Department
SHEW

Laser Safety

Guidance for Users of Lasers

Document Information

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Contents

1. Summary

The University is committed to ensuring the health, safety and welfare of all staff, students and visitors. To achieve this the University aims to control the risks to human health from lasers people may be exposed to at work.

The principal legislation that applies to laser safety is the Control of Artificial Optical Radiation (AOR) Regulations 2010.

Regulation 4 states that:

"An employer must ensure that any risk of adverse health effects to the eyes or skin of employees as a result of exposure to artificial optical radiation which is identified in the risk assessment is eliminated or, where this is not reasonably practicable, reduced to as low a level as is reasonably practicable."

The safety of laser pointers broadly fall under two pieces of legislation; the Air Navigation Order which is managed by the Department for Transport, and the General Product Safety Regulations (GPSR) for which BEIS is responsible.

2. Scope

This guidance document applies to all users of all types and classes of Lasers at the University of Bath.

3. Introduction/Background

LASER is an acronym for **L**ight **A**mplification by the **S**timulated **E**mission of **R**adiation.

The 'light' produced by a laser is a form of non-ionising optical radiation. It also has a unique combination of properties:

- spatial coherence (all the waves are in phase);
- monochromaticity (i.e. have just one colour or a narrow bandwidth); and
- usually high collimation (i.e. low angular divergence such that the beam does not 'spread out' significantly with distance).

This combination of characteristics distinguishes laser radiation from all other light sources.

Lasers produce electromagnetic radiation at wavelengths extending from 100 nm in the ultra-violet, through the visible (400-700 nm), and the near infrared (700 - 1400 nm), to the far infrared (1400 nm - 1 mm). Thus, the light emitted can be either visible or invisible.

To protect people's health, the risks arising from work-related exposures to the hazards from lasers need to be assessed prior to any work being started. Controls need to be put in place and monitored to make sure they are maintained and are suitable and sufficient.

For more information, please refer to HSE Guidance on the regulations, along with the SHEW Control of Artificial Optical Radiation Standard and AURPO Guidance on the safe use of lasers in education and research (available from SHEW).

In addition, the safety of laser products is covered by the BSI Group, BS EN 60825 series of documents. The 60825 documents encompass a range of standards for manufacturers on lasers, fibre optic systems, laser guards and free-space communications systems etc. Of particular importance for users is the Technical Report PD IEC/TR 60825-14:2004 which is a detailed user's guide that incorporates a risk assessment approach to laser safety.

Lasers can be operated in a number of different modes. Some lasers produce a continuous output and are known as continuous wave or CW lasers. The power outputs of CW lasers are usually expressed in terms of watts (W). Others operate in a pulsed mode producing short bursts of radiation. The power of the laser output can vary from less than 1mW to many watts in some CW devices. The energy output of pulsed lasers is generally expressed in joules (J) per pulse.

Lasers come in various shapes and forms. They have many uses in teaching, research, manufacturing, medicine, dentistry, communications, shop checkouts and most commonly at work in the office. In fact, some applications may be so well engineered that users are not even aware that the equipment contains a laser.

4. Definitions

Maximum Permissible Exposure (MPE) Levels: An MPE is a level of laser exposure which it is believed an individual could be exposed to without incurring an injury. An MPE may therefore be considered as a maximum safe level of exposure. MPE levels are specified for both the eye and skin as a function of the wavelength of the laser radiation and the duration of exposure. These MPE values are internationally agreed and can be found in Tables A.1 to A.5 in BS EN 60825-1:2014 Safety of laser products Part 1: Equipment classification and requirements.

Accessible Emission Level (AEL): An AEL is the maximum value of accessible laser radiation to which an individual could be exposed during the operation of a laser and is dependent on the laser class.

Nominal Ocular Hazard Distance (NOHD): is the distance along the axis of the emitted beam at which the irradiance is equal to the MPE. The NOHD is dependent on beam characteristics such as the power, diameter, and divergence.

Natural Aversion Response: This is a natural involuntary response which causes an individual to blink and avert their head thereby terminating the eye exposure.

