



Let's Clear the Air: Using Ventilation Practices to Promote Healthy IAQ in Schools

Thursday, July 30, 2020

Webinar: 1:00 p.m. – 2:00 p.m. EDT

Question & Answer Session: 2:00 p.m. – 2:30 p.m. EDT



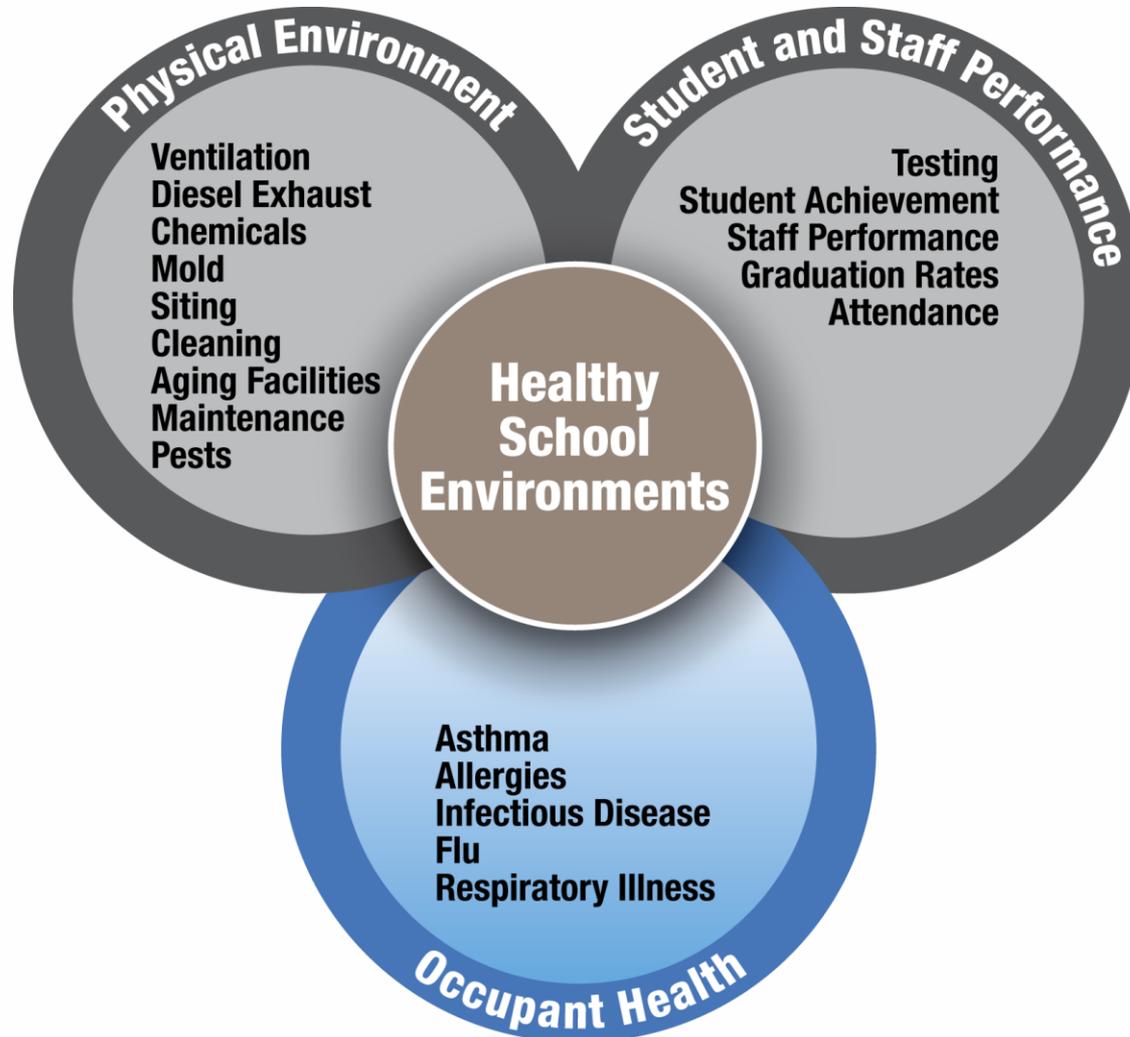
Learning Objectives

Webinar participants will learn how to—

- Operate and maintain efficient HVAC systems to provide clean and healthy air in schools.
- Apply findings from scientific research and guidance on ventilation to reduce the spread of viruses and bacteria through the air using comprehensive indoor air quality (IAQ) plans and practices.
- Put in place key strategies for quality HVAC, including developing a plan to regularly inspect and maintain HVAC systems, as well as provide outdoor air in accordance with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards.
- Gain buy-in from senior management and other stakeholders by successfully communicating how health and academic performance can be improved with a comprehensive IAQ management program, which includes providing optimal ventilation.



Maintaining Healthy Indoor Learning Environments



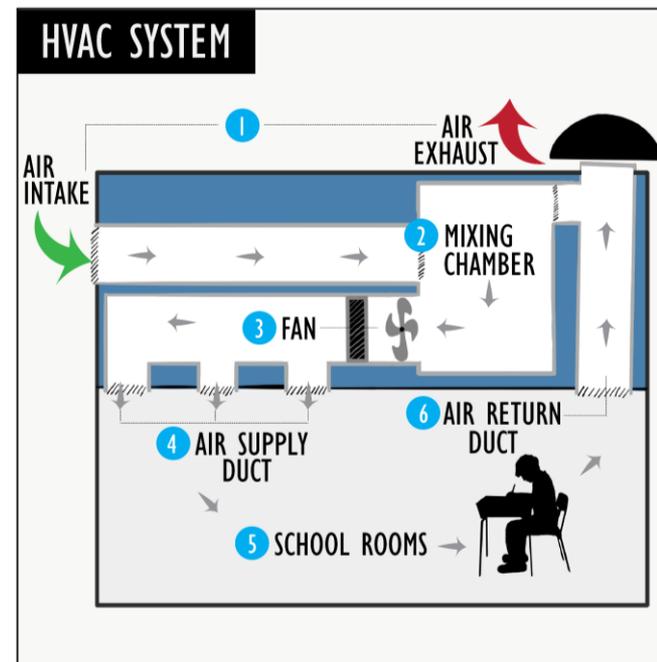
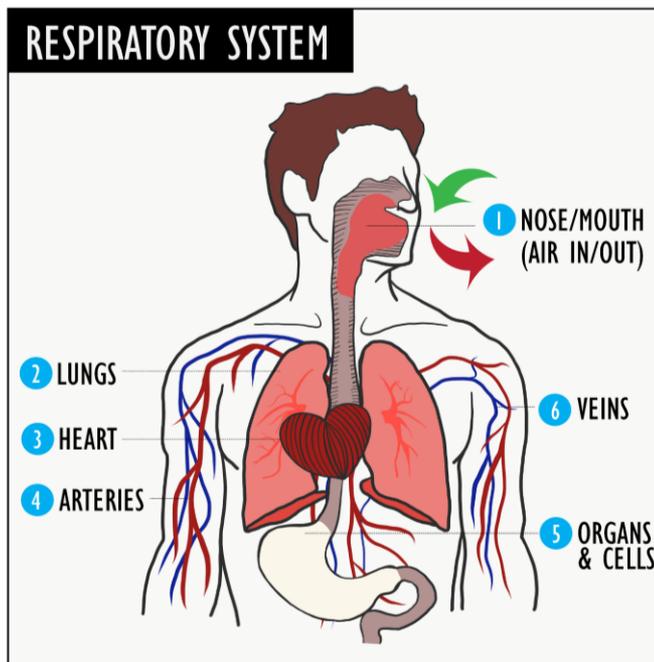
IAQ Management and Respiratory Health

IAQ management includes—

- Control of indoor air pollutants
- Ventilation and filtration
- Maintenance of acceptable temperature and relative humidity

Ventilation brings in outside air and exhausts building air, which dilutes the concentration of indoor pollutants.

IAQ management practices can also help reduce the spread of viruses, such as SARS-CoV-2 (i.e., the virus causing COVID-19).



Guidance for Schools

GUIDANCE FOR CLEANING AND DISINFECTING

PUBLIC SPACES, WORKPLACES, BUSINESSES, SCHOOLS, AND HOMES



SCAN HERE FOR MORE INFORMATION

This guidance is intended for all Americans, whether you own a business, run a school, or want to ensure the cleanliness and safety of your home. Reopening America requires all of us to move forward together by practicing social distancing and other [daily habits](#) to reduce our risk of exposure to the virus that causes COVID-19. Reopening the country also strongly relies on public health strategies, including increased testing of people for the virus, social distancing, isolation, and keeping track of how someone infected might have infected other people. This plan is part of the larger [United States Government plan](#) and focuses on cleaning and disinfecting public spaces, workplaces, businesses, schools, and can also be applied to your home.

Cleaning and disinfecting public spaces including your workplace, school, home, and business will require you to:

- Develop your plan
- Implement your plan
- Maintain and revise your plan

Reducing the risk of exposure to COVID-19 by cleaning and disinfection is an important part of reopening public spaces that will require careful planning. Every American has been called upon to slow the spread of the virus through social distancing and prevention hygiene, such as frequently washing your hands and wearing face coverings. Everyone also has a role in making sure our communities are as safe as possible to reopen and remain open.

The virus that causes COVID-19 can be killed if you use the right products. EPA has compiled a list of disinfectant products that can be used against COVID-19, including ready-to-use sprays, concentrates, and wipes. Each product has been shown to be effective against viruses that are harder to kill than viruses like the one that causes COVID-19.

For more information, please visit [CORONAVIRUS.GOV](https://www.cdc.gov/coronavirus)



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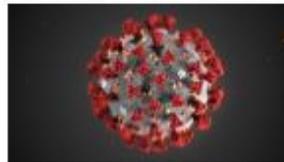


Coalition for Healthier Schools

...providing the national platform and the forum for environmental health of schools, since 2001...
Coordinated by Healthy Schools Network

NATIONAL CALL TO ACTION

The Pandemic v. Schools



States Must Guide Schools on Reopening, Slowing Spread of Virus
Prepared by

Healthy Schools Network
New Jersey Work Environment Council

With contributions from

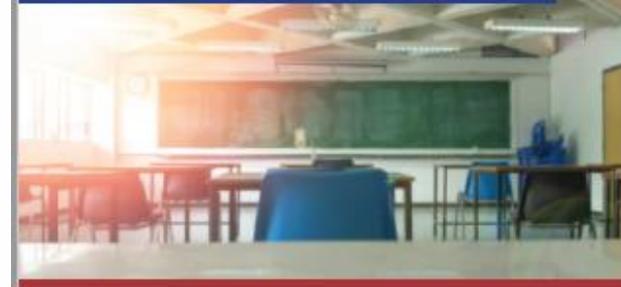
New Jersey Education Association, Healthy Schools Now (NJ), NEA Healthy Schools Caucus, Learning Disabilities Association of America, National Association of School Nurses, New York Lawyers for the Public Interest, Asthma and Allergy Foundation of America

SCHOOLS FOR HEALTH

Risk Reduction Strategies for Reopening Schools

COVID-19

June, 2020



HARVARD T.H. CHAN
SCHOOL OF PUBLIC HEALTH

HEALTHY BUILDINGS
FOR HEALTH | health.org



Guidance for Schools



ASHRAE EPIDEMIC TASK FORCE
SCHOOLS & UNIVERSITIES | Updated 7-17-2020



Introduction
Determining Building Readiness

- Summer Checklist for Fall Classes
- Startup Checklist for HVAC Systems Prior to Occupancy

Equipment & System Specific Checks & Verifications During Academic Year

- Cleaning & Air Flush
- Boilers
- Chilled, Hot & Condenser Water Systems
- Air Cooled Chillers
- Water Cooled Chillers
- Cooling Towers & Evaporative-Cooled Devices
- Steam Distribution Systems
- HVAC Water Distribution Systems
- Pumps
- Air Handling Units
- Roof Top Units
- Unitary & Single Zone Equipment

New/Modified Facility Design Recommendations

- Introduction
- Designer Guidelines – General School
- Nurses Office – General Requirements

Filtration Upgrades

- Introduction
- Filtration Basics
- Filtration Target Level
- Information Gathering Stage
- Data Analysis & Review
- Implementation & Considerations

Operation of Occupied Facilities
Controlling Infection Outbreak in School Facilities

Higher Education Facilities

- Student Health Facilities
- Laboratories
- Athletic Facilities
- Residence Facilities
- Large Assembly



QUESTIONS? COVID-19@ashrae.org www.ashrae.com/covid19

Interim Guidance for Administrators of US K-12 Schools and Child Care Programs to Plan, Prepare, and Respond to Coronavirus Disease 2019 (COVID-19)

Accessible version: <https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/guidance-for-schools.html>

Summary of Recent Changes

Revisions were made on 3/11/2020 to reflect the following:

- Clarification of appropriate mitigation strategies based on level of community transmission of COVID-19 and presence of COVID-19 cases within the school.
- Schools, working together with local health departments, have an important role in slowing the spread of diseases and protecting vulnerable students and staff, to help ensure students have safe and healthy learning environments.
- Guidance for child care programs and schools is organized into three categories based on the level of community transmission: 1) when there is no community transmission (preparedness phase), 2) when there is minimal to moderate community transmission, and 3) when there is substantial community transmission.
- Guidance is also provided for when a confirmed case has entered a school, regardless of the level of community transmission.
- All decisions about implementing school-based strategies (e.g., dismissals, event cancellations, other social distancing measures) should be made locally, in collaboration with local health officials who can help determine the level of transmission in the community. Information about level of transmission is available in CDC's framework for mitigation.

In This Document

[Who is this guidance for?](#)

[Why is this guidance being issued?](#)

[What is the role of schools in responding to COVID-19?](#)

[How should schools prepare for, and respond to, COVID-19?](#)

[When a confirmed case has entered a school, regardless of community transmission.](#)

[When there is no community transmission \(preparedness phase\).](#)

[When there is minimal to moderate community transmission.](#)

[When there is substantial community transmission.](#)



3/25/2020

For more information: www.cdc.gov/COVID19



EPA Resources for Responding to COVID-19



Related Topics: [Coronavirus](#)

CONTACT US SHARE

Frequent Questions Related to Coronavirus (COVID-19)

View frequently asked questions related to [Coronavirus \(COVID-19\)](#) and find key EPA resources.

Disinfectants

I can't tell if the product I'm interested in is on the list or not. Can you help me?

I want to use a product to kill SARS-CoV-2 but it isn't on List N. Is it effective against SARS-CoV-2?

[View all frequent questions about disinfectants and Coronavirus \(COVID-19\).](#)

Questions from State, Local and Tribal Leaders

Can states expect any regulatory relief or flexibility if they temporarily suspend certain inspections, monitoring, and reporting requirements such as vehicle emissions testing programs or certain air quality monitoring reports under the Clean Air Act?

[View all Frequent Questions from State, Local and Tribal Leaders about Coronavirus \(COVID-19\).](#)

Drinking Water

Do I need to boil my drinking water?

Is tap water safe to use for hand washing?

Is drinking tap water safe?

[View all frequent questions about drinking water and Coronavirus \(COVID-19\).](#)

Wastewater and Septic Systems

Can I get COVID-19 from wastewater or sewage?

Will my septic system treat COVID-19?

Do wastewater treatment plants treat COVID-19?

[View all frequent questions about wastewater and septic systems and Coronavirus \(COVID-19\).](#)

Grants

May EPA waive prior approval requirements specified at 2 CFR 200.407 if a waiver is necessary to address COVID-19 related concerns?

What documentation does EPA require for resumption of non-competitive awards?

[View all frequent questions about grants and Coronavirus \(COVID-19\).](#)

Waste

Does RCRA regulate wastes that may contain the virus that causes COVID-19, such as used medical equipment or personal protective equipment?

Where can I find information regarding the handling of wastes associated with Coronavirus and COVID-19?

What information has EPA shared to provide the public, the regulated community and other government agencies with the most complete and up-to-date information on actions related to COVID-19?

[View all frequent questions about waste and Coronavirus \(COVID-19\).](#)

Indoor Air

Is there HVAC guidance that building and maintenance professionals can follow to help protect from COVID-19?

Will an Ozone Generator protect me and my family from COVID-19?

Will an air purifier protect me and my family from COVID-19 in my home?



Related Topics: [Coronavirus](#)

CONTACT US SHARE

Indoor Air and Coronavirus (COVID-19)

COVID-19 is thought to spread mainly through close contact from person-to-person. However, some uncertainty remains about the relative importance of different routes of transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19). There is growing evidence that this virus can remain airborne for longer times and further distances than originally thought. In addition to close contact with infected people and contaminated surfaces, there is a possibility that spread of COVID-19 may also occur via airborne particles in indoor environments, in some circumstances beyond the 2 m (about 6 ft) range encouraged by social distancing recommendations. See [Science and Technical Resources related to Indoor Air and Coronavirus \(COVID-19\)](#) or [Indoor Air and COVID-19 Key References and Publications](#) for technical information.

