THE UNIVERSITY OF WARWICK

HEALTH AND SAFETY LEGISLATION UPDATE

The Control of Artificial Optical Radiation at Work Regulations 2010 came into effect on the 27th April 2010.

Artificial Optical Radiation includes light emitted from all artificial sources ie light in all its forms including ultraviolet, infrared and laser beams, but excluding sunlight.

The majority of artificial light sources are safe e.g. ceiling-mounted lighting used in offices, task lighting such as desk lamps, photocopiers, Light Emitting Diode (LED) remote control devices, any Class 1 laser light product such as laser printers and bar code scanners. These light sources do not present a risk of harm to health and there is no need to do anything further.

However some sources of light can cause harm and ill health such as burns or redening (erythema) of the skin, or surface of the eye (photokeratitis); burns to the retina of the eye; 'blue-light' damage to the eye (photoretinitis) and, damage to the eye that may bring about early onset of cataract. Examples of hazardous sources of light are :-

- Glass and metal working e.g. furnaces emit infra-red radiation.
- Welding activities.
- Plastics manufacturing involving laser bonding.
- Printing e.g. inks and paints set by photo-induced polymerisation.
- In entertainment e.g. performers (and possibly the audience) illuminated by spotlights, effect lighting, modelling lights, flashlamps.
- Non-destructive testing e.g. ultraviolet radiation used to reveal fluorescent dyes.
- Medical treatments e.g. exposure operating theatre spot lighting and therapeutic use of optical radiation.
- Cosmetic treatments using lasers, flashlamps, ultraviolet and infrared sources.
- Where large open buildings are illuminated by powerful area lights, e.g. workshops/stores.
- Pharmaceuticals and research, where ultraviolet sterilisation may be in use.
- Research e.g.use of lasers, solar simulators and where ultraviolet-induced fluorescence .

If hazardous sources of light are used then control measures must be put in place to reduce risk of harm to workers to as low as reasonably practicable. **This is the key requirement of the new Regulations.** Control measures to consider when managing AOR risks are :-

- Use an alternative safer light source that can achieve the same result.
- Use filters, screens, remote viewing, curtains, safety interlocks, dedicated rooms, remote controls.
- Training workers in best practice and give them appropriate information.
- Organise work to reduce exposure to workers and restrict access to hazardous areas.
- Use protective equipment such as clothing, goggles or face shields.
- Use relevant safety signs.

Risk Assessments should already exist for work activities at the University. They should be reviewed to check whether any hazardous sources of AOR are involved and if they are, to make sure controls have been identified to minimize risk and that the controls are in place.

For further information, refer to the Radiation Protection Officer within the Health and Safety Department. The Health and Safety Executive and Health Protection Agency Guidance documents are also available from:
http://www.hse.gov.uk/radiation/nonionising/optical.htm
http://www.hse.gov.uk/radiation/nonionising/aor-guide.pdf

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The aim of the Control of Artificial Optical Radiation at Work Regulations 2010 is to protect workers from the risks arising from exposure to sources of artificial light that the Directive describes as artificial optical radiation. Artificial optical radiation can occur as ultraviolet light, infrared radiation and as laser beams with the risks from exposure dependent on the type and intensity of the light and the parts of the body exposed. The skin and the eyes are the areas of the body most at risk.

Guidelines from the International Commission for Non-ionising Radiation Protection (ICNIRP) have been used which are designed to prevent the effects on health that can occur at high levels of exposure. At or below the established exposure limit values, (ELVs), there will be no adverse health effects for workers. If workers were to be exposed at levels substantially in excess of these values, adverse health effects could well be observed. For example, in the case of the eye, ultraviolet radiation can damage the cornea, infrared radiation can produce cataracts and laser radiation can cause severe damage that may result in blindness. In the case of the skin, UV radiation can produce a range of symptoms from reddening to burning and blistering and an increased risk of skin cancer. Powerful lasers can cause skin burns.

Whether optical radiation is produced deliberately or as a by-product of a process, it is still necessary to control exposure to it.

