UVC: Florida Hospital puts HVAC maintenance under a new light

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HVAC system during coil cleaning can compromise humidity and temperature control, potentially leading to air quality or comfort problems. *Florida Hospital has found that high-output ultraviolet-C lights installed in the AHUs reduce or eliminate coil-cleaning programs--yielding ongoing energy savings, a reduction in HVAC system maintenance, and the elimination of cleaning chemicals. The facility also reports IAQ and infection control benefits as the regimen continues.*

Florida Hospital's (FH) experience with ultraviolet-C (UVC) began in 1998 after seeing a presentation on the technology at an ASHRAE conference. A new generation of UVC devices promised to offer an improvement over the UV lights that were long ago popular for upper air disinfection in hospitals and other health care environments. *Unlike the upper air devices, the newer UVC Lights were engineered specifically to provide peak output under HVAC conditions. Output of these devices was reportedly so much higher than conventional UV tubes in cold and moving air that they could be installed just downstream of a cooling coil to eradicate bacteria, viruses, and mold.*

Upon learning about the benefits of the new UVC fixtures, FH staff felt that the potential for the health care system was enormous. FH is an acute-care health system with more than 2,800 beds throughout Florida. With a network of 17 hospitals and 12 walk-in urgent care centers, FH treats more than a million patient visits per year and is the second busiest system in the country.

To test the efficacy of the UVC devices, we decided to install the lights in AHU #107, a 27-year-old, 6,000 cfm refit located at the main Orlando campus. A UVC Lamp , was specified for this and for subsequent installations. We selected AHU #107 because the coil and drain pan areas had a very visible buildup of mold, and the coil was clogged to approximately 50%.

Within weeks after the UVC installation, static pressure over the coil decreased from 1.8 in. wg to just 0.7 in. wg. Air velocity over the coil more than doubled, from 230 fpm to 520 fpm. Both the coil and drain pan areas looked absolutely clean, with no more visible evidence of mold or organic buildup. The air exiting wetbulb temperature from the AHU also decreased significantly, from 57[degrees] F (before UVC) to 53[degrees] (with UVC).

We calculated the increase in capacity to be 95,245 Btuh or approximately 7.9 tons of air conditioning. If we use 1 kW/ton and multiply by 24 (hours/day) by 365 (days/year) by $0.07 (our electric rate), we arrive at a total of $4,867 in savings fur this one unit. The total installed cost of the UVC Lamps was less than $2,000. *Given the number of our facilities and the number of AHUs in these facilities, we estimate yearly energy savings well into the six figures. This estimate does not include additional savings for reduced maintenance.*

Stated another way, we project that the hospital is conservatively saving 15% in HVAC system energy costs, and probably much more. These results are consistent with long-accepted industry studies documenting that just a one-micron buildup of dirt or debris on coil surfaces can lead to a 15% loss in operating efficiency.

AHU #107 has essentially returned to its original performance specifications and has continued to operate like a "new" system since we installed the UVC devices more than four years ago. The coil and drain pan areas have also maintained their clean condition, eliminating the necessity for the monthly inspections and twice annual cleanings that used to be required. How is this possible? *We have found that the high output UVC energy kills or inactivates both coil and drain pan mold and bacteria (to eliminate their toxins, VOC and spore production, and allergens) as well as ordinary coil and drain pan debris. The result is a continuous form of source control.*

We next installed UVC devices in an additional unit, AHU #42, in the same hospital. In this unit, static pressure over the coil dropped from 1.4 in. wg to 0.8 in. wg, and velocity over the coil increased from 365 fpm to 468 fpm. On a parallel AHU (#43) without UVC light, we cleaned the coils to compare the results. Although the coil visually appeared to be clean, pressure drop over the coil increased by 0.3 in., and mold buildup occurred in the drain pan shortly after the cleaning.

After reviewing these initial results, the hospital administration agreed to expand the use of UVC. By the beginning of 2004, more than 100 AHUs in seven FH campuses were outfitted with the lights (Table 1), as well as some ceiling-mounted and portable air recirculating units. To obtain desired results in the AHUs, we generally follow the manufacturer's recommended guideline of 24 in. of UVC tube length for every 4 sq ft of coil face area.

Following are some of our most noteworthy experiences and observations.

CELEBRATION HEALTH

We were experiencing problems with excessive organic buildup on the coils in large (15,000 cfm) units at our Celebration Health Hospital facility. These AHUs, which have about an 8 in. thickness of coil, did not respond well to pressure cleaning. We found that this technique would tend to compress the growth inside the center of the coil, increasing air-flow resistance, and allowing mold proliferation to continue. Since the cost to replace

the coils would have been $16,000 to $18,000 per unit, we were seeking a more economical yet effective solution.

We installed UVC lights in one of the units at a cost of about $5,000. No cleaning was performed; since the lights are easy to install, system downtime was only about two hours. The UVC energy successfully "cooked away" existing buildup all the way through six rows of coil and has maintained the unit in a clean condition.

On an identical AHU, we removed the coil and immersed it in a chemical bath for 24 hrs to loosen up the debris. Although we have had mixed results with this technique in the past, it was successful in this case. Total shutdown time for this unit was 48 hrs, at a cost of more than $6,000 in labor and materials. However, the unit has required three subsequent cleanings at six-month intervals and has been operating at a much higher pressure drop than the UVC-equipped AHU.

FACILITY BUILDING

A facility building on the main Orlando campus was experiencing IAQ problems. Though no patients were affected, hospital personnel in the building were reporting allergic reactions such as coughing, sneezing, and watery eyes. One employee complained of a cold that would not go away. *After installing UVC lights, all of the symptoms disappeared within about a week.*

Several weeks later, we were puzzled to find that the problem had reappeared. Upon inspection, we discovered that a service crew had turned the UVC lights off during filter changeout and neglected to turn them back on again. Mold growth had reappeared in about a month. With the lights reactivated, the problem again abated quickly and there have been no further recurrences.