However, there are straightforward steps that can be taken to reduce potential airborne transmission of COVID-19 and the focus of this material is on those measures. The layout and design of a building, as well as occupancy and type of heating, ventilation, and air conditioning (HVAC) system, can all impact potential airborne spread of the virus. Although improvements to ventilation and air cleaning cannot on their own eliminate the risk of airborne transmission of the SARS-CoV-2 virus, EPA recommends precautions to reduce the potential for airborne transmission of the virus. These precautions include increasing ventilation with outdoor air and air filtration as part of a larger strategy that includes social distancing, wearing cloth face coverings or masks, [surface cleaning and disinfecting](#), handwashing, and other precautions. By themselves, measures to reduce airborne exposure to the virus that causes COVID-19 are not enough since airborne transmission is not the only way exposure to SARS-CoV-2 could potentially occur.

All best practices recommended by the Centers for Disease Control and Prevention (CDC) should be followed.

- [How to Protect Yourself and Others](#)
- [Cleaning and Disinfecting Your Home](#)
- [Community, Work and School: Cleaning and Disinfecting](#)
- [Use of Cloth Face Coverings to Help Slow the Spread of COVID-19](#)

Frequent Questions

- [Read Frequent Questions about Indoor Air and Coronavirus \(COVID-19\).](#)
- [Explore all EPA Frequent Questions related to Coronavirus \(COVID-19\).](#)

List N: Disinfectants for Use Against SARS-CoV-2

All products on this list meet [EPA's criteria](#) for use against SARS-CoV-2, the virus that causes COVID-19.

Finding a Product

To find a product, enter the **first two sets** of its **EPA registration number** into the search bar below. You can find this number by looking for the EPA Reg. No. on the product label.

For example, if EPA Reg. No. 12345-12 is on List N, you can buy EPA Reg. No. 12345-12-2567 and know you're getting an equivalent product.

[Search by EPA registration number](#)

Other COVID-19 Resources

- [EPA's Coronavirus Site](#)
- [CDC's Coronavirus Disease 2019 Site](#)
- [CDC's Cleaning and Disinfection Recommendations for COVID-19](#)
- [NPIIC's COVID-19 Virus Factsheet](#)



EPA Resources for Responding to COVID-19 in Schools



EPA Supports Healthy Indoor Environments in Schools During COVID-19 Pandemic

The Environmental Protection Agency (EPA) Indoor Air Quality (IAQ) Tools for Schools Program remains fully committed to our stakeholders who are working to ensure that schools are healthy places to work and learn, whether school is in session or not. Below is a set of health and safety resources to consult as you respond to COVID-19 in your facilities:

CDC Guidance:

Please refer to the Centers for Disease Control and Prevention (CDC) website for the most recent updates related to COVID-19 and schools:

- [Guidance for Schools and Child Care Programs](#)
- [Cleaning and Disinfecting Your Facility](#)
- [Interim Guidance for Administrators of US K-12 Schools and Child Care Programs](#)

Helpful Tips for Maintaining Healthy Indoor Environments in Schools:

Whether your school is open or closed, indoor air quality is still an important part of maintaining a healthy indoor environment in schools. Employ the actions and strategies in the [IAQ Tools for Schools](#) and [IAQ Tools for Schools Preventive Maintenance](#) documents, action plans, and checklists. In these documents you'll find tips on:

Routine HVAC Systems Maintenance:

- Ensure school HVAC systems are operating properly, with outdoor ventilation air maintained at or above design minimum values. Determine whether HVAC systems comply with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.1 ventilation requirements at the system level and in the breathing zones of all occupied spaces.
- Employ filtration and gas-phase air cleaning strategies to further improve IAQ, in conjunction



Healthy Indoor Environments in Schools: Plans, Practices and Principles for Maintaining Healthy Learning Environments

Join the U.S. Environmental Protection Agency (EPA) for a three-part webinar series on creating and maintaining healthy learning environments in schools. The webinars will feature experts, including school district leaders who will discuss the plans, practices and principles they have put in place to sustain comprehensive indoor air quality (IAQ) management programs. Each webinar includes a moderated question-and-answer session with speakers and representatives from EPA and the Centers for Disease Control and Prevention (CDC).

Register for the upcoming webinars in this series—

Thursday, July 30, 2020 | 1:00 p.m. – 2:30 p.m. EDT



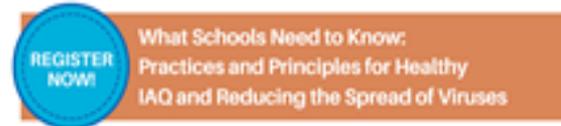
Register for this webinar to hear about strategies for operating and maintaining efficient HVAC systems to provide clean and healthy air in schools. You will learn how to apply findings from scientific research and guidance on ventilation to reduce the spread of viruses and bacteria using comprehensive IAQ plans and practices.

Thursday, August 6, 2020 | 1:00 p.m. – 2:30 p.m. EDT



Register for this webinar to learn how to tailor your cleaning and maintenance plan and procedures to help implement cleaning guidance for schools and reduce the spread of viruses and bacteria. You will hear about strategies for training staff and building a capable, committed team to effectively implement robust procedures focused on cleaning for health, as well as CDC's [Guidance for Schools](#) guidance.

Thursday, August 13, 2020 | 3:00 p.m. – 4:30 p.m. EDT



EPA Resources for Responding to COVID-19 in Schools



A Clean Start: Controlling Viruses and Bacteria in Schools with Healthy Cleaning Practices

Part 2: Ventilation in Schools

You asked, we answered! The US Environmental Protection Agency (EPA) Indoor Environments Division received many questions from the recent webinar *Cleaning Schools to Control for Viruses and Bacteria: Maintaining Healthy Indoor Learning Environments* that were not able to be answered during the presentation. Over the summer, questions will be answered in the Schools IAQ Connector series: *A Clean Start: Controlling Viruses and Bacteria in Schools with Healthy Cleaning Practices*.



Question: What HVAC maintenance is recommended for schools? How much ventilation is needed? And why are proper ventilation and HVAC maintenance important?

Answer: Proper ventilation and HVAC maintenance are key components of a comprehensive indoor air quality (IAQ) management program. HVAC systems help maintain good indoor air quality through adequate ventilation with filtration and provide thermal comfort. Providing optimal ventilation improves student health and academic performance, creating a healthy and productive learning environment.



IAQ Tools for Schools Action Kit

What is it? A practical plan for improving your IAQ knowledge using straightforward solutions and individuals already on staff.

The Action Kit includes—

- Reference guides
- Checklists
- Fact sheets
- Sample policies
- Comprehensive IAQ management plans
- The Framework for Effective School IAQ Management
- The Seven Technical Solutions



The Framework for Effective School IAQ Management: Six Key Drivers



The Framework for Effective School IAQ Management: Seven Technical Solutions



★ Quality HVAC

- Inspect HVAC systems regularly
- Establish a maintenance plan
- Change filters regularly and ensure condensate pans are draining
- Provide outdoor air ventilation according to ASHRAE Standards or local code
- Clean air supply diffusers, return registers and outside air intakes
- Keep unit ventilators clear of books, papers and other items

★ Control of Moisture/Mold

- Conduct routine moisture inspections
- Establish a mold prevention and remediation plan
- Maintain indoor humidity levels between 30% and 60%
- Address moisture problems promptly
- Dry wet areas within 24–48 hours

★ Strong Integrated Pest Management (IPM)

- Inspect and monitor for pests
- Establish an IPM plan
- Use spot treatments and baits
- Communicate with occupants prior to pesticide use
- Mark indoor and outdoor areas treated with pesticides

★ Effective Cleaning and Maintenance

- Conduct routine inspections of school environment
- Develop a preventive maintenance plan
- Train cleaning/maintenance staff on protocols
- Ensure material safety data sheets (MSDS) are available to staff
- Clean and remove dust with damp cloth
- Vacuum using high-efficiency filters

★ Smart Materials Selection

- Maintain products inventory
- Develop low-emitting products purchasing and use policies
- Use only formaldehyde-free materials
- Use only low-toxicity and low-emitting paint
- Select products based on product rating systems
- Use least toxic cleaners possible (only those approved by the district)

★ Aggressive Source Control

- Conduct regular building walkthrough inspections
- Test for radon; mitigate if necessary
- Implement a hazardous materials plan (use, label, storage and disposal)
- Establish a school chemical management and inventory plan
- Implement smoke-free policies
- Establish an anti-idling school bus policy
- Use walk-off mats at building entrances
- Conduct pollutant-releasing activities when school is unoccupied

★ Integrated Energy Management Solutions

- Protect IAQ during energy efficiency upgrades and building renovations
- Conduct regular HVAC maintenance and tune-ups
- Install programmable thermostats
- Consider performing post-construction commissioning for HVAC systems
- Control moisture in building assemblies, mechanical systems and occupied spaces





Andrew Persily, Ph.D.

**Chief, Energy and Environment Division,
Engineering Laboratory
National Institute of Standards and Technology
(NIST)**



Impacts of Ventilation and Building Airflows on Indoor Aerosol Transport

Andrew Persily

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EPA Schools Ventilation Webinar

July 30, 2020



Outline

Which airflows and their magnitudes

Reducing aerosol exposure with airflow

Ventilation suggestions to reduce viral exposure

Summary

Some Key Concepts

Ventilation: (ASHRAE Standard 62.1) the process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity or temperature within the space

Every building is different.

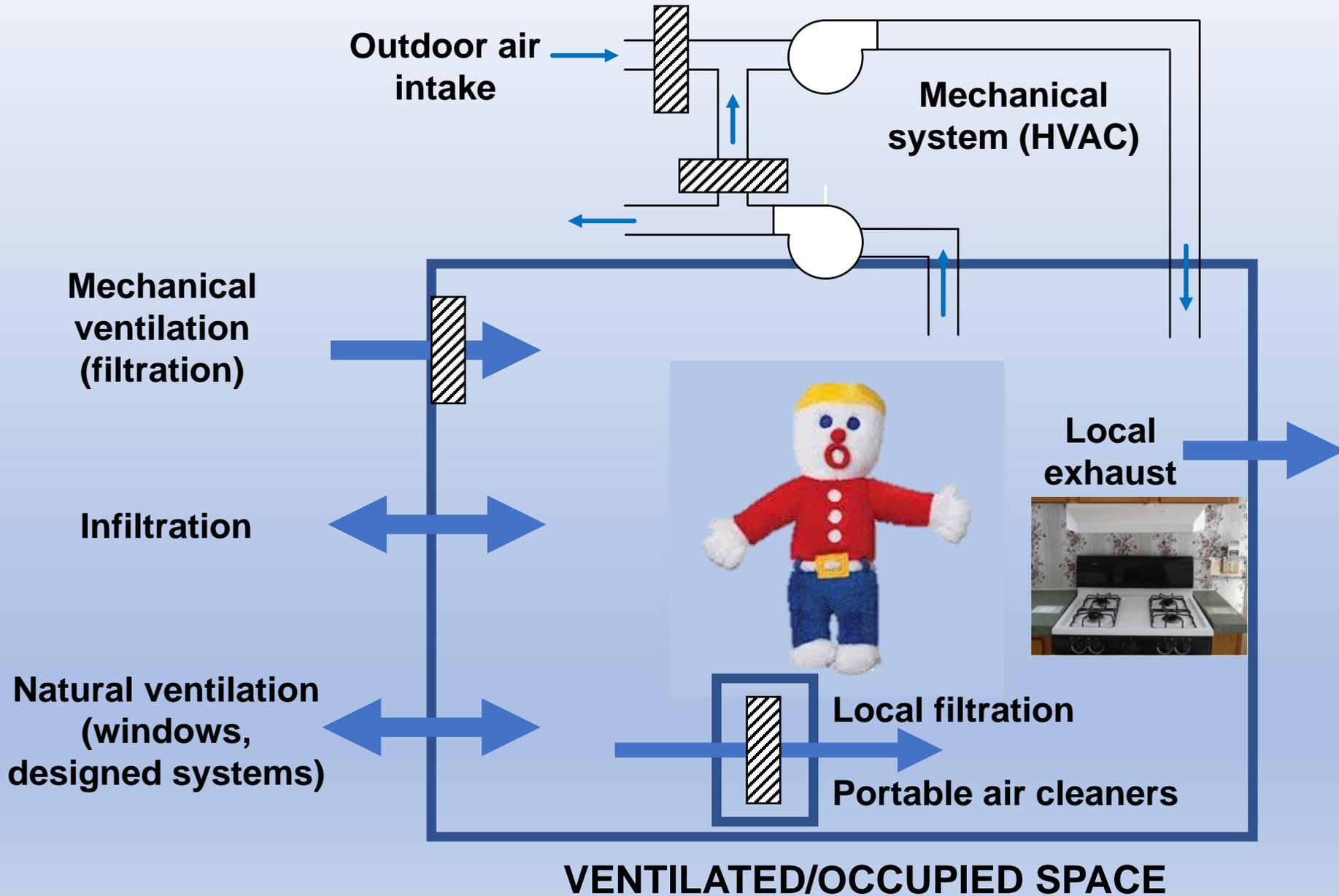
Buildings are not tight unless built that way.

Air moves based on physics, not design intent.

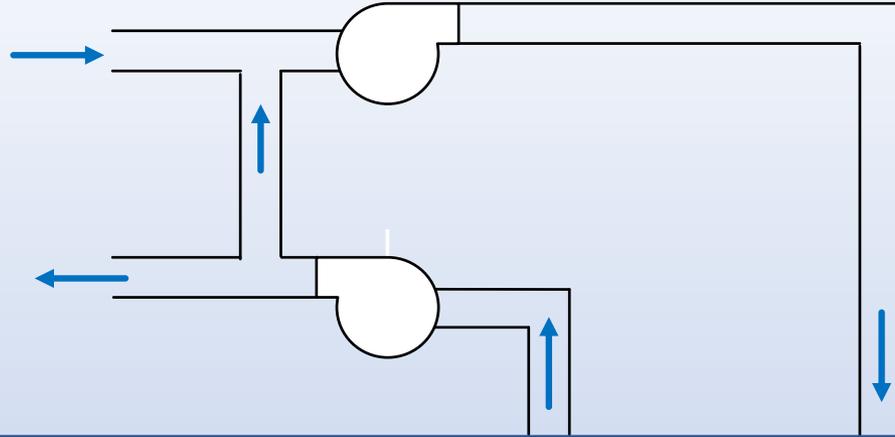
Airflow has been studied in very, very few buildings.

Outdoor air isn't necessarily fresh air.

Which Airflows



Magnitudes



Mechanical/Commercial
Outdoor air: $\sim 1 \text{ h}^{-1}$, highly variable, up to $\sim 5 \text{ h}^{-1}$
Supply air: ~ 3 to 5 h^{-1} , higher in health care

Mechanical/Residential
OA: ~ 0.1 to 0.5 h^{-1}

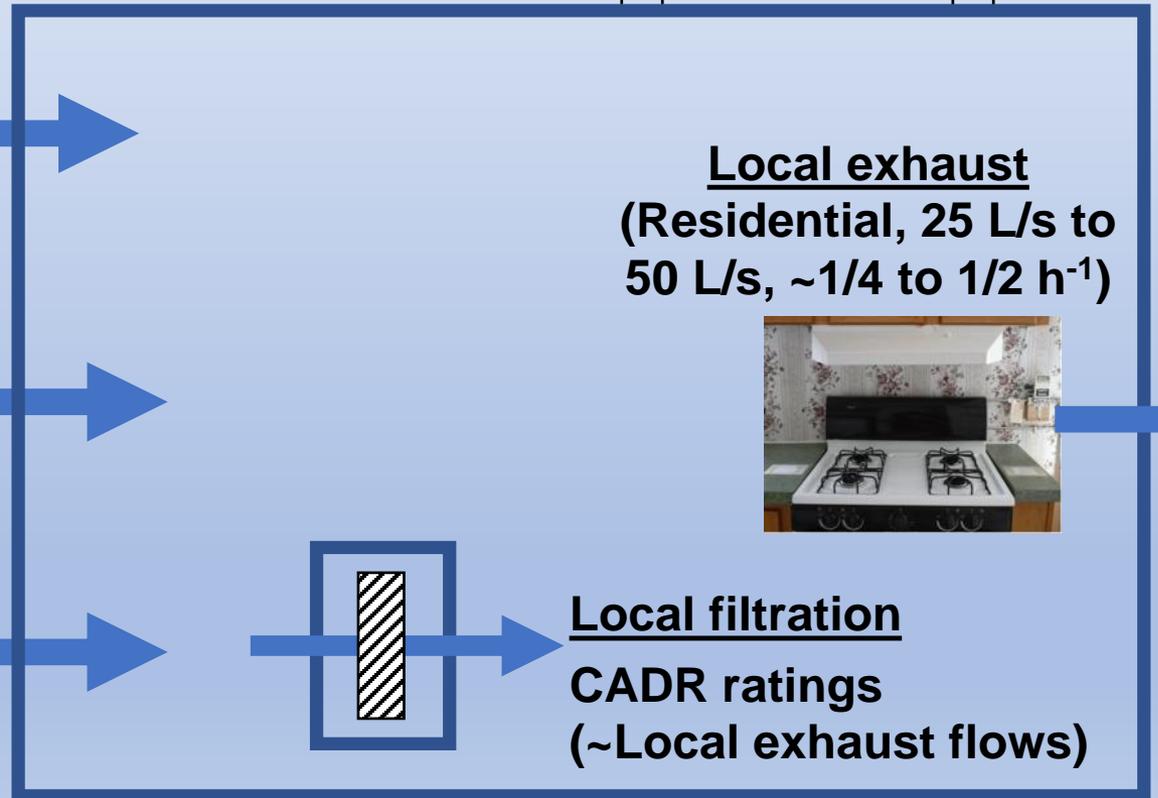
Infiltration
 ~ 0.1 to 1.0 h^{-1}
 ~ 5 to 1 variation in individual building

