Chapter 6.A. Introduction

Institutional cleaning technology has undergone rapid change over the past few years. New advances in device technology are providing environmentally friendlier and safer ways to care for public buildings while protecting the health of the users and other occupants.

These technologies need to be combined with other infection-control strategies, such as ventilation, air treatment, and personal hygiene strategies (e.g., hand washing for microbes transmitted by contact with surfaces, or cough etiquette for microbes transmitted by an airborne and/or droplet route).

Cleaning industry manufacturers have introduced water-based devices for surface cleaning, sanitizing, and disinfecting in the past few years. Although the processes are different, they all use water as the basis for the technology. These innovations are possible because of advances in electrical engineering, software, and solid-state circuitry. Listed below are devices that have been proven effective as cleaners, sanitizers and/or disinfectants.

How These Technologies are Regulated

• Pesticide Product (Disinfectant, Sanitizer)

Antimicrobial pesticides (disinfectants) are required to be registered with the Environmental Protection Agency (EPA) to document the product’s kill claims for specific microbes, and the product label must list this registration number.

If a device incorporates a substance or mixture of substances to perform its intended purpose, or is packaged together for sale with a disinfectant, then it is considered a pesticide product, not a device, and must be EPA registered.

• Device

A pesticidal device is an instrument or other machine that is used to destroy, repel, trap, or mitigate any pests, including viruses. A device must work solely by physical means (such as electricity, light, or mechanics). Examples of devices may include ozone generators, UV lights, etc.

Unlike chemical pesticides, EPA does not register devices and, therefore, does not routinely review their safety or efficacy. Because EPA does not review or register pesticidal devices, EPA cannot confirm whether, or under what circumstances, such products might be effective against SARS-CoV-2.

Thus, EPA advises companies to maintain records that confirm claims made on device labels/labeling are true and not misleading. Selling or distributing pesticidal devices with false or misleading claims about their safety or efficacy may subject the seller or distributor to penalties under FIFRA.

There are other regulatory requirements that apply. For example, device labels must include adequate warning and caution statements and directions for use as well as the EPA establishment number (they will not have an EPA registration number because they are not subject to the same registration requirements as pesticides).
• Pesticide Application Equipment

Product application equipment that is sold separately from the pesticide itself is **not** a device or a pesticide. For example, an electrostatic sprayer for a disinfectant that is sold separately from the disinfectant is considered to be application equipment, which EPA does not regulate.

Information on disinfectant application equipment in the handbook is in *Appendix G: Disinfectant Application Equipment.*

**Benefits of Using Disinfecting and Sanitizing Devices**

- Reduced exposure to hazardous chemicals for custodians and building occupants
- Reduced cost of purchasing, storing, and disposing of chemicals
- Ease and effectiveness of use

**Sources:**

# Chapter 6.B. Using Devices to Clean

## Introduction

The following products are now widely available and have been evaluated for their disinfecting efficacy. Check with equipment manufacturers and vendors for details.

