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INTRODUCTION

There is a legal requirement to identify risks and take appropriate action to eliminate or control those risks (optical and non-optical). We all have a responsibility under the Health & Safety at Work etc. Act 1974 to ensure that work with lasers is carried out safely. Users have a duty to protect both themselves and others from the potential hazards involved, particularly when working with the more powerful lasers

1. The aim of this procedure is to protect staff, students, contractors and visitors from exposure to harmful levels of laser radiation.
2. The potential hazard posed by a particular laser is indicated by its classification against the requirements of BS EN 60825-1:2014, Edition 2 - *Safety of laser products – Part 1: Equipment classification and requirements*⁽¹⁾, the primary standard for laser safety to which many other standards and guidelines refer. Guidance to ensure that work with lasers in universities is carried out safely and in accordance with this standard is given in *Guidance on the Safe Use of Lasers in Education and Research* issued by the Association of University Radiation Protection Officers (AURPO)⁽²⁾. It is the policy of the University of Northumbria to ensure compliance with this document.
3. This Code of Practice recognises the special hazards associated with lasers of Class 3B and Class 4 and the stricter control measures necessary to ensure safety in their use.
4. In accordance with the AURPO guidance the University has appointed a Laser Safety Officer, Mr Lee Rounds, Senior Health and Safety Advisor.

GENERAL PRINCIPLES

1. All lasers must bear labels giving details of their maximum output(s), of the wavelength(s) concerned, whether continuous wave or pulsed and if the latter, of pulse duration and repetition frequency and energy. In addition, each laser must be classified and labelled with a hazard warning appropriate to its class.
2. A laser of the minimum power or energy commensurate with the desired experimental objective should always be used.
3. Open beam paths should be located above or below eye level. The beam path from the laser to any equipment should be as short as possible with the minimum of optical reflection. Care should be taken to avoid unexpected reflections or refractions whenever items of apparatus are inserted or removed from the beam path.
4. Under no circumstances must intrabeam viewing be allowed unless authorised by the Laser Safety Officer and as documented in the local rules and schemes of work for the specified laser.
5. A laser product may consist of a single laser with or without a separate power supply or may incorporate one or more lasers in a complex optical, electrical, or mechanical system. Laser products such as laser printers, CD/DVD players, barcode scanners, laser cutters and some scientific analytical equipment that employ high power lasers, may be given a low classification provided that they incorporate engineering controls to prevent user access to high levels of laser radiation.

DEFINITIONS

The word **laser** is an acronym for Light Amplification by the Stimulated Emission of Radiation. The 'light' produced by a laser, a form of non-ionising optical radiation, has a unique combination of 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.

TABLE 1 CLASS	MEANING	Old Classification	New Classifica tion	Reason for Change
Class 1	Normally Safe	1	1 1M	1M - diverging/low power density devices that could be hazardous if beam focussed. Eye safe when used without optical instruments, may not be safe when optical instruments are used.
Class 1c	No need for protection Equipment	1C	NA	This class is only valid for medical applications. In General, the emitted radiation is not subject of any limitations. The protection is ensured by technical procedures in the following way: The laser can only irradiate a beam, while having contact to the skin or tissue and the accessible radiation is reduced or below the AEL of class 1.
Class 2	Eye protected by aversion response (visible only)	2	2 2M	2M - diverging/low power density devices that could be hazardous if beam focussed
Class 3	Eye hazard	3A & 3B	3R	Low eye hazard, power density restriction removed
		3B	3B	No significant change
Class 4	Eye and skin hazard	4	4	No significant change

Class 1: Lasers that are safe under reasonably foreseeable conditions of operation, either because of the inherently low emission of the laser itself, or because of its engineering design such that it is totally enclosed and human access to higher levels is not possible under normal operation. **NB** If access panels of a totally enclosed system are removed for servicing etc. then the laser product is no longer

Class 1 and the precautions applicable to the embedded laser must be applied until the panels are replaced.

Class 1C - Safe without viewing aids, lasers are designed explicitly for contact applications to the skin or non-ocular tissue.

Class 1M: Laser products emitting in the wavelength range 302.5 nm to 4000 nm, whose total output is in excess of that normally permitted for Class 1 laser products but because of their diverging beams or very low power density do not pose a hazard in normal use and comply with the measurement conditions for a Class 1M product. However, they may be hazardous to the eyes under certain conditions if gathering optics are used with them, i.e.

