Ventilation and filtration provided by heating, ventilating, and air-conditioning systems can reduce the airborne virus concentration and thus the risk of transmission. There are some many things to consider, age and type of air systems, long term planning, and obviously available funding. Big picture there are two things to consider, Filtration (increased air filtration merv 13 or 14 up to Hepa) and Disinfection (UV lights, bi polar ionization, and chemical disinfectant). Rather than replace with new equipment, enhancements to existing systems may be less costly and reduce system down time.

From the CDC

- Increase ventilation rates.
- Ensure ventilation systems operate properly and provide acceptable indoor air quality for the current occupancy level for each space.
- Increase outdoor air ventilation, using caution in highly polluted areas. With a lower occupancy level in the building, this increases the effective dilution ventilation per person.
- Disable demand-controlled ventilation (DCV).
- Further open minimum outdoor air dampers (as high as 100%) to reduce or eliminate recirculation. In mild weather, this will not affect thermal comfort or humidity. However, this may be difficult to do in cold or hot weather.
- Improve central air filtration to the MERV-13 or the highest compatible with the filter rack, and seal edges of the filter to limit bypass.
- Check filters to ensure they are within service life and appropriately installed.
- Keep systems running longer hours, 24/7 if possible, to enhance air exchanges in the building space

Taken from the ASHRAE email links…..

Operate and maintain the HVAC systems

Building owners and service professionals should follow the requirements of ASHRAE Standard 180-2018, Standard Practice for the Inspection and Maintenance of Commercial HVAC Systems which has tables to show the typical maintenance required for equipment that has been in operation. Consider PPE when maintaining ventilation materials including filters, condensate. Consult additional guidance before duct cleaning. Check specifically:

- Dampers, filter, and economizers seals and frames are intact and clean, are functional and are responding to control signals.

- Zone and air temperature, humidity and CO2 system sensors, as applicable, are calibrated and accurately reporting environmental conditions to the BAS or local controllers.
- Air Handling systems are providing adequate airflow, there are no blockages in the duct system (for example – closed fire/smoke dampers) and air from the air handling system is reaching each occupied space.
- Exhaust fans are functional and venting to the outdoors.
- Check outside air intake regularly for any potential risk such as exhaust nearby and provide proper clearance if assessible by pedestrians, etc.
- Update or replace existing HVAC air filtration to a minimum of MERV 13 (MERV 14 preferred) or the highest compatible with the filter rack, and seal edges of the filter to limit bypass. Make sure the air handling systems and fans can overcome the additional pressure drop of the new filters and still maintain air flow at acceptable levels.

Operate and maintain the HVAC system – Air conditioning and ventilation systems

- Continued operation of all systems is recommended.
- Outside air for ventilation be increased to as much as the HVAC system can accommodate and still maintain acceptable indoor conditions during occupied hours.
- Flushing sequence or mode may be implemented to operate the HVAC system with maximum outside airflows for two hours before and after occupied times.
- Systems may be operated at minimum outside air settings when the building is unoccupied or not operating in the flushing mode.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: General information

- For central or floor-by-floor VAV systems that have the capacity to operate with 100% outside air, such as an economizer cycle, close return air dampers and open outdoor air dampers to 100% or to the maximum setting that the HVAC system can accommodate and still maintain acceptable indoor conditions.
- If there are heating and cooling coils to temper the air, it can provide comfort and eliminate recirculation (in the mild weather seasons this will have smaller impacts to energy consumption, thermal comfort, or humidity control, however, using 100% outside can be more difficult in extreme weather conditions).
- Considerations also should be given in areas with dry outside air that may lower the relative humidity to below 40%.
- Prioritize increasing outside air over humidity (see concerns about operating at indoor humidity outside the range of 40%-60%.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: Floor-by-floor

- In floor-by-floor VAV systems that have only minimum outside air damper positions or openings, open outside air damper to its maximum position (the same cautions and concerns stated above apply).
- If outside air is supplied centrally from outside air handling units (typically at mechanical levels) to all floors, and there are unoccupied tenant floors, divert the outside air to the occupied floors.
- Consider changing the floor level VAV air handling units' discharge air temperature setpoint the maximum (typically no higher than 60º F).
- This will cause VAV terminal units (boxes) to open to try and satisfy space cooling loads which will increase the number of air changes in the space being served.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: Heat or energy recovery

