ensavior

Energy • Environment • Sustainability

- IAQ Improvement
- Germicidal Irradiation
- Energy Savings
- Green Building Benefits

# UV Treatment in HVAC and Other Industries for SARS and Similar Viruses

Ultra-Violet Germicidal Irradiation

*“In this age of globalization, the smarter and healthier buildings require high-performance air engineering solutions.*

*Today, is the need for businesses to make a switch to best engineering practices and promote environmentally responsible products and services.”*


## Who We Are

***Ensuring Quality, Retaining Trust***

We, Ensavior Technologies Pvt. Ltd., are engaged in the promotion of Air Purification Solutions with a vision to provide you with clean, fresh, odourless and purified air to make every place comfy and homey for you. We design, build and install the products and systems using cutting edge technologies based on scientific breakthrough that help clean, filter and purify the air by expelling particulate matters, removing organic and inorganic odours, gaseous pollutants, microbes, allergens, bacteria, viruses, and VOCs.

We engage in the project right from the conceptualization stage and help in right selection, optimum design and implementation of most energy-efficient products. Besides that, we ensure on-site job training to project managers, facility managers and operators so that the systems are operated in most efficient and simplest manner. Based on the needs of the project, we also undertake the operation and maintenance of the system for which we have back up of spare parts and trained manpower.

Every project for us is a golden opportunity for continuous improvement and swift growth. This results in maximum cost-effectiveness, efficiency, and productivity for our customers.

The technologies used are:

- Ultra-Violet Irradiation (UVGI)
- Photo-Catalytic Oxidation (PCO)
- Gas Phase Filtration
- Cold Plasma
- Ionizers (Unipolar & Bipolar)
- Electrostatic Precipitator (ESP)
- Ozonisation
- Adsorbents and Catalysts
- Biological Treatments
- Special Media Filtration

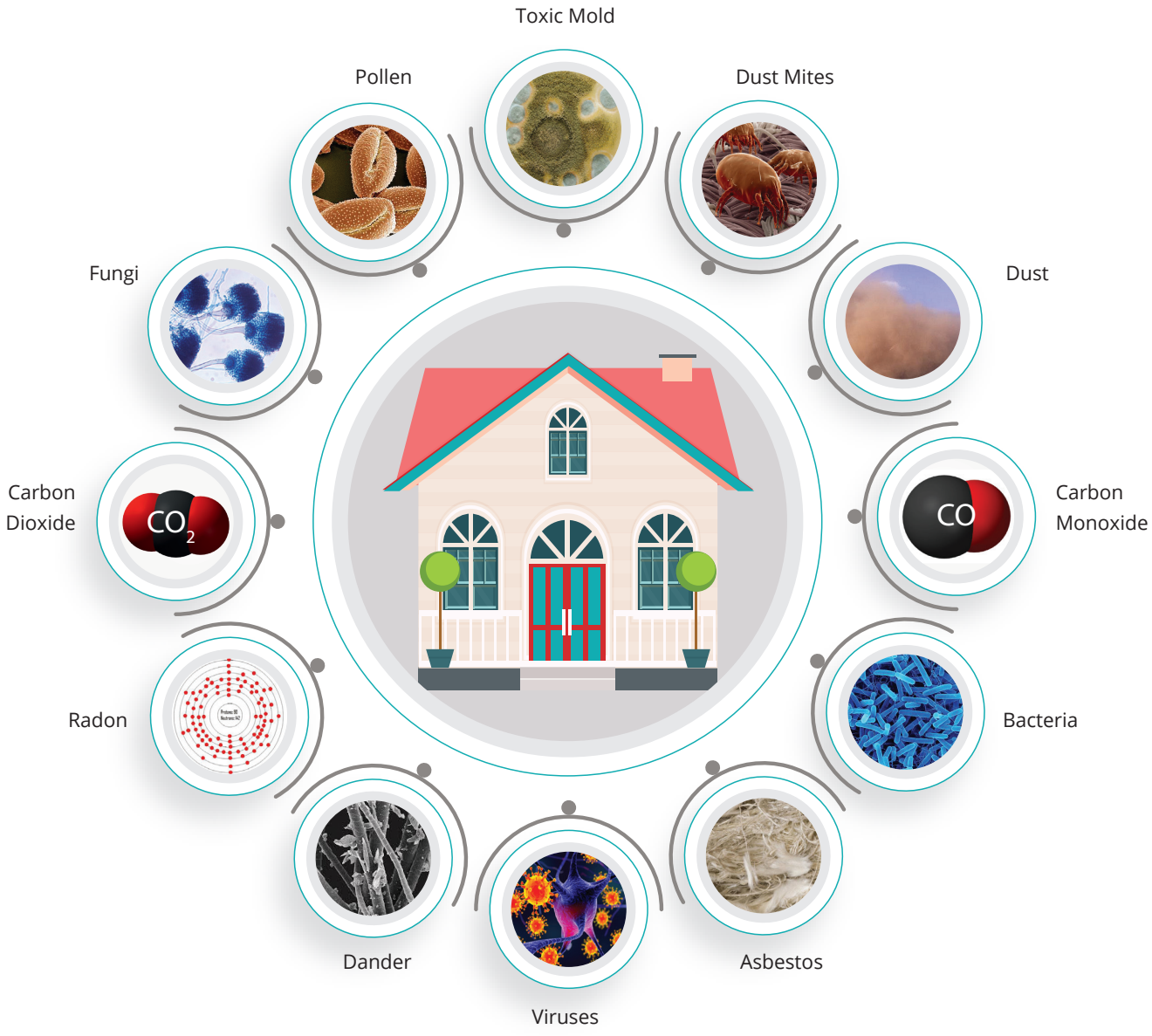
## Importance of Indoor Air Quality

Indoor air quality (IAQ) is one of many factors that determine building functionality and economics.

A building with good IAQ is more desirable place to work, learn and conduct business as it affects building occupants and their ability to conduct their activities and creates positive or negative impressions on them. IAQ directly affects occupant health, comfort and productivity. Serious health impacts resulting from poor IAQ include - Legionnaires' disease, lung cancer from radon exposure, and carbon monoxide (CO) poisoning.

More widespread health impacts include increased allergy and asthma from exposure to indoor pollutants, molds and other infectious diseases that are transmitted through the air, and "sick building syndrome" symptoms due to elevated indoor pollutant levels as well as other indoor environmental conditions. These more widespread impacts have the potential to affect large number of building occupants and are associated with significant costs due to health-care expenses, sick leave, and lost productivity.

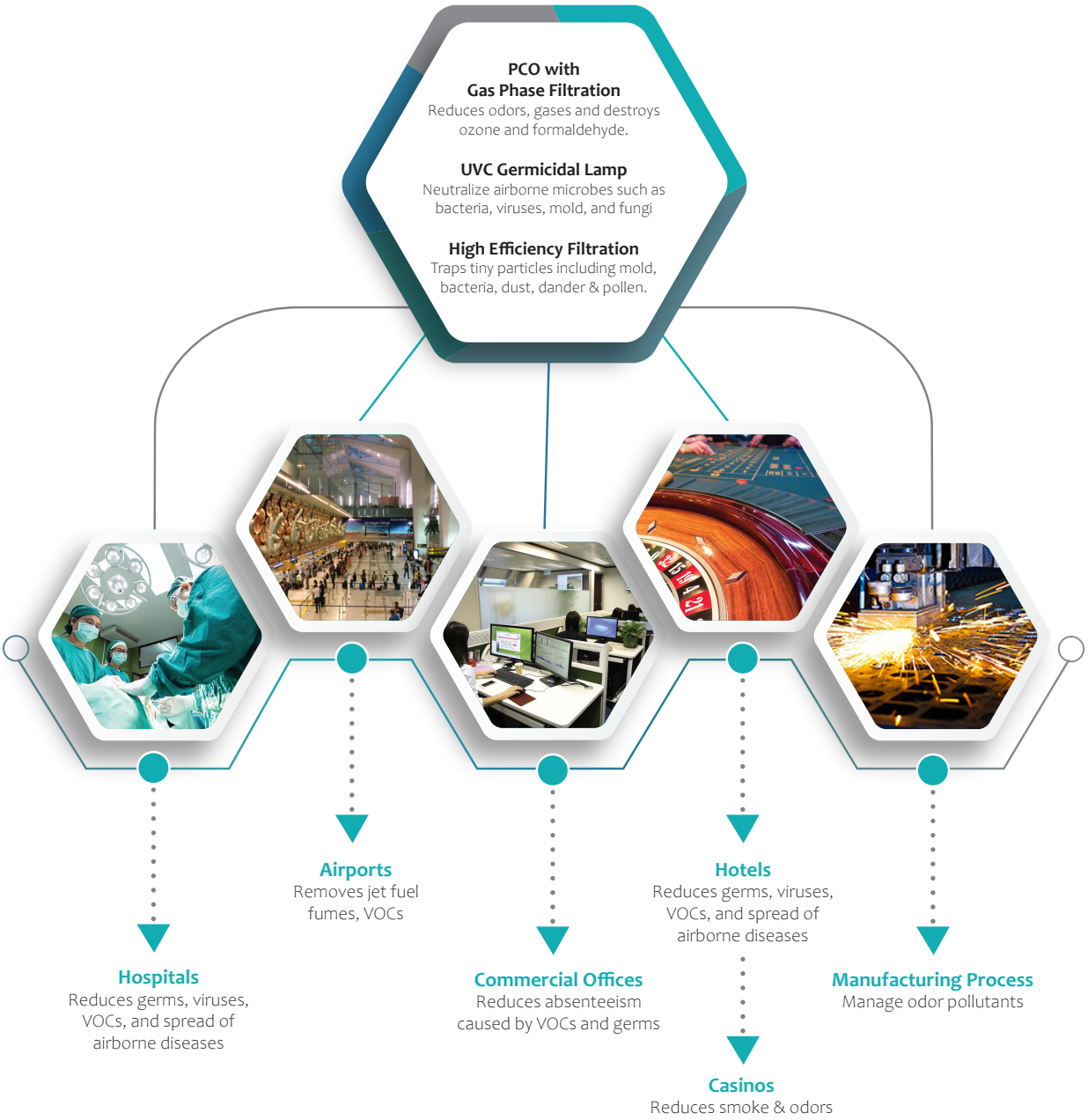
## Contaminants Affecting the Indoor Air