Intrabeam exposure: This means that the eye or skin is exposed directly to all or part of the laser beam. The eye or skin is exposed to the full irradiance or radiant exposure possible.

5. Laser Beam Hazards

Lasers emit radiation as narrow concentrated beams of light, not necessarily visible to the human eye. The optical and skin hazards presented by lasers vary markedly according to the wavelength and power of the output. Appendix 1 provides a summary of hazards for various wavelengths and radiation types. The following sections provide an overview of the general damage possible to the eyes and skin.

5.1.Skin Effects

Exposure to UV radiation may cause reddening of the skin (erythema) with short term (acute) exposure, that may eventually result in skin tanning (darkening of pigment from the production of melanin). Long term repeated (chronic) exposures are known to accelerate ageing of the skin resulting in thickened, dry and wrinkled skin (elastosis or photoageing) and increase the likelihood of skin cancer.

Exposure to visible and IR laser radiation can result in thermal damage to the skin resulting in burns.

5.2.Eye Effects

When the eye is inadvertently exposed to UV radiation the damage is confined to the outermost layers resulting in inflammation of the cornea (photokeratitis) or the conjunctiva, the membrane that lines the inside of the eyelids and eye socket (photoconjunctivitis). These conditions are similar to sunburn and can be very painful, however recovery is usually within a few days and long term damage is very unlikely. Excessive long term exposure to UV can also result in cataracts.

Visible and IRA radiation are focused by the cornea and lens onto the retina and therefore this is where the damage will occur. Both can cause thermal damage due to an increase in temperature resulting in retinal burns. Visible radiation can also cause photochemical damage similar to UV radiation. Chronic exposure to IRA my also induce cataracts, as can exposure to radiation in the IRB region.

Infrared radiation is essentially a heat transfer process, therefore most injuries tend to result from an increase in temperature in the absorbing tissue. For the longer wavelengths in the IRB and IRC region, the damage will occur to the lens of the eye and the cornea resulting in cataracts and burns.

6. Types of Laser

Lasers are categorised on the basis of the "active medium" used to generate the laser beam. This medium may be a solid, liquid or gas. The following table provides a summary of the different types of lasers commonly used. All of the types listed here are used at the University principally for research purposes.

Type	Laser	Application
Gas	Helium Neon (HeNe)	Holography, civil engineering for alignment, spectroscopy, optical demonstrations
	Helium Cadmium (HeCd)	Spectroscopy, biological fluorescence, photoluminescence, printing/plate making
	Argon Ion (Ar)	Holography, lithography, spectroscopy, retinal phototherapy (for diabetes)
	Krypton Ion (Kr)	Light shows, displays, colour reproduction, scientific research
	Carbon Dioxide (CO_2)	Materials processing (cutting, welding, etc.), laser surgery, military applications such as radar, research
	Nitrogen (N)	Pumping dye lasers, research
	Excimer: Xenon chloride (XeCl) Krypton fluoride (KrFl) Xenon fluoride (XeFl) Argon fluoride (ArFl)	Photolithography, laser eye surgery, production of microelectronic devices, research
Solid State (tend to be crystals)	Ruby	Holography, medical applications such as tattoo/hair removal, cutting/trimming
	Neodymium/Yttrium Aluminium Garnet (Nd:YAG)	Medical and dental applications, ngraving/etching, miltary applications such as rangefinders, research including spectroscopy
	Neodymium/Glass (Nd:Glass)	Research, optical communication, materials processing
Diode/Semi-conductor	Various materials e.g. Gallium:Aluminium:Arsenide (Ga:Al:As)	Laser scanners, printers, barcode readers, laser pointers, blu-ray disc reading, telecommunications, measuring applications such as rangefinders, research (including into quantum optics and atomic clocks)

	Indium:Gallium:Arsenide:Phosphide (In:Ga:As:P)	
Fibre	Optical fibre doped with rare earth elements such as: Ytterbium (Yb) Neodymium (Nd)	Telecommunications, laser cutting, engraving and welding, spectroscopy
Liquid (Dye)	Uses organic dyes that fluoresce Examples include: Rhodamine (orange) Fluorescein (green) Coumarin (blue)	Astronomy, spectroscopy, medical applications such as dermatology, treatment of port wine stains, scars, tattoos etc.
Solid State	Ti:Sapphire	Ultra-short, high-power pulses lasers, often widely tunable in wavelength (UV, VIS & NIR), used for multiphoton medical imaging, research into nonlinear optics.

