**Steril-Aire Germicidal UVC for simultaneous coil efficiency and Indoor air quality**

Steril-Aire are the only UVC supplier/ manufacturer who has more than 80 successful case studies in substantial facilities spread across multiple industries around Australia over more than 10 years.

Steril-Aire has been rigorously studied and installed by many sophisticated end users.

Whilst many infer performance from laboratory settings Steril-Aire specification has been proven effective and can be relied upon for performance in the field.

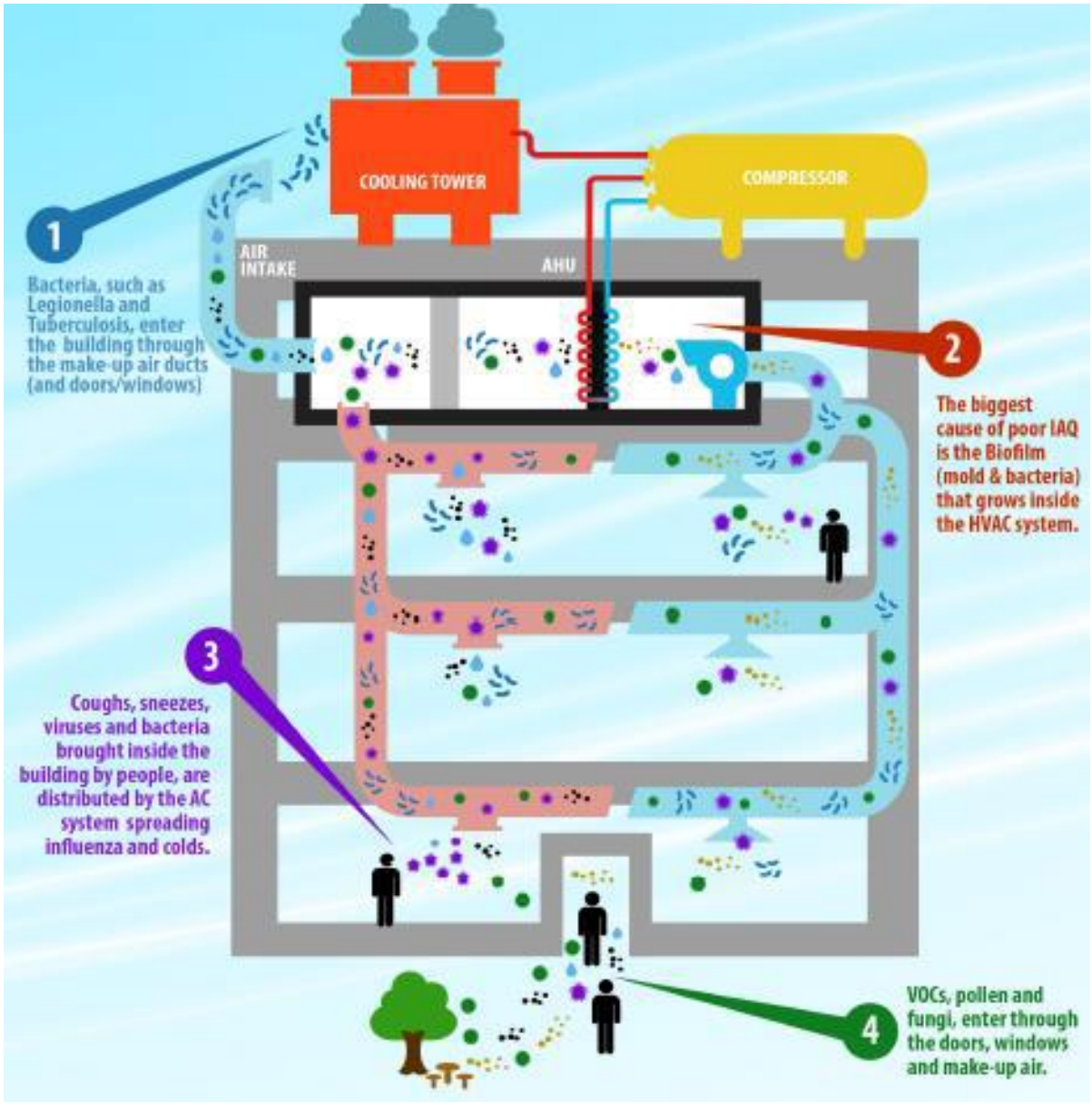
These field results correlate with peer reviewed research where microbial growth is known to proliferate on coils and drain pans (specifically in the location of the air off side of the cooling coil) and that sufficient UVC can remove it.

