Ultraviolet Light Safety in the Laboratory

Presented by the Office of Environmental Health & Safety

EHS

Many of the ultraviolet (UV) sources used in the laboratory emit high intensities of UV light, capable of producing painful eye and skin burns. This training presentation provides information about the hazards associated with UV exposure and the safety precautions to take when working with these sources.

EHS provides these training materials for the use of Princeton University faculty, staff and students to meet training needs specific to Princeton University.

UV Sources in the Laboratory

The most likely sources of UV light in the lab setting include:

- Transilluminators (used to visualize DNA bands in gels)
- Crosslinkers
- Germicidal lamps in biological safety cabinets
- Handheld UV lamps
- UV Lasers
- Blue-emitting LEDs used for photocatalysis (some of the emissions fall into the UV range)
- Examples include plasma sources for spectroscopy research, collateral and plasma radiation from cutting and welding processes

The UV Spectrum

	Wavelength Range
Ultraviolet A (UVA)	320 – 400 nanometers (nm)
Ultraviolet B (UVB)	290 – 320 nm
Ultraviolet C (UVC)*	200 – 290 nm
The **actinic** range, from 200 - 315 nm, is the portion of the UV spectrum that produces biological effects in humans.	

People cannot perceive UV directly. The lens of the human eye blocks most radiation in the wavelength range of 300–400 nm; shorter wavelengths are blocked by the cornea.

Biological Effects of UV Exposure

The eye is the most vulnerable organ to UV exposure; skin is somewhat less sensitive.

Eyes

The epithelial cells of the cornea absorb radiation in the actinic portion of the UV spectrum (200 – 315 nm). This exposure produces symptoms known as photokeratitis, which are not felt until several hours after the exposure. Photokeratitis is very painful and produces the sensation of having sand in your eye. It also causes an aversion to bright light, as well as the production of tears. The effects typically last up to 48 hours but will disappear as the cells of the cornea are replaced.

Long-term effects can also occur. Most of the UV radiation that enters the eye is absorbed in the cornea, but UVA absorption by the lens can alter proteins in the lens and result in cataract formation.

Biological Effects of UV Exposure

Skin

Excessive UV exposure in the actinic range (200-315 nm) produces symptoms that are comparable to sunburn and includes redness, swelling, pain, blistering, and peeling of the skin.

Factors that can affect skin response to UV include your degree of skin pigmentation and photosensitization by certain foods (e.g., figs, limes, parsnips and celery root) and drugs (e.g. tetracycline).

You will recover from short-term skin damage, but chronic exposure to UV may increase your risk of skin cancer.

UV Exposure Guidelines

There are no regulations in the U.S. that establish limits on UV exposure in the workplace, but the American Conference of Governmental Industrial Hygienists (ACGIH) has established guidelines that ere widely used.

ACGIH recommends that exposure not exceed 0.1 μWatts/cm^2.

Measuring UV Levels

EHS maintains a calibrated UV radiometer to measure UV levels in the actinic range. EHS can make measurements for your application and can provide you with recommended daily exposure durations, based on the ACGIH guidelines.

Contact the Radiation Safety Officer at 609-258-5294 to request a survey and assessment for your UV-emitting apparatus.

Transilluminators

Transilluminators are used to visualize the DNA on a gel. Researchers often need to cut bands from the gels, resulting in extended close contact to a powerful UV source.

Transilluminators emit very intense UV light in the actinic range (200-315 nm) and will cause severe eye and skin burns if sufficient protective measures are not taken.

Transilluminator Study

A 2005 paper, "Ultraviolet Radiation Exposure from UV-Transilluminators." examined transilluminator use and measured UV levels in the actinic region for unshielded transilluminators. In conclusion, the authors stated:

"All UV-transilluminators studied were originally designed and equipped with a UV blocking cover … but in most cases the cover was not used as intended …. Almost all operators worked within 62 cm of the UV-transilluminator, with most of them commonly working at ≤ 25 cm from the surface. The recommended allowable [daily] *UVR duration, as calculated in this study, is* ***less than 35 sec within a distance of 25 cm****, and less than 2 min at 50 cm."*

Akbar-Khanzadeh, Farhang and Mahdi Jahangir-Blourchian. "Ultraviolet Radiation Exposure from UV-Transilluminators." *Journal of Occupational and Environmental Hygiene.* 2.10 (2005): 493-496.

Transilluminator Precautions

Sometimes researchers remove shields from transilluminators. It is never advisable to remove the shields!

A filter protector is a thin UV-transmitting plastic covering placed over the transilluminator filter surface to protect the surface from cuts and scratches.

- The filter protector is **not** intended to be used as a UV shield.

Protect Others: Transilluminators are often used in small rooms. Anyone else in the room will be relatively close to the transilluminator and should wear the same PPE as the transilluminator user.