Natural ventilation
 $> 1 \text{ h}^{-1}$, hard to measure and predict

Local exhaust
(Residential, 25 L/s to 50 L/s , $\sim 1/4$ to $1/2 \text{ h}^{-1}$)



Local filtration
CADR ratings
(\sim Local exhaust flows)

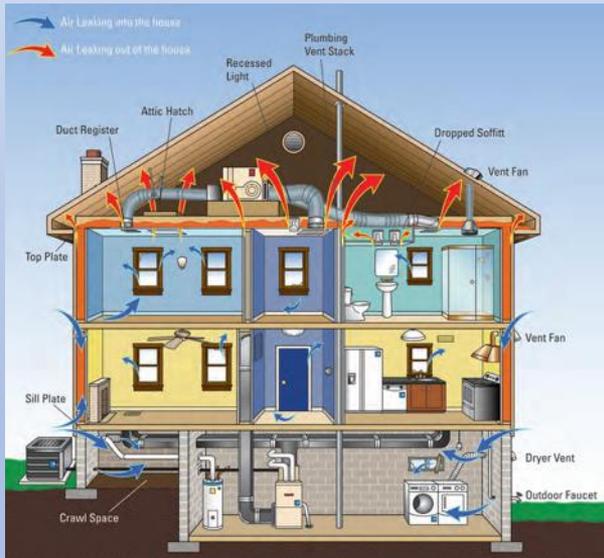


Interzone Airflows

Magnitudes similar to airflows from outdoors

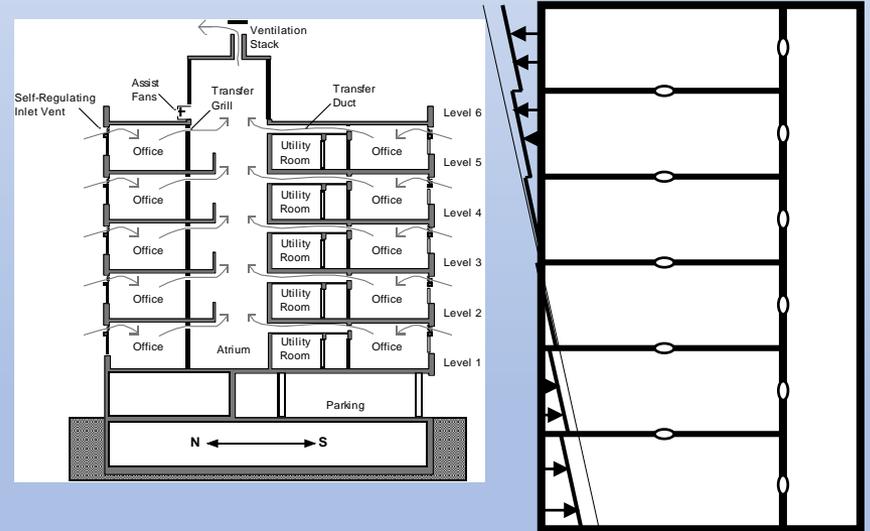
Residential

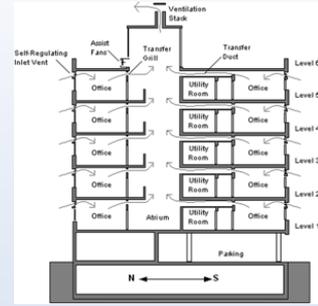
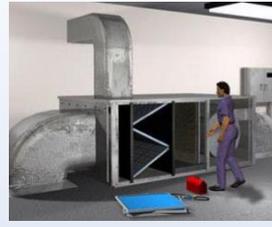
Crawl spaces, basements, attics ...



Commercial

Return air plenums, plumbing chases, mechanical rooms ...





Buildings are diverse

USA: 100 million dwellings; 6 million commercial

Building systems vary and matter

Layout, design & controls, occupant activities, operation & maintenance (O&M) ...

Ventilation has been studied in very few buildings

Impacts of HVAC & ventilation on aerosol transport in even less



Reducing Aerosol Exposure with Airflow

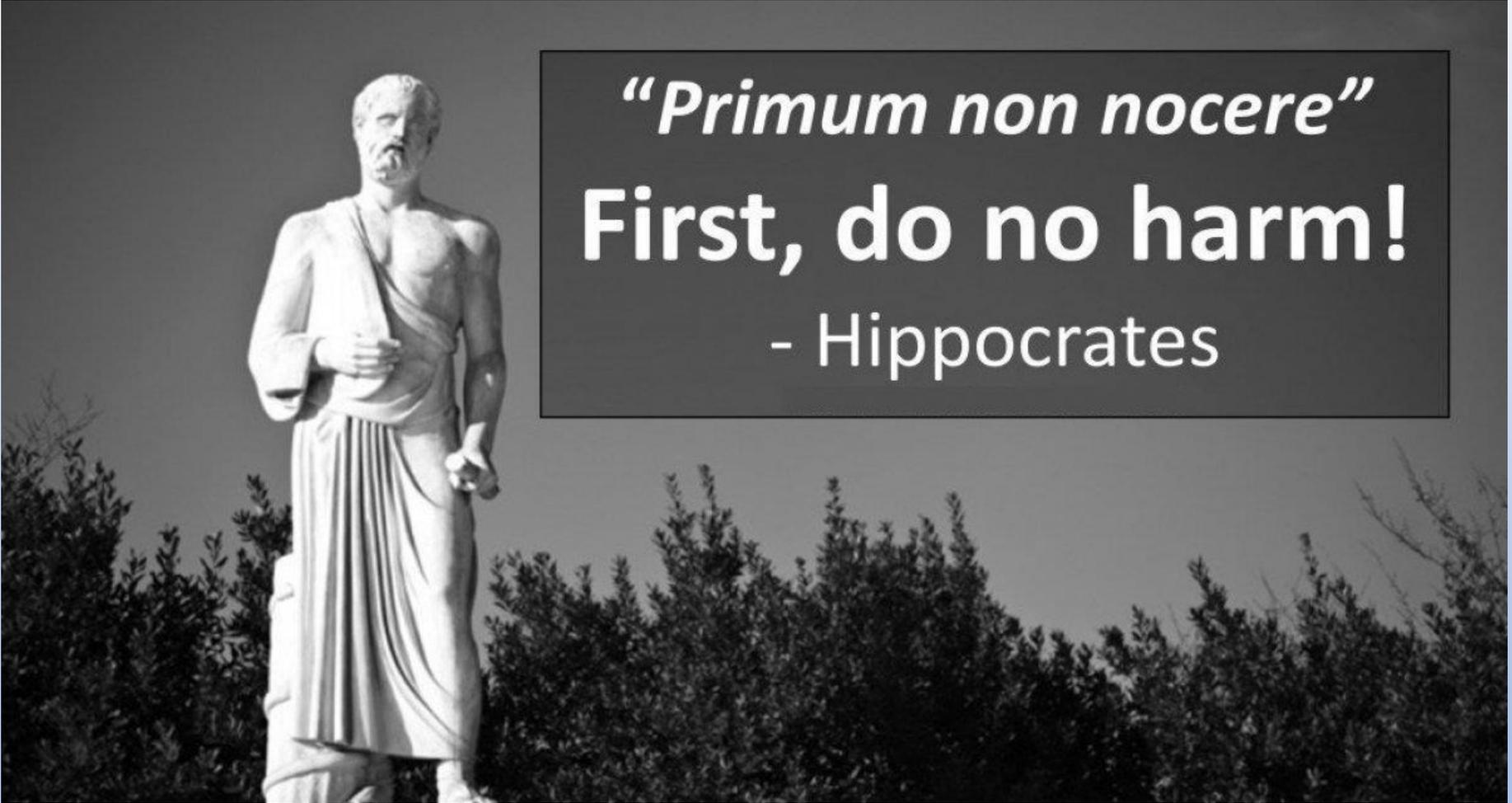
Build tight, ventilate (filter) right

Overpressure buildings (careful with moisture)

Airflow/pressure from clean spaces to dirty

Commissioning, O&M

Ventilation limited for strong, local sources



“Primum non nocere”
First, do no harm!
- Hippocrates

Some Suggestions to Reduce Viral Exposure

Increase outdoor air ventilation rates

System capacity

Outdoor air quality

Moisture management

Assuming good HVAC control



More efficient filtration

System capacity

Sealing

Maintenance



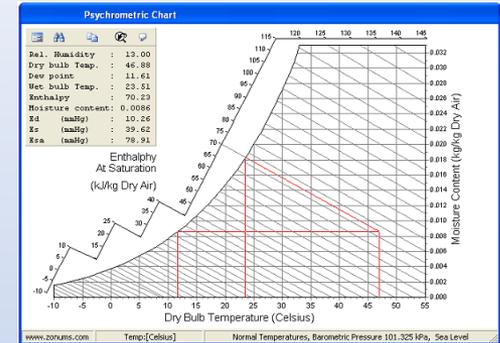
Some Suggestions to Reduce Viral Exposure

Change relative humidity

Do we know the right number?

System capacity

Condensation potential/microbial growth



Open windows

Outdoor air quality

Moisture

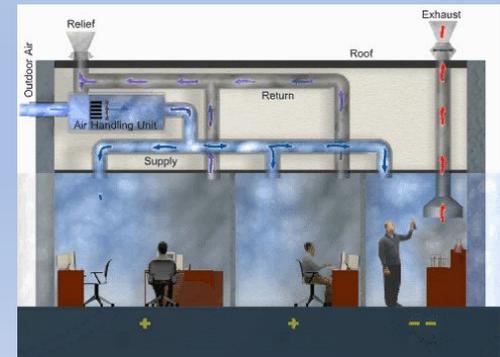
Direction, magnitude, distribution



Change air distribution

System configuration

Options may be limited



Summary

Do no harm.

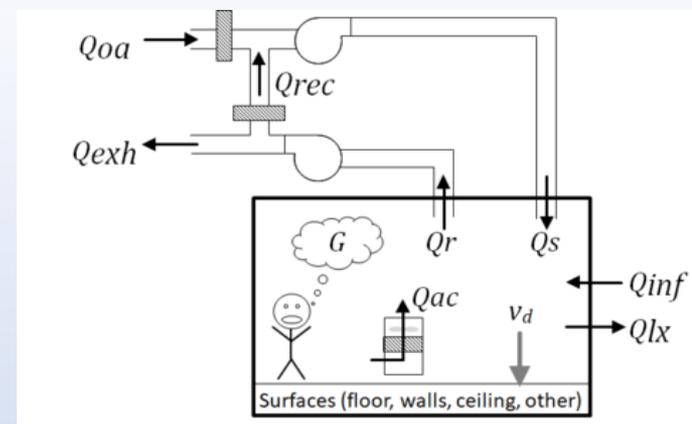
Good ventilation is good practice.

Excellent time to check system, review O&M practice (Schoen 2020 and ASHRAE guidance):

<https://www.ashrae.org/technical-resources/resources>

NIST online tool for comparing impacts of ventilation, filtration, etc., on indoor aerosols:

<https://www.nist.gov/services-resources/software/fatima>



Schoen, L.J. (2020) Guidance for Building Operations During COVID-19 Pandemic, *ASHRAE Journal*, 62 (5), 72–74.



School Ventilation Basics

Indoor Air Quality Background: The Basics

Indoor air quality (IAQ) is an increasingly important issue in schools across the nation. IAQ can directly affect the health and comfort of students and staff. There are many ways that school occupants can help to improve air quality. EPA developed the *Indoor Air Quality Tools for Schools (IAQ TFS)* Program to help schools address many IAQ issues using practical and often low-cost measures (such as unblocking ventilation supply vents to improve airflow).

By simply reviewing this *Indoor Air Quality Background* and completing the IAQ checklists, occupants can learn how to make a significant impact on IAQ and provide a healthy learning and working environment.

This guidance is based on the following principles:

- Most IAQ problems can be prevented and resolved by school staff through simple, inexpensive measures.
- The cost and effort needed to prevent most IAQ problems is significantly less than the cost and effort required to resolve problems after they develop.

WHY IAQ IS IMPORTANT TO YOUR SCHOOL

Most people are aware that outdoor air pollution can impact their health, but indoor air pollution can also have significant, harmful effects. EPA studies of human exposure to air pollutants indicate that indoor levels of pollutants may be two to five times—and occasionally more than 100 times—higher than outdoor levels. EPA and its Science Advisory Board consistently rank indoor air pollution among the top five environmental health risks to the public.

This is especially important to schools, as children may be more susceptible to air pollutants.

Failure to prevent or respond promptly to IAQ problems can:

- Increase potential for long- and short-term health problems for students and staff.
- Negatively impact student attendance, comfort, and performance.
- Reduce teacher and staff comfort and performance.
- Accelerate deterioration and reduce efficiency of school facilities and equipment.
- Increase potential for school closings or relocation of occupants.
- Strain relationships among school administration, parents, and staff.
- Create negative publicity.
- Impact community trust.
- Create liability problems.

UNDERSTANDING IAQ PROBLEMS AND SOLUTIONS

To understand IAQ problems and solutions, it is important to know what factors affect IAQ. These include:

- Sources of indoor air pollutants.
- Heating, ventilation, and air conditioning (HVAC) systems.
- Building occupants.
- Pollutant pathways.

SOURCES OF INDOOR AIR POLLUTANTS

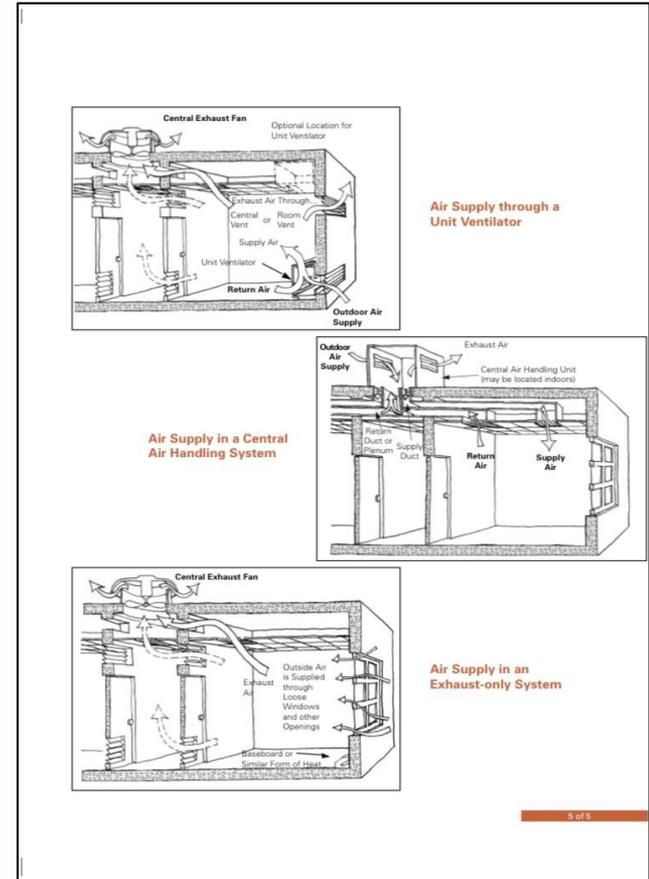
Indoor air contaminants can originate within the building or be drawn in from outdoors. Air pollutants consist of numerous particulates, fibers, mists, bioaerosols, and gases. It is important to control air pollutant sources (see the table on the next page), or IAQ problems can arise—even if the HVAC system is properly operating.

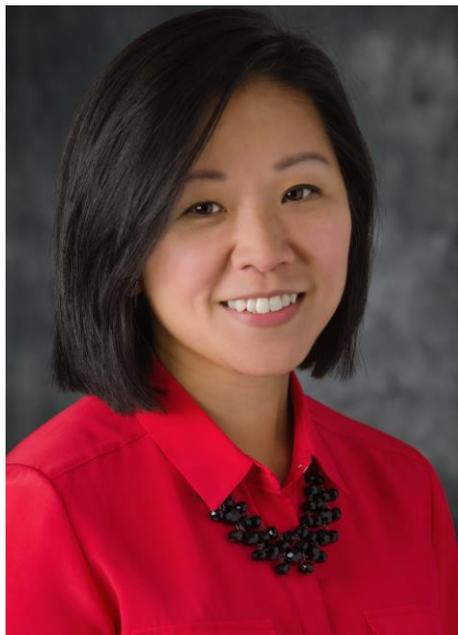
Indoor Air Quality



Tools for Schools

Good IAQ helps to provide a healthy and productive environment for students, teachers, and staff in order to assist a school in its core mission—educating children.





