

Non-visible Light Safety Guide

Environmental Lights is committed to the safety and well-being of our employees and customers. This document is meant to serve as an information guide on non-visible lights and includes information on best practices for how to prevent and protect yourself from overexposure to Blue (High-Energy Visible) Light, Ultraviolet light, and Infrared light. Proper preventative measures for non-visible light exposure scenarios are unique and require specialized protective equipment. When encountering these types of light hazards in the workplace proper controls, such as custom enclosures to contain exposure so the light source cannot be directly viewed, is always the preferred choice. If you are not professionally trained on how to handle non-visible light sources, please reach out to us for further guidance.

Blue (HEV) Light

The general population is exposed to Blue Light (ranging from 400nm – 485nm) daily, whether it be from the sun, computer monitors, television screens or handheld electronic devices. Exposure to the natural blue light in moderation has benefits and can maintain a healthy circadian rhythm. However, overexposure to Blue Light can lead to an increased risk of macular degeneration (deterioration of the macula, which is the small central area of the retina of the eye that controls visual acuity). It is a common myth that household electronics may increase the risk of macular degeneration, however most consumer electronics do not contain a light source that is concentrated enough to increase this risk (1). The biggest health risk to exposure of Blue Light from consumer electronics is that it can disrupt overall circadian rhythm.

On the contrary, high-intensity blue light sources such as the sun or high-power LED sources where the output is not diffused across a large surface area can be hazardous to the eye. The best preventative measure for reducing retinal damage due to the exposure of concentrated Blue Light is simply to not stare directly into blue lights for prolonged periods of time. In addition, if direct exposure to intense amounts of blue light is unavoidable, eye protection such as yellow or amber tinted glasses is recommended and should be compliant with ANSI Z87.1 which requires a Z87 safety marking on the eye protection to indicate that it is rated to defend against that specific hazard (8).

Ultraviolet Light

Ultraviolet (UV) light sits just below the visible light spectrum at 180-400nm and is divided into three bands: UV-C (180-280nm), UV-B (281-315nm) and UV-A (316-400nm) (9).

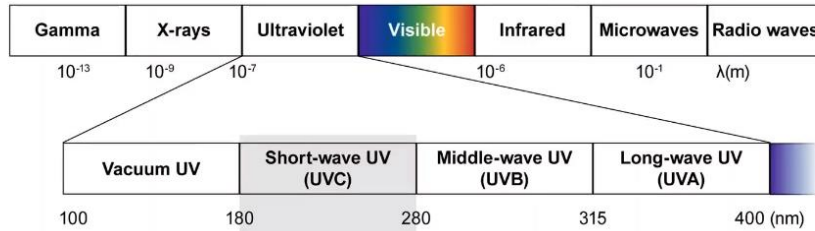


Figure 1- Visual representation of UV-C, UV-B and UV-A bands (9)

UV-A is the longest wavelength light in the UV spectrum and the least harmful of the three bands. The most common daily source of UV-A is the Sun, as about 10% (3) of solar radiation is comprised of 95% UV-A and 5% UV-B (7). Risks associated with exposure to UV-A include long-term damage to the skin and eyes (10).

Due to the characteristics of being a shorter wavelength (281-315nm), exposure to UV-B is more harmful than UV-A and causes immediate effects such as sunburns. Direct damage to the DNA in skin and eyes occurs when exposed to UV-B. Prolonged exposure to UV-B can increase the risk of skin cancer (5) and lead to other conditions such as Photokeratitis (6), which is a condition that develops when the cellular layers of the cornea and conjunctiva within the eye are damaged. General preventative measures to reduce exposure to UV-B include wearing the appropriate eye and skin protection (4).

UV-C is shortest and most harmful wavelength (180-290nm) out of the three bands. The general public is not exposed to UV-C in natural environments, as most UV-C light from the sun is absorbed by the Earth's ozone layer. However, UV-C is commonly used in germicidal applications for commercial and consumer grade lamp and lamp system products. There are strict national and international standards defined by IESNA RP-27 and IEC 62471 for the photobiological safety of lamps and lamp systems that have been put in place to access the photobiological hazards related to UV products used in commercial applications or sold to the general public. These standards have clearly defined measurement procedures and exposure limits that help to classify each product within one of four risk groups ranging from 0 to 3 where 0 = little or no risk to humans even after extended exposure, to 3 = can cause eye and skin damage with only momentary exposure (9). Since unprotected momentary exposure to concentrated UV-C can cause harmful effects, best engineering practices to fully contain the light source must be followed when designing a UV-C lamp or lamp system product. Properly designed UV-C lamp products should be packaged with appropriate warning labels as well as integrated fail-safe switches to immediately disable the light source if an enclosure were to be

inadvertently opened. Only trained professionals with appropriate personal protective equipment should be operating UV-C devices, regardless of the risk group rating.