The microbial growth in this location often aggregates into hardy communities known as biofilm. Biofilm has profound effects on coil efficiency and hygiene and very predictably and measurably restricts heat transfer, restricts airflow and increases pressure drop. It also contributes to corrosion and significantly lower indoor air quality.

The air quality is negatively affected because biofilm formation leads to aerosolization of microbes and mycotoxins known to be harmful to human health as well as building interiors. This includes Bacteria such as Legionella pneumophila and Pseudomonas aeruginosa, Fungi and moulds such as Aspergillus spp. Penicillium spp. Cladosporium spp as well as yeasts such as Candida spp

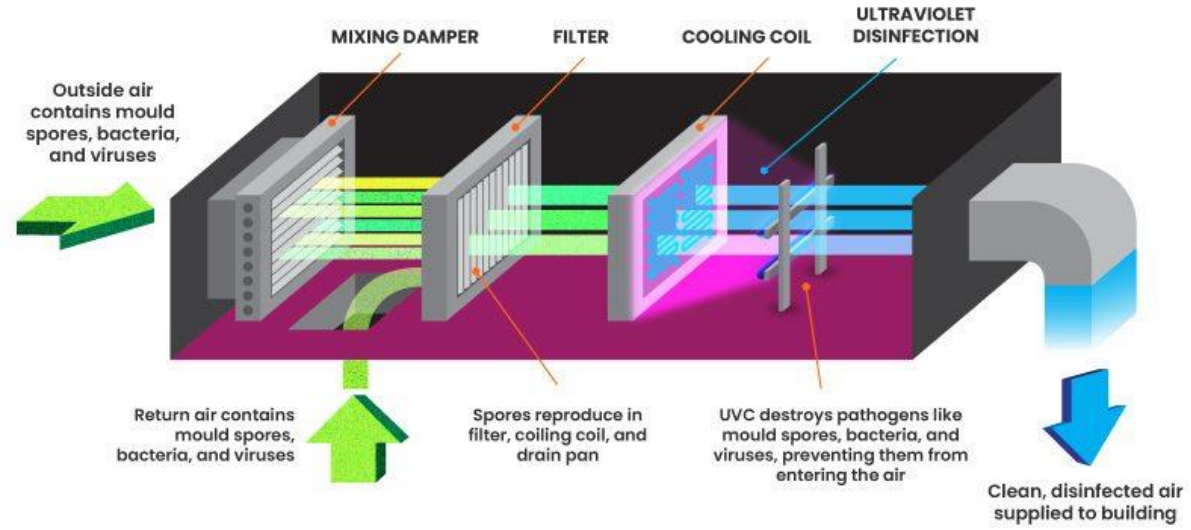
The cycle of biofilm formation and aerosolization is continuous and follows the direction of airflow from coils to ducts to the conditioned space.

Whilst biofilm releases its own microbial load from the coils , drain pan and plenum into the duct and the conditioned space  the air supplied by the HVAC system is also affected by the outside air drawn in and the return air brought back from the room. Both of these sources also contain a range of microbes and pathogens, and they provide further nutrients for the biofilm.




From here it is logical to conclude that ***any measures to improve IAQ should be installed after the cooling coil*** because at this point the outside air, the return air and the air released from the coil can all be treated at the same time.