- a) With a diverging beam if optics are placed within 100 mm of the source to concentrate/collimate the beam.
- b) With a large diameter collimated beam viewed with binoculars or a telescope.

Class 2: Lasers that only emit visible radiation in the wavelength range from 400 nm to 700 nm and whose output is less than the appropriate AEL. They are safe for accidental viewing as eye protection is afforded by aversion responses, including the blink reflex. This reaction may be expected to provide adequate protection under reasonably foreseeable conditions of operation including the use of optical instruments for intrabeam viewing.

Class 2M: Laser products that only emit visible radiation in the wavelength range 400 nm to 700 nm, whose total output is in excess of that normally permitted for Class 2 laser products but because of their diverging beams or very low power density are safe for accidental viewing during normal use and comply with the measurement conditions for a Class 2M product. However, they may be hazardous to the eyes under certain conditions if gathering optics are used with them, i.e.

- a) With a diverging beam if optics are placed within 100mm of the source to concentrate/collimate the beam.
- b) With a large diameter collimated beam viewed with binoculars or a telescope.

Class 3R: Lasers that emit in the wavelength range from 180 nm to 1 mm where direct intrabeam viewing is potentially hazardous but the risk is lower than for Class 3B lasers, and fewer manufacturing requirements and control measures for the user apply. The AEL is restricted to no more than five times the AEL of Class 2 for visible wavelengths and no more than five times the AEL of Class 1 for other wavelengths.

Additional control measures apply to the use of Class 3R lasers:

- (i) the laser beam must be terminated at the end of the useful path by a suitable beam stop;
- (ii) open laser beam paths at eye-level should never be used and the beam should be enclosed where practicable;
- (iii) laser warning signs should be displayed at the entrance to areas where these classes of laser are used.

Class 3B: Lasers that are normally hazardous when direct intrabeam exposure occurs (i.e. within the Nominal Ocular Hazard Distance (NOHD), which is the distance within which the beam irradiance or radiant exposure will exceed the appropriate Maximum Permissible Exposure (MPE)). Viewing diffuse reflections is normally safe. Output levels must be less than the appropriate Accessible Emission limit (AELs) for Class 3B devices.

Class 4: High power lasers that exceed the AELs for Class 3B products that are also capable of producing hazardous diffuse reflections. They may cause skin injuries, could also constitute a fire hazard and could cause hazardous fumes to be produced as well as being a hazard to the eyes. **Their use requires extreme caution.**

Class 3B and Class 4 Lasers

1. Class 3B and Class 4 lasers may only be used in a Designated Laser Area (listed in Appendix III).
2. Use of Class 3B and Class 4 lasers where it is not reasonably practicable to totally enclose the beam path may only be operated in accordance with an approved scheme of work designed to ensure the safe operation of the lasers. The Laser Safety Officer must be consulted and, in consultation with the relevant Departmental Laser Safety Officer, is responsible for drawing up approved schemes of work.
3. Class 3B and Class 4 lasers must incorporate the following safety features:
 - (i) key control to ensure that only authorised personnel use the laser;
 - (ii) a beam shutter or attenuator which operates automatically to prevent the inadvertent exposure of persons to hazardous laser radiation;
 - (iii) a remote interlock which shuts down the laser on opening the door to the Designated Laser Area;
 - (iv) an emission indicator sited outside the Designated Laser Area to give warning of lasers in use.

Appropriate laser safety goggles must be provided for all work with Class 3B and Class 4 lasers where the laser beam is not totally enclosed.

In the event of an eye injury caused by a laser beam the Emergency Procedure for Exposure to Class 3B or Class 4 Laser (Appendix VIII) should be followed.

RESPONSIBILITIES

The University laser safety officer

1. A register of all lasers on University premises is held by the Laser Safety Officer. No laser is to be used on the premises unless it has been notified to the Laser Safety Officer and listed on the University Laser Register .
2. The University Health and Safety Adviser will notify the departmental Laser Safety Officer if, during the course of departmental safety inspections, they become concerned at the conditions in which a laser is being used.

