Safety Tips for Using Transilluminators and Crosslinkers

What Are UV Transilluminators?

Ultraviolet (UV) transilluminators or UV light boxes are used in biotechnology for visualization of nucleic acids (DNA or RNA) after gel electrophoresis and ethidium bromide staining. Samples are placed on the illumination window and illuminated by UV light. The clear glass face allows the light to illuminate the gel, but also potentially exposes the user. To reduce the risk of injury, most models come equipped with a shield to filter excess light. For older models, various types of shields can be attached that provide equal protection.

UV transilluminators operate at one of several wavelength bands, depending on the type of sample. Standard wavelength bands are 254, 312, and 365 nanometers (nm). Most of these instruments are stationary, but a few hand-held types carry the same hazards as those of the stationary models.

Equipment must be used for the purpose for which it was designed. For example, portable UV readers must not be used UV side up as mini-transilluminators for cutting gels.

What Are UV Crosslinkers?

An apparatus called a UV crosslinker is used to literally “cross-link” to covalently attach nucleic acid to a surface or membrane following Southern blotting, Northern blotting, dot blotting, and colony/plaque lifts. Since the DNA will be used in place, a 254 nm wavelength is used to maximize adherence.

Hazard and Risks from Transilluminator UV Radiation

It is important to note that the UV radiation used in transilluminators is harmful to both skin and eyes. UV radiation cannot be seen and is not felt immediately; the user may not realize the danger until after the exposure has caused damage. Symptoms typically occur 4 to 24 hours after exposure.

Most UV sources can emit a small amount of blue light, but this does not indicate anything about the amount of emitted UV. Unfortunately, the low intensity of visible light gives a false illusion that the intensity of UV radiation is low.

The effects on skin are of two types, acute and chronic. Acute effects appear within a few hours of exposure, while chronic effects are long-lasting and cumulative, and may not appear for years. An acute effect of UV radiation is redness of the skin called erythema (similar to sunburn). Chronic effects include accelerated skin aging and skin cancer.

UV radiation is absorbed in the outer layers of the eye – the cornea and conjunctiva. Acute overexposure leads to a painful temporary inflammation, mainly of the cornea, known as
photokeratitis. Repeat overexposure to the UV is unlikely because of the pain involved. However, chronic exposure leads to an increased risk of certain types of ocular cataracts. Working unprotected for even a few minutes can cause injury. It is possible to calculate acute threshold for acute effects and to set exposure limits. It is not possible, however, to calculate threshold for chronic effects; therefore, there is no exposure level is safe, exposure should be reduced as much as possible.

**Hazard Substitution**

It is always preferable to remove a hazard than to implement protective measures. Dyes are available that fluoresce in blue light, eliminating the ethidium bromide and, thus, the need to use UV. These dyes have the advantage that although filter glasses are generally worn to remove background light and enhance contrast, the UV hazard is no greater than that from any other bright visible light source. This alternative also eliminates the use of ethidium bromide, which is mutagenic, irritant, and toxic by inhalation.

**Limiting UV Exposure**

Consult the manufacturer’s manuals for information about the potential exposure level and frequency of radiation, as well as for the suggested operating protocols. There are three types of control measures: engineering, administrative, and personal protective equipment.

**Engineering Controls**

*Location*

UV-generating devices should be located in a separate room, alcove, or low-traffic area of a lab. To prevent exposure to other employees, avoid placing equipment in the vicinity of desk areas or other equipment.

*Enclosure*

The use of light-tight cabinets and enclosures is the preferred means of preventing exposure. Where it is not practicable to fully enclose the UV source, use screens, shields, and barriers.
UV transilluminators are often fitted with a plastic safety cover that provides partial shielding by filtering out some or all of the UV radiation. Transilluminators are often designed with a cover that is hinged at the front of the unit to partially shield the user at the same time as allowing the user to manipulate the sample. Covers or partial enclosures must not be removed when the equipment is in use. They should be replaced if discolored, degraded, or damaged in any way.

