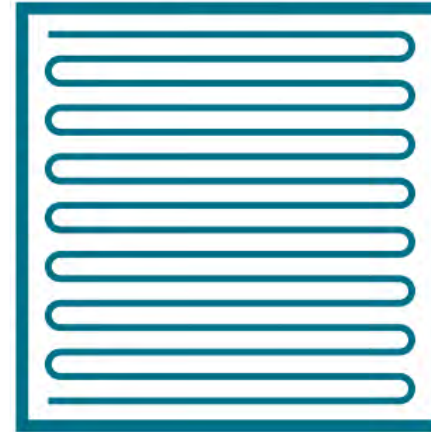
- Verify outdoor and exhaust air paths – Inspect filters, air intakes, and control devices
- Recommend filter upgrades based on fan capability and space available in units



MERV-8 to MERV-13  
1" or 2" up to 4" thickness



HEPA Filter  
12" thickness



Considerations: Physical size, pressure drop (fan capacity to maintain airflow), availability, and cost vs. benefit



# Minimum Efficiency Reporting Value (MERV)

Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle Size Efficiency, % in Size Range, $\mu\text{m}$			
	Range 1 0.30 to 1.0	Range 2 1.0 to 3.0	Range 3 3.0 to 10.0	Average Arrestance, %
1	N/A	N/A	$E_3 < 20$	$A_{avg} < 65$
2	N/A	N/A	$E_3 < 20$	$65 \leq A_{avg}$
3	N/A	N/A	$E_3 < 20$	$70 \leq A_{avg}$
4	N/A	N/A	$E_3 < 20$	$75 \leq A_{avg}$
5	N/A	N/A	$20 \leq E_3$	N/A
6	N/A	N/A	$35 \leq E_3$	N/A
7	N/A	N/A	$50 \leq E_3$	N/A
8	N/A	$20 \leq E_2$	$70 \leq E_3$	N/A
9	N/A	$35 \leq E_2$	$75 \leq E_3$	N/A
10	N/A	$50 \leq E_2$	$80 \leq E_3$	N/A
11	$20 \leq E_1$	$65 \leq E_2$	$85 \leq E_3$	N/A
12	$35 \leq E_1$	$80 \leq E_2$	$90 \leq E_3$	N/A
13	$50 \leq E_1$	$85 \leq E_2$	$90 \leq E_3$	N/A
14	$75 \leq E_1$	$90 \leq E_2$	$95 \leq E_3$	N/A
15	$85 \leq E_1$	$90 \leq E_2$	$95 \leq E_3$	N/A
16	$95 \leq E_1$	$95 \leq E_2$	$95 \leq E_3$	N/A

Aerosols potentially carrying coronavirus are approximately  $5\mu\text{m}$  (5 microns)