## Solutions for Industries

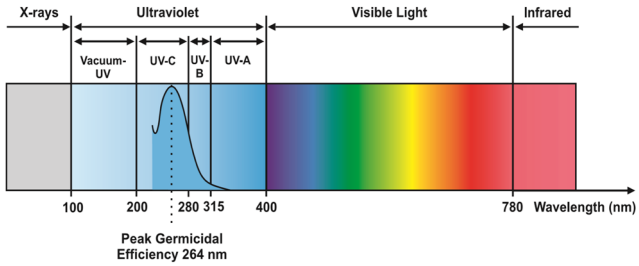
Each project has special air quality needs and challenges, hence we offer a comprehensive solution that is customizable, scalable, effective and robust. Our advanced technology combines high output UVC germicidal irradiation with a state-of-the-art photo-catalytic oxidation process that reduces VOCs and odors. PCO combined with gas phase and high efficiency filtration provides a complete solution for clean, pure, odor-free air and a healthier, people-friendly environment.

### Fresh, Clean, Pure Air



# Ultraviolet Solutions

## *The Electromagnetic Spectrum*

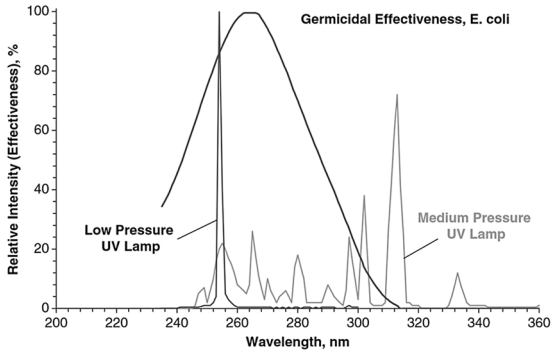



- UV-A — the most abundant in sunlight; responsible for skin tanning and wrinkles
- UV-B — primarily responsible for skin reddening and skin cancer; also used for medical treatments
- UV-C — naturally blocked by the earth's ozone layer and is the germicidal wavelength

The spectrum of ultraviolet light extends from wavelengths of about 100–400 nm. The subdivisions of most interest include UVC (200–280 nm), and UVV (187 nm). Although all UV wavelengths cause some photochemical effects, wavelengths in the UVC range are particularly damaging to cells because they are absorbed by proteins, RNA, and DNA. The germicidal effectiveness of UVC is illustrated in the figure, where it can be observed that germicidal efficiency reaches a peak at about 260–265 nm. This corresponds to the peak of UV absorption by bacterial DNA.

The sun delivers specific UV wavelengths that destroy and deactivate chemical contaminants that are introduced into the atmosphere. Our UV lamp produces the same UV wavelength the sun produces, UVC (Germicidal 254nm) and UVV (Oxidizing 187nm) are produced using quartz glass.

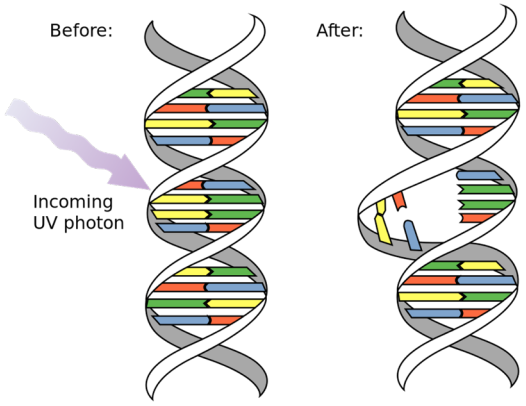
Ultra-violet (UV) energy kills or inactivates microbes (viral, bacterial and fungal species). UV energy attacks the DNA of a living cell, penetrating the cell membrane, breaking the DNA structure of the micro-organism, inhibiting reproduction. UVC is effective in destroying biological contaminants and odours such as mould, bacteria and viruses. UVGI has been used as a supplement to mechanical ventilation to inactivate airborne infectious agents to protect the health of building occupants.




*Germicidal efficiency of UV wavelengths, comparing High (or medium) and Low pressure UV lamps with germicidal effectiveness.*

Low pressure mercury vapour lamps radiate about 95% of their energy at a wavelength of 253.7nm, which is coincidentally so close to the DNA absorption peak (260–265 nm) that it has a high germicidal effectiveness.

UVGI inactivates micro-organisms by damaging the structure of nucleic acids and proteins at the molecular level, making them incapable of reproducing. The most important of these is DNA, which is responsible for cell replication. Absorbed UV photons can damage DNA in a variety of ways, resulting in the organism's inability to replicate or even its death. An organism that cannot reproduce is no longer capable of causing disease. UVGI effectiveness depends primarily on the UV Dosage delivered to the micro-organism.




*Ultraviolet photons penetrate the cell wall of micro-organisms and alter their DNA structure such that the micro-organism is unable to reproduce or infect.*

Vacuum Ultraviolet (UVV)-based processes are used for environmental remediation such as air cleaning, wastewater treatment, and air/water disinfection. When UVV irradiation, photolysis, photo-catalysis, and ozone-assisted oxidation are involved at the same time, it results in the fast degradation of air pollutants because of their strong oxidizing capacity.

Both UVC and UVV wavelengths can work together to destroy biological and chemical contaminants that continually circulate within the building. Depending on the application, UVC, UVV or a combination of both wave lengths are used to achieve the desired results.

### *Applications of UVGI*

- Air-conditioned Offices and Residential Buildings
- Hotel Rooms, Restaurants, Sewage Treatment Plants and Kitchen Exhausts
- Hospitals – OPD, Doctor Chamber, Patient Rooms, Operation Theatres and Laboratories
- Manufacturing facilities of Foods and Pharmaceutical products
- Cold Storage and Refrigerated spaces for storing of fruits, flowers and vegetables etc.
- Industrial Kitchens, Auditoriums, Airports, Cinema Halls and Shopping Malls.

### *Strategy to Address Infectious Aerosols*

**ASHRAE recommends UVGI as one strategy to address infectious aerosol disease transmission.**

Coronaviruses are members of the Corona *viridae* group and contain a single-stranded, positive-sense RNA genome surrounded by a corona-like helical envelope. Coronaviruses have a size range of 60-140nm, with a mean size of 0.10 microns. Table summarizes the results of studies that have been performed on Coronaviruses under UV exposure,

with the specific species indicated in each case. The D value indicates the ultraviolet dose for 90% inactivation. The range of D values is 7-241 J/mt$^2$ the mean of which is 67 J/m$^2$, should adequately represent the ultraviolet susceptibility of the SARS-CoV-2 virus.

*Table – Summary of Ultraviolet Studies on Coronavirus*

| Microbe | Dose (D) J/m$^2$ | UV k m$^2$/J | Base Pairs kb | Source |
|---|---|---|---|---|
| Coronavirus | 7 | 0.35120 | 30741 | Walker 2007[a] |
| Berne virus (Coronaviridae) | 7 | 0.32100 | 28480 | Weiss 1986 |
| Murine Coronavirus (MHV) | 15 | 0.15351 | 31335 | Hirano 1978 |
| Murine Coronavirus | 29 | 0.08079 | 31335 | Saknimit 1988[b] |
| Canine Coronavirus | 29 | 0.08079 | 29278 | Saknimit 1988[b] |
| SARS Coronavirus COV-P9 | 40 | 0.05750 | 29829 | Duan2003[c] |
| Murine Coronavirus (MHV) | 103 | 0.02240 | 31335 | Liu 2003 |
| SARS Coronavirus (Hanoi) | 134 | 0.01720 | 28751 | Kariwa 2004[d] |
| SARS Coronavirus (Urbani) | 241 | 0.00955 | 29751 | Darnell 2004 |
| **Average** | **67** | **0.03433** | | |

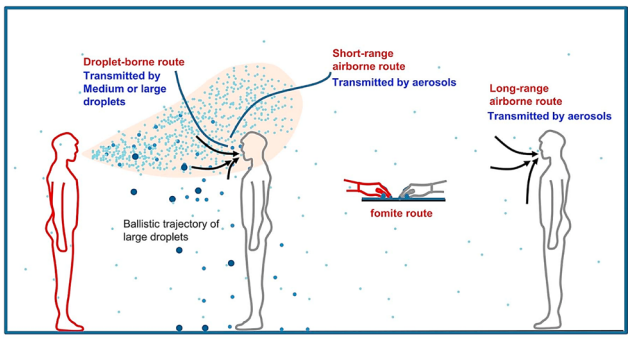
**Ref**: Kowalski, Wladyslaw & Walsh, Thomas & Petraitis, Vidmantas. (2020). 2020 COVID-19 Coronavirus Ultraviolet Susceptibility. 10.13140/RG.2.2.22803.22566.

