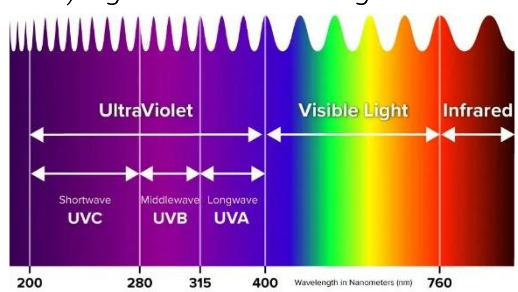
Frequently Asked Questions About UV-C Systems

What is UV-C?

A highly energetic form of light that is lethal to pathogens

UV-C only occurs naturally in Outer Space and is filtered from reaching the Earth by the Ozone layer.

The energy from the Sun comes to us in the form of light of varying wavelengths. We see light in the visible spectrum, but there is a lot more to sunlight than meets the eye. The warmth we feel from the Sun comes to us in the form of longer wavelength Infrared (infrared = "below" red) light. Infrared light is invisible to our eyes, but can be felt on our skin in the form of radiant heat. Certain sensors can "see" infrared, such as thermal imaging cameras. On the other end of the spectrum is Ultraviolet (ultraviolet = "beyond" violet) light. Ultraviolet light is highly energetic, and is broken into three different portions, UV-A, UV-B and UV-C. UV-A covers the range just below visible light, starting at 400 nanometers (nanometer = 1 billionth of a meter) and going down to 315 nanometers. UV-B covers the more energetic range below UV-A, starting at 315 nanometers and extending down to 280 nanometers. Finally, UV-C is the most energetic part of the ultraviolet spectrum, characterized by wavelengths from 280 nanometers down to 100 nanometers. Due to its highly energetic nature, UV-C is highly lethal to organisms such as bacteria, viruses, spores, molds and fungi.



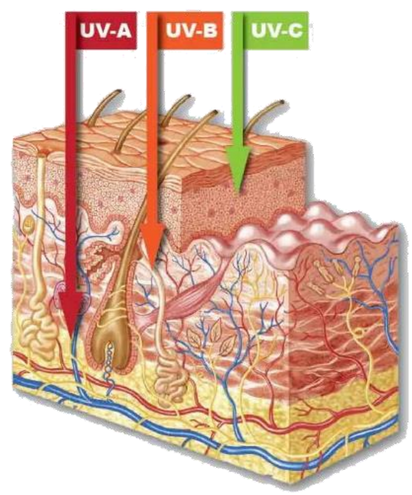
Representation of Sunlight Wavelengths

Does UV-C cause Cancer?

UV-C does not penetrate deeply enough into the skin to pose a significant risk for skin cancer

Human skin does a remarkable job of protecting the body from UV-C mutagenic damage.

Ultraviolet light is made up of three different bands of energy, with each band characterized by shorter and shorter wavelengths. We know these as UV-A, UV-B and UV-C. UV-C has the shortest wavelength and the highest energy, and might be expected to cause the most damage to human skin, but this is not the case. UV-C is almost completely absorbed by the protective outer layers of the skin and has a low risk of causing cancer. UV-C doses greatly exceeding the allowed Exposure Limits, however, may cause irritation and inflammation of the skin known as erythema which feel a lot like sunburn, or itching of the eyes known as photokeratitis, but does not have the potential mutagenic (cancer-inducing) properties of the other portions of the Ultraviolet spectrum. Such skin or eye irritation lasts only a day or so, with no long-term adverse effects. Longer wavelength UV-A and UV-B penetrate deeply into the reproductive epidermis and dermis of the skin and can cause mutations to the DNA of the living cells resulting in skin cancer.