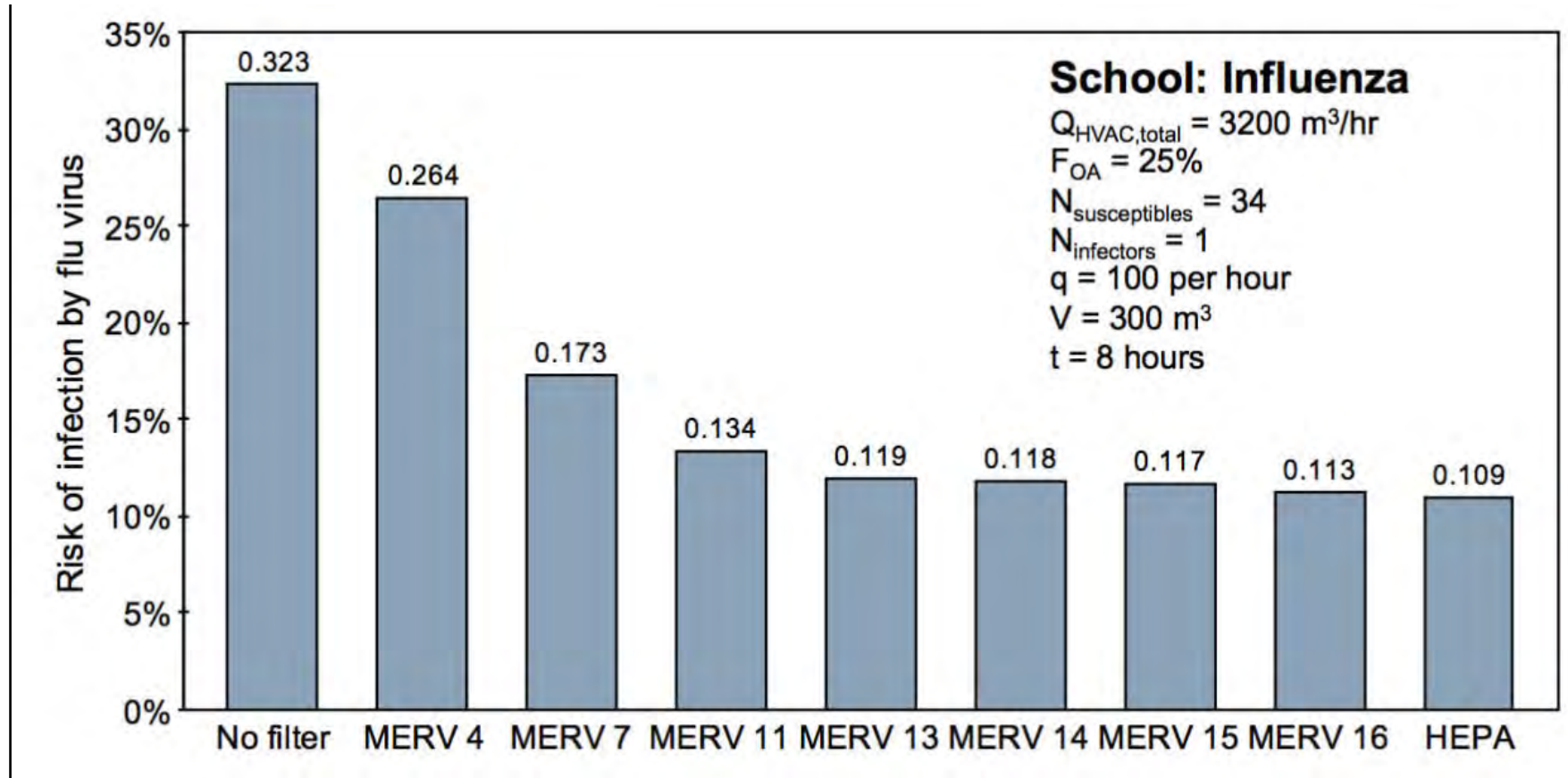
Current AAPS Air Filters

AAPS Design Standard for 2019 Bond

Source: [ASHRAE Standard 52.2-2017 Minimum Efficiency Reporting Value \(MERV\)](#)

# Minimum Efficiency Reporting Value (MERV)

Study based on one contagious person with the flu virus in a room with 35 people for 8 hours. With no filtration of the air there is a 32.3% of spread, or on average 11 people would become infected. The rate of infection drops rapidly as air filtration is introduced.



Source: Wells-Riley & HVAC Filtration for infectious airborne aerosols, NAFA Foundation Report

# Other Technologies for Cleaning Air

## Other Technologies to Consider:

- Vaporized Hydrogen Peroxide (VHP)
- Ultra Violet Light - Whole Room Disinfection
- Ozone Disinfection
- Gas-Phase Air Cleaners (Carbon Filters)
- *Ultra Violet Light - In Air Supply Disinfection*
- *Bipolar Ionization*
- **Portable Air Cleaners**