## Airborne Spread of Infectious Agents

### *In Indoor Environment*

Airborne transmission of infectious agents involves droplets that are expelled by sneezing or coughing or are otherwise distributed into the air. Although the liquid/vapour around the infectious agent evaporates, the residue (or droplet nuclei) may remain in the air for long periods, depending on such factors as particle size, velocity, force of expulsion, particle density, infectivity (i.e., viability of the micro-organism when exposed to the environment and its ability to cause infection when a susceptible host is subsequently exposed), humidity and rate of air flow. Airborne spread of infectious agents is directly relevant to the airborne route, and indirectly to the droplet-borne and fomite routes.

The role of air-conditioning and ventilation, in preventing airborne infections has drawn extensive attention since the SARS outbreak. The mechanism of dispersion of airborne droplets/droplet nuclei in space, the risk estimation of airborne infection, the role of airflow rate, the impact of airflow pattern, etc. are the elements affecting the airborne transmission.

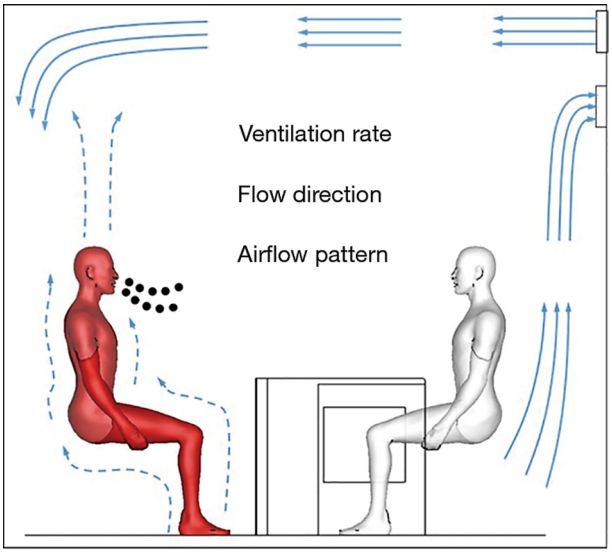



- Large droplets (>100 µm) : Fast deposition due to the domination of gravitational force
- Medium droplets between 5 and 100 µm
- Small droplets or droplet nuclei, or aerosols (< 5 µm): Responsible for airborne transmission

***Small droplets (<5 µm), called aerosols, are responsible for the short & long-range airborne route, and indirect contact route. Large droplets are responsible for the direct spray route and indirect contact route. (Source: Am J Infect Control. 2016 Sep 2;44(9 Suppl))***

### *UVGI Applications and System Types*

| Application | Type of UVGI System | Disinfection Type |
|---|---|---|
| Health Care | Surgical Site Infection Control | Air & Surface |
| | Isolation Wards & Rooms | Air |
| | General Hospital Areas | Air |
| | Emergency Rooms | Air & Surface |
| | TB Clinics | Air |
| | Equipment Disinfection | Surface |
| Commercial Buildings | Bio-defense | Air |
| | Mold Growth Control | Surface |
| | Respiratory Disease Control | Air |
| | Building Remediation | Surface |
| Residential | Allergen & Pathogen Control | Air |
| | Mold Growth Control | Surface |
| Hotels | Allergen & Pathogen Control | Air |
| | Mold Growth Control | Surface |
| Schools | Respiratory Disease Control | Air & Surface |
| Airplanes | Respiratory Disease Control | Air |
| Ships | Disease Control | Air and Surface |
| Laboratories | Bio-hazard Control | Air & Surface |
| Animal Facilities | Airborne Bio-hazard Control | Air |
| Libraries & Museums | Mold Growth Control | Surface |
| | Allergen Control | Air |
| Sewage & Waste Facilities | Bio-hazard Control | Air & Surface |
| Food Industry | Bio-contamination Control | Air & Surface |
| Agricultural Industries | Bio-hazard Control | Air & Surface |
| Industrial Facilities | Bio-hazard Control | Air & Surface |




***Three key elements of air movement affecting the airborne transmission. (Source: J Thorac Dis 2018;10 (Suppl 19):S2295-S2304)***

## UV System Design Criteria

UVC system design relies on performance data from lamp, ballast, fixture and the experience of system designers. UVGI effectiveness depends primarily on the UV dosage (μJ/cm²) delivered to the micro-organisms:

$$D_{UV} = Et$$

where ***E*** is the Average UV Intensity in μW/cm², and ***t*** is the exposure time in seconds (note that 1 J = 1 W/s).

**The ASHRAE 2012 Standard** and its recommendation are followed for calculating UV Intensity at coil surface and In-duct system. The formula is:

$$E = \Phi/(2\Pi LA)$$

***Where***:

***E*** : UV intensity in W/cm²;

Φ : UV Wattage of UV Lamps;

Π : Pi;

***L*** : Length of lamp (cm);

***A*** : Distance between Lamp & Coil surface (cm).

A key difference between surface decontamination and airborne inactivation of organisms is exposure time. The basis of determining the radiant energy levels are as follows:

- Length of Exposure
  - If target is stationary, length of exposure is high.
  - If target is moving, length of exposure is low.
- Intensity of Source
  - Type of UVC lamp/Electronic Ballast/Mounting Assembly/ Lamp placement.
- Distance from Source to Surface
  - Closer the surface, higher the intensity and vice versa.
- Air Velocity
  - Useful to calculate and determine the length of UV Exposure for the moving particle.

UVGI is used as a supplement to mechanical ventilation to inactivate airborne infectious agents, to protect the health of building occupants. UVC lamp systems, that kill 70 to 95% of all microbes in the air, can be deployed in the following areas:

### *UVGI System Configurations to Help Mitigate Viruses*

- On AHU Coils and Drain Pan for Cleaning the Supply Air
- In Supply / Return Air Ducts
- Wall Mounted Upper-Room Air Disinfection
- Portable Hand-Held Surface Cleaner

### *Hospital Wide Application Areas of the UVGI System*

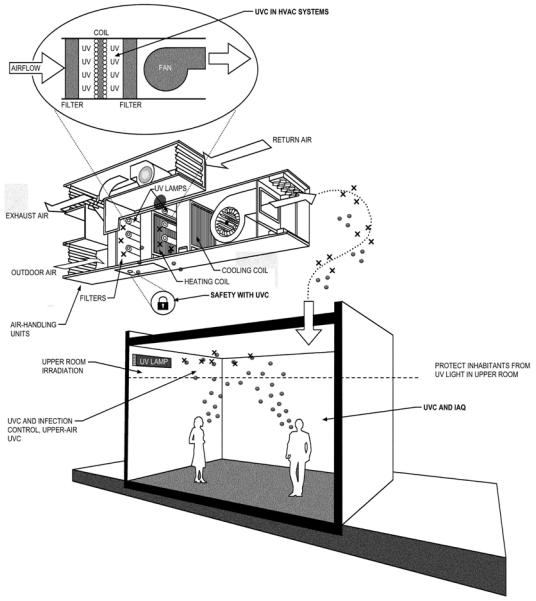
- Operating Rooms, ICU / CCU
- Doctors Cabin
- Patient Rooms / Wards
- Out-Patient Waiting Areas

## Coil-o-Care - Surface Disinfection

### *AHU and Drain Pan Irradiation*

Application of UVC is becoming increasingly frequent as concerns about indoor air quality increase. UVC is now used as an engineering control to interrupt the transmission of pathogenic organisms. UVC lamp devices and systems are placed in air-handling systems and in room settings for the purpose of air and surface disinfection. Control of bio-aerosols using UVC can improve indoor air quality (IAQ) and thus enhance occupant health, comfort, and productivity.

HVAC systems can promote the growth of bacteria and mold-containing bio-films on damp or wet surfaces such as cooling coils, drain pans, plenum walls, humidifiers, fans, energy recovery wheels, and filters. Locations in and down-stream of the cooling coil section are particularly susceptible because of condensation and carryover of moisture from coil fins.