Due to its location in the air loop the ***air off side of the cooling coil above the drain pan is the ideal single location*** to purify air that comes from the coil, comes from outside air and is returning back from the conditioned space( RA).




***Installations before the coil and in the duct* will not deliver the concurrent benefits UVC can create, significantly short-changing the end user. End users aiming to create improvements in IAQ, maintenance, corrosion reduction, condensate water reclamation and energy efficiency simultaneously must install high output UVC above the drain pan on the air off side of the cooling coil.**

In terms of energy inefficiency, coils with biofilm are causing facilities to spend 10-20 % more on their total air conditioning energy consumption than if the coils were efficient.

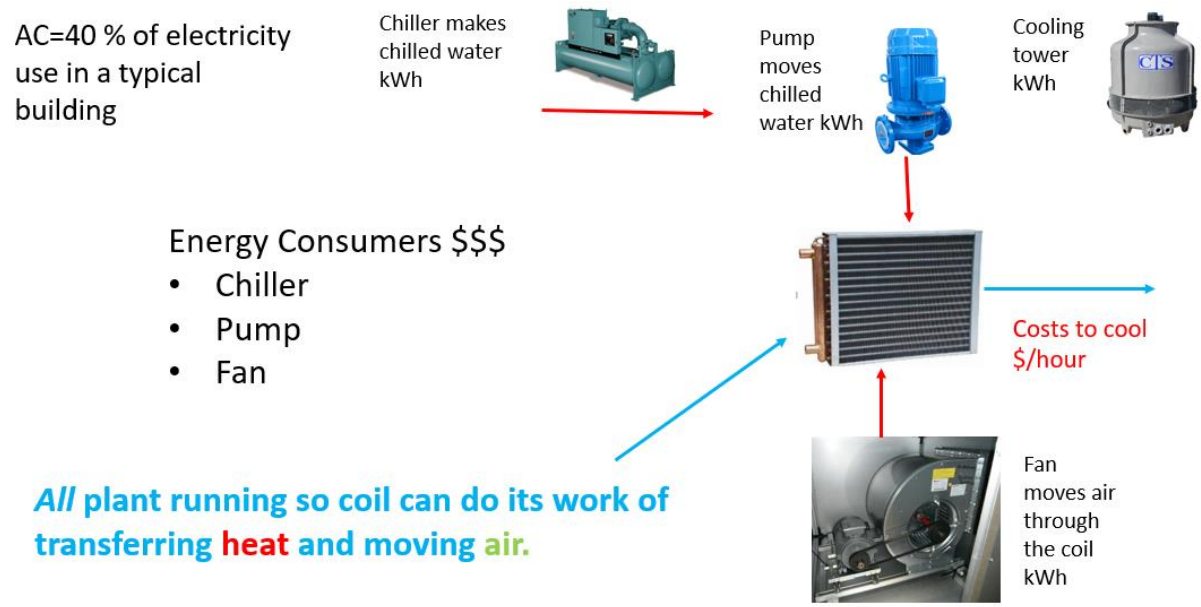
In simple terms the fans, pumps and compressors *must* work longer and harder to remove the same amount of heat as they will be impeded by microbial growth(biofilm).

**Biofilm is almost always present on any coil including conventionally maintained coils and this will consistently and measurably reduce whole ac plant energy efficiency.**

