Ultra Violet Radiation Safety

Case Western Reserve University

Environmental Health

and Safety

CASE WESTERN RESERVE UNIVERSITY EST. 1826

UV Training Topics Covered

- Definition of UV Radiation
- Biological Hazards of UV Radiation
- Sources of UV Radiation in the Workplace
- Safety Measures
- Administrative Practices

The Discovery of UV Radiation

- In 1801 German Physicist Johann Wilhelm Ritter observed that silver salts darken when exposed to sunlight. He noted that invisible rays just beyond the end of the visible spectrum were the cause of darkening silver chloride soaked paper.

Definition:

Ultra Violet means “beyond violet” in Latin since violet is the shortest wavelength of visible light and UV light is the next shortest.

UV is part of the electromagnetic radiation spectrum with wavelengths from 100 nanometers (nm) to 400 nm.

There are 3 types/regions of UV radiation

- UVA (near UV-Black Light) 315-400 nm
- UVB (middle UV-Erythemal) 280-315 nm
- UVC (far UV-Germicidal) 100-280 nm

Definition:

UVA radiation is easily transmitted through air and glass. It can penetrate the epidermis and the anterior ocular media.

UVB and UVC radiation is transmitted through air and quartz, but absorbed by ordinary glass. These wavelengths are absorbed through the ozone layer. UVB radiation that reaches the earth is extremely harmful to the epidermis and the cornea.

UVC radiation is almost completely absorbed by the ozone layer and does not affect the skin or eyes. UVC radiation becomes dangerous when it is present in commercial sources such as mercury arc lamps or germicidal lamps. This “artificial” UVC is harmful to the epidermis and the cornea.

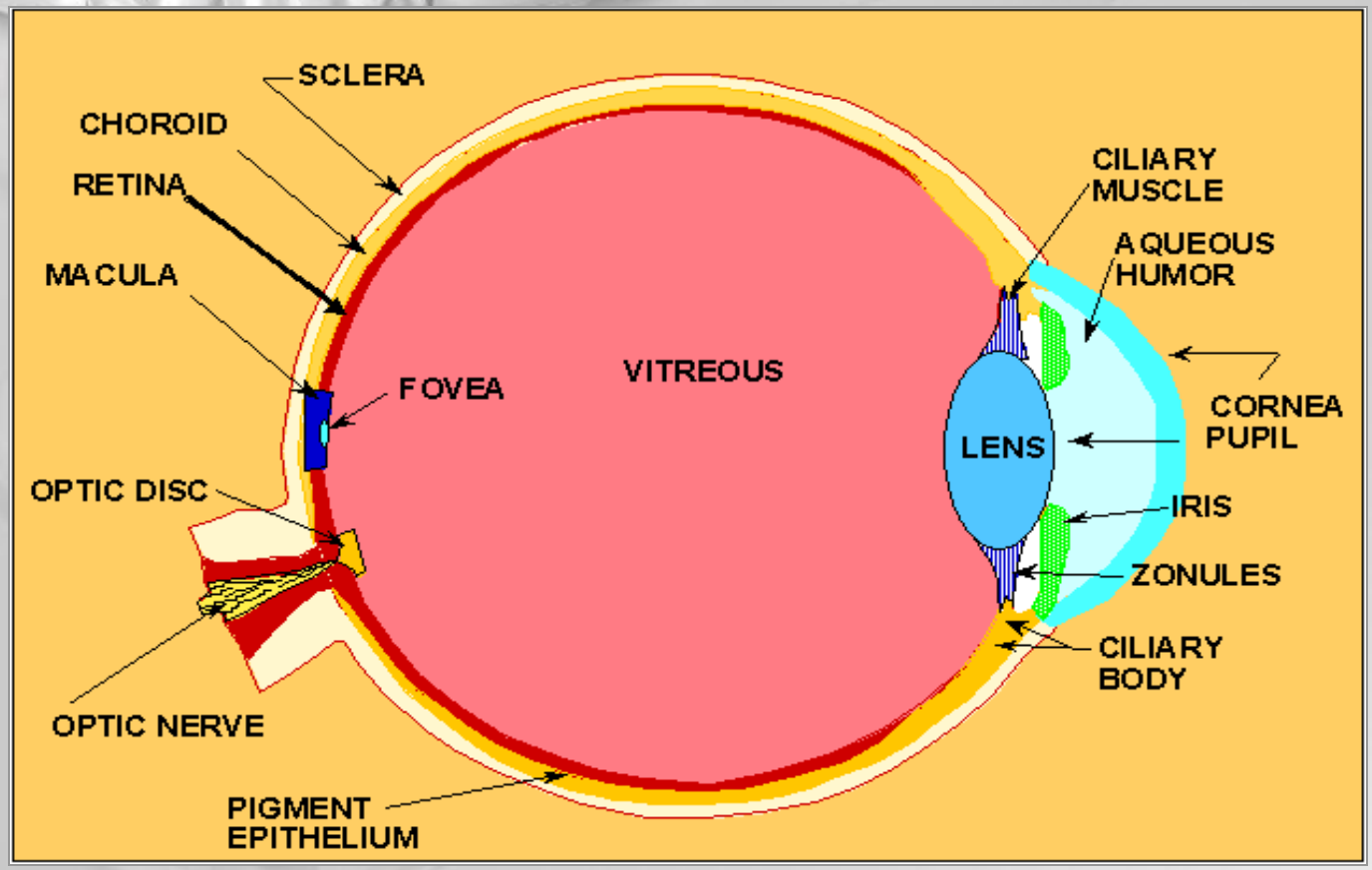
Ultraviolet (UV) MPE's Maximum Permissible Exposure