# Vaporized Hydrogen Peroxide (VHP)

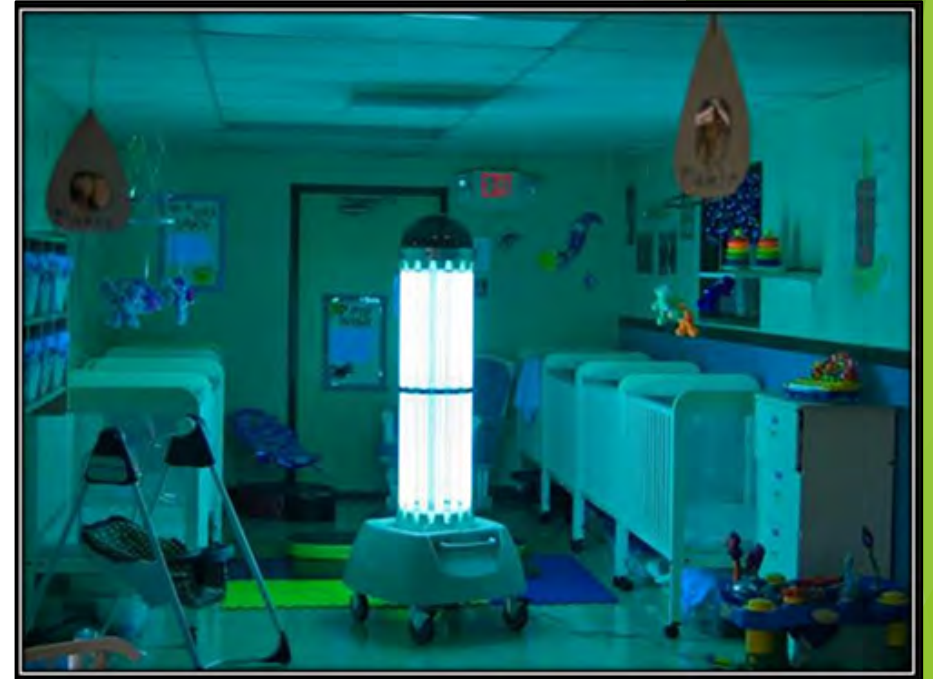
- Liquid hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) is vaporized and the vapor fills the space to disinfect all exposed surfaces.
- **Space MUST be unoccupied during VHP treatment.**
- Requires spaces to be sealed, including all doorways, plumbing/electrical penetrations and HVAC supply and return vents, to prevent vapor from escaping.
- **The effectiveness and safety of VHP when generated inside active HVAC ducts and occupied spaces has not been rigorously studied.**





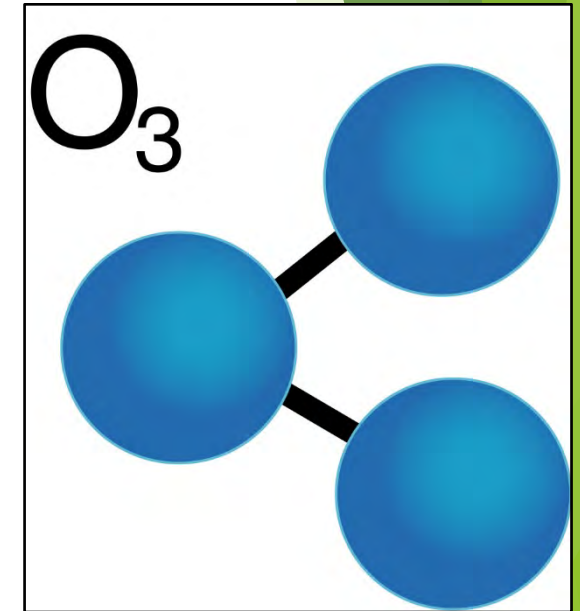
# Ultra Violet Light (UV-C) - Whole Room Disinfection

- Banks of UV-Lamps installed on a portable fixture
- Used for surface disinfection
- System operates remotely to avoid exposure to direct or reflected germicidal ultraviolet rays, since they cause painful eye irritation and reddening of the skin. Typically used in highly sensitive medical environments.



# Ozone Disinfection

- Ozone (O<sub>3</sub>) is a reactive gas that can disinfect air and surfaces by killing viruses, bacteria, and fungi.
- Ozone is harmful for health and exposure to ozone creates risk for a variety of symptoms and diseases associated with the respiratory tract.
- Should only be considered for disinfection in unoccupied spaces; it should never be used in occupied spaces.
- **Available scientific evidence shows that, at concentrations that do not exceed public health standards, ozone is generally ineffective in controlling indoor air pollution.**



## Gas-Phase Air Cleaners (Carbon Filters)

- Gas-phase air cleaners are those used to remove smoke, volatile organic compounds and other odors from the air.
- Most contain sorbent materials such as carbon (e.g., activated charcoal).
- **While there may be exceptions, most sorbent beds alone are not generally efficient at removing viruses from airstreams**