Penetration of UV Varies by Wavelength

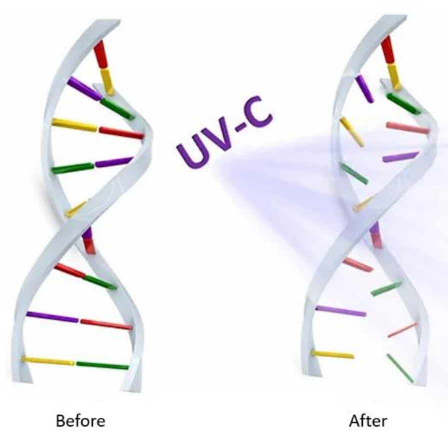
Reference: https://www.fda.gov/radiation-emitting-products/tanning/ultraviolet-uv-radiation#UVCrisks

How much UV-C is needed to “kill” a pathogen?

UV-C works to cause changes to the RNA or DNA of pathogens, rendering them unable to reproduce

The 254 nanometer wavelength of low pressure Mercury lamps is nearly optimal for disinfection.

All wavelengths of Ultraviolet light have the ability to “kill” pathogens, and the shorter the wavelength, the more effective it is at providing this effect. For all pathogens, Ultraviolet light has the ability to cause mutagenic changes to the DNA or RNA within them, thereby rendering them incapable of reproducing. Short wavelength, highly energetic UV-C light has the greatest effect in causing these changes, with the light produced by low pressure Mercury lamps at 254 nanometers providing nearly the optimal effect for inactivating pathogens. Not all pathogens are created equal, however, as each one has its own characteristic sensitivity to UV-C, which have been tabulated for use in the study and application of UV-C for disinfection. It is important to understand that different doses of UV-C may be required to inactivate different pathogens, and the higher the UV-C Watts a unit can produce, the more assurance you have that you’re getting the job done.



UV-C causes destruction of RNA in pathogens

How do I know how effective my UV-C unit is?

The effectiveness of UV-C room disinfection combines a number of factors, including wavelength, intensity, duration, distance, setting (air, water, surface) and type of pathogen

The dosage a unit can generate is the most important factor when considering effectiveness.

When determining the effectiveness of a UV-C room disinfection system, there are several important factors that combine to predict how well the system will be against a given pathogen. The key factors to be considered are the irradiance of the light source per unit area, expressed in Watts per square meter (W/m^2), or alternatively, milliWatts per square centimeter (mW/cm^2), as well as the amount of time the light is shining, as measured in seconds. These two factors combine to produce a given dose of UV-C light, as measured in Joules per meter squared (J/m^2) or milliJoules per square centimeter (mJ/cm^2). The higher the dose a unit can generate, the better it will disinfect. There is a third factor to be taken into account, and that is the distance from the unit to the surface being disinfected. A UV-C disinfection unit should provide charts or other figures of merit with respect to how high a dose in mJ/cm^2 it can deliver at a given distance. Only dose comparisons between units can provide a fair measure for comparison purposes.

UV-C dose is the most important factor

What is meant by "Log kill"?

The effectiveness of a disinfection method is mathematically exponential in behavior

Each "Log" represents the dose needed to inactivate 90% of the remaining population of pathogens.

When a disinfection method is used, it follows an exponential pattern, where it is rated in its effectiveness based upon the dosage needed or time it takes to inactivate or kill 90% of the remaining pathogen population. This is known as being Logarithmic in nature, or "Log" for short. There are many processes in nature which follow a similar pattern, including our perception of the loudness of sound, the rate of decay of radioactive elements, and how we rate the magnitude of earthquakes. For disinfection, the simple way to think about Log scales is shown in the figure to the right. In it, you will see that a one Log reduction is equal to the dose needed to inactivate 90% of a given pathogen, two Log is the dosage needed for 99% inactivation, three Log Is the dose for 99.9% reduction, and so on. Generally, infection control personnel look to see what it takes to inactivate 99.9% of a pathogen, or a 99.9% reduction. The interesting thing here is that we do not strive to eliminate 100% of a pathogen, because it is statistically very difficult to do, but accept 99.9% reduction as a quality figure of merit as it results in a reduced chance of becoming infected due to the greatly reduced infection population of a given pathogen.

