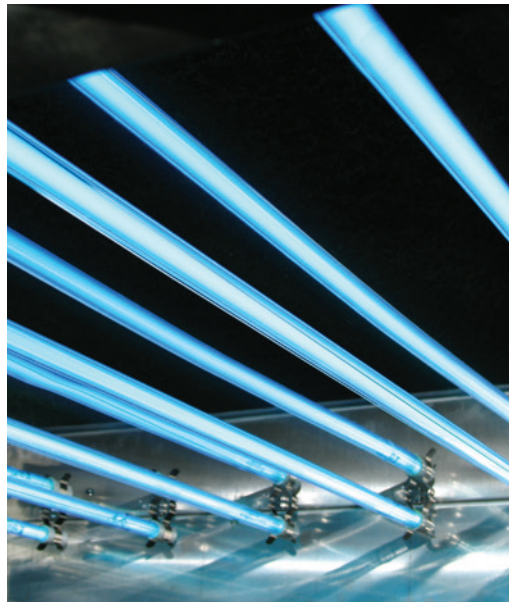
UVC History & Analysis

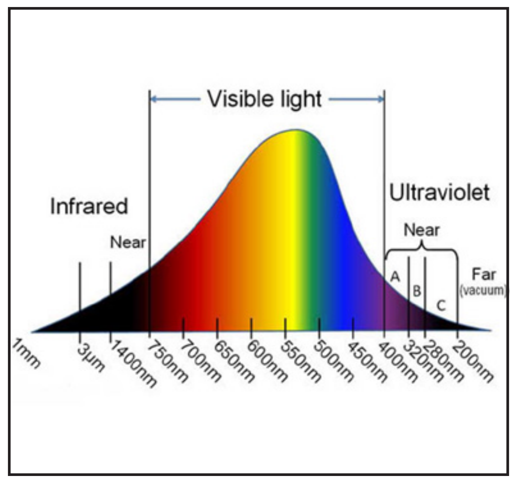
Basic Explanations - What Is UVC?



Ultraviolet light is electromagnetic radiation with wavelengths shorter than visible light. UV can be separated into various ranges, with short range UV (UVC) considered "germicidal UV." Short-wave ultraviolet radiation, in the "C" band (200 to 280 nanometers) has been used for over 100 years.

UV light in the form of germicidal lamps has been used since the late 1800s to kill the types of microorganisms that typically cause indoor air quality problems -- bacteria, mold, yeast, and viruses.

At certain wavelengths UV is mutagenic to bacteria, viruses and other micro-organisms. At a wavelength of 2,537 Angstroms (254 nm) UV will break the molecular bonds within micro-organismal DNA, producing thymine dimers in their DNA thereby destroying them, rendering them harmless or prohibiting growth and reproduction. It is a process similar to the UV effect of longer wavelengths (UVB) on humans, such as sunburn or sun glare. Micro-organisms have less protection from UV and cannot survive prolonged exposure to it.



UltraViolet Germicidal Irradiation (UVGI)

A UVGI system is designed to expose environments such as water tanks, sealed rooms and forced air systems to germicidal UV. Exposure comes from germicidal lamps that emit germicidal UV electromagnetic radiation at the correct wavelength, thus irradiating the environment. The forced flow of air or water through this environment ensures the exposure.

Niels Ryberg Finsen (1860-1904) is first to employ UV rays in treating disease. He is awarded the Nobel Prize for Medicine in 1903. He invents the Finsen curative lamp, which was used successfully through the 1950s. UVC is used to disinfect the municipal water supply in Marseille, France, in 1908.

In the 1930's, Westinghouse Electric Company R&D engineers and scientists developed and patented the first commercially available ultraviolet lamps. They are used primarily in hospitals.

The first products were simple compared to modern-day technology, but they were very effective and initially were sold in conjunction with water filters to the U.S. Department of Agriculture to disinfect surface drinking water sources used by Arizona agricultural workers.

Broad Market Acceptance of UVC

After World War II, UVC is used for sterilizing air in hospitals, kitchens, meat storage and processing plants, bakeries, breweries, dairies, beverage production, pharmaceutical plants, and animal labs -- anywhere microbiological contamination is a concern. Typically a beam of UVC is directed across the ceiling of a room. During the 1950s UVC is incorporated into air handling equipment. It becomes a major component in the control and eradication of tuberculosis (TB).

During the 1960s, concern about microbes lessens with the introduction and increasing availability of new drugs and sterilizing cleaners. As mechanical ventilation becomes more popular, UVC performance suffers due to the lack of effective UVC performance in cold-air settings.

Technological Improvements

In the 1970's and 80's, concerns over chemical use and improvements in UVC bulb manufacturing caused more organizations and companies to revisit UVGI. In the early 1990's, UVGI was pioneered into significant water treatment processing for municipal systems as well as for treatment of swimming pools.