7. Laser Classification

A system of laser classification is used to indicate the potential risk of adverse health effects. It is the responsibility of the laser manufacturer to provide the correct classification of a laser product. This classification is made on the basis of a combination of output power(s) and wavelength(s) of the accessible laser radiation over the full range of capability during operation at any time after manufacture which results in its allocation to the highest appropriate class. A laser is assigned to a particular class when the measured emission level exceeds the AEL for all lower laser classes but does not exceed the AEL for the class assigned.

The following laser classification scheme is taken from BS EN 60825-1.

Class 1: laser products that are considered to be safe during normal operation including long term direct intrabeam viewing even when using optical viewing instruments.
This class includes products that contain higher power lasers within an enclosure that prevents human exposure and that cannot be accessed without shutting down the laser or using tools to open the enclosure and expose the laser beam.

Typical examples include laser printers, CD and DVD players and materials processing lasers for cutting/welding type operations.

Class 1M: safe for the naked eye under reasonably foreseeable conditions of operation but may present a hazard if magnifying optical instruments are used with them. The possible danger in the case of Magnification is indicated with the letter M.

Lasers used in fibre optic communication systems tend to be Class 1M.

Class 2: lasers which are limited to a maximum output power of 1 milliwatt or one-thousandth of a watt (abbreviated to mW) and the beam must have a wavelength between 400 and 700 nm, i.e. only visible lasers. A person receiving an eye exposure from a Class 2 laser beam, either accidentally or as a result of someone else’s deliberate action (misuse) will be protected from injury by their own natural aversion response. However, repeated deliberate exposure to the laser beam may not be safe.

Typical examples of Class 2 lasers include barcode scanners and some laser pointers.

Class 2M: similar to a Class 2 laser product, however, they can be harmful to the eye if the beam is viewed using magnifying optical instruments or for long periods of time. The possible danger in the case of Magnification is indicated with the letter M.

Some lasers used for civil engineering applications, such as level and orientation instruments are Class 2M laser products.

Class 3R: laser products that emit in the wavelength range from 180 nm to 1 mm (i.e. can be both visible and invisible) where direct intrabeam viewing is potentially hazardous but the risk of injury is relatively low for short and unintentional exposure.

Examples of Class 3R products include some laser pointers (see Appendix 4 for further information), alignment and surveying equipment.

Class 3B: lasers which may have an output power of up to 500 mW and are hazardous to the eye if direct intrabeam exposure occurs. Viewing specular and diffuse reflections is also not normally safe but they are generally safe to the skin. The extent and severity of any eye injury arising from an exposure to the laser beam of a Class 3B laser will depend upon several factors including the radiant power entering the eye and the duration of the exposure. **Class 3B lasers should be controlled with all laboratory safety precautions in place.**

Examples of Class 3B products include lasers used for physiotherapy treatments and many research lasers such as He/Ne laser.

Class 4: High power lasers for which direct beam and reflected beam viewing is always hazardous. Diffusely reflected beams should also be assumed to be hazardous. They are capable of causing injury to both the eye and skin and will also present a *fire hazard* if sufficiently high output powers are used. **Class 4 lasers should be treated with caution with all laboratory safety precautions in place.**

Class 4 lasers tend to be used for laser displays, laser surgery, cutting metals and research.

