



ASHRAE EPIDEMIC TASK FORCE

FILTRATION & DISINFECTION | Updated 10-20-2020



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Facilities/Maintenance – PPE Basics



- [Refer to CDC Guidance on PPE use](#), especially banners at bottom of webpage
- N95 filtering facepiece respirators
 - Protects the wearer from respiratory droplets AND aerosols.
 - Can be an effective tool for worker protection with proper use.
 - Require fit testing and a medical clearance to wear for work.
 - Tested for efficiency against 0.3 micrometer airborne particles.
 - Certified to filter at least 95% of these particles.
 - Generally disposed of after each use, but pandemic has resulted in limited supplies. CDC issued [Strategies to Optimize the Supply of PPE](#)
- Silicone half mask respirators with N95 cartridges (or better) can be used instead of filtering facepiece respirators.



Facilities/Maintenance – PPE Basics



- Eye Protection
 - Safety glasses (side shields preferred)
 - Goggles
 - Face shields
- Disposable Gloves
 - Can be vinyl, rubber or nitrile
 - Double gloves reduces likelihood of cuts/punctures
 - Can be worn under work gloves if necessary
- Disposable coveralls, gowns and/or shoe covers can be worn to enhance overall protection.
- After maintenance activities, wash hands with soap and water or use an alcohol-based hand sanitizer. Change clothes if soiled.

HVAC System Maintenance and Filter Replacement during the COVID-19 Pandemic



- For HVAC systems suspected to be contaminated with SARS-CoV-2, it is not necessary to suspend HVAC system maintenance, including filter changes, but **additional safety precautions are warranted.**
- The risks associated with handling filters contaminated with coronaviruses in ventilation systems under field-use conditions have not been evaluated.
- Workers performing maintenance and/or replacing filters on any ventilation system with the potential for viral contamination should wear appropriate personal protective equipment (PPE):
 - A properly-fitted respirator (N95 or higher)
 - Eye protection (safety glasses, goggles or face shield)
 - Disposable gloves



HVAC System Maintenance and Filter Replacement during the COVID-19 Pandemic



- Consider letting the filter load up further than usual to reduce frequency of filter changes.
 - Don't let pressure drop increase enough to disrupt room pressure differentials.
 - Confirm filters remain snug in their frames.
- When feasible, filters can be disinfected with a 10% bleach solution or another [appropriate disinfectant, approved for use against SARS-CoV-2](#), before removal. Filters (disinfected or not) can be bagged and disposed of in regular trash.
- When maintenance tasks are completed, maintenance personnel should immediately wash their hands with soap and water or use an alcohol-based hand sanitizer.

Modes of Transmission



- SARS-CoV-2, the virus that causes COVID-19, is thought to spread mainly from person-to-person through respiratory droplets and aerosols.
- Infectious respiratory droplets are produced when an infected person coughs or sneezes.
 - Droplets can land in the mouths or noses of nearby people.
 - Droplets can land on surfaces and be spread through contact with contaminated surfaces.
 - When in close contact with an infected person, droplets can be inhaled into the lungs.
- Airborne transmission in some circumstances seems probable. See [ASHRAE Statements on Airborne Transmission](#)
- The SARS-CoV-2 virus may be aerosolized by [flushing the toilet](#).



Airborne Transmission



ASHRAE Statement on airborne transmission of SARS-CoV-2:

- 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 HVAC systems can reduce airborne exposures.

ASHRAE Statement on operation of heating, ventilating and air-conditioning systems to reduce SARS-CoV-2 transmission:

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



Transmission Through Air in Toilet Rooms



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

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



Mechanical Air Filters



- Filters consist of media with porous structures of fibers or stretched membrane material to remove particles from airstreams.
- The fraction of particles removed from air passing through a filter is termed “filter efficiency” and is provided by the Minimum Efficiency Reporting Value (MERV) under standard conditions.
 - MERV ranges from 1 to 16; higher MERV = higher efficiency
 - MERV ≥ 13 (or ISO ePM₁) are efficient at capturing airborne viruses
 - MERV 14 (or ISO equivalent) filters are preferred
 - High efficiency particulate air (HEPA) filters are more efficient than MERV 16 filters.
- Some filters have a static electrical charge applied to the media to increase particle removal. Since the efficiency of these filters often drops off over months of initial use, a MERV-A value, if available, will reflect the actual minimum efficiency better than a standard MERV value.
- Increased filter efficiency generally results in increased pressure drop through the filter. Ensure HVAC systems can handle filter upgrades without negative impacts to pressure differentials and/or air flow rates prior to changing filters.