Personnel Protective Equipment

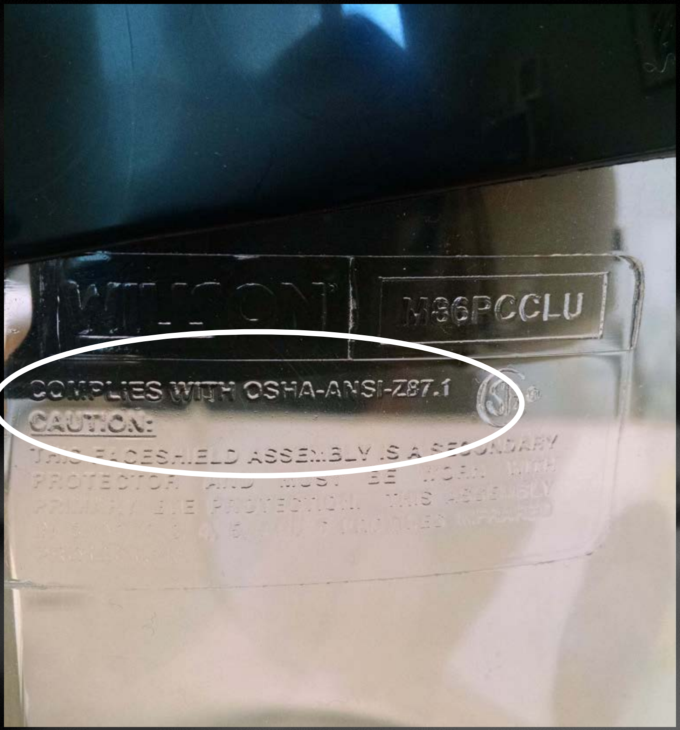
Protective Clothing: Wear a fully buttoned lab coat, long pants and closed toe shoes. Make sure that **ALL** skin is protected, including face, neck, hands and arms. Make sure there are no gaps in your protective clothing, especially at the wrist and neck areas.

Gloves: Wear disposable latex or nitrile gloves to protect exposed skin on the hands. **Do not use vinyl gloves**, which can transmit significant amounts of actinic UV.

Eye/Face Protection: Always wear a full face shield. To protect the eyes and face, use a polycarbonate face shield stamped with the ANSI Z87.1-1989 UV certification. See the next slides for more information about face shield use. Note: if you're working with splash or projectile hazards, you may also need to wear safety glasses or goggles under the face shield.

Face Shields

Only use polycarbonate face shields that are rated for UV protection. The face shield should be marked with the term Z87 to indicate that the shield meets the ANSI standard to provide at least basic UV protection. Read the specs provided with the face shield to verify that the shield provides adequate UV protection.



You may not be totally protected by the face shield. For example, suppose that you are working over a transilluminator, wearing PPE, but you are looking up while talking to someone nearby. This would expose your throat and chin to excessive UV radiation. You must be sure that there is no exposed skin.

Never remove the face shield in order to get a closer look at the material being visualized.

Care & Use of Face Shields

Keep face shields clean and in good condition. Lab personnel will avoid using dirty and scratched face shields. Hang face shields from hooks and do not place them face down on surfaces.

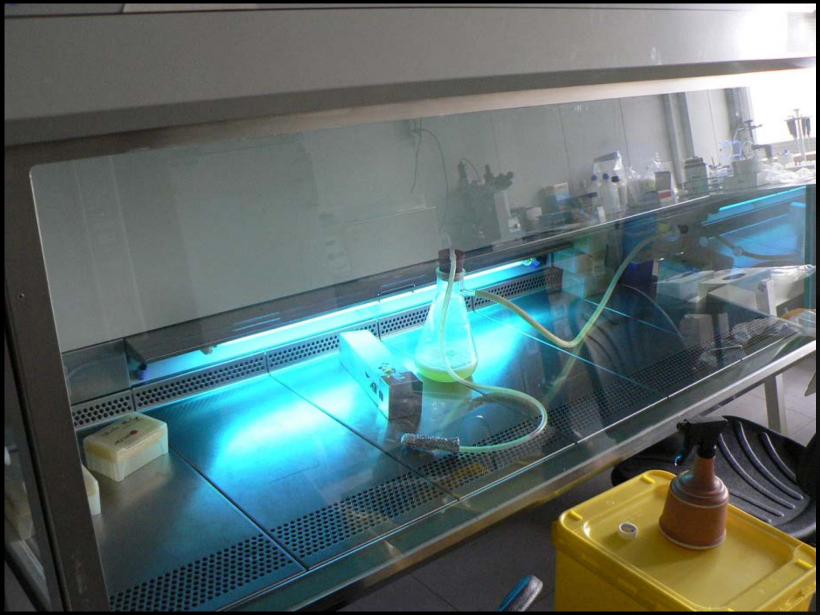
Don't do this!