<table>
<thead>
<tr>
<th>Equipment and Vendor</th>
<th>Technology</th>
<th>Cleaning, Sanitizing, and Disinfecting Claims and EPA Registration</th>
<th>Independent Research and Third-Party Certification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force of Nature</td>
<td>This device uses a capsule containing salt and vinegar. The capsule is then mixed with water inside the device, and electrolyzed. This creates a hypochlorous acid solution.</td>
<td>The capsule used is an EPA registered disinfectant active against the virus causing COVID-19 when used according to the label instructions.</td>
<td>The chemical produced has been Green Seal® certified as meeting their health, safety, and performance standards.</td>
<td>The active ingredient produced by their device has not been evaluated by the DfE Safer Choice program. Research is showing that the hypochlorous based products can combine with other chemicals in the air to form hazardous fumes.</td>
</tr>
<tr>
<td>Kaivac Cleaning Systems™</td>
<td>Multipurpose, no-touch cleaning systems (also known as spray-and-vac or high-flow fluid-extraction units) are designed to work on most surfaces. They can be used with just water, a cleaning chemical or a disinfectant.</td>
<td>Kaivac’s disinfecting products are EPA registered as active against the virus causing COVID-19.</td>
<td>Kaivac’s cleaning solution, KaiO™ has been Green Seal® certified as meeting their health and safety standards as a cleaner.</td>
<td>The active ingredient in their disinfectants will not pass the DfE’s Safer Choice standards. The system can also be used with an EPA registered product that meets DfE’s Safer Choice standards.</td>
</tr>
<tr>
<td>Equipment and Vendor</td>
<td>Technology</td>
<td>Cleaning, Sanitizing, and Disinfecting Claims and EPA Registration</td>
<td>Independent Research and Third-Party Certification</td>
<td>Comments</td>
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<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>Liquefied ozone (e.g., Tersano products)</td>
<td>Liquid ozone is created by introducing an extra oxygen atom to an oxygen molecule and water molecules. The instability of the third oxygen atom creates a high-quality cleaning agent in which atoms of oxygen search for something to bond with. As it searches, the oxygen atoms break up dirt bonds and combine with hydrogen and oxygen to create more molecules of water and oxygen while cleaning the surface.</td>
<td>Meets EPA requirements as a disinfection device. Request test data on disinfectant efficacy from the device manufacturer. Aqueous ozone generators are approved by the US Food and Drug Administration (FDA) as sanitizers for food and non-food contact surfaces. Testing is in process for effectiveness against the virus causing COVID–19.</td>
<td>Green Seal® has certified the product as meeting their health, safety, and performance standards. USDA/National Organic Program approved.</td>
<td>The contact time to eliminate salmonella and <em>E. coli</em> is 30 seconds. There is no residue from the product so rinsing is not required.</td>
</tr>
<tr>
<td>Equipment and Vendor</td>
<td>Technology</td>
<td>Cleaning, Sanitizing, and Disinfecting Claims and EPA Registration</td>
<td>Independent Research and Third-Party Certification</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
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<td>----------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Thermal Accelerated Nano Crystal Sanitation (TANCS®) Steam Vapor System</strong></td>
<td>The TANCS Steam Vapor System technology (see Figure 2) works by facilitating the redistribution of charges between the water molecules and dissolved mineral components naturally found in tap water, which results, in part, in the development of nano crystals. This enhanced water is then transformed into super-heated, low-moisture steam. High-temperature, low-moisture steam vapor is applied at low pressure and low volume. It cleans by breaking the bond between the soils and the surface and destroys microorganisms by disrupting their cell membranes.</td>
<td>Meets EPA requirements as a disinfection device with claims (that the company must have but that EPA does not review) to effectively kill a broad range of microorganisms within 3 to 5 seconds, reducing surface-mediated infection risks. Although the TANCS System is not listed on the EPA List N, it is effective against viruses that are more difficult to kill than the virus causing COVID–19 and therefore expected to be effective against the virus causing COVID–19.</td>
<td>Nelson Laboratories, Inc. of Utah certified that a 7-second exposure to TANCS steam vapor produced a 5-to-7-log reduction in microbes, which was consistently achieved on all microbes tested. The TANCS System has also been tested by independent researchers and found to be very effective against a variety of microbes.</td>
<td>The system only uses tap water and is designed to get into hard-to-reach areas. Although it has a dry (6%) moisture content, the manufacturer recommends that to reduce risk for mold after use, all surfaces must be dried and rooms must be ventilated and not closed up. Claims to eliminate biofilms and mold. It has a number of attachments for cleaning various surfaces, such as tile, carpet, and more.</td>
</tr>
</tbody>
</table>
Ultraviolet Light (UV)

Ultraviolet light (UV) has been used for decades to destroy airborne microbes (germs). Short-wave ultraviolet light (UV-C) has been used to destroy bacteria and viruses in hospital wards and operating theaters to control superbugs. This must be done overnight or when the areas are unoccupied because of the danger to human health.