***Applications of UVC to Control Micro-organisms in Air and on Surfaces (ASHRAE 2009)***

Cooling coil fouling by bio-films may increase coil pressure drop and reduce airflow and heat exchange efficiency. Filters capture bacteria, mould, and dust, which may lead to microbial growth in damp filter media. As the growth proliferates, a filter's resistance to airflow can increase. This can result in more frequent filter change-outs and increased exposure to microbes for maintenance workers and building occupants. As airflow and coil performance degrades, so does the air quality in occupied spaces.

Aluminium or other highly reflective material reflectors on the UVC lamps, can improve the overall reflectivity of the inside of the air handler and thereby reflecting UVC energy back into the irradiated zone, thus increasing the effective UV dose and the UVC system performance.

Conventional methods for maintaining air-handling system components include chemical and mechanical cleaning, which can be costly, difficult to perform, and dangerous to

*Coil-o-Care - UVC Lamp Assembly Arrangement for AHU Coil Cleaning*

maintenance staff and building occupants. Vapours from cleaning agents can contribute to poor air quality, chemical runoff contributes to groundwater contamination, and mechanical cleaning can reduce component life. Furthermore, system performance can begin to degrade again shortly after cleaning, as microbial growth reappears or re-activates.

UVC applied in air-handling units, complements conventional system maintenance procedures and has shown to be effective in reducing air-side pressure drop and increasing air-side heat transfer coefficient of wetted cooling coils.

### *Safety*

Human exposure to UVC light may result in unnoticed eye (cornea) damage and skin (sunburn) damage. While these effects are mostly temporary, they can still be very painful.

Most materials, including glass and plastic, attenuate UVC radiation. Maintenance personnel should wear protective clothing, eye wear, and gloves when dealing with lamp replacement tasks to protect against broken lamps and accidental UV exposure.

### *Additional Safety Considerations*

- Dispose of used lamps in accordance with regulations regarding mercury content.
- Air ducts should be fully enclosed to prevent UV leakage.
- All access doors and panels should have warning labels posted on the outside.
- Interlocks should be installed such that opening any door to a UV lamp chamber will turn off the lamps.
- The UV lamp chamber should have a view-port large enough for the UV state to be viewed from a distance outside the chamber Specially for AHU application.
- Educate installation and maintenance workers on equipment hazards and safe practices.

## Duct-o-Care - Air Disinfection

### *In-Duct Cleaning*

Environmental conditions within an air-duct promotes the growth of biological contaminants (viz. mould). This contamination eventually spreads down the ductwork and into the living spaces.

The in-duct UVGi System is designed to maximize airborne kill of dangerous pathogens such as viruses, bacteria, and mold spores. This duct-mounted UVGI system is designed for intensive air-stream UVC irradiation. The system features multiple UV high-output germicidal UV lamps which sterilize airborne biological contaminates as they pass by. The In-duct UVGI system is fully customizable and can be configured to fit a wide variety installation parameter.

The desired exposure time for adequate dosage in ductwork is an important design criteria. When there is limited time of exposure due to the velocity of the moving air-stream, more than one UV light unit may be required to achieve adequate exposure time. The primary variables important to the design configuration of a UVGI system include: air duct dimensions (W x H x L); airflow rate; UV lamp specifications (viz. UV power, arc length, lamp radius); lamp quantity and locations; duct reflectivity; and filtration.

When the air-stream disinfection is the approach, then having the most amount of UV production possible is the preferred method. This can be achieved by using high output (HO) UV lamps. The average irradiance for a typical air duct application should range from 1,000 to 10,000 $\mu W/cm^2$ depending on the microbe to be inactivated and operating conditions such as air temperature, air velocity, and humidity.

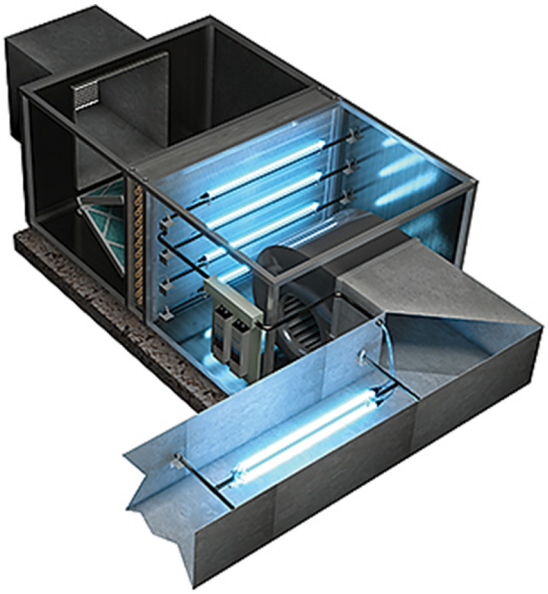
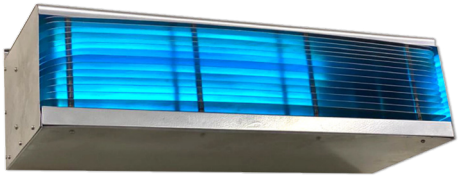


*Illustration showing the AHU Coil cleaning and Duct cleaning arrangement in a HVAC system.*
*(Source: https://www.achrnews.com/articles/128955-uv-and-air-purification-effectively-contain-airborne-pathogens)*

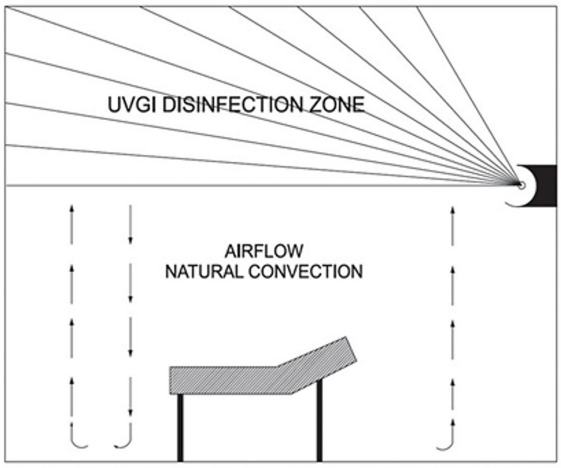
# SteraShield - Upper-Air Disinfection

***SteraShield - Wall Mounted Upper-Air Disinfection***

The primary objective of Upper-Air UVC placement and use is to interrupt the transmission of airborne infectious pathogens within the indoor environment.



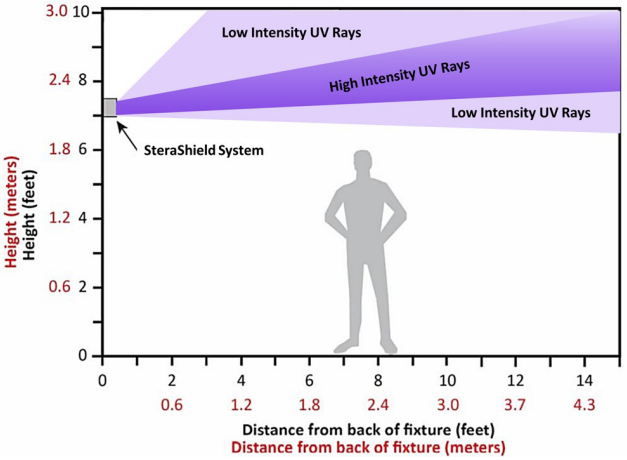
The source of these infectious organisms may be infected humans, animals, or bio-aerosols. There are at least two transmission patterns: within-room exposure such as in a congregate space, and transmission beyond a room through corridors and by entrainment in ventilation ductwork, through which air is then recirculated throughout the building.




*Installation in a Room of Wall Mounted System*

Numerous experimental studies have demonstrated the efficacy of Upper-Air UVC. Effectiveness has also been established for inactivating tuberculosis, reducing measles transmission and the interruption of influenza transmission within a hospital.

*SteraShield - Wall Mounted Upper-Air UVC Device Installed in a Hospital*




*UV Intensity Distribution in a Room with Wall Mounted System*

Upper-Air UVC devices are designed to generate a controlled UVC field above the heads of occupants and to minimize UVC in the lower, occupied area of the room. Settings appropriate to upper-air UVC placement include congregate spaces, where unknown and potentially infected persons may share the same space with uninfected persons (e.g., a medical waiting room or homeless shelter). Common corridors potentially used by unknown infected persons in a medical facility would also benefit from Upper-Air UVGI fixtures. Upper-Air UVC also covers situations where untreated recirculated air might enter an occupied space.

The device consists of UVC lamps installed in a specially designed reflector assembly; the whole system is to be mounted on a wall to create a UVC beam directed to the ceiling. Natural convective currents take microbes to upper level which are effectively eliminated by the germicidal action of UVC. It is very helpful to the patients and even more to the health care workers.

### *Upper-Air UVGI System Benefits*

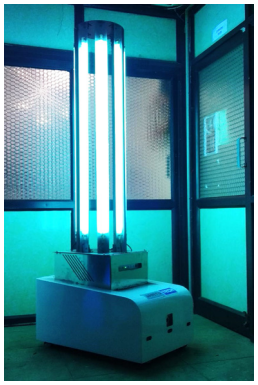
- Effective control against secondary air borne infection, including drug resistant pathogens.
- Works 24/7 without affecting occupants of the space.
- Cost effective system.
- Does not require any air-conditioning/ventilation system.
- No secondary contaminants are produced.
- Maintenance free system.
- Safeguards patients and health care workers.