Mechanical Air Filters



- Increased filter efficiency generally results in increased pressure drop through the filter. Ensure HVAC systems can handle filter upgrades without negative impacts to pressure differentials and/or air flow rates prior to changing filters.
 - [Upgrading and Improving Filtration](#)
 - [Practical Approach to Increase MERV in an AHU](#)
 - [Calculation Approach to Increase MERV in an AHU](#)
- Generally, particles with an aerodynamic diameter around 0.3 μm are most penetrating; efficiency increases above and below this particle size.
- Overall effectiveness of reducing particle concentrations depends on several factors:
 - Filter efficiency
 - Airflow rate through the filter
 - Size of the particles
 - Location of the filter in the HVAC system or room air cleaner

For more information, see the [ASHRAE Position Document on Filtration and Air Cleaning](#).





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

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



ASHRAE MERV vs. ISO 16890 Ratings



Approximate Equivalent Ratings for Filters Tested Under ASHRAE Standard 52.2 (MERV) and ISO 16890

ASHRAE MERV* (Standard 52.2)	ISO 16890 Rating
1-6	ISO Course
7-8	ISO Course >95%
9-10	ePM ₁₀
11-12	ePM _{2.5}
13-16	ePM ₁

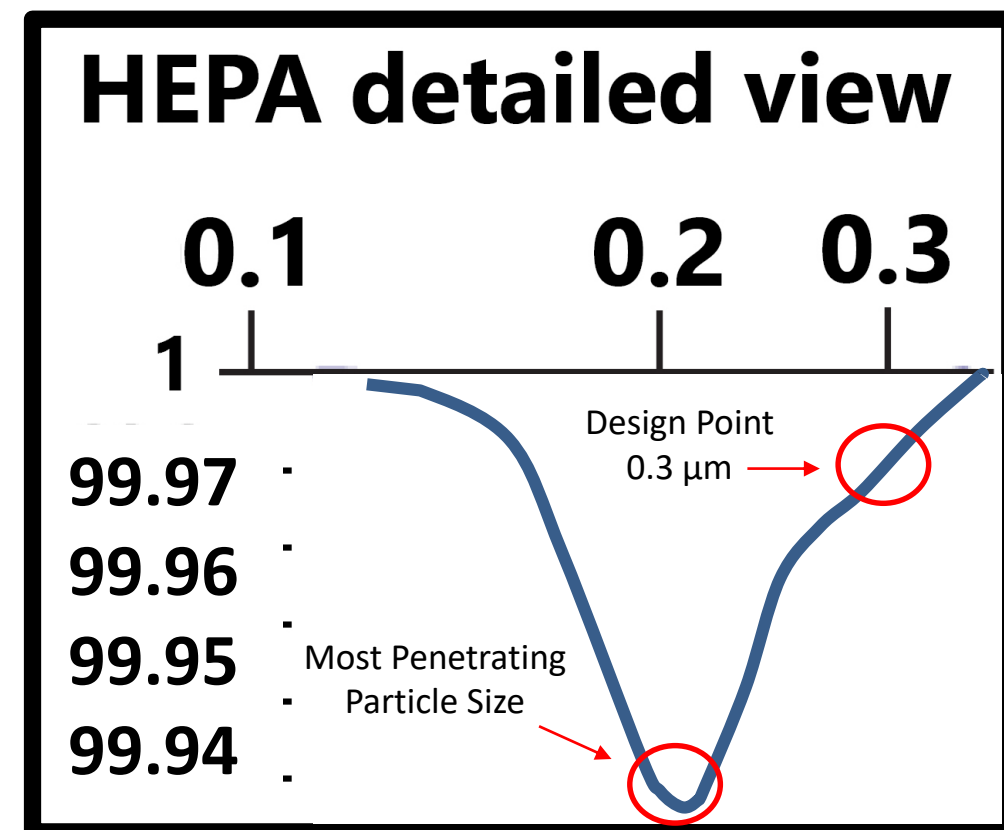
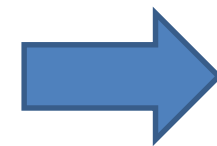
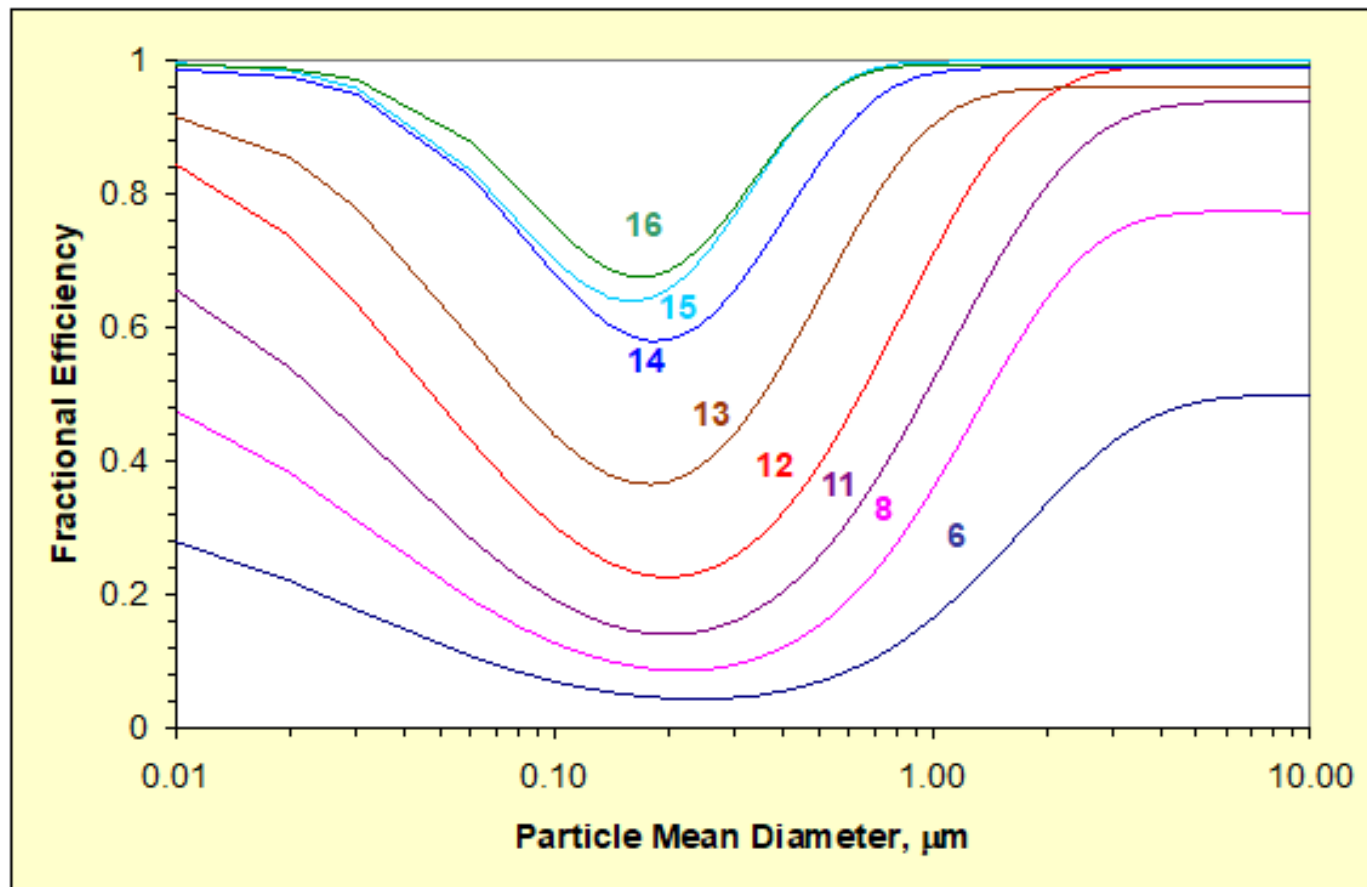
*MERV-A will give closer results. Charged media filters usually show a drop-off in efficiency with use. ISO 16890 captures this with an IPA condition step. ASHRAE 52.2 can capture this drop if the test is done with the optional Appendix J which gives the MERV-A. Thus the MERV and the ePM ratings do not reflect the same testing. For charged media, the MERV will likely make the filter appear more efficient than the ePM rating.