Lisa Ng, Ph.D.

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Energy and Environment Division,
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Summary of Current HVAC Recommendations for Re-Opening Buildings



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Twitter: [@lisacng](https://twitter.com/lisacng)



EPA Let's Clear the Air:
Using Ventilation Practices
to Promote Healthy IAQ in
Schools
7/30/2020

Outline

- **To be or not to be**
- **Transmission routes (as far as they know)**
- **List of resources**
- **Specific guidance made available**
- **Summary**

To be or not to be

What this talk is—

- Summary of available guidance provided by reputable organizations
- Focused on commercial buildings (e.g., offices but applicable to schools)
- Focused on HVAC-related O&M

What this talk isn't—

- Guidance for disinfecting buildings, social distancing, etc.
- Transmission of infectious diseases
- Comprehensive, mandatory guidance



Transmission routes of SARS-CoV-2



Updated April 3, 2020

*“Two transmission routes are dominant: via **large droplets** (droplets/particles emitted when sneezing or coughing or talking) and via **surface (fomite) contact** (hand-hand, hand-surface etc.). A third transmission route that is gaining more attention from the scientific community is the **faecal-oral route**.”*



Position Document on Infectious Aerosols

*“Transmission of SARS-CoV-2 through the air is sufficiently likely that **airborne exposure to the virus should be controlled**. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.”*

Updated April 14, 2020

Letter to WHO

**It is Time to Address Airborne Transmission
of COVID-19**

**Lidia Morawska, Donald Milton
+ 239 scientists**

Studies by the signatories and other scientists have demonstrated beyond any reasonable doubt that viruses are released during exhalation, talking and coughing in microdroplets small enough to remain aloft in air and pose a risk of exposure at distances beyond 1 to 2 m from an infected individual.

Resources

Ventilation



Health & Safety

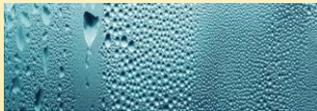


Broad coverage



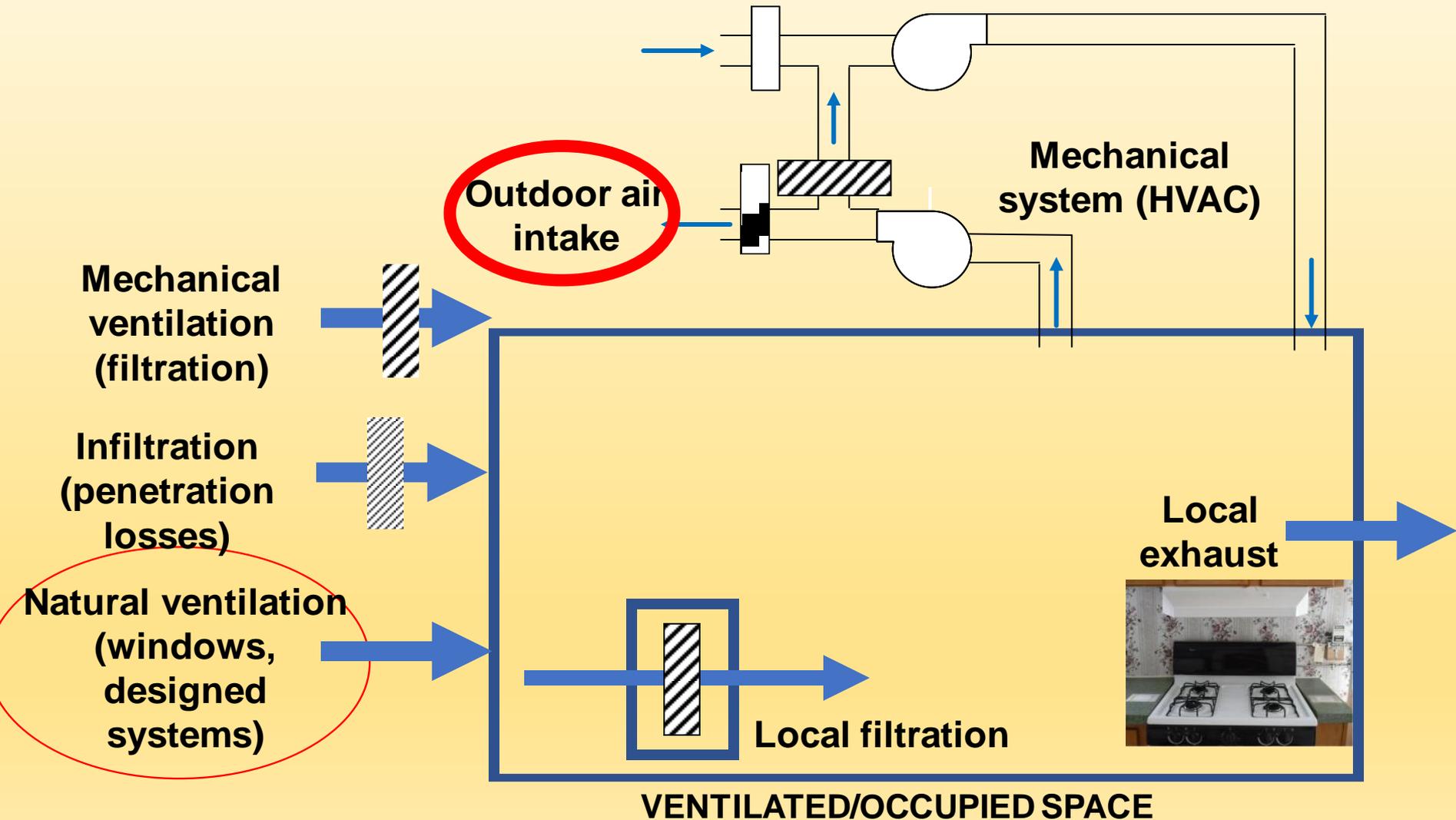
Maintenance personnel

Available guidance



- **Outdoor ventilation**
- **Filtration**
- **Relative humidity**
- **Toilet areas**
- **UV-C and air cleaners**
- **Maintenance personnel**

Outdoor Ventilation



Outdoor Ventilation

Increase ventilation



Reduce recirculation



Outdoor Ventilation

Maintain 24/7 outdoor ventilation

- Perhaps lower rates during unoccupied hours



- Ventilation at “occupied rates” 2 h prior to and after occupied hours



Disable or increase setpoints for demand controlled systems (DCV)



Outdoor Ventilation



Check heat recovery devices for leaks

- Possible recontamination of supply air stream



Check airflow directions and pressures

- Especially for critical spaces



Clean/disinfect intakes and returns

Filtration

Ensure proper filtration

- Install high-efficiency filters



Continue routine maintenance



Filtration



MERV-13 minimum

- MERV-14 preferred
- HEPA better
- Must consider equipment and operating conditions



Dispose of existing filters

Relative Humidity

Maintain between 40 percent and 60 percent RH



Relative Humidity



The evidence does not support that moderate humidity (RH 40–60%) will be beneficial in reducing viability of SARS-CoV-2, thus the humidification is NOT a method to reduce the viability of SARS-CoV-2.



Humidity kept in the 40% to 60% range may be ideal.



Several recent studies recommend 40–60% RH for disease-specific infection risk.

Toilet Areas

Close lid when flushing



Maintain underpressure

- Exhaust fans 24/7
- Keep windows/doors closed



Occupational Safety and Health Administration



UV-C Air Cleaners

“Consider” as supplementary



Maintenance Personnel

No PPE recommended



**Most in-home services workers are unlikely to need PPE beyond what they use to protect themselves during routine job tasks. However, employers should consider whether their hazard and risk assessments warrant the use of more protective PPE ensembles.*

“Common protective measures”



Maintenance Personnel

PPE recommended

- N95
- Surgical masks
- Face coverings
- Face shields
- Goggles
- Gloves
- Booties



the **NEWS**



Summary

Increase ventilation, reduce recirculation

- Specific recommendations available

Filtration

- Higher efficiencies with practical limitations

Relative humidity

- 40–60 percent

Toilet areas

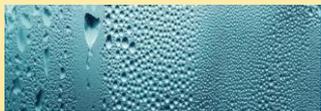
- Maintain underpressure (e.g., 24/7 operation)

UV-C and air cleaners

- Supplementary

Maintenance personnel

- PPE level depends on circumstances



Links to School-Specific Guidance

ASHRAE—[ASHRAE Epidemic Task Force – Schools and Universities](#) (July 7, 2020)

Harvard T.H. Chan School of Public Health—[Risk Reduction Strategies for Reopening Schools](#) (June 2020)

Johns Hopkins Center for Health Security—[Filling in the Blanks: National Research Needs to Guide Decisions about Reopening Schools in the United States](#) (May 15, 2020)

The National Academies of Sciences Engineering Medicine (NASEM)—[Reopening K-12 Schools During the COVID-19 Pandemic: Prioritizing Health, Equity, and Communities](#) (July 2020)

WHO [Considerations for school-related public health measures in the context of COVID-19](#) (May 10, 2020)

Links to Resources

ACHR News—[Comprehensive Guide: HVAC Service Calls During COVID-19](#) (March 24, 2020)

AIHA: American Industrial Hygiene Association—[Reopening: Guidance for General Office Settings](#) and [Recovering from COVID-19 Building Closures](#)

APPA—Leadership in Educational Facilities ([FAQs](#))

ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers [Epidemic Task Force](#) (April and May 2020)

BOMA: Building Owners and Managers Association International—[Getting Back to Work: Preparing Buildings for Re-Entry Amid COVID-19](#) (May 1, 2020)

CDC: Centers for Disease Control and Prevention—[CDC Activities and Initiatives Supporting the COVID-19 Response and the President's Plan for Opening America Up Again](#) (May 2020)

DOE: U. S. Department of Energy—[Webinar: Managing HVAC Systems to Reduce Infectious Disease Transmission](#) (May 2, 2020)

NIBS: National Institute of Building Sciences—[COVID-19 Virtual Town Hall: Preparing for Re-entering Buildings](#) (May 7, 2020)

OSHA: Occupational Safety and Health Association—[Guidance on Preparing Workplaces for COVID-19](#) (March 9, 2020)

REHVA: Federation of European Heating, Ventilation, and Air Conditioning Associations—[How to operate and use building services in order to prevent the spread of the coronavirus disease \(COVID-19\) virus \(SARS-CoV-2\) in workplaces](#) (April 3, 2020)

TUA: The United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada—[Guidelines to Protect Workers Related to Coronavirus \(COVID-19\) and Other Potential Infectious Materials \(OPIM\) in Plumbing and HVAC Systems](#) (March 25, 2020)

Thanks!

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Quality HVAC

- Inspect HVAC systems regularly.
- Establish a maintenance plan.
- Change filters regularly and ensure condensate pans are draining.
- Provide outdoor air ventilation according to ASHRAE standards or local code.
- Clean air supply diffusers, return registers and outside air intakes.

Control of Moisture/Mold

- Establish a mold prevention and remediation plan.
- Maintain indoor humidity levels between 30 percent and 60 percent.



Outdoor Ventilation
Filtration
Relative Humidity
Toilet Areas
UVC and Air Cleaners
Maintenance
Personnel/Practices



Photo credit: EPA Walkthrough of Langston Hughes Elementary School, New Orleans, LA



Raj Setty, P.E., LEED AP, Member ASHRAE

ASHRAE Schools Technical Task Force SETTY





GET EDUCATED

BUILD A PLAN

WORK THE PLAN

GET EDUCATED

STEP 1

Know Where You Stand:

Gather HVAC plans and system manuals; educate yourself on your options

STEP 2

Speed & Cost: Establish your budget

STEP 3

Prepare: With your HVAC P.E., create your statement of work plan

STEP 4

Execute Phase 1: Put into place the fast, short-term interim adjustments

STEP 5

Execute Phase 2: Mid- to longer term projects; harden your buildings

STEP 6

Audit: Is it working? Adjust

GET EDUCATED

Who do you listen to – filter the noise for me

ASHRAE'S (American Society of Heating and Air-Conditioning Engineers):

Transmission of SARS-CoV-2 through the air **is** sufficiently **likely**....
Changes to building operations, including the operation of HVAC systems, can **reduce airborne exposures**.

Ventilation, disinfection and **filtration** provided by HVAC systems can reduce the airborne **concentration** of SARS-CoV-2 and the **risk of transmission** through the air.

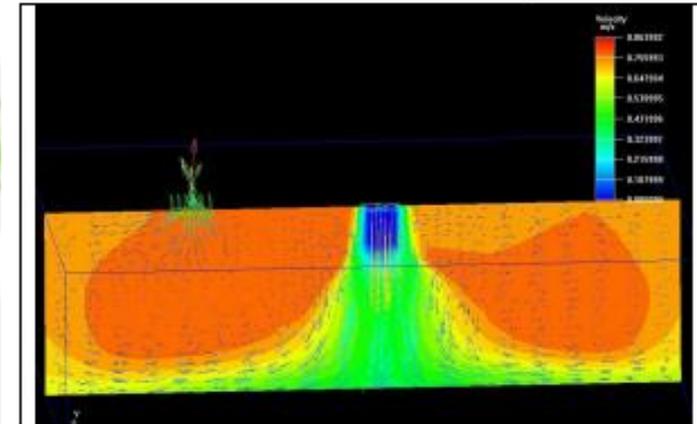
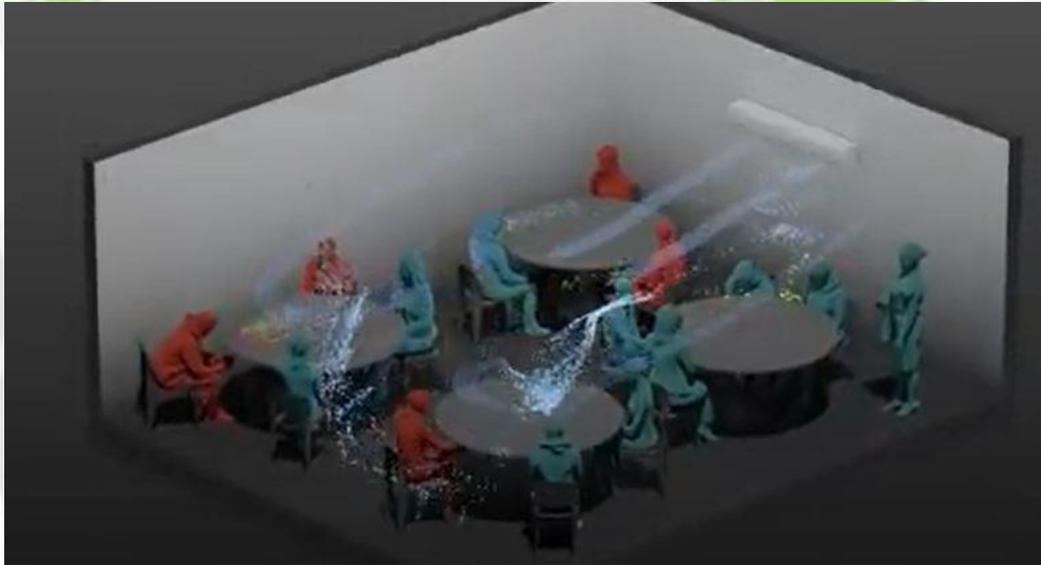
CDC guidance states:

“Intensify cleaning, disinfection, and ventilation.”



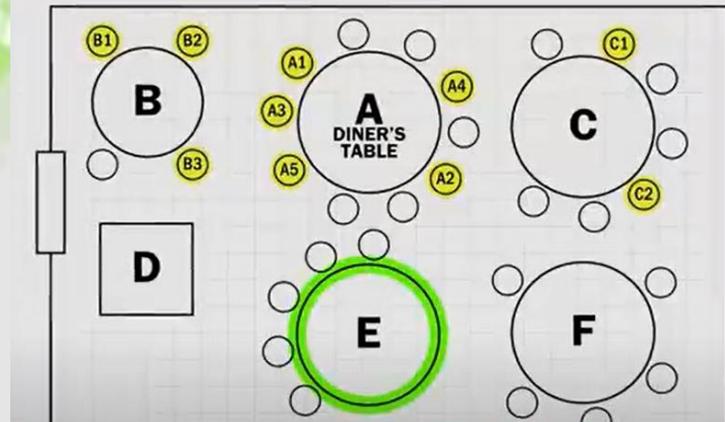
GET EDUCATED

Room air recirculation can spread contaminants?
Partitions are not the solution.



