Broaddus & Associates

COVID-19 RESOURCES

Post-COVID-19 Resilient-Resistant Workplaces

As society and the economy move from the Stand-down phase to Re-start and eventually to Recover and ultimately into the Thriving phase, how will resilient leaders and organizations transform themselves and their work environments? How will they ensure the safety of their employees and customers? How can they build Trust and improve the WorkPlace making it more Resilient and Resistant to bacteria and virus?

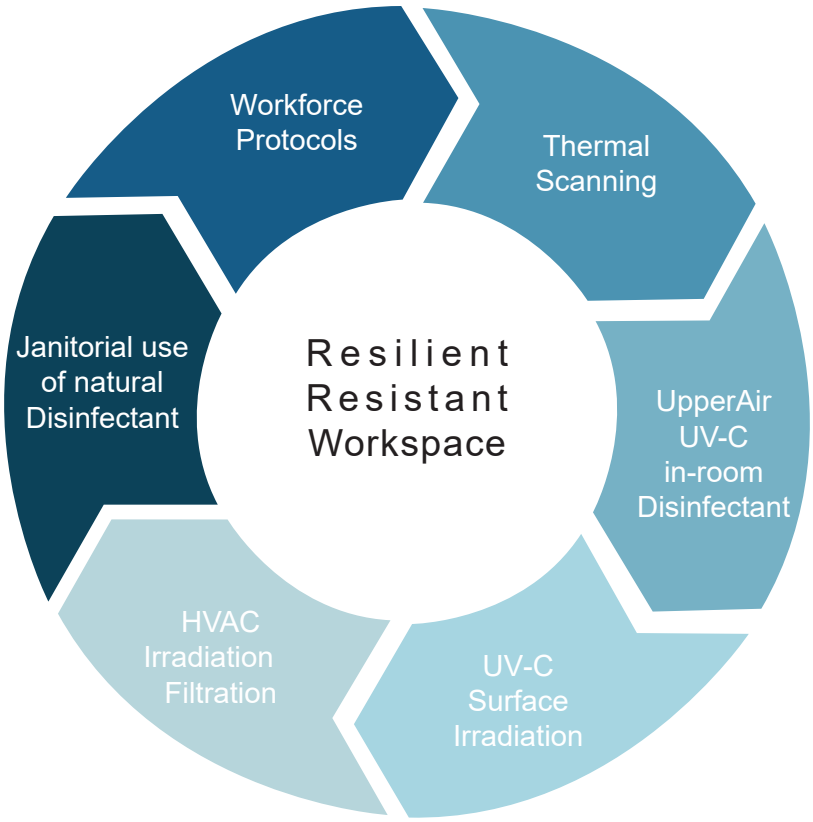
Thankfully, there are established technologies that have been used for decades by hospitals, bio-research laboratories, and the government that have proven to be effective at killing viruses.

Broaddus & Associates can facilitate these improvements to your workplace environment, buildings and facilities by make them more Resilient and Resistant. A Resilient-Resistant Workspace (or facility) is safer and helps build trust with both employees and customers by showing their well-being remains the top priority. As a result, places of business can move from the Recover phase to Thriving more quickly (and possibly ahead of the competition).

Broaddus & Associates has 20 years of experience consulting and working with leading hospitals, academic healthcare facilities, and biological research laboratories to build and improve safe working environments. The science of building facilities to control the spread of infectious diseases has been successfully tested and used for decades in healthcare, bio-research and government facilities. These technologies can be leveraged to build a multi-layered defense for your workplace resulting in a Resilient-Resistant Workplace.

We can advise your teams, bring industry best practices, and quickly deliver turn-key solutions to make your office and facilities Resilient and Resistant against biological threats now and ready for the Re-Start and Recover phases.

A **Resilient-Resistant Workplace** combines multiple technologies, practices, and products in a multi-layered approach. These layers are described below, and include resources to remotely monitor individuals' temperatures, sanitized air systems, UV-C Germicidal lights, Photohydorionization-(safe active disinfecting air), and safer FDA approved healthcare grade disinfectants and cleaners effective against COVID type viruses, bacteria and fungi.