WHAT AFFECT WILL THIS HAVE ON THE UNIVERSITY OF WARWICK?

This new piece of statute should not require the University to consider risks any differently than they do today. It will just require anyone managing an activity involving work with equipment or processes that could be a source of artificial optical radiation to ensure that the risks associated with this have been considered and that steps have been taken to eliminate or reduce exposure to artificial light to as low as is reasonably practicable. This may be by way of containment, use of interlocks, filters and viewing windows, alignment aides, moving further away from the source, reducing exposure time, or as a last resort, the provision of personal protective equipment (PPE). For many applications, access to the optical radiation will be restricted by the appropriate use of engineering controls, but in some applications, the optical radiation may still be accessible. Risk assessments need to consider all risks associated with the activity, including those that a person could come across under normal circumstances, under reasonably foreseeable fault conditions and during maintenance or servicing operations and these need to include potential exposure to artificial optical radiation.

Similarly, training needs to include exposure to artificial light and an explanation on how to mitigate these risks and the importance of control. Under certain circumstances, health surveillance may also be necessary. This may include cases where individuals have increased photosensitivity or where individuals work with photosensitising chemical substances and are also exposed to artificial optical radiation. Less common conditions to be alerted to include those who are aphakic (where the lens of the eye may be absent or it is impaired so that it is able to see ultraviolet wavelengths) or pseudophakic (presence of an intraocular lens after cataract extraction). Questions around these conditions should be asked before anyone works with equipment where there are risks of exposure to artificial optical radiation.

When conducting the risk assessment, the combined exposures that an individual may come across during the course of the day need to be considered, so not to exceed the ELV, again, similar to what you would do if anyone was exposed to ionising radiation, noise etc. This may be particularly relevant to anyone who works on a variety of equipment or processes where exposure to artificial optical radiation is possible.

The HSE has assumed that there will be insignificant costs from action that has to be taken as a result of risk assessments for workers at low risk from artificial optical radiation. However, where there are potential high risk applications, processes or equipment that fall outside of the Health Protection Agency (HPA) guidelines, there may be a requirement to take into consideration the cost of a consultant to establish the levels of irradiance from the given source to determine whether the time

that the person may be exposed could exceed the ELV. It is likely that most applications, processes and equipment will fall within the guidelines given. **Where there are concerns about potential risks, please consult with the Radiation Protection Officer within the Health and Safety Department.**

The following Appendices are provided as further information and have been taken directly from the Health Protection Agency Guidance document A Non-Binding Guide to the Artificial Optical Radiation Directive 2006/25/EC. A link to this document is also given below.

Appendix A – 'Safe' sources and sources not likely to produce a health risk under specific circumstances

Appendix B - Health effects associated with different wavelengths of Optical Radiation

Appendix C - Determination of exposure and assessment of risks

Appendix D - Summary of required controls for different laser safety classes

Appendix E - Safety Classification for Machinery

Appendix F - Work activities which generate hazardous levels of intense light and which need to be considered in relation to the Control of Artificial Optical Radiation Regulations 2010

The appendices have been taken directly from the Health Protection Agency Guidance which can be downloaded for free: http://www.hse.gov.uk/radiation/nonionising/aor-guide.pdf
Further information is also available from: http://www.hse.gov.uk/radiation/nonionising/optical.htm

Appendix A

Sources that have been evaluated already which are only likely to produce insignificant exposures, which can be considered as 'safe'

Ceiling mounted fluorescent lighting with diffusers over the lamps
Computer or similar display screen equipment
Ceiling mounted compact fluorescent lighting
Compact fluorescent floodlighting
UVA insect traps
Ceiling mounted tungsten halogen spotlighting
Tungsten lamp task lighting (including daylight spectrum bulbs)
Ceiling mounted tungsten lamps
Photocopiers
Interactive whiteboard presentation equipment
Indicator LEDs
Personal digital assistants
Vehicle indicator, brake, reversing and foglamps
Photographic flashlamps
Gas-fired overhead radiant heaters
Street lighting