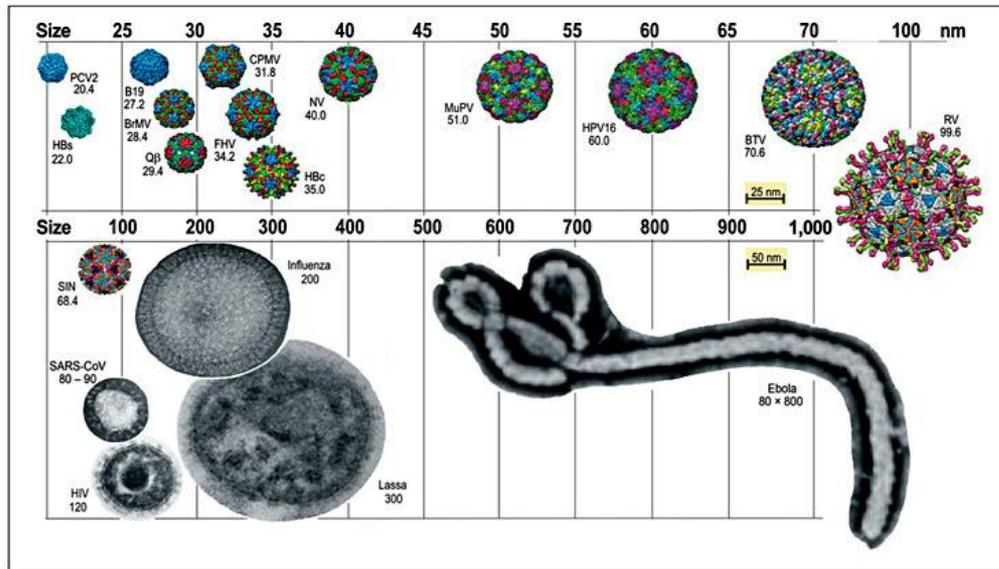
HVAC diffusers are meant to mix the air

Chinese restaurant
case study of
transmission via
HVAC



GET EDUCATED

What do we know about viruses?



For detailed SARS/COVID guidance:

<https://www.cdc.gov/coronavirus/2019-ncov/index.html>

Coronaviruses are ***Enveloped Viruses*** — one of the easiest types of viruses to kill with the appropriate approach.

Viruses can be categorized into **3** groups

1. Enveloped Viruses

Easiest to kill
(e.g., influenza A virus)

2. Large, Non-enveloped Viruses

Difficult to kill
(e.g., a rotavirus)

3. Small, Non-enveloped Viruses

Hardest to kill
(e.g., rhinovirus, norovirus)

WORK THE PLAN

Wells-Riley Equation – Can I model transmission risk? Use Setty modeling spreadsheet.

$$C = S[1 - \exp(-Iqpt/Q)]$$

C = new infections

S = number of susceptibles

I = number of infectors

Q = number of infectious doses

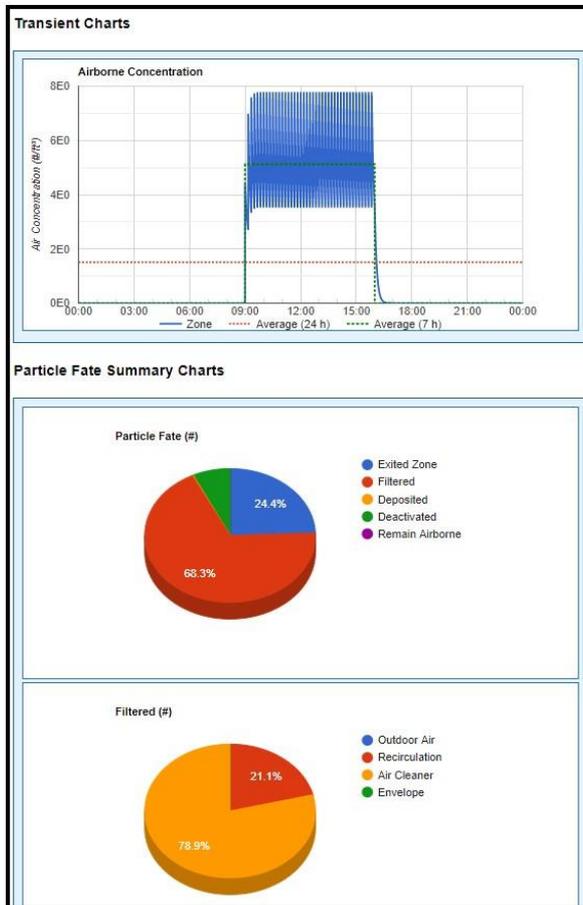
P = pulmonary ventilation rate per susceptible

t = exposure time

Q = flow rate of contaminated air

Translate?

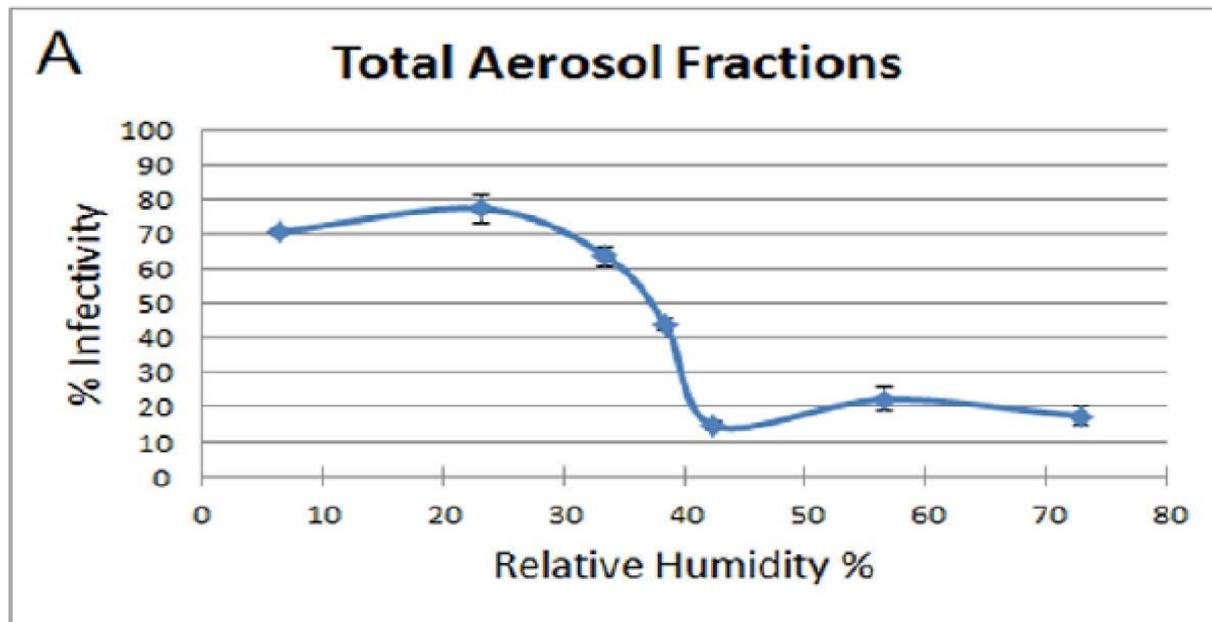
We have the factors to individually adjust to reduce “C.” We can apply engineering principles to reduce airborne transmission.



GET EDUCATED

What do we know* about airborne transmission?

Relative humidity between (40%-60%) slows the transmission of viruses



Influenza A
is the
subject of
the study

*High RH results in
droplet stability

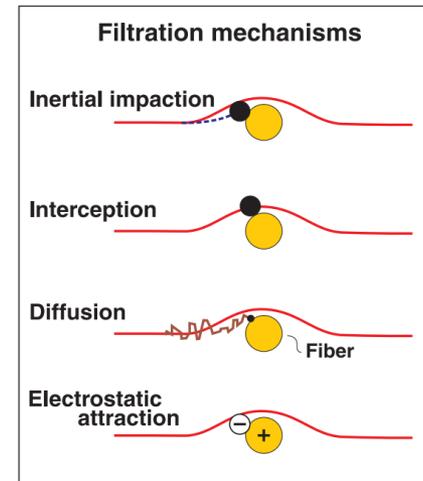
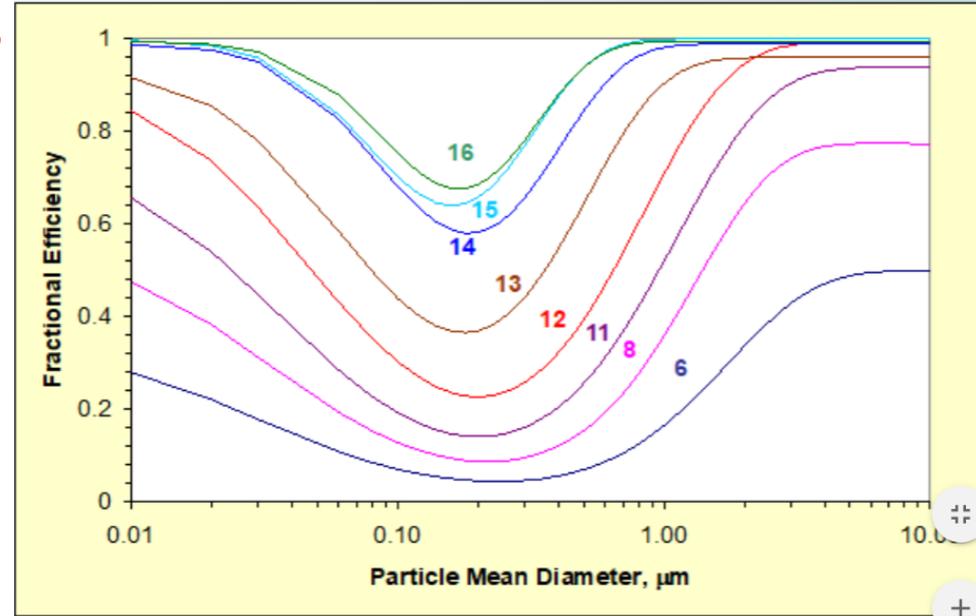
* Noti, John D., et al. "High humidity leads to loss of infectious influenza virus from simulated coughs." *PloS one* 8.2 (2013).

* Wan Yang and Lindsey Mars, "Mechanisms by Which Ambient Humidity May Affect Viruses in Aerosols", 2012 Oct.

GET EDUCATED

Filtration – target MERV 13

Std. 52.2 Application Guidelines			
Minimum Efficiency Reporting Value (MERV)	Typical Controlled Contaminant	Typical Applications and Limitations	Typical Air Filter/Cleaner Type
16	0.30 to 1.0 µm Particle Size All bacteria	Hospital inpatient care General surgery	Bag Filters Nonsupported (flexible) microfibre fiberglass or synthetic media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
15	Most tobacco smoke Droplet nuclei (sneeze)	Smoking lounges Superior commercial buildings	Box Filters Rigid style cartridge filters 150 to 300 mm (6 to 12 in.) deep may use lofted (air laid) or paper (wet laid) media.
14	Cooking oil Most smoke		
13	Insecticide dust Copier toner Most face powder Most paint pigments		
12	1.0 to 3.0 µm Particle Size Legionella	Superior residential Better commercial buildings	Bag Filters Nonsupported (flexible) microfibre fiberglass or synthetic media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
11	Humidifier dust Lead dust	Hospital laboratories	Box Filters Rigid style cartridge filters 150 to 300 mm (6 to 12 in.) deep may use lofted (air laid) or paper (wet laid) media.
10	Milled flour Coal dust		
9	Auto emissions Nebulizer drops Welding fumes		
8	3.0 to 10.0 µm Particle Size Mold	Commercial buildings Better residential	Pleated Filters Disposable, extended surface, 25 to 125 mm (1 to 5 in.) thick with cotton-polyester blend media, cardboard frame.
7	Spores Hair spray	Industrial workplaces Paint booth inlet air	Cartridge Filters Graded density viscous coated cube or pocket filters, synthetic media.
6	Fabric protector Dusting aids		Throwaway Disposable synthetic media panel filters.
5	Cement dust Pudding mix Snuff Powdered milk		
4	>10.0 µm Particle Size Pollen	Minimum filtration Residential	Throwaway Disposable fiberglass or synthetic panel filters
3	Spanish moss Dust mites	Window air conditioners	Washable Aluminum mesh, latex coated animal hair, or foam rubber panel filters
2	Sanding dust Spray paint dust		Electrostatic Self charging (passive) woven polycarbonate panel filter
1	Textile fibers Carpet fibers		



Note: A MERV for other than HEPA/ULPA filters also includes a test airflow rate, but it is not shown here because it has no significance for the purposes of this table.

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DISINFECTION

UV-C and IAQ Tech to Consider

- Electronic air filters/air cleaners – Agglomerate
- **UV-C in air handlers and UV-C in upper-air**
- UVGI – ultraviolet germicidal irradiation
- UV-V can generate ozone
- UV-A (400-315 nm)
- Photocatalytic Oxidation (PCO)
- **Bipolar Ionization** (Refer to ASHRAE)
- Vaporized Hydrogen Peroxide (VHP)
- Pulsed Xenon (Pulsed UV)
- 405 nm visible light (“Near UV”)
- Non-Ionizing Polarization
- Far UV (205 to 230 nm)
- Glass Filters

Watch out for ozone

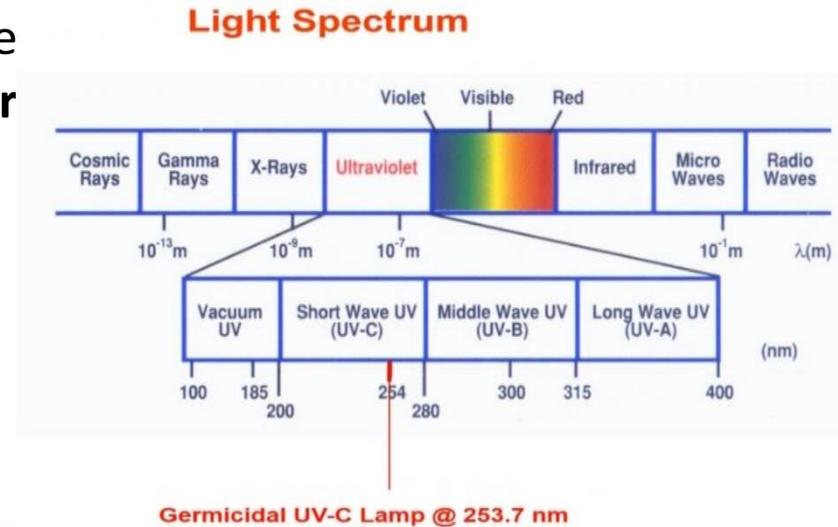
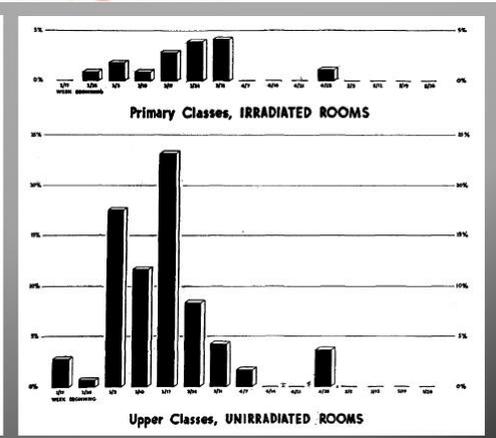


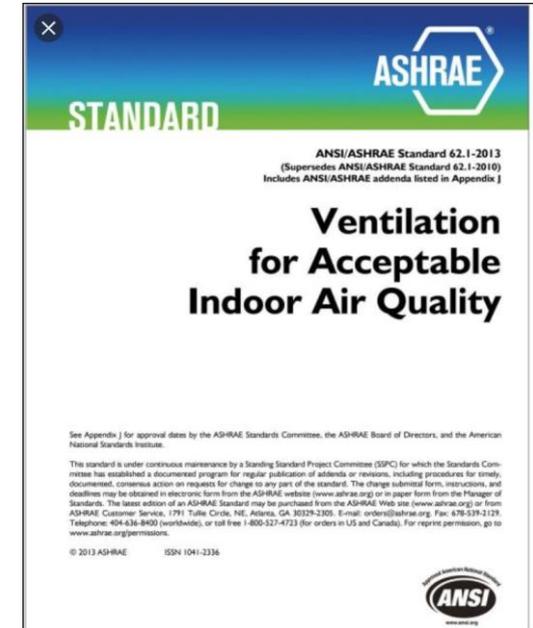
FIGURE 1. Classroom, Germantown Friends School, central radiant sources.



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Outside Air Ventilation – Dilution

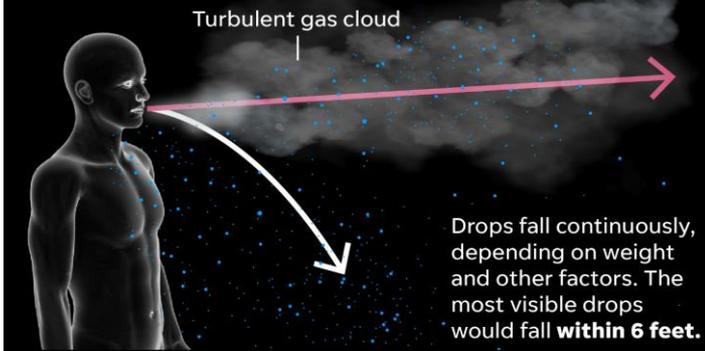
- Outside air requirements are governed by ASHRAE 62.1.
- There is no relaxation in the code requirements.