Layer 1: A comprehensive, multilayered defense approach begins with you, your team and your personnel protocols, including virtual work and occupancy policies.
Layer 2: Thermal testing and cameras to check individual temperatures.
Layer 3: Active and passive UV-C Disinfected Upper Air Systems with hydro-ionization technology.
Layer 4: Active and passive In-duct Air filtration and UV-C disinfection systems with hydro-ionization systems. **Layer 5:** Direct UV-C Germicidal light and disinfectant systems (mobile, handheld, and robotic).
Layer 6: New infrastructure options, including automatic doors, voice activated elevators, motion sensor sinks, sanitizer dispensers, to germicidal floors and desks.
Layer 7: Safe and effective FDA approved natural disinfectants and cleaners.

Combine these multi-layered approaches to deliver a Resilient-Resistant Facilities Workplace solution. These approaches have been used for years in hospitals and research laboratories for infectious disease control and can be safely, effectively and affordably applied to the corporate office place.

Our team of engineers and architects can help tailor the right layered facilities solutions for your office and work place. Resilient-Resistant facilities make employees feel more comfortable returning to a workplace environment.

Resilient-Resistant Workspace Layers

Layer 1: Workforce protocols are generally centered around CDC protocols and are well documented at this point (ex. if sick stay at home; wash hands frequently; use sanitizer, social distancing, etc.). Other employer sponsored measures could include providing all employees with masks and sanitizer.

Layer 2: Thermal Imaging Devices can read body temperatures from a distance of 6 feet or more, thus limiting the amount of personal contact needed for testing. Placed at building entrances, all employees and visitors would receive a reading as they arrive at the workspace.

Layer 3: Upper Air In-Room systems treat air in the room with UV-C light. The clean air circulates down, and infected air floats up and is killed by the UV light. These can also include active ionization systems that kill germs all over the room, and with in 3

Thermal imaging cameras like these are used at Memorial Hermann Hospital in Houston to check temperatures. B&A has worked at MMHS since 2008.

Layer 4: In-Duct systems use UV-C and Fresh Air to Kill Virus. Per the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), there are four primary methods of reducing airborne infectious agents in the duct systems: 1. Dilution, 2. Filtration, 3. Pressurization and 4. Disinfection.

- Dilution of the air stream involves bringing in more outside fresh air into the HVAC system.
- Filtration uses advanced highly efficient HEPA filters to capture the contaminants and includes UV-C light to disinfect HVAC coils and system air.
- Pressurization uses positive or negative pressures to contain and move primary air and makeup air around as desired.
- Disinfection involves Ionization and uses UV-C energy combined with naturally occurring compounds to create disinfecting oxidized radials that kill viruses throughout the room.

Layer 5: Direct UV-C light surface Disinfection. Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses short-wavelength ultraviolet light (UV-C), which has been used by infection control professionals for decades. CDC Guidelines recommend its use as an engineering tool to help mitigate the spread of infection.

Layer 6: New Infrastructure such as anti-microbial flooring systems and counter-tops, automated doors, and motion activated sinks and other items that can be installed in high use areas.

Layer 7: Natural Disinfectant and Cleaners that kill COVID-19 and are FDA approved as human and food safe. Some, like the R-water system, allow owners to make their own disinfectant and cleaners safely at the office with no chemicals.

Please contact Scot Sanders,PE,CEM, Region Vice President; ssanders@broaddususa.com; Broaddus & Associates for questions and visit www.Broaddususa.com

Broaddus & Associates Credentials

- $12B in managed Capital Improvement Projects
- $7B in managed hospitals, academic health, and research programs
- 19 Hospitals served
- 12 Research Laboratories, including 5 BSL-level facilities
- Service to every Public Higher Education System in Texas, and 5 of the 7 largest private universities

Airborne Viruses Airstream Disinfection

As our workforce returns to shared workspace, several relevant questions should be addressed in understanding the effect of the virus in this environment:

1. Can COVID-19 spread through HVAC ducts?
2. Can UV light mitigate the spread of airborne viruses?
3. Does UV-C kill the COVID-19 Coronavirus?
4. What is Active Ionization and how does it kill viruses?

1. Can COVID-19 (or other viruses) spread through HVAC ducts?

"Transmission of SARS-CoV-2 (COVID-19) 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."