### *Applications*

- Hospitals
- IT Parks, Schools and Colleges
- Commercial Spaces – Malls, Restaurants, Pubs
- Hotels, Casinos
- Pharmaceutical
- Food Processing
- Waiting Rooms
- Residential Spaces

# UVGI SteRobot

### *Ultra-Violet Germicidal Irradiation for Room and Surface Sanitization*



Designed specifically to target zero infections in the environment, the SteRobot is a less expensive, more efficient, easily transportable,and powerful disinfection system designed to provide a rapid and highly effective method to disinfect surfaces, components, and common touch points.It is powered by UVC lamps rated for 12,000 hours; and features motion sensors as a safety precaution.

### *SteRobot for Room & Surface Sanitization-The System*

A **MAKE IN INDIA** initiative, SteRobot is a specialized UV sanitizer machine, that can eliminate more than 99% of bacteria and viruses on contaminated surfaces within minutes. It brings together the proven UV and the robotic technology in a single system.

### *SteRobot UV Room Sanitizer Technology*

- High power, UL certified, Ozone free lamp technology helps in better coverage of sterilization area.
- Employs high-intensity, shatter proof, UV-C lamps to efficiently deactivate bacteria and viruses.
- 360-degree coverage of UV radiation ensures the least shadow areas i.e. areas where one cannot reach through usual cleaning mechanism.
- Handheld remote controller records the run hours of the system, distance travelled during each operation and time spent in sanitation mode.

### *SteRobot – Mobile UV Room Sanitizer Highlights*

- UV-C light of 253nm wavelength is used to give fast treatment in large areas and office spaces.
- Powerful 800W UV system that delivers high efficiency irradiation UV dose.
- Battery life of over 2 hours.
- Hot swappable battery for continuous operations.
- Front and Back Camera for live visual guidance plus obstacle detection.
- Reduce up to 99% of microbes including SAR Covid viruses and TB bacteria.
- It can cover 100 sq. ft. in one minute and 10,000 sq. ft. in under 2 hours.

### *Advantages of SteRobot UV Room Sanitizer*

- Automated UV disinfection system with minimal human intervention.
- Easy to install, operate, and handle, so any level of staff members can operate this sanitizer machine for sanitization.
- UV disinfection tower is a portable machine and can be easily moved around from one room to another.
- With SteRobot UV Sanitizer, the surface disinfection happens without any direct touching of objects, which ensures fewer chances of the machine being contaminated in any way.

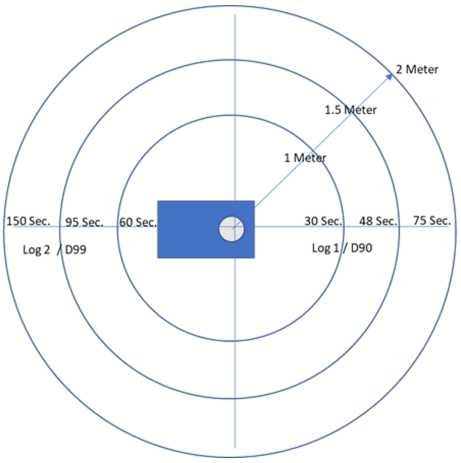
### *Applications of SteRobot UV Room Sanitizer Machine*

- The portable UV sanitization tower can be used in Hospitals and Nursing homes, Quarantine Centers, Offices and Meeting Rooms, Hotels, Restaurants, Pantries, Washrooms, Gymnasiums, Factories & Warehouses, etc

### *SteRobot UV Room Sanitizer Machine – Use Cases*

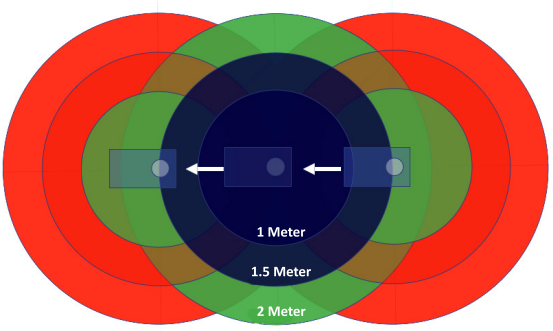
The SteRobot has been tested for two use cases, one where it can be stationed in a space or room and kept for the required time to achieve sanitation. The second use case is the continuous operation across a large work hall at its design speed and sanitation is achieved during movement.

**Use Case 1: Stationary Operation**




- Will sanitize a room to 90%, up to a radius of 2 meters in 75 seconds and up to 99% in 150 seconds.
- Useful in small offices, meeting rooms, hospital rooms, OT's and ICUs.

**Use Case 2: Continuous Operation**




- Operates at a speed of 1.5 meters per minute, sanitizes an area of 100 Sq. feet in 48 seconds, or an area of 10,000 Sq. feet in about 1 Hr 20 min.
- Useful for large spaces, and work halls.

## SteraAirMini

***Custom Built Air Sanitizer with UV-C, UV-V and PCO***

SteraAirMini Air Sanitizers can help protect occupants in small rooms from infection due to airborne microbes, particularly in frequented or poorly ventilated areas, and in situations where the risk of cross infection is high.

These custom built units can be fitted with:

- Pre-Filter to trap particulate matter,
- EC-Axial Fan for efficient air movement through the system,
- Germicidal ultraviolet lamp (UV-C) that effectively destroys airborne microbes including bacteria, mold, and virus, in occupied spaces.
- UV-C Lamps are completely enclosed within an exposure chamber and are safe for use in every application.
- UV-C lamp and UV-V lamp in combination are assembled together to take care of airborne microbes and VOCs.
- UV-C lamp and MMO coated plates to create Photo-Catalytic Oxidation process to eliminate the airborne microbes and VOCs.

The unit can be mounted on a wall or the roof. Plug into an appropriate power source.

- EC-Axial fan draws air through the Pre filter to trap particulate matter.
- The air then passes into the exposure chamber, where it is irradiated by UV-C/UV-V lamp.
- MMO coated Photo-catalytic system can be provided to take care of the VOCs.
- The treated and clean air is then discharged through the louvers, located on top of the unit.

***UV-C Lamps and Ballast***

- Lamps are instant starting and provide the utmost in quality, sustained output, and longevity
- Electronic ballasts for the operation of ultraviolet lamps, provide high lamp output; are lightweight, efficient, and operate cool for longer life.

***Reflector Surface***

- Interior surface is a reflective surface to maximize ultraviolet intensity within the chamber.

***Exhaust Louvers***

- Exhaust Louvers are provided to protect the room's occupants from ultraviolet exposure by restricting ultraviolet radiation from passing into the room.

***Disposable Filter***

- Cost effective, disposable pre-filter is provided to trap dust, other particles suspended in the air.


**SteraAirMini Air Sanitizer – Technical Data**

| Model | Nominal Capacity | Dimensions (mm) | | | Coverage Area | MOC of Casing |
|---|---|---|---|---|---|---|
| | (cfm) | Length | Width | Hight | (square feet) | |
| EN-SAM-100-C | 100 | 180 | 100 | 560 | 300 ~ 350 | SS-304 |
| EN-SAM-100-C-V | | | | | | |
| EN-SAM-100-C-P | | | | | | |

- *Model capacity incorporates an estimated allowance for airflow friction loss across filter.*
- *For more capacities and other configurations, contact factory.*

**SteraAir Mobile Air Sanitizer Germicidal Lamp Data**

| UV-C | Lamp Size (mm) | | UV Lamp Current | Average Life | Effective Life | Driver |
|---|---|---|---|---|---|---|
| nm | Dia | Length | (mA) | (hrs) | (hrs) | Electronic Ballast (PF > 0.95) |
| 254 | T5 ~ 15 | 287 | 425 | 12,000 | 9,000 | |

## SteraSure

***Custom Built Mobile Air Sanitizer with UVGI, PHI-Plus Cell and Filters***

These sanitizers are equipped with Pre-Filter, Activated Carbon Filter, HEPA filter and Advanced PHI-Plus cells with UV-C Lamp. Advanced PHI-Plus cells effectively destroy airborne microbes including bacteria, mold, and virus in enclosed occupied spaces.

The unit is mobile and requires no installation. Roll the unit into the occupied area to be treated and plug into an appropriate power source. During operation, air is drawn into the unit through the Pre-filter. The air passes into the exposure chamber, where it is irradiated by PHI-Plus cells. The treated air then passes through the Activated Carbon and HEPA Filter to trap odours and particulate matters.

The unit protects the occupants from ultraviolet exposure, by restricting ultraviolet radiation from passing into the occupied room.

These custom built units are fitted with:

***PHI-Plus Cell***

- PHI-Plus Cell employs the most advance nanotechnology of specialized multi-metallic oxide (MMO) coating on metallic surface and UV lamp for Advanced Oxidation Process (AOP), thereby creating: Hydro-peroxides, super-oxide ions and hydroxide ions. The ions generated in the process are friendly oxidizers, that convert back to oxygen and hydrogen after the oxidation of the pollutant.
- PHI-Plus Cell are completely enclosed within an exposure chamber and are safe for use in every application.

