Ultraviolet Radiation Hazards

ISSUED BY

ENVIRONMENTAL HEALTH & SAFETY

OFFICE OF RADIOLOGICAL SAFETY

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What are the Hazards of UV Light?

Exposure to ultraviolet light can result in harmful effects to your skin or eyes that occurs without any initial pain or other warning symptoms. The harm may not present itself until minutes or even hours after the exposure. Prolonged exposure to certain UV wavelengths can increase your risk for cataracts or skin cancer.

Skin Injuries

Excessive skin exposure to UV in a short amount of time can result in redness, pain, and blistering, just like a sunburn. Prolonged exposure to UV can increase your risk of skin cancer.

Eye Injuries

Excessive eye exposure to UV in a short amount of time can result in injuries to the eyes. Symptoms include pain and redness of the eye, sensitivity to light, and a gritty feeling in the eye. Various symptoms are sometimes referred to as 'Welder's Flash', 'Arc Eye', or 'Snowblindness'. Prolonged exposure to certain UV wavelengths can increase your risk of cataracts.

For more detailed information on skin and eye injuries, refer to the "Further Understanding - How does UV cause harm?" section of this document.

What Sources of UV are There at Georgia Tech?

At Georgia Tech, UV is used primarily by researchers in laboratories or by Facilities Management in air handlers. There are some welding and cutting processes that generate UV as well. Some of these sources can cause harm in minutes or even seconds of exposure. Specific sources and protective measures are discussed below, but should not be considered a comprehensive list of UV sources at Georgia Tech. If you have any questions about a given type of UV source in your lab/work area, please refer to the section "Georgia Tech Resources" later in this document.

How Do We Protect Ourselves?

Engineering Controls

The best control measures are engineering controls. The UV source should be designed so that no skin or eye exposure can occur when the UV lights are on. This is often accomplished by the use of shields or interlocks that turn the light off when a door or port is opened.

Administrative Controls

All UV sources should have a conspicuous warning label at the point of access to the source. This label should warn the person that UV light is present, and that eyes and skin must be protected.

Finally, all new employees, faculty or students should be informed of hazardous UV sources (and all hazards, actually) that may be encountered in their work area, and how they should protect themselves from those hazards.

PPE

If engineering controls are not present or do not completely prevent exposure of your eyes or skin to the UV source, then you must wear personal protective equipment. For the UV sources listed here (except for lasers), appropriate PPE would consist of clothing that covers all skin (lab coat, gloves, pants, closed-toe shoes) and a polycarbonate face shield that covers the entire face. Pay attention to ensure that any exposed skin on the neck and wrist are covered.

Specific UV sources and protective measures are discussed below.

Common Sources of UV at GT, and Proper Protective Measures

Germicidal Lamps in Air Handlers

These are used for controlling microbial growth on cooling coils[i] and is also helpful with disinfecting air as it is supplied to rooms and areas inside buildings.

They are found in many buildings across campus but are typically in maintenance areas accessed only by Facilities Management.

Exposure is controlled ideally by interlocks that prevent entry into the area with the lights on. Some of these air handlers do not have interlocks, but still have labels indicating the UV hazard inside. In either case, workers should be very careful to pay attention to the warning labels and make sure the UV lights are off before entering or working in the unit.

What PPE is needed? In the rare case that work must be performed with the UV lights on, GT EHS should be consulted prior to the work. Clothing that covers the entire body and a polycarbonate face shield must be used.

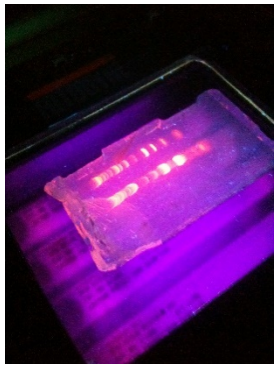
Germicidal Lamps in Biosafety Cabinets or Laminar Hoods

These are used for sterilization and disinfection, although their use for these purposes is no longer recommended. If you have questions about alternate methods of sterilization and disinfection, please reach out the Biosafety Office. (https://www.ehs.gatech.edu/biosafety)

They are found in laboratories, primarily for the biological sciences.