A good and creative use of ring stands for hanging up face shields

UV Crosslinkers

- **Crosslinkers are u**sed to attach nucleic acids to a surface or membrane following blotting procedures.
- Crosslinkers produce high levels of actinic UV radiation, but they typically pose little UV hazard because they are equipped with door safety interlocks. These interlocks, which function like the interlocks on household microwave ovens, cause the crosslinker to shut off when the door opens or they prevent the crosslinker from starting if the door is open.
- Do not use a crosslinker If the interlock system is not functioning correctly. Notify EHS about any malfunctioning interlocks.

Biological Safety Cabinets*



- Turn off the UV light before working in the cabinet.
- Typically it is safe to work near a BSC when the UV light is on, ***as long as the sash is completely pulled down***.

* **Note:** EHS does not recommend the use of UV germicidal lights to sanitize BSCs. The lights cannot be relied upon to provide an adequate degree of germicidal protection. Contact the EHS Biosafety Officer for more information.

Hand Held UV Lights

Handheld UV lights may be used in research laboratories for visualizing nucleic acids following gel electrophoresis and ethidium bromide staining or for other purposes.

A grad student in the History Department experienced facial burns after using a handheld light to visualize markings in the margins of a 14th century book. The UV reflected from the light-colored pages onto the student's skin.

Precautions

- Wear a face shield.
- Cover all exposed skin.
- Be aware of reflective surfaces which can reflect UV radiation to unprotected parts of your skin.

UV Lasers

Examples of lasers operating in the ultraviolet region include the neodymium:YAG-Quadrupled (QSW & CW) laser, and the Ruby (doubled) laser.

When lasers are used, eye protection is always critical. But, in the case of UV lasers, protecting the skin is also important, because moderate-to-long exposures to diffuse reflections are possible.

The lens principally absorbs UVA (315-400 nm). The lens is particularly sensitive to the 300 nm wavelength. XeCl eximer lasers operating at 308 nm can cause cataracts with an acute exposure.

Precautions for ultraviolet lasers are similar to precautions required for other UV producing devices.

Plasma Emissions

Interactions between very high-power laser beams and target materials may produce plasmas that may contain hazardous UV emissions. Plasma emissions created during laser - material interactions may contain sufficient UV and blue light (0.18 to 0.55 um) to raise concern about long-term ocular viewing without protection.

Other Research UV Sources

- UV lights to induce mutations in plants

- Blue-emitting LEDs used for photocatalysis

  Very bright blue LED lights are used in Chemistry to catalyze chemical reactions. These lights may produce emissions in the UV range.

  Contact EHS to request a UV survey for these and other experiments using UV sources.

UV Burn Incidents – Case 1

A researcher rested her arms against the side of a transilluminator on which a blue converter box was sitting. The surface of the transilluminator was exposed on each side of the box (See Photo A). The researcher's lab coat did not fully cover her arms. The exposure time was 10-15 minutes.

A measurement with a UV radiometer indicated an exposure level of 200 μW/cm^2 , at the point where the arms rested. At 200 μW/cm^2, the maximum permissible daily exposure is **20 seconds**.

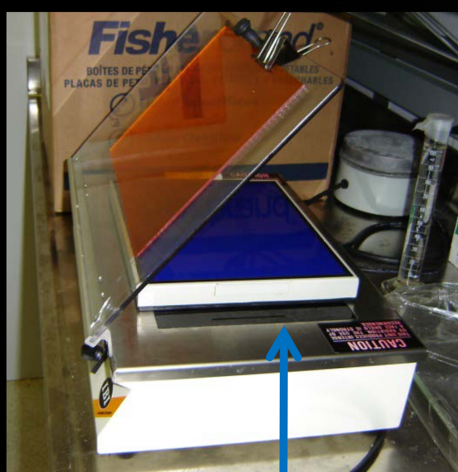


Photo A

See exposed surface of the transilluminator on each side of the blue converter plate.

After the incident, a piece of cardboard was carefully cut to shield the exposed surface of the transilluminator. No UV is detectable with the shield in place.

UV Burn Incidents – Case 2

A researcher spent several minutes cutting bands from gels while working at a transilluminator. The researcher did not wear a face shield because the face shields in the room were too scratched and dirty, which obstructed his vision. Instead he wore a pair of goggles.

He developed a burn on the skin of his face, except for the area where the goggles protected the skin and eyes.

Dealing with UV Burns

If you develop skin or eye irritation or pain after working with a UV source in the lab, seek medical attention at University Health Services immediately. The injury will heal relatively quickly, but a doctor should assess the severity of the injury and can prescribe medications to reduce the pain of the injury.

After you have sought medical attention, notify EHS about the incident. EHS will investigate your incident to find practical and helpful ways to prevent a recurrence.