- When heat or energy recovery devices such as heat wheels or enthalpy wheels used in air handling systems and DOAS and the systems serves more than one space, care should be taken to determine whether the energy recovery device should remain in operation or be shut down.
- Some energy wheels have the potential of cross contamination between the intake and exhaust air stream.
- Refer to ASHRAE specific guidance on energy recovery device operation during epidemics and pandemics for further guidance.
- Other heat recovery devices that decouple the intake and exhaust air steams such as run around coils, plate heat exchanges, and heat pipes can continue to operate.
- Heat wheels may continue operation if the unit serves only one space.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: Cooling coils

- Cooling coils, heating coils, condensate drain pans, and humidifiers inside air handling equipment can become contaminated.
- Therefore, consider adding UVGI for coil surface and drain pan disinfection are encouraged as it will reduce the needs and frequency for in-person coil surface disinfection.
- These devices and systems should be monitored often and regular and emergency maintenances should continue.
- Provide PPE protection for building operators, maintenance technicians and anyone else who must inspect or come in contact with the device or equipment.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: Operable windows

- In buildings with operable windows, when outside air thermal and humidity conditions and outdoor air quality are acceptable, open windows where appropriate during occupied hours.
- Disabling the interlock between opening windows and air conditioning system lockout or shut down if this feature is provided for in the Building Automation System.
- Monitor indoor spaces for possible contaminants entering through the windows such as toilets exhaust located nearby or for windows assessible to public and high traffic on adjacent streets and walkways.
- Exposure to seasonal and other outdoor allergens (pollen and mold spores) may occur with windows opened.
- Special ductwork cleaning, or, changing filters more often than normal is not necessary.

Heating Water systems:

- Keep heating water systems circulating and maintain temperatures above 140°F to avoid microbial incursion. Do not let water temperature to drop below 120°F.

Operate and maintain the HVAC system - Exhaust systems | Return to Top

- Exhaust system for toilets should run 24/7. Do not open operable windows in toilets.
- Garage exhaust systems should run two hours before occupancy. It is preferred to run garage exhaust systems continuously during occupied hours. Continue to operate garage exhaust systems 2 hours after the building becomes unoccupied. These measures may require disengage the demand ventilation controlled by Carbon Monoxide.
- Other exhaust systems should continue to run as normal. Run exhaust systems 2 hours before and after occupied periods.
- If there are exhaust outlets located in pedestrian areas outside, provide warning signs and consider diverting or rearranging the exhaust air discharge locations so that they would pose no opportunity to cause harm.
- Temporary and Special exhaust systems:
    - Consider installing temporary and special exhaust systems if there are rooms that may accommodate infected people or have the opportunity generate and entrain harmful particulates in the air. Particulates or aerosols should be captured and filtered or disinfected as close to the source as possible. Particulates can possibly be a means where the virus can adhere to become aerosol.

Pressure Control | Return to Top

- Maintain equal pressures on all the floors in multi-floor buildings. Maintain slightly positive pressure as compared to outside in both single story and multistory buildings. Shut off return air to the central air conditioning systems in the spaces where infected people may be present and use exhaust fans discharging air directly to the outside away from outdoor public gathering spaces, outdoor air intakes and operable windows. Consider HEPA filter, or, UVGI lamps with exhaust fan if exhaust can cause harm to public.
- In tall buildings, pressurizing the building will need to take into consideration of stack effect and wind effects. Stack effect direction can be reversed between summer and winter; therefore, settings likely will need to be adjusted throughout the year to maintain the above recommended conditions. To help mitigate stack effect, close all the doors in public areas along the path of least resistance where stack effect is strongest such as at elevator shafts connecting all floors, atriums, open stairs, escalators, etc. to isolate air transfer between floors. Consider providing signage to inform occupants to keep these spaces closed off.
- Tenants and visitors should use revolving doors and properly designed vestibules in buildings that have these types of entrance and exit ways rather than using single swinging doors to enter the building. Caution should be taken when going through air-locks by allowing social distance to “air” the space after the passage of a person. Consider providing signage to inform and direct occupants as to what entrances and exits to use.
- Wind speed and pressure in the upper part of a tall building can be significantly higher than lower levels. Pressure control, especially the upper part of a tall building, needs to consider the wind pressure. Buildings with operable window in mild weather can increase the air changes more in the higher levels.

