



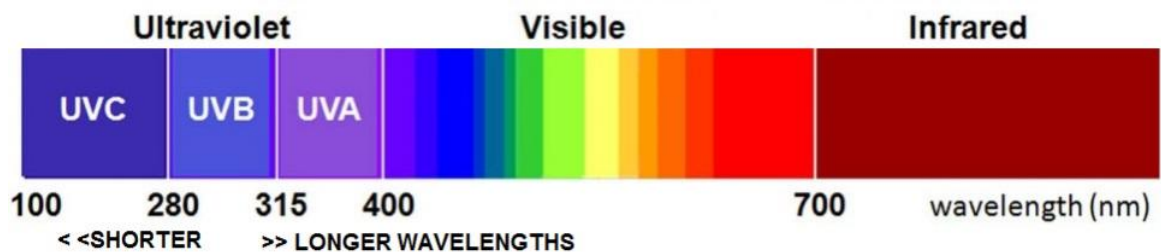
The Science Behind UV-C Light

Ultra Violet (AKA 'UV') light is not new. It has been around since the 1800s. Hospitals and laboratories have been using it for a long time for their more sensitive areas that require extreme cleanliness.

UV light is energy that is emitted at a certain frequency and wavelength. We are able to classify different forms of energy based on their wavelength. The UV spectrum is between 100 nanometers and 400 nanometers in wavelength.

UV light is categorized into 3 subsections: UV-A, UV-B, UV-C. Out of all three forms of UV light, UV-C is the most damaging to organic life. It is also known as the germicidal wavelength because of its effectiveness at killing pathogens and microorganisms.

UV-C light is particularly good at killing microorganisms because organic materials are very good at absorbing the level of energy emission from UV-C. This absorption can lead to damage at the cellular level by causing a distortion of DNA. This distortion leads to several outcomes for these pathogens. They are either left functionless (ex. A virus can no longer infect a cell or a bacteria can no longer reproduce and replicate), the microorganism begins to die, or it just kills the pathogen.





The Science Behind Ozone

-Applicable to The Plymouth Medical UV-C Lamp (with ozone)-

The 180-nanometer wavelength of UV-C creates the ozone. This emission of light gives a jolt of energy to oxygen molecules in the air. Oxygen is a stable and strong molecule composed of 2 oxygen atoms. When the jolt of energy hits this Oxygen molecule it is able to form an additional bond with another oxygen atom. It turns O₂ into O₃.



Ozone is a naturally unstable molecule. It does not like having three oxygens together. Over a brief period of time, it will naturally return back to Oxygen. It basically cleans up after itself.



Ozone reverts back to the normal O₂ state naturally, leaving no chemical residue. Nonetheless, ozone on its own is carcinogenic, an oxidizer, and overall to be avoided. Long exposure to excess ozone can lead to health and respiratory issues. We recommend that you ventilate the room with fresh air when the cleaning cycle with the UV-C Lamp (with ozone) is complete to mitigate any health concerns. Even after the area has been ventilated and some time has passed, you may experience a residual "ozone smell" for a short amount of time. This is normal, and not harmful.

OSHA Guidelines for Ozone

OSHA Guidelines for ozone in the workplace are based on time-weighted averages. Ozone levels should never exceed 0.10 ppm (parts per million) for 8 hours per day exposure¹.

The OSHA website cites several ACGIH (American Conference of Governmental Industrial Hygienists) guidelines¹ for ozone in the workplace:

- 0.2 ppm for no more than 2 hours exposure
- 0.1 ppm for 8 hours per day exposure doing light work
- 0.08 ppm for 8 hours per day exposure doing moderate work
- 0.05 ppm for 8 hours per day exposure doing heavy work

For more information, see the OSHA web page regarding ozone:

<https://www.osha.gov/laws-regs/standardinterpretations/1994-09-29-0>



Log Reduction

Logarithmic (log) reduction is the standard used for quantifying disinfection by the EPA.

Log reduction correlates to a 10-fold reduction, i.e. 1-log=90% reduction. A table of log reduction is shown in the figure below. The performance standard of log reduction is measured in terms of colony forming units (CFUs). For example, a 6-log inoculum has 1,000,000 colony forming units (CFUs). A 1-log reduction of 1,000,000 CFUs would result in 100,000 CFUs remaining.

When speaking in terms of bacterial, viral and fungal pathogens, log reduction is incredibly important because these organisms are numbered in the millions or more due to the rapid doubling time of microorganisms.

Log Reduction	Number of CFUs Remaining	Percentage Reduction
0-Log	1,000,000	0%
1-Log	100,000	90.00%
2-Log	10,000	99.00%
3-Log	1,000	99.90%
4-Log	100	99.99%
5-Log	10	99.999%
6-Log	1	99.9999%

The Plymouth Medical UV-C Disinfection Lamp has reported an average of 3.2 Viral Log Reduction for rooms up to 32m² (344ft²) and a radius ≤ 4m (13ft) with the 60-minute timer setting². This means that The Plymouth Medical UV-C Disinfection Lamp kills 99.9% of viruses.