# Ultra Violet Light (UV-C) - In Air Supply Disinfection

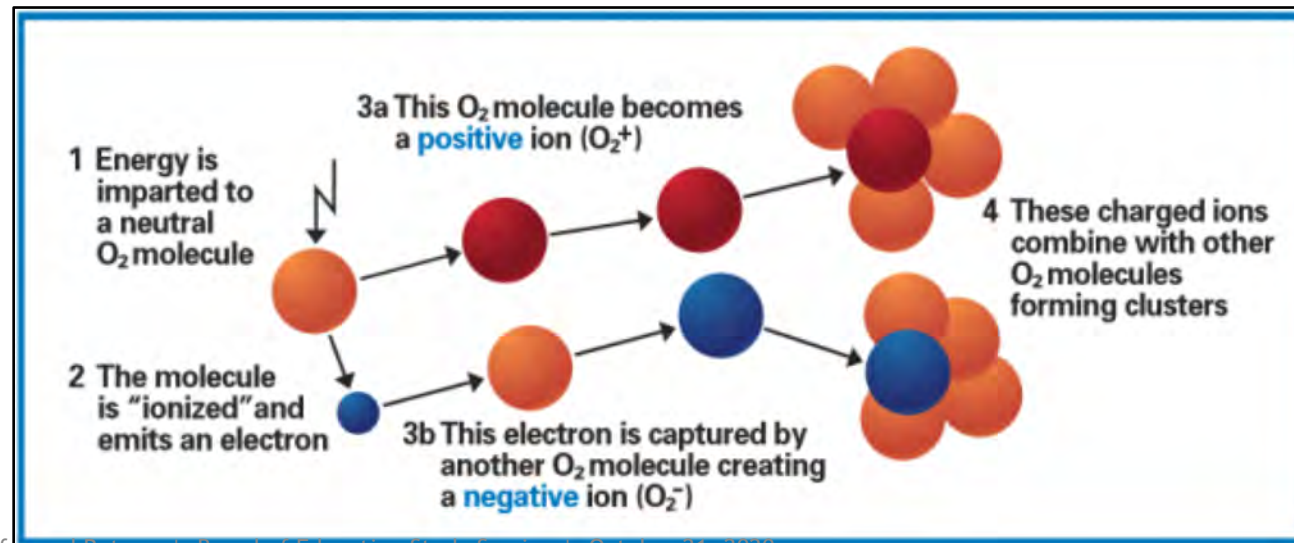
- Banks of UV-Lamps installed inside HVAC systems or associated ductwork.
- Requires high UV doses to inactivate microorganisms on-the-fly as they pass through the irradiated zone due to limited exposure time.
- Lamps pose imminent danger if used without taking the proper precautions. You **MUST** avoid exposure to direct or reflected germicidal ultraviolet rays, since they cause painful eye irritation and reddening of the skin.
- Typically used in highly sensitive medical environments.





# Bipolar Ionization / Needlepoint Ionization and Other Ion or Reactive Oxygen Air Cleaners

- Technologies utilize various methods to create reactive ions in air that react with airborne contaminants, including viruses.
- Systems are reported to range from ineffective to very effective in reducing airborne particulates and acute health symptoms.
- **Convincing scientifically-rigorous, peer-reviewed studies do not currently exist on this emerging technology; manufacturer data should be carefully considered.**
- Systems may emit ozone, some at high levels.

