CASE STUDY

Call Center Improves Office IAQ and Reduces Maintenance Through Ultraviolet-C Technology

Facility Manager "Protects" $450,000 Remediation Investment Using Germicidal Energy to Sanitize HVAC/R system 24/7/365

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SOURCE: UV Resources
CONTACT: Joel Williams
joel.williams@UVResources.com
708-227-1095

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Ever since chief building engineer Rick Hansen assumed responsibility for a three-story 200,000 square-foot North Carolina office complex, he worked to resolve long-standing tenant complaints of dusty HVAC vents.

The single-tenant Class A building housed roughly 650 call center employees, who routinely asked maintenance teams to clean dust and debris from the tops of desks, bookcases, cubicle walls and carpet spaces directly under HVAC supply diffusers.

Upon joining the building's national property management team in 2015, Hansen discovered that the "dust-up" had occurred for several years, but was especially prevalent during high heat loads, or approximately nine months out of the year when higher air volumes would expel handfuls of dust particles. Causes for the HVAC debris ranged from theories of poor filters or insufficient maintenance to rubber dust generated from the air handler belts.

Instead of speculating, Hansen's team sent several dust samples to be analyzed by an independent laboratory. Upon discovering traces of mold in the test lab samples, the chief engineer convinced building ownership to disinfect the building's entire HVAC system and incorporate preventative technology to maintain its cleanliness.

The extensive four-month remediation project—estimated at $450,000—would painstakingly clean and sanitize all mechanical systems and ductwork across the facilities' roughly 250 variable air volume terminals (individual zones). To limit the impact of such a project on the building's tenants, this effort was conducted entirely at night and over weekends; while maintaining the small off-shift team of customer service staff that oversaw nighttime operations.

In order to prevent organic growth from returning in each of the building's five air handlers, Hansen turned to Jess Kota with Clark Air Systems, a manufacturers' representative specializing in commercial and industrial air handling equipment based in Greensboro, NC.

A specialist in ultraviolet air and surface treatment, Kota recommended the use of ultraviolet germicidal irradiation (UVGI or UV-C) technology that uses short-wavelength ultraviolet energy—similar to sun rays—to kill or inactivate airborne and surface-bound microbes.

The 253.7 nm germicidal C-band wavelength inactivates virtually all microorganisms living on HVAC/R surfaces with a kill ratio of 90 percent or higher, depending on UV-C intensity and the length of exposure.

"We knew that UV-C germicidal energy would stop and prevent microbial growth in the HVAC system, and would provide the extra benefit of improving cooling capacity and heat transfer efficiency," says Jess Kota with Clark Air Systems.

"After 20 years of running 55-degree saturated air nonstop throughout the building, it became apparent that the source of the HVAC dust began with organic growth proliferating from the cooling coils that had been plaguing building tenants and frustrating maintenance teams," explains Kota. "Once the coils were mechanically cleaned, we knew that UV-C germicidal energy would stop and prevent microbial growth in the HVAC system, and would provide the extra benefit of improving cooling capacity and heat transfer efficiency."

The Use of UV Lighting

The UV-C wavelength has been used extensively since the 1990s to improve IAQ and later to improve heat exchange efficiency, boost airflow and reduce maintenance. However, it is the technology's ability to potentially slash between 10 to 25 percent of HVAC energy use that drives nine-of-every-10 UV-C installations, notes Kota, who worked with Hansen's team to size and specify the sustainable UV-C solution.

According to the U.S. Department of Energy (DOE), Hansen is not alone in targeting HVAC/R as a potential source of savings, as this equipment accounts for between 30 to 50 percent of a building's total energy use – a figure that may be even more pronounced in humid climates such as North Carolina.

"There are many benefits of UV-C," says Hansen, who enthusiastically supported the addition of a UV-C energy install. "Most important is the improvement to air quality, so tenants enjoy cleaner, healthier air.

Absenteeism due to the airborne spread of unsafe microorganisms via HVAC systems is almost eliminated. Moreover, equipment life is improved, downtime and preventive maintenance expenses like cleaning the coils, drain pans, and the purchase of coil and drain treatments, etc., is significantly reduced."

The Call Center Installation

The LEED O&M Silver certified (2018) building had HVAC equipment running around the clock to provide cooling for a small team of overnight workers and to maintain operational set points for telecommunications and data servers. Five large York® variable volume air handlers ranging from 35,000 CFM to 55,000 CFM conditioned the three-story building that was divided across roughly 260 zones, each equipped with MERV 13 filters in the mixing chambers.