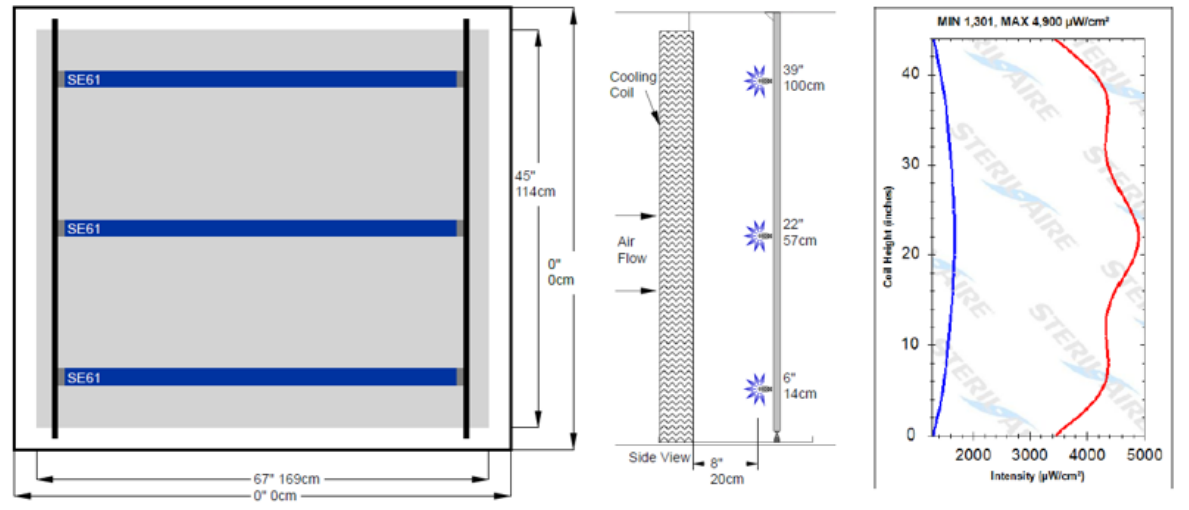
*The issue of coil inefficiency is usually hidden as it is not resolved by conventional manual cleaning, low output UVC, upstream filters and downstream duct installations and is rarely tested for. This results in significant extra expenditure to control temperature, airflow and comfort conditions in the property as well as decreased effectiveness from other energy saving initiatives.*

**Biofilm** blocks and insulates coils, and this has measurable effects ,specifically, pressure drop, airflow and heat transfer at the coil.

Improvements in these three metrics *fundamentally improve the coils* heat removal and airflow characteristics ( cooling capacity) and therefore the whole cooling plants( AHU FANS, CHILLED WATER PUMPS AND CHILLER) COP/ energy efficiency.




**Steril-Aire reliably achieves this by perpetually irradiating the evaporator coil** ( air off above the drain pan) **with a predetermined amount of high output UVC**.




**Dose On the Down Stream Coil Face At Extremities: The UVC dose at the extreme edges of the coil shall not be less than 930 µW/cm² and end of life intensity on the coil face shall exceed 740 µW/cm² at the end of the 18000 hours of operation period measured in 2.0 m/s airflow at 13 Deg C. (Necessary to remove and prevent Biofilm from forming)**

This high intensity UVC irradiation removes biofilm and prevents it from forming.

*Each Steril-Aire installation delivers and maintains sufficient intensity in cold moving air* which will penetrate through the coil, cleaning and unblocking it and simultaneously irradiate the airflow creating concurrent energy efficiency and IAQ improvements.

The intensity delivered is predetermined by the coil dimensions and thickness

*Despite conventional cleaning attempts microbiological growth thrives in the HVAC* environment, particularly the cooling coil and drain pan. In 84 case studies there is yet to be a case where significant improvement wasn't achieved despite the coil being cleaned and maintained to Australian standards.

The solution to improving energy efficiency and Indoor air quality simultaneously is relatively simple.

A) High output Germicidal UVC with the **appropriate calculated output and in the correct location** will reliably remove microbial growth from coils, always keep the coil efficient and substantially remove pathogens from the airflow.

Lower UVC outputs, the use of reflectors and / or different installation locations cannot be relied upon to generate the same results.