The introduction of UVC into HVAC systems is pioneered in 1996. Recent technological advancements have made it possible for companies to produce high-output ultraviolet germicidal devices further improving efficiency and effectiveness.

Rethinking the Mechanics of UVGI

Prior to the introduction of the GreenZapr/miniZapr, the single method for UVC treatment was to pass the medium (water/air) across the UVC apparatus. By solving the portable power question and designing proper safety and efficiency controls, the GreenZapr/miniZapr allows for mobile sterilization. The miniZapr further effects mobility by consolidating all the necessary UVC components into a small, lightweight package.

Specialized UVC Bulbs, Light Modules, and Controls - The bulbs used in the GreenZapr are a specifically developed, high-intensity mercury-vapor lamp with a protective Teflon® coating to protect the bulbs and encase the glass during breakage.

Each light module on the GreenZapr utilizes a reflector made from spectrally polished aluminum, yielding a UVC reflectance of 73%. The combination of the bulb and reflector allow for a significantly greater amount of directed energy.

The GreenZapr is equipped with a number of important safety features including an motion shut-off and light-bed lift shut-off. The Central Control Module monitors and measures power so the lights operate at optimal voltage.

Target Levels of UVC Energy...

Each micro-organism has different traits or reactions to UVC in terms of the amount of energy (or exposure) needed to break down the nucleic acids. In order to effectively combat micro-organisms, one has to understand how target energy levels can be reached. In short, one has to balance the intensity of the UVC light source, the distance from the light source to the target surface, and the amount of time the target is exposed. For a listing of select microbes and their associated kill factors, click here.

GreenZapr - The GreenZapr® uses a total of sixteen (16) specifically designed UVC lamps. It's designed to operate at a distance of 2.5" from the surface. At this distance, the energy intensity (measured in terms of micro watts per square centimeter) is 6,558 µW-s/cm². When operating the unit at the recommended 3-pass/6 mph method, the "dosage" is 6,707 µJ/cm². For reference, Staphylococcus aureus (MRSA) requires 6,600µW/cm² for a 3-log (99.9%) reduction.

miniZapr - The miniZapr® has two different modules, the base unit and the hand-held. The base unit uses a total of eight (8) specifically designed UVC lamps and is designed to operate at a distance of 2" from the surface. At a standard walking speed of 2 mph and 3 passes, a dosage of 6,874 µJ/cm² is reached. The hand-held module relies on the operator to control all aspects of exposure (speed, distance, passes). At the basic use method of 2" at a speed of .5 feet per second and two passes, a dosage of 7,350 µJ/cm² is reached.

Energy & Method Comparisons.

In order to understand the variables involved in exposure, the following tables are provided. In the simplest description — more time delivers higher dosages.

GreenZapr® - Calculations for Various Operational Speed/Passes for Energy Exposure

Module/Cart Speed (mph)	6	5	10	10	5
Passes over field	3	3	4	5	6
Peak Exposure @ 2.5” (µW-s/cm²)	6,558	7,672	3,836	3,836	7,652
Total CALCULATED Dosage (µJ/cm²)	**6,707**	**9,416**	**3,139**	**3,923**	**18,831**

miniZapr® Base Module - Calculations for Various Operational Speed/Passes for Energy Exposure

Module/Cart Speed (mph)	2	1	2	1
Passes over Surface	3	3	2	2
Peak Exposure @ 2.5” (µW-s/cm²)	11,125	11,125	11,125	11,125
Total CALCULATED Dosage (µJ/cm²)	**6,874**	**13,748**	**4,583**	**9,165**

miniZapr® Hand-held Module - Calculations for Various Operational Speed/Passes for Energy Exposure

Module/Cart Speed (mph)	.5	.5	.5	.5
Passes over Surface	2	3	2	3
Peak Exposure @ 2” (µW-s/cm²)	4,410	4,410	4,410	4,410
Peak Exposure @ 3” (µW-s/cm²)	2,940	2,940	2,940	2,940
Total CALCULATED Dosage (µJ/cm²)	**4,900**	**7,350**	**7,350**	**11,025**

NOTE: These operational methods are flexible and can be adjusted to meet the various needs or objectives of the user. Once these basic variables are understood, it is possible to develop the optimal method of UVGI treatment and continued schedule that effectively combats the microbes of greatest concern.

It is important to keep in mind that when operating any UVC equipment that more exposure/energy is better. In the case of the GreenZapr/miniZapr equipment, a more significant level of exposure is achieved in fractions of seconds. One should not get focused too precisely on any specific exposure number.

A more careful, deliberate approach to UVC equipment operation will result in greater certainty that any risk of infection by microbes has been reduced significantly.