***UV-C Lamps and Ballast***

- Lamps are instant starting and provide the utmost in quality, sustained output, and longevity
- Electronic ballasts for the operation of ultraviolet lamps, provide high lamp output; are lightweight, efficient, and operate cool for longer life.

***Disposable Filters***

- Cost effective, disposable Pre-Filter, **Activated** Carbon Filter and HEPA filter are provided to trap dust, odours and other particles suspended in the air.

***Power Supply and Interlock Safety Switch***

- Detachable power cord is provided for power supply.
- The interlock safety switch disconnects power to the unit when the access panel is opened for servicing the PHI-Plus cells or Fan.

***AQI Monitor & Controller***

- Air quality controller is provided with touch screen to display air quality readings, such as PM2.5, $CO_2$, TVOC, Temperature, Humidity, etc.
- The controller can control the system, e.g., switch the fan and UV Lamps ON or OFF, based on the set parameters of PM, $CO_2$ and VOC.

***Fan***

- Fan is provided for efficient air handling.


### SteraSure – Technical Data

| Model | Nominal Capacity (cmh) | Dimensions (cm) | | | Max. Room Size at 2 Air Changes/Hr | Max. Room Size at 4 Air Changes/Hr |
|---|---|---|---|---|---|---|
| | | Length | Width | Height | (Cubic meter) | (Cubic meter) |
| ETPL-SS-500 | 500 | 45 | 50 | 80 | 80 ~ 400 | 40 ~ 200 |

- *Model capacity incorporates an estimated allowance for airflow friction loss across filter.*
- *For more capacities and wall mounting configurations, contact factory.*

### Germicidal Lamp Data

| UV-C | Lamp Size (mm) | | UV Lamp Current | Average Life | Effective Life | Driver |
|---|---|---|---|---|---|---|
| nm | Dia | Length | (mA) | (hrs) | (hrs) | Electronic Ballast (PF > 0.95) |
| 254 | 15 | 287 | 425 | 12,000 | 9,000 | |

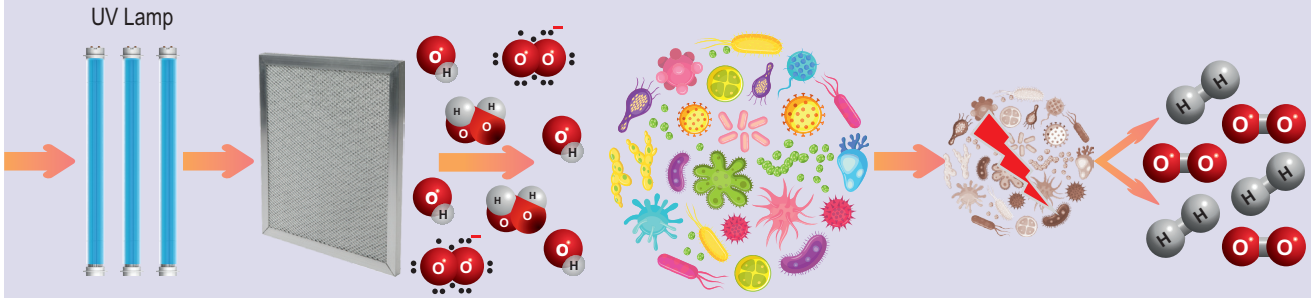
## Advanced Photo Hydro-Ionized Oxidation (PHI+Plus) Cell

***Air Purification System***

The PHI+Plus Cell is designed to effectively reduce the odors, air pollutants, VOCs (chemical odors), smoke, mold bacteria and viruses from the moving air in AHUs and inside the air-ducts. The PHI+Plus Cells are easy to mount in the air conditioning ducts, thereby eliminating the sick building syndrome risks.

PHI+Plus Cell employs the most advance nano-technology of specialized multi-metallic oxide (MMO) coating on metallic surface and UV lamp for Advanced Oxidation Process (AOP), thereby creating: Hydro-peroxides, super-oxide ions and hydroxide ions. The ions generated in the process are friendly oxidizers, that convert back to oxygen and hydrogen after the oxidation of the pollutant.


### Advanced Photo Hydro-Ionized Oxidation (PHI+Plus) Principle

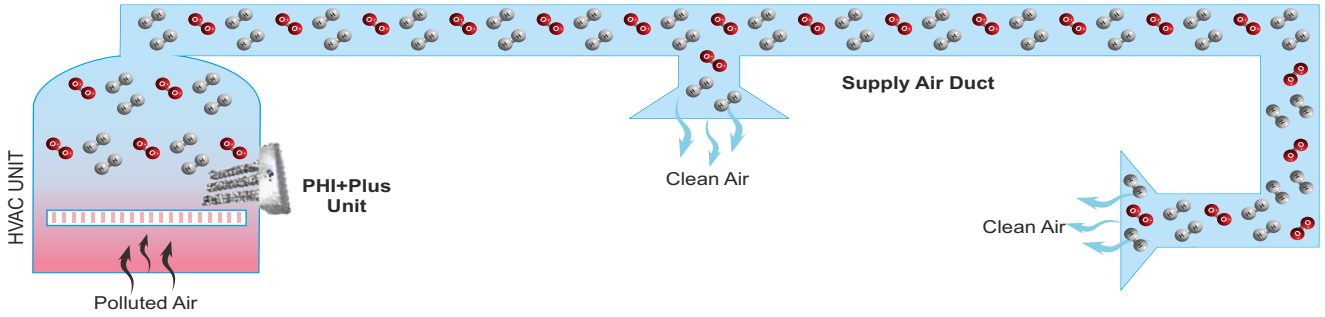


### *Advanced Photo Hydro-Ionized Oxidation Cell Technology*

Ultra-Violet lamps having germicidal properties are being used extensively as an effective tool for destroying micro-organisms (germs, viruses, bacteria). Germicidal UV lamps combined with Advanced Photo Hydro-Ionized Oxidation is effective not only in reducing the airborne micro-organisms that come in contact directly with the UV light rays but is very effective on gases, vapors, VOCs and odors.

UV light enhanced by the specialized MMO coating on metallic surface, develops an Advanced Oxidation Process (AOP) reaction. This reaction produces hydro-peroxides, super-oxide ions and hydroxides. By using proper UV light wavelength, in combination with AOP function, the PHI+Plus Cell purifies the air.

With the Advanced Photo Hydro-Ionized Oxidation (PHI+Plus) Cell System, micro-organisms can be reduced by over 95%. Gases, VOCs and odors can also be reduced significantly, and the room will have hydro-peroxides, super oxide ions and hydroxides which will help give your room fresh, clean and odor free air.




| PHI+Plus Applications | |
|---|---|
| ✦ Hospital, Clinic & Laboratories | ✦ Commercial Buildings |
| ✦ School, Universities, Libraries, Museums | ✦ Hotels, Restaurants, Food Courts |
| ✦ Food & Packaging Industries | ✦ Casinos, Bars, Pubs |
| ✦ Clean Room Applications | ✦ Data Centers, Semi Conductor Facilities |

| Technical Data | | | | |
|---|---|---|---|---|
| Installation | Installed in HVAC Duct or Plenum | | Model - E/PHI+Plus-1-12 | 5,000 CFM |
| Electrical | 220 VAC, 50 Hz, 14-20 Watts | | Model - E/PHI+Plus-2-12 | 15,000 CFM |
| Materials | Powder Coated MS Housing | | Model - E/PHI+Plus-3-12 | 25,000 CFM |
| Replaceable Parts | PHI+Plus Cell | | Lamp Type | UV-C |
| CFM Range | 300 ~ 35,000 CFM | | Wave Length / Driver | 254 nm / Electronic Ballast |

- *The PHI+Plus Cell unit size is available for various air flow rates of HVAC systems.*
- *Consult factory for other models.*
- *Due to continuous development, the specifications and product appearance subject to change without prior notice.*

# UVGI SteraStic

### *UVGI - Portable Surface Sanitizer*

UVGI SteraStic is very useful for surface and volumetric disinfection by ultraviolet light. In addition to being very light, it is very powerful, and within a few seconds, produce germicidal effect on the surfaces where the UV light is applied. Uses no chemicals; produces no ozone or other toxic contaminants.

- Easy to use and flexible enough to quickly bring the power of UVC where and when you need it
- Improved environmental hygiene means improved clinical outcomes, reduced cross-contamination and enhanced safety
- Produces no ozone or other secondary contaminants – will not harm equipment or furnishings.

UVGI SteraStic can be used to effect a 99% reduction of various microbes including COVID 19 viruses on surfaces. UV-C light of 254nm wavelength is used to provide an average intensity of 10,000 microWatt at its surface. SteraStic can be used on table tops, railings, doors, walls. It can also be used in hospitals for masks overalls, effective in minutes.