Effective removal of microbial growth consistently returns efficiency to the cooling coil (or prevents it from ever getting inefficient), and this can be established by testing the performance of the cooling coil before and after using first engineering principles.

| **AHU #** | **Pressure drop** | **Heat Transfer** | Airflow | **Cooling capacity** |
|---|---|---|---|---|
| 84 | 18.89% | 36.1% | 12.73% | 36.7kWr |
| *total* | *Average* | *Average* | *Average* | *Average* |

**IMPORTANT TO NOTE:** These results have been achieved not just because UVC was used but because exact UVC specifications (output and location) were followed on every installation.

**UVC irradiance field must be maintained at a minimum intensity** (*end of life intensity on the coil face shall exceed 740 µW/cm$^2$ at the end of the 18000 hours of operation period measured in 2.0 m/s airflow at 13 Deg C)* to be effective against microbial growth and to penetrate the coil. If the irradiance field is too low microorganism can continue to grow,

the coil may remain inefficient, corrosion may occur, and the air supplied by the air conditioning unit may still contain pathogens.

**B) The specification** ensures the maintenance the necessary germicidal output to remove biofilm and sustain that removal in a working HVAC environment at the far edges of the cooling coil at end of life (18,000 hours). This guarantees effectiveness for the equipment lifecycle.

**C) UVC output drops in cold moving air**. Additionally, it is important to consider that UVC irradiance potential drops significantly in cold moving air (40 %). Therefore, the HVAC environment irradiance calculations must be subject to 10 c air moving at 2.5 meters per second as this would be typical.

**CAUTION**. Some UVC manufacturers don't mention the effect of cold moving air or use fine print to mention that cold moving air may affect ultimate irradiance.

Steril-Aire technology was specifically and uniquely developed to provide the necessary UVC output in cold moving air. Steril-Aire guarantees the UVC irradiance in each installation in cold moving air at end of life.

**Intensity and time are fundamental to UVC effectiveness.** UVC dose is defined as (µW·s/cm2) = (intensity) x (exposure time). The specification that has proven successful in the field is *end of life intensity on the coil face shall exceed 740 µW/cm² at the end of the 18000 hours of operation period measured in 2.0 m/s airflow at 13 Deg C*

The destruction of microbes by UVC is established in science. UVC has a known effect of the destruction of microbes whereby a certain amount of intensity for a certain period will destroy microbes**. If you reduce time or intensity or both you will not get the desired outcome.**

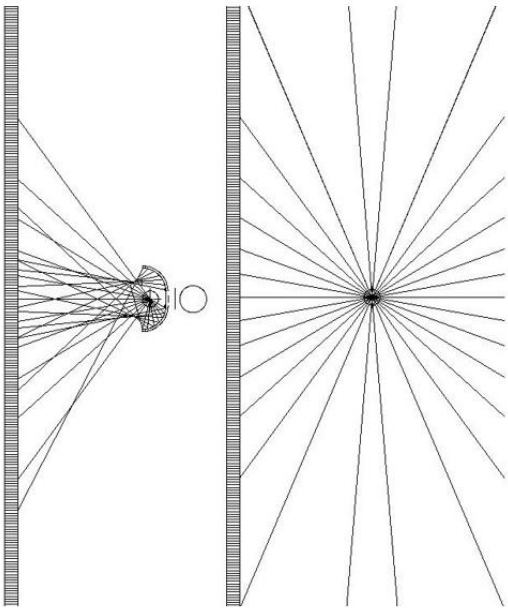
| MICROORGANISM | $D_{10}$ Dose (µW·s/cm²) |
|---|---|
| *Acinetobacter* | 5,500 |
| *Aspergillus flavus spores* | 60,000 |
| *Aspergillus glaucus spores* | 44,000 |
| *Aspergillus niger spores* | 132,000 |
| *B. subtilis* | 5,800 |
| *B. subtilis spores* | 11,600 |
| *Cladosporium* | 26,000 |
| *Escherichia coli* | 3,000 |
| *Fusarium spores* | 24,300 |
| *Mucor mucedo* | 33,800 |
| *Penicillium digitatum* | 44,000 |
| *Penicillium expansum* | 13,000 |
| *Penicillium roqueforti* | 13,000 |
| *Pseudomonas aeruginosa* | 5,500 |
| *Rhodotorula* | 48,600 |
| *Serratia marcescens* | 2,420 |

