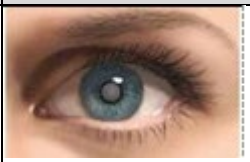
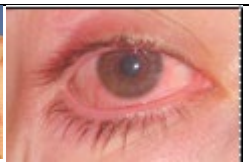
ULTRAVIOLET (UV) SAFETY

Ultraviolet (UV) light* is electromagnetic radiation with wavelength between 100 nanometers (nm) and 400 nm. UV radiation is invisible to naked eye and are broken down into three main bands (UV-A, UV-B, and UV-C).

The main source of UV exposure is from the sun, but it is typically limited to the UV-A band, as the earth atmosphere protects us from the harmful UV-B and UV-C rays. Nonetheless, UV rays from all three bands can be produced from man-made sources, such as those in research laboratory.

Band	Wavelength	Hazard Potential	Description	Biological effects
UV-A (Near UV)	315-400 nm	Lowest	Accounts for up to 95% of UV radiation, penetrates deeper into skin layers	 Cataract  Sunburn
UV-B (Middle UV)	280-315 nm	Mid to High	Biologically active, but cannot penetrate beyond the superficial skin layers, most solar UV-B is filtered by the atmosphere	 Erythema  Photokeratitis
UV-C (Far UV)	100-280 nm	Highest	Most damaging, completely filtered by the atmosphere and does not reach the earth's surface	 Skin cancer  Conjunctivitis

*UV lasers are not covered in this document; see the Laser Safety webpage for safety precautions related to UV lasers.

UV RADIATION SOURCES

Below are examples of UV devices generally found in research laboratory, their uses, safety precautions and recommended personal protective equipment.

Germicidal lamps (in biological safety cabinets)

Germicidal lamps emit radiation almost exclusively in the far-UV band of 254 nm. It is usually used in laminar air flow hoods, in biosafety cabinets, and in some clinical areas (ceiling level) for sterilization/decontamination purposes.

Image via projects.nfstc.org

EH&S does not recommend the use of UV lights as a method of disinfection due to several factors including requirement for regular cleaning, maintenance, and monitoring to ensure germicidal activity. For more information, please visit EH&S's website.

*The Center for Disease Control (CDC) and the National Institute of Health (NIH) agree that UV lamps are not recommended nor required in Biological Safety Cabinets (BSC). The National Sanitation Foundation (NSF) Standard 49, the industry testing standard for all biohazard cabinetry, does not provide any performance criteria for UV lighting and specifically states in section 4.24.2 that "**UV lighting is not recommended in class II (laminar flow) biohazard cabinetry"** as it is possible to produce ozone levels from UV wavelengths below 250 nm sufficient to affect rubber or other polymer made materials, low or no ozone UV light bulbs are commercially available*.

For your safety, EH&S recommends:

- Avoid working in or around the safety cabinet when the UV light is on or avoid using the room when UV light is on.
- Always close the sash completely when the UV light is on. Even small opening of the sash can cause skin damage and other biological effects.
- Ensure the UV light is off prior working at the cabinet.
- Control access to the room/UV light area while the lamps are operating to prevent exposure.
- Personal protective equipment (PPE) includes UV safety eyewear, UV face shields, long- sleeved, tightly woven clothing that covers much of the body and gloves (with no gap between the cuff and the glove) should be worn at all times when there is potential for UV exposure.

UV light box/transilluminator

UV light boxes/transilluminators are commonly used for visualizing nucleic acids (DNA and RNA) that has been stained with the chemical Ethidium Bromide or Sybr Green. The unit contains a UV lamp under a glass top with a clear shield to protect user from UV exposure while visualizing the sample.

Transilluminator and hand-held UV units should be used with protective shields in place per the manufacturer's instructions.

Image via www.camlab.co.uk

For your safety, EH&S recommends:

- Check shields regularly for cracks or other damage. Shields must be kept clean and replaced when damaged.
- Do not remove face shield or protective shield to get a closer look at material being visualized with transilluminator or hand-held unit.
- Personal protective equipment (PPE) includes UV safety eyewear, UV face shields, long- sleeved, tightly woven clothing that covers much of the body and gloves (with no gap between the cuff and the glove) should be worn when there is potential for UV exposure.
- Access to rooms with transilluminator should be controlled and posted with a warning sign indicating face and other skin protection is needed to enter when transilluminator is in use.

UV Crosslinkers

Image via www.fishersci.com

UV crosslinkers are used to "cross-link" to covalently attach nucleic acid to a surface or membrane following Southern blotting, Northern blotting, dot blotting, and Colony/Plaque lifts. It can be used for curing or UV sterilization and sanitization.

As the DNA will be used in place, a 254 nm wavelength is used to maximize adherence.

For your safety, EH&S recommends:

- Do not use the crosslinker if the door's safety interlocking mechanism is not working properly. Discontinued until the unit is serviced by the manufacturer.

- Do not attempt to disengage or override the internal safety interlocks.
- Do not expose unprotected eyes or skin to UV radiation.

UV Dental Curing Light

Image via www.wikipedia.org

Dental curing light is commonly used in dentistry to cure adhesives or for polymerization of light cure resin-based composites. The probe is held very close to the tooth for one to two minutes. Although the expected exposure from this reflected radiation may be of low intensity, the effects of the light may have compound effects on vision if exposed numerous times.

While there is little risk to operator or patient when the procedure is performed correctly, high intensity blue light can reflect off dental structures and instruments, and the light can be inadvertently directed to the eye.