High Efficiency Particulate Air (HEPA) Filters



- By definition, true HEPA filters are at least 99.97% efficient at filtering 0.3 μm mass median diameter (MMD) particles in standard tests.
- Most penetrating particle size may be smaller than 0.3 μm , so filtration efficiency of most penetrating particles can be slightly lower.



Note: Numbers in graph represent MERV values.



High Efficiency Particulate Air (HEPA) Filters



- HEPA filter efficiency is better than MERV 16.
- HEPA filters may not be feasibly be retrofitted into HVAC systems due to high pressure drops and the likelihood that systems will need new filter racks to allow sufficient sealing to prevent filter bypass.
- To function properly, HEPA filters must be sealed properly in filter racks.
- Filters are often delicate and require careful handling to prevent damage and preserve performance.
- HEPA filters can be located in HVAC systems or in:
 - In-Room or Portable HEPA Air Cleaners
 - Pre-Assembled Systems
 - Ad Hoc Assemblies



Electronic Air Filters



- Include a wide variety of electrically-connected air-cleaning devices designed to remove particles from airstreams.
- Removal typically occurs by electrically charging particles using corona wires or by generating ions (e.g., pin ionizers) and:
 - Collecting particles on oppositely charged plates (precipitators, ESP), or
 - Charged particles' enhanced removal by a mechanical air filter, or
 - Charged particles' deposition on room surfaces
- The fraction of particles removed from air by an electronic filter is termed “removal efficiency.”
- Overall effectiveness of reducing particle concentrations depends on:
 - Removal efficiency
 - Airflow rate through the filter
 - Size and number of particles
 - Location of the filter in the HVAC system
 - Maintenance and cleanliness of electronic filter components



Electronic Air Filters



- It is critical to wipe the wires in electrostatic precipitators as silicone buildup reduces efficiency.
- Always follow manufacturer's instructions when using electronic air filters.

For more information, see the [ASHRAE Position Document on Filtration and Air Cleaning](#).



Gas-Phase Air Cleaners



- Gas-phase air cleaners are those used to remove ozone, volatile organic compounds and odors from the air.
- Most contain sorbent materials such as carbon (e.g., activated charcoal).
- While there may be exceptions, most sorbent beds alone are not generally efficient at removing viruses from airstreams.
- Carbon/sorbent impregnated fiber filters will remove particles; check for a MERV rating to show efficiency just as you do with standard particulate filters.

Ultraviolet Energy (UV-C)

- Ultraviolet energy inactivates viral, bacterial and fungal organisms so they are unable to replicate and potentially cause disease.
- The entire UV spectrum is capable of inactivating microorganisms, but UV-C energy (wavelengths of 100 – 280 nm) provides the most germicidal effect with 265 nm being the optimum wavelength.
- The majority of modern UVGI lamps create UV-C energy with an electrical discharge through a low-pressure gas (including mercury vapor) enclosed in a quartz tube, similar to fluorescent lamps.
- Roughly 95% of the energy produced by these lamps is radiated at a near-optimal wavelength of 253.7 nm.
- [UV-C light-emitting diodes \(LEDs\)](#) are emerging for use.
- Types of disinfection systems using UV-C energy:
 - [In-duct air disinfection](#)
 - [Upper-air disinfection](#)
 - [In-duct surface disinfection](#)
 - [Portable room decontamination](#)



Ultraviolet Energy (UV-C)



- Requires special PPE to prevent damage to eyes and/or skin from overexposure.
- The Illuminating Engineering Society (IES) Photobiology Committee published a FAQs on Germicidal Ultraviolet (GUV) specific to the COVID-19 pandemic.

For more information, see the [ASHRAE Position Document on Filtration and Air Cleaning](#).