Outside air ventilation rates should be increased to as much as the systems can accommodate (up to 100 percent), depending on outside climate conditions and the systems' ability to maintain air handling system discharge air conditions, airflow rates, temperature, and humidity conditions necessary in order to maintain good thermal, humidity, and indoor air quality.

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The study suggests that droplets of various sizes are trapped in a turbulent gas cloud allowing them to travel up to **26 feet**.

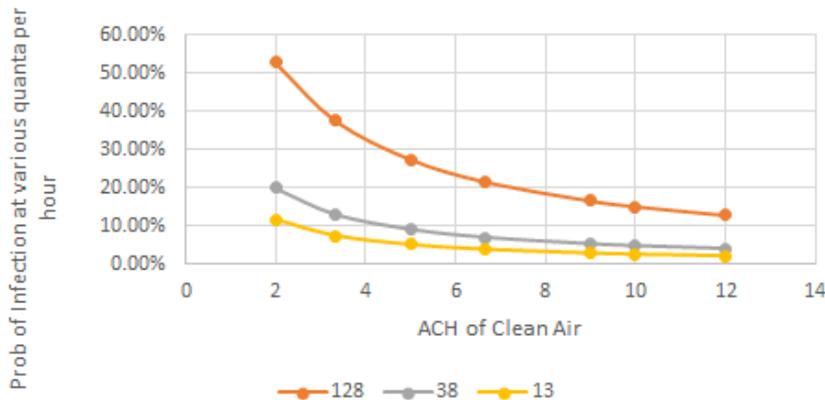


Air Change of Clean Air

Increasing air change rate can decrease in-room concentration of infectious particles or quanta.

There is a point of diminishing return in the reduction of quanta within a room:

Probability of Infection for 5 hour class
No Masks 1 Infector



6 Air Changes per Hour

An air change per hour is defined as how many times the air in the room is turned over and passed through a filtered device or outside air and complies with ASHRAE Std. 62.1 and the ASHRAE position document on filtration and cleaning.

What is the game plan?

GET EDUCATED

BUILD A PLAN

WORK THE PLAN

BUILD A PLAN

First: Financial Budgeting Guiding Principles

As you establish a budget, use CABA scorecard.

- 1) Cost per building or per system
- 2) Speed of implementation – done by the fall of 2020?
- 3) Level of risk mitigation
- 4) Increase maintenance and staffing needs, such as extra cleaning and disinfecting

Imagine Hope PCS - Lamond Campus Scorecard

Building Score Card		
Certification Levels	Points	Grade
Zero Star	<30	F
One Star	30	D
Two Stars	50	C
Three Stars	75	B
Four Stars	90+	A



Certification Level	Categories	Category Multiplier	Tasks	Risk Mitigation			
				Level One	Level Two	Level Three	Level Four
Prerequisite	N/A		Identify Stakeholders				
			Establish a Budget				
			Perform a Facility Audit				
			Testing & Balancing of main air handlers				
			Develop a Facility Strategic Programming / Space planning				
			Complete Checklist				
			PPE Score				
			Ventilation Air Change per Hour (Fresh Air)	None 0 Points	Minimum per ASHRAE 62 1 Point	10% above code 2 Points	30% above code 4 Points
			Air Rotation per Hour - All air should see a filter or elec. disinfectant	1 Air Changes (Once an hour) 0 Point	2 Air Changes (Once an hour) 1 Point	4 Air Changes (Once an hour) 2 Points	6 Air changes (Once an hour) 4 Points
			DOAS (Dedicated Outside Air System)	None 0 Points	Minimum per ASHRAE 62 1 Point	DOAS size 10% above code 2 Points	DOAS 30% above code 4 Points

Maximum Points	Existing Points	Target Points
4	1	2
4	1	4
4	0	0

BUILD A PLAN

Second: Stakeholders Team

Owner

Architect

HVAC Engineer of Record

Building Officials

Installing Contractor(s)

TAB Agents

Building Automation System (BAS) Provider

Commissioning Provider (CxP)

Operators

Maintenance Technicians

Building Users

- Create a District or Campus Health and Safety Committee:
 - Include key stakeholders (environmental health and safety, administration, education staff, operations staff, local healthcare providers)
- Identify Key Reference Standards/Authorities to Follow:
 - Consider OSHA, CDC, State Agencies, Insurance Provider Recommendations



BUILD A PLAN

SETTY

Third: Get Organized, HVAC Pre-Assessment and Begin

Gather Information – Administrative Phase

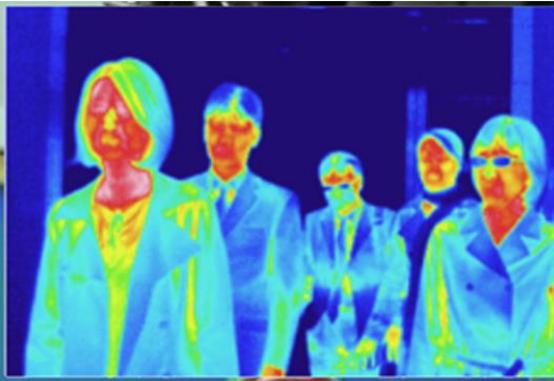
- **Baseline/Indoor Air Quality** – Professional Engineer
 - *Check temperatures and humidity – find out how much OA you have*
 - Gather HVAC plans and **manuals** and maintenance information on systems in place
 - Understand your **Building Management System (BMS)**
- **Maintenance** – Prioritize HVAC backlog – Building Engineer
 - *Ex: outside air dampers, building management systems*
 - Review **filter order** information for existing MERV 13 or higher
 - Work with vendors and procurement officers to make sure supplies will not be interrupted



BUILD A PLAN

Fourth: Develop Playbooks for Operations

- **Entry/Circulation** – Security and Entry Protocols
 - *Phased entry, thermographic scanning, disinfection protocols, questionnaire, telepresence, temperature apps*
- **Operational** – Sick child? Develop metrics for action – 10% out sick, close school? People flow



BUILD A PLAN

Fifth: Facilities/Maintenance PPE

- Eye Protection and Masks
 - **Surgical or cloth mask respiration** filtering
 - Safety glasses (side shields preferred)
 - Face shields
- Disposable Gloves
 - Can be vinyl, rubber or nitrile
 - Double gloves reduce likelihood of cuts/punctures
 - Can be worn under work gloves if necessary
- After maintenance activities, wash hands with soap and water, or use an alcohol-based hand sanitizer. Change clothes if soiled.



- **Staff needs to wear PPE while doing service calls.**
- **Dispose** of filters per OSHA guidelines and treat with CAUTION. Flush with bleach solution before disposing.
- Create a **PPE storage** area with decontamination ability.

Easy to Implement Recommendations – Short & Long Term

GET EDUCATED

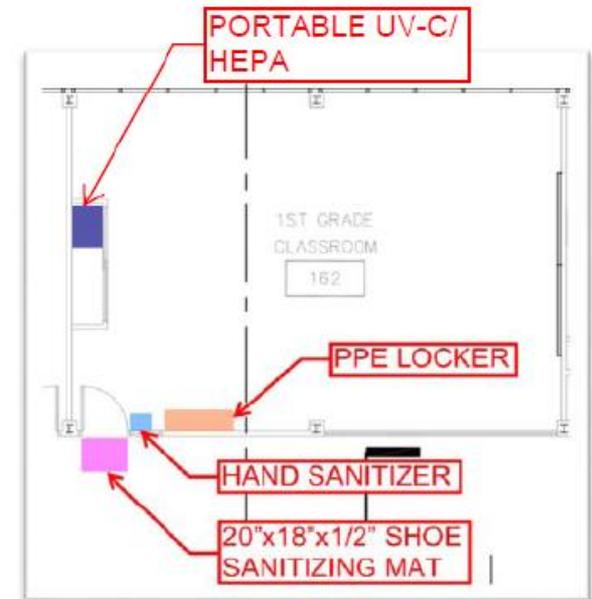
BUILD A PLAN

WORK THE PLAN

WORK THE PLAN

Common Sense Recommendations – *Short Run*

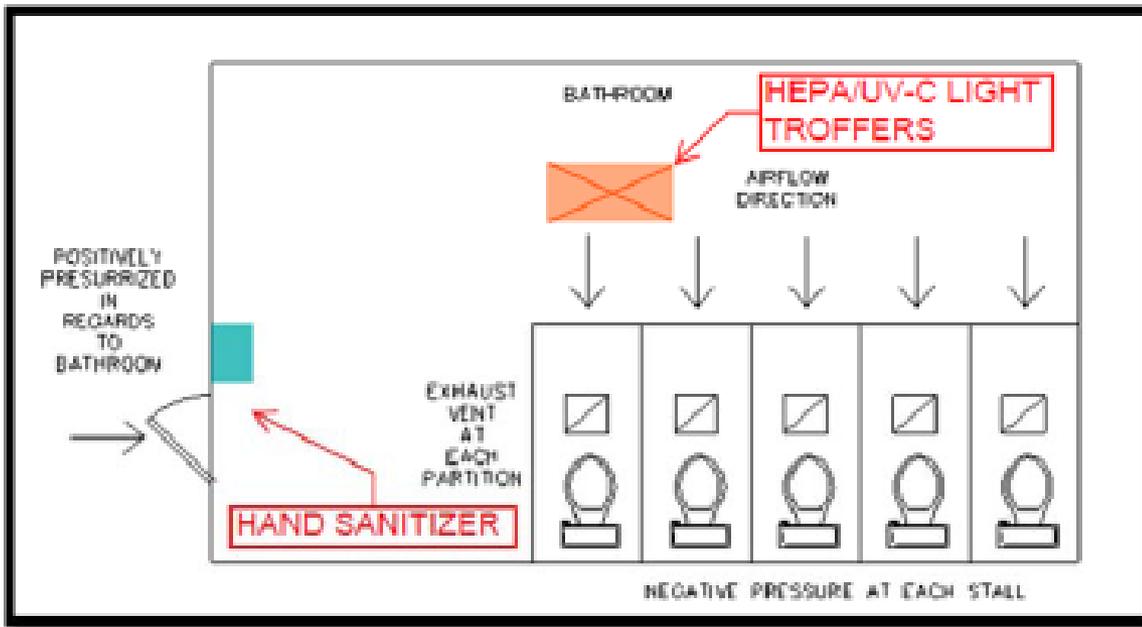
- Test and balance – Know the real numbers
- Switch to **MERV13/14 filters** on major AHUs
 - Compensate for reduction in airflow – filter change impact to be evaluated with HVAC professional
- Remote operation of BAS systems where possible
- Introduce **portable HEPA/UV-C machines**
- PPE storage cabinet and **separate waste stream**
- **Evaluate** exhaust fans, create a non-occupied air flush routine
- Recommend two hours before and two hours after occupancy
- If there is a DOAS – **Increase OA – Strive for dilution**



Typical Classroom Layout

WORK THE PLAN

Recommendations – Long Run – Areas where you can't social distance



Typical Bathroom Layout



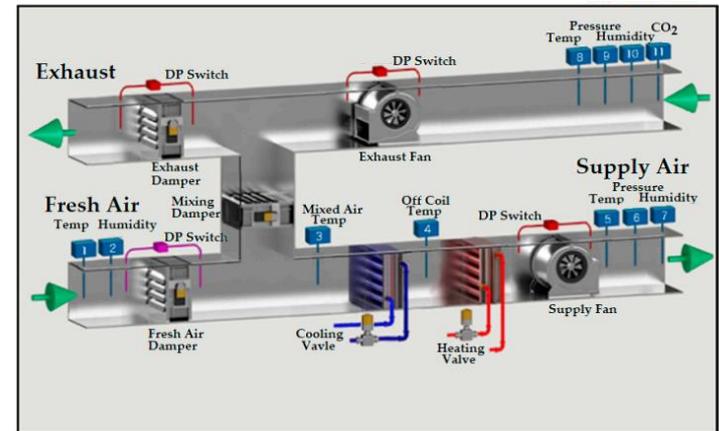
Survival of Severe Acute Respiratory Syndrome Coronavirus, Dept. of Health Hong Kong, extended survival in stool samples vs. air

WORK THE PLAN

SETTY

Recommendations – *Future Strategies to the Plan*

- Disinfectant **mats** at all entrances
- Evaluate by climate zone, **DOAS** with energy recovery per ASHRAE 90.1
- Convert all AHUs to operate with **MERV 13/14 with motor upgrades**
- Include UV-C to all AHUs
- Plan for humidifiers in the class, 40% RH
- Operator to switch to “**building air flush**” mode
- Mailroom and loading isolation
- Consider airflow paths, **supply high/return low**
- Upgrade restrooms exhaust to minimize transmission
- Isolation suites and janitors’ closets
- Big spaces – Increase OA percentages? Limit occupancy? Air scrubbers?
- Advanced building management controls to create a Pandemic Mode



WORK THE PLAN

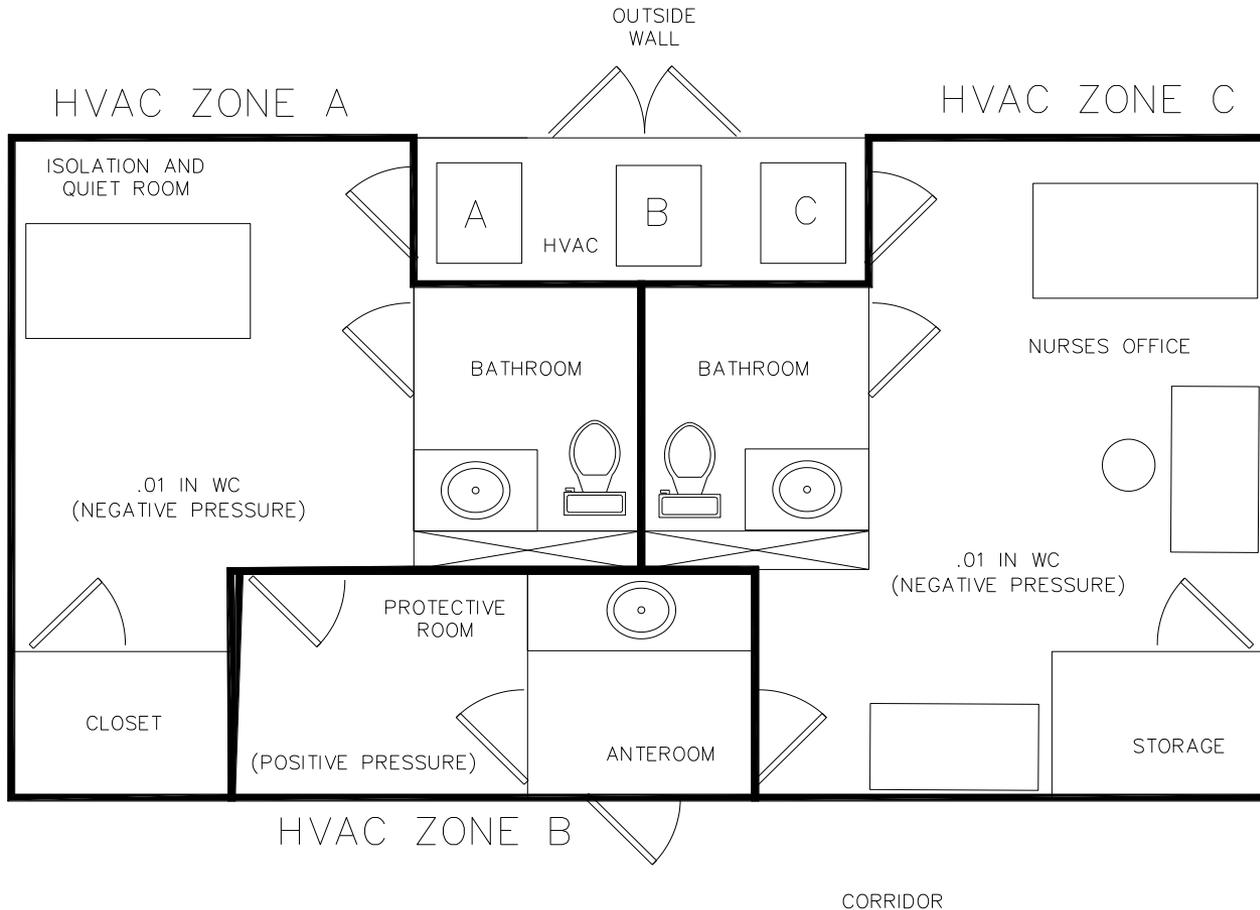
Recommendations – Long Run – Specialized Areas

- Nurses Stations
 - Isolation rooms – Follow ASHRAE 170
 - Conduct risk assessment by area
 - Provide one isolation per 500 students (minimum of 2)
 - 100% outside air unit
 - Anteroom/protective equipment room
 - Normal non-isolation nursing station
 - Biohazard waste and PPE storage
 - Dedicated HVAC



WORK THE PLAN

Recommendations – Long Run – Specialized Areas



WORK THE PLAN

STEP 1

Know Where you Stand:
Gather HVAC plans and System Manuals

STEP 2

Speed & Cost:
Establish your budget

STEP 3

Prepare:
With your HVAC P.E., create your statement of work plan

STEP 4

Execute Phase 1:
Put into place the fast, short-term interim adjustments

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Mid- to longer term projects; harden your buildings

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Audit:
Is it working?
Adjust

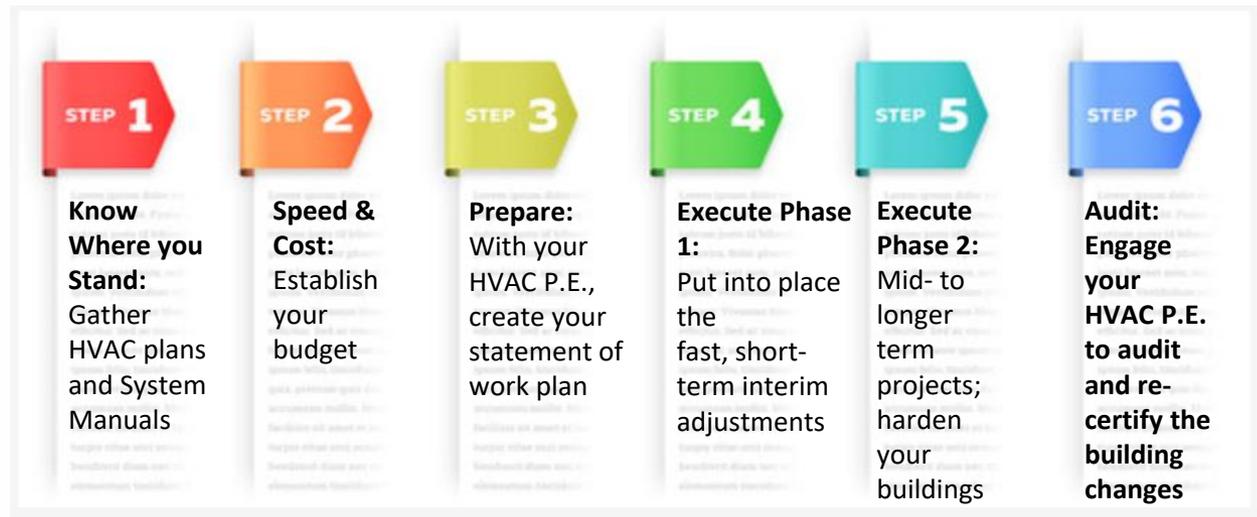
Questions?

