Annex 1

Laser Classification System

Lasers are grouped into classes in order to give an indication of their potential to cause harm. These classes are specified in the British Standard BS EN 60825-1: 2007. The classification of a laser is determined by its Accessible Emission Limit (AEL), which is the maximum level of laser radiation that is accessible under all reasonably foreseeable single fault conditions. The classification system applies to laser systems (i.e., the laser itself and an appropriate energy source) and laser products (i.e., any product or assembly of components which constitutes, incorporates or is intended to incorporate a laser or laser system).

The laser classes are:

Class 1

Visible and invisible lasers. Class 1 lasers are considered safe under reasonably foreseeable conditions of operation and present no hazards to the eye or skin. Class 1 lasers may contain embedded lasers of higher class that could be accessible during servicing.

Class 1M

302.5 nm to 4000 nm only. The difference between a Class 1 and a Class 1M laser is that the total power in the beam can be much higher for the latter. However, the beam will be either highly divergent or collimated and of large diameter. Class 1M laser beams are considered safe to the skin. However, class 1M lasers may present a hazard to the eye if viewed using magnifying optics, e.g., lenses.

Class 1C

Laser products that intended for direct application of laser radiation to the skin or internal body tissues for medical, diagnostic, therapeutic or cosmetic procedures such as hair removal, skin wrinkle reduction, acne reduction. Although the emitted laser radiation may be at Class 3R, 3B or 4 levels, ocular exposures are prevented by one or more engineering means.

Class 2

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Visible lasers only (400 nm to 700 nm only). Class 2 are low powered lasers and emit continuous or pulsed radiation. They do not present a hazard to the skin. Protection of the eye is afforded by the human blink reflex, i.e., the 'Aversion' response. The maximum power into the eye is 1mW.

Class 2M

The difference between a Class 2 and a Class 2M laser is that the total power in the beam can be much higher for the latter. However, the beam will be either highly divergent or collimated and of large diameter so that the proportion of the beam that can normally enter the eye is small. Class 2M laser beams are considered safe to the skin. However, class 2M lasers are not safe to the eye if the beam is viewed using magnifying optics.

Class 3R

302.5 nm to 1 mm. These are medium power lasers where the AEL is generally five times larger than that of a class 1 laser. Class 3R lasers present a higher risk to the eye than Class 1 or 2 lasers, but do not pose a hazard to the skin.

Class 3B

Visible and invisible lasers. Medium/high power lasers where the maximum power can be up to 500 mW. Although not hazardous to the skin, direct viewing of a beam from a class 3B laser is always hazardous. Specular reflected beams (reflections off shiny surfaces) present a hazard to the eye.

Class 4

These lasers are high powered lasers and are considered extremely hazardous. Class 4 lasers present a hazard to both eye and skin. Direct beam or reflected beam viewing is always hazardous and is likely to result in injury. Environmental damage (e.g. fire) is also a serious possibility. The use of class 4 lasers requires extreme caution.

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Annex 2

Non-Laser Classification System

The classes for non-laser optical radiation sources are specified in BS EN 62471:2008.

CONTINUOUS WAVE LAMPS

Exempt Group

The basis for the exempt group classification is that the lamp does not pose any photobiological hazard under any conditions. The requirement is met by any lamp that does not pose:

- An actinic ultraviolet hazard within 8-hours exposure
- A near-ultraviolet hazard within 1,000 s (about 16 min)
- A retinal blue-light hazard within 10,000 s (about 2.8 h)
- A retinal thermal hazard within 10 s
- An infrared radiation hazard for the eye within 1,000 s
- Lamps that emit infrared radiation without a strong visual stimulus (< 10 cd m-2) and also do not pose a near-infrared retinal hazard within 1,000 s.

Risk Group 1 (low risk)

The basis for the Risk Group 1 classification is that the lamp does not pose a hazard due to normal behavioural limitations on exposure. This requirement is met by any lamp that exceeds the limits for the Exempt Group but does not pose:

- An actinic ultraviolet hazard within 10,000 s
- A near-ultraviolet hazard within 300 s
- A retinal blue-light hazard within 100 s
- A retinal thermal hazard within 10 s
- An infrared radiation hazard for the eye within 100 s
- Lamps that emit infrared radiation without a strong visual stimulus (< 10 cd m-2) and also do not pose a near-infrared retinal hazard within 100 s.

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Risk Group 2 (moderate risk)

The basis for the Risk Group 2 classification is that the lamp will not pose a hazard due to the aversion response to very bright sources or due to thermal discomfort. This requirement is met by any lamp which exceeds the Risk-Group 1 limits but does not pose:

- An actinic ultraviolet hazard within 1,000 s
- A near ultraviolet hazard within 100 s
- A retinal blue-light hazard within 0.25 s (aversion response time)
- A retinal thermal hazard within 0.25 s
- An infrared radiation hazard for the eye within 10 s
- Lamps that emit infrared radiation without a strong visual stimulus (< 10 cd m-2) and also do not pose a near-infrared retinal hazard within 10 s.

Risk Group 3 (high risk)

The basis for Risk Group 3 is that the lamp may pose a hazard for even momentary or brief exposure. Lamps that exceed the limits for Risk Group 2 are therefore in Risk Group 3.

PULSED LAMPS

The risk group determination of a pulsed lamp is made as follows:

- A lamp that exceeds the exposure limit is classified as belonging to Risk Group 3.
- For single pulsed lamps, if the weighted radiant exposure or weighted radiance dose is below the exposure limit the lamp is classified as ‘Exempt’.
- For repetitively pulsed lamps, if the weighted radiant exposure or weighted radiance dose is below the exposure limit, the lamp is evaluated against the criteria for continuous wave lamps (see Annex 3, Section 1), using time averaged values of the pulse emission.

