GN202 – ULTRA-VIOLET TRANSILLUMINATORS

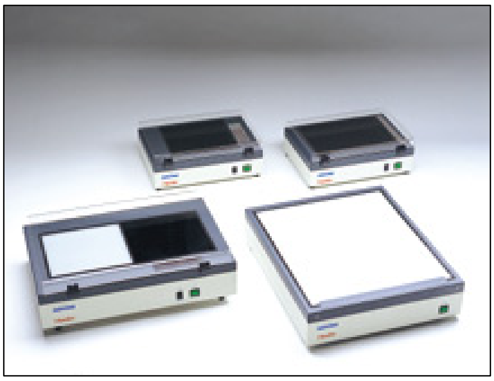
Introduction

This Guidance Note concerns "UV transilluminators" used in the University. These devices emit relatively high levels of ultra-violet radiation, and do so in a manner that is directed towards the face of the user. There have been several cases of injury at the University due to overexposure to the UV radiation emitted from transilluminators. This Guidance Note explains the risk from them and what appropriate control measures can be taken to minimise that risk.

Scope

Some typical illuminators are shown in figure 1. They are often used in gel electrophoresis studies to visualize proteins, DNA, RNA, and their precursors. This work requires the UV light to be directed upwards, but the whole of the UV source is not covered by the material that is being irradiated. This Guidance Note applies to devices of this nature, emitting electromagnetic radiation in the wavelength region of 100 – 400 nm, and at sufficient intensity (radiance or irradiance) to permit an exposure during normal use in excess of the maximum permissible exposure (MPE) during an 8h day. UV levels from transilluminators should be assumed to exceed the MPE unless appropriate measurements have shown otherwise.

Fig. 1 - Some typical transilluminators



Hazard and Risk

Ultra-violet radiation cannot be seen. Most UV tubes also emit a small amount of blue light, but this does not indicate anything about the amount of UV that is being emitted. Unfortunately, the low intensity of visible light gives a false illusion that the intensity of UV radiation is also low.

UV radiation does not penetrate the eye, and is absorbed in the outer layers – the cornea and conjunctiva. Acute overexposure of this part of the eye leads to a painful inflammation, mainly of the cornea and known as photokeratitis. The condition, which fortunately is only temporary, is also named after the source of the UV exposure that causes it, such as "arc eye" and "snow blindness". Due to the painful nature of photokeratitis, repeat overexposure to the UV from a transilluminator is unlikely. However, chronic exposure leads to an increased risk of certain types of ocular cataracts.

The acute overexposure of the skin to ultra-violet radiation is well known; sunburn, more correctly known as erythema, occurs fairly quickly, although the latent period and degree of erythema depends upon the skin type of the exposed person. A high degree of burning leads to skin blistering. Chronic exposure of the skin leads to an increased risk of skin cancer. It is also associated with skin ageing.

A survey has been carried out of the transilluminators used in a number of University departments. Many of these were fitted with a hinged plastic lid, which is intended to shield the face of the user from the UV radiation. This can be seen in figure 2. However, the shield does not offer any protection at the sides, and seemed to be frequently missing, broken or both. There was nothing to prevent the user moving the lid out of the way and working close to the top surface of the source; this has been the cause of two injuries in the University.

Fig. 2 – Picture showing the hinged lid often supplied

One of the common applications for transilluminators involves the user leaning closely over the transilluminator to cut gels. Measurements were taken of the effective irradiance from some typical transilluminators at a distance of 30 cm from the transilluminator, roughly the same point as a user's eyes. The levels at this point were up to 3.4 W_{eff} m^{-2}. At this irradiance, the exposure limit value for the eyes and skin is exceeded in less than 10 seconds. Measurements have been taken by others, and report time-to-exposure-limit-values of about 40 s [1]. It should be noted that at the time of writing this Guidance Note, new models are being sold that do not offer anything better than the hinged lid approach shown in figure 2.

These values – and the experience of those who have being overexposed – show that it is necessary to take some precautions to prevent or reduce the exposure of persons operating a transilluminator, and those in the vicinity, to the ultra-violet radiation being emitted.

