By Tim Kridel, Freelance Writer

BUG ZAPPERS

COVID-19 spurred demand and budgets for disinfection technologies in classrooms, offices, and other public spaces. That's creating opportunities for ultraviolet lighting, which could get an additional boost from new standards.

By the time you read this, the World Health Organization (WHO) might have officially declared COVID-19 endemic. Or maybe yet another variant has emerged to keep the pandemic going. Either way, one thing is certain: COVID has triggered a long-term change in how and why schools, hospitals, businesses, and other organizations disinfect their buildings and the air inside. Those changes create opportunities for the electrical industry, starting with disinfection lighting.

"The COVID-19 pandemic has dramatically spurred awareness and is defining a 'new normal' focused on indoor air quality and indoor health," says Travis Jones, vice president and general manager at Pittsburgh-based Wesco International. "As we move forward, there are other air and surface quality hazards — such as mold, influenza, E-coli, and salmonella — that still cause millions of occupants to suffer."

Electric UV lamps are often used in industrial, commercial, and industrial settings for sterilization and disinfection purposes.

Disinfection lighting covers a variety of technologies and use cases, including ultraviolet germicidal irradiation (UVGI), which is used to disinfect the air or surfaces such as desktops. Water also is a big market, says Mike Krames, president of Arkesso, a consultancy specializing in LED technologies. Like lighting for illumination, UVGI is available in incandescent and solid-state versions. The research analyst firm IHS predicts that the germicidal LED (GLED) segment alone will be worth over $5 billion by 2024. Just to put that into perspective: In 2019 (before the pandemic), it forecast just $150 million over the same period.

BROAD-SPECTRUM BUSINESS CASE

That hockey stick growth is even more impressive in light of how long UVGI has languished as a niche play. Since the 1950s, it's been used mainly to neutralize tuberculosis (TB) — an application that's become the foundation for Centers for Disease Control and Prevention (CDC) and National Institute for Occupational Safety and Health (NIOSH) guidance for the design, installation, testing, and safe operation of "upper-room" UVGI systems. Read more at https://bit.ly/36TH2Yb.

Also known as "upper air," these systems have luminaires installed close to the ceiling, where the light can zap viruses as they're circulated up by the HVAC system. This location also keeps the UV light directed horizontally rather than being projected down on the room's occupants, thus helping to alleviate concerns about damage to their skin and eyes — more about that aspect in a moment.

Although COVID has put a spotlight on UV, its long-term business case could revolve around its ability to neutralize multiple types of pathogens. For example, a company might view the cost of equipment, installation, and electricity as being far outweighed by savings such as increased productivity and reduced sick time because the UV system would zap common cold viruses and other bugs, too.

"Upper-room UVGI systems can be used to control SARS-CoV-2 as a useful ventilation tool to consider in reducing the spread of infectious pathogens," the CDC says. "Influenza viruses are more susceptible to UV energy than the bacteria that causes TB. Thus, any upper-room UVGI system installed to help during the COVID-19 pandemic will also be useful against seasonal flu, if it is properly maintained."

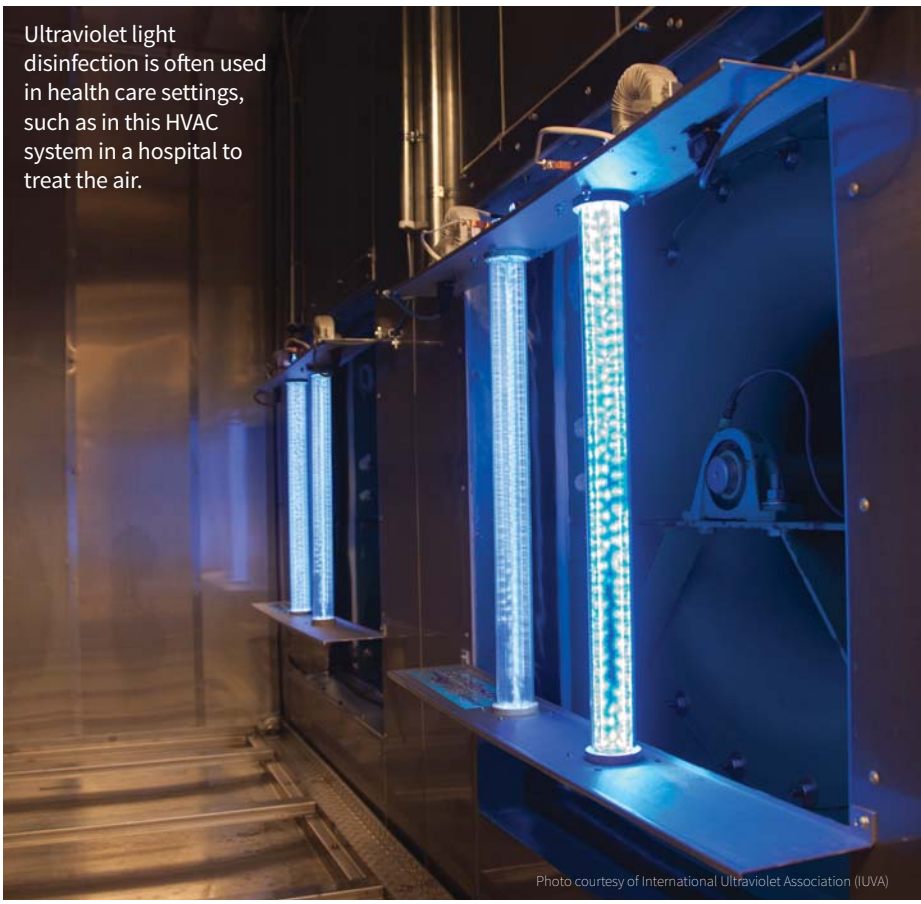
For more information from the CDC on the various prevention strategies that can be employed in a space as well as how upper UVGI systems actually work, see **Fig. 1** and **Fig. 2** on page 28.

