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Health and Safety

Laser Safety

Policy, Guidance and Management Arrangements

SAF-POL-LAS

Document Control

Document Details	
Reference	SAF-POL-LAS
Title	Laser Safety
Version Number	2
Approval Date	
Issue Date	4 March 2020
Review Date	March 2021
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

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 for Links
Laser Pointers	Information and Guidance regarding selection and use of laser pointers	Approval awaited of updated document
Interlocks	Information and Guidance regarding standards for laser interlocks	https://www.nottingham.ac.uk/safety/documents/laser-interlocks.pdf
Confocals	Information and Guidance regarding the safe use of Confocal laser systems	https://www.nottingham.ac.uk/safety/documents/lasers-confocal.pdf

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Links to:

- Laser Registration Form
 - Laser User Registration Form
 - Laser Survey Form
 - Laser Risk Assessment Form (in draft)
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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.

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, specifically in laboratory and workshop environments. In particular the focus is on the higher 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 would be 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 systems 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 to oversee laser safety at the University.

University Executive Board will

- 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 all health and safety arrangements for laser safety are adequately resourced;
- Seek assurance that risk control measures to ensure laser safety are in place and are being acted upon;
- Seek assurance that those with laser risk management and assessment responsibilities are adequately trained and competent;
- Seek assurance that there is a process for auditing health and safety performance where laser systems are in use;
- 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, policies, 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 Advisor who will be appointed from an appropriate academic discipline by the Director of Health and Safety);
- Will review that any open beam working with the higher classes of laser is suitably managed
- Ensure appropriate oversight for compliance with laser safety regulations and provide reports;
- 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;
- Lead on and coordinate visits by external agencies such as the Health and Safety Executive;
- Provide an annual report and as appropriate, specialist advice to the University Health and Safety Committee;

- Have an oversight of reported incidents concerning laser systems and make recommendations where necessary;
- Maintain an inventory of all Class 3B and 4 laser systems;
- 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;
- Provide advice to the University Health and Safety Committee on all workplace laser hazards;
- Review and approve relevant 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;
- Promote good practice for work with laser systems among all laser users;
- 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 advice on other laser issues as required.

Heads of Business Unit will

- Ensure that local management of laser safety meets the requirements as set out in University policy and associated arrangements;
- Ensure that a local Laser Safety Officer (LSO) is appointed, where laser work is undertaken, in line with UoN procedures for appointing safety roles;
- Ensure that any decisions taken by the local Laser Safety Officer (LSO) regarding suspending work are supported by the Head of Business Unit;
- Ensure that the local LSO has sufficient training, experience or knowledge and 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 local (and if deemed necessary) university approval;
- Ensure 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;
- Review performance of direct reports in terms of laser safety management and use the information to inform future laser risk management planning;
- Ensure any significant accident, incident or enforcement action is appropriately investigated.

Principal Investigators / Line Managers /Facility Managers will

- Ensure that the safety management of laser systems under their control, meets the requirements as set out in University policy and associated arrangements;
- Ensure that any new or modified laser system or facility is notified to the LSO in the first instance;
- Ensure that the appropriate paperwork is provided to the local LSO;
- Ensure that no laser work starts before the LSO has agreed it and recorded a laser safety survey;
- Ensure that appropriate risk assessments are in place and approved 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 suitable justified and approved by the LSO/ULSA.
- Ensure laser system risk assessments are monitored and reviewed regularly in line with University policy;
- Ensure that new facilities and modifications are notified to the LSO for their approval and keep the LSO up to date on the lasers their group has;
- 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

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;
- Maintain an inventory of laser systems for the BU and sync this with the inventory held by the Health and Safety Department;
- Advise and support on laser safety training for new laser users and ensure that training records are robustly kept in accordance with UoN 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 the Health and Safety Department laser safety inspections and audits;
- Report on laser safety to their BU Safety Committee and highlight significant failings, incidents, etc. to senior management;
- Support in the investigation of any significant accident, incident or enforcement action 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.)

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.

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

- Comply with all policies, arrangements, risk assessments and safe 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 control measures used when working with hazardous laser systems.

5. Definitions and Laser Classification

Definition of a Laser System

A laser system is a system containing one or more lasers connected for a single application or process and under the control of a single operator, i.e. lasers that are exchanged on the same system or are running simultaneously on the same experiment (e.g. pump laser and main laser). There is more than one laser system if the lasers are not operating together or are used by different operators although mounted in the same area.

Definition of a Controlled Laser Area

A Controlled Laser 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.

Maximum Permissible Exposure Levels / Exposure Limit Values (MPE/ELV)

Maximum Permissible Exposure levels are those levels of laser radiation to which, in normal circumstances, persons may be exposed without suffering adverse effects. A guide to MPE levels are given in BS EN 60825-1. 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 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.

Laser Classes

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

Class 1

The most limiting MPE values cannot be exceeded and no specific safety controls are required. For CW (Continuous Wave) visible lasers, the maximum limit is 70 microwatts.

Lasers that are safe under reasonably foreseeable conditions of operation, either because of the 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. Class 1 operation cannot be claimed for a product containing an embedded laser of a higher class unless full-interlocked high-integrity enclosures using fail-safe interlocks are incorporated. If access panels to a totally enclosed system are removed for servicing, etc., the laser system is no longer Class 1, additional precautions will be required, particularly in open laboratory environments.