Legal Requirements

At the time of writing this Guidance Note, the "Control of Artificial Optical Radiation at Work Regulations" are about to be laid before the Westminster Parliament. These would apply to the use of UV transilluminators. Such work is also covered by the more general safety legislation such as the Health and Safety at Work etc. Act and the Management of Health and Safety at Work Regulations. Various supply regulations concern the safety of work equipment supplied within the EU, which would apply to transilluminators, but these apply to the supplier within the EU[2]. It appears that transilluminators are still being supplied with ready access to harmful levels of UV radiation, and it should not be assumed that the presence of the *CE* mark indicates that the transilluminator is safe to use.

Recommendations

Substitution

It is of course always preferable to remove a hazard than to have to implement protective measures. There are dyes available that fluoresce in blue light. The high background illuminance of the blue light source is minimised by the use of a supplied filter that permits the dye to be seen. The use of such dyes and transilluminators completely eliminates the risk of exposure to ultra-violet radiation. This technique also has the added benefit of eliminating the use of ethidium bromide, which is mutagenic, irritant and toxic by inhalation.

The use of UV transilluminators should be replaced wherever practicable by the use of blue-light transilluminators and appropriate dyes.

At the time of writing this guidance note, there are at least two companies that manufacture blue-light transilluminators available in the UK. There is some option in size. Photographs of their products are shown overleaf:

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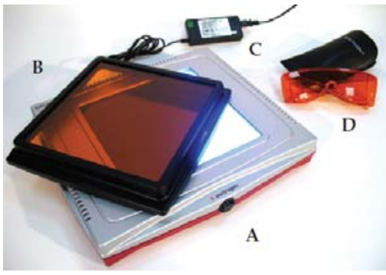
[1] F. Akbar-Khanzadeh and M. Jahangir-Blourchian, Journal of Occupational and Environmental Hygiene, Vol. 2, No. 10, Oct. 2005, pp 493-496.

[2] Note that if the equipment is actually purchased by the University from outwith the EU, then the University becomes the supplier for the purposes of these regulations.

Fig. 3 – Two makes of blue-light transilluminators on the market

Clare Chemical Research,
Dolores, Colorado, USA

Dark Reader Transilluminator DR159m



Invitrogen
Carlsbad,
California, USA

Safe imager 2.0 Blue-Light Transilluminator

General Protection

If the use of a blue-light transilluminator is not practicable, then precautions need to be taken to minimise the risk of UV exposure. The immediately apparent safety measure is to use a face mask. However, this approach suffers from a number of limitations:

- A face mask only protects the person wearing it.
- Like all ocular personal protective equipment (PPE) it restricts to some extent the wearer's view.
- <u>Many people will not wear PPE</u> – this was the cause of two of the transilluminator injuries at the University.
- Administrative measures are needed to maintain the ready presence of suitable and sufficient PPE.
- Unsuitable, or potentially unsuitable, PPE can readily be acquired and worn.

It is therefore far preferable to use engineering methods. All the UV transilluminators seen at the University lend themselves towards relatively easy shielding.

All UV transilluminators should be fitted with a suitable and sufficient shield. The shield will most probably have to be made to individually match the dimensions of the transilluminator. Details of what is considered suitable and sufficient shielding are outlined further on.

In order to make the shielding effective, there must be a means to prevent access to the UV radiation if the shield is removed.

The shield should preferably be fixed down with permanent fasteners. However, if frequent access is required to the front face of the transilluminator, then the shield can instead be fitted with an interlock which switches off the UV source when the shield is removed. Suitable interlocks are discussed further on.

UV radiation cannot be seen. Therefore, there must be some means of indicating when UV radiation is being emitted.

There should be a warning light to indicate when the UV source is energised. This light should be clearly labelled to indicate its meaning.

As always, the hazard should be indicated by the use of suitable warning sign.

A suitable warning sign should be fitted <u>on the transilluminator</u> in a place where it can be easily seen by persons who wish to use it. A suitable form of sign is shown overleaf.

Where access is required to the material being exposed, then skin protection will still be required.

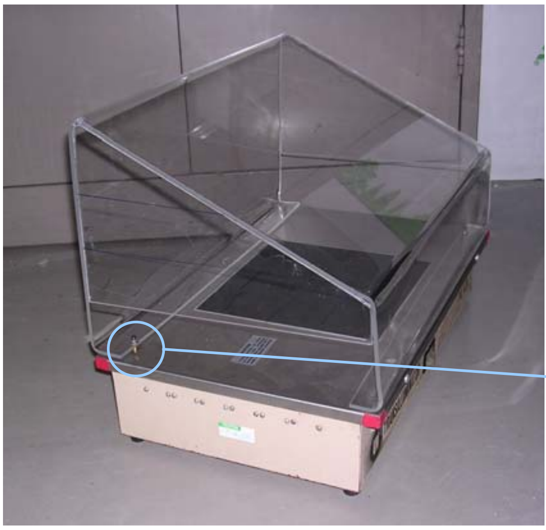
If manual access is required to the material being exposed, such as when nicking a gel, gloves and suitable arm protection should be worn to protect the skin of the hands, wrists and forearms from exposure. What is considered suitable is outlined below.