Exposure is controlled by closing the sash of the hood/cabinet whenever the UV lights are on. If the hood (e.g., laminar flow hood) does not have a sash, then PPE, as previously described, is needed when working where exposed to the UV light. Access to the UV light area should be controlled by the use of conspicuous warning labels and room postings, and by making sure all workers in the lab are aware of the hazard.

Transilluminators



These are used for the visualization of DNA following gel electrophoresis and ethidium bromide staining.

They are found in biological research laboratories.

Exposure is usually controlled by a UV shield that is placed over the gel when the unit is turned on. Often, these shields have interlocks that prevent the UV lights from illuminating until the shielding is in place. **If this shield does not completely cover the light, then PPE (as previously described) must be worn when working near the transilluminator**. These units should not be placed in a highly trafficked area of the lab.

Users of transilluminators must not bypass the shield interlocks. Also, the unit should not be used if the shield is cracked or damaged. Keep this shield clean.

Handheld UV lights

These are used primarily for visualizing nucleic acids following staining.

They are found in biological research laboratories.

Exposure is controlled by wearing PPE as previously described and never directing the UV light towards your face.

UV Mask Aligners

These are used to transcribe a fine pattern on a substrate using UV light. Substrates are made of various materials like silicon, glass, ceramic, GaAs, quartz, etc. They are used in the manufacturing of semiconductor devices, such as general transistors and Integrated circuits, and also used for LCD glass patterns and quartz crystal units.ii

They are typically found in clean rooms.

Exposure is controlled by shields that are designed into the equipment by the manufacturer. Do not operate these devices without the proper shielding in place. If the device being used does not have built in shields, exposure is controlled by wearing PPE as previously described. When operated in cleanrooms, individuals are typically already wearing PPE that is protective.

Welding Equipment and Plasma Cutters

These are used for welding and cutting metals in research-related machine shops and by Facilities employees in shops and repair locations on campus.

Exposure to operators and individuals in the surrounding area is controlled with the use of UV blocking transparent curtains or welding curtains. For welding operations otherwise, the welder must wear full coverage clothing, gloves, and a proper welding helmet.

UV Lasers

These are used for various purposes in research laboratories. Users of UV lasers must follow the Georgia Tech Laser Safety Policy (https://www.ehs.gatech.edu/radiation/laser).

What Do I Do if I Think I Have Been Exposed?

If you experience skin effects similar to a sunburn, or eye discomfort following exposure to UV, then you should seek medical attention and follow the *EHS Injury and Illness Reporting Guidelines*, found under *Occupational Injury Reporting* at https://www.ehs.gatech.edu/general/occupational-injury.

If you believe you were exposed to UV, but are not experiencing any symptoms, you can contact the Office of Radiological Safety (ORS) at 404-894-3605 or ors@ors.gatech.edu. ORS can measure the UV intensity and determine if the exposure may lead to skin or eye injury.

Further Understanding - How Does UV Cause Harm?

Ultraviolet light is invisible electromagnetic radiation of wavelengths between 100 nm and 400 nm. It is further divided in to three bands - UVA, UVB, and UVC (a sub-part of UVC is called VUV). Each of these bands has a different potential for health effects:

Band	Wavelengths (nm)	Eye Hazard	Skin Hazard	Notes
UVA	320-400	Less harmful. Prolonged exposure may lead to cataracts	Less harmful. Prolonged exposure may lead to sunburn or skin cancer.	95% of the UV radiation received from the sun on the earth's surface. Harder to shield.
UVB	280-320	Can lead to eye injury (photokeratitis/conjunctivitis). Prolonged exposure may lead to cataracts	Deposited more deeply into the skin and can lead to sunburn, peeling, and blistering that is more severe and longer lasting. Considered major cause of skin cancer.	Relatively easy to shield.
UVC	180-280	Very damaging. Can lead to eye injury (photokeratitis/conjunctivitis)	Deposited in outer layer of skin. Can lead to sunburn, peeling, and blistering. May contribute to risk of skin cancer.	Very easy to shield. UVC received from the sun is entirely blocked by the atmosphere.
VUV	100-180	These UVC wavelengths are not transmitted through air and are referred to as vacuum UV. Because they are absorbed by air, they do not pose biological health and safety concerns.		