Class 1M

Class 1M is 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 which is designed explicitly for contact application to the skin or tissue, see further detail in the AURPO guidance.

Class 2

Laser products limited to a maximum output power of 1mW or 0.001W (Continuous Wave) with a wavelength in the visible range 400-700nm.

Laser products which produce beams with a large diameter or are widely divergent in the visible range 400-700nm. 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 with a large diameter or widely divergent beam in the visible range 400-700nm. Only a small part of the whole laser beam can enter the eye and this is limited to 1mW, similar to Class 2. These products could be harmful to the eye if the using magnifying optical instruments to view the beam.

Class 3R (Previously Class 3A)

Laser products that may have a maximum output power of 5mW.

The AEL is restricted to no more than five times the AED of Class 2 for visible wavelengths and not more than five times the AEL of Class 1 for other wavelengths.

Lower risk than 3B, but direct viewing of beam 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 behaviour (blink response).

Class 3B

Laser products that have an output power of up to 500mW (0.5W) Continuous Wave and 105 J m⁻² for pulsed lasers (less for ultraviolet wavelengths).

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. Exact duration and distance depends on the power of the laser source. Class 3B products which approach the upper limit for the Class may produce minor skin injuries and there is also a risk of igniting flammable materials.

Class 4

Laser products that have an output power greater than 500mW (0.5W).

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. 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. To enable this, all laser work is subject to a suitable and sufficient assessment of the risks (see the University Policy and Arrangements for Risk Assessment). Given the classification explained above, the priority is with higher hazard lasers (Class 3R, and particular so, Class 3B and 4), particularly where the laser beam is not enclosed.

The risk assessment must apply the standard approach of:

- identifying the key hazards and who is at risk
- evaluating the level of risk
- implementing appropriate control measures to minimise the risk

The risk assessment must be recorded and the level of detail included must be proportionate in relation to the class of laser and how it is being used. The University has a [specific form](#) for recording the risk assessment of laser work - this must be used for any laser work excepting that involving totally enclosed and interlocked equipment (i.e. Class 1 in normal operation) – the standard UoN risk assessment form will be sufficient in such cases. Guidance on completion of the form is incorporated in the form.

Open Beam Working with Class 3 or 4 Lasers – Justification and Approval Procedure

Justification

Enclosing high powered laser beams is the key priority with regards to optical safety and open beam work with such lasers must be the absolute exception.

Once an experiment is set up, it is expected that total enclosure and interlocking will be implemented to eliminate the risk of exposure to harmful laser radiation.

For any other operations (e.g. alignment of laser beams, change of optics), in line with the statutory requirement to eliminate the risk of exposure to harmful laser radiation or to reduce the risk to as low as reasonably practicable, suitable control measures that follow the hierarchy of control (engineering controls rather than administrative) must be implemented and recorded in the risk assessment.

It is expected that by employing suitable engineering controls (see Guidance section below) that the maximum level of exposure is reduced to the level of Class 2/2M or equivalent, where this is not deemed reasonably practicable, a robust justification must be recorded and reviewed by the LSO (see approval section below).

The justification of any open-beam working must be part of the risk assessment and, specifically, Section 3 on the laser risk assessment form prompts this to be recorded. Additional detail, such as MPE calculations, must be attached and a specific [Open-Beam Justification form](#) is available for recording complex justifications.

Approval procedure

Prior to the commencement of laser work involving exposed (Class 3B/4) laser beams, the LSO will review the Laser Risk Assessment and Open-Beam Working Justification at the time of the initial Laser Survey. If satisfied that the open-beam working has been eliminated or is well managed through engineering controls, they may permit work to commence. In any case, where less robust engineering controls, such as use of personal protective equipment are proposed, the LSO must refer the case to the ULSA and H&S Department. The latter will review whether all controls that would eliminate, or reduce by engineering means, the risk of exposure, have been appropriately considered and whether it is acceptable for the open-beam task to take place in the way proposed. The review outcome will be recorded and sent to the LSO and PI. Compliance will be monitored (see section 7 below).

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

Other Hazards

The risk assessment must record consideration of other hazards related to the work, the main ones being:

- Electrical - high voltages
- Chemical/Fume - sample preparations, use of dyes and solvents (apply COSHH Regulations)
- Mechanical - manual handling, trips, slips, noise, vibration
- Optical - open beam paths, misalignment problems, mounting of optics
- Fire - high power, direct and reflected beams
- X-rays/electromagnetic interference

If not included in the Laser Risk Assessment, any other risk assessment must be clearly referenced, e.g. COSHH assessments may be recorded separately.

Safe Operating Procedures

As a result of the risk assessment, it is expected that a written safe operating procedure (SOP) will be drawn up for each laser experiment. In designated laser 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 (templates available). 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 of new experiments or new controlled laser rooms 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.

Design of controlled laser areas must consider light tightness of the room (e.g. window coverings, door 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 a number of 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 a technical file which documents the design, manufacture and safe operation of the equipment. The technical file should be assembled by a competent 'responsible person' and comprise the following:

- 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 UoN 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.
Principal Investigators (PI's) working/managing laser systems	Appropriate scientific and lab experience, completion of the University Introduction to Safe Use of Lasers (Moodle-based course). Familiar with local arrangements for the safety management of lasers (typically via LSO).
Laser Workers	Completion of the University Introduction to Safe Use of Lasers (Moodle-based course) plus local induction and training specific to the laser systems being