UV-C LEDs



- Have been common in the UV-A spectrum (315 – 400 nm)
- LEDs are starting to be produced in the 265 nm range
- Efficiency is dramatically less than current low-pressure mercury vapor lamps
- Minimal UV output compared to a low-pressure mercury vapor lamp
- For equal output, UV-C LEDs are more expensive than current low-pressure mercury vapor lamps
- Limited availability; not yet practical for commercial HVAC applications

For more information, see the [FAQs on Germicidal Ultraviolet \(GUV\)](#) published by the Illuminating Engineering Society (IES) Photobiology Committee:



UV-C In-Duct Air Disinfection



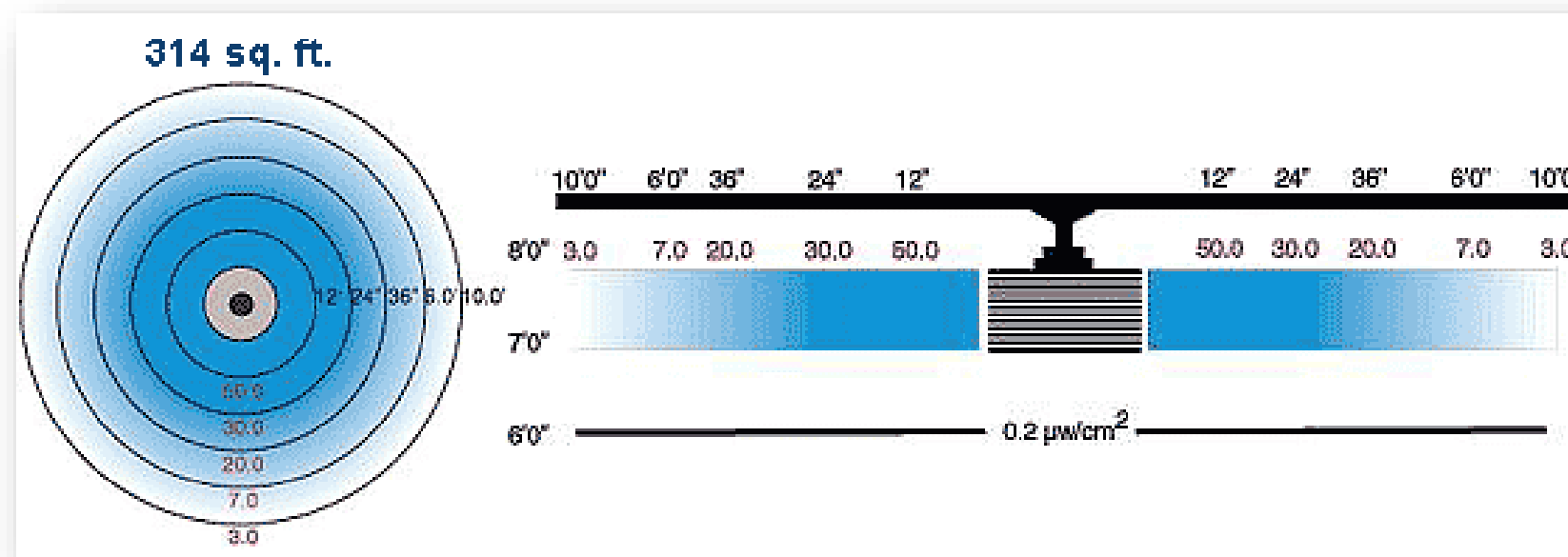
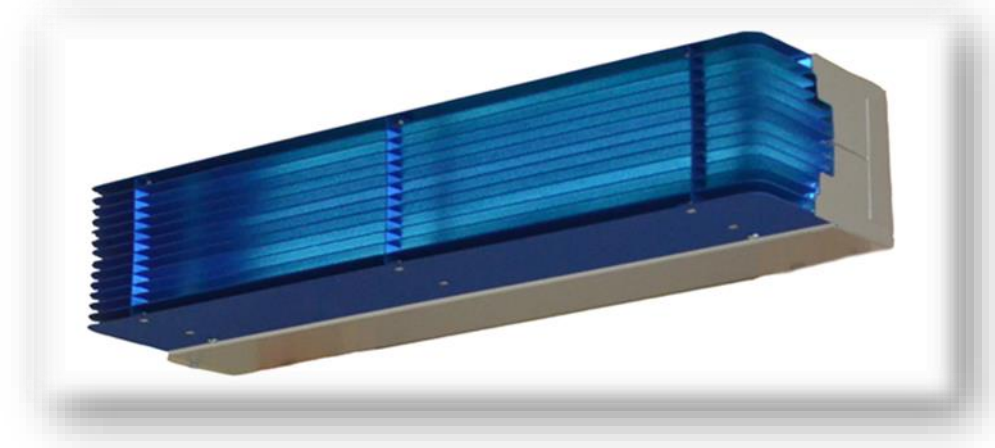
- Banks of UV-Lamps installed inside HVAC systems or associated ductwork
- Requires high UV doses to inactivate microorganisms on-the-fly as they pass through the irradiated zone due to limited exposure time
 - Minimum target UV dose of $1,500 \mu\text{W}\cdot\text{s}/\text{cm}^2$ ($1,500 \mu\text{J}/\text{cm}^2$)
 - Systems typically designed for 500 fpm moving airstream
 - Minimum irradiance zone of two feet
 - Minimum UV exposure time of 0.25 second
- Should always be coupled with mechanical filtration
 - MERV 8 filter for dust control
 - Highest practical MERV filter recommended
 - Enhanced overall air cleaning with increased filter efficiency