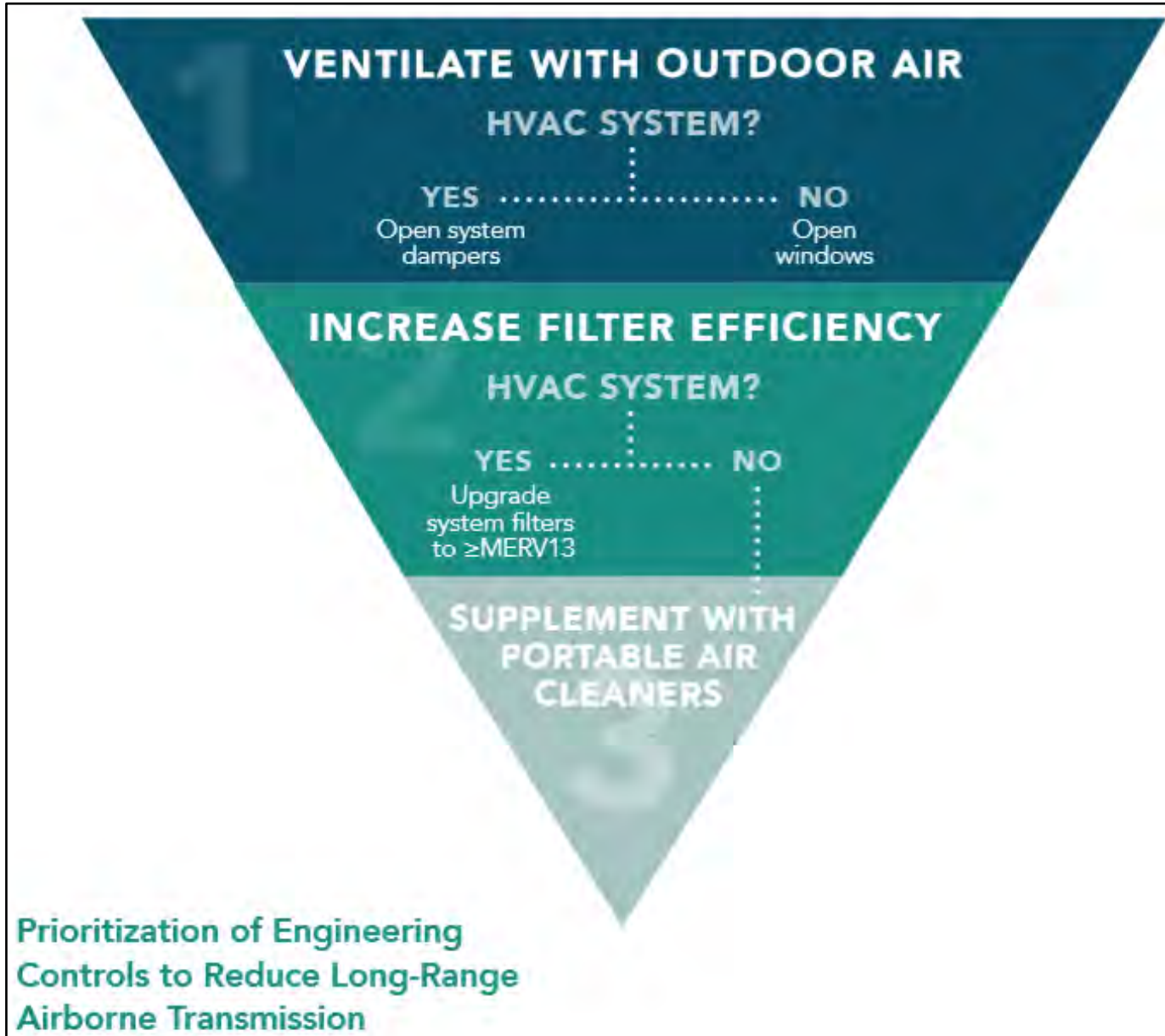


# Portable Air Cleaners

- Portable device located in the room where air cleaning is desired.
- Air is pulled into the device, and cleaned air is returned to the room.
- Devices may include any or combinations of air cleaning technologies (HEPA filters, sorbents, UV, etc.). Users are advised to carefully determine that the application of the technology is appropriate for their need.
- The rate of particle removal from air is termed the Clean Air Delivery Rate (CADR), typically in units of cubic feet per minute (CFM).



# Harvard School of Public Health Summary Recommendations



TARGET IS AT LEAST 5 TOTAL AIR CHANGES PER HOUR (ACH)	
	<i>Ideal (6 ACH)</i>
	<i>Excellent (5-6 ACH)</i>
	<i>Good (4-5 ACH)</i>
	<i>Bare minimum (3-4 ACH)</i>
	<i>Low (&lt;3 ACH)</i>



# Harvard School of Public Health Summary Recommendations: Air Changes per Hour (ACH)

Air Changes per Hour (ACH) is a measure of how often the air in a room is replaced by either outside air or recirculated filtered air.

## SAMPLE CALCULATION

Room Size is 30'wide x 30'long x 10'high = 9,000 cubic feet of air

Ventilation system provides 1000 cubic feet per minute (CFM) of fresh and/or filtered air.

1000 CFM x 60 minutes = 60,000 cubic feet per hour

$$\frac{60,000 \text{ cubic feet per hour}}{9,000 \text{ cubic feet}} = 6.6 \text{ Air Changes per Hour (ACH)}$$



# Harvard School of Public Health Summary Recommendations: Air Changes per Hour (ACH)

- Code minimum ventilation rates are approximately 2.8 - 3.5 ACH for schools
- Recommended rates for creating better air quality is 5+ ACH
- When operating in the Enhanced Indoor Air Quality Mode AAPS building mechanical systems are generally able to provide between 5 and 11 ACH depending on the room and/or school mechanical systems. In some older buildings ACHs in a limited number of rooms have been calculated to be below 5.
- Portable Air Cleaners can provide **1-4 additional ACH** depending on room size and equipment model.