UV-C can cause cancer, affects the corneas, and destroys DNA. It uses short-wavelength ultraviolet light (UV-C) to disrupt the viruses’ DNA and inactivate essential acids. Although studies verify that it can destroy SARS and other corona viruses and is likely to be effective against the virus causing COVID-19, it has not been verified at this time and should not be relied upon for destroying the virus causing COVID-19.

The International Ultraviolet Association (IUVA) has a website, https://iuva.org/IUVA-Fact-Sheet-on-UV-Disinfection-for-COVID-19, dedicated to UV and COVID-19. It provides a fact sheet, FAQs, guidance on the selection and operation of equipment for the UV disinfection of air and surfaces.

Sources

- E-mail correspondence from Tom Morrison, Vice President of Marketing, Kaivac, Inc., 7/10.
- Kaivac, Inc - https://kaivac.com/
- Tersano - https://www.tersano.com/
- International Ultraviolet Association - https://www.iuva.org/IUVA-Fact-Sheet-on-UV-Disinfection-for-COVID-19
- Toxics Use Reduction Institute, Surface Solutions Laboratory - https://www.turi.org/Our_Work/Cleaning_Laboratory
Introduction
Microfiber cloths and mops are considered an essential tool in an infection-control program. They are superior at capturing microbes and other organic matter (dirt, food, liquid, etc.) while requiring less cleaning solution and water.

What is Microfiber?
Microfiber is a polyester and nylon (polyamide) fiber that is split many times smaller than a human hair and used to make cleaning cloths and mop heads. The small-size fiber is able to penetrate cracks and crevasses that cotton cloths or paper towels are not able to reach. The increased surface area of the fibers and their star shape enable them to absorb up to 7 to 8 times their weight in liquid. This capillary action is mechanically increased by the scrubbing movements during cleaning. These features also enable the microfiber to pick up grease and oil better than other alternatives.

The fibers have a static electric charge that attracts dust and holds it in a superior manner, rather than spreading it around or releasing it into the air when dry dusting.

The cloths and mops can be washed and reused hundreds of times; however, there is current research underway to determine the efficacy of microfiber after being washed numerous times.

Microfiber comes in different grades for a variety of uses. The term microfiber technically applies to fiber that is 1.0 denier or smaller, but some being sold under the microfiber name has not been split and has a larger denier measurement. The smaller the denier measurement, the finer and more effective the microfiber. Superior microfiber measures 0.13 denier.

When purchasing microfiber, make sure it is from a reputable manufacturer and that the fibers are split and are a smaller denier measurement.

Benefits of Using Microfiber
Infection-control benefits

1. *Ability to capture microbes and minimize microbial growth:* Microfiber is more effective at capturing microbes and dries (sheds water) more quickly than traditional cloths and mops, which helps to prevent the growth of microbes inside the fabric. Several studies have determined that microfiber is better at capturing bacteria than cotton.

   The University of California Davis Medical Center compared the amount of bacteria picked up by a cotton-loop mop and by a microfiber mop. The cotton-loop mop reduced bacteria on the floors by 30%, whereas the microfiber mop reduced bacteria by 99%.

2. *Prevention of cross-contamination:* This common problem in facilities can be reduced by using microfiber mops and cloths. Changing mop pads after each room avoids the opportunity for cross-contamination. Microfiber cloths and mops are available in different colors so that a color-coding system can be implemented for specific uses. For instance, in restrooms, pink cloths can be used for toilets and yellow cloths for sinks.
Green cloths can be used for classroom cleaning. See Chapter 3.H. Preventing Cross-Contamination.

**Cost-saving benefits**

1. The University of California Davis Medical Center study found that initiating a microfiber mopping system also resulted in the following cost benefits:
   - 60% lifetime cost savings for mops
   - 95% reduction in chemical and water usage associated with mopping tasks
   - 20% labor savings per day

2. The Sustainable Hospitals Project at the University of Massachusetts Lowell found similar cost savings:
   - a reduction in water and chemical usage
   - microfiber mop pads last 10 times longer than a cotton-loop mop
   - improved worker productivity

**Ergonomic benefits of microfiber mop systems**

Microfiber mopping systems consists of a handle and mop pads. Microfiber mop pads are easily detachable using Velcro® or snap-on fastening systems.