UV-C Upper-Air Disinfection



- UV fixtures mounted in occupied spaces at heights of 7 feet and above.
- Consider when:
 - No mechanical ventilation
 - Limited mechanical ventilation
 - Congregate settings and other high-risk areas
 - Economics/other
- Requires low UV-reflectivity of walls and ceilings
- Ventilation should maximize air mixing
- Use supplemental fans where ventilation is insufficient



UV-C In-Duct Surface Disinfection



- Banks of UV-Lamps installed inside HVAC systems, generally focused on:
 - Cooling coils
 - Drain pans
 - Other wetted surfaces
- UV irradiance can be lower than in-duct air disinfection systems due to long exposure times.
- Goals are:
 - Even distribution of UV energy across the coil face
 - Generally, 12 to 36 inches from the coil face
 - Operated 24 hours a day, 7 days a week





UV-C Portable Room Decontamination

- For surface decontamination
- Portable, fully automated units; may use UV-C lamps or Pulsed Xenon technology
- Settings for specific pathogens such as MRSA, *C. difficile*, both of which are harder to inactivate than coronaviruses
 - >99.9% reduction of vegetative bacteria within 15 minutes
 - 99.8% for *C.difficile* spores within 50 minutes

(Rutala et al. 2010)



Photocatalytic Oxidation (PCO) and Dry Hydrogen Peroxide (DHP)



- Consists of a pure or doped metal oxide semiconductor material
 - Most Common Photocatalyst is TiO_2 (titanium dioxide)
- Activated by a UV light source
 - UV-A (400-315nm)
 - UV-C (280-200nm)
 - UV-V (under 200nm) **Ozone can be formed at UV-V wavelengths**
- Light mediated, redox reaction of gases and biological particles absorbed on the surface
- Some units claim disinfection from gaseous hydrogen peroxide (sometimes called dry peroxide)
- Possible by-products formed by incomplete oxidation, including from gaseous contaminants



Photocatalytic Oxidation (PCO)



- Some air cleaners using PCO remove harmful contaminants to levels below limits for reducing health risks set by recognized cognizant authorities.
- Some are ineffective in reducing concentrations significantly; manufacturer data should be considered carefully.

For more information, see the [ASHRAE Position Document on Filtration and Air Cleaning](#).



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



- Air cleaners using reactive ions and/or reactive oxygen species (ROS) have become prevalent during the COVID-19 pandemic. New devices that are not mentioned elsewhere in this guidance likely fall into this category.
- High voltage electrodes create reactive ions in air that react with airborne contaminants, including viruses. The design of the systems can be modified to create mixtures of reactive oxygen species (ROS), ozone, hydroxyl radicals and superoxide anions.
- Systems are reported to range from ineffective to very effective in reducing airborne particulates and acute health symptoms.
- Convincing scientifically-rigorous, peer-reviewed studies do not currently exist on this emerging technology; manufacturer data should be carefully considered.
- Systems may emit ozone, some at high levels. Manufacturers are likely to have ozone generation test data.

For more information, see the [ASHRAE Position Document on Filtration and Air Cleaning](#) and [CDC Response to ASHRAE ETF on Bipolar Ionization](#).