Raj Setty, PE, CxA

rsetty@setty.com



When a Plan Comes Together



Build a Plan Work the Plan

ASHRAE EPIDEMIC TASK FORCE
SCHOOLS & UNIVERSITIES | Updated 7-17-2020

- Introduction**
 - Determining Building Readiness
 - Summer Checklist for Fall Classes
 - Startup Checklist for HVAC Systems Prior to Occupancy
- New/Modified Facility Design Recommendations**
 - Introduction
 - Designer Guidelines – General School
 - Nurses Office – General Requirements
- Equipment & System Specific Checks & Verifications During Academic Year**
 - Cleaning & Air Flush
 - Boilers
 - Chilled, Hot & Condenser Water Systems
 - Air Cooled Chillers
 - Water Cooled Chillers
 - Cooling Towers & Evaporative-Cooled Devices
 - Steam Distribution Systems
 - HVAC Water Distribution Systems
 - Pumps
 - Air Handling Units
 - Roof Top Units
 - Unitary & Single Zone Equipment
- Filtration Upgrades**
 - Introduction
 - Filtration Basics
 - Filtration Target Level
 - Information Gathering Stage
 - Data Analysis & Review
 - Implementation & Considerations
- Operation of Occupied Facilities**
 - Controlling Infection Outbreak in School Facilities
- Higher Education Facilities**
 - Student Health Facilities
 - Laboratories
 - Athletic Facilities
 - Residence Facilities
 - Large Assembly

QUESTIONS? COVID-19@ashrae.org | www.ashrae.com/covid19

IAQ Tools for Schools

Back

IAQ Tools for Schools



Getting Started



Indoor Air Quality



Tools for Schools



Action Kit Resources



Walkthrough Checklists



FAQ



Checklist
Ventilation Checklist



User Information



1. Outdoor Air Intakes



2. System Cleanliness



3. Controls For Outdoor Air Supply



4. Air Distribution



5. Exhaust Systems



6. Quantity of Outdoor



Notes



Picture

Submit

Cancel



Home



Action Kit



Checklist



FAQ

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.

Build a Plan Work the Plan

Project Planning

IAO PREVENTIVE MAINTENANCE **Indoor Air Quality Preventive Maintenance Checklist** **EPA**

HVAC

Make a Copy of Checklist

Select and Customize a Checklist
HVAC

Use Filters Below to Customize Checklist

School Name: _____
Date: _____

This tool is designed to allow you to add your own checks or modify the existing checks to match your needs. You may want to add additional activities related to IAQ preventive maintenance, such as those in *IAQ Tools for Schools Action Kit*. Enable macros to use this checklist customizer. Refer to Help files to learn how to enable macros for your version of MS Excel.

Category	Category Details	Action	Priority	Y	N	Notes
HVAC	Outdoor Air Ventilation	Designed and installed new HVAC systems to meet all ventilation requirements of ASHRAE Standard 62.1 using the Ventilation Rate Procedure.	MA	<input type="checkbox"/>	<input type="checkbox"/>	
HVAC	Outdoor Air Ventilation	Verified that all HVAC systems meet any local code requirements for ventilation.	MA	<input type="checkbox"/>	<input type="checkbox"/>	
HVAC	Outdoor Air Ventilation	Replaced or upgraded existing HVAC systems to meet ASHRAE Standard 62.1.	EA	<input type="checkbox"/>	<input type="checkbox"/>	
HVAC	Outdoor Air	For mechanical ventilation applications, installed permanent outdoor airflow monitoring systems in accordance with ASHRAE Standard 189.1, Section 8.3.1.2.	EA	<input type="checkbox"/>	<input type="checkbox"/>	

Instructions **PMChecklist**

Equipment and System Specific Checks and Verifications During the Academic Year Continued



Unitary and Single Zone Equipment (For example: Wall Hung Units, Unit Ventilators, Mini-Splits, Packaged Terminal Air Conditioners, Water-Source Heat Pumps, Fan Coil Units):

Monthly

- Check for particulate accumulation on filters, replace filter as needed.
- Check P-trap.
- Check drain pans for cleanliness and proper slope.
- Check the control system and devices for evidence of improper operation.
- Verify control dampers operate properly.



Equipment and System Specific Checks and Verifications During the Academic Year Continued



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.



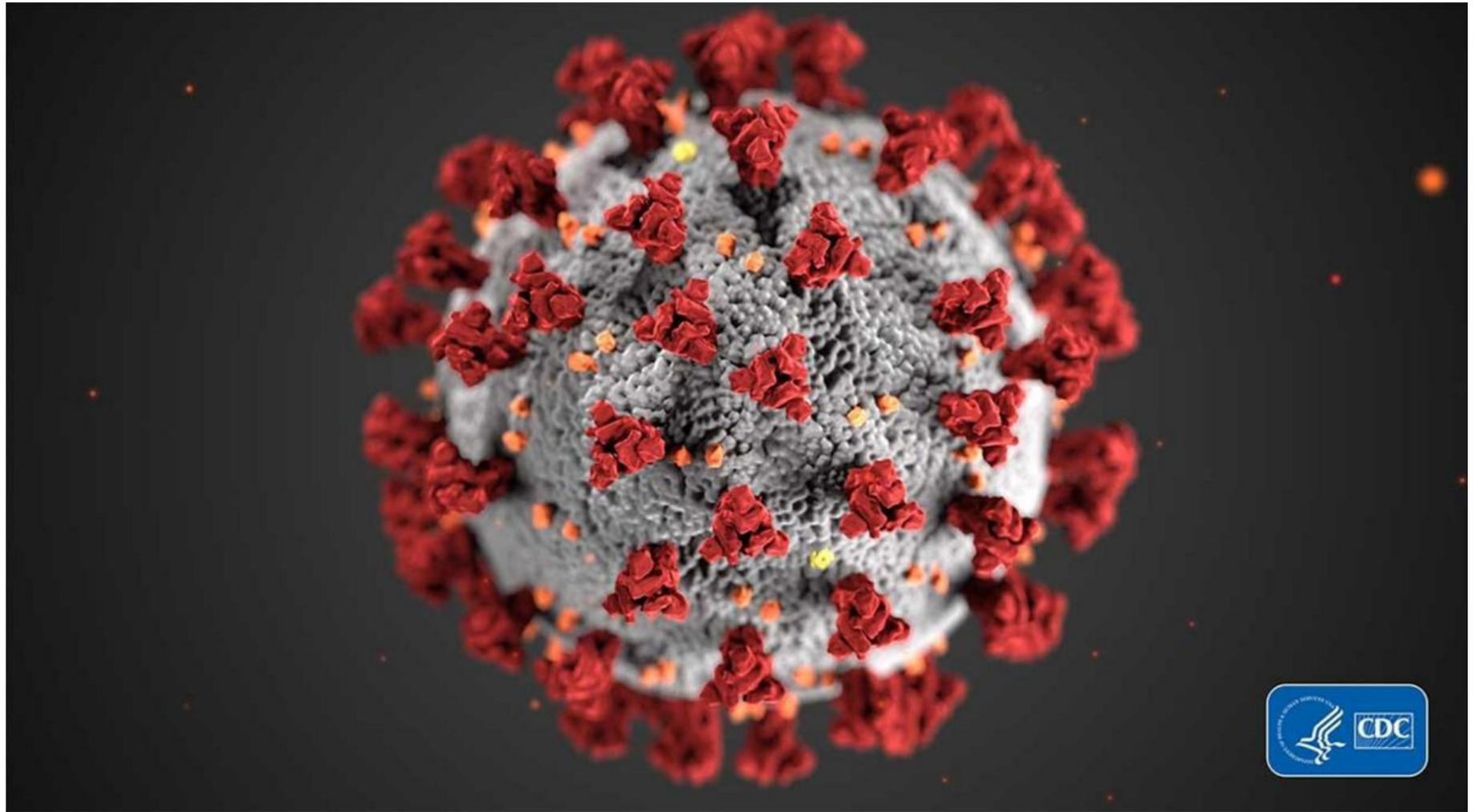


Fred Remelius
Director of Operations
Upper Merion Area School District (UMASD),
Pennsylvania



The REAL Director of Operations at UMASD







National Academy of Sciences

Poor-quality school buildings (i.e., those that have bad indoor air quality, are not clean or have inadequate bathroom facilities) complicate reopening and may make it difficult for school districts to implement the recommended health and safety measures.

1. SARS-CoV-2 is transmitted primarily by **respiratory droplets** from close contact with infected persons, and
2. by **surfaces that have been contaminated by infected persons** and then touched by previously uninfected persons who then touch their mouth, nose or eyes without first **properly washing their hands**.

The average number of secondary cases per infectious case ranges from 2.5 to well over 3.0, making **this virus considerably more infectious than influenza** (Inglesby, 2020). Current evidence suggests that, given how the virus is spread, **prolonged close contact in indoor environments is particularly high-risk** (Centers for Disease Control and Prevention [CDC], 2020).



CDC: Key Findings About Transmission

- The virus is transmitted primarily through exhaled respiratory droplets that contain the virus, though aerosol (very small, floating droplets) transmission and transmission from contaminated surfaces may also play a role.
- When breathing or talking normally, droplets are thought to be capable of traveling about **3-6 feet**.
- **Sneezing, coughing, singing or loud talking can propel droplets farther.**
- Inhaling or ingesting droplets, or getting droplets in your eyes (**face shields**), are the main mechanisms of transmission.
- Droplets can land on surfaces and then be transferred to the hands and into the mouth, nose or eyes. It is unclear how much exposure to the virus through surface contact is necessary to cause an infection.
- **Aerosols containing the virus can accumulate in the air in a closed space with limited ventilation such that people can become infected by breathing in virus-containing aerosols.**
- The virus does not enter the body through the skin.
- People can be contagious before they show symptoms.
- The role of children in transmission is unclear.



My Plan for COVID-19

I'm going to **double down on what I do best** and let the rest of the world decide if they can/want to come back to school. These are the items that I'm going to focus on:

- Protect my staff from themselves and each other – per CDC, wearing a mask is the primary safety precaution, washing hands secondary. Keep beating that drum until your staff is deaf!
- Help protect district employees who have high contact with the general public or lots of students and staff (e.g., front office secretaries, IT technicians and food service cashiers) using sneeze guards.
- Our custodians will disinfect as many high touch points as often as they can to help stop physical transfer of the virus.
- No extra funding to hire more people to do more disinfecting. We are reassigning some second-shift custodians to day work so they can dedicate more time doing **real-time disinfecting** while getting some general cleaning done.



My Plan for COVID-19 (continued)

- Provide teachers and staff with approved disinfectant so they (not students) can disinfect high touch surfaces in their classrooms and workspaces during the day as they wish.
- Encourage principals, teachers and staff to declutter their classrooms/workspaces. Over the years many classrooms, especially in elementary schools, become filled with filing cabinets, bookshelves, storage totes, rocking chairs, bean bags, couches, carpet squares, hoarded art supplies, etc., etc., etc. All custodians can do in some cases is just empty the trash and run away. One silver lining from COVID-19 is the opportunity to get teachers and staff to shovel out their spaces so we can be clean and disinfect efficiently.
- **Recognize and reinforce with our maintenance staff that COVID-19, as with asthma, allergies and a whole host of other ailments, is an **airborne/respiratory problem**. This is why good indoor air quality is so very important in K–12 schools, where children are often packed very close in classrooms. PREVENTIVE MAINTENANCE IS KEY!!**



UMASD took advantage of the shutdown to double down and follow the U.S. EPA's *IAQ Tools for Schools* guidelines on cleaning and disinfecting UNIVENTS & AHUs.

We are focusing on boosting our performance of PREVENTIVE MAINTENANCE on HVAC SYSTEMS.

Huge side benefit: A study by Jones Lang LaSalle shows the Return On Investment from PREVENTIVE MAINTENANCE can be as much as

545%!













VF6000

FITS. COMPATIBLE AVEC:
COMPATIBLE CON:

5-20 GAL
18-75 L

**HEPA Material
Wet/Dry Vac Filter**

**Filtre pour aspirateur de
liquides et de poussières
en matériau HEPA**

**Filtro para
material
HEPA para
aspiradoras
para
seco/mojado**

Filter NOT appropriate for
EPA's Lead Paint RRP Rule

Filtre NON conforme à la
Règle RRP de l'EPA sur les
rénovations en présence
de peinture au plomb

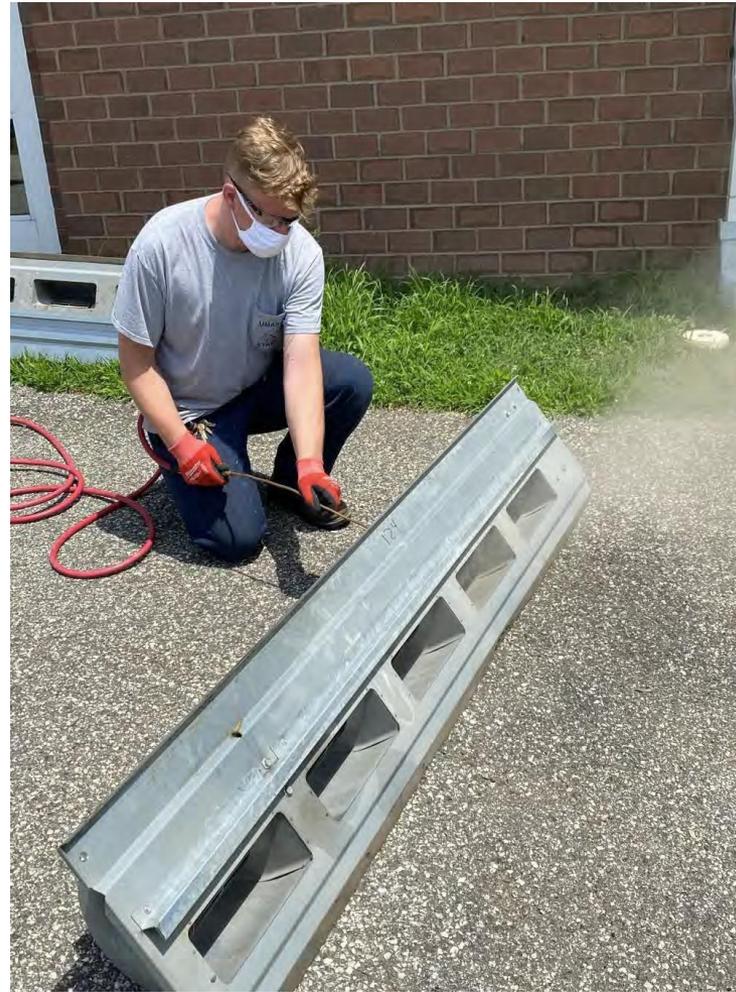
Filtro NO apropiado
para la regla de RRP
relacionada con la
pintura con plomo
de la EPA