DUCTWORK

Since installing UVC in the air handlers, we have observed that the devices also help to eliminate mold buildup on duct surfaces, even though there are no lights installed in the ducts themselves. This phenomenon occurs because the coil--not the ductwork--is the source of mold growth in the system. Fresh inoculation coming off the coil typically migrates downstream and some of it settles in the ductwork--a process that is self-perpetuating. But when UVC energy is used to destroy mold and microbial growth at the coil, the food source is eliminated and the chain is broken. As a result, the contamination that has already built up on duct surfaces will eventually decay away, a process that may take months.

Where duct surfaces are badly contaminated, it isn't always possible to wait for the effects of UVC. Therefore, in those areas where buildup was particularly heavy, we performed duct cleaning as a precaution

prior to installing UVC lights. We have not experienced any recurrence of duct contamination since adopting UVC, nor do we anticipate any future duct cleaning requirements. *This will mean thousands of dollars' additional maintenance savings in coming years.*

INFECTION CONTROL

Though FH's interest in UVC has been largely maintenance driven, we have never lost sight of the fact that infection control is one of the primary functions of this technology. Back in the 1950s and '60s, the older-style UV devices were popular for upper air disinfection of tuberculosis wards and similar areas. When air conditioning became prevalent, however, the lights suffered losses in output--and therefore, germicidal effectiveness--under the cooler temperatures, and they began to lose favor.

Since the new-style UVC lights are not subject to these limitations, we decided to introduce the devices for infection control applications. Over the past year, we have incorporated UVC into self-contained ceiling units that are equipped with prefilters, fans, and HEPA filtration.

Although HEPA filters have the capability to trap bacteria, they are not always effective against smaller microbes such as chicken pox, small pox and other highly contagious viruses.

UVC energy's ability to inactivate all types of bacteria and viruses (no matter how small) is well documented. Also, by destroying microbes trapped in the HEPA filters, the presence of UVC light may increase the service life of these components and allow for safer changeout.

The devices are installed between the fan and the HEPA filter to provide an extra level of protection against the spread of airborne diseases in such locations as ER waiting areas, endoscopy, radiology, and patient waiting rooms.

Though we do not yet have sufficient data to measure the effectiveness of UVC as an infection control tool at our facilities, our infection control people have greeted it as a welcome enhancement to current prevention strategies.

MAINTENANCE PRACTICES

The UVC devices at our hospitals operate round the clock to ensure continuous eradication of mold and microbial growth. To monitor performance of the lights, we currently use portable radiometers that measure the output of these devices. The manufacturer recommends replacement of the UVC tubes if they fall below 60% of the original output. We change the tubes preventively on an annual basis even if output still exceeds the recommended changeout level, as is often the case. Tube replacement, which is literally as easy as changing a light bulb, takes only minutes to perform.

Inspection windows and similar indicators enable us to verify that the lights are on. Access doors to many of the AHUs are equipped with switches that automatically de activate the lights when the doors are opened, since direct exposure to UVC energy is to be avoided. As an additional precaution, maintenance personnel wear safety glasses when inspecting the devices and gloves when handling the glass tubes. *Apart from these minor precautions, UVC has significantly reduced out overall HVAC system maintenance while having few maintenance requirements of its own.*

CONCLUSION

* **Cleaning costs:** *UVC devices have performed beyond expectations for their originally intended maintenance function--e.g., to reduce or eliminate coil cleaning. Given that our AHUs used to require two coil cleanings per year on average, and we have equipped more than 100 AHUs with UVC, we have succeeded in eliminating more than 200 coil cleaning procedures annually. Cost per cleaning can range anywhere from $500 (for a two-person, four-hour job, including labor and materials) to $6,000 or more for a "problem" coil requiring more extensive cleaning. Anticipated long-term savings in duct cleaning costs should also be significant.*

* **Reduced downtime**: *A reduction in the downtime associated with coil cleaning carries another important benefit. Whenever you shut down an AHU in a hospital, rh can increase dramatically, especially in the tropical Florida climate. In turn, when humidity and temperature control are compromised, patient comfort is at stake and proper IAQ control becomes more challenging. UVC helps to keep systems "up and running," minimizing the potential for these problems to occur.*

* **Energy savings**: *By keeping coils in a constantly clean state, UVC improves heat transfer efficiency, improves airflow through the system, and allows air handlers to operate at peak performance. The resulting savings in HVAC system energy, estimated to be in the six figures annually, would be enough to pay back the cost of the UVC installation very quickly--even without the savings already realized through reduced coil cleaning.*

As an engineer for this large hospital system, my primary concerns have always been the quality of the air and the comfort of our patients, visitors, and employees. FH's experiences of the last four years have shown us repeatedly that UVC enhances IAQ and infection control, while saving on maintenance labor, materials, and downtime. The substantial energy savings achieved have been a great bonus. Since our administrators now have a high confidence level in the effectiveness of UVC lights, we will continue to equip both new and existing AHUs with the devices.

TABLE 1. Overview of Florida Hospital UVC usage.

Facility	*# of beds*	*#UVC-equipped AHUs*
Orlando (main campus)	*882*	*53*
Altamonte	*258*	*9*
Apopka	*50*	*1*
Celebration Health	*60*	*7*
East Orlando	*119*	*3*
Kissimmee	*50*	*19*
Winter Park	*334*	*13*
Totals:	*1,753*	*105*