# Harvard School of Public Health Summary Recommendations: Air Changes per Hour (ACH)

Increasing Air Changes per Hour (ACH) reduces the probability of virus transmission

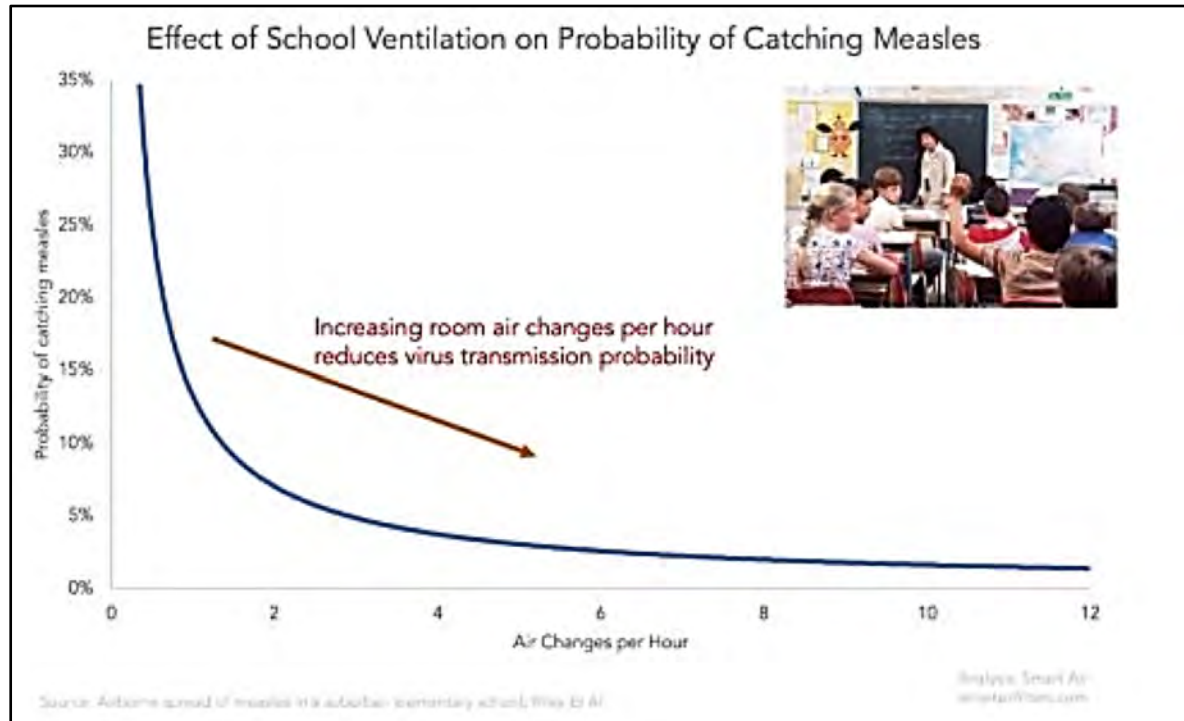


Chart is based on the Wells-Riley model developed as part of a study of a measles outbreak in NY public school in the 1970s



# American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Summary Recommendations

- It is likely, but not yet conclusively shown, that COVID19 could be spread through the air.
- **Air cleaning and increased ventilation can help mitigate disease transmission.**
- Options for air cleaning include: HVAC systems optimization and In-Room devices
- Technologies that can be effective include:
  - Mechanical Air Filters
  - Electronic Air Filters/Air Cleaners
  - UV-C Systems
  - Other Emerging Technologies
- **Care and professional judgment should be taken to understand choices for ventilation, filtration and air disinfection, pros and cons of each and impact(s) on existing buildings systems.**

# Next Steps and Recommendation

## NEXT STEPS

- Continue flushing water systems
- Continue installation of touchless water fixtures
- Continue commissioning HVAC systems
- Continue HVAC filter replacements and upgrades
- Continue to work with Teachers, Administrators and other Staff to implement building preparedness for a safer return to in-person instruction

## RECOMMENDATION

- **Purchase Portable Air Cleaners to further enhance indoor air quality for a safer return to in-person instruction**