### *Operating Instructions*

SteraStic should be held within 6 inches of the surface to be treated and then turned on. It should be moved slowly over the entire surface providing sufficient exposure time.

### *Safety Precautions*

Must be used by trained operator. The operator must be equipped with a face shield, cotton gloves and full sleeved shirt. SteraStic must not be pointed towards other people, it should be ideally operated when there are no other people in the room or area. Direct or reflected UV exposure to skin and eyes must be avoided as it may cause damage.

### *Cost Effective*

SteraStic uses made in India UV lamps coupled to a tested electronic ballast. The combination provides 6 months of optimum output and life for the lamp. The design ensures no direct UV on the operator. Requires no maintenance except for periodic replacement of the UV lamp.

### *Dimensions*

Length (L) 53 cm x Width (W) 7 cm

Weight (W) 1.5Kg

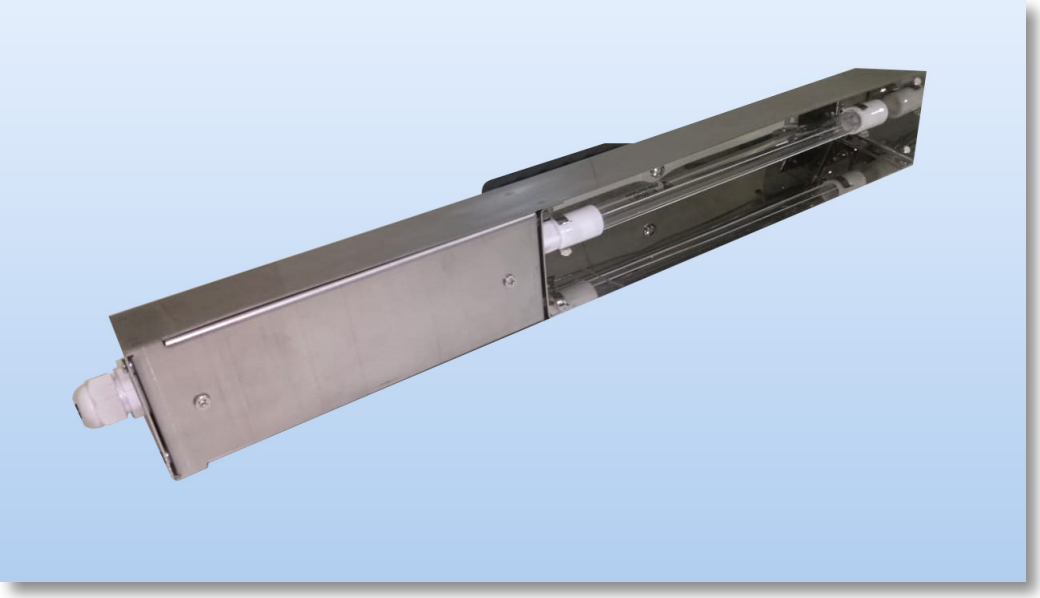
### *Portable*

SteraStic is light weight and can be easily carried by a single person.

### *Applications*

SteraStic can be used for surface decontamination in hospitals, labs, clean-rooms, food processing, clinics, kennels, institutional, residential and commercial applications.

- Laboratories and clean-rooms to prevent cross-contamination
- Ideal for residential and commercial mold remediation
- Hard to reach and high-touch surfaces such keyboards, doorknobs, bed-rails
- Libraries, to eradicate mold on book surfaces
- Food preparation, processing and packaging areas to reduce pathogens such as *Coliform*, *Salmonella*, *E. coli*, *Staphylococcus, Listeria*



## UVGI SteraBelt

### *Ultra-Violet Germicidal Irradiation in Baggage Conveyor System*

SteraBelt baggage conveyor system is designed specifically to target zero infections on the incoming baggage into a building. The fully automated stand-alone, powerful surface disinfection system provides a rapid and highly effective method to disinfect baggage, components, and other volumetric objects. It does not use any chemicals for disinfection.

### *Objective*

To reduce the risk of bacteria and viruses spreading through the movement of baggage into the buildings.

### *The Conveyor System*

The system is an automated stand-alone roller-based conveyor carriage system, which is equipped with accurately calibrated and optimally placed UVC lamps to disinfect any item within seconds, passing through the chamber. The sensing mechanism of the system automatically detects the entry of bags and powers on the UVC illumination.

The system has been specifically designed to irradiate the outer surface of the baggage in all directions and disinfects the entire surface at the required intensity levels and exposure time. It also has inbuilt safety features for ensuring the prevention of any direct UVC exposure outside the chamber.

### *Applications*

This system is suitable for Airports, Railway Stations, Metro Stations, Bus Stations, Hotels, Malls, Hospitals, Industrial and Institutional gates.

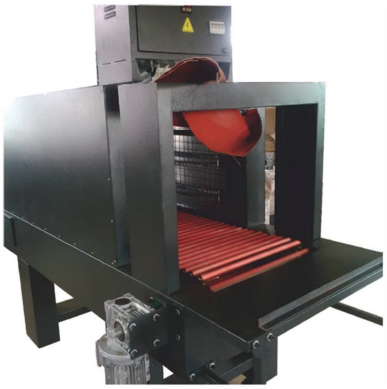
### *Design*

UVC lamps provides an average intensity of 2,300 μW/cm² in the tunnel. For 90% reduction of bacteria and viruses, the sanitation time is 10 seconds. For 99% reduction of bacteria and viruses, the sanitation time must be increased to 20 seconds.

A higher sanitation time is considered to provide for redundancy such as various shapes of material. Also, there will be certain areas in the tunnel section, where there shall be shadow due to the size and shapes of material passing through it.

### *Details of the Conveyor System*

- UV System Wattage – 520 Watts
- Number of UV Lamps – 4 Nos.
- UV Enclosure Length – 1,800 mm
- UV Enclosure Opening – 560 x 560 mm
- Conveyor Length – 2,100 mm
- Conveyor Width – 600 mm
- Conveyor Height – 900 mm
- Motorized Rollers – Included, with Variable Speed Drive



## Catalytic Air Purification

***PCO with Gas Phase Filtration***

It is an advanced process by which volatile organic compounds (VOCs), bacteria, molds and fungus are destroyed by incorporating photon and ultraviolet (UV) energy activating a catalyst thereby creating the photo catalytic oxidation (PCO) process.

UVPCO often utilizes a honeycomb configured, reactor coated with titanium dioxide (TiO2 or titania) as the photo-oxidative catalyst. This design potentially can have high conversion rates with low pressure drop making it suitable for use in building HVAC systems.

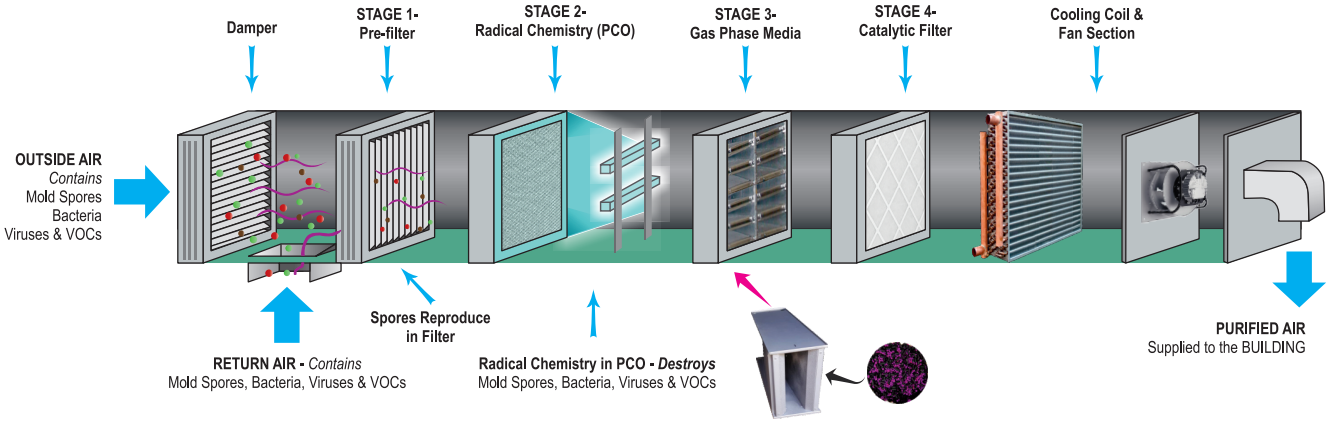
The coated screen is irradiated with UV light near 254 nm UVC. Air containing organic pollutants flows through the screen , where the VOCs adsorb on the catalyst. The UV light interacting with the catalyst in the presence of oxygen and water vapor, produces hydroxyl radicals. Hydroxyl radicals are highly chemically reactive and, in-turn, breakdown the adsorbed VOCs, ideally producing only carbon dioxide and water as bye products.

Gas Phase Filtration with Photo-Catalyst Oxidation systems are tailored precisely to your needs and operate with the highest efficiency. The multistage design allows for selection of the required filters in a specific sequence to meet the requirements of each application.