“Closed” systems are preferred when utilizing UV-C because the light is contained. That being said, there are many applications that are in use / in development to disinfect surfaces and/or occupied rooms/areas.

Near Surface Disinfection – Near surface disinfection is a method of directing UVC radiation onto a surface a short distance away. The effectivity of near surface disinfection is dependent upon three key variables including intensity, duration of exposure and proximity to the radiant source. Due to the complexity of manipulating the three key variables, and the safety implications of radiating surfaces with UVC, Environmental Lights looks at each application as a unique scenario and opportunity to create an effective and safe solution.

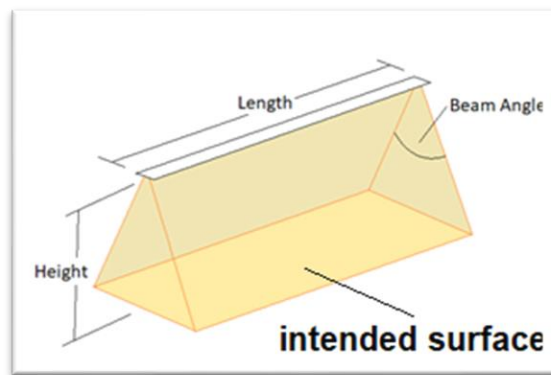


Figure 2: Near Surface Disinfection

Upper-Room Disinfection – Upper-Room Disinfection directs UV-C upwards towards the volume of air above people’s heads. The constant circulation of air in the upper volume of a room is an alternative method to disinfect a space by irradiating the continuously circulating air.

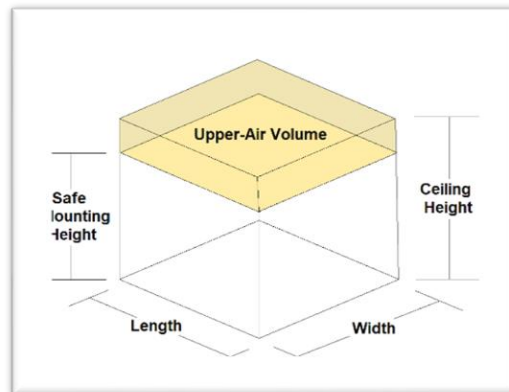


Figure 3: Upper-Room Disinfection

UV radiation is not visible to the human eye, so the natural response of aversion (pupil miosis, eyes squint, turn away from source) is not present. This lends itself to accidental excessive

exposure to the eyes and accidental skin exposure. Due to the possible inability to clearly determine if UV exposure is occurring along with the safety implications; All uses of UV radiation should be handled on a case-by-case basis and EVERY application should adhere to the minimum safety precautions including, but not limited to:

- Indicator lights notifying the presence of UV-C
- Clearly posted warning signs and labels
- Restricted access to regions where UV radiation may be present
- Redundant safety mechanisms – (PIR sensors, occupancy sensors, timers and delays)
- Enclosed beam paths when possible

Furthermore, there is inherent danger to those who manufacture and install UV products. Any person or persons manufacturing, testing, or installing UV radiation sources needs to be informed on the short and long-term dangers and how to prevent inadvertent exposure. In addition, anyone involved in the manufacturing, testing or installing UV radiation sources should adhere to the following guidelines:

- Wear protective eyewear, gloves and clothing
- Cover arms and neck and limit exposure time
- Post warning signs at the entrance of any areas where UV radiation may be present
- Restrict access to any areas where UV radiation may be present

Infrared Light

IR light can be broken down into three bands: IR-A (near-infrared 760 to 1,400nm), IR-B (mid-infrared 1,400 to 3,000nm) and IR-C (far-infrared 3,000 nm to 1mm). Each band IR-A, IR-B and IR-C has similar characteristics in that they are distinguished by their depth of their penetration into tissue, which is directly correlated with water absorption, with IR-A penetrating several millimeters, IR-B less than 1 mm and IR-C no further than the uppermost layer of skin cells. As a result, IR-A and IR-B are both considered a risk to the human eye, while IR-C has largely been eliminated from optical risk assessments (11).

Near infrared is adjacent to visible light on the electromagnetic spectrum and are short waves that cannot be seen. This makes IR-A quite dangerous because even though it cannot be perceived by the human eye, IR-A can still cause damage to skin and eye tissues (2). Extended exposure to IR-A is known to cause several types of damage to the eye such as cataracts, retinal burns and corneal ulcers (10). Although IR-B is classified as penetrating tissues less than 1mm, it still poses the same type of risks to skin and eye tissue as IR-A and similar preventative measures to prevent exposure should be taken. As with other forms of non-visible light, those working with IR light should take the necessary safety precautions and wear the appropriate PPE if containing the light source is not an option.

Non-visible lights sources can be effective when used for the right application and proper safety precautions. Please contact us for more information so we can help you responsibly utilize these technologies.

References:

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