Cooling was managed through a 44-degree York 350-Ton chilled water system, while approximately 165 Envirotech Parallel-Fan Terminal Units powered by two-stage electric reheat coils provided tenant heating. This space conditioning approach funneled saturated air throughout the building's ductwork, which acted as a magnet to attract dust and other particulates contained in the airstream. Once present, these bacteria and microbes multiplied quickly due to an air handler's ideal moist and dark environment.

"By installing the UV-C germicidal fixtures, we're saving future dollars that inevitably would need to be spent again in another 7-10 years to sanitize the AHUs and ducts," says Rick Hansen, chief building engineer.

To maintain the five AHUs, Kota recommended the installation of the RLM Xtreme™ high-output 360-degree UV-C lamp system from UV Resources. This modern UV-C system installs in about half the time of conventional fixtures allowing installers to configure multiple lamps to achieve the desired UV-C dosage.

Following the installation of the germicidal lamps, Hansen's team saw a drastic decrease in HVAC dust and accompanying maintenance calls. The one surprise the team did not anticipate was the amount of biomatter that was released after the UV-C started to kill the mold and bacteria growing deep in the cooling coil. Hansen commented that because of the effectiveness of the UV-C, they experienced brief clogging of the condensate drains.

"For roughly a month after the UV-C fixtures were installed, nearly all of our AHU condensate drains were filled with tan-colored, leathery shreds of 'bacon-like' material," recalled Hansen. "We asked our supplier, Clark Air Systems, and they reported that the discharge represented additional organic materials and biofilm left on the cooling coil that had gone untreated by the mechanical cleanings."

According to Clark Air Systems' Kota, pressure-washing or chemical cleaning coils cannot reach organic growth or biofilm lodged deep within the 18-inch thick chilled water coil that would continue to impede heat transfer efficiency. Kota noted that by removing accumulated microbial growth in commercial air handlers, UV-C significantly improves airflow and reduces energy use by up to 30 percent once capacity has been restored.

To illustrate his point, Kota says that an AHU designed to condition 25,000 CFM but is fouled might only be capable of conditioning 17,500 CFM. This biofilm fouling can be several millimeters thick and will "choke" an air handler's ability to move air across the coil to the point of severely inhibiting system performance. To compensate, building engineers respond with more energy-intensive inputs such as drawing additional chilled water and/or increasing fan speeds to offset the loss in cooling capacity. In contrast, even the thickest, impacted coil buildup is no match for the killing power of the UV-C germicidal wavelength, irradiating HVAC components continuously 24/7/365.

Based on this physical proof, Hansen extended the facility's service agreement with Clark Air Systems to include an annual inspection and re-lamping maintenance program.

"By installing the UV-C germicidal fixtures, we're saving future dollars that inevitably would need to be spent again in another 7-10 years to sanitize the AHUs and ducts," said Hansen, who noted the property management firm is evaluating similar retrofits for eight other office buildings it manages in North Carolina.

ABOUT CLARK AIR SYSTEMS

Serving the North Carolina market, Clark Air Systems is the custom air handler Rep for Buffalo Air Handling systems and specializes in commercial and industrial air handling equipment, including industrial fans, custom air handling units, coils, UV lights, Thermotech sensible and enthalpy wheels and related HVAC accessories.

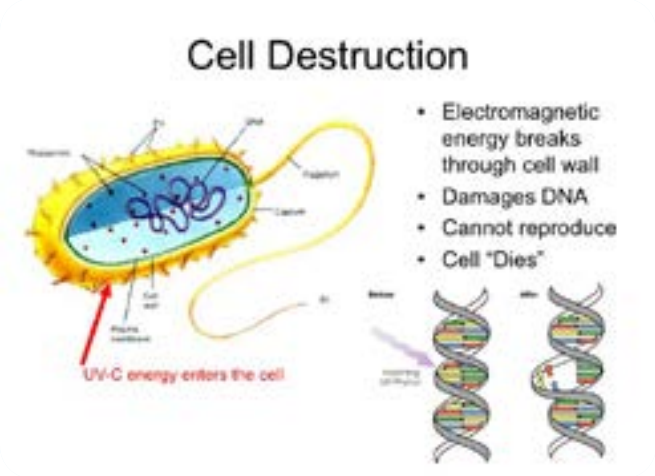
ABOUT UV RESOURCES

The founders of UV Resources pioneered the application of Ultraviolet Germicidal (UV-C) energy in HVAC/R equipment nearly 25 years ago. Today, UV Resources operates a comprehensive manufacturing and distribution network to supply market-leading UV-C solutions for building engineers, facility managers, HVAC/R contractors and OEM equipment

For editorial assistance, contact Joel Williams at (708) 227-1095; e-mail: joel.williams@UVResources.com

SIDEBAR: WHAT IS UV-C ENERGY?