The University of Massachusetts Lowell study determined that because the microfiber mopping system uses less water and chemicals, it reduced strain associated with handling water and chemicals and eliminated the need to wring the heavy cotton mops, resulting in less potential for worker injury.

1. **Less weight to handle:** Microfiber mops reduce the amount of weight to be handled because:
   - The handles are ergonomically designed using lightweight metals.
   - A typical cotton-loop mop may weigh 60 pounds when saturated with water, whereas a microfiber mop weighs just over 2 pounds.
   - The mop solution does not need to be changed between rooms, because the dirty mop pad is not immersed in the clean solution. This reduces the need to lift an approximately 30-pound bucket of solution several times a day.

2. **No wringing heavy mops:** Mop heads are changed after cleaning each room, eliminating the need to wring out a conventional mop. Also, due to their higher water-retention capacity, microfiber mop heads do not need to be wrung out.

**Advantages:** Due to microfiber’s numerous advantages, including its long-lasting profile, ability to remove microbes, ergonomic benefits, superior cleaning capability, and reduction in the amount of chemical and water needed, it is considered to be preferable to conventional cotton cloths or paper towels for cleaning tasks.
Washing Instructions

- **Washing**: Microfiber should be washed only with other microfiber materials because it can pull the lint out of cotton or other materials during the washing and drying process. Use a mild laundry detergent, and never use bleach, fabric softener, or dryer sheets because they can degrade the fabric.

- **Drying**: Microfiber can be line dried or dried using the low setting of an automatic dryer.

- **Caution**: Microfiber is flammable and burning microfiber can emit toxic fumes. Therefore, microfiber should be dried only using low heat. Follow the manufacturer’s cleaning and management instructions.

Microfiber for Different Tasks

In general, look for microfiber from a reputable company. There are different weaves and weave densities for specific tasks. Ask the vendor about the grading system and which grade is best for specific cleaning tasks.

<table>
<thead>
<tr>
<th>Hand tasks: dry and wet cleaning and dusting</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image of microfiber cloths]</td>
</tr>
</tbody>
</table>

- **Glass**: Glass cleaning cloths have a much tighter weave than a dusting or wet cleaning cloth. Many schools have found that using a wet microfiber glass cloth for cleaning the surface and then a dry glass cloth for polishing is effective. In many cases, water is all that is needed. These cloths are also useful for cleaning and polishing stainless steel.

- **Dusting**: These soft fiber cloths require no polish or other chemical while removing up to 99% of dust, dirt, and other materials.

- **Wet cleaning**: Used for all wet cleaning tasks, these require a reduced amount of chemical for effective cleaning. Start by spraying the cloth with a minimal amount of all-purpose cleaner and add more product as needed or dip into a container of cleaning solution. Teachers can use these cloths instead of wipes.

- **High-dusting wands**: Wands reach places that are difficult to access and remove the dirt and dust that has accumulated.

<table>
<thead>
<tr>
<th>Floor tasks: dry and wet mopping, dust mopping, and scrubbing</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image of floor cleaning tools]</td>
</tr>
</tbody>
</table>
• **Wet mopping**: Use wet mops for classrooms, restrooms, and tiled areas within carpeted spaces. Some microfiber mopping systems have an on-handle solution reservoir for accurate measurement.

• **Dust mopping**: Using microfiber mops can eliminate the need for petrochemical-based dust-mop treatment. Microfiber dust mops with a fringe around the edge are now available. These more closely resemble the conventional loop mops and pick up larger pieces of debris.

• **Floor finishing**: Use microfiber to apply floor finish with a specially designed flat mop that reduces fatigue and that does a better job at applying the product.

• **Scrubbing**: Microfiber floor pads available for auto scrubbers use less water and chemicals while cleaning and polishing more effectively.

**For More Information**

*Green Cleaning for Dummies*, by Stephen Ashkin and David Holly, is a comprehensive resource on Green Cleaning.