UV Region	Wavelength	MPE
UV-A	315 - 400 nm	1mW/cm2 8 hrs
UV-B	285 - 315 nm	500 uW/cm2 1 min
UV-C	100- 285 nm	100 uW/cm2 1 min

These MPE's are lower when someone is photosensitized by medication or diet.

Eye Damage Wavelengths

UV-A: 315-400 nm UV-B: 285-315 nm UV-C: 100-285 nm



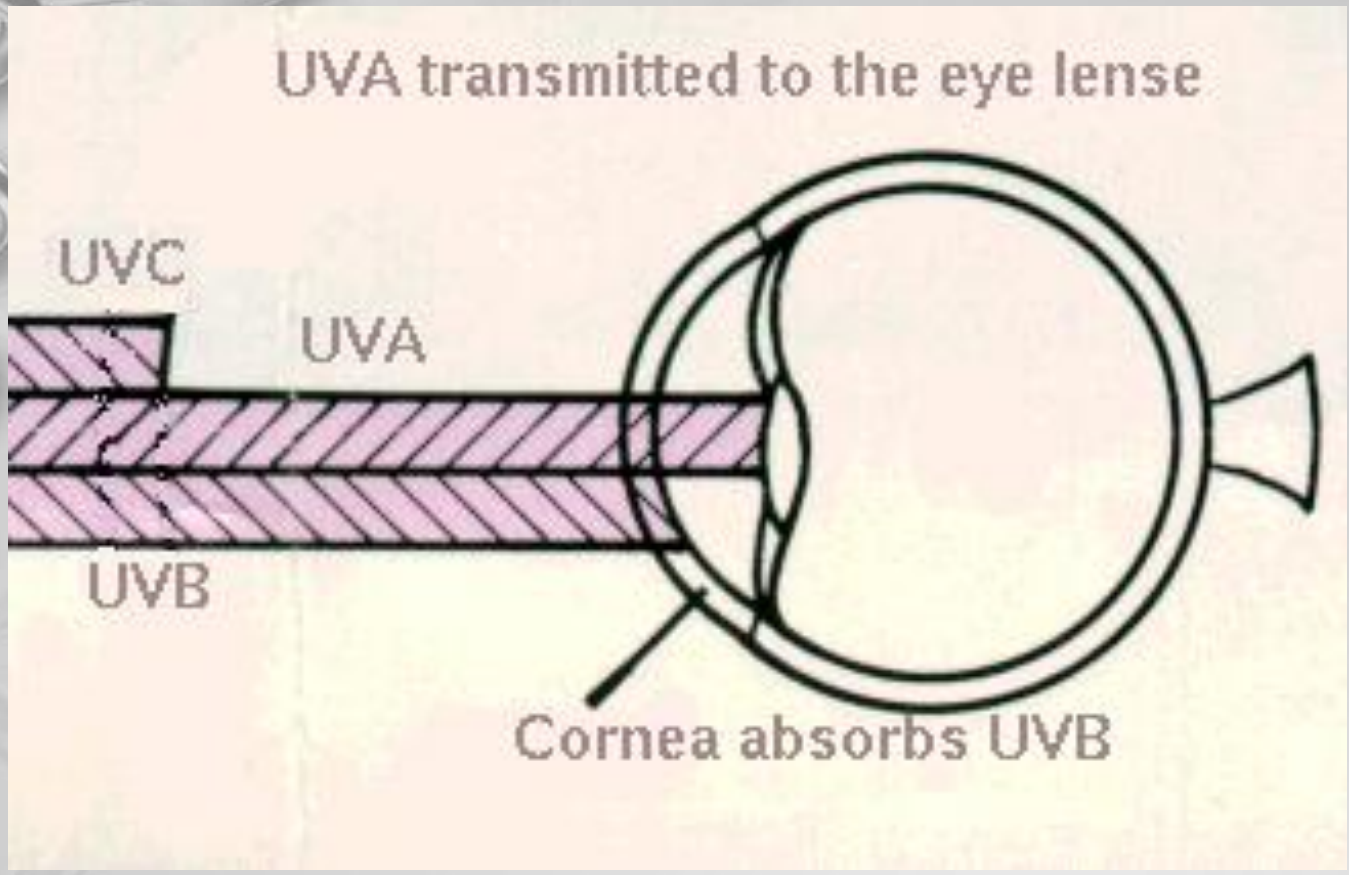
UV-A hits lens

UV-B hits Cornea

Natural UV- C absorbed by air. No penetration.

Commercial UV-C hits the Cornea

Eye Damage Wavelengths Simplified Cartoon