Most of us are familiar with the harmful effects of UV energy transmitted by sunlight in the UV-A and UV-B wavelengths, giving rise to UV "sunburn" inhibitors, or blocking agents, which are found in glasses and lotions. We are also familiar with products engineered to withstand the effects of UV radiation, such as plastics, paints, and rubbers. However, unlike the UV-A and UV-B wavelengths, the UV-C band has more than twice the electron volt energy (eV) as UV-A, and it is well absorbed (not reflected) by organic substances, adding to its destructiveness. Without the ozone layer protecting our Earth's stratosphere, for example, the Sun's ultraviolet radiation would make life on Earth uninhabitable.



UV-C's germicidal or germ-killing effects are well proven. The UV-C wavelength owes these destructive effects to the biocidal features of ionizing radiation; or, more simply, UV-C does far more damage to molecules in biological systems than temperature alone can. Sunburn, compared to the sensation of warmth, is one example of that damage. Sunburn is caused by sunlight striking and killing living cells in the epidermis; the resulting redness from a sunburn reflects the increased capillary action and blood flow that allow white blood cells to remove the dead cells.

It is this ionization function that drives UV-C's power to alter chemical bonds. The 254 nm wavelength carries enough energy to excite doubly bonded molecules into a permanent chemical rearrangement, causing lasting damage to DNA, ultimately killing the cell. Even a very brief exposure to UV-C can permanently eliminate microbial replication.

SIDEBAR: ABOUT THE TECHNOLOGY

The RLM Xtreme fixtureless UV-C lamp system generates up to twice the ultraviolet irradiation levels as fixtured lamp systems, making it one of the most effective germicidal irradiation solutions available today.

With the industry's highest UV-C fluence (dosage) and flexible mounting options to fit nearly all plenums, the near-universal applicability of the RLM Xtreme is ideal for high-volume coil irradiation and airborne on-the-fly treatments. Designed for both new and retrofit applications, RLM Xtreme lamps eliminate the need for rows of costly, cumbersome and potentially unsafe metal and glass fixturing.

"Whether your application is coil irradiation, killing pathogenic microorganisms or extending HVAC system life, the RLM Xtreme's high-output performance combines the best UV-C components in a simple and flexible system that features the industry's lowest cost of ownership — making it the best value on the market," explains Dan Jones, president of UV Resources.

SIDEBAR: HOW TO APPLY GERMICIDAL TECHNOLOGY

There are three primary means of applying UV-C for air and HVAC surface protection against infectious agents: 1) Upper-Room or Upper-Air, 2) HVAC airstream disinfection, and 3) HVAC coil/surface irradiation:

Upper-Room Disinfection: The primary objective of upper-Room UV-C germicidal fixtures is to interrupt the transmission of airborne infectious diseases in communal spaces (e.g., waiting areas, cafeterias, sports facilities, etc.). Airborne droplets containing infectious agents can remain in room air for 6 minutes and longer. Upper-Air UV-C fixtures can destroy those microbes in a matter of seconds including measles, mumps, TB and cold viruses. Kill ratios over 99.9 percent on a first-pass basis have been modeled and, as air is recirculated, concentrations are further reduced by each subsequent pass ("multiple dosing"). The Upper-Room UV-C fixtures utilize the natural rise-and-fall of convection or mechanical air currents to lift airborne infectious agents into the upper room where they are exposed to UV-C irradiation and killed.

HVAC Air- Stream-Disinfection: UV-C air disinfection systems are installed in-duct in air-handling units or air distribution systems to inactivate microorganisms and disinfect moving airstreams "on-the-fly." UV-C exposure and the resulting dosage is determined by the quantity of germicidal energy absorbed by a pathogen over a specific period of time i.e., disinfection is a function of the time and UV-C intensity a microbe is exposed to UV-C energy, and that microbes' specific susceptibility to UV-C Predictive-modeling based on scientific studies of each pathogen's susceptibility to UV-C can assist in designing the recommended dosage rates required to kill individual bacteria, viruses, or spores. Studies have demonstrated that viruses (e.g., influenza, measles, SARS and smallpox) are more susceptible to UV-C inactivation than say bacteria.

Coil-Irradiation Systems: Surface-cleaning UV-C systems provide 24/7 irradiation of HVAC/R components to destroy bacteria, viruses and mold that settle and proliferate on HVAC coils, air filters, ducts and drain pans. UV-C prevents these areas from becoming microbial reservoirs for pathogen growth that will eventually spread into airstreams. A system installed for coil irradiation can also have a secondary benefit of eliminating up to 30% of airborne pathogens on a first-pass basis, with ancillary benefits of restored cleanliness, heat-exchange efficiency and energy use.