

APPLICATION NOTE:

## Environmental Health and Safety for Crystal IS UVC Diodes

April 23, 2014

THIS APPLICATION NOTE DESCRIBES THE PROPER USE OF CRYSTAL IS LEDS WITH RESPECT TO ENVIRONMENTAL HEALTH AND SAFETY. THIS PROVIDES GENERAL INFORMATION REGARDING THE EFFECTS OF UV RADIATION ON EYES AND SKIN AND PRECAUTIONS FOR WORKING WITH UV LIGHT SOURCES.



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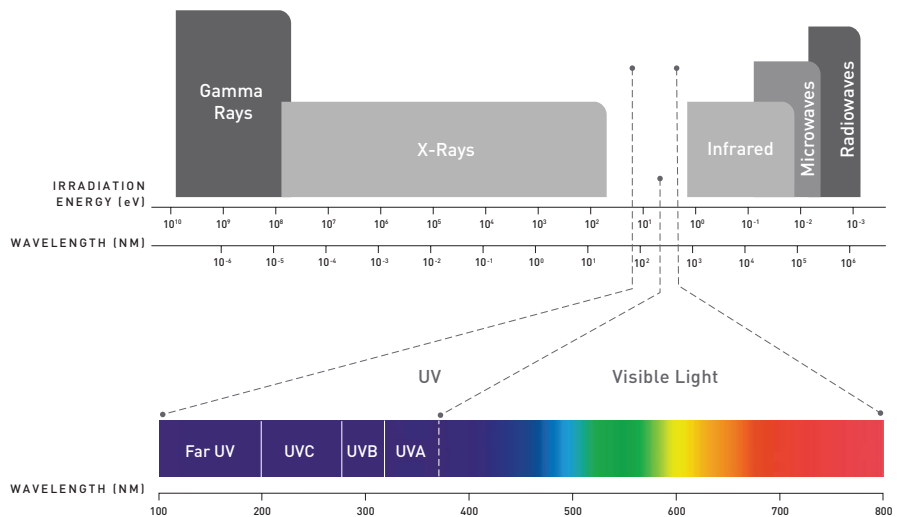
## Introduction

UVC LEDs are irradiation sources and require due precautions to ensure safe usage. The aim of this note is to familiarize users with the general practices and precautions most often recommended for UV irradiation sources<sup>i</sup>. It is not meant to be an exhaustive review on the topic. Currently, there are no workplace related rules and regulations set by OSHA (Occupational Safety and Health Association) in regards to UVC environmental health and safety<sup>ii</sup>.

## UV Light and Health Risk

The UV range of the electromagnetic radiation spectrum extends from 10 nm to 400 nm. Depending on the wavelength and time of exposure, UV radiation may cause harm to the eyes and skin.

FIGURE 1: ELECTROMAGNETIC SPECTRUM



The UV spectrum as shown above is separated into four parts: UVA (315 nm to 400 nm), UVB (280 nm to 315 nm)<sup>iii</sup>, UVC (200 nm to 280 nm) and UV Vacuum (100 nm to 200 nm)<sup>iii</sup>. Decreasing wavelengths correspond with higher frequency radiation and a higher amount of energy per photon.

## BIOLOGICAL EFFECT OF UV LIGHT

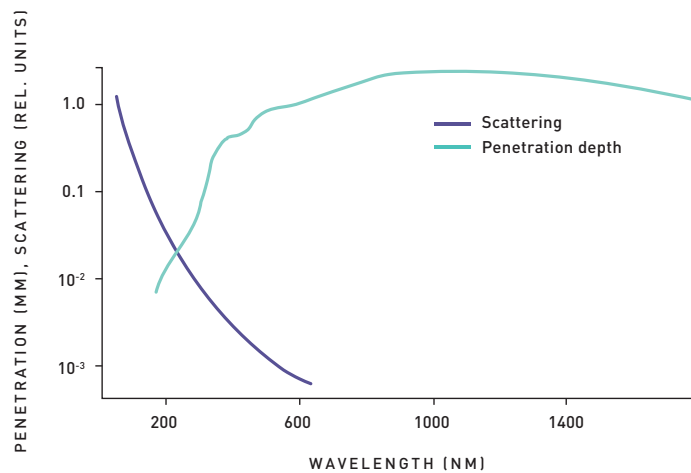
UVB has often been noted for its harmful effects on human skin, however each of the UV bands—UVA, UVB and UVC—have a potential for damage. Adverse health effects that may occur include erythema, photokeratitis, retinal burn, cataracts and others<sup>iv</sup>. The table on the next page summarizes these effects.

## HEALTH RISK VS UV BANDS

Band	Wavelength	Primary Visual Hazard	Other Visual Hazard	Other Hazards
UVA	315 - 400 nm	Cataracts of Lens		Skin Cancer; Retinal Burns
UVB	280 - 315 nm	Corneal Injuries	Cataracts of Lens; Photokeratitis	Erythema; Skin Cancer
UVC	100 - 280 nm	Corneal Injuries	Photokeratitis	Erythema; Skin Cancer

The shorter UVC wavelengths are typically absorbed in atmosphere, as shown in Figure 2, and thus are thought to have less long-term damaging effects on human tissue. However, in rare instances, prolonged direct exposure to UVC light has caused eye and skin damage. Because of this, exposure precautions are recommended when using UVC light.