8. Other non-beam Hazards

In addition to the hazards that may arise from exposure to the laser beam there are many other hazards that could be present in a laser area that also need to be considered in the risk assessment. The main hazards that could be present include:

- **Other radiation sources** – this could be from x-rays, UV or Electromagnetic Fields.
- **Electrical –** high voltage and capacitors used with pulsed lasers in particular can present a serious hazard if the work is not undertaken by competent persons. Detectors for laser light could also require a high-voltage power supply.
- **Hazardous substances –** dye lasers can use chemicals which are toxic or carcinogenic, and many lasers use gases which may present an asphyxiation hazard. In addition, any substances used for cleaning purposes should be included in a COSHH assessment. If materials are processed, then fume or dust may be generated which may require adequate ventilation.
- **Fire/Explosion -** high-powered (class 4) lasers can ignite materials and even relatively low-powered lasers (>35mW) can cause explosions in combustible gases and dusts.
- **Mechanical –** this could include the use of cutting tools for materials processing, handling of gas cylinders and any other large items of equipment. Lasers can be heavy, especially due to large metal plates used for temperature control.
- **Cryogenic liquids –** such as liquid nitrogen may be used for cooling which can cause cold burns upon contact or constitute an asphyxiation hazard if a release were to occur in an enclosed space.
- **Work Environment –** various items of equipment associated with lasers can generate noise and heat which may require assessment particularly if in a small, enclosed space. Unexpected noise from powerful pulsed lasers focusing on metal can be loud enough to trigger a panic reaction in users.

- **Ergonomic –** poor setup of the laser equipment can make access to parts difficult and cause unnecessary bending and stretching.

9. Laser Safety Management

When determining which type of laser is required for the task to be undertaken, the safest option should be chosen. Therefore, the lowest class of laser possible should be used and the lowest power output possible.

A risk assessment should always be produced prior to undertaking tasks using a laser, ensuring it considers all modes of operation such as alignment, set-up, and maintenance as well as normal operation. As mentioned above it should also cover non-beam hazards present in the laser controlled area and consider all persons who may be in the vicinity when the laser is in operation.

In accordance with the regulation 3 of AOR the risk assessment must include the following:

- the level, wavelength and duration of exposure;
- the exposure limit values; including Maximum Permissible Exposure (MPE) and Nominal Ocular Hazard Distance (NOHD)
- the effects of exposure on employees or groups of employees whose health is at particular risk from exposure;
- any possible effects on the health and safety of employees resulting from interactions between artificial optical radiation and photosensitising chemical substances;
- any indirect effects of exposure on the health and safety of employees such as temporary blinding, explosion or fire;
- the availability of alternative equipment designed to reduce levels of exposure;
- appropriate information obtained from health surveillance, including where possible published information;
- multiple sources of exposure;
- Calculations for determining appropriate PPE

As with any risk assessment, the hierarchy of control should be applied, implementing engineered controls before administrative to either eliminate or reduce the risk to a level as low as reasonably practicable. Examples of the different types of controls are given below.

9.1. Engineered Controls

Once it has been determined what laser is required, consideration should be given to reducing the possibility of exposure to the laser beam and therefore its classification to as low as possible. In accordance with the legislative requirement to eliminate or reduce the hazard as far as reasonably practicable. The most effective way to do this is to totally enclose the laser (including regions where access is required, e.g. for adjustments/maintenance) and to install interlocks that cut the power to the laser or shut the beam closed when triggered. As contact with the laser beam is not possible then the class of the laser is reduced to Class 1, and the enclosed laser can be labelled as such. The additional benefit of enclosing the laser is that the area is kept clean and free of debris which may be a fire hazard. An enclosure needs to be secure, constructed of appropriate material and be tamper proof.

Working with open beams should not be normal practice unless a robust justification can be provided, e.g. in the risk assessment, that it is absolutely necessary and/or it is not reasonably practicable to enclose or restrict access to the beam using engineered controls. Reasons such as cost, time and too difficult are not acceptable.