Elevator Control | Return to Top

1. Turn on elevator cab (lift) ventilation fans, where possible
2. Encourage occupants to take stairs, where possible, especially when elevator lobbies are crowded.
3. Allow elevators to run at high speed to minimize time in elevator.
4. Close elevator lobby vestibule doors, if available.
5. Consider local air treatment devices in frequently used lifts.

Building Automation System and Access Control System Programming | Return to Top

Building Automation Systems:

- Automate the control sequences in this document as a "Epidemic Mode" operation that can be turned on, shut down or override, if needed, by manual selection of the operator.
- Monitor the measures as described in this document and set alerts and notification to provide real time feedback to building operators and maintenance personnel where possible.
- If the building system has sensors for PM 2.5 and PM 10 particulate monitoring setup alerts and notifications to notify tenants when high particulate counts occur.
- Provide remote access to staff and trusted service providers who are responsible for operating and maintain Building Automation Systems, security, access control, information technology, fire alarm and life safety systems. Have written procedures and test remote access and secure access levels and permissions for all individuals prior to an emergency, if possible.
- Monitor and trend indoor humidity if the system has the capability and setup alerts and notifications to building operators and maintenance personnel when conditions occur beyond the recommended range of 40%-60% RH.
    - Consider adding humidity sensors and monitoring if the system can accommodate adding this feature. Consider using local data loggers that monitor temperature and humidity if the BAS cannot. Place loggers in high occupancy spaces such as lobbies, atriums, conference rooms, and spaces deemed critical by facility managers to building function and safety etc.
- For HVAC system that use Demand-controlled ventilation sequences we recommend disabling this feature for the duration of the crisis.
- Regularly check battery backup and generator backup power supplies for BAS, Security, Fire Alarm, Life Safety, Lighting Control, and IT systems and IOT devices that must remain in operation.

Access Control Systems:

- Post signage and communicate to tenants, and post visitors' procedures for entering and leaving the building that will minimize the time spent in public spaces.
- Use touchless assess control system if available and where possible.
- Require and enforce social distancing within public and shared spaces using signage.
- Ensure that workspaces are situated to accommodate social distancing recommendations.

Tony: I've been hearing a lot about air changes and CDC Guidelines. Can you explain the context of this discussion and put it into perspective for our listeners?

Increased outside air and higher air exchange rates in buildings will help to dilute the indoor contaminants, including viral particles, from air that is breathed within buildings. Increasing air change rates without increasing outdoor air may potentially increase transmission. The CDC states that with 6 air changes in a patient room 99% of air contaminates will be removed in 46-69 minutes, increase to 12 air changes per hour 99% of the airborne contaminates are removed in 23-35 minutes.

Tony and/or Athene: What about tenants? What kind of power or control do they have over building systems if they lease space?
According to ashrae, social distancing, surface cleaning and disinfection, handwashing and other good hygiene strategies are more important than anything related to HVAC systems.

Athene: Tell us a little bit about MA Bio and the facility that you have just finished constructing – would you have designed your systems or the space differently had you known we were going to be dealing with this pandemic?

Athene: In what ways are you treating the varied programmatic spaces within your facility different – if you are at all?

Tony: Let's discuss techniques for limiting the spread of Covid-19. I want to specifically touch on Filtration, Irradiation (also known as Ultraviolet light), and Thermal.

From ashrae……..i'll go through systems also

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
- 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.

Mechanical Air Filters

- Consist of media with porous structures of fibers or stretched membrane material to remove particles from airstreams.
- Some filters have a static electrical charge applied to the media to increase particle removal.
- 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 equivalent) 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.
- 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.
- 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
- 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.

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.

- HEPA filter efficiency is better than MERV 16.
- Due to high pressure drops, HEPA filters may not be able to be retrofitted into HVAC systems.
- 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:
    - Portable HEPA Machines
    - 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),or
    - Charged particles' enhanced removal by a mechanical air filter, or
    - Charged particles' deposition on room surfaces.
- The fraction of particles removed from air passing through an electronic filter is termed "removal efficiency."
    - For portable, self-contained electronic filters, the rate of particle removal from air is termed the Clean Air Delivery Rate (CADR).
    - CADR ≈ airflow rate × 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 or room air cleaner
    - Maintenance and cleanliness of electronic filter components
- 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).
- Alone, sorbent beds are NOT efficient at removing particles (including 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
- Requires special PPE to prevent damage to eyes and/or skin from overexposure.
- The Illuminating Engineering Society (IES) Photobiology Committee published a FAQ 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 FAQ 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.
    - 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

