University of Nottingham
UK | CHINA | MALAYSIA

Health and Safety

Laser Safety

Policy, Management Arrangements, And Guidance

SAF-POL-LAS

Document Control

Document Details	
Reference	SAF-POL-LAS
Title	Laser Safety
Version Number	2
Approval Date	Oct 2022
Issue Date	Oct 2022
Review Date	Oct 2024
Status	Published
Author	Sarah Watson, Health & Safety Department

Document Revision History

Revision	Date	Nature of Revision	Prepared by	Approved by
1	February 2020	Updated Roles and Responsibilities section and Risk Assessment section in relation to open beam working justification.	Sarah Watson	Laser Safety Committee
2	October 2022	Modifications to policy and arrangements related to risk assessment, training of laser workers, safety critical devices checks, emergency grab cards, transfer of control to third parties. Updated arrangements on laser safety calculations and registration of laser systems. Further guidance on laser safety signage, lone working, and procurement of laser systems.	David Kemp/Sarah Watson	Peer Review

The Health and Safety Department will maintain the official version of this document. Before referring to any printed copies, please ensure that they are up-to-date.

University Safety Policy documents represent the standards to which Business Units must comply. To guide University members further in how compliance may be achieved and recorded, see associated documents listed below.

Associated Documents

Title and Reference	Explanation	Link
Guidance	Guidance on the safe use of lasers in the University	Contained within this document
Arrangements	University and Business Unit specific arrangements for the safe use of lasers	As above
Forms	Laser Registration Form Laser User Registration Form Laser Survey Form Laser Risk Assessment Form	See Forms section below for Links or see the H&S Laser webpage

Laser Pointers	Information and Guidance regarding selection and use of laser pointers	https://www.nottingham.ac.uk/safety/documents/saf-gui-las-poi.pdf
Interlocks	Information and Guidance regarding standards for laser interlocks	https://www.nottingham.ac.uk/safety/documents/laser-interlocks.pdf
Confocal microscopes	Information and Guidance regarding the safe use of Confocal laser systems	https://www.nottingham.ac.uk/safety/documents/lasers-confocal.pdf
Laser Safety Calculations and using LaserBee	Information and guidance on understanding and performing laser safety calculations and using calculations to recommend laser safety eyewear.	https://workspace.nottingham.ac.uk/display/safety/Laser+Safety
Safety Signs and Labels	Provides the details for safety signs and labels that are relevant to laser controlled areas and equipment.	https://www.nottingham.ac.uk/safety/documents/lasers-safety-signage.pdf

Contents

Procurement and Registration of New Lasers

Planning (Pre-purchase)

Laser on site - being set up before use

Laser in use

Planning to purchase a laser?

For all equipment containing a >Class 2 laser system:
PI to inform LSO before placing order to ensure:

1. Equipment meets safety standards.
2. Suitable facility available or can be made available.
3. Control measures to operate safely discussed to ensure needs can be met.

LSA to be informed, and advice to be sought on whether equipment is appropriate or additional safety features need to be considered ahead of equipment being purchased.

For all equipment purchased as and confirmed as a >Class 3R laser product by LSO:
PI to Register Laser on Online Registration Form.

https://forms.office.com/r/i98EYuYbfX

Laser survey carried out by LSO.

PI to liaise with LSO to set up this up.

PI to ensure Laser Risk Assessment (LRA), SOP, and MPE calcs completed to acceptable standard.
PI to review LRA.
https://www.nottingham.ac.uk/safety/documents/laser-ra-form.docx

Survey and Risk Assessment submitted through online form by PI or designated responsible person (must be declared on laser registration)
https://forms.office.com/r/RiRjr3UMRU

Risk Assessment reviewed by LSO and HSD, and approval must be received before work starts.

Laser Work begins with control measures implemented.

Risk Assessment and SOP reviewed at least every 2 years and documentation / significant changes to be notified to HSD.
https://forms.office.com/r/RiRjr3UMRU

Key:

- **Completed and satisfactory**
- **Not Completed or unsatisfactory**

Also, ensure that:

Laser users have undertaken online training and are registered.

Laser users undertaken on-the-job training for all laser-related tasks they will perform

Authorised users displayed.

Emergency Grab cards displayed.

Monthly checks carried out.

Third parties such as service engineers managed.

1. Policy Introduction

University policies establish standards and expectations for health and safety across the organisation and set the minimum standards expected. This policy covers the safe management of laser systems used within university premises or for university purposes offsite.

Each unit, which may be a Faculty, School, Department or Institute, will be referred to as Business Unit (BU) in this policy and should produce its own local arrangements on laser safety (See Arrangements section). Any local arrangements imposed at a local level must meet all requirements set out in this policy. Where there is a discrepancy, the University policy takes precedence.

2. Scope

This policy covers the safe use of lasers for university activity, specifically in laboratory and workshop environments. The focus is on high-powered lasers where there is a risk of harmful exposure to optical radiation. Enclosing high powered beams is the absolute priority with regards to optical safety. In line with statutory requirement to eliminate, or to reduce as far as is reasonably practicable, the risk of adverse effects to the eyes or skin, suitable control measures that follow the hierarchy of control must be implemented. Routine and frequent reliance on administrative controls, such as personal protective equipment, for protecting workers against harmful laser radiation will not be acceptable without suitable justification.

3. Regulatory Requirements

Legal duties to adopt and maintain safe methods of working are placed on both employers and employees by general health and safety legislation, principally by the Health and Safety at Work etc Act 1974 and the Management of Health and Safety at Work Regulations 1999.

The Artificial Optical Radiation Regulations 2010 are the key relevant regulations relating to lasers and require the University to eliminate, or reducing as far as is reasonably practicable, the risk of adverse health effects to the eyes or skin of workers from exposure to harmful laser radiation.

In addition, laser systems are considered to be work equipment and therefore the requirements of PUWER (Provision and Use of Work Equipment Regulations 1998) and the Supply of Machinery (Safety) Regulations 2008 apply.

The key sector-specific laser safety guidance is the Guidance on the Safe Use of Lasers in Education and Research 2018 (AURPO – Association of University Radiation Protection Officers). It is expected that the University approach is in line with this guidance which is endorsed by the Health and Safety Executive. (Further references are contained within the AURPO guidance, Section 13.)

BS EN 60825 Parts 1, 2 and 4 relate to safety of laser products:

- Part 1: Equipment and Classification and requirements
- Part 2: Safety of optical fibre communications
- Part 4: Laser guards

Medical lasers are subject to special provisions, and revised guidelines on their use have been published by the Department of Health.

4. Roles and Responsibilities

University Council will

- Seek assurance from the Director of Health and Safety that appropriate arrangements are in place to ensure compliance with this policy;
- Receive annual reports from the Director of Health and Safety on laser safety;
- Require a University Laser Safety Advisor (ULSA) to be appointed by the Director of Health and Safety, to oversee laser safety at the University.

