



## **“Evidence Based Design” determines the proper energy field for a UVC installation:**

The UV industry has been a great emerging market for many reasons. Constant coil cleaning, pathogen removal and energy savings are now documented and reported in many industries and applications. Since Steril-Aire pioneered the use of UVC in HVAC systems in 1994, the acceptance of and dependence on proper UVC Solutions has grown dramatically. Unfortunately, many of the companies that formed in the wake of this discovery never took the time to understand the science of the solutions needed. and started creating their own way of selling UVC that rarely had anything to do with what was required to achieve the goals above. Their approach was about selling a “blue light” that did everything the customer wanted for less. The waters were muddied with misconception, misinformation, and misdirection. This led to a debate with specifying engineering firms as to how the solution should be specified without an accepted industry standard. Steril-Aire provided guidance based in science while others provided guidance based on what they could sell.

Past specifications provided to A&E firms by different UV manufacturers have included differentiators to ensure sales rather than achievements that lead to solutions. Some specs will highlight the difference in their offerings of electronic accessories while others have listed mechanical differences. When output measured in microwatts ( $\mu\text{W}/\text{in}^2$ ) measured over an inch of lamp at one meter was included, it was almost never a measurement they achieved at 45-55 degrees in 450-550 CFM airstreams as you would find in a typical airhandler coming off a coiling coil. Many UV suppliers have used watts as criteria for proper design. But watts are the measurement of bulb consumption and not an indication of output as dose per watt differs from manufacturer to manufacturer. A fact supported by testing data going back to 2006 when the EPA/Homeland security study on UVC lamps was conducted. Other specifications applied compared numbers of lamps covering the coil face or differentiations in accessory electronic devices to decide between UV suppliers.

If the goal is to achieve a clean coil, energy efficiencies and better indoor air quality, then specification should focus on the energy field. Intensity of UVC from a UVC array needs to inactivate the spectrum of pathogens that can affect the outcome of this goal. If inactivation is based upon time and power and knowing the amount of UV energy it requires to inactivate specific organisms, then the proper test value can be determined for success.

Steril-Aire utilized an “Evidenced Based Design” criteria to achieve the proper energy field in a healthcare environment and reduce the infection rates in critical care facilities. From studies taken over seven years in over 21 states Steril-Aire reinforced conclusions as to the proper amount of UV energy for an effective solution. The data has been verified and the resulting organism reduction can be seen in the only medically published, peer reviewed, white paper documenting the UV intensity and proper install in a HVAC system for a NICU unit. This paper was presented at ASHRAE National Meeting in 2014 by the Director of Healthcare Solutions for Steril-Aire. Conference Paper Session 6 **“Ultraviolet Germicidal Irradiation (UVGI) in hospital HVAC systems for Reduction of Ventilator Associated Pneumonia” (NY 14-C023).**

The results from using 1225 $\mu$ W/in<sup>2</sup> of UV output, measured at all corners of the coil upon initial install, and 730 $\mu$ W/in<sup>2</sup> at end of lamp life, yielded a 99.9% reduction in gram negative bacteria and aspergillus. The occurrence of Ventilator Associated Pneumonia (VAP) dropped by 50%. In addition, a five-log reduction of the organisms was obtained at this output. Documented savings of \$800,000 were recorded by the hospital while significant reductions in Hospital Acquired Infections (HAI’s) were achieved.

In addition, seven more healthcare facility results were included in the study with related improvements utilizing independently tested swab samples. Test results included pathogen reduction, pressure drop improvement, and air flow consistency. All treated and tested coils met or exceeded the ASHRAE hospital design manual (section 3.3.6) stating that a variance of 10% air flow differential measured across the coil should be obtained for best results.

In addition, Steril-Aire presented an additional study to the ASHRAE National Meeting 2017 in Las Vegas for IAQ Session 3 titled **“Restoring acceptable UVGI Performance with Ultraviolet (UVGI) Coil Treatment”**.

Between the 2 studies, members of an ASHRAE committee released an opinion paper on UV intensity at a coil. The ASHRAE UV opinion called for 50-100 microwatts of intensity as a solution. Even after the ASHRAE published paper from 2014, many in the industry ignored the scientific findings presented to rely on the newer opinion document. To lessen the confusion created between the opinion and the science

backed conclusions, Steril-Aire continued to support those who sought a solution based in scientific evidence. Steril-Aire participated in even more field studies to further prove the need for the correct UVC dosages to achieve desired results.

The study presented in 2017 compared the 100 microwatt opinion against a test at 1000 microwatts. Initial swab samples and intensity readings were entered from specific locations and distances on and *within* the coils. Results quickly showed that the *Pseudomonas aeruginosa* organisms, measured in CFU's, were not being eradicated but rather increased in population utilizing the ASHRAE opinion of 50-100 microwatts. Conversely, the same coils demonstrated steady reductions over time of organism growth when 1000-microwatt UV output was applied. Study data is given below

**CHART 1**

<b>Inactivation 1 Monolayer (<math>10^5</math>) CFUs <i>Pseudomonas aeruginosa</i></b>		
<b>5,495 <math>\mu\text{J}/\text{cm}^2</math></b>		
<b>Irradiance at Coil Surface</b>	<b>ASHRAE 100 <math>\mu\text{w}/\text{cm}^2</math></b>	<b>Steril-Aire 1,000 <math>\mu\text{w}/\text{cm}^2</math></b>
<b>Irradiance 2" (50.8 mm) Deep in Coil</b>	<b>1 <math>\mu\text{w}/\text{cm}^2</math></b>	<b>10 <math>\mu\text{w}/\text{cm}^2</math></b>
<b>UVC Dose After 20 Minutes</b>	<b>1,200 <math>\mu\text{j}/\text{cm}^2</math></b>	<b>12,000 <math>\mu\text{j}/\text{cm}^2</math></b>
<b>Microbial Inactivation Rate</b>	<b>22% Reduction</b>	<b>&gt;99% Reduction</b>
<b>Microbial Survival After 20 Minutes</b>	<b>78,000 CFUs</b>	<b>1,000 CFUs</b>
<b>Microbial Survival After 40 Minutes</b>	<b>122,000 CFUs</b>	<b>20 CFUs</b>
<b>Microbial Survival After 60 Minutes</b>	<b>190,000 CFUs</b>	<b>ND</b>

Additional data is available on the intensity loss within several inches of the coil face.

The ASHRAE UV output opinion is not effective for organism inactivation especially for mold species. It also should be noted that biological test data or field samples were never performed to achieve the ASHRAE opinion. The opinion was all based upon a university theory and mathematical modeling.

Facilities spend hundreds of thousands of dollars on HVAC systems for equipment (chillers, cooling towers, pumps, compressors, fans etc.) in order to perform one task. That task would be to transfer temperature from a fin to an airflow. So why are they not always clean? That would be the equivalent of buying a new car and never changing the oil. The ASHRAE opinion of energy required is insufficient for eliminating biofilm, increasing air flow or accomplishing a pressure drop.

It is important to note that the referenced studies and recommended output is for all companies dealing in the UV arena. In addition, like all other vital components of a buildings HVAC system, commissioning the system to meet the specification is recommended (ASHRAE section 12.4). The standard energy needed in an HVAC system and supported in these studies provide guidelines for UVC solutions that should be used by all UV suppliers for the proper installation and output. If the goal is more efficient systems and protecting the health and wellbeing of individual, then this data cannot be ignored. Evidence Based Design insures you'll meet that goal.

## References

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