REDUCES ALLERGENS
RÉDUIT LES ALLERGÈNES
REDUCE LOS ALÉRGENOS

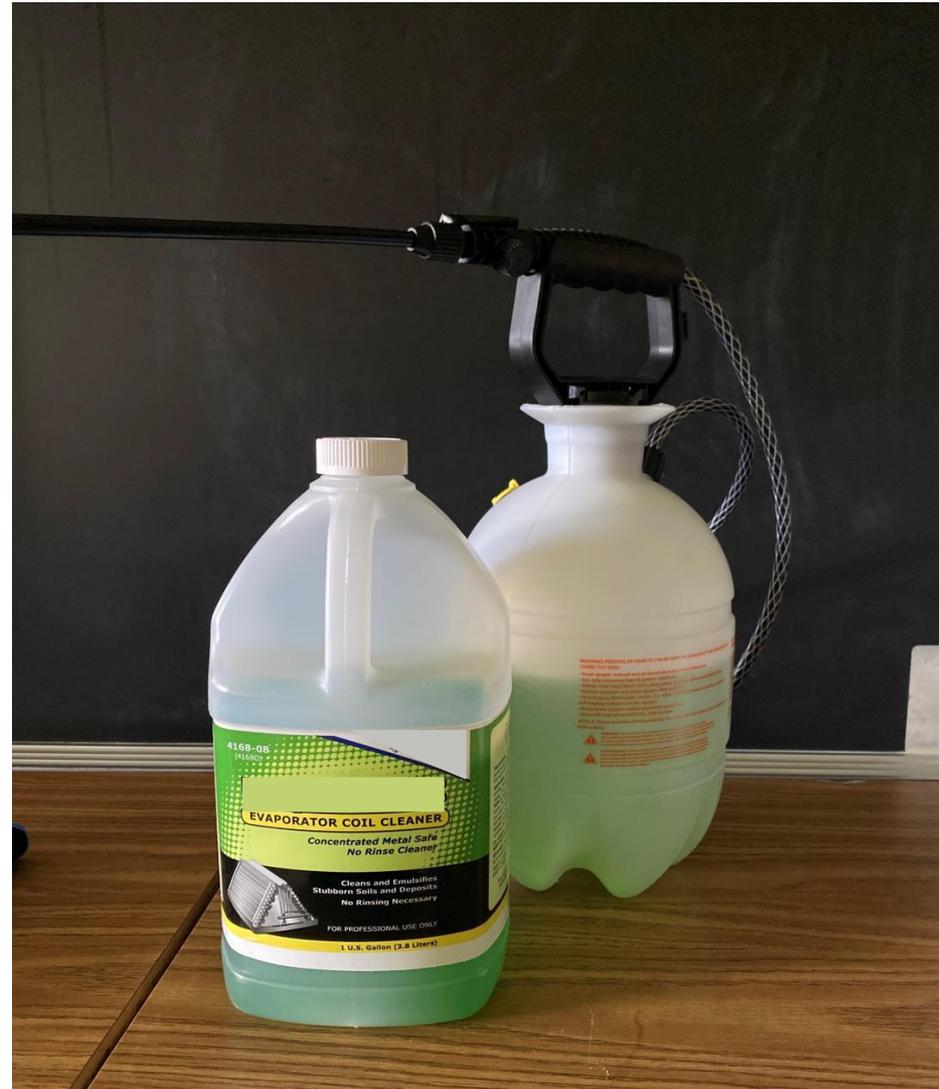


2nd Grade is a Community of Learners Connecting
Lives to Ours Through Reading and Writing

















AHUs are just really big Univents that serve multiple classrooms

A Totally Uncleanable Classroom Because of All of the CLUTTER!



William Bahnfleth, ASHRAE presidential member and professor of architectural engineering at Pennsylvania State University:

- There have been thousands of papers and articles published since the pandemic started, and in all of the reports of how COVID-19 is transmitted, there are **no reports of space-to-space transmission through an HVAC system.**
- There's **no reason to change out filters on a really high frequency schedule.** Changing them as often as they're supposed to be changed would be a good thing to do.
- Another important issue is maintenance/retro-commissioning, because **how systems are designed and how they operate can be quite different.**
- One **myth** is this idea that the **HVAC system itself is going to be highly contaminated.**
- Contractors should impress upon their customers the need to make sure that their system is operating as intended and designed. Customers could spend a lot of money to try to block this virus, but **if the equipment isn't working right, if the whole system isn't working right, then it could all be for naught.**

www.achrnews.com/articles/143255-can-hvac-systems-spread-the-covid-19-virus



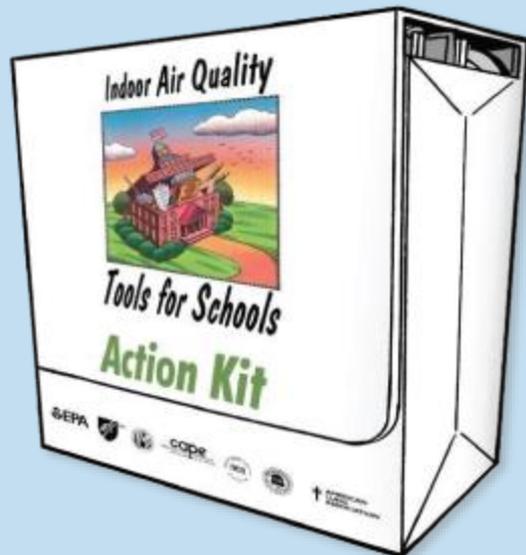
Summary

- Recognize and **reinforce with maintenance staff that COVID-19, as with asthma, allergies and a whole host of other ailments, is an **airborne, respiratory problem****. Good indoor air quality is so very important in K–12 schools because children are often packed very close together in confined spaces.
- Protect staff from themselves and each other—**enforce mask wearing**.
- Protect employees who have high contact with the general public or lots of students and staff—**sneeze guards**.
- Purchase, stockpile and use **approved disinfectants**.
- Reassign second-shift custodians to day work so they can dedicate more time doing **real-time disinfecting**.
- Provide teachers and staff with **approved disinfectant** (not for student use).
- Declutter so custodians can *actually* clean and **disinfect**.

PREVENTIVE MAINTENANCE IS KEY!!



The IAQ Tools for Schools Guidance



EPA
Indoor Air Quality Tools for Schools: Coordinator's Guide
A Guide to Implementing an IAQ Program

Indoor Air Quality



For Schools

Tools



Indoor Air Quality (IAQ)

Indoor Air Quality Background: The Basics

Indoor air quality (IAQ) is an increasingly important topic in schools across the nation. IAQ can directly affect the health and comfort of students and staff. There are many ways that schools can help to improve air quality. EPA developed the Indoor Air Quality Tools for Schools (IAQ Tools) Program to help schools address many IAQ issues using practical and often low-cost measures such as addressing ventilation supply rates to improve airflow.

By simply following this Indoor Air Quality Background and completing the IAQ checklist, complete checklist how to make a significant impact on IAQ and provide a healthy learning and working environment.

This guidance is based on the following principles:

- Most IAQ problems can be prevented and corrected by school staff through simple, non-technical measures.
- The cost and effort needed to prevent most IAQ problems is significantly less than the cost and effort required to resolve problems after they develop.

WHY IAQ IS IMPORTANT TO YOUR SCHOOL

Many people are aware that indoor air pollution can impact their health, but indoor air pollution can also have significant health effects. EPA studies of homes exposed to air pollution indicate that indoor levels of pollution may be two to five times higher than outdoor levels.

Science Advisory Panel Report on Indoor Air Quality in Schools

- Failure to prevent or remedy IAQ problems can:
- Increase potential for long- and short-term problems for the staff.
 - Significantly impact student academic and performance.
 - Reduce teacher and staff job performance.
 - Accelerate deterioration and inefficiency of school building equipment.
 - Increase potential for school-related absenteeism or non-attendance.
 - Decrease student safety, attendance, and performance.
 - Create negative public impact.
 - Impact community health.
 - Create liability potential.

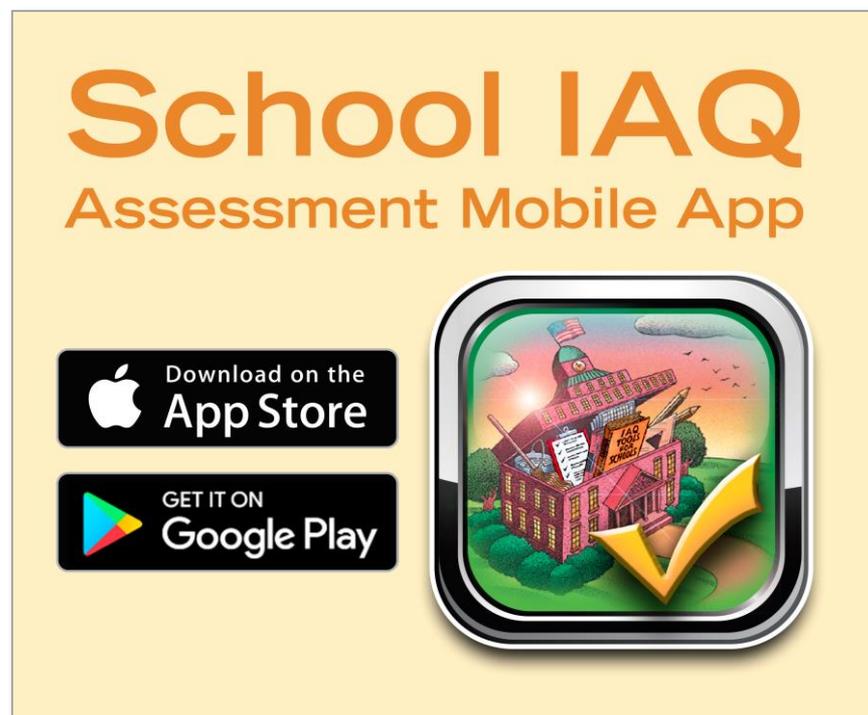
UNDERSTANDING PROBLEMS

To understand if a problem exists, it is important to:

- Identify the problem.
- Determine the cause.
- Determine the extent.
- Determine the impact.

Download the App Today

- ✓ Android: Google Play
- ✓ Apple: iTunes
- ✓ www.epa.gov/iaq-schools/school-iaq-assessment-mobile-app



IAQ Preventive Maintenance: Guidance, Tools and Resources



EPA 402-K-18-001 | March 2019 | EPA Indoor Environments Division | www.epa.gov/iaq



Indoor Air Quality Tools for Schools: Preventive Maintenance Guidance




Indoor Air Quality (IAQ)

Preventive Maintenance Guidance



Indoor Air Quality (IAQ) Tools for Schools: Preventive Maintenance Guidance
Appendix B: IAQ Preventive Maintenance Model Plan

Model Plan¹

IAQ Preventive Maintenance Plan

[School District Name]

[Date]

[Italicized sections in this Model Plan could be completed according to the instructions or simply deleted. The footer could be replaced with your school or district name, name of plan, and the date or version of the plan.]

[This could be a standalone IAQ Preventive Maintenance Plan, or you could add elements of this plan to your IAQ Management Plan² or your Preventive Maintenance Plan.]

Table of Contents

- [1. Mission and Goals](#)
- [2. Checklists, Procedures and Schedules](#)
- [3. Walkthroughs and Assessment](#)
- [4. Team and Staffing](#)
- [5. Communication and Training](#)
- [6. Evaluation](#)



Indoor Air Quality Preventive Maintenance Checklist

Preventive Maintenance Full



Make a Copy of Checklist

Select and Customize a Checklist

Preventive Maintenance Full

Use Filters Below to Customize Checklist

School Name: _____

Date: _____

This tool is designed to allow you to add your own checks or modify the existing checks to match your needs. You may want to add additional activities related to IAQ preventive maintenance, such as those in IAQ Tools for Schools Action Kit. Enable macros to use this checklist customizer. Refer to Help files to learn how to enable macros for your version of MS Excel.

Category	Category Data	Action	Priority	Y	N/A	Notes
Project Planning	Project Planning	Gathered feedback from the school's faculty and staff on IAQ issues and gained an understanding of the current building status.	AP	<input type="checkbox"/>	<input type="checkbox"/>	
Project Planning	Project Planning	Performed a periodic building walkthrough inspection to identify environment health issues and concerns (recommend monthly inspections).	AP	<input type="checkbox"/>	<input type="checkbox"/>	
Project Planning	Project Planning	Clearly defined all IAQ and energy efficiency goals.	MA	<input type="checkbox"/>	<input type="checkbox"/>	
Mold and Moisture	Mold and Moisture	Inspected the interior and exterior of the building and the building's mechanical systems for evidence of moisture problems, and documented the results.	AP	<input type="checkbox"/>	<input type="checkbox"/>	
Mold and Moisture	Mold and Moisture	Determined whether the project requires mold remediation or additional moisture control measures based on the findings of the moisture inspection.	AP	<input type="checkbox"/>	<input type="checkbox"/>	
Mold and Moisture	Mold and Moisture	Worked with a general contractor or other experienced building experts to define the scope of moisture improvements and repairs.	AP	<input type="checkbox"/>	<input type="checkbox"/>	
Mold and Moisture	Mold and Moisture	Assessed moisture or mold problems that could not be resolved under the project. Did not start construction projects that would reduce the school's air infiltration rate if there are unresolved moisture problems.	AP	<input type="checkbox"/>	<input type="checkbox"/>	
Mold and Moisture	Mold and Moisture	Repaired moisture problems identified during the assessment including plumbing leaks, rain leaks, and foundation leaks.	MA	<input type="checkbox"/>	<input type="checkbox"/>	



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Indoor Air Quality Tools for Schools: Preventive Maintenance Guidance Documents

With thoughtful planning and regular maintenance for your buildings and facilities, you can prevent many issues from becoming costly problems through preventive maintenance. This guide will walk you through the steps to develop and implement your indoor air quality (IAQ) preventive maintenance plan. Within its pages, you will find tips to help you make the case for your plan and gain the buy-in you need from your school community. You also will find detailed guidance on why walkthroughs and assessments of your facilities, integrated pest management (IPM), green cleaning, heating, ventilating, and air conditioning (HVAC) and equipment upkeep, and mold and moisture prevention are important and how you can include them in your plan. Finally, you'll find tips on staffing and communication, as well as evaluating your program to make your IAQ preventive maintenance plan a success.

- [IAQ TFS Preventive Maintenance Guidance](#)

Appendices

- [Appendix A: IAQ Preventive Maintenance Checklist](#) (251 K)
- [Appendix B: IAQ Preventive Maintenance Plan](#) (8 pp, 88 K)
- [Appendix C: IAQ & Preventive Maintenance Value Proposition Worksheet](#)
- [Appendix D: IAQ Preventive Maintenance Sample Equipment Inventory](#) (17 pp, 98 K)
- [Appendix E: Annual Facility Equipment Preventive Maintenance Timeline](#) (14 pp, 119 K)
(Source: New York State Energy Research and Development Authority [NYSERDA])
- [Appendix F: Sample IAQ Measurements Tracking Sheet](#) (1 pg, 52 K)
- [Appendix G: Monthly Health Statistics](#) (1 pg, 59 K)
- [Appendix H: Example Preventive Maintenance Schedule](#)
(Source: [Minnesota Department of Health](#))



These resources are available to you at no cost at

www.epa.gov/iaq-schools/indoor-air-quality-tools-schools-preventive-maintenance-guidance-documents.

Indoor Air Quality (IAQ)



Professional Training Webinar Series

 Free Online Training, Earn CEUs!

IAQ Master Class Series

Ten technical trainings to build your knowledge base to start, improve or sustain an IAQ management program. Complete all 10 to join the IAQ Master Class.

IAQ Knowledge-to-Action Series

Technical trainings to deepen your IAQ knowledge and build capacity to take immediate action.

Technical Knowledge

- Asthma Triggers
- HVAC Systems
- Moisture and Mold
- Energy Efficiency
- Integrated Pest Management
- Cleaning and Maintenance
- Materials Selection and Source Control

Capacity Building

- Funding
- Assessment and IAQ Mobile App
- Staff Training
- Gaining Buy-In
- Evaluation and Data

www.epa.gov/iaq-schools/ondemand-training-webinars



EPA Resources to Get You Started!



**IAQ Tools for Schools
Action Kit**



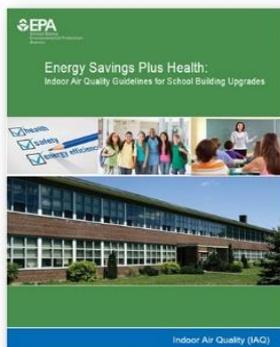
**IAQ Tools for Schools
Mobile App**



**Framework for Effective
IAQ Management**



**IAQ Master Class
Professional Training
Webinar Series**



**Energy Savings Plus Health Guide
and Interactive Air Quality Planner**



**IAQ Tools for Schools:
Preventive Maintenance
Guidance**

www.epa.gov/iaq-schools



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