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

Based on the information available from authorities, corona-viruses can be transmitted via air and direct contact. Researchers have found the COVID-19 virus can live in the air for several hours and, on some surfaces, for as long as two to three days. Therefore, HVAC systems could inadvertently broadcast the infection and amplify its spread. Facility managers should consider employing both upper-air UV, in-duct /coil HVAC germicidal fixtures, and germicidal Ionization technologies to ensure the greatest mitigation practical for controlling microbes and airborne microorganisms in communal spaces.

UV-C's ability to decontaminate the air flowing through a building's HVAC system can be most beneficial where communicable diseases are more common, such as office buildings, schools, healthcare settings, municipal offices, etc. An improperly maintained HVAC system in these environments can promote disease transmission as it recirculates those same germs throughout the building. Conversely, installing UV lamps, with their ability to destroy airborne viruses, bacteria and mold spores, can prevent disease transmission and/or cross-contamination.

https://www.cdc.gov/niosh/docs/2009-105/pdfs/2009-105.pdf?id=10.26616/NIOSHPUB2009105

2. Can UV light mitigate the spread of airborne viruses?

"The entire ultraviolet (UV) spectrum can kill or inactivate microorganisms, but UV-C energy (in the wavelengths from 200 to 280 nm) provides the most germicidal effect, with 265 nm being the optimum wavelength.

The majority of modern UVGI (UV-C) lamps create UV-C energy at a near-optimum 254 nm wavelength. UVGI inactivates microorganisms by damaging the structure of nucleic acids and proteins with the effectiveness dependent upon the UV dose and the susceptibility of the microorganism. The safety of UV-C is well known. It does not penetrate deeply into human tissue, but it can penetrate the very outer surfaces of the eyes and skin, with the eyes being most susceptible to damage."

ASHRAE Position Document on Infectious Aerosols 2020

https://www.ashrae.org/File%20Library/About/Position%20Documents/Airborne-Infectious-Diseases.pdf

A safe option for using UV-C technology in occupied space is "upper-room germicidal ultraviolet (GUV). In this application, UV-C fixtures are used to continuously irradiate the air above 7 feet from the floor. This application boosts the amount of air that is being sanitized in the occupied room. An Illuminating Engineering Society report on GUV says that in two studies, upper-room GUV was shown to be "80 percent effective against tuberculosis (TB) spread." Work above 7 ft in the room must be completed with the system off.

https://www.facilitiesnet.com/hvac/tip/Ultraviolet-Light-Kills-Coronavirus-But-Caution-Required--46065

Germicidal UV-C lamps can be used in ceiling fixtures suspended above the people in a room, or within air ducts of re-circulating systems. The first method is called Upper Air Irradiation. The fixtures are shielded on the bottom so that the radiation is directed only up toward the ceiling and out the sides. These upper-air germicidal fixtures are mounted at least 7ft. above the floor so that people will not bump into them or look directly at the lamps.

Coil Irradiation / Airstream Disenfenction

In-Duct UV-C systems, another method of air disinfection uses UV-C lamps placed inside the ventilation system ducts. If a ceiling is too low for an upper-air irradiation fixture, an in-duct germicidal fixture can be used. Also, because people are not exposed to the UV-C radiation, very high levels can be used inside the ducts.

3. Does UV-C Light kill the COVID-19 Coronavirus?

Since the 1940's, upper-air ultraviolet light has been an effective tool in reducing airborne disease transmission and is recommended by CDC. In addition, Germicidal UV-C lamps kill up to 99.9% of most viruses, airborne bacteria and mold spores.

Upper-room germicidal UV-C fixtures—ideal for infection control—work by interrupting the transmission of airborne infectious diseases in high traffic areas such as healthcare emergency rooms, patient waiting areas, surgical suites, as well as communal areas such as cafeterias, classrooms and churches. As convection or mechanical air currents lift airborne infectious agents into a room's upper-air, they are exposed to UV-C irradiation, which breaks the bacteria or virus DNA chain and renders it incapable of replicating and killing it. Operating 24/7/365, upper-room germicidal fixtures can inactivate microbes in under a second including measles, mumps, TB and cold viruses.