When it comes to surface disinfection, there also could be savings if the lighting reduces the need for manual cleaning and harsh chemicals. One example is antimicrobial lighting, which uses LED but at different wavelengths than UV. Chatham Brewing in Chatham, N.Y., uses antimicrobial luminaires in the ceiling and walls to kill mold around its tanks. During the day, they emit a white antimicrobial light. At night, when the space isn't in use, they switch to a violet enhanced antimicrobial light.

Before they were installed, an employee did a deep, thorough chemical cleaning every two months. That's been reduced to no more than twice a year.

"Given that they are LED, they are actually more efficient than the lights they replaced, and with the savings in cleaning chemicals, there are cost savings," says Chatham Co-Founder Tom Crowell. "The payback for the equipment and installation will be longer term, but increasingly the cleanliness of the brewery and reducing chemical usage make it worth it. We did inquire about the lights and any potential risk to the eye, both for employees and patrons, as the lights are visible from the taproom. We were assured that there is no risk."

Even so, UV and non-UV lighting won't eliminate manual cleaning and chemicals, such as floors shadowed by desks.



Ultraviolet light disinfection is often used in health care settings, such as in this HVAC system in a hospital to treat the air.

Photo courtesy of International Ultraviolet Association (IUVA)

A New York City Metro Transit Authority subway car is bathed in germ-killing ultraviolet light emitted from portable and pole-based fixtures.