Sources not likely to pose a health risk under specific circumstances

Source	***Circumstances for safe use***
Ceiling mounted fluorescent lighting without diffusers over the lamps	Safe at normal working illumination levels (≈ 600 lux)
Metal halide/high pressure mercury floodlighting	Safe if front cover glass intact and if not in line of sight.
Desktop projectors	Safe if beam not looked into
Low pressure UVA blacklight	Safe if not in line of sight.
Any "Class 1" laser device (to EN 60825-1)	Safe if covers intact. May be unsafe if covers removed
Any "Exempt Group" product (to EN 62471)	Safe if not in line of sight. May be unsafe if covers removed
Vehicle headlights	Safe if extended direct intra-beam viewing avoided

Appendix B

Health effects associated with different wavelengths of Optical Radiation

Different wavelengths cause different effects depending on which part of the skin or eye absorbs the radiation, and the type of interaction involved: photochemical effects dominate in the ultraviolet region, and thermal effects in the infrared. Laser radiation can produce additional effects characterised by very rapid absorption of energy by tissue, and is a particular hazard for the eyes where the lens can focus the beam.

Wavelength (nm)	**Artificial Optical Radiation**	**Eye**	**Skin**
100-280	UVC	Photokeratitis Photoconjunctivitis	Erythema Skin cancer
280-315	UVB	Photokeratitis Photoconjunctivitis Cataracts	Erythema Elastosis (photoageing) Skin cancer
315-400	UVA	Photokeratitis Photoconjunctivitis Cataracts Photoretinal damage	Erythema Elastosis (photoageing) Immediate Pigment Darkening Skin cancer
380-780	Visible	Photoretinal damage (Blue Light Hazard) Retinal burn	Burn
780-1400	IRA	Cataracts Retinal burn	Burn
1400-3000	IRB	Cataracts	Burn
3000-10^6	IRC	Corneal burn	Burn

Appendix C

Determination of exposure and assessment of risks

To be considered	Comment
(a) the level, wavelength range and duration of exposure to artificial sources of optical radiation;	This is the fundamental information about the scenario considered. If the exposure level is significantly below the exposure limit that would apply for exposure for a complete working day (assumed to be 8 hours) then no further assessment is required unless exposure to multiple sources are a concern. See (h).
(b) the exposure limit values referred to in Article 3 of the Directive;	From the information in (a) it should be possible to identify the applicable exposure limit values.
(c) any effects concerning the health and safety of workers belonging to particularly sensitive risk groups;	It is suggested that the approach should be reactive rather than proactive. There may be some workers who know that they are particularly sensitive to flickering light, for example. The employer should then consider whether modifications to the work activity can be introduced.
(d) any possible effects on workers' health and safety resulting from workplace interactions between optical radiation and photosensitising chemical substances;	It is suggested that employers should specifically consider the possibility of photosensitisation from chemical substances used in the workplace. However, as with (c), the employer may need to react to issues raised by workers where the photosensitivity is caused by chemical substances used outside of the workplace.
(e) any indirect effects such as temporary blinding, explosion or fire;	Eye exposure to bright lights may be an issue for some work practices. The normal aversion responses should provide a level of protection at exposure levels below the exposure limit value. However, the employer should consider sources of artificial optical radiation that may cause distraction, dazzle, glare and afterimages, where such exposures could compromise the safety of the worker or others. The optical radiation from some artificial optical radiation sources may be capable of causing an explosion or a fire. This is particularly relevant for Class 4 lasers, but should also be considered for other sources, especially in environments whereflammable or explosive agents may be present.
(f) the existence of replacement equipment designed to reduce the levels of exposure to artificial optical radiation;	It is suggested that this should be considered where the exposure of workers to artificial optical radiation above the exposure limit values is possible.
(g) appropriate information obtained from health surveillance, including published information, as far as possible;	This information may come from within the employer's organisation, from industry representative groups or from international organisations such as the World Health Organisation and the International Commission on Non-Ionizing Radiation Protection.