Biological Affects of UV-A Exposure to Eyes

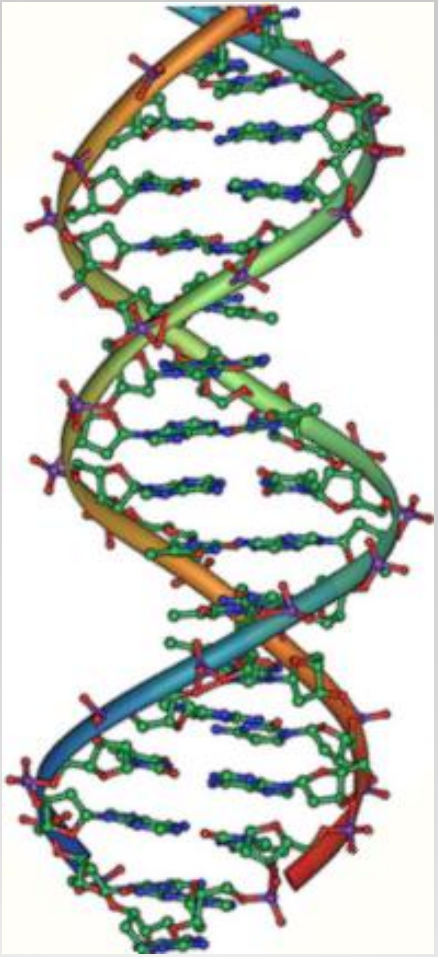
- UV-A passes through the cornea to the lens and overexposure contributes to the formation of cataracts by creating oxidants that cause accelerated formation of cataracts.
- Corneal damage is possible since UVA passes through it to get to the lens.
- A cataract is any opacity or loss of transparency of the lens of the eye. Blurry vision and eventual blindness occur.