CDC Position on Bipolar Ionization

ASHRAE does not currently have a Society position on bipolar ionization. However, the ASHRAE ETF did reach out to CDC for their position on the technology. The following is the response from CDC in its entirety:

Thank you for your question. Although this was pointed out in the earlier CDC responses, it is important for me to re-emphasize that CDC does not provide recommendations for, or against, any manufacturer or manufacturer's product. While bi-polar ionization has been around for decades, the technology has matured and many of the earlier potential safety concerns are reportedly now resolved. If you are considering the acquisition of bi-polar ionization equipment, you will want to be sure that the equipment meets UL 2998 standard certification (Environmental Claim Validation Procedure (ECVP) for Zero Ozone Emissions from Air Cleaners) which is intended to validate that no harmful levels of ozone are produced. Relative to many other air cleaning or disinfection technologies, needlepoint bi-polar ionization has a less-documented track record in regards to cleaning/disinfecting large and fast volumes of moving air within heating, ventilation, and air conditioning (HVAC) systems. This is not to imply that the technology doesn't work as advertised, only that in the absence of an established body of evidence reflecting proven efficacy under as-used conditions, the technology is still considered by many to be an "emerging technology". As with all emerging technologies, consumers are encouraged to exercise caution and to do their homework. Consumers should research the technology, attempting to match any specific claims against the consumer's intended use. Consumers should request efficacy performance data that quantitatively demonstrates a clear protective benefit under conditions consistent with those for which the consumer is intending to apply the technology. Preferably, the documented performance data under as-used conditions should be available from multiple sources, some of which should be independent, third party sources.



Ozone



- Ozone (O₃) is a reactive gas that can disinfect air and surfaces by killing viruses, bacteria and fungi.
- **Ozone is harmful for health and exposure to ozone creates risk for a variety of symptoms and diseases associated with the respiratory tract.**
- ASHRAE's Environmental Health Committee issued an [emerging issue brief](#) suggesting “safe ozone levels would be lower than 10 ppb” and that “the introduction of ozone to indoor spaces should be reduced to as low as reasonably achievable (ALARA) levels.”
- Should only be considered for disinfection on unoccupied spaces; it should never be used in occupied spaces.
 - Available scientific evidence shows that, at concentrations that do not exceed public health standards, ozone is generally ineffective in controlling indoor air pollution.
 - Reputable cleaning and restoration companies should be used for effective, safe disinfection of unoccupied spaces.



In-Room or Portable Air Cleaners



- Device is located in the room where air cleaning is desired. Place air cleaner where air intake and discharge are not impeded (e.g., not near furniture or behind curtains).
- Air is pulled into the device, and cleaned air is returned to the room. Flexible ductwork can be attached to some devices to allow strategic positioning of intake and/or discharge locations, including discharge outside the room to create pressure differences and/or create clean to less-clean directional airflow.
- Devices may include any or combinations of air cleaning technologies (filters, sorbents, UV, etc.). Users are advised to carefully determine that the application of the technology is appropriate for their need.
- Devices are rated by the Association of Home Appliance Manufacturers.
 - The rate of particle removal from air is termed the Clean Air Delivery Rate (CADR), typically in units of cubic feet per minute (CFM).
 - $CADR \approx \text{airflow rate} \times \text{removal efficiency}$
- To reach a desired air exchange rate in air changes per hour (ACH):

$$ACH = CADR \text{ (cfm)} \times 60 \text{ (min/hr)} \div \text{room volume (ft}^3\text{)}$$



Chemical Disinfectants



- EPA reviews and registers antimicrobial pesticides, which include disinfectants for use on pathogens like SARS-CoV-2.
- **Carefully read product labels and use as directed.**
- Most products have a required contact or dwell time, which is the amount of time a surface must remain wet to kill a certain pathogen.
- Applying a product in a way that does not align with its intended use may render the product less effective.
- Products on EPA List N have not been tested specifically against SARS-CoV-2, however the EPA expects them to kill the virus because they:
 - Demonstrate effectiveness against a harder-to-kill virus; or
 - Demonstrate efficacy against another type of human coronavirus similar to SARS-CoV-2.
- All surface disinfectants on EPA List N can be used to kill viruses on surfaces such as counters and doorknobs.
- Because SARS-CoV-2 is a new virus, this pathogen is not yet readily available for use in commercial laboratory testing of disinfectant product effectiveness at killing that specific virus.



Vaporized Hydrogen Peroxide (VHP)



- Liquid hydrogen peroxide (H_2O_2) is vaporized and the vapor fills the space to disinfect all exposed surfaces.
- Space MUST be unoccupied during VHP treatment.
- Requires spaces to be sealed including all doorways, plumbing/electrical penetrations and HVAC supply and return vents to prevent vapor from escaping.
- After prescribed exposure times, remaining H_2O_2 vapor is scrubbed from space and converted back to oxygen and water before space can be safely reoccupied.
- The effectiveness and safety of VHP when generated inside active HVAC ducts and occupied spaces.
- VHP is hazardous at high concentrations and lengthy exposure is often necessary to inactivate bacteria and viruses in sealed spaces.