University Executive Board will

- Ensure sufficient resources are available for implementation of this policy;
- Ensure that they are provided with information on the significant risks from laser hazards facing the institution;
- Consider the risk implications of strategic decisions such as large projects involving high powered laser systems;
- Seek assurance that all mandatory requirements for laser systems are met;
- Seek assurance that risk control measures to ensure laser safety are implemented;
- Seek assurance that those with laser risk management and assessment responsibilities are adequately trained and competent;
- Seek assurance that monitoring of laser safety is being undertaken and actions to improve performance are being tracked to completion;
- Seek assurance that competent health and safety advice is available to assist BUs in managing and accessing risks where laser systems are present;
- Be notified of any significant accident, incident or enforcement action in relation to laser use.

The University Health and Safety Department will

- Provide, and keep updated, polices, arrangements and guidance to ensure any statutory requirements for laser safety are met;
- Ensure effective communication on laser safety with relevant BUs;
- Provide competent advice and support on laser safety to the University in conjunction with the University Laser Safety Adviser;
- Ensure appropriate oversight for compliance with laser safety regulations, particularly regarding open beam working with Class 3B and 4 lasers;
- Provide reports as appropriate to the University Health and Safety Committee on laser safety performance;
- Advise on laser safety training provided to key role holders and laser users, and ensure adequacy through routine review;
- Maintain records of training for laser safety roles (ULSA and LSO);
- Lead on and coordinate visits by external agencies such as the Health and Safety Executive;
- Have an oversight of reported incidents concerning laser systems and be involved in the detailed investigation of serious laser-related incidents;
- Maintain an inventory of all Class 3B and 4 laser systems in use across the university;

- Ensure that BUs adhere to the University Policy by carrying out routine monitoring, inspections and audits.

The University Laser Safety Committee will

- Be the formal oversight and compliance committee on laser safety for the University and will provide assurance to the University Health and Safety Committee and ultimately Council;
- Review relevant laser safety policies and arrangements within the University to ensure compliance with current legislation, and to recommend to the University Health and Safety Committee any actions necessary to improve compliance and/or performance;
- Consider and advise on reports on laser safety and compliance of projects and facilities across the University arising from formal inspections, monitoring, benchmarking and reviews;
- Provide peer-review advice on laser risk assessment and new laser facilities;
- Provide advice on other laser issues as required.

Heads of Business Unit will

- Ensure that management of laser safety meets the requirements as set out in University policy and associated arrangements;
- Ensure that a Laser Safety Officer (LSO) is appointed, where laser work is undertaken, in line with UoN procedures for appointing safety critical roles;
- Support any decisions taken by the Laser Safety Officer (LSO) regarding suspending work due to unsafe practices;
- Ensure that the LSO has sufficient training, experience and knowledge, as well as time and resources, to enable them to assist in undertaking the measures required to meet relevant statutory and University provisions;
- Ensure that no laser work is undertaken prior to appropriate university approval;
- Require that new facilities and modifications are notified to the LSO for approval;
- Ensure that adequate resources are allocated to the management of laser safety;
- Ensure that internal safety monitoring is in place in accordance with this policy and ensure reports from the LSO are considered by the local health and safety committee;
- Consider any laser risk implications of strategic decisions such as new projects and multidisciplinary facilities;
- Ensure any significant accident, incident or enforcement action is appropriately investigated and support the implementation of improvements.

Principal Investigators / Line Managers / Facility Managers will

- Ensure that the safety management of laser systems under their control, meets the requirements of University laser safety policy and associated arrangements;
- Ensure that any new or modified Class 3B or 4 laser systems or facilities are notified to the LSO, and the LSO has carried out a laser survey with any recommendations being actioned ;
- Ensure that the appropriate health and safety documentation is provided to the local LSO;
- Ensure that appropriate risk assessments are in place and approved by the Health and Safety Department before commencing work. In particular, ensure that any open beam working with Class 3 or 4 lasers that has not been eliminated by engineering means, has been suitably justified and approved by the LSO/ULSA;

- Ensure laser risk assessments are monitored and reviewed regularly in line with University policy;
- Lead by example e.g., be involved in health and safety inspections;
- Ensure suitable and sufficient training and supervision related to the work being carried out with the laser system is completed and recorded; in accordance with UoN Policy and local arrangements;
- Where health and safety is being compromised, suspend the activity pending a further assessment and notify the LSO in the first instance;
- Report any significant failings relating to the local laser system risk assessment process to senior managers and LSO;
- Ensure any defects in infrastructure are reported to local management or Estates as appropriate;
- Investigate any significant accident or incident occurring in their group's activities

University Laser Safety Advisor will

- Be the appointed competent advisor for all matters relating to laser safety at the university;
- Advise on laser safety management, policy and arrangements for the university, including
    - Laser risk assessments and SOPs;
    - Training and competency of laser workers;
- Provide advice on laser safety for higher risk laser systems and experiments;
- Contribute and provide advice to the university Laser Safety Committee;
- Participate in monitoring activities (inspection and audit) for laser safety;
- Where health and safety is being compromised, suspend the activity pending a further assessment;
- Support the investigation of serious incidents related to laser activity;
- Support any enforcement visits related to laser activity;
- Provide/approve performance reports to relevant committees

Laser Safety Officers (LSOs) will

- Monitor the local management of laser safety to meet the requirements as set out in university policy and associated arrangements;
- Attain and maintain their competence by attending appropriate internal or external training in line with university requirements;
- Inform the Health and Safety Department of any new laser facilities where Class 3B and/or Class 4 lasers will be operated;
- Monitor that new, modified or relocated laser systems are registered and notify the Health and Safety Department of any new Class 3 or 4 lasers systems coming into use and new facilities being set up for such systems;
- Carry out surveys of new, modified or relocated laser systems, reviewing that appropriate laser risk assessments and where relevant, satisfactory justification of any open beam working with Class 3 or 4 lasers, are in place;
- Ensure that the inventory of laser systems held by the Health and Safety Department is kept up-to-date and accurate;
- Advise and support on laser safety training for new laser users and ensure that training records are robustly kept in accordance with university policy;

- Carry out annual laser surveys to monitor and review the quality of laser risk assessments, the justification of any open beam working with Class 3 or 4 lasers and the implementation of the required control measures;
- Participate in monitoring undertaken by the Health and Safety Department;
- Report on laser safety to their BU Safety Committee and highlight significant failings, incidents, etc. to senior management;
- Provide support and technical input in the investigation of any significant accident, incident or enforcement action relating to laser safety and report to the BU's senior management;
- Where health and safety is being compromised, suspend the activity pending a further assessment.
- (The ULSA and/or Health and Safety will assess systems owned by the LSO to avoid a conflict of interest.)

