Guidance Note

Ultraviolet Radiation Safety

Introduction

Ultraviolet (UV) lamps, trans-illuminators, UV cross-linkers, and germicidal lamps (in Microbiological Safety Cabinets) are commonly used in laboratories particularly to visualise fluorescent markers in gel electrophoresis. UV equipment usually consists of a UV light source at a number of possible wavelengths and optical filters. Equipment may have door interlock mechanisms to prevent UV radiation exposure, or have transparent screens whilst others UV lamp may not be fixed to a unit.

UV Cross-linker

UV Trans-illuminator

The Hazard

Region	Wavelength (nm)	Hazard Rating
UVA	315-400 (long)	Lowest
UVB	280-314 (medium)	Mid to High
UVC	180-280 (short)	Highest

Sunlight falls into the UVA region. UV radiation from laboratory equipment is in a concentrated form and usually falls in UVB and UVC range. Thus it poses a significant hazard to researchers if no control measures are used. Trans-illuminators can produce UV radiation at 254nm, 302nm or 365nm depending on lamp(s) installed. Tissue damage may occur in only a few seconds, with the eyes and skin (hands, arms, face) the most vulnerable sites of injury.

Effects on the eyes: The cornea of the eye is very susceptible to absorbing UV radiation particularly due to its thickness (although UV is unlikely to penetrate to retina if <315nm). Exposure to UV-B and UV-C can cause inflammation of the conjunctiva (photo-conjunctivitis) and lesions to the cornea (photo-keratitis (PK). Eye injury can occur even with a very brief exposure or with just a flash of intense UV. The severity of injury is dependent on the duration, intensity and wavelength of the exposure (maximum effect at 270 nm). The symptoms may only appear 6 to 12 hours after exposure with PK causing a sensation of sand in the eye that may last for several days. In addition sensitivity to light, unexplained tearing, and a burning or painful sensation in the eye. This usually subsides after

24 to 36 hours without permanent damage. However, unlike the skin, the eyes do not develop a tolerance to repeated exposure to UV. The absorption of UV radiation in the lens of the eye also contributes to the formation of cataracts, causing partial or complete loss of transparency.

Effects on the Skin: Effects on skin can be either acute with symptoms appearing within a few hours, which are similar to sunburn with redness of skin (erythema). Severity of injury is determined by the duration and intensity of exposure. Other symptoms of severe exposure could include swelling, pain, blisters, peeling, headache and nausea. Chronic cumulative effects are likely not to appear for a significant period of time after exposure. Potential long term effects include accelerated skin ageing (elastosis and photo-aging) and skin cancer.

Some individuals are more photosensitive, as result of skin pigmentation, genetic susceptibility, or photosensitization from certain foods, drugs (e.g., tetracycline) and chemical agents.

Other potential Hazards: UV radiation below about 250 nm can dissociate oxygen in the air to form ozone (threshold limit 0.1 part per million), thus sufficient ventilation must be in place where UV sources are used. UV lamps often operate at pressures below or above atmospheric and may produce a risk of explosion particularly during lamp replacement or maintenance work.

Control Measures for Reducing Exposure

Legal Requirements: The **Control of Artificial Optical Radiation (AOR) at Work Regulations 2010** introduced legal limitations on exposure to artificial sources of non-coherent non-ionising radiation. These regulations implemented 'Exposure Limit Values (ELV)' (**AOR Regulation 1**). ELVs are based on the Guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and account for type of emission and maximum exposure in an 8 hour day. A person using a typical trans-illuminator with UV source at 302nm (irradiance 3.4 W m-2) working at less than a distance of 60cm from the UV source would breach the legal ELV within 10 seconds to 2 minutes, depending on actual distance and if unprotected by sufficient controls. Whereas it is possible to calculate threshold and set exposure limits for acute effect it is not possible to do so for chronic effects. Therefore there is no safe exposure level and exposure should be kept as low as reasonably practicable (ALARP). Organisations are expected ensure practical steps are taken to encompass this principle including a statutory requirement to carry out a **risk assessment** to identify any hazards from any UV equipment (**AOR Regulation 3**). The manufacturer's specification for equipment should be consulted for information on its time weighted exposure limits to assess potential exposure level, frequency of radiation and operating protocols.

AOR Regulation 4: Requires employers to eliminate or reduce to a minimum any risk of exposure to AOR and take actions and measures if the ELV's are exceeded. The risk assessment should evaluate control measures required and apply the following hierarchy of control.

Elimination or Substitution: Use a source of UV at a safer frequency or alternative systems of visualisation, such as blue light fluorescence. Change experimental procedures to avoid exposure e.g. alternative methods to cutting gel bands out under UV.

Engineered Controls:

- Use equipment with full enclosure of UV source
- Ensure equipment has effective guarding , shielding, screening of UV source
- UV equipment should have interlock mechanisms that will make the device safe (i.e. turn it off) if the guard or enclosure is opened when UV source is active.
- Old or modified equipment e.g. trans-illuminators that are not interlocked, interlock has failed or shielding is damaged should be repaired or disposed of.
- Equipment should be replaced with CE compliant items.
- Interlock mechanisms should be fitted where germicidal UV lamps are used in Microbiological Safety Cabinets (MSCs).
- Reflective surfaces should be avoided and surfaces surrounding the equipment painted in dark or matt colours.

Administrative Controls:

- Training, staff and students should be aware of hazards, understand the risks, and know the correct operating procedures and situations that need to be avoided (**AOR Regulation 5**).
- A local SOP should be written and displayed.
- Procedures should apply the principles of Shielding, Time (minimise exposure time) and Distance (maximise distance from the source)
- Interlocks should be regularly checked to ensure they have not been defeated/over-ridden
- Access should be restricted, especially if UV source is not in a fully interlocked enclosure. E.g. un-shielded UVB from a trans-illuminator can be hazardous up to 2 metres away.
- Warning signage must be displayed warning users and others of the potential hazards and the protective measures that need to be taken e.g. PPE to be worn.

Personal Protective Equipment (PPE):

- **Skin:** Wear laboratory coats (e.g. Howie style high neck and with fitted cuffs) and long sleeved clothing to protect the skin. Special care should be taken to avoid gaps where skin is exposed e.g. wrists, neck, chin and upper chest
- **Hands:** Appropriate gloves should be worn accounting for irradiance of the UV source, absorbance of the gloves, in both relaxed and stretched condition e.g. there can be UV transmission of 10% for some makes of nitrile gloves.
- **Eyes:** Appropriate UV filtering goggles or full face visor (with chin protection) should be worn if there is any risk of exposure. Standard safety glasses will not sufficiently protect eyes. Eye protection must meet BS EN 170:2002 standard for UV filtering.

Do's and Don'ts for users of UV equipment:

Do	Don't
Read the manufacturer's instructions and identify the ELV for equipment	Don't expose other people to UV radiation due to your activities
Carry out a written risk assessment	Don't modify the UV equipment or use for purposes other than that intended
Apply the hierarchy of control measures identified in risk assessment for the procedure you are performing	Don't remove covers.
Prevent harmful exposure to eyes or skin by wearing correct PPE. There is no safe exposure level to avoid skin cancer.	Don't defeat interlocks.
Communicate risk assessment, SOP's to all users –Training	Do not allow untrained staff to use UV equipment

Document Control

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