Biological Affects of UV-B Exposure to Eyes

- Photokeratitis, Welders Flash , or Arc Eye is literally burning of the cornea by intense exposure to UVB. It is a painful inflammation that leaves lesions on the cornea.
- Cataracts can form as described with UVA affects.
- Inflammatory, invasive and proliferating lesions called pterygia can form on the cornea.
- Pinguecula or yellowish deposits between the cornea and sclera can occur.

Biological Affects of UV-C Exposure to Eyes

- Although literature on UVC damage is scarce since it is relatively benign in the natural form, it is the most dangerous form industrially. It can cause damage to eyes in as little as 3 seconds and DNA damage to all biological surfaces.
- Photokeratitis is prevalent documented injury.
- Chronic exposures to acute intense UVC can lead to cataract formation and retinal damage.



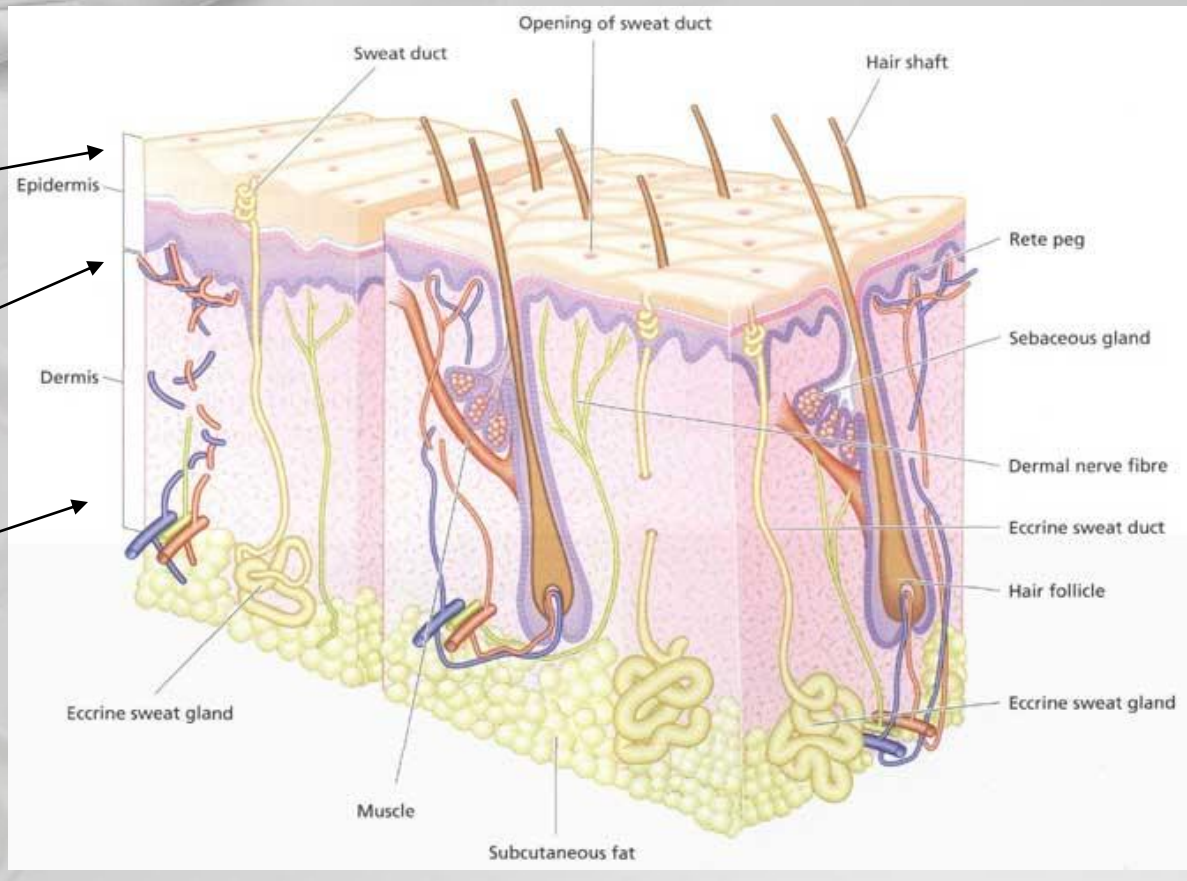
Skin Damage Wavelengths

Natural UVC rarely reaches the skin

Commercial UVC penetrates the surface of the epidermis

UVB penetrates the epidermis

UVA penetrates though the dermis just above the hypodermis



UV-A: 315-400 nm UV-B: 285-315 nm UV-C: 100-285 nm

Biological Affects of UV Exposure to Skin

- The hazards associated with skin exposure are less hazardous than eye hazards; however, with the expanding use of higher-power ultraviolet equipment, the unprotected skin of personnel may be exposed to extremely hazardous levels.