Laser Users (Staff and Students & other workers) at the University will

- Comply with all laser safety policies, arrangements, risk assessments and standard operating procedures, both at university and local level;
- Complete the university's introductory training course on the Safe Use of Lasers as well as any other relevant training to the laser systems they will be using;
- Ensure they have been registered formally as a laser user;
- Implement all safety control measures identified for their work and use personal protective equipment as directed by the local risk assessment and procedures;
- Report any accidents or near misses to their supervisor/manager;
- Report any shortcomings or defects with laser safety control measures to their supervisor/manager.

Occupational Health will

- See management-referred laser workers where the individual has been advised through their own medical practitioner to seek advice from them. There is no legal requirement for health surveillance of laser workers.

5. Definitions and Laser Classification

Definition of a Laser Product

A laser product is a system or piece of equipment, commercially built or not, containing one or more lasers connected for a single application or process, i.e., lasers that are running simultaneously on the same experiment (e.g., pump laser and main laser).

A laser product will usually be certified with a laser class by the supplier (see class definitions below). **The user cannot change the classification of a laser product.**

There is more than one laser product if the lasers are operating and performing independent tasks/experiments, whether it is in the same area or not.

Definition of a Laser System

A laser system is an individual piece of equipment that it **capable of lasing**. A system may contain some of, or all, the following:

- A gain medium;
- A pump source;
- A laser cavity;
- An output coupler

Definition of a Laser Controlled Area

A Laser Controlled Area is an area **or** room where one or more Class 3B and/or Class 4 lasers are in use. Signage is mandatory at the entrance to the area/room, or on the enclosure. (See Laser signage document – links in Associated Documents section.)
Note: The Laser Controlled Area may not be a full room and may simply be the inside of an interlocked enclosure which contains Class 3B/4 lasers.

Maximum Permissible Exposure Levels (MPE)

Maximum Permissible Exposure levels are those levels of laser radiation to which, in normal circumstances, persons may be exposed without suffering adverse effects. They are based upon biological data collected to date.

Laser Classification

It is a requirement of the laser manufacturer to provide the correct classification of a laser product. This classification is based on a combination of output power(s), pulse duration, and wavelength(s) of the accessible laser radiation over the full range of capability during operation.

Laser Classes

Lasers are grouped according to ability to do harm, the higher the number the greater the harm. The eight laser classes are: **1, 1M, 1C, 2, 2M, 3R, 3B and 4**. A brief description of each is given below.

Class 1

Laser products or systems limited to a maximum power of 0.39 mW for CW (Continuous Wave) visible lasers. The power limit can vary greatly for pulsed lasers and lasers operating outside of the visible region of the electromagnetic spectrum. No specific safety controls are required.

A **laser system** that does not meet the requirements for Class 1 may still operate as a Class 1 **product** if the system is fully interlocked with high-integrity enclosures and uses fail-safe interlocks. Please note that if access panels to a totally enclosed system are removed for servicing, etc., the laser system is no longer operating as a Class 1 product and additional precautions will be required, particularly in open laboratory environments.

Class 1M

Any product or system which operates with a large diameter or widely divergent beam (wavelength 302.5 – 4000 nm) whose total output is in excess of that normally permitted for Class 1 lasers but because of their very low power density do not pose a hazard in normal use.

Class 1C

Any laser product or system which is designed explicitly for contact application to the skin or tissue. Protection measures must be in place to prevent accessible emission of radiation above the Class 1 threshold.

Class 2

Laser products or systems limited to a maximum output power of 1 mW or 0.001 W (Continuous Wave) with a wavelength in the visible range 400-700 nm. Once again, this power limit varies greatly for pulsed lasers, so the above numbers cannot be assumed for all lasers.

The MPE cannot be exceeded in less than 0.25 seconds. The natural aversion response (blink response) protects from an eye injury. Repeated, deliberate exposure to the laser beam may not be safe.

Class 2M

Laser products or systems with a large diameter or widely divergent beam in the visible range 400-700 nm. Only a small part of the whole laser beam will be able to enter the eye, by design, and this is limited to 1 mW, like Class 2. These products could be harmful to the eye if the using magnifying optical instruments to view the beam.

Class 3R

Visible and CW laser products or systems that may have a maximum output power of up to 5 mW. The power limit varies greatly with pulsed lasers and/or those operating outside of the visible region.

Lower risk than 3B, but direct viewing of the beam is potentially hazardous. The laser beams exceed the MPE for accidental viewing but practically, the risk of injury in most cases is relatively low for short and unintentional exposure because of the natural aversion response (blink response). This becomes a higher risk if the laser beam operates outside of the visible region.

Class 3B

Visible and CW Laser products that have an output power of up to 500 mW (0.5 W). The power limit varies greatly with pulsed lasers and/or those operating outside of the visible region.

Direct viewing of Class 3B laser beams is always hazardous. Specular reflected beams may also be harmful to the eye. Diffuse reflected beams are usually safe to the eye.

Class 4

Visible and CW Laser products that have an output power greater than 500 mW (0.5 W). The power limit varies greatly with pulsed lasers and/or those operating outside of the visible region.

Their use requires extreme caution.

There is no upper restriction on output power. Viewing a direct beam or a reflected beam is always harmful to the eye and skin. Diffusely reflected beams should be assumed harmful to the eye or skin unless proven otherwise, both scattered and reflected beams can present a fire hazard.

6. Laser Procurement, Registration and Risk Assessment

To comply with the Artificial Optical Radiation Regulations and other legislative requirements, all laser work must be managed in such a way as to ensure the health and safety of those carrying out the work and others who may be affected by the work. See flowchart for an overview of the Laser Procurement, Registration and Review Process.

Ahead of the purchasing of any laser system or product which contains a >Class 2 laser, guidance shall be sought from the LSO on the suitability of the plans for the prospective laser equipment and experiment. Due diligence checks must be undertaken to ensure that any equipment to be purchased is compliant with relevant British legislation and standards and is safe to use. The Principal Investigator (PI), or prospective owner of the equipment shall be responsible for the equipment being safe to use as well as all necessary engineering controls, such as interlocks, laser warning lights, etc. **The PI shall be liable for any further costs in ensuring the safety of the equipment should it not arrive in a state whereby it is safe to use**. This extends to any additional costs related to safety, such as the purchasing and maintenance of necessary specialist PPE, such as laser safety eyewear.

Prior to use of any laser systems or products which operate >Class 3R, the laser shall pass through a formal registration and approval system. The laser must be registered through the Health and Safety Department, surveyed by the LSO and suitably risk assessed – see Arrangements for further details. The risk assessment must be formally reviewed by PI, LSO and potentially the Health and Safety Department before any work may begin. For laser products or systems that are Class 3R or below, please see "Application of policy to low-risk laser experiments".