Preliminary research has shown that SARS-CoV-2, the virus that causes COVID-19, may be inactivated by UV-C (254nm) at a dose of 22mJ/cm².³ Tests have proven that The Plymouth Medical UV-C Disinfection Lamp surpasses the dose of 22mJ/cm² within 60 minutes (Room size: ≤ 32m² (344ft²) + radius ≤ 4m (13ft). Access results [here](#).

In addition, we performed a test against a human coronavirus OC43 (ATCC: VR-1558), known for causing the common cold. The testing results show that The Plymouth Medical UV-C Disinfection Lamp kills an average of 99.93% of the virus (Log 3.2 Reduction) in a room ≤ 4m (13ft) with the 60-minute timer setting. Access results [here](#).



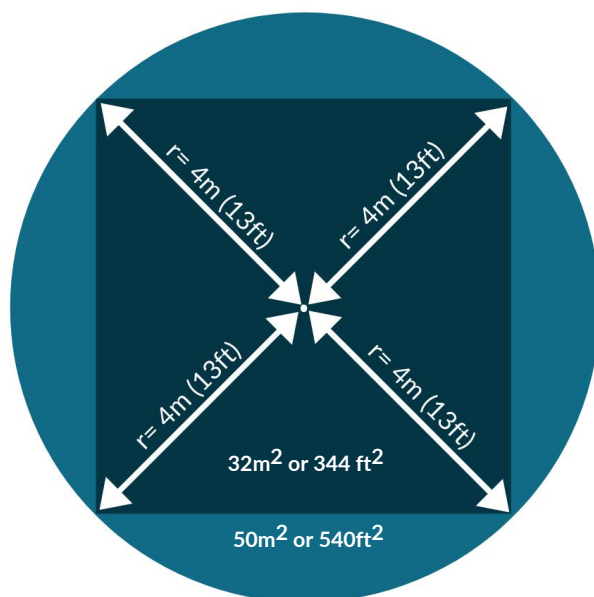
The Plymouth Medical UV-C Disinfection Lamp

What we have done is taken this powerful UV-C germicidal light and wrapped it in safety features. While The Plymouth Medical UV-C Disinfection Lamp (without ozone) emits light at only 253.7nm, The Plymouth Medical UV-C Disinfection Lamp (with ozone) emits light at 253.7nm and 180nm. Although both wavelengths are within the germicidal UV range, the 180nm wavelength emission has a secret weapon - It is able to create ozone. This ozone acts as a secondary form of sanitation. Therefore, The Plymouth Medical UV-C Disinfection Lamp (with Ozone) is able to disinfect using '2-in-1 cleaning': The UV-C light itself disinfects and sanitizes surfaces while the ozone will help purify the air.

The ozone emission from The Plymouth Medical UV-C Disinfection Lamp (with ozone) is enough to have an effect on the pathogens while being relatively harmless to people. While the ozone is great for a secondary form of sanitation, it is important to know that UV-C light is the heavy hitter and does most of the work.

Disinfection Range

The Plymouth Medical UV-C Disinfection Lamp is a medium-sized lamp that stands at 20 inches tall and uses 60 Watts of power to achieve 99.9% viral disinfection coverage for rooms up to 32m² (344ft²) and a radius ≤ 4m (13ft) with the 60-minute timer setting². If the room size exceeds 32m² (344ft²) and/or the radius > 4m (13ft), we recommend placing multiple UV-C lamps in different areas of your room to achieve 99.9% viral disinfection coverage.



LEGEND

Dot= The Plymouth Medical UV-C Disinfection Lamp Location

Square = Room

Circle = 99.9% Viral Disinfection Range (Log 3.2 Reduction)

Covered Surface Area | Square

$$\begin{aligned} &= 2 \times r^2 \\ &= 2 \times 4\text{m}^2 \\ &= 32\text{m}^2 \text{ or } 344\text{ft}^2 \end{aligned}$$

Covered Surface Area | Circle

$$\begin{aligned} &= \pi \times 2 \times r^2 \\ &= \pi \times 4\text{m}^2 \\ &= 50\text{m}^2 \text{ or } 540\text{ft}^2 \end{aligned}$$

¹<https://www.osha.gov/chemicaldata/chemResult.html?RecNo=9>

²BCS Laboratories, Inc. - July 27, 2020: The Plymouth Medical UV-C Disinfection Lamp UV-C Lamp Human Coronavirus Reduction Efficacy Testing

³Press Release - June 16, 2020: Signify and Boston University validate effectiveness of UV-C light sources on inactivating