If the laser cannot be totally enclosed, then other methods to enclose as far as reasonably practicable should be implemented such as:

- Use an optical table enclosure
- Use of beam tunnels and/or tubes along beam and beam dumps at the end of beams
- All optical components should be securely attached to table

Other engineered controls that should then be considered include:

- There should be no windows in the laboratory (or windows should be covered) to avoid laser exposure outside the laboratory
- Where possible, the laser should be installed pointing away from doors/windows
- Laser beam height should not be at eye level
- No chairs or computer screens in the lab should be at laser beam height level
- Use of shutters, attenuating filters to prevent access to the laser beam from the aperture
- Key switch which renders the laser inoperable when removed
- Laser on indicator outside the laboratory door
- Laser-lab door interlock system that shuts the laser beam off in the case of the door being opened
- Use of alignment aids (see below)
- Adequate ventilation may be required if cryogenics or any other hazardous gases/fumes are used or produced by the operations

9.2. Administrative Controls

These are the management controls and procedures required to further reduce the risk of harm to as low as reasonably practicable. For laser use these should include:

- Appointment of a competent Laser Safety Officer (see below for training and duties);
- Production of risk assessments and associated operating procedures and/or local rules;
- Instruction, training and supervision where required;
- Posting of safety signs, with clear instructions to person entering and hazard warning triangle

Local rules or written instructions are particularly important as they are the means by which the hazards and the controls to keep persons from harm are communicated. Typical contents include:

- Designation, type (CW or pulsed), class, wavelength, and maximum power of laser/s
- List of authorised users with contact details in case emergency access is needed
- Access restrictions to laser areas
- Summary of hazards, including non-beam hazards
- Risk assessment forms
- Protection measures:
  - Key control
  - Alignment procedures

- Wearing of PPE; with type specified

- Contingency plans, e.g. what action to take if an incident occurs and/or someone is harmed, including contact details of first aid person

A template of the type of information which should be posted on Laser laboratory doors can be found in Appendix 5.

9.3.Set-up and Alignment

The majority of incidents occur during set-up and alignment activities as this is when the beam may be exposed. Therefore, extra precautions need to be taken by users to ensure they protect themselves and others from harm. These tasks should be adequately planned and assessed prior to being undertaken.

These should include:

- Restricting access to necessary persons only, although set-up and alignment should be done with two persons present in case emergency action needs to be taken;
- Other lab users should be warned that alignment will take place;
- Ensuring anything that could result in unwanted reflections such as watches, jewelry etc. are removed prior to the task;
- An experiment diagram should be produced prior to setting up an experiment which should be recorded in the lab book;
- Risk assessment form should be filled in;
- The lowest possible/practicable power is used;
- Remote viewing tools such as a CCD camera;
- Use of an alignment laser tools, such as He-Ne or CW diode laser for initial alignments and for invisible beams;
- Ensure beam paths are at a safe height, below eye level when standing or sitting and not at a level where a person may bend down to look at the beam;
- Use of beam tubes/pipes for longer runs of the beam path or when they leave the laser table;
- Identifying when the beam is directed out of the horizontal plane and blocking them;
- Checking the stability and rigidity of all optical mounts, beam blocks and stray beam shields;
- Wear appropriate protective eyewear when deemed necessary.

9.4.Training

All persons who use lasers in their work at the University must undertake the required training in their safe use. General training is provided on moodle through this Laser Safety Training Module which should then be followed by specific training by their supervisor or that of the laser controlled area on the use, hazards and controls for the equipment they will be using. A risk assessment and operating procedure for the operations should be in place that should be read and acknowledged by the user. The training checklist should then be signed and approved by the department Laser Safety Officer, see Appendix 3.

Laser Safety Officers who do not have applicable experience are required to attend an approved training course such as those provided by UK Health Security Agency (UKHSA).

9.5.Laser Safety Officer

The principal duties of the departmental Laser Safety Officer (LSO) include:

- Provision of advice prior to persons procuring new lasers to ensure appropriate laser is being acquired and required controls can be implemented
- Identifying all Class 3B and 4 lasers within their area of responsibility and maintaining an accurate inventory;
- Ensuring all lasers are appropriately labelled and laser designated areas clearly identified;
- Ensuring procedures and risk assessments for the safe operation of lasers are produced and readily available to users;
- Identifying personnel intending to work with lasers, and ensuring they receive training in the safe use of lasers;
- Checking that undergraduates working with lasers use the minimum power laser practicable, and be appropriately instructed, trained and supervised;
- Ensuring all lasers in the department are used in accordance with legislation, industry standards and best practice and University guidance;
- Undertaking routine audits to ensure compliance with the above requirements. These audits should be recorded, and any actions identified tracked to completion. This monitoring could be carried out at the department/faculty H&S Committee or similar forum.