All laser work is subject to a suitable and sufficient assessment of the risks (see the university Policy and Arrangements for Risk Assessment). The risk assessment shall take into account the hazards related to the laser radiation itself, as well as other "non-beam hazards" that arise from the laser experiment, e.g., electrical, mechanical, chemical, etc. If there are hazards risk assessed outside the Laser Risk Assessment, those other risk assessments must be clearly referenced, e.g., COSHH assessments may be recorded separately.

The risk assessment must be recorded, and the level of detail included must be proportionate to the complexity of hazards involved in the experiment.

The assessment must be reviewed in line with university risk assessment policy, i.e. routinely every 2 years and whenever there are changes to the experiment that alter the hazard profile and risk.

Consideration shall be given to risk assessing scenarios that involve external engineers or workers performing open-beam work on university systems on site (See Maintenance and Servicing section below).

Lone Working

Any form of lone working involving lasers must be considered as part of the risk assessment, and suitable controls must be identified and implemented to mitigate potential risks to the worker.

Application of policy to low-risk laser experiments

For laser **products** classed as 1 or 2 at purchase, but contain a >Class 3R laser system, the PI should ensure, ahead of first use, that any prospective users cannot accidentally or easily access the beam during normal use. Lasers that are purchased as 3R must initially be surveyed by the LSO, but do not need to be registered, and annual surveys are not required.

If the above statement is true and/or the laser **system** is Class 1 or 2, then it is not necessary to follow the formal laser registration or monitoring processes. Such systems are thus exempt from:

- Formal registration with the H&S Department
- Specific Laser Risk Assessment (a standard activity risk assessment can be used)
- Laser survey
- Monthly checks (as there will be no safety-critical features involved)

For laser products that are purchased at Class 3B or above and are only ever operated in a totally enclosed manner due to controls **applied by the university**, these may also be covered by a standard activity risk assessment and, if no safety critical features are involved, the monthly checks do not need to be carried out. **They should still be formally registered** with the H&S Department and a laser survey be carried out to confirm the safety of the set up.

Laser Safety Calculations

The hazards related to open-beam use shall be fully quantified with laser safety calculations. Calculations must take into consideration of exposure to the eyes of the laser worker. All Class 4 lasers will be considered as an exposure risk to the skin.

All calculations shall be evidenced within the risk assessment, whereby all the calculations presented must be performed using the university-procured software. (see Arrangements section below).

Open Beam Working with Class 3 or 4 Lasers

Open beam working must be avoided where reasonably practicable to do so. Where it cannot be avoided, it must be fully justified as part of the risk assessment process. The justification of open-beam work shall be discussed with the LSO and must undergo review by both the LSO and Health and Safety department before work can proceed.

In certain situations, peer review via members of the Laser Safety Committee can be instigated by the Health and Safety Department.

Standard Operating Procedures

It is expected that a written standard operating procedure (SOP, university template available) will be drawn up for each laser experiment involving Class 3 and 4 lasers in LCAs (Laser Controlled Areas). Where more than one laser system is in use, the procedures should be expanded to cover the precautions in place for the whole area. SOPs must be available locally and laser users must be trained in them. See Training, Competency and Supervision section below.

7. Experiment Set-up / Controlled Laser Area and In-house Design, Construction & Modification of Laser Systems

Setting up new experiments or new Laser Controlled Areas must be subject to an assessment of health and safety hazards to ensure the design is appropriate to the nature of the work and is compatible with any other nearby activity. Compliance with the Artificial Optical Radiation Regulations must be taken into account in terms of designing the experiment in such a way that exposure to harmful laser beams is eliminated or, if not deemed reasonably practicable to eliminate, is suitably managed by engineering control measures.

A Laser Controlled Area can be defined as an area in which lasing activity must be suitably controlled to prevent exposure to potentially hazardous radiation. This could be either a full lab area or a suitably designed compartment. Design of laser controlled areas must *consider* light tightness of the room or enclosure (e.g., window coverings, door entry, enclosure entry), surfaces (e.g., reflective wall cupboards) and access control (interlocking of entrances), signage and emission indicators. See further detail in the Guidance section.

Anyone involved in the designing, constructing or modifying of laser systems must be competent to do so and aware that there are several legislative requirements to comply with:

- Supply of Machinery (Safety) Regulations 2008
- Provision and Use of Work Equipment Regulations 1998
- Electrical Equipment (Safety) Regulations 2016

Each item of in-house designed and constructed equipment must be accompanied by information about the design, manufacture and safe operation of the equipment. Such information is often referred to as a technical file and it should be assembled by a competent 'responsible person,' including following as relevant to the set-up:

- Description of the apparatus, usually accompanied by block process diagram
- General Arrangement drawing
- Wiring and circuit diagrams
- Description of control philosophy / logic
- Identification of Essential Safety Requirements ESR's associated with the equipment
- Description of function and operating parameters of any safety devices provided.
- (Description of critical operating pressures, temperatures, speeds etc. if applying)
- (Datasheets for critical sub-assemblies and relevant fluids, gases etc. if applying)
- List of any specific standards applied
- Records of risk assessments and assessments made against specific standards
- Copies of relevant test reports

- Copies of quality control & commissioning procedures
- Copy of instructions (user, maintenance, installation)

In addition, a PUWER risk assessment must be completed, a template is available from the Health and Safety Department.

8. Training, Competency and Supervision

Training, the attainment of competency, and the level of supervision required for laser work must be identified and conducted and recorded in accordance with the university policy for training and supervision.

The following training and competencies are required under this policy:

Role	Expected minimum experience and training
University Laser Safety Advisor (ULSA)	Significant practical experience in working with Class 3B and 4 laser systems. Ideally experience in the LSO role. Will be expected to undertake appropriate certified training as identified by the Health and Safety Department plus internal training regarding the university's laser safety arrangements.
Local Laser Safety Officer (LSO)	Appropriate practical experience working with the classes of lasers typically used in their Business Unit. Will be expected to undertake appropriate certified training as identified by the Health and Safety Department plus internal training regarding the University's laser safety arrangements. Completion and certification of the university *Introduction to Safe Use of Lasers*.
Principal Investigators (PIs) working/managing laser systems	Appropriate scientific and lab experience, completion of the university *Introduction to Safe Use of Lasers* (eLearning) for Class 3B and 4 systems/products. Knowledge of local arrangements for the safe management of lasers (typically via LSO).
Laser Users	For users of Class 3B and 4 systems/products, completion and certification of *Introduction to Safe Use of Lasers* eLearning must be completed. Local induction and training specific to laser systems being used must be undertaken. Re-certification via eLearning course must be completed every 3 years.
	For users of low-risk systems that are not covered by the above statement, the *Laser Safety Awareness* Moodle course must be completed and refreshed every 3 years.

Records of all training and instruction shall be kept at university level (by Health and Safety Department) for both the ULSA and LSO and at Business Unit level for PIs and laser users. (See Arrangements section for further detail.)