UVC output inside the chamber is achieved by **using emitters with appropriate UVC output and in sufficient quantity** to create the specified irradiance at end of life.
A 360-degree irradiance field is critical to ensure there is enough time for effective airborne pathogen reduction as well as corrosion and mould remediation inside the chamber.

Installation of reflectors dramatically reduces airborne irradiance potential through reduced time exposure and cannot produce the same IAQ outcomes nor cover all surfaces in the chamber.

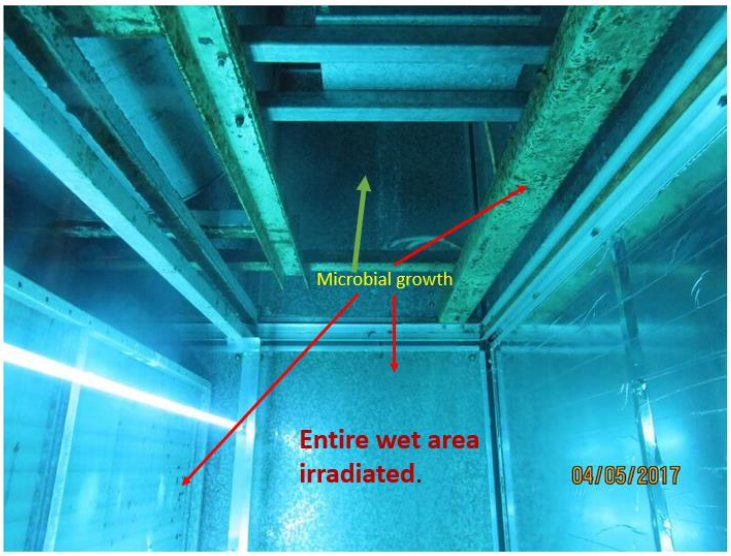
Other UVC devices use
Reflector Shields

DOSAGE = Intensity & Time of Exposure



**Installation of insufficient irradiance will result in inability to penetrate the coil and limited effects on airborne pathogens thereby jeopardizing the intent of the UVC installation.**