- Photochemical reactions called erythema are the principal cause of threshold level tissue damage following exposures to either UVB radiation for any exposure time or UVA "blue light" visible radiation when exposures are greater than 10 seconds.

Biological Affects of UV-A Exposure to Skin

- Suntans are related to UVA exposure. They do not cause sunburns because of their lower energy than UVB or UVC.
- Commercial UVA in the form of a black light emits long wave radiation with very little visible light.
- The long waves of UVA generates free radicals and causes indirect DNA damage which is responsible for malignant melanoma.
- Since UVA penetrate deeper they damage collagen fibers and destroy vitamin A.

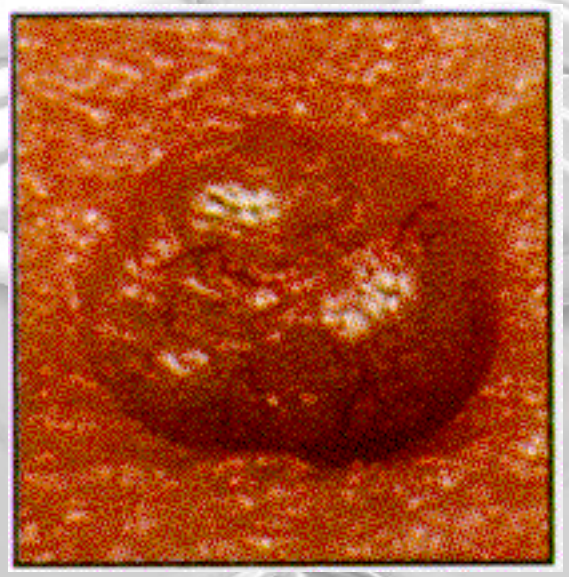
Biological Affects of UV-B Exposure to Skin

- Erythema or “sunburns”are related to UVB exposure. Symptoms depend on the intensity and or length of the exposure.
- Skin cancer, the most deadly form malignant melanoma, is caused by indirect DNA damage from UVB.
- Direct photochemical damage to DNA also causes skin cancers.
- One positive affect of moderate doses of UVB is that in induces the production of vitamin D and vitamin K.

Biological Affects of UV-C Exposure to Skin

- The most common injuries of UVC are corneal burns and erythema or severe skin burns.
- UVC burns are painful, but most injuries are short lived.
- Excessive exposure to UVC causes skin cancers as UVA and UVB.