Kill ratios of up to 99.9% on a first-pass basis have been modeled and concentrations are further reduced by each subsequent pass of recirculated air ("multiple dosing").

While studies on COVID-19 are limited, one study recently published shows UV disinfection technology has been proven to deactivate the SARS-CoV-2 virus (also known as COVID-19). The UV-C system was validated against the live (not surrogate) SARS-CoV-2 virus at the Texas Biomedical Research Institute in the biosafety level 4 (BSL-4) containment laboratory, which is used to study deadly pathogens for which there are no known treatments or vaccines.

https://xenex.com/resources/news/xenex-lightstrike-robot-destroys-sars-cov-2-coronavirus-in-2-minutes/

The exceptional results showed a 99.99% reduction in pathogen load in 2 minutes at 1 meter for hard surfaces and 5 minutes for N95 respirator masks. More studies are in the works, but all indications are that they will affirm current, published studies.

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4. Active Ionization of the supply airstream.

This technology discovered by Sandia National Labs in the 1980's introduces hydro-ionized radial hydroperoxides into the supply air, mimicking one of nature's cleaning methods. Hydroperoxides are created in our atmosphere whenever three components are present: oxygen molecules, water vapor and energy (electromagnetic). Though not tested against the COVID-19 virus yet, this technology has been shown effective against other corona viruses, and a wide variety of bacteria.

Ionized-Hydro-Peroxides™ are very effective at destroying harmful microbials in the air and on surfaces. As oxidants, they do this by either destroying the microbe through a process known as cell lysing or by changing its molecular structure and rendering it harmless (which is typically the case in VOC's and odors). The amount of hydroperoxides required to accomplish this task in a conditioned space is below the level that is constantly in our outside air. The Advanced Oxidation technology has brought the oxidants found in the outside air into the indoor conditioned air. One of the best features of Ionized-Hydro-Peroxides™ is that as they settle out of the air, they disinfect surfaces. This was validated in a Kansas State University Bio Chamber on stainless steel surfaces, resulting in a 99+% kill on numerous viruses and bacteria.

There is no known case of hydroperoxides ever creating a health risk. Considering we have been exposed to hydroperoxides in nature since the day man stepped on the planet, it is a reasonable assumption that hydroperoxides do not constitute a health risk and have been used for over 25 years with no adverse effects.

Partial List of University Test Results

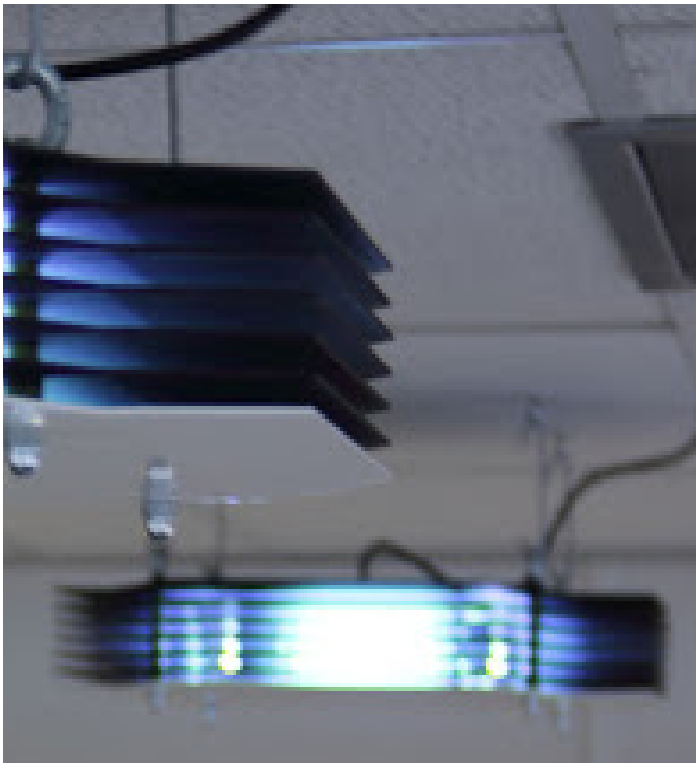
- Avian Influenza (Bird Flu)*
- Norwalk Virus*
- Pseudomonas Sp.*
- MRSA Bacteria*
- Listeria*
- E.coli*
- Staph*
- Strep*
- Stachybotrys chartarum*
- Candida*
- H1N1 Swine Flu