To be considered	Comment
(h) multiple sources of exposure to artificial optical radiation;	From the information obtained in (a) and (b), it may be possible to determine the proportion of the exposure limit that will be provided by each artificial optical radiation source. A simplified approach will be to consider this for the number of sources that may expose workers and add the proportions. If the sum is less than one, then the exposure limit values are unlikely to be exceeded. If the sum exceeds one then a more detailed assessment will be required.
(i) a classification applied to a laser as defined in accordance with the relevant CENELEC standard and, in relation to any artificial source likely to cause damage similar to that of a laser of class 3B or 4, any similar classification;	Class 3B and Class 4 laser products emit accessible laser radiation that could lead to the exposure limit values being exceeded. However, under some circumstances, lower hazard class lasers may also need assessment. EN 62471 assigns non-laser artificial optical radiation sources into a different classification scheme. Risk Group 3 devices should be assessed, but consideration should also be given to the likely exposure scenarios for lower Risk Groups.
(j) information provided by the manufacturers of optical radiation sources and associated work equipment in accordance with the relevant Community Directives.	Employers should request adequate information from manufacturers and suppliers of artificial optical radiation sources and products to ensure that they can undertake the assessments required by the Directive. It is suggested that the availability of such information could form the basis for procurement policy.

Appendix D

Summary of required controls for different laser safety classes							
	Class 1	**Class 1M**	**Class 2**	**Class 2M**	**Class 3R**	**Class 3B**	**Class 4**
Description of hazard class	Safe under reasonably foreseeable conditions	Safe for naked eye;, may be hazardous if the user employs optics	Safe for short exposures; eye protection is afforded by aversion response	Safe for naked eye for short exposures,; may be hazardous if the user employs optics	Risk of injury is relatively low, but may be dangerous for improper use by untrained persons	Direct viewing is hazardous	Hazardous for eye and skin; fire hazard
Controlled area	Not required	Localised or enclosed	Not required	Localised or enclosed	Enclosed	Enclosed and interlock protected	Enclosed and interlock protected
Key control	Not required	Not required	Not required	Not required	Not required	Required	Required
Training	Follow manufacturer instruction for safe use	Recommended	Follow manufacturer instruction for safe use	Recommended	Required	Required	Required
PPE	Not required	Not required	Not required	Not required	May be required – subject to the findings of the risk assessment	Required	Required
Protective measures	Not necessary under normal use	Prevent use of magnifying, focusing or collimating optics	Do not stare into the beam	Do not stare into the beam. Prevent use of magnifying, focusing or collimating optics	Prevent direct eye exposure	Prevent eye and skin exposure to the beam. Guard against unintentional reflections	Prevent eye and skin exposure from direct and diffuse reflection of the beam.

Laser safety classification relates to accessible laser radiation – this classification doesn't take into account additional hazards, such as electricity, collateral radiation, fume, noise, etc

Laser safety classification relates to normal use of the product – it might not be applicable to maintenance or service, or when the original device forms a part of a complex installation

Laser safety classification relates to a single product – it doesn't account for accumulative exposure from multiple sources

Appendix E

Safety Classification for Machinery

Machinery which produces optical radiation may be also classified to EN 12198. This standard applies to all emissions, either intentional or adventitious, apart from sources used purely for illumination.

Machinery is classified into one of three categories, depending on the accessible emission. The three categories, in increasing order of risk, are listed in the following table.

Safety classification of machinery according to EN 12198		
Category	**Restrictions and protective measures**	**Information and training**
0	No restriction	No information needed
1	Restrictions: limitation of access, protective measures may be needed	Information about hazards, risks and secondary effects to be provided by manufacturer
2	Special restrictions and protective measures essential	Information about hazards, risks and secondary effects to be provided by the manufacturer. Training may be necessary

Assignment of a machine to one of these categories is based on the effective radiometric quantities presented below, as measured at a distance of 10cm.