The Faculty laser safety officer

1. Each faculty Laser Safety Officer will maintain an inventory of the lasers in their Faculty/Service Department except for low power Class 1 devices (and excluding laser printers, DVDs, Class 2 laser pointers etc.) are identified; and advise the University Laser Safety Officer who will ensure that the University Laser Register is updated annually.
2. All lasers are labelled in accordance this procedure and laser designated areas clearly identified;
3. Risk assessments are created for the safe operation of lasers. These will normally be required for all Class 3B and Class 4 lasers when not totally enclosed;
4. Personnel intending to work with Class 3R, Class 3B and Class 4 lasers, and others who may be working with modified Class 1M or Class 2M devices, will need to be identified, registered and receive training in the safe use of lasers;
5. Laser safety eyewear are provided and worn (when appropriate) by all people working with Class 3B and Class 4 lasers when the beam is not totally enclosed and that training is given in the use and maintenance of this eyewear;
6. Undergraduates working with lasers should use the minimum power laser practicable and follow a written scheme of work;
7. All lasers in the department are used in accordance with this guidance; and
8. Routine surveys are undertaken to ensure compliance with this guidance.
9. Annually, the Faculty Laser Safety Officer will assess each laser against the requirements of the Laser Survey Form. Any laser failing to comply will be taken out of use until appropriate remedial action has been taken to secure compliance.
10. The faculty Laser Safety Officer will notify the University Laser safety officer of any concerns regarding laser safety.

The Head of Faculty/Department has overall responsibility for health and safety arrangements within that Faculty/Service Department.

1. Responsibility for ensuring that lasers are used in accordance with this Code of Practice is that of the relevant member of University staff in charge (Class 1, Class 1M, Class 2 and Class 2M lasers) or the registered laser user (Class 3R and above). This includes ensuring the appropriate level of supervision.
2. In departments where Class 3B and Class 4 lasers are used the Head of Department in consultation with the University Laser Safety Officer should appoint a suitably qualified member of staff as faculty Laser Safety Officer who will be responsible for ensuring that all

lasers used in the faculty are identified and used in compliance with this procedure. A system should be in place so that the LSO is aware of lasers being acquired, prior to them arriving on the premises, to ensure that adequate facilities are available for their safe use.

3. All work involving hazardous lasers must be covered by risk assessments and where appropriate by written schemes of work and protocols. There should also be procedures to ensure that lasers are made safe prior to disposal and dealt with appropriately if they contain hazardous materials. The head of faculty should also ensure that their laser workers are effectively trained in the operating techniques required and that inexperienced staff are adequately supervised.

Laser users

1. Observe the Policy/Guidance and Schemes of Work applicable to the lasers that will be used and to follow the guidance of supervisors and the faculty Laser Safety Officer;
2. Not leave a laser experiment running unattended unless a risk assessment has established that it is safe to do so;
3. Responsible for their own safety and that of others who may be affected by their acts or omissions; and
4. When working with Class 3B or Class 4 lasers there is the possibility of stray laser beams that could damage the eyesight; where required the appropriate laser eyewear **MUST BE WORN**.

TRAINING

1. Initial training will be a basic instruction in laser hazards, risks and their control. Class 3R, Class 3B and Class 4 laser workers should attend training before commencing any laser work and should also be familiar with the schemes of work/protocols provided. A record of attendance should be made. Training in the use of individual lasers is the responsibility of the Research Supervisor and a record of this training must also be made. Appropriate refresher training should also be provided to ensure that people are kept up to date with the latest British Standard requirements.
 - The general nature of laser radiation;
 - The health hazards, the tissues of the body at risk, and the severity of harm which can result;
 - The different laser classes and the meaning of the warning labels appropriate to the classes;
 - The proper use of hazard control procedures and where appropriate the need for personal protective equipment;
 - The need for any necessary additional precautions when undertaking non-routine activities; and
 - Be familiar with the Institution's procedures and policy governing laser use, including emergency action and accident reporting procedures.

NOTE: Laser safety training videos are available on the H&S web pages [Laser training videos](#)

RELATED DOCUMENTS

BS EN 60825-1:2014, Edition 2 - *Safety of laser products – Part 1: Equipment classification and requirements*. London: British Standards Institute.

Association of University Radiation Protection Officers (2012) *Guidance on the Safe Use of Lasers in Education and Research*, AURPO Guidance Note No. 7. 2012 Revised Edition. [This document is available at <http://www.aurpo.org>.]

Emergency Procedure for Exposure to Class 3B or Class 4 Laser [Link](#)

Hazard and Risk Assessment (Class 1M, 2, 2M and 3R Lasers)

Hazard and Risk Assessment (Class 3B and 4 Lasers)

The Safe Use of Laser Pointers [Link](#)

FORMS

University Laser Register [Link](#)

Laser Inventory [Link](#)

Designated Laser Areas [Link](#)

Laser Survey Form [Link](#)

Laser User Registration Form [Link](#)

Laser User Training Record Form [Link](#)