The university has a duty to ensure workers are competent to carry out their work tasks and where competency has not been attained, appropriate supervision must be in place. The user's manager /supervisor is responsible for managing this.

Refresher training for Laser users

All users and persons that oversee the use of lasers shall undertake the Introduction to Safe Use of Lasers eLearning course. Completion of the course (and suitable experiment-specific induction and training) will allow a laser user a 3-year period in which they may perform laser work. After this period, the user shall refresh their training by retaking the course (new certificate as evidence).

Laser users who have had an extended time away from practical laser work are expected to refresh their training before recommencing practical work. The training records of each user shall be reviewed on a yearly basis by their manager/supervisor, and elements that have not been undertaken by the user for at least 6 months shall be identified, refreshed and competency-attainment documented.

9. Monitoring and Inspection

To ensure high standards of laser safety are maintained, monitoring and inspections are to be carried out in all areas in line with the University's policy for this. Monitoring must be carried out at both business unit and university levels, records of monitoring must be kept, and the responsible person must ensure that actions are being followed up and completed.

Laser workers shall inspect all safety critical devices (including interlocks, shielding, eyewear, etc. before use.

A formal check of functionality and condition of all safety-critical equipment, as well as laser safety eyewear, shall be performed and documented at least monthly.

Annual laser surveys are required for Class 3B and 4 laser systems unless involving commercially certified Class 1 or 2 equipment that is totally enclosed and interlocked. Any equipment that is purchased at >Class 3R but has retrofitted controls installed that prevent the user accessing the beam are still subject to annual laser surveys.

The Health and Safety Department, in conjunction with the University Laser Safety Advisor will also undertake monitoring, either in the form of annual reviews or periodic in-depth audits.

See Arrangements section for further detail on monitoring.

10. Accidents and Incident Reporting

Eye Injury

It is important for laser users to know what action they must take if they suffer or suspect they have suffered an eye injury as a result of their laser work. The procedure must be available locally and included in any training.

If eye injury as a result of exposure to the eye is suspected, the individual should attend the Queen's Medical Centre eye casualty unit for assessment and treatment as soon as possible after the event.

The University also has an arrangement with a consultant ophthalmic surgeon at QMC who will see within 24 hours anyone suffering a laser injury. This should be arranged via Occupational Health (Ext. 14329).

Skin Burns

Skin burns, i.e., thermal burns, can be treated in the same way as other burns. A local first aider should be contacted in line with BU procedures.

Incident reporting

Any suspected or confirmed injuries should be reported on the university's on-line incident reporting system for record keeping purposes and for investigation by the relevant PI and LSO and also, if appropriate, the University Laser Safety Adviser and Health and Safety Department. All incidents will be investigated with the aim of identifying lessons learnt and preventing similar occurrences in future.

In addition to actual injury incidents, it is expected that near misses are also reported and investigated with the aim of minimising the risk of a future injury.

11. Occupational Health and Eye Health

There is no statutory requirement for health surveillance of laser workers. However, if a user has concerns regarding their eye health, perhaps because of existing conditions (e.g., cataracts, macular degeneration, hyper-sensitivity to light, pterygium, retinitis pigmentosa) or a previous laser-related eye injury, they should take advice from their GP and, if still concerned, notify their supervisor who can then refer their details to Occupational Health for review.

12. Emergency Procedures

Any emergency actions in relation to the safe use of laser systems must be in writing and laser workers trained in the action to be taken, e.g., in the case of a laser eye strike, critical equipment defect/breakdown, chemical exposure/spillage.

Emergency action cards (grab cards) must be in place and nearby the experimental set-up. Action cards shall contain information about the laser energy/power and wavelength, and these should be carried by the injured person and presented to the healthcare provider in the event of an emergency.

Priority must be given to keeping workers safe over equipment and premises and emergency procedures should be practiced.

It may be appropriate to have emergency stop buttons in place.

If equipment is to be left unattended, particularly out of hours, emergency contact details and other relevant details must be provided.

13. Maintenance and Servicing

Equipment maintenance promotes its correct and safe function and extends its useful life. The BU is responsible for ensuring that all infrastructure in connection with laser setups, door interlocks, emission lighting, interlocking is checked and maintained to enable safe use of the laser system.

Maintenance and servicing must only be undertaken by competent and authorised individuals, whether they are internal workers or contractors. Where high class (3B and 4), open beam lasers are being worked on and are potentially powered up, only authorised and trained workers may be present in the area.
For Class 3B and 4 systems that in normal use are totally enclosed but may be accessed during maintenance or servicing, all those except for the competent person carrying out the maintenance or servicing must be excluded from the area.

When employing third parties to undertake work, managers/ experiment owners must ensure the third party is inducted in the local safety procedures and make due diligence checks of their competence to undertake the work. The responsible person shall confirm that the documentation and controls to be employed by the third party are suitable and sufficient and must initiate a transfer of control of the area/room to the third party, with both sides signing the Transfer of Control form prior to the maintenance/ servicing work starting.

Following completion of the work, the third party shall reinstate all safety controls, and the responsible person will confirm that the equipment/area is safe to operate. Control of the equipment/area can then be transferred back to the responsible person.

14. Disposal of Laser Equipment

Owners of laser equipment are responsible for ensuring safe disposal of laser equipment at the end of its life. There must be consideration of the hazards inherent to the item. If suitable for disposal in a Waste Electrical and Electronic Equipment (WEEE) skip, ensure key control and power cables are removed. If there are any chemical hazards, then the item is likely to require specialist waste disposal.
Seek advice from the supplier, if known, or the Health and Safety Department.

15. Arrangements – University Level and Local (BU) Level

University Level

Appointment of Laser Safety Roles

University Laser Safety Advisor

The Director of Health and Safety will formally appoint the University Laser Safety Adviser (ULSA) to undertake the duties specified in the Laser Safety Policy. The appointee will be expected to attend the training identified by the Health and Safety Department as part of their appointment. They must also gain a good working knowledge of the university's Laser Safety Policy and arrangements through a formal training with the Health and Safety Department.

Laser Safety Officer

Each business unit operating non-office-based laser systems must appoint a Laser Safety Officer (LSO). LSOs are expected to attend a formal Laser Safety Officer Training course. The Health and Safety Department hold the details of the current training provider and will supplement this with an induction for new appointees on the university's arrangements for laser safety. LSOs will undertake the duties specified in the Laser Safety Policy.

Laser Safety Consultation

The university has a Laser Safety Committee (LSC) which meets three times per year. Membership is made up of the Health and Safety Department representative, the University Laser Safety Advisor and the Laser Safety Officers. The LSC has formal terms of reference.

Key points will be fed back to University Health and Safety Committee and University senior management through the Annual Laser Safety Report and updates from each LSC meeting.