**Resources**


2. U Mass Lowell, 10 Reasons to Use Microfiber Mopping, [https://www.uml.edu/docs/10%20Reasons%20for%20Microfiber%20Mops%20052215_tcm18-187539.pdf](https://www.uml.edu/docs/10%20Reasons%20for%20Microfiber%20Mops%20052215_tcm18-187539.pdf)
Chapter 6.D. Using Ventilation Technologies to Help Reduce Disease Transmission

Introduction

Contracting an infectious disease is related in part to the number of microbes a person is exposed to. Thus, if the volume of infectious microbes in the air is reduced, so is the risk of contracting a related disease through inhalation. Airborne transmission of diseases can be reduced by proper ventilation and air treatment technologies.

Because microbes attach themselves to particulate matter, this section discusses the use of two ventilation technologies appropriate for use in school buildings to remove bioaerosols. Bioaerosols are biological particles (viruses, bacteria and fungi) about 0.5 to 20 microns in diameter which can stay suspended in the air for an extended period of time and are considered a potential cause of airborne disease.¹

In their position paper on infectious aerosols, ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers)² states that various strategies have been found to be effective to some degree at controlling the transmission of bioaerosols. It is beyond the scope of this document to address those possibilities. Some of these strategies and related mechanicals incur significant capital costs for new HVAC systems, HVAC upgrades, redesign of distribution systems, etc. Due to the status and condition of HVAC and ventilation systems in many older school buildings, these options are not feasible in the short term. Many school buildings do not have any mechanical ventilation systems.

Therefore, this document has focused on possible options for reducing transmission using existing equipment that can possibly be enhanced through the addition of enhanced filtration or an increase in air exchange rates.

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¹ ASHRAE is a global community that focuses on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability within the industry. They set standards for HVAC systems and other forms of technology used to condition the indoor air and address indoor air contaminants.
Infection Control Handbook for Schools

Increasing Air Exchange to Reduce Transmission of Bioaerosols

<table>
<thead>
<tr>
<th>Ventilation Technology</th>
<th>How It Works</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides fresh air supply and dilutes and removes a certain percentage of contaminated indoor air using a general mechanical ventilation system. There are passive ventilation systems in older buildings that circulate the air through intentional (e.g., windows) and unintentional openings (e.g., leaks) in the building envelope. Mechanical systems that condition and move the air through the building mechanically are called Heating, Ventilating and Cooling Systems (HVAC). School buildings often have a mix of systems to bring in and condition outdoor air. Although there are numerous configurations, two of the most common HVAC designs in schools are unit ventilators (UV) and central air-handling units (AHU). Both can perform the same HVAC functions, but a unit ventilator serves a single room while the central air-handling unit serves multiple rooms.</td>
<td>An HVAC system includes an outside air intake; filters; fans; ductwork; air exhaust; and vent diffusers/grilles for proper distribution of the air. Some also have humidity modification mechanisms and heating and cooling equipment. One of the HVAC’s key roles is to exchange and dilute the indoor air by exhausting a certain percentage of it from the building, replenishing that amount with outside air supply, and recirculating it to all spaces served by that system. Please note that recirculation in an AHU can also circulate contaminants that were not completely removed through this process to all of the spaces served on that system. The amount of outside air exchange per hour can be increased to remove more of the contaminants for infection-control purposes. Any increase in the amount of air exhausted needs to be balanced with the air supply to prevent putting the building under negative pressure.</td>
<td>This option enables the existing HVAC system (while it is operating) to be used as is without modifications to the equipment. It can be modified to increase the air exchanges per hour on an “as needed” basis. Thus, this option only incurs operating costs for increased electricity to run the HVAC system and heat and/or cool an additional amount of air. Capital costs are not incurred. Please note that not all school buildings have mechanical systems, or have HVAC systems that are operational, or operate at an optimum level. Also, ASHRAE states: “However, it remains unclear by how much infectious particle loads must be reduced to achieve a measurable reduction in disease transmissions (infectious doses vary widely among different pathogens) and whether these reductions warrant the associated costs (Pantelic and Tham 2011; Pantelic and Tham 2012).”</td>
</tr>
</tbody>
</table>