Photo courtesy of New York City Metro Transit Authority

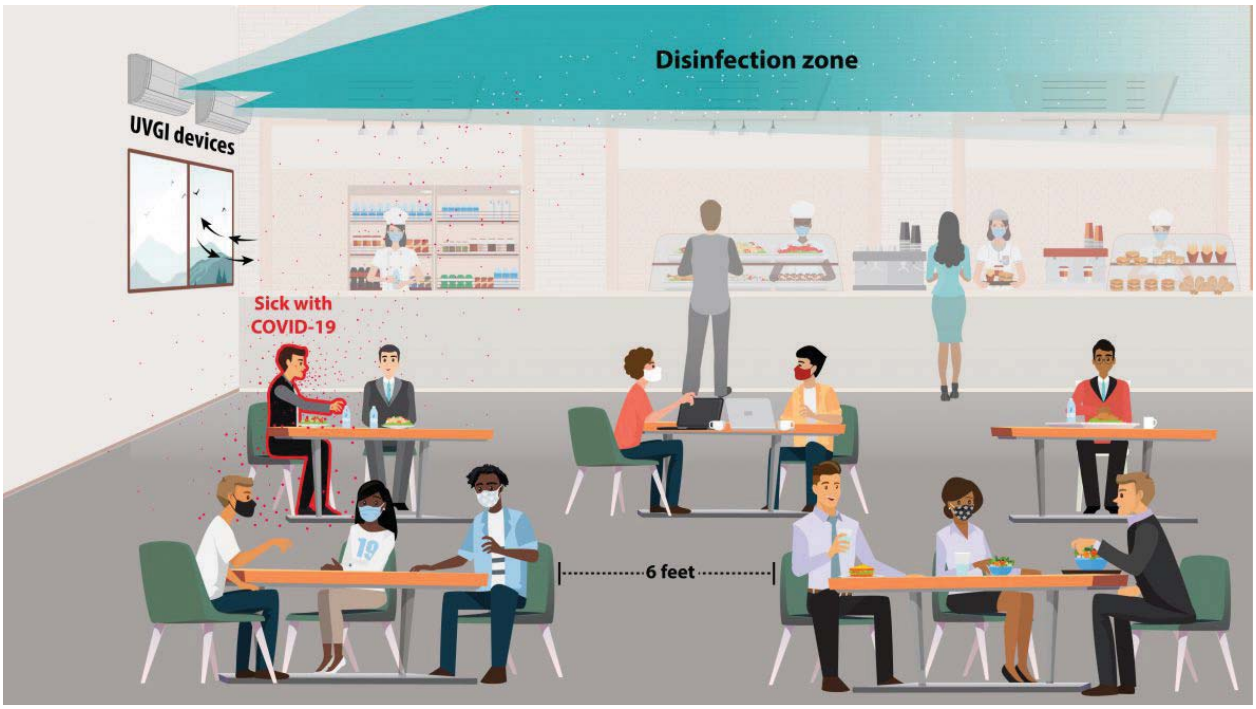


Image courtesy of the CDC

Fig. 1. Ultraviolet germicidal irradiation, or UVGI, is the use of ultraviolet (UV) energy to inactivate viral, bacterial, and fungal organisms. This illustration demonstrates how the system employs various prevention strategies to reduce infection.

"Surface disinfection technologies do not replace the need for chemical cleaning in hospitals," says Jennifer Brons, research program director for the Light and Health Research Center at the Mount Sinai Icahn School of Medicine in New York City. "If a surface is soiled, UV cannot penetrate down to the surface. UV is a line-of-sight technology. When it comes to surface disinfection, these technologies are an added layer of protection against increasingly antibiotic-resistant organisms, not a replacement."

Some demanding applications, such as health care facilities, could have three layers of protection: an upper-air UV system for aerosolized pathogens, a "direct-view" UV system for surfaces, and periodic manual cleaning with chemicals. In those cases, the two UV layers' value is based partly on their ability to reduce the time and money spent on the manual layer.

C THE LIGHT

When most people hear "UV," they think of sunlight… and sunburns and skin cancer. That perception is noteworthy because it affects the market for UVGI lighting. For example, a school board, teachers union, and parents might be concerned that a proposed classroom UVGI upper air system will hurt students' and teachers' eyes and skin. That would put the UVGI upper air system at a competitive disadvantage compared to HVAC-based alternatives, such as high-efficiency particulate absorbing (HEPA) filters. The company suggesting UVGI — such as a lighting designer or electrical contractor — could overcome those concerns by explaining the principle of how an upper-air system works.

"It's shining into the air above where people are, or shining it only inside the ductwork," says Troy Cowan, coordinator of the Healthcare Working Group at the International UV Association (IUVA), based in Chevy Chase, Md. "That's how you avoid overexposing anybody in the room."

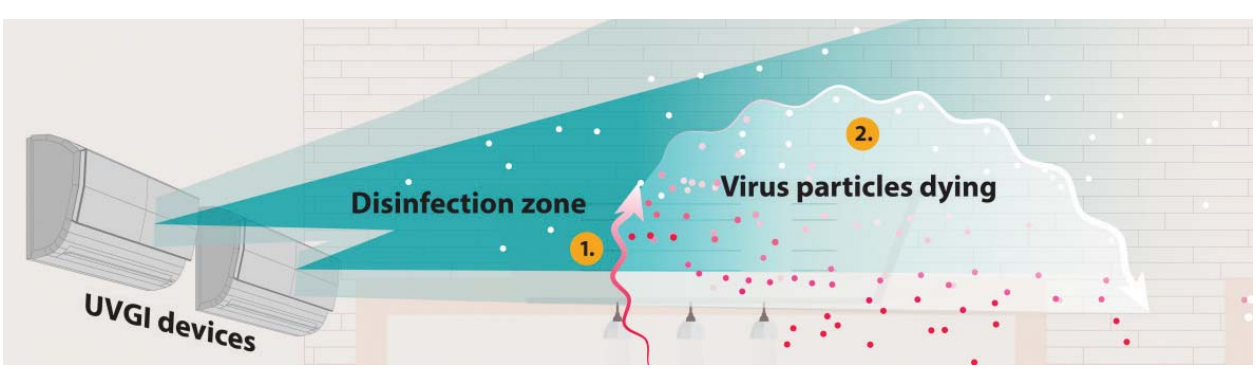


Image courtesy of the CDC

Fig. 2. In an upper room UVGI system, air passes through the disinfection zone from air flow through HVAC system, fans, and/or open windows. The airborne pathogens are inactivated once they receive an appropriate amount of UV energy. The particles remain in the air, but they are no longer infectious.

Another factor is the UV system's wavelength. Sunscreen is designed to protect against UV-A and UV-B rays, whose wavelengths in the 280 to 400 nanometer (nm) range are more damaging to the skin. UVGI systems are UV-C, which is in the 100 to 280 nm range.