The LSC has the remit for setting and reviewing laser safety policy and guidance, for discussing any laser safety issues of general application in the University and for reviewing any laser incidents. It will also be the forum for peer review of high-risk laser work where this is identified by members as needing additional consideration or where it would be beneficial for examples of good practise to be shared.

Laser Safety Training

Suitable training for the ULSA and LSOs will be identified by the Health and Safety Department and will be notified to each new appointee for them to organise attendance.

The Health and Safety Department provides two introductory training courses on the safe use of lasers. The training requirements table in Section 8 states the training requirements for users.

Business units are responsible for providing specific training on the systems their users will be operating.

Records of Training

All training must be recorded on a suitable form, including an indication of the user's competence to work with specific lasers. Records of training shall be reviewed on a yearly basis, and refresher training should be identified, carried out and acknowledged by the manager/supervisor of the laser user – this should be clearly documented.

Laser Systems Administration

Registration of, and Notification of, changes to Laser Systems

For an overview of the Laser Procurement, Registration and Use Process, please refer to the process flowchart

The Health and Safety Department (HSD) maintains an inventory of Class 3B and 4 lasers kept at the UK campuses. To enable this, the owner of the laser experiment must notify the HSD of all such systems using the online **Laser Registration Form**. This is used for notification of the acquisition and intention to use new lasers.

After a laser has been registered, a laser survey must be completed by the LSO (see below), and the experiment risk assessed. These completed documents must be sent to the Health and Safety Department for approval through the **Laser Registration Modification form.**
Where laser systems are moved, significantly reconfigured, disposed of, or switch ownership, the HSD shall also be notified through the **Laser Registration Modification form**.

The HSD and LSOs, together, will maintain records of laser systems for the university. The LSO should liaise with the responsible laser users within their BU to ensure the laser system records for their BU remain up to date.

Registration of Class 1 and 2 lasers and lasers contained within office equipment, e.g., laser printers, CD Rom drives and laser pointers (if <Class 3B) is not required by the University. However, records may be kept by the BU. These can also be registered through the Laser Registration Form.

Lasers that are purchased as Class 3B or above but are then modified to operate as Class 1 or 2 products shall be registered with the University prior to first use.

Laser Surveys

Alongside completion of the Laser Registration Form, it is expected that the Principal Investigator (or other equivalent person responsible for the laser system) will notify the Laser Safety Officer (LSO) of all new lasers prior to them being put into use for the first time. The LSO will then complete a Laser Survey for all systems or products operating at 3R or above, using the University template.

The Laser Survey involves checking the implementation of control measures, particularly those relating to justified open-beam work and the completion of any outstanding actions. It also presents an opportunity to routinely review whether new products or ways of working can be implemented to further improve the safety of a system. The survey shall be completed ahead of the first use of the laser, and then yearly (except for 3R lasers), or upon significant changes to the experimental setup - see Monitoring for Annual Laser Surveys

The responsible person will submit the survey form to the Health and Safety Department via the Laser Registration Modification form and may only begin work after receiving confirmation of approval (and after the risk assessment is approved, see below).

Risk Assessment Process

The University has a specific Laser Risk Assessment form for recording a suitable and sufficient assessment of laser systems or products operating >Class 3R. This must be completed prior to first such systems/products. Guidance for filling in the form is given within the document.

For low-risk systems, please see "Application of policy to low-risk laser experiments".

In the Laser Risk Assessment, consideration shall be given to:

- Quantification of Laser hazards – see Laser Safety calculations below
- Qualification of **significant** hazards to the user, and the controls in place to mitigate the risks.
- Justification of why full enclosure cannot be attained, if applicable.
- Personal protection equipment (PPE) required (with suitable evidence provided)
- Any additional requirements (First aid, waste handling, emergency procedures, etc.)
- Training and Competence
- Lone Working, if applicable.

The risk assessment is to be completed by a person who is knowledgeable about the experimental hazards, and it must be approved by the responsible person, usually the Principal Investigator. It must then be submitted and reviewed by the LSO and Health and Safety Department through the **Laser Registration Modification form** ahead of any work beginning. Local review of the risk assessment shall occur at least every 2 years, or upon a significant change to the experimental set-up, such as relocation, introduction of other hazards, change of ownership, etc.

Laser Safety calculations and LaserBee

During the risk assessment process, consideration shall be given to quantifying the risk of both direct and indirect laser strikes to eyes **and** skin.

For all class 3B and 4 lasers in which a degree of open-beam work is expected, a series of calculations shall be performed to detail the maximum permissible exposure (MPE) for the given laser system, as well as the degree by which the laser system exceeds the MPE.

In circumstances where open-beam work is required, calculations shall also be performed to indicate which laser safety spectacles should be worn. Identified eyewear must conform to the British Standard EN 207 and should be selected based upon the LB rating and **not** optical density (OD).

The University has procured a laser safety calculation package which laser workers shall use to perform these calculations. Guidance on both Laser Safety principles and using LaserBee to perform Laser Safety calculations is located on the Laser Safety subsection of the Health and Safety website. Evidence of performed calculations must be available upon inspection by the LSO or ULSA/ Health and Safety Department.

Summary of Paperwork to be completed prior to first use of a laser system:

Paperwork	Submission Method	Laser Class required for	Level of Approval Required
Laser Registration Form	University Laser Registration form.	All lasers	≤ Class 3R – LSO only (if requested)
			> Class 3R - LSO + Health & Safety Department
Laser Survey Form	University Laser Registration Modification form.	3R, 3B, 4	LSO only
Laser Risk Assessment	University Laser Registration Modification form.	3B, 4	Review by LSO and Health & Safety Department
Task Risk Assessment	University Activity Risk Assessment form	3R and below	PI only

Laser User Registration

All users of Class 3B and above lasers systems/products are required to formally register as a laser user before they begin work with lasers. This process involves the user completing the Safe Use of Lasers eLearning course, passing the test associated with the course, and then completing the registration form and attaching the certificate. The application will then be passed to the PI and LSO for review.

The Laser User Registration Form includes a checklist to ensure that the user has obtained full information on the risks involved in their work and the procedures adopted to control them. The laser user must be provided with:

- University and Local laser safety documents
- The risk assessment(s) and procedures relevant to the laser systems they will be working with
- The MPE calculations relevant to the laser systems they will be working with and, where applicable, instructions on the use of appropriate personal protective equipment.
- General laser safety training (i.e., university eLearning course) and specific training relevant to the laser systems they will use.

The certificate will expire after 3 years. Should the user want to continue practical laser work, they must repeat the above procedure.

Third parties and transfer of control

Prior to any work on site on **equipment containing Class 3B or 4 systems,** being carried out by third parties, a Transfer of Control form must be completed for each case.