FIGURE 2: IMPACT OF UV LIGHT ON HUMAN TISSUE



*The penetration spectrum of light and UV radiation into human tissue.  
The scattering increases with decreasing wavelength<sup>v</sup>.*

## UVC EFFECT ON SKIN

Acute (short-term) effects include redness or ulceration of the skin. At high levels of exposure, these burns can be serious. For chronic (long-term) exposures, there is also a cumulative risk, which depends on the amount of exposure during your lifetime. The long-term risk for large cumulative exposure includes premature aging of the skin and skin cancer<sup>vi</sup>.

## UVC EFFECT ON EYES

Eyes are also susceptible to UV damage. Even a few minutes' exposure to the UVC radiation can result in photokeratitis (an inflammation of the cornea) and conjunctivitis (inflammation of the conjunctiva). Both the conditions are painful but not permanent.

## Personal Protective Equipment (PPE)

UV radiation is easily absorbed by clothing, plastic or glass. Once absorbed, UV radiation is no longer active. When working with open UV radiation during maintenance, service or other situations, personal protective equipment covering all exposed areas is recommended. When working around UVC devices, employees should:

- > Use UV goggles and/or full face shields
- > *Prescription glasses and normal safety glasses do not protect eyes from UV exposure, so ANSI Z87 rated eyeglasses with wrap around lens to protect the side exposure is recommended. Consult with ANSI Z87 manufacturers for proper UV exposure protection equipment.*
- > Cover any exposed skin using lab coats, nitrile gloves or other lab attire

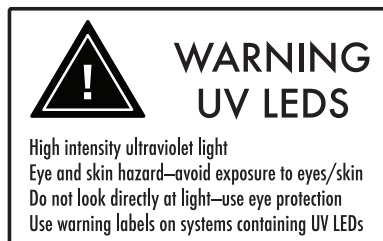
## Personal Safety Training

Personnel working with UVC fixtures or near UVC installations should be provided with training on health and safety topics, handling and maintenance of UVC sources, and first aid response after exposure to UVC light.

## Warning Signs Recommendation

It is highly recommended that warning signs be placed where the UVC LEDs are electrically connected to warn incidental observers of the potential UV light exposure. These labels should be localized in all relevant languages and indicate that eye and skin hazard is probable and only authorized operators are permitted in the area.

Warning labels should be placed outside access panels and doors to the UVC source as well as panels or doors to adjacent areas where UVC radiation may penetrate or be reflected.



Example UV warning label

## Safety Design/Control/Monitoring/Maintenance

UVC exposure can be reduced through product safety design considerations and controls. For example, safety switches wired in series allow UVC sources to be turned off without exposing workers to UV light. Or placing ON/OFF switches for UVC light sources separate from general room lighting in locations only accessible by authorized persons. Switch locations should be locked or password protected to ensure that the UVC source is not accidentally turned on. Each UVC system should have the option of a viewport so workers can view the lamp assembly without the possibility of over-exposure to UVC.

Proper installation, monitoring, education of maintenance personnel, signage and use of safety switches can help to avoid overexposure. The operating instructions and recommendations for proper use of any UV system should be kept for reference to reduce hazardous exposure. These should be clearly visible for the operators or maintenance personnel and include the temperature and relative humidity ranges specified by the system design to ensure safe operation.

Maintenance should be performed according to manufacturer's instructions electric power should always be turned off to prevent accidental exposure. There are no standard guidelines for monitoring UV equipment, but there are commercial UV monitors that detect output or leakage.

## Response to UV Exposure

The effects of acute exposure to UV radiation are usually not severe and many symptoms are delayed. In the event of UV exposure, the following actions are recommended.

- > See an ophthalmologist if eye damage is suspected.
- > Treat skin lesions immediately.
- > Follow your organization's EHS incident reporting procedure. These often require documentation of the date and time of incident, persons involved, equipment involved and type of injury.

## Conclusion

In most workspaces, the exposure to UV radiation can be easily prevented if proper precautions are put in place. Methods such as increasing the distance to the UV source, using proper PPE and/or limiting exposure time can reduce UV hazards.

Also, safety design controls for the equipment, performing routine maintenance and providing proper training reduces the risk of exposure to employees.

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Each user must identify and perform all tests and analyses necessary to assure that its finished application incorporating Crystal IS' Products will be safe and suitable for use under end-use conditions. Each user of devices assumes full responsibility to become educated in and to protect from harmful irradiation. Crystal IS specifically disclaims any and all liability for harm arising from buyer's use or misuse of UVC devices either in development or in end-use.

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## FOOTNOTES

- i *The UV radiation safety program; University of Toronto; 2011*
- ii *Non ionizing radiation; www.OSHA.gov*
- iii *Soehnge, H., Ouhtit, A. and Ananthaswamy, H. N.; Mechanisms of Induction of Skin Cancer by UV Radiation; Frontiers in Bioscience 2, d538-551, 1997*
- iv *Akram, M and Rubock, P; Environmental, health and safety, Columbia University Health science department, 2005*
- v *Moan, J; Visible light and UV Radiation*
- vi *<http://www.uvm.edu/safety/lab/hazards-of-ultraviolet-light>*

We invite you to learn more about our UVC LEDs.



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