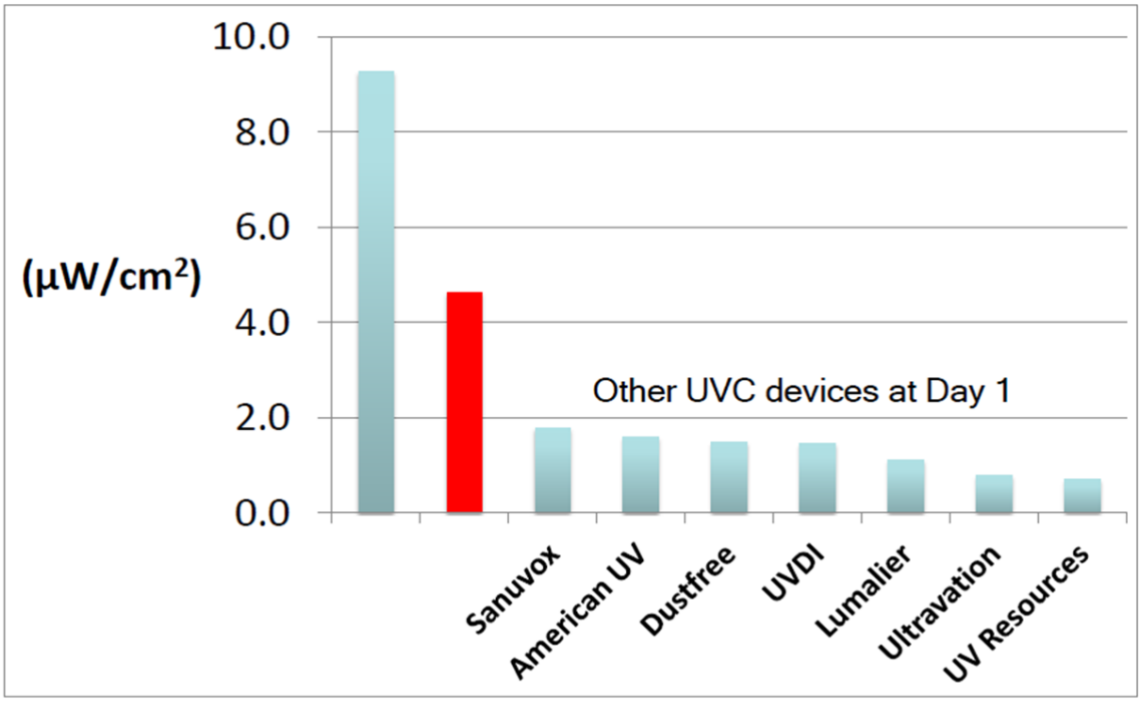
AHU 2.3




Correct location
Correct UVC output

1. Remove Biofilm from surfaces
2. Prevent Biofilms from growing
3. Prevent dispersion of pathogens in the air

## Independent Testing of UVC manufacturers lamps under HVAC Conditions:




Source: Rapid Precision Testing Laboratories - Robert M. Sayre, Ph.D

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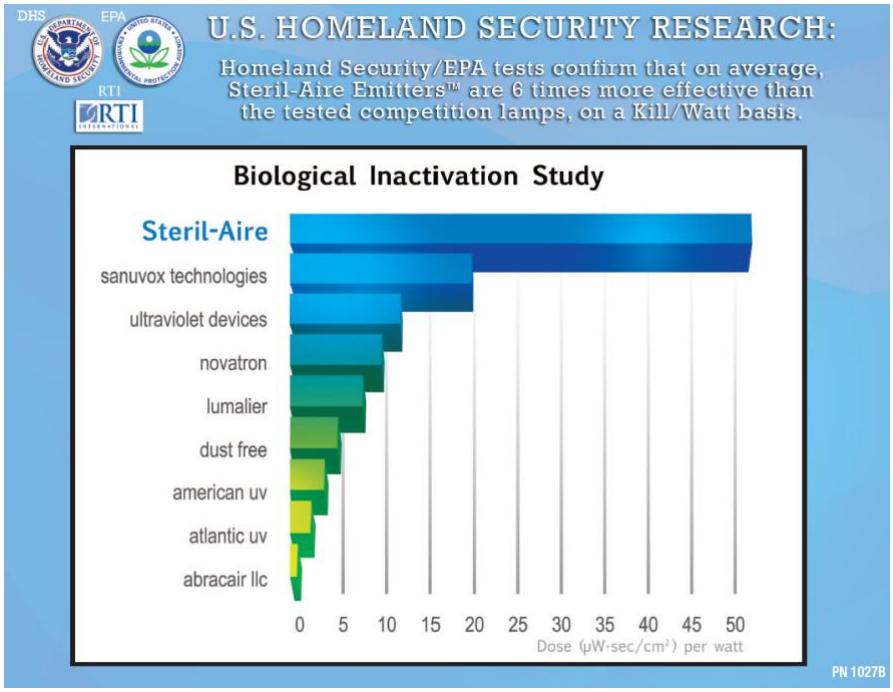

**Location**- Regardless of technology the **ONLY** location to achieve energy efficiency, maintenance and IAQ improvements simultaneously is on the air off side of the cooling coil. As soon as you move any technology away from this location the client loses significant opportunity, particularly with ROI and *with running costs*.