The responsible person is required to coordinate with the third party, prior to work commencing, and to complete the **Transfer of Control Form**. Transfer of control involves the responsible person ensuring that they have received a suitable risk assessment and method statement from the third party and ensuring that the correct controls are in place to protect university personnel from any primary beam and non-beam hazards that may be prevalent as a result of the third party's work.

After the work is complete, the Laser Controlled Area shall have the safety features reinstalled by the third party, and they must declare on the Transfer of Control form that the area is safe for university personnel to re-enter. This must also be checked and confirmed by the responsible person. Only after both the third party and responsible person are satisfied, may any work continue.

Advice and Support

The University Laser Safety Advisor, in conjunction with the Health and Safety Department, will support LSOs and laser workers with advice in relation to laser safety, particularly in relation to higher risk laser systems (open beam work involving Class 3B and 4 lasers).

Monitoring laser safety standards

University level

The Health and Safety Department will monitor the implementation of the University's policy and guidance on laser safety. Each Business Unit operating Class 3B and/or Class 4 laser systems/products will be visited for review of laser safety arrangements and inspection of selected systems. This will be carried out by the University Laser Safety Advisor, a representative of the University Health and Safety Department and the LSO. In terms of frequency, this will be annual for higher risk locations (operating open beam Class 3B and/or Class 4 systems) and biennial for lower risk locations (totally enclosed 3B/4 and other Classes).

The inspection team will examine the premises and equipment to establish if they are fit for purpose, examine relevant documentation such as risk assessments, SOPs and Codes of Practice, and discuss laser safety with workers and, if possible, observe them working. The opportunity to check that engineering controls and PPE are used correctly will be taken. In addition, scope for further improvements on existing systems will be considered in relation to aiming for the highest level of control that is reasonably practicable to achieve. There will be particular focus on new systems and those that have been significantly modified or involve new facilities.

The main purpose is to establish whether standards "on the ground" match university policy and local arrangements, risk assessments, procedures, and the reasons for taking precautions are understood by the workers.

A written report will be submitted by the HSD representative to the LSO. The report will include details of any issues highlighted, the remedial actions required, who is responsible for taking action and the timescale within which the actions must be completed. The LSO must coordinate with colleagues to ensure remedial actions are carried out and must report to their local Health and Safety Committee.

Business Unit Monitoring

Safety Critical Checks:

For all Laser Controlled Areas, the responsible person shall ensure a check of the safety critical features is completed and documented at least monthly. This shall be performed using the **Monthly Laser Safety Checks form** and should be completed and stored locally, and available upon request.

Safety critical checks involve performing inspections on the quality, availability, and suitability of any locally used laser safety eyewear, as well as testing the functionality of equipment such as laser warning lightboxes, door interlocks, etc.

This task can be delegated and performed by suitable workers within the lab at the discretion of the responsible person.

Laser Survey

The Laser Survey Form is the standard record form for local level monitoring.

A new survey should be carried out by the LSO for every new laser system or when there are significant changes to an existing experiment. When no changes have been carried out, it is sufficient for the existing survey to be updated with a simple statement such as "survey checked 3rd July 20xx, no changes made or required" and for it to be signed by the LSO.

The updated survey form shall also be submitted by the responsible person to the Health and Safety Department through the Laser Registration Modification form.

It is the responsibility of the appropriate PI/Manager to address any issues recorded in the survey. The LSO has the authority to recommend to the Head of BU that the use of a certain facility should cease until remedial action has been taken.

The LSO will carry out a further check on any laser system/experiment where issues have been identified no later than one month after the date of the original survey - and should the issues still exist, the LSO will again advise the Head of BU, who may choose to close that area to further research work until appropriate action has been taken.

16. Laser Safety Arrangements within Business Units

To inform members of the business unit about laser safety policy and arrangements, it is necessary for each Business Unit to have local arrangements. As a minimum, the following template is suggested (modified to suit):

- The (BU Name) implements the University policy for Safe Use of Lasers.
- This local arrangement covers the following:
- Registration of new laser systems/products and changes to existing systems/products
- Training and registration of new laser users
- Carrying out a risk assessment and accompanying standard operating procedures
- Carrying out and recording system-specific training for laser users
- Monitoring standards by carrying out laser surveys for all in-use systems

- Emergency procedures and provision of Emergency Action cards

See the table below for the detail on each point:

The (BU Name) has appointed a Laser Safety Officer (LSO) to oversee its laser safety arrangements and to provide feedback to senior management on the status of laser safety via the BU Safety Committee.

Current Laser Safety Officer: XX

Laser Safety Duties and Requirements		
Task	**Requirements**	**By Whom**
Registration of new laser systems/products **(Class 3B and above)**	▪ An online Laser Registration Form is completed for all new systems and is approved by the LSO and Health and Safety Department for entry into the University database. ▪ The LSO carries out a Laser Survey, and the PI submits this to the Health and Safety department via the University Laser Registration Modification form.	PI/LSO/ H&S LSO/ PI
Registration of new laser users	▪ The laser user completes the University eLearning Laser Safety Introductory Course and the associated test. ▪ The laser user formally registers through the online Laser User registration system and is approved by the PI and LSO. The PI ensures the laser user is suitably training on the usage of the equipment and is aware of all hazards related to the experiment they are to carry out.	PI/Laser User PI/ Laser User/ LSO PI
Risk Assessment and Standard Operating Procedures	▪ The PI ensures that the laser work is covered by an approved suitable and sufficient risk assessment, MPE calculations and standard operating procedures for the different tasks. ▪ The Laser Risk Assessment must be submitted through the Laser Registration Modification form and be formally approved by the LSO and Health and Safety Department prior to first use of the equipment. ▪ The PI ensures that standard operating procedures for the experiment are in place prior to the experiment being used for the first time.	PI PI/ LSO/ H&S PI
Carrying out & recording system-specific training for laser users	▪ The PI ensures that laser users in their research group are provided with sufficient training, instruction and supervision as relevant to the individual's experience and competence for the tasks they need to carry out. ▪ Records of training and competence are kept evidencing the status for each worker in line with the BU requirements for record keeping. (As a minimum this must be a training record similar to the University Training Form. ▪ Gaps in user competence should be evaluated by the PI on a yearly basis (and documented) and suitable refresher training identified.	PI PI PI
Monitoring of laser safety standards	▪ The PI ensures that monthly safety critical checks are carried out, documented and are available locally.	PI LSO

	▪ The LSO carries out an annual laser survey on all active laser systems, i.e., those that are in use or easily put back into use. ▪ An annual (biennial if BU only has low-risk systems) University laser safety inspection is carried out.	Health & Safety Department / Laser Safety Advisor

All queries connected with laser safety should be directed to the LSO in the first instance.

Guidance

17. Precautions in Use

The **AURPO Guidance on the Safe Use of Lasers in Education and Research** provides advice on the precautions recommended for each class of laser (see Summary table below).