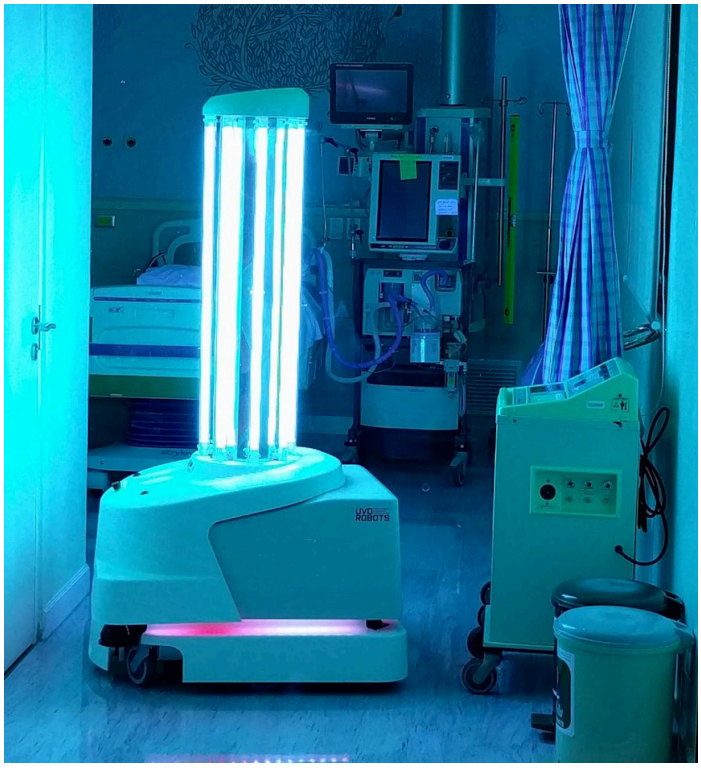
These Active Systems are used in conjunction with UV-C upper-air or In-duct Passive Systems to treat the air throughout the room continuously. Passive systems treat the air only at the location of the light. Active systems treat all of the air in the space. This video shows how an active system works. https://www.youtube.com/watch?v=Ke54GtDaarQ . Together these systems along with direct UV-C surface disinfectants will provide an effective Resilient-Resistant Facility.

Environmentally Safe

Is this ionization process safe? When the oxidation is complete, unused oxides convert back to H20 and O2 within 15 minutes with no chemical residue or additional decontamination. This makes the ionization technologies one of the most environmentally friendly air purifier methods on the market. The purification process constantly occurs in nature and has been used in thousands of HVAC installations with no known health risks. Independent safety tests performed on hydroperoxide gas molecules have shown concentrations of 0.01 ppm are an effective infection control and microbial threat agent. Government safety guidelines on hydroperoxide gas state that 1 ppm is the maximum allowable limit of concentration, therefore 0.02 ppm is 1/50th or well below the government safety limit. Testing of hydroperoxide generators showed:

- Hydro-Peroxides outdoor level – 0.01
- Hydro-Peroxides inside unit off – 0.00
- Hydro-Peroxides inside unit on – 0.01





Upper Air In-Room systems and mobile UV-C carts treat air in the room with UV-C light

Ozone levels have also been tested over 6 consecutive days, including sunny and rainy days. Levels of Ozone ranged from 0.01 to 0.02 ppm. Levels inside the tested area were comparable to outside levels. Levels of 0.02 are considered very low.

Ionized hydro peroxide purifiers rapidly destroy bacteria, virus, VOCs and odors. Independent studies by labs and universities confirmed following results:

- 99.99% reduction in surface bacteria/virus
- Over 80% VOC reduction
- 97% airborne bacterial reduction
- 99% reductions of E-Coli, Listeria, Strep and Bird Flu
- 85% odor reduction
- 97% airborne mold reduction
- US Military approved for mold protection in field hospitals
- Hospital approvals Infectious Diseases – U.S. and International 99% reduction of Staph (MRSA)
- 99% food surface microbial reduction
- Tested and approved by the Chinese Government for protection against the SARS virus
- Approved by the USDA, FSIS and FDA for use in food processing

Together these proven healthcare and bio-research industry technologies can be combined to create a layered safe Resilient-Resistant Facility. These technologies and products are widely available in both mobile applications and as installed applications. Companies can phase in the use of these technologies to meet their budget and operational goals.