Exposure to UV causes photochemical reactions in tissue. For the skin, this can lead to darkening of the skin and eventually sunburn, peeling or blistering. For the eyes, the cornea can become damaged, called keratitis, or the membrane lining the eyelid and white of the eyes can become injured, known as conjunctivitis. When these conditions are caused by exposure to UV light, we call them photoconjunctivitis or photokeratitis.

The injury to the eyes can be extremely painful but is usually temporary because of the recuperative powers of the epithelial layer of the eye. The latent period is usually 4–12 h from the time of UVB/C exposure, and the damage is dependent on both the UVB/C dose and the UVB/C spectrum. It takes at least 8 h for visual incapacitation to become evident and the individual may be visually incapacitated for 48 h. The latent period varies inversely with the intensity of exposure. Symptoms can include blurred

vision, photophobia or sensitization to light, lacrimation or tears, blepharospasm (painful uncontrolled blinking), and a sensation of sand in the eyes. Symptoms, including severe pain, may last from 6 to 24 h and recovery may take up to 48 h. Conjunctivitis develops more slowly than photokeratitis and may be accompanied by erythema of the facial skin around the eyelids. Cataract formation and photodegradation of the eye lens by UVA/B exposure has not been demonstrated in humans and has only been observed in animal studies at extremely high doses. So, prolonged UVA/B exposure should be considered a potential risk for cataract development.[iii]

Ultraviolet radiation exposure can produce various effects on skin including erythema, photosensitivity, skin aging, immune system damage, and skin cancer. Erythema is the reddening of the skin, like sunburn, after exposure to UVB/C. UVA can also cause erythema, but only at very high doses. Skin color effects how bad the reddening can be, with darker pigmentation offering more protection against UV damage. The melanin that is present in the skin acts like a UV-blocking filter. Prolonged UVA/B/C exposure to skin or tissue can increase the risk of skin cancer.[iv]

The earth's atmosphere shields all of the UVC and most of the UVB that comes from the sun. Therefore, exposure to UVC and UVB bands comes from manmade sources, such as those listed here. Fortunately, UV is easy to shield with tightly woven clothing for your skin and polycarbonate eyewear or face shields for your eyes.

Exposure Limits

There is no Occupational Safety and Health Administration (OSHA) standard for exposure to ultraviolet light, but the American Conference of Governmental Industrial Hygienists (ACGIH) has issued recommended Threshold Limit Values (TLVs) for occupational exposure to UV.[v] These TLVs refer to incoherent ultraviolet radiation with wavelengths between 180 and 400 nm and represent conditions under which nearly all healthy workers may be repeatedly exposed without acute adverse health effects such as erythema and photokeratitis.[vi] When UV hazard assessments are performed at Georgia Tech, the ACGIH TLVs are typically used for reference.

UV lasers are not included in the sources of UV covered by these TLVs. Please refer to the Georgia Tech Laser Safety Program for laser hazards.

Georgia Tech Resources

If you have a UV source that you are concerned about, contact ORS at 404-894-3605 or ors@ors.gatech.edu. ORS can measure the UV intensity and determine if the source has the potential to lead to skin or eye injury. ORS will also help make sure adequate controls are in place to prevent or reduce the likelihood of exposure.

Other Links

Ultraviolet (UV) Radiation | FDA, https://www.fda.gov/radiation-emitting-products/tanning/ultraviolet-uv-radiation

References

[i] Wladyslaw Kowalski, Ultraviolet Germicidal Irradiation Handbook: UVGI for Air and Surface Disinfection (New York: Springer, 2009) 5-6.

[ii] Kyodo International Inc. *Mask Aligners*. n.d. <https://www.kyodo-inc.co.jp/english/electronics/equipment/oai.html>.

[iii] Wladyslaw Kowalski, Ultraviolet Germicidal Irradiation Handbook: UVGI for Air and Surface Disinfection (New York: Springer, 2009) 289.

[iv] Wladyslaw Kowalski, Ultraviolet Germicidal Irradiation Handbook: UVGI for Air and Surface Disinfection (New York: Springer, 2009) 291-293.

[v] Columbia University Health Sciences Division. Working Safety with Ultraviolet Radiation (New York: 2005) 2.

[vi] American Conference of Governmental Industrial Hygienists (ACGIH). TLVs and BEIs, Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices (Cincinnati: 2019) 152.