- Destroys moulds, viruses, bacteria and allergens etc.
- Maintains desired levels of particulate matter
- Efficient regeneration of media
- Flexible design, Easy to retrofit
- Adequate controls for safety
- No harmful emissions
- Reduces all odorous and hazardous air pollutants
- Provides very high single-pass efficiency of gas removal
- Prevents corrosion / breakdown of electronic equipment

***Optional Equipment***

- Differential Pressure Monitoring System
- VOC Sensors
- Lab Analytical Services




### *Stage 1 – Pre-Filtration*

Air entering the system passes first through a MERV 8 high-efficiency particulate filter, which captures many of the larger biological contaminants and small airborne particles such as mold spores and pollen.

Bag Pre-Filters are provided with 95% efficiency (MERV 14, EU 8), bag filter made of 100% dual layer synthetic fibers to capture finer particulates.

### *Stage 2 – Radical Chemistry (PCO)*

Viruses, odors, VOCs and micro-organisms are exposed to a high-intensity ultraviolet light. This UV radiation penetrates micro-organisms such as fungi, bacteria and viruses and damages their DNA bonds, sterilizing them.

This air passing through a panel coated with titanium dioxide ($TiO_2$), when subjected to ultraviolet photons, creates hydroxyl radicals. The radicals oxidize gaseous organic compounds, e.g. odors and VOCs

### *Stage 3 – Gas Phase Media*

The system media panel is uniquely designed to continually renew itself and has a very long life, under normal use.

Media is in the form of granular pellets that are made of binders and activated alumina or other elements. Potassium permanganate is used as media, as it boosts the adsorption rate for a longer duration. The filtration media generally targets contaminants such as sulphur oxides, hydrocarbons, formaldehyde, organic acids, hydrogen sulphide, nitric oxide, and VOC's.

### *Stage 4 – Final Filters*

Final set of pleated disposable fiber matrix filters are provided with 30% efficiency (MERV 8, EU 4), to capture any left over elements.

*"Volatile Organic Compounds (VOCs) are emitted as gases from certain solids or liquids. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoor. Elevated Concentrations of VOCs can persist in the air long after use of the VOCs containing product is completed. No standards have been set for VOCs in non-industrial settings."*

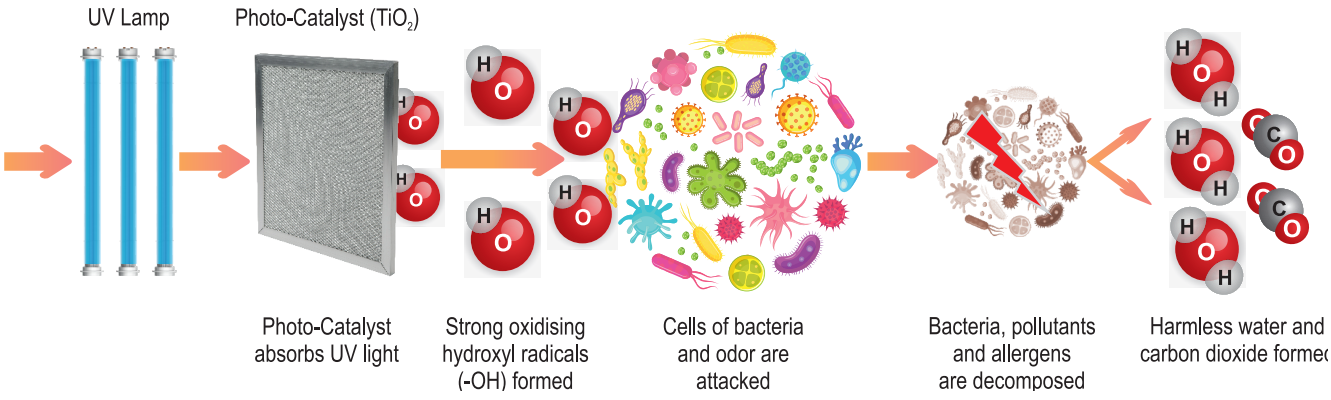
*Source: U.S. Environmental Protection Agency*

## Photo-Catalytic Oxidation

Photo-Catalytic Oxidation (PCO) is a reaction that occurs when Titanium Dioxide ($TiO_2$) is exposed to ultraviolet (UV) light rays. VOCs, gaseous contaminants, and odors gets converted to odorless, harmless water vapor and Carbon Dioxide when they come into contact with the catalytic surface making the air ultra purified.

The titanium dioxide catalyst is activated by UV light which neutralizes biological contaminants such as bacteria, viruses, mold and fungi. When used properly, PCO is a powerful element ideal for controlling air quality.

## Principle of Photo-Catalytic Oxidation




### Deactivates

**Biologicals**

Viruses | Bacteria
Fungi | Mold

### Eliminates

**VOCs**

Paint | Pesticides
Chemical | Solvents

### Reduces

**Odors**

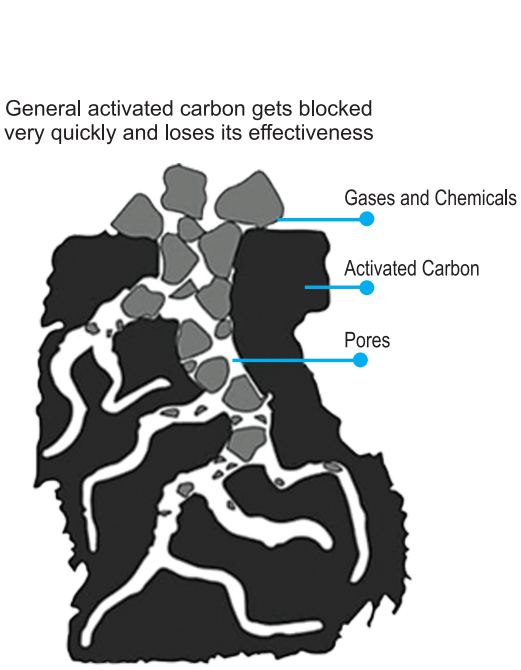
Cigarettes | Garbages
Kitchens | Bathrooms

## Adsorbent Media

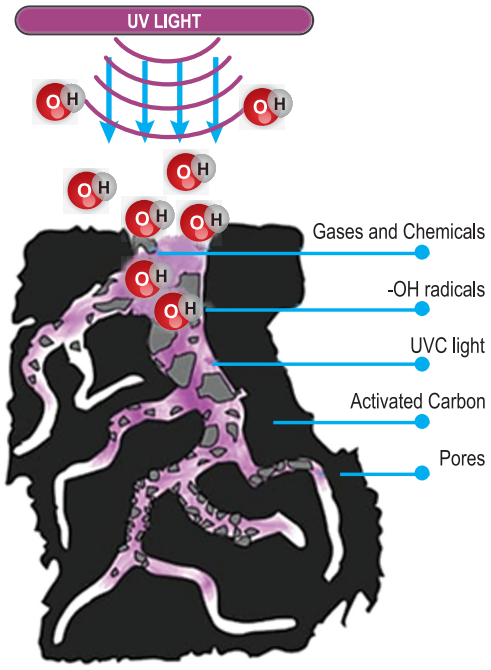
Chemical media, both granular and fluted type is used in a range of combination – activated alumina/carbon impregnated with various impregnants majorly Potassium Permanganate ($KMnO_4$), Phosphoric Acid ($H_3PO_4$) and Potassium Hydroxide (KOH).

## Self Rejuvenating Activated Carbon with UV/PCO

General activated carbon can not adsorb at a stable equilibrium. In the presence of UVC+PCO unstable equilibrium is achieved.




Activated carbon adsorbs gases and chemicals




Activated carbon adsorbs gases and chemicals much better with UVC light whilst -OH radicals neutralise them.

- Activated carbon pores are blocked in a very short time.
- Activated carbon traps the gases and chemicals using UV and -OH radicals resonance time in order to neutralize them, thus keeping the carbon pores clear.

# Partial List of Project

- WORLDWIDE SPECIALITY LAMPS LTD., USA
- MEDANTA HOSPITAL GURGAON
- CANCER HOSPITAL LUCKNOW
- LALA LAJPAT RAI MEMORIAL MEDICAL COLLEGE MEERUT
- SECTOR 39 HOSPITAL NOIDA
- BRD MEDICAL COLLEGE GORAKHPUR
- GRAND HYATT HOTEL
- WIPRO
- ACCENTURE
- EVA GMBH
- WORLDWIDE SPECIALITY LAMPS LTD LLC
- BLUE HYDRO
- TAJ TRISTAR HOTEL
- PERSISTENT SYSTEMS LTD.
- Genpact
- BSNL
- BLUE HYDRO, AUSTRALIA
- HONEYWELL
- LILAVATI HOSPITAL
- ITT WATER & WASTEWATER AUSTRALIA LTD.
- JW MARRIOTT HOTEL
- MARIPLEX
- HYATT REGENCY
- LODHA DEVELOPERS
- DELHI METRO RAIL CORPORATION
- JAIPUR METRO RAIL CORPORATION
- CHENNAI METRO
- AIIMS JODHPUR
- ILBS HOSPITAL DELHI
- AAI
- No. Of Airports

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