Chapter 6: Equipment for Infection Control
Illustrations of the Various Types of Systems and Configurations of Systems in School Buildings

Central Air Handling System

Exhaust Only System

Typical School HVAC Design

Source for graphics: EPA Tools for Schools

Note: Buildings with Partial or No Mechanical Ventilation Systems

Buildings that are fully or partially naturally ventilated may use operable windows for providing or supplementing fresh air supply; therefore, their airflow and air exchange is affected by intentional and unintentional openings in the building envelope. The airflow and air distribution patterns in these buildings is variable and unpredictable. Thus, the ability to actively manage risk in such buildings using ventilation is much reduced.

These are circumstances where air treatment systems have been considered.
### Increasing Filtration Levels to Reduce Transmission of Bioaerosols

<table>
<thead>
<tr>
<th><strong>Ventilation Technology</strong></th>
<th><strong>How It Works</strong></th>
<th><strong>Comments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtration, the physical removal of particulates from air, is the first step in achieving acceptable indoor air quality. It is the primary means of cleaning the air.(^3)</td>
<td>Droplets from sneezing, coughing, and talking can dry out and stay suspended in the air. These droplets produce particles ranging in size from 1–5 μm (microns). Filtration is measured by MERV Rating (Minimum Efficiency Reporting Value) established by ASHRAE. The rating uses a scale of 1-16 to represent how effectively the filter traps particles. The higher a rating, the higher the number of particulates the filter traps.</td>
<td>The equipment must be designed to handle a higher-rated filter based on its fan power. Increased filtration increases the resistance to air flow through the filter, requiring the HVAC system to be able to generate a stronger air flow. Many older HVAC systems do not have the capacity to use an optimum level of filtration. If the system cannot handle the higher filtration, it can operate inefficiently and become overworked.</td>
</tr>
</tbody>
</table>

**How to Select a MERV Rating for Filters**

Due to discrepancies in manufacturers’ claims for contaminants the various MERV rated filter can filter out, check the ANSI/ASHRAE Standard 52.2 “Understanding MERV” User Guide created by the National Air Filtration Association (NAFA). NAFA is an international group of air filter distributors, manufacturers and engineers. This Guide, and the application of a particle-based contaminant removal standard prescribed by ANSI/ASHRAE Standard 52.2-2017 “Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size,” are intended to assist end-users and specifiers in their selection of appropriate air filtration products and understanding of the MERV values in the 52.2 test reporting. This information is available at [https://www.nafahq.org/understanding-merv-nafa-users-guide-to-ansi-ashrae-52-2/](https://www.nafahq.org/understanding-merv-nafa-users-guide-to-ansi-ashrae-52-2/).
Below is an example of a chart by a filter manufacturer to illustrate what the various levels of MERV rated filters can do. One note illustrated below is the statement that a MERV 13 rated filter can filter out virus carriers. Other manufacturers claim that you need a MERV rating of 16 to filter out viruses. Viruses range in sizes from 5 to 300 nanometers. ASHRAE states a MERV 13 rated filter is a good choice if the HVAC system can handle a filter this efficient.


The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Position on Increased Filtration

The use of highly efficient particle filtration in centralized HVAC systems reduces the airborne load of infectious particles. This strategy reduces the transport of infectious agents from one area to another when these areas share the same central HVAC system through supply of recirculated air.

When appropriately selected and deployed, single-space high-efficiency filtration units (either ceiling mounted or portable) can be highly effective in reducing/lowering concentrations of infectious aerosols in a single space.