The University Activity Risk Assessment form includes guidance on the considerations for the risk assessment section, covering the laser itself, the beam delivery, the laser process and the working environment and non-laser hazards.

The general safety precautions fall into several sections. The headings listed below, should be considered in relation to the system being used and its hazard classification. The aim is to reduce to a minimum the risk of exposure to hazardous levels of laser radiation and other associated hazards, both to the laser user and any other worker who might inadvertently be affected.

1. Use of a remote interlock connector
2. Key control
3. Beam stop or attenuator
4. Warning signs
5. Beam paths
6. Specular reflections
7. Eye protection

Engineering Controls

OPEN BEAM working with Class 3B and Class 4 laser systems

It must be noted by all involved in the safe management of lasers that high powered laser beams should be enclosed as far as is reasonably practicable to achieve. Open beam work needs to become the exception. Enclosing the beam hazard is the priority with regards to optical safety. Where it is felt that total enclosure is not reasonably practicable, robust justification must be recorded in the risk assessment and on the laser survey.

In terms of the hierarchy of control, engineering controls are strongly preferred to administrative controls such as wearing protective equipment, the former are considered more robust and less prone to human errors. In summary, examples of engineering controls are: (more detail is available in Section 5 of the AURPO guidance):

- Access prevention
- Viewing windows
- Remote viewing aids
- Interlocks

- Laboratory Door Interlocks
- Access Panel Interlocks

(More detail is available in Section 5 of the AURPO guidance)

Summary of Precautions by Laser Class

Classification	Class 1	Class 2	Class 3R	Class 3B	Class 4
Local Laser Safety Officer	Not essential		Must be appointed to coordinate laser safety compliance		
Laser Controlled area	Not required			Control of open beams, interlock connected to room or door circuits where appropriate	
Safety interlocks in protective housing	Not required			Engineering control on panels, compartments, etc.	
Key Control	Not required			Remove key when not in use	
Beam Stop or Attenuator/Shutter	Not required			When in use prevents inadvertent exposure	
Beam path (level and termination)	Not required			Terminate beam at end of useful length. Keep open beams above/below eye level	
Beam Enclosure - Open Beam working	No action required		Consider avoiding	Must avoid if reasonably practicable, if not reasonable, justify and increase procedural controls.	
Emission indicator device	Not required			Indicates laser is energised	
Warning signage	Not required			Required on entry doors to rooms/compartments	
Laser labels	Required for all lasers except low power Class 1 (in close proximity if size of laser product does not permit direct affixing				
Specular reflection	No requirements			Prevent unintentional reflections	
Eye protection	No requirements		Required if engineering and administrative procedures not practicable and MPE exceeded		
Protective clothing (skin)	No requirements			Sometimes required	Specific requirements
Laser-specific Risk Assessment and SOP	Not required		Required		
Training	No requirements		Required for all operator and maintenance workers		
Eye examinations	Not required		Not required except after an accident.		

18. Laser Eyewear

Eyewear is the most common and certainly the most important aspect of personal laser protection, wherever there is some risk of laser exposure above the specified MPEs. Protective eyewear does not, however, preclude a full safety evaluation and consideration of all alternative means of

affording protections - such as total enclosure of the beam, interlocks, beam dumps, remote viewing systems. Laser safety glasses are the last line of defence and not a convenient alternative to avoiding any engineering controls that it may be reasonably practicable to implement (see Engineering Controls section above).

Laser safety eyewear incorporates optical filters to reduce the laser radiation to below the level of the MPE, whilst at the same time maintaining a reasonable level of visible light transmission.

The filter damage threshold must be sufficiently high to withstand the maximum possible exposure long enough for appropriate avoiding action to be taken. The absorbance of the filters must be appropriate to the wavelength of the laser(s) used. Clear information must be available to identify the eyewear that is suitable for each laser and whether it is for alignment work or full protection.

There are standards for laser eye protection, BS EN 207 (for full protection – 180 nm to 1 mm) and BS EN 208 (for alignment work – 400 nm – 700 nm) Eye protection should conform to these standards and should be clearly marked to indicate the protection that is provided.

Users are responsible for exercising care in the use and storage of eye protection. These items are expensive and easily scratched, degrading performance and comfort. Any defects must be notified to the user's supervisor and work requiring the defective item should cease until a safe replacement is made.

19. Maximum Permitted Exposure Levels (MPE)

It is mandatory to carry out calculations for each laser system in order to show the factor by which the MPE is exceeded. All laser users should then be made aware of the results to emphasise the hazard associated with the laser system they are using.

The MPE values are dependent upon:

- the wavelength of the radiation
- the exposure time or pulse duration
- the spectrum of wavelengths, when the tissue is exposed to more than one wavelength
- the nature of the tissue exposed
- the angular subtense of the source (which determines the size of the retinal image) in the wavelength range from 400 nm to 1400 nm.

When MPE calculations are carried out the table below can be used to record them. The calculation should be kept with the risk assessment for the laser system.

20. New Set-ups

A list of possible risk reduction measures to consider when designing a new set up or facility (Refer to AURPO guidance for more detail):

Possible Risk Reduction Measures
• A high level of illumination that will minimise pupil size and reduce the risk of stray laser light reaching the retina;

- Covering or suitable blinds and minimal windows where required to protect against inadvertent exposure beyond the laser controlled area;
- Walls, ceilings and fittings painted with a light coloured matt paint to enhance illumination and minimise specular reflections;
- Multiple experiments in a room - consider the number of laser experiments in the room for compartmentation and the additional interlocking that may be required on the access to those compartments;
- Use local enclosure, interlocked where possible;
- Restrict output power for alignment and other operations where full power is not essential. Use low-power devices for alignment or use neutral density filters. For alignment, aim to reduce output power to <1mW. Use remote viewing if an option;
- Use engineering design where possible for intra-beam viewing (see Engineering Controls above);
- Create a screened off area to limit the potential for others to be affected;
- Set up equipment so that laser beams point away from lab entry points;
- Keep beam paths below eye height for the user, as short as possible, optical reflections should be minimised and the beam terminated with an energy absorbing non-reflective beam stop;
- Allow for secure fixing of the laser and optical components to the bench to avoid displacement and unintended beam paths;
- Use coated optical components to eliminate chance of stray reflections, or shroud them so that only the intended beam can be refracted or reflected;
- Allow for suitable and sufficient storage to keep optical benches free from clutter.

21. Resources

Related Guidance

See Associated Documents

Mini-Audit template for self-assessment

In order that Business Units may self-assess their compliance with University policy and guidance for the safe use of lasers, a list of indicators is available as a checklist.

Forms and Systems

1. Online Laser Registration Form
2. Laser Registration Modification Form
3. Laser User Registration Form
4. Laser Survey Form
5. Laser Risk Assessment Form
6. Monthly Safety Checks Form
7. Transfer of Control Form