Industry Published Research and ASHRAE Standards. This is proven Technology has been used in Hospitals and BSL labs for years.

Technologies such as hydro-ionizations exist now that can actively disinfect the air in your building and kill covid19 within 3 ft of a sneeze. And UV-C germicidal lights have been proven effective in killing CoV2. These 2 technologies when used together can make your office, workplace, school safer now, so you can return to work.

ASHRAE Ultraviolet papers and Timeline

- 2005 -TG 2.UVAS created at the ASHRAE- Winter Meeting 2005
- TG2.UVAS Scope – TG2.UVAS is concerned with all aspects of equipment and systems that utilize ultraviolet radiation to destroy or de-activate chemical and/or biological air and surface contaminants in HVAC systems and indoor spaces, including, but not limited to, effectiveness, safety, maintenance, and economics.
- 2006 - TG 2.UVAS was turned into a full Technical Committee (TC-2.9)-Ultraviolet Air & Surface Treatment (same scope as TG2.UVAS)

https://www.ashrae.org/standards-research--technology/technical-committees/section-2-0-environmental-quality/tc-2-9--ultraviolet-air-and-surface-treatment

- 2006 - SPC-185.1 was formed -Method of Testing UV-C Lights for Use in Air Handling Units or Air Ducts to Inactivate Airborne Microorganisms

https://www.ashrae.org/standards-research--technology/standards--guidelines/titles-purposes-and-scopes#SPC185-1P

- 2007- SPC-185.2 was formed -Method of Testing Ultraviolet Lamps for Use in HVAC&R Units or Air Ducts on Irradiated Surfaces.

https://www.ashrae.org/standards-research--technology/standards--guidelines/titles-purposes-and-scopes#Std185-2

- 2008 - ASHRAE Fundamentals Handbook Published, Chapter 16; ULTRAVIOLET LAMP SYSTEMS
- 2009 – ASHRAE Board of Directors publishes a position paper on Airborne Infectious Diseases, Highlights upper Room UV-C and in-duct UV as top research priorities.
- 2011 – SPC-185.1 goes out for first public review.
- 2011 – ASHRAE HVAC Applications Handbook Published; Chapter 60; ULTRAVIOLET AIR AND SURFACE TREATMENT

https://www.ashrae.org/resources--publications/description-of-the-2011-ashrae-handbook-hvac-applications

- 2012 – ASHRAE Handbook-HVAC Systems and Equipment (updated from 2008 handbook); Chapter 17; ULTRAVIOLET LAMP SYSTEMS

https://www.ashrae.org/resources--publications/description-of-the-2012-ashrae-handbook-hvac-systems-and-equipment

- 2012 – ASHRAE Position Document on Health Effects of Air Cleaning Devices committee started.
- 2013 – SPC-185.2 goes out for first public review.
- 2013 – SPC-185.1 goes out for second public review
- 2014 ANSI/ASHRAE Standard 185.2-2014 – Becomes a Published Standard. Method of Testing Ultraviolet Lamps for Use in HVAC&R Units or Air Ducts to Inactivate Microorganisms on Irradiated Surfaces.

http://www.techstreet.com/ashrae/products/1881838

- 2014 - ASHRAE Board of Directors updates a position paper on Airborne Infectious Diseases, ranks Upper Air UVGI as number highest priority.

https://www.ashrae.org/about-ashrae/position-documents

- 2014 – GPC-37P- Guidelines for the Application of Upper-Air (Upper Room) Ultraviolet Germicidal (UV-C) Devices to Control the Transmission of Airborne Pathogens Committee formed.

https://www.ashrae.org/standards-research--technology/standards--guidelines/titles-purposes-and-scopes#gpc37p

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We exist to advocate for owners and
dramatically improve the building process