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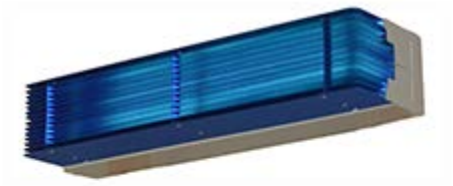
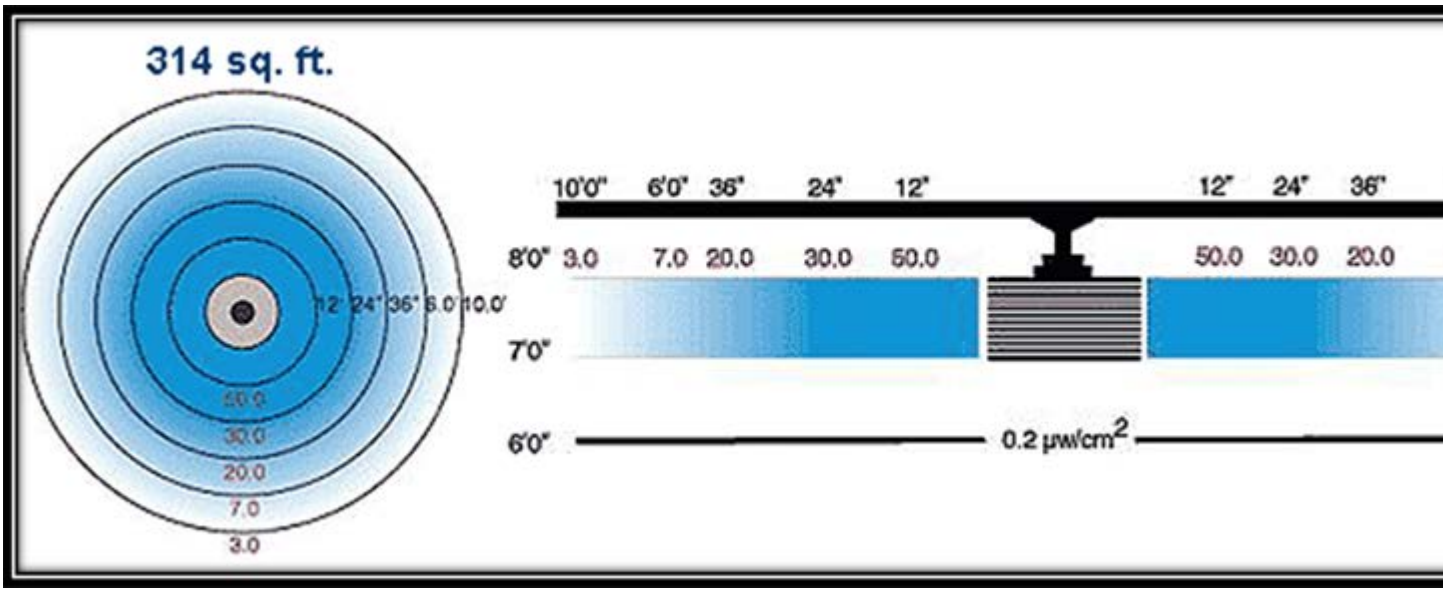
UV-C Upper-Air Disinfection