For your safety, EH&S recommends:

- During dental procedures, patients and dental personnel should wear protective eyewear that blocks short wavelength light.
- Orange or amber tinted, blue-blocking glasses or shield should be used to reduce the exposure.

HAZARDS AND BIOLOGICAL EFFECTS

The critical organs which are affected by the UV radiation are the skin and the eye. The UV light levels found in UV equipment greatly exceed the levels found in nature.

Eye

Clinical effects of UV on the eyes are photokeratitis and conjunctivitis, which appear 2-24 hours after irradiation/exposure. Photokeratitis is caused preferentially by UV-B and UV-C and is a painful inflammation. Symptoms include a “sand-like” feeling in the eye that can last several days (no permanent damage as the corneal cells will grow back). In very severe cases, the cornea may become clouded and corneal transplants may be needed to restore vision. However, the absorption of UV-A radiation in the lens of the eye is thought to produce progressive yellowing with time and may contribute to the formation of cataracts, causing partial or complete loss of transparency. Chronic exposures to UV radiation can lead to the formation of cataracts.

Skin

All wavelengths of UV damage the collagen fibers in the skin, thus accelerate the changes due to aging and a major role in production of wrinkles. UV-B rays is responsible for erythema and together with UV-A, they are associated with skin cancers (Basel-cell carcinoma, squamous-cell carcinoma, and melanoma). Erythema (sunburn) consists of redness ulcerations that can vary in severity and can occur from only a few seconds of exposure. Symptoms can vary with one's genetic background such as darkly pigmented skin is much less susceptible to sunburns than pale/fair skin individual. Additionally, certain medications (tetracycline antibiotics, sulfa drugs, antihistamines, non-steroidal anti-inflammatory drugs, and even certain herbal remedies) can increase one's photosensitivity to UV radiation.

ENGINEERING CONTROLS

Enclosures, screens, or filter used to contain the UV radiation or devices such as interlocks must be used at all times.

UV can easily be shielded by materials such as polycarbonate, metal, cardboard, and wood. Ordinary glass blocks most UV light of wavelengths less than 330 nm but may also transmit most of the UV for longer wavelengths. It should not be relied for UV protection unless UV shielding is verified. Please check your safety equipment to ensure that it is rated for the wavelength in use.

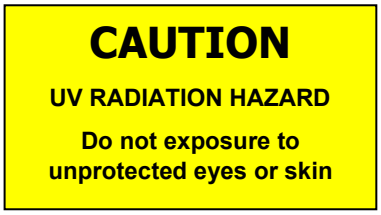
ADMINISTRATIVE CONTROLS

UV exposure may also be minimized by limiting exposure time and increasing the distance between personnel and the UV source.

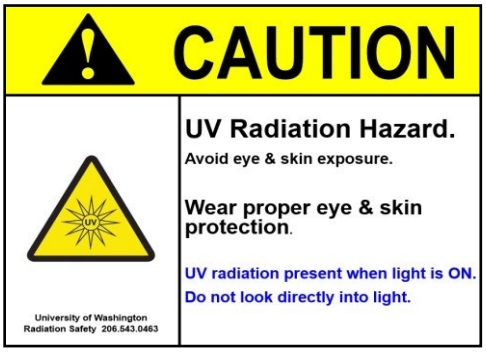
Access to the UV radiation area/UV room/lab should be limited to only authorize personnel who is properly trained on the procedures. If experiments using the UV radiation is conducted in shared spaces, all occupants must receive prior notification and warning signs must be clearly posted.

WARNING SIGNS AND LABELS

Any equipment that emits UV radiation must be conspicuously labeled with a caution label.



A warning sign must also be posted on entrances to the lab/room during UV irradiation and/or on the biosafety cabinet.



Warning signs are available from EH&S's Radiation Safety Office; contact us at 206.543.0463 or radsaf@uw.edu.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

PPE may consist of protective clothing, UV rated eye and face protection, and gloves.

Protective clothing

- Wear long sleeves, fully buttoned lab coat, long pants, and gloves.
- Tightly woven clothing that covers much of the body (especially neck) and gloves (with no gap between the cuff and the glove) should be worn at all times.

Eye/Face protection

- A polycarbonate face shield and/or eyeglasses (wrap around lens) with Z87 marking (ANSI Z87.1 UV certification) must be worn to protect the eyes and face.
- The new ANSI Z87.1- 2015 UV certification for UV rated lenses must be marked with Z87U 5 and scale number (scale ranges from two to six, with the higher number providing the highest protection from far and near UV) Example: Z87U6.
- Ordinary prescription eyeglasses or contacts is inadequate for protection against the UV rays.

Gloves

- Wear nitrile gloves to protect exposed skin on the hands. Ensure exposed skin (wrist and forearms) are covered.

PROTECTION FROM THE SUN

Outdoor workers can minimize their UV exposure by:

- Avoid outdoors between 10 a.m. and 2 p.m. when UV rays from the sun are the greatest.
- Stay in the shade when possible.
- Wear tightly woven clothing that covers your arms and legs.
- Wear a hat with a wide brim to shade your face, head, ears, and neck.
- Wear sunglasses that wrap around and block UV rays.
- Use sunscreen with sun protection factor (SPF) 15 or higher. For more information on sunscreen, please visit the U.S. Environmental Protection Agency's *Sunscreen: The Burning Facts* brochure.

EH&S SERVICES

Contact EH&S Radiation Safety Office at radsaf@uw.edu or at 206.543.0463 for assistance with shielding, PPE, hazard evaluation (including measurement of UV radiation) and training for UV radiation.