Log_{10} Reduction	Pathogen Elimination
1	90%
2	99%
3	99.9%
4	99.99%
5	99.999%

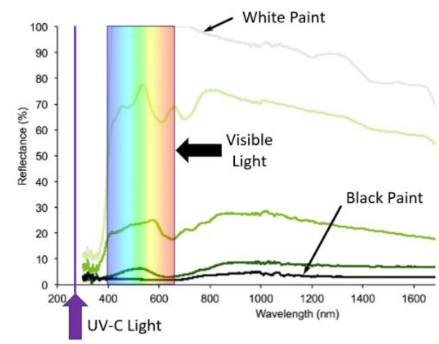
Log Scale of Disinfection Effectiveness

What is meant by "Line of Sight"?

All forms of light travel in straight lines

Most materials will absorb UV-C light rather than reflect it.

The light from a high-powered UV-C system is generated by the use of low-pressure Mercury lamps that emit light in all directions. Once the light hits a surface, it can do one of three things - it can be absorbed, reflected or transmitted through the surface. For visible light, when light strikes a white surface, most of the light will reflect off of it, and this is why it appears white to us. Also, when light strikes a piece of glass, nearly all of it is transmitted through the glass and very little is absorbed or reflected. For black surfaces, they appear black because nearly all of the light is absorbed into the surface. A similar phenomenon occurs for UV-C light as well, except that most materials will not reflect or transmit it but instead will absorb it. So, while we think of visible light as bouncing all around a room, UV-C is nearly completely absorbed by most surfaces, and if we want to get good disinfection on all surfaces, we need to be sure that the light from the unit can "see" the surface, or have direct line of sight to it. Another way to help this situation is to have an extremely bright UV-C source like the Guardian that can provide reflected dosage into corners and behind objects.



Reflectivity of White and Black Paint for Visible and UV-C Wavelengths

Why are UV-C systems so expensive?

The only reason UV-C systems are so expensive is because they can be

The mission of Camillus is to make lifesaving UV-C technology available at an affordable price to every facility that needs it.

The statement that UV-C systems are so expensive because they can be may sound odd, but it is the truth. Simply put, a UV-C unit is a large light fixture. It has lamps and a power source called a ballast. There are controls and sensors needed and the structure to support and protect those items, and that's pretty much all there is. A lot of UV-C systems are massively overcomplicated with advanced wireless controls and sensors, mechanisms and exotic designs, but again, at their core, they are simply large light fixtures. When it comes down to it, you need a system that's does the job its intended to, is safe and easy to operate, requires very little training and lasts for a long time. This is the beauty of the Guardian. It's built to Military standards for durability, out performs other competitive units on the market, and is priced 50 to 75% less than those units. All companies deserve to make a profit, but it becomes almost criminal when the lifesaving technology provided by a UV-C unit is being kept out of the hands of those that need them simply due to the high profit demands of the companies that build them.

Excess profits keep UV-C from saving lives

Guardian UV-C Room Disinfection

Specification/Feature	Description/Value
Mechanical	
Dimensions	24”W x 24”D x 77”H
Weight	105 lbs (48 kg)
Casters	4 Swivel – Non-marking
Electrical	
Operating Voltage	120 VAC, 60 Hz
Power Consumption	1450 Watts (12 Amps)
Occupancy Sensors	4 – Passive Infrared/Ultrasound
Switches	30mm Industrial Grade
Indicator LEDs	Sealed Industrial Grade
Circuit Breaker	Push button resettable & Power Cord GFCI
Speaker	3W waterproof
Lamps	
Type	Mercury Amalgam Low Pressure
Quantity	4
Rated Life	12,000 hours to 90% output
UV-C Output	118W @ 0 Hours per lamp, 472 W Total
System Software	
Diagnostics	Continuous Built-In Test
Controls	Dual Tactile Switch/Audio Controls
Data Logging	Continuous Data/Event Logging
Operational Switches	
Power Switch	Black 30 mm Industrial Switch
Cycle Select	Two Cycles: Short (5 min) & Long (10 min)
Cycle Start	Green 30 mm Industrial Switch
Cycle Stop	Red 30 mm Industrial Switch
Environmental	
Operational Temp	50°F to 80°F
Relative Humidity	20% to 90% Non-Condensing
Storage Temp.	40°F to 100°F
Storage Rel. Humidity	95% Maximum Non-Condensing
Test Specification	MIL-STD-810H

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