The installation location is critical to performance because the remediation technology must be located where the reservoir and distribution point for microbial growth is and where you can achieve the trifecta of energy efficiency, IAQ and maintenance improvements.

This is on the air off side of the coil above the drain pan where this water from condensate.


**Regardless of technology and specifically for UVC**, installing on the filter side does not address this growth (address energy efficiency or improve maintenance). Installing downstream in the duct does not address the growth and the installation is now at the mercy of higher air velocities making it less effective (time as above).

**Performance based warranty**- It is critical that the emitters maintain the correct UVC output to prevent microbial growth **at the end of life (18,000 hours)** so that the customer receives the intended benefit throughout the life of the product (many UVC lamps are 9,000 hours). The coil should be substantially free from microbial growth at the end of life as part of this warranty

**Warranty**- The power supply should have a lifetime warranty, and the emitters should be warranted to perform and have no defects for 18,000 hours. Failure to adhere to this requirement could result in substantially increased costs for the end user.

**Electrical certification**

Many products on the market do not have electrical certification which can easily be checked by searching databases.

The following must be incorporated to protect the end user

Australian/NZ Electrical Safety Approval (ASA): Tested to comply with AS/NZS 61347.1:2016 + A1, AS/NZS 61347.2.3:2016, AS/NZS 60335.2.65:2015 & AS/NZS 60335.1:2020.

EMC Testing to Standard AS/NZS CISPR 15

**Conclusion**

**Specifying UVC without considering intensity, time and location provide no guarantee of any performance or benefit to the end user**.

Vague specifications enable lower quality and lower output UVC to be installed with no performance parameters and therefore doubtful outcomes for energy efficiency and IAQ. This does not serve the client who chooses to install and pay for UVC with the mindset of specific proven outcomes delivered by UVC.

Steril-Aire's specification is technology agnostic requiring the delivery of a minimum amount of UVC in cold moving air and above the coil. Other manufacturers can meet the specification providing they provide sufficient lamp quantity in the correct location. These lamp quantities may be many times that required by Steril-Aire to create the same effect (from three to 10 times as many lamps).

**Summary -**The logic and reliability of outcome with Steril-Aire is based on the following

1. AHU's, despite typical maintenance and best effort, will be negatively affected by microbial growth/ airborne pathogens affecting surfaces (energy efficiency, hygiene, and corrosion) and air (Mould, bacteria, viruses, VOC.s and odours).
2. Microbial growth in HVAC is unwanted from both a human and fiscal perspective, and removal of microbial growth creates significant advantages across multiple KPI's
3. UVC is scientifically verified to destroy microbes however it requires a certain amount of sustained intensity to be effective in cold moving air HVAC conditions.
4. With the correct intensity, High Output UVC can reliably deliver microbial remediation on surfaces and in air improving energy efficiency, hygiene, and corrosion, and reducing Mould, bacteria, viruses, VOC.s and odours.
5. Steril-Aire UVC deliberately delivers the correct intensity known to achieve microbial remediation and does not drop off its intensity in cold moving air facilitating predictable performance for the duration of equipment lifecycle.
6. Installing on the air off side of the coil above the drain pan where there is moisture, microbes grow and where air moves the slowest is the ideal location to achieve surface and airborne microbial remediation and therefore simultaneously improved energy efficiency and indoor air quality
7. Each specification/ installation unconditionally relies on a specific set of criteria which must be achieved for each coil and is based on UVC science and evidence of performance in the field.
8. Following the Steril-Aire specification creates highly predictable and consistent microbial remediation outcomes on surfaces and in air
9. Surface growth will be removed, and removal of surface microbial growth has predictable and measurable energy efficiency effects based on mechanical engineering first principles.
10. Airborne pathogens will be substantially reduced (COVID and flu 99.99 % in one pass) removal of airborne pathogens results in cleaner safer and healthier air being delivered to the occupied space
11. Decades of field work, established UVC science and case studies around Australia validate all above