Shielding

The use of an appropriate shield will permit sight of the item being exposed, and yet prevent irradiation of the eyes and skin. An appropriate material for a shield is Perspex, grade CS VE. It is important to choose the right grade of Perspex, since the spectral transmission of UV varies according to the grade. Any material other than the above should therefore always be checked with the Radiation Protection Unit before using. If manual access is required, then the shield needs to have slots in the sides to allow hand access. Whilst this permits the emission of UV radiation outwith the shield, there is no direct exposure of the user, and significantly reduces exposure of other persons. In this case, protection by the use of PPE would still be necessary for the skin of the hands and wrists.

The Radiation Protection Unit has designed and trialled an example of a suitable shield. Photographs of this are shown in figure 4 below. If the shield does not need to be removed, then it must be fixed down with permanent fasteners. If the shield does need to be removed, which is likely, then it should be designed to be readily removable. It is suggested that locating pegs could be used. These are shown in the diagram in figure 5.

Figure 4 – Photographs showing a suitable form of shield



Interlocking
In order to prevent the UV source being energised while the shield is removed, it must be interlocked to the power supply. The nature of the risk does not warrant a high-integrity interlock design, and a suitable type of interlock would be a tongue-switch type, or a sunken microswitch. Since this design assumes that the shield is to be readily removable, pegs have been shown to be an appropriate means of locating and holding the shield in position when the transilluminator is in use. A suggested location for these two devices is shown in figure 5, and the interlock used on the prototype shield is shown in the photo insert in figure 4.

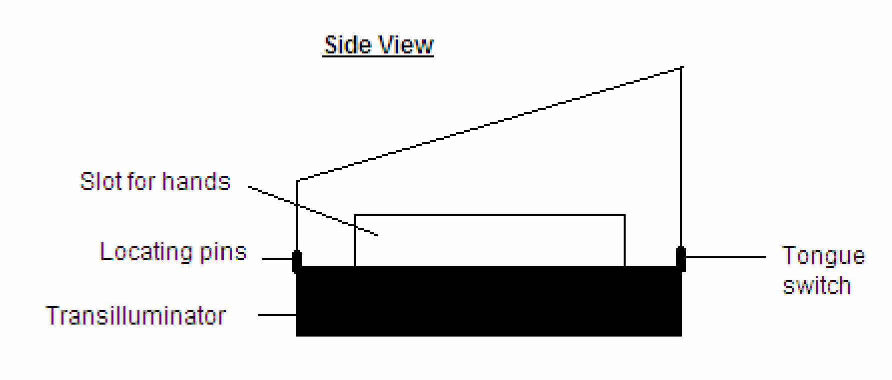


Figure 5 – Diagram of the side of a suggested transilluminator shield design

Warning signs
A warning sign should be fitted on the UV transilluminator where it can be seen by persons who wish to use the transilluminator. The warning sign should look like figure 6. Warning signs are not required in the room, on walls or on doors as this would suggest that the UV light is not being controlled at source.

Figure 6 – Example of suitable warning sign

Hand and Arm Protection
Protection for the skin of the hand, wrist and forearm will still be required if manipulating some material under UV exposure. All skin that may be exposed must be covered including the wrist area up to the end of the lab coat sleeve. If conventional disposable laboratory gloves are to be used, then nitrile gloves should be used in preference to vinyl [3]. They should be replaced at the end of each working day.

Further Information

For further information on UV risks and control measures, or in case of any uncertainty of application of this Guidance Note to your transilluminators, please contact the Radiation Protection Unit.

[3] See “Determination of the Attenuation Properties of Laboratory Gloves Exposed to an Ultraviolet Transilluminator”, E. Gazdik, F. Rosenthal and W. Wang, Journal of Occupational and Environmental Hygiene, Vol. 1, No. 6, June 2004, pp 391-402.