9.6.Personal Protective Equipment (PPE)

Personal Protective Equipment should always be a last resort, engineered controls should always take priority where practicable. Regarding the use of lasers, the principal protective equipment will be that to protect the skin and eyes from harm depending on the classification of the laser and operations being carried out.

Any PPE required needs to meet the appropriate standards and provide a suitable level of protection. The main item that may be required when using lasers is protective eyewear. This should be designed to reduce the incident radiation to a level at or below the appropriate Maximum Permissible Exposure (MPE) level. It should be noted that protective eyewear for laser use provides protection only against accidental viewing, they are not designed to enable a person to intentionally stare into a beam.

Protective eyewear for laser use must meet the requirements of either BS EN 207:2017 Filters and eye protectors against laser radiation or BS EN 208: 2009 Eye protectors for adjustment work on laser and laser systems. There are a number of factors to take into consideration when choosing the correct eyewear and filters including the wavelength at which the laser operates, its power and/or pulse energy, and the optical density of the filter. The eyewear also should have the CE mark.

Appropriate calculations should be carried out and included in the risk assessment and/or operating procedures to ensure the correct eyewear is chosen.

As with all PPE it should be appropriately stored and maintained in a good condition and used correctly. Operating procedures and training should include instructions on how to use safely. PPE should be regularly checked for defects and if any found such as broken arms, scratches on lenses and cracks it should be taken out of service and replaced.

10.Accident and Emergency Procedures

In the event of a serious incident, arrangements should be in place to make hazard information readily available to individuals (including security and external emergency services) attending the incident to enable the appropriate action to be taken.

- Where there is serious risk to health, immediate steps are taken to mitigate the effects, provide information to those who may be affected and restore the situation to normal.
- Where staff are required to carry out work in response to a laser incident they are provided with appropriate PPE and equipment, information and training.

- Emergency procedures and arrangements are identified by risk assessments; this should consider what to do in the event of fire, provision of first aid and eye/skin damage.
- In the event of eye damage, a medical expert should be consulted as soon as possible. Please see below for process to follow when contacting/attending the RUH in the event of an eye strike.
- The response in the event of skin damage will depend on the severity of the burn.
- First aid provisions (including any specialist requirements) are suitable for use by their staff and students.

10.1. RUH Procedure for Laser Eye Strike

During working hours, first call the nurses on the emergency Ophthalmology line at RUH (01225 824403) and then attend the RUH eye department.
Outside working hours (up until 8pm), contact the RUH switchboard (01225 428331) and ask to speak to the on-call eye doctor.

11. Waste Disposal

Lasers once disconnected at the power supply do not pose any danger to persons as the generation of the laser beam is dependent upon the presence of power. Therefore, lasers should be disposed of as waste electrical equipment in accordance with the Waste Electrical and Electronic Equipment (WEEE) Regulations 2013. Please contact the University waste department on waste@lists.ac.uk for collection and disposal.

12. References

https://www.hse.gov.uk/radiation/nonionising/employers-aor.pdf

Public Health England laser radiation safety advice

BS EN 60825-1: 2007. Safety of laser products: Part 1. Equipment classification and requirements. British Standards Institution, London

Non-binding Guide to the Artificial Optical Radiation Directive 2006/25/EC

Association of University Radiation Protection Officers Guidance on the safe use of lasers in education and research

Appendix 1: Summary of laser beam hazards

Wavelength (nm)	Radiation type	Effect on Eye	Effect on 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 (tanning) 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

Table reproduced from Non-binding Guide to the Artificial Optical Radiation Directive 2006/25/EC