Interlocks
UV transilluminators should come with interlock devices. Interlocks must not be tampered with. They must be replaced or repaired when defective. Old transilluminators that are not interlocked should be disposed of and replaced with alternatives.

Administrative Controls
Typical administrative controls include limiting access, ensuring that people are aware of the potential hazards, and providing training and safe working instructions for users.

Training
Personnel should be trained in using the UV equipment safely. The manufacturer’s manuals provide specific safety-related information (e.g., type of eye/skin protection needed, ventilation requirements) that must be completely understood before using the equipment. If any uncertainty or concern exists regarding the safe use of UV-generating equipment, contact the manufacturer for clarification.

Personnel should carefully study the manufacturer’s manuals for the UV-generating equipment and be familiar with its use. It is important never to deviate from the instructions for safe operation without first contacting the manufacturer.

At a minimum, lab personnel should be familiar with the following when working with or around UV light:

- UV light–producing equipment
- Warning signs and labels
- Protective equipment
- Symptoms of UV exposure

Minimizing exposure

- Never view the UV lamp directly. Although the inverse square law applies to non-laser beam UVR, it is not advisable to look directly at any UV source) – at any distance.
- Keep exposure time to a minimum, and where the source is not enclosed or shielded, keep as far away from it as practicable.
- Restrict access to those personnel who are directly concerned with the operation of the UV source.
**Hazard warning signs**

Warning signs are necessary to inform about the risk of exposure during use and maintenance. Warning signs should be used where applicable to indicate the presence of potential UVR hazards, to restrict access, and to specify PPE.

**Personal Protective Equipment**

UV transilluminators are used not only for viewing gels but also during the process of cutting samples. PPE may be the only practical way of limiting exposure while the user is working with the plate. Appropriate PPE includes eyewear, face shields, gloves, and lab coats.

**Eyewear**

Use eyewear that is appropriate for the work. Special safety glasses are available for the different UV ranges. For best UV protection, the eyewear should be compliant with ANSI Z87.1 and should have a UV filter marking, $U$, followed by a number on a scale from 2 to 6.

**Face shield**

UV-absorbing, full face shields should be worn in addition to safety glasses or goggles (goggles may not provide sufficient face protection). Severe skin burns can happen in a very short time, especially under the chin (which is often left exposed). **Full face shields are the only appropriate protection when working with UV light boxes for more than a few seconds.**

**Gloves**

At a minimum, wear nitrile, latex, or tightly woven fabric gloves to protect against the significant amounts of UV-A and UV-B that may pass through to the skin; these types of gloves have a low transmission of UV compared to vinyl gloves. Gloves should protect personnel from UV light, as well as from the hazard of the activity being performed.
**Lab coat**

Wear a lab coat that fastens securely at the wrists and up the neck so that no skin is exposed. Note that burns to uncovered wrists and the neck are not uncommon.

Tyvek® protective wear, such as arm shields, coveralls, and lab coats, is NOT appropriate PPE because it may allow significant leakage of UV through it.

PPE must be either readily available and cleaned between users or personally allocated to each user. Eye and face protection must be regularly inspected either regularly or before each use for damage or defects such as cracks, crazing, or bleaching, and replaced when necessary. Note that PPE may need to serve multiple purposes, such as protecting against both chemical splashes and UV.

**Take-Away Safety Tips**

- NEVER use a transilluminator without its protective shield in place.
- NEVER tamper with or bypass the interlocks.
- NEVER use a UV crosslinker that does not have a door safety interlock.
- NEVER use a bioimaging system with a transilluminator within a drawer, with the drawer in the open position.
- ALWAYS use appropriate PPE for the hazard: UV face shield, goggles, gloves, buttoned-up lab coat.
- ALWAYS keep shields clean, and replace if damaged.

The Environment, Health & Safety Division can provide assistance in measuring UV emissions and selecting the appropriate PPE to wear.