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Annex 3

British standards and guidance documents relevant to artificial optical radiation safety

Harmonised standards

Laser equipment

- BS EN 60825-1 *Safety of laser products – Part 1: Equipment classification and requirements*
- BS EN 60825-2 *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*
- BS EN 60825-12 *Safety of laser products – Part 12: Safety of free space optical communication systems used for transmission of information*
- BS EN 60601-2-22 *Medical electrical equipment Part 2. Particular requirements for safety. Section 2.22 Specification for diagnostic and therapeutic laser equipment*
- BS EN 60065 *Audio, video and similar electronic apparatus. Safety requirements*

Non-laser equipment

- BS EN 62471 *Photobiological safety of lamps and lamp systems*
- BS EN 12198 *Safety of machinery – assessment and reduction of risks arising from radiation emitted by machinery*

Personal protective equipment

Laser protective eyewear

- BS EN 207 *Personal eye-protection – Filters and eye protectors against laser radiation (laser eye-protectors)*
- BS EN 208 *Personal eye-protection – Eye protectors for adjustment work on lasers and laser systems (laser adjustment eye-protectors)*

Eyewear conforming to BS EN 208 may only be used for alignment work on visible laser beams.

The University requires eyewear to be selected according to the guidance in Annex B of the appropriate harmonised standard. The University Laser Safety Adviser must be consulted in relation to eyewear specification.

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Non-laser protective eyewear

- BS EN 166 *Personal eye protection – specifications*
- BS EN 175 *Personal protection – equipment for eye and face protection during welding and allied processes*

Note that where non-laser protective eyewear is in use the requirement for skin protection should also be considered. Protective eyewear should be fitted with filters affording appropriate protection and specified against one of the following standards where appropriate:

- BS EN 169 *Personal eye-protection – filters for welding and related techniques – transmittance requirements and recommended use*
- BS EN 170 *Personal eye-protection – ultraviolet filters – transmittance requirements and recommended use*
- BS EN 171 *Personal eye-protection – infrared filters – transmittance requirements and recommended use*
- BS EN 379 *Personal eye-protection – automatic welding filters*

Good practice guides

There are a number of British Standards and other guidance documents that provide useful guidance to the safe use of lasers and the University requires staff and students to follow this advice where applicable and relevant.

General laser safety

- PD IEC TR 60825-14 *Safety of laser products – Part 14: A User's Guide*
- AURPO Guidance Note No 7 *Guidance on the safe use of lasers in education and research*

Medical laser safety

- PD IEC/TR 60825-8 *Safety of laser products – Part 8: Guidelines for the safe use of medical laser equipment*
- Medicines and Healthcare Products Regulatory Agency (MHRA) DB2008 (03) *Guidance on the safe use of lasers, intense light source systems and LEDs in medical, surgical, dental and aesthetic practices*

Safety of entertainment displays

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- PD IEC/TR 60825-3 *Safety of laser products – Part 3: Guidance for laser displays and shows*
- HS(G) 95 The radiation safety of lasers used for display purpose.

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Annex 4
Laser Safety Training for Users

The following training matrix is to be followed in the provision of training for all laser users.

	Training Matrix					
	Awareness training	Legal requirements training	Demonstration of capability (in practical user of equipment)[i]	PHE training or equivalent	Laser Safety Training	Practical Training
Training given by	Approved Supplier	Approved Supplier	-	External Provider	LSO	Standard User
Position						
Senior Management	X					
Laser Safety Co-ordinator		X		X		
Laser Safety Officer		X	X			
Standard User (including PhD/MA and all other unsupervised students)					X	X
Escorted Students						X[ii]

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Standard user training should contain the following information:

a) Characteristic features of laser radiation emitted from different types of laser;

- Generation of laser radiation and hazards;
- Laser-tissue interactions;
- Effects of exposure of eye and skin to laser radiation;
- Laser safety management, role of the ULSA, School LSO and investigation of suspected cases of accidental exposure;
- Laser Controlled Areas – boundaries, warning signs, access control etc.;
- Personal protective equipment;
- Hazards from reflection or absorption of the laser beam;
- Precautions to ensure that exposure of unprotected skin and eye of those present is less than the Exposure Limit Values;
- Associated hazards, such as electrical hazards, fire and explosion risks, cryogenic liquids, fume;
- Relevant legislation;
- Relevant standards and guidelines;

Principles of laser risk assessment and management

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Annex 5

Matters that must be considered in any assessment of risks from work with artificial optical radiation

It is requirement of Regulation 3(5) of the Control of Artificial Optical Radiation at Work Regulations that the following matters must be considered in any assessment of risks. This does not preclude consideration of matters not listed below.

a) the level, wavelength and duration of exposure;

b) the exposure limit values;

c) the effects of exposure on employees or groups of employees whose health is at particular risk from exposure;

d) any possible effects on the health and safety of employees resulting from interactions between artificial optical radiation and photosensitising chemical substances;

e) any indirect effects of exposure on the health and safety of employees such as temporary blinding, explosion or fire;

f) the availability of alternative equipment designed to reduce levels of exposure;

g) appropriate information obtained from health surveillance, including where possible published information;

h) multiple sources of exposure;

i) any class 3B or 4 laser that is classified in accordance with the relevant IEC standard that is in use by the employer and any artificial optical radiation source that is capable of presenting the same level of hazard; and

j) information provided by the manufacturers of artificial optical radiation sources and associated work equipment in accordance with the relevant European Union Directives.

[i] In most cases this will be a relevant professional qualification and familiarity with the equipment used.
[ii] This is to be supported by an outline of the minimum information required

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