Filtration will not eliminate all risk of transmission of airborne particulates because many other factors besides infectious aerosol concentration contribute to disease transmission.
Research on Ventilation Rates and Reduction in Disease Transmission

A multidisciplinary expert panel reviewed 40 studies conducted between 1960 and 2005 and concluded that higher ventilation rates reduced the transmission and spread of infectious agents in buildings.\textsuperscript{5} In their report, the authors of the report recommended that schools and similar high-density facilities increase their ventilation rates during peak influenza season. Although the authors found that there was strong and sufficient evidence to demonstrate the association between ventilation, air movement in buildings, and the transmission/spread of infectious diseases such as measles, tuberculosis, chickenpox, influenza, smallpox, and severe acute respiratory syndrome (SARS), they found that there was not enough research to specify the ventilation requirements in schools.\textsuperscript{5}

In addition, a controlled study in office buildings found a link between short-term sick leave, often associated with respiratory illness, and low ventilation rates. Occupants of buildings with low ventilation rates and high occupant densities experienced far higher rates of respiratory illness than did occupants of similar buildings with higher ventilation rates.\textsuperscript{6}

ASHRAE Recommendations

ASHRAE leadership has approved the following two statements regarding transmission of SARS-CoV-2 and the operation of HVAC systems during the COVID-19 pandemic.

1. 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.

2. Ventilation and filtration provided by HVACs can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air. Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. In general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus.

In the 4/14/20 Position Document on Infectious Aerosols, ASHRAE notes that “An HVAC system’s impact will depend on source location, strength of the source, distribution of the released aerosol, droplet size, air distribution, temperature, relative humidity, and filtration.”

Project Recommendations

1. Consult with an HVAC Engineer - to obtain an accurate assessment of the building’s current HVAC system capacity and condition, and what the building needs to provide adequate ventilation during normal operating conditions and during pandemic conditions.

2. Consider the following options - to improve indoor air quality in consultation with the HVAC Engineer:

   1. Increase Air Changes Per Hour - To accomplish an increase in air changes per hour (ACH), check the number of air exchanges per hour the current system is programmed for, and determine whether the air exchanges per hour can be increased when needed.\textsuperscript{7} You can view ASHRAE’s most recent Standard 62.1-2019 -- *Ventilation for Acceptable Indoor Air Quality* for free on their website to find recommended ventilation rates for school spaces. Go to
https://www.ashrae.org/technical-resources/standards-and-guidelines to find this standard to review.

2. Increase Filtration Levels:
   
   - Identify the Minimum Efficiency Reporting Value (MERV) rating of the filters, and determine the highest MERV-rated filter that the system can accommodate. The higher the MERV rating, the more it will filter the air.\(^7\)
   


Ventilation Resources for School Districts to Mitigate Transmission of SARS-CoV-2

Overview
The following list of resources and information provides more in-depth information and tools to further help school districts to understand and prevent the transmission of SARS-CoV-2 by assessing and addressing ventilation and air treatments in their buildings.

Resources

- **COVID-19 Guidelines from ASHRAE**
  ASHRAE is considered the industry leader in North America producing the most current COVID-19 guidelines and best practices to prevent indoor transmission of airborne pathogens such as SARS-CoV-2. Latest COVID-19 Workplace Guidance from ASHRAE:
  - Schools and Universities
  - Guidance for Building Operations During the COVID-19 Pandemic
  - ASHRAE Resources Available to Address COVID-19 Concerns

- **“Reducing the Risk of COVID-19 Using Engineering Controls”**
  A seven-page guidance document explains the importance of engineering solutions, such as ventilation to reduce the risk of COVID-19. It provides details on air change rates and high efficiency filtration systems.
  American Industrial Hygiene Association (AIHA) Guidance Document, August 28, 2020

- **“Indoor Ventilation and Reducing Transmission of COVID-19 (SARS-CoV-2)”**
  The fact sheet briefly explains airborne transmission of the virus and use of ventilation and air treatment systems to mitigate transmission of the virus.
  MFL Occupational Health Centre (OHC)
• **Ventilation Checklist (COVID-19)**

  This checklist that follows the NIOSH Hierarchy of Controls and can be used as a guide to assess the suitability of ventilation in the workspace/building that are to be occupied. This checklist references AHSRAE information in addition to other sources.