Skin Cancer Images



Basal Cell Carcinoma

Malignant Melanoma Treatable Stage

Squamous Cell Carcinoma

Advanced stage Malignant Melanoma

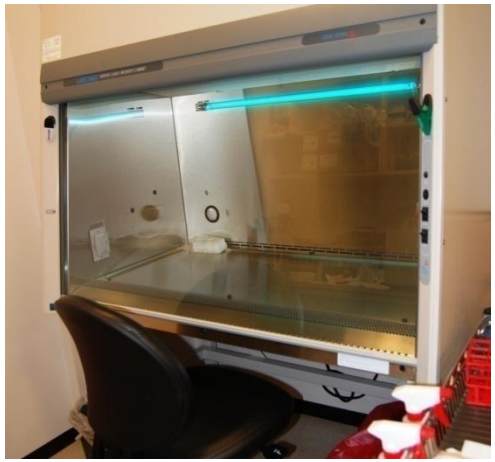
Sources of UV Radiation in the Workplace

- Germicidal lamps
- Transilluminators
- Hand Held UV units
- Crosslinkers
- Photo-therapy lamps
- Lasers
- Copy Machines

Germicidal Lamps

Germicidal lamps or low pressure mercury lamps are commonly used in laboratory. They are usually in housed fixtures such as a biological hood, but may not always limit exposure to the eyes or skin. The UV wavelength of these lamps is between 200-280 nm and work by breaking DNA which removes the capability of organisms to reproduce or kills them.

Unprotected persons should not be in a room where a lamp is active. Hood lamps should be turned off after sterilization time has ended.

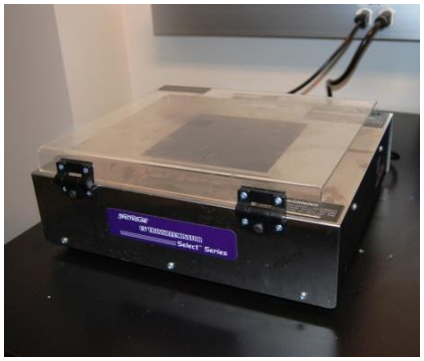


Germicidal Lamps

- Some germicidal UVC lamps are installed at the ceiling level for air and surface disinfection.
- Air disinfection units are housed in vents, therefore should pose any exposure problems. They should be monitored for light leakage.
- Surface disinfection units are not housed and need to be turned off manually or by a motion sensor.

Transilluminators

Nucleic acid transilluminators are used for visualization of DNA on a gel. The DNA sample is stained with a UV absorbing dye such as ethidium bromide. The UV output is about 312nm. Face shields must be worn with other lab appropriate attire when the apparatus is turned on. Damage to the eyes is the most common injury with this equipment.



Hand Held UV Units

Some units combine UVA blacklights and fluorescent white lights. Some units have UVC only. Although the light is directed away from the face, full face shields will protect from stray radiation. These units are used for quick detection of stained nucleic acids.

Crosslinkers

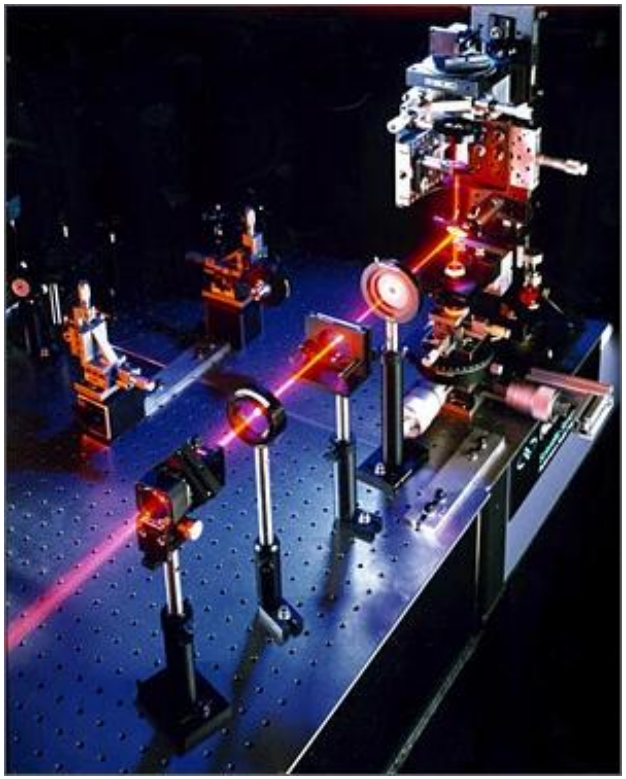
Crosslinkers use UV energy for curing applications or for bonding nucleic acids to a medium. Some use a fixed wavelength, some have variable wavelengths. They are equipped with a UV blocking window. It's best to leave the immediate area while the unit is on if the unit is old or suspected to have any leakage.