Emission limits for machinery classification according to EN 12198				
Eeff	**EB** (for < 11 mrad)	**LB** (for 11 mrad)	**ER**	**Category**
0.1 mW m-2	1 mW m-2	10 W m-2 sr-1	33 W m-2	**0**
1.0 mW m-2	10 mW m-2	100 W m-2 sr-1	100 W m-2	**1**
> 1.0 mW m-2	> 10 mW m-2	> 100 W m-2 sr-1	> 100 W m-2	**2**

Appendix F

Work activities which generate hazardous levels of intense light and which need to be considered in relation to the Control of Artificial Optical Radiation at Work Regulations 2010

What industries use hazardous sources of intense light?	What are the hazardous activities?	How might workers be harmed by the intense light?	What key measures do you need to consider?
Metal working	• Welding (arc and oxyfuel) • Plasma cutting	• Damage to eyes – photokeratitis & photoconjuctivitis ('arc eye'; 'snow blindness), cataracts, photoretinal damage (blue light hazard), retinal burn, cataracts, corneal burn • Damage to skin – UV burning	• Provide face shield, coveralls and gloves • Protect others using screens/ curtains/restricted access • Provide information and training • Display appropriate warning signs • Monitor & enforce use of control measures • If any staff over-exposed, provide medical examination and consider whether health surveillance is appropriate
Pharmaceuticals and research	• Ultraviolet sterilisation and induced fluorescence	• Damage to skin	• Provide face shield and ensure other areas of skin not exposed (eg lab coats and gloves) • Protect others using screens/ curtains/restricted access • Provide information and training. • Display appropriate warning signs • Monitor & enforce use of control measures • If any staff over-exposed, provide medical examination and consider whether health surveillance is appropriate
'Hot industries'	• Proximity to furnaces, burners and hot metals/glass	• Damage to eyes and skin • Thermal discomfort	• Engineering measures – remote controls; screening, interlocks, clamps to hold material • Provide face shield, coveralls and gloves -full body PPE may be required • Enforced max working periods -routine change of activity • Protect others using screens/ curtains/restricted access • Provide information and training • Display appropriate warning signs • Monitor & enforce use of control measures • If any staff over-exposed, provide medical examination and consider whether health surveillance is appropriate
Printing and Paint (motor vehicle repairs)	• Ultraviolet curing of inks and paints	• Damage to skin	• Engineering measures – screening, automation • Provide face shield and ensure other areas of skin not exposed by providing coveralls and gloves • Protect others using screens/ curtains/restricted access • Provide information and training • Display appropriate warning signs • Monitor & enforce use of control measures • If any staff over-exposed, provide medical examination and consider whether

What industries use hazardous sources of intense light?	What are the hazardous activities?	How might workers be harmed by the intense light?	What key measures do you need to consider?
			health surveillance is appropriate
Medical and cosmetic treatments	• laser surgery (Class 3B and 4 lasers) UV and blue light therapy	• Potentially permanent damage to eyes from lasers, including blindness Laser burns to skin Other damage to eyes and skin	• Specialist input likely to be required for laser work • Provide face shield/goggles and coveralls • Provide gloves where appropriate (it is recognised that thin nitrile gloves are likely to be needed for dexterity and that these will offer limited protection against laser burns) • Designated treatment rooms with restricted access • Curtains around equipment • Staff distant whilst patient exposed • Provide information and training • Display appropriate warning signs • Monitor & enforce use of control measures • If any staff over-exposed, provide medical examination and consider whether health surveillance is appropriate
Research and Education	• Class 3B and 4 lasers	• Potentially permanent damage to eyes, including blindness • Laser burns to skin • Potential ignition source	• Specialist input likely to be required • Engineering measures – enclosed, controlled area, interlocks, remote controls, screening, clamps to hold material • Designated laboratories with restricted access • Provide face shield/goggles and coveralls • Provide gloves where appropriate (it is recognised that thin nitrile gloves are likely to be needed for dexterity and that these will offer limited protection against laser burns) • Include laser sources as part of fire assessment • Provide information and training • Display appropriate warning signs • Monitor & enforce use of control measures • If any staff over-exposed, provide medical examination and consider whether health surveillance is appropriate