"UV-C penetrates only the superficial layers of the skin and eye, with the shortest wavelengths hardly penetrating at all to living cells (epidermis), so only a very mild, transitory sunburn occurs from accidental over-exposure of skin areas," notes the Illuminating Engineering Society (IES) on its website. "Even though GUV lamps can pose a theoretical delayed hazard, incidental UV exposures in the workplace would not significantly increase one's lifetime risk for cataract or skin cancer when compared to daily exposure to the UV radiant energy in sunlight."

UVGI disrupts viruses' DNA and RNA.

"You're messing with the reproductive system of the bad bugs, making them reproductively sterile, if you will," Cowan says. "Once they're sterile, they can't cause an infection. And since UVGI attacks the bugs' reproductive system, the chances of there ever being a super bug coming out of the mix is almost [nil]."

"Far" UV-C lighting operates around 222 nm.

"'Far UV' or 'far UV-C' are wavelengths shorter than 254 nm, the Hg line," Krames says. "The definition is somewhat vague but lately we have been saying < 240 nm for far UV. There's a lot of interest in far UV-C. The threshold exposure elements climbed dramatically, especially with the newest proposed ones."

STANDARDS

Standards are another potential market driver. In June 2020, the IUVA and the IES began work on American National Standards Institute (ANSI) standards for measuring and characterizing UV-C device output. These will help enable apples-to-apples comparisons between different vendors' products, including models using LED, low-pressure mercury, xenon, and other technologies. They also will help determine how much UV light is needed to neutralize each type of pathogen.

In March 2022, ANSI certified ANSI/IES/IUVA LM-92-22, *Approved Method: Optical and Electrical Measurement of Ultraviolet LEDs*. Meanwhile, ANSI/IES LM-91 (C303)-2022, *IES (Guide to) Approved Method: Application Distance Specific Radiometry*, also had been approved but not yet published at press time.

UV LED efficiency also is steadily increasing. UV-C LEDs are being used in all kinds of applications to disinfect water, surfaces, and air, says Frank Harder, CRO at Bolb, a Livermore, Calif.-based company.

MARKET SHARE

For electrical contractors, the potential UVGI business opportunities range from simply installing equipment based on another company's design to helping clients select a UVGI solution and designing/installing the equipment.

"A typical room with 500 square feet of floor space will generally require two to three UV fixtures," the CDC says.

Some types of UVGI lighting are portable, such as handheld wands and devices mounted on roving robots. They aren't something that electrical contractors would sell or install, but they're still worth noting as a competitor in some applications. Perhaps the biggest competitor is HVAC-based systems, such as HEPA filters and in-duct UV lights that sterilize the passing air.

"COVID-19 incidence was 39% lower in schools that improved ventilation," says a May 2021 Centers for Disease Control (CDC) report. "Ventilation strategies associated with lower school incidence included methods to dilute airborne particles alone by opening windows, opening doors, or using fans (35% lower incidence), or in combination with methods to filter airborne particles with HEPA filtration with or without purification with UVGI (48% lower incidence)."

How UV stacks up against alternatives is important for understanding the market opportunity and developing a market strategy to sell against those alternatives. For example, HVAC systems usually cycle on and off, partly to save electricity. If a UVGI system is in the duct, that means it's disinfecting only some of the time, and won't refresh an entire room's air fast enough to kill the majority of pathogens circulating in a space.

> **"COVID-19 incidence was 39% lower in schools that improved ventilation."**
>
> —CDC Report, May 2021

"One option is to leave the fan and the UVGI unit on all the time. Another is to install upper-air UVGI, to disinfect the air up next to the ceiling," Cowan says. "If you just look at what goes through the filter duct, you're maybe getting only a 10% air exchange at any one time versus broadcasting it all the time [with] UV disinfection. Upper air is more efficient because you're treating a lot more air at once when you have the ceiling height to accommodate it. Otherwise, I'd go with UVGI in the ductwork. Either way, UVGI helps disinfect the air, reducing the risk of inhaling infectious 'bugs.'"

Even so, some applications might require the aforementioned multi-layer approach.

"What we've come to learn is that UV-C is a viable solution to air disinfection, but it comes with some challenges," says Wesco's Jones. "For example, it may not adequately clean surfaces in occupied spaces, or it requires a significant amount of energy in unoccupied spaces. The unoccupied space solutions — typically portable solutions that radiate UV-C over some time — are usable for general disinfection in certain types of spaces.

"However, these only work line of sight. Surfaces between the source and target area block any UV-C light. This is not viable where there are short changes in occupancy (such as in schools) during the school day. As soon as a pathogen enters the space, this solution provides no disinfection until the next time the solution is used. In that time, pathogens may cross-contaminate unprotected spaces."

But this scenario also creates a potential major opportunity for far-UV solutions.

"This problem would be knocked out if UVGI were eventually allowed to be used continuously in an area, which may be possible with far UV," Krames says. EC&M

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