- 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



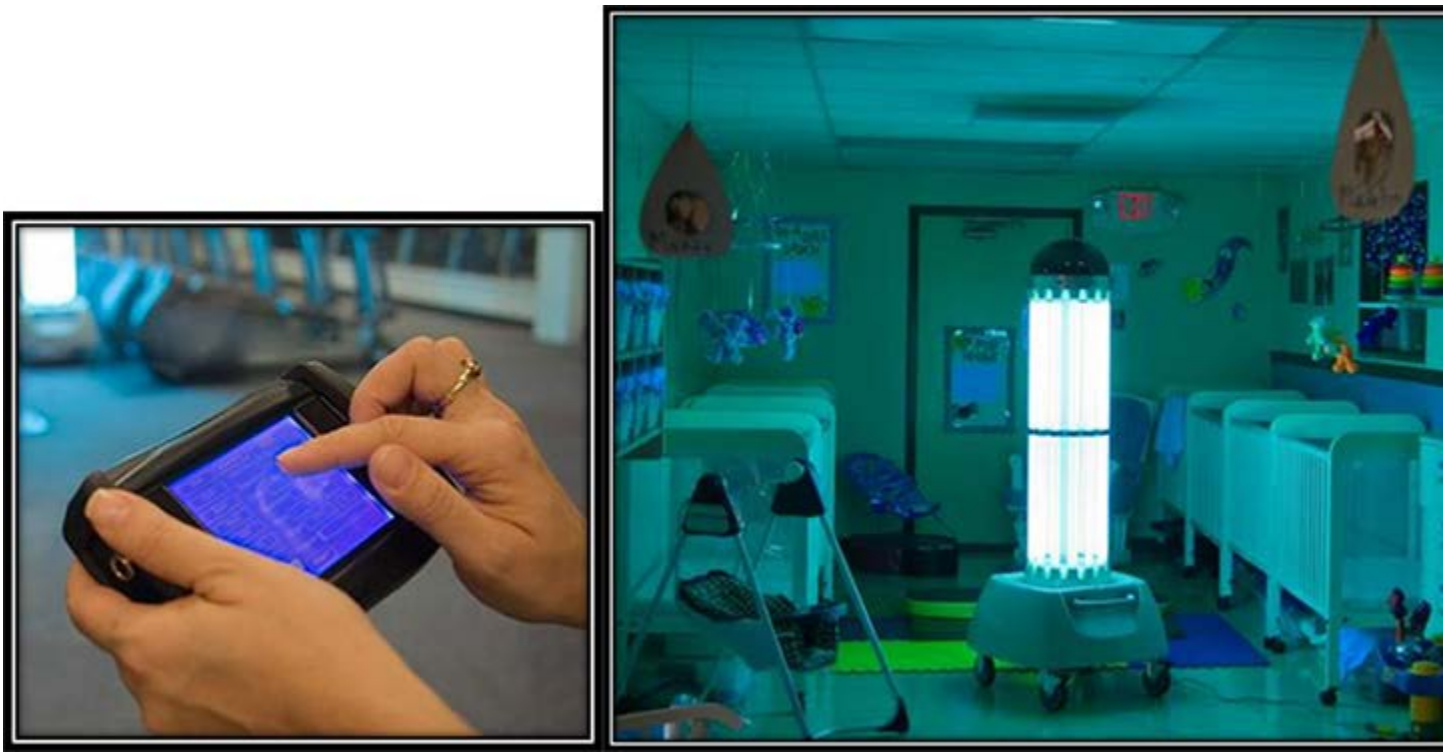
UV-C In-Duct Surface Disinfection

- 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 24/7

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)

- Consists of a pure or doped metal oxide semiconductor material
    - Most Common Photocatalyst is Ti02 (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.
- Possible by-products formed by incomplete oxidizing.
- 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

- High voltage electrodes create reactive ions in air that react with airborne contaminants, including viruses.
- The design of the corona discharge system 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.

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.

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 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 (H2O2) 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 H2O2 vapor is scrubbed from space and converted ack 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 has not been rigorously studied.
- 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 brand of visible and ultraviolet wavelengths, with a significant fraction in the UV-C band.
    - Uses significantly higher power outputs that 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 FAQ on Germicidal Ultraviolet (GUV) published by the Illuminating Engineering Society (IES) Photobiology Committee.

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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 1µm 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, 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 shown, that COVID19 could be 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.

Athene: I know you have had some past experience with Ultraviolet light. Could you share that with us and your thoughts about its use in this application?

Tony: At Elaine Construction, in a lot of the work we do, we utilize HEPA filters to mitigate the spread of construction dust. Is this something that tenants could employ to minimize the spread of the virus? If so, do we need special guidelines for their removal and disposal to protect the service professional from exposure?

- Yes single room high efficiency filtration units can be highly effective in reducing/lowering concentrations of infectious aerosols in a single space. The also achieve directional airflow source control meaning the can move air away from individuals. An option may be a portable HEPA filter unit with integrated UV lights.

Athene: You have full time employees as well as visitors that come to MA Bio's space regularly. Have either or both expressed concerns about returning to the space as it relates to HVAC, and how are you approaching it?

Tony and Athene: Is there anything that I didn't ask of you both that you think is critical for our listeners to consider as they prepare to invite employees back into their offices?

I am open to adding questions, deleting questions or refining any that I have provided here.
You won't hurt my feelings – you are both the experts.

I look forward to hearing back from you.

Best,

Jackie