Appendix 2: Laser labels

Class of Laser	Label Required
1	No hazard label required, or explanatory text required
1M	Triangle hazard warning label not required. Explanatory label as follows: LASER RADIATION DO NOT STARE INTO BEAM OR VIEW DIRECTLY WITH OPTICAL INSTRUMENTS CLASS 1M LASER PRODUCT
2	Triangle hazard warning label required and Explanatory label as follows: LASER RADIATION DO NOT STARE INTO BEAM CLASS 2 LASER PRODUCT
2M	Triangle hazard warning label required and Explanatory label as follows: LASER RADIATION DO NOT STARE INTO BEAM OR VIEW DIRECTLY WITH OPTICAL INSTRUMENTS CLASS 2M LASER PRODUCT
3R	Triangle hazard warning label required, and Explanatory label as follows: LASER RADIATION AVOID DIRECT EYE EXPOSURE CLASS 3R LASER PRODUCT

Class of Laser	Label Required	
3B	Triangle hazard warning label required, and Explanatory label as follows:	LASER RADIATION AVOID EXPOSURE TO BEAM CLASS 3B LASER PRODUCT
4	Triangle hazard warning label required, and Explanatory labels as follows:	LASER RADIATION, AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERERED RADIATION, CLASS 4 LASER PRODUCT
Class 3B or 4 laser completely enclosed and/or interlocked	No hazard label required. Explanatory label as follows: May need to be adapted depending on original class of laser	CAUTION LASER RADIATION WHEN OPEN AVOID EXPOSURE TO BEAM
Aperture Labels for Class 3R, Class 3B & Class 4 lasers	Each Class 3R, Class 3B and Class 4 laser product shall display a label close to where the beam is emitted bearing the words 'LASER APERTURE' or 'AVOID EXPOSURE – LASER RADIATION IS EMITTED FROM THIS APERTURE'. Example label is as follows:	LASER APERTURE

Appendix 3: Laser safety training form

Form for recording the instruction and training provided by the Department Laser Safety Officer (LSO)

Candidate	
Candidate's Department	
Candidate's Supervisor	
Contact Details	

Item	**Date**
Candidate shown video on the safe use of lasers by the Department Laser Safety Officer (LSO)	
Candidate given a tour of a typical laser installation, with the hazards and controls highlighted, by the Supervisor or Department LSO	
Candidate discusses hazards and controls associated with his application with the Supervisor or Department LSO	
Candidate produces a risk assessment and safe operating procedure for his/her application – either alone or with assistance of their supervisor	
Candidate presents his/her risk assessment and safe operating procedure to the Department LSO for discussion and review	

Training provided by and date	
Assessment reviewed by and date	

Appendix 4: Laser pointers

Laser pointers are commonly available, and some can be classed higher than Class 1 and therefore could cause harm. Therefore, they should be purchased with caution; they should be low power (<1mW) and no more than Class 2. Instructions for their safe use should be readily available. They should only be purchased from reputable suppliers.

Laser pointers should only be used as a pointing device and securely stored when not in use. Persons who use laser pointers should ensure that they are aware of potential hazards, and they should comply with the basic instructions below.

Instructions for use:

When operating laser pointers, users must ensure that they use them in a safe manner and do not expose themselves or others to the beam. Laser pointers are not to be modified in any way.

✓	• Follow the manufacturer's safety instructions. • Take care when operating the laser pointer. • Keep the 'on' button depressed only when necessary.
✗	• Do not keep the 'on' button depressed when not pointing at the screen. • Do not point at or towards the audience. • Do not point at mirrored surfaces. • Never look into the laser aperture. • Never look directly or stare into the beam/beam aperture when on. • Never allow unauthorised use, especially by children.

Appendix 5: Laser Lab Door Template

Academic: Office: Phone number:

Authorised personnel:

Name: Office: Phone number:
Name: Office: Phone number:
Name: Office: Phone number:
Name: Office: Phone number:
Name: Office: Phone number:
Name: Office: Phone number:
Name: Office: Phone number:

LASER LIST

Make/designation	
Laser Class	
Laser type (pulsed/CW)	
Wavelength	
Maximum power/energy	

Make/designation	
Laser Class	
Laser type (pulsed/CW)	
Wavelength	
Maximum power/energy	

Make/designation	
Laser Class	
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Wavelength	
Maximum power/energy	