Photo-therapy Lamps

Artificial sources of UVB in phototherapy lamps are used primarily for clinical purposes. Acne, psoriasis, neonatal
high levels of bilirubin, and daylight deprivation depression are some of the ailments treated with UVB. The exposures times and radiation intensities are controlled and should not cause any unusual harmful effects that one would not get in sunlight. Regardless, equipment should be monitored regularly to avoid accidental overexposure.

Lasers

The term "LASER" is an acronym for "Light Amplification by Stimulated Emission of Radiation." The light from a laser has a very small divergence. The most common injury from a laser is thermal, but chronic exposure around UV lasers even outside of the beam can have the same effects as exposure to UVA or UVB. Damage to the eyes from lasers is irreversible. Face shielding when working with lasers is mandatory.



Copy Machines

Photocopier light sources produce a small amount of UV Radiation. They do not pose a large health threat. Keeping the lid closed while copying, looking away, or covering the stage with a sheet if making a copy from a book that inhibits closure of the lid is sufficient for protecting the eyes.

Safety Measures

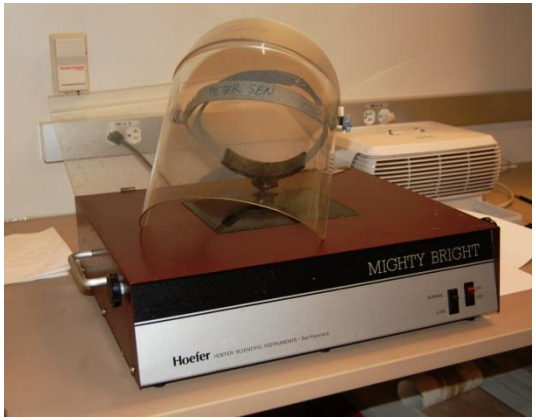
- Personal Protection Equipment (PPE)
- Labeling
- Monitoring & Maintenance
- Administrative controls

Personal Protective Equipment

- Face shields designed to protect against the UV wavelength should be used. Check manufacturer for specs including proper optical density. Polycarbonate shields provide adequate protection. Standard eyewear with open sides is not acceptable.

Personal Protective Equipment

- All exposed skin should be covered with opaque material including face, neck, head, hands and arms. It is assumed that other body parts are covered if wearing proper laboratory attire, i.e. long pants, closed toe shoes, gloves and long sleeve lab coats.



Labeling

- Warning signs should be posted where UV exposure may occur.
- Signs should indicate eye and skin hazard is probable and only authorized operators are permitted in the area.

Monitoring & Maintenance

- There are no guidelines for monitoring UV equipment. Maintenance should be performed according to manufacturer's instructions. UV monitors are available commercially if checking the output or leakage is desired.
- Germicidal UV light should be kept clean to prevent defects and promote effectiveness. Cooled lights should be wiped off on a monthly basis with soft lint free scratch free clothes dampened with ethanol.

Administrative Controls

- New lab personnel should review the UV radiation presentation on the Environmental Health and Safety website.
- No training is necessary until it’s required by OSHA or the Department of Labor.
- All UV equipment should be registered with EHS in the event that routine monitoring becomes mandatory.

Response to UV Exposure

- Stay calm! The effects of acute exposure to UV radiation are usually not severe.
- Most symptoms are delayed and can be treated as if one were sunburned.
- See and ophthalmologist if ocular damage is suspected.
- Treat skin lesions immediately.
- Report the incident in writing to EHS. Include date and time of incident, person(s) involved, equipment involved, type of injury and name of primary investigator.

The End

- Thank you for your time.