Pulsed Xenon (Pulsed UV)



- High-powered UV lamps (generally containing xenon gas) used in rapid pulses of intense energy.
- Emits a broad band of visible and ultraviolet wavelengths, with a significant fraction in the UV-C band.
 - Uses significantly higher power outputs than usual UV-C techniques
 - Inactivates viruses, bacteria and fungi using the same mechanisms as standard UV-C systems
- Typically used for healthcare surface disinfection but can be used in HVAC systems for air and surface disinfection.

For more information, see the [FAQs on Germicidal Ultraviolet \(GUV\)](#) published by the Illuminating Engineering Society (IES) Photobiology Committee.



405 nm Visible Light



- Sometimes referred to a “Near UV,” although not in the UV spectrum.
- Generally integrated into standard room lighting systems.
- Kills bacteria and fungi via different mechanism than UV-C.
 - Targets and excites naturally-occurring porphyrin molecules inside organisms creating reactive oxygen species
 - Reactive oxygen species kill by a mechanism similar to bleach
- **Effectiveness at killing viruses, including SARS-CoV-2, is not as well documented.**
- Provides continuous disinfection of air and exposed surfaces in occupied spaces.
- In the [FAQs on Germicidal Ultraviolet \(GUV\)](#), the Illuminating Engineering Society (IES) Photobiology Committee notes that effectiveness is approximately 1000 times less than UV-C and the effective doses are not practical in an occupied environment.

Far Ultraviolet



- Far UV spectrum is 205 to 230 nm
- Some deactivation of bacteria and viruses at the 207 nm and 222 nm range
- 222 nm said to effectively penetrate microorganisms 1 μ m in size and smaller
- Unable to fully penetrate larger microorganisms
- UV Dose required to inactivate microorganisms is significantly higher at these wavelengths than in the UV-C range
- While safety concerns are reduced, Far UV can still cause damage to eyes and skin

For more information, see the [FAQs on Germicidal Ultraviolet \(GUV\)](#) published by the Illuminating Engineering Society (IES) Photobiology Committee.



Special Precautions



- Exposure to UV-C energy can cause eye and skin damage.
 - Photokeratitis (inflammation of the cornea)
 - Keratoconjunctivitis (inflammation of the ocular lining of the eye)
- Symptoms may not be evident until several hours after exposure and may include an abrupt sensation of sand in the eyes, tearing and eye pain, possibly severe.
 - Symptoms usually appear 6 to 12 hours after UV exposure
 - Symptoms are fully reversible and resolve within 24 to 48 hours
- Maintenance workers should receive special training before working on UV-C systems.
- If exposures are likely to exceed safe levels, special personal protective equipment (PPE) is required for exposed eyes and skin.
 - Eyewear that blocks UV-C energy
 - Clothing, suits or gowns known to be nontransparent to UV-C

Summary



- It is likely, but not yet definitive, that COVID-19 is spread through the air.
- Air cleaning can help mitigate disease transmission.
- Options for air cleaning include:
 - HVAC systems
 - In-Room devices
- Technologies that can be effective include:
 - Mechanical Air Filters
 - Electronic Air Filters/Air Cleaners
 - UV-C Systems
 - Other Emerging Technologies
- Care and professional judgement should be taken to understand choices for filtration and air disinfection, pros and cons of each and impact(s) on existing buildings systems.



Disclaimer



This ASHRAE guidance document is based on the evidence and knowledge available to ASHRAE as of the date of this document. Knowledge regarding transmission of COVID-19 is rapidly evolving. This guidance should be read in conjunction with the relevant government guidance and available research. This material is not a substitute for the advice of a qualified professional. By adopting these recommendations for use, each adopter agrees to accept full responsibility for any personal injury, death, loss, damage or delay arising out of or in connection with their use by or on behalf of such adopter irrespective of the cause or reason therefore and agrees to defend, indemnify and hold harmless ASHRAE, the authors, and others involved in their publication from any and all liability arising out of or in connection with such use as aforesaid and irrespective of any negligence on the part of those indemnified.