  Occupational Health Clinic for Ontario Workers.

Overview

Below are links to peer-reviewed evidence-based research on the aerosol transmission of SARS-CoV-2 and indoor ventilation best-practices. Note that some of these articles were written during the time when airborne transmission of SARS-CoV-2 had not yet been verified. They provide excellent information on how the virus is transmitted.

- **It Is Time to Address Airborne Transmission of Coronavirus Disease 2019 (COVID-19).**
  Article was written at the time when the guidance from international and national bodies focused on hand washing, maintaining social distancing, and droplet precautions, and did not recognize airborne transmission except for aerosol-generating procedures performed in healthcare settings. The article appealed to the medical community and national and international bodies recognize the potential for airborne spread of COVID-19.

- **Analysis - Two metres or one: what is the evidence for physical distancing in covid-19?**
  Discusses why rigid safe distancing rules are an oversimplification based on outdated science and experiences of past viruses.
  Nicholas R Jones, Zeshan U Qureshi, Robert J Temple, Jessica P J Larwood, Trisha Greenhalgh, Lydia Bourouiba, BMJ 2020;370:m3223 [https://www.bmj.com/content/bmj/370/bmj.m3223.full.pdf](https://www.bmj.com/content/bmj/370/bmj.m3223.full.pdf)

- **Recognition of aerosol transmission of infectious agents: a commentary.**
  Discusses the concepts and definitions of aerosols and large droplet transmission.

- **Reducing transmission of SARS-CoV-2.**
  Discusses why control measures are important to address the transmission of aerosols.
Videos

- **Airborne Transmission of SARS-CoV-2: A Virtual Workshop.** This Environmental Health Matters Initiative (EHMI) workshop delved into the science on the spread of the virus, as part of a larger body of COVID-19 related work at the National Academies available at [https://www.nationalacademies.org/topics/covid-19-resources](https://www.nationalacademies.org/topics/covid-19-resources).

  Experts from the National Academies of Sciences Engineering Medicine in aerosol science, virology, infectious disease, and epidemiology discussed questions such as:

  - Whether the virus be transmitted through speech and exhaled breath?
  - How long do aerosols containing the virus linger in the air?
  - How far can these aerosols travel?


- **Let’s talk about transmission of respiratory infectious diseases.** This presentation used animation to clearly illustrate aerosol and droplet transmission of SARS-CoV-2, and what types of distances are required to minimize exposures.

  Video Text by Professor. Shelly Miller, University of Colorado Boulder, drawings and editing by Professor Marina Vance, University of Colorado.

  [https://youtu.be/AGQYlrXzVJQ](https://youtu.be/AGQYlrXzVJQ)

- **How Can Airborne Transmission of COVID-19 Indoors be Minimized?** Discusses transmission and technologies to mitigate transmission.

  Video by Shelly L. Miller, Ph.D., Professor of Mechanical Engineering, and faculty in the Environmental Engineering Program at the University of Colorado Boulder.

  [https://youtu.be/jK6Cef5A8FQ](https://youtu.be/jK6Cef5A8FQ)

- **How is COVID-19 Being Transmitted? How and Why Has This Changed Over the Course of This Pandemic?** Chronicles how the knowledge about transmission of the SARS CoV-2 virus has changed since its emergence, and the challenges of communicating the new information and protocols to the global community.

  Kim Prather, Director of The NSF Center for Aerosol Impacts on Chemistry of the Environment, is an Atmospheric Aerosols expert.

  [https://youtu.be/d3ssV9JDE_k](https://youtu.be/d3ssV9JDE_k)
References

1. A. Skinner, Microbes in Air and Bioaerosols presentation, University of North Carolina, School of Public Health, https://slideplayer.com/slide/9353409/


3. CDC, Infection Control Guidelines, section b. Filtration, i. Filter Types and Methods of Filtration, available at https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/air.html#c3b


Sources for some of the ventilation articles are from the MCL Occupational Health Centre, https://ohcmb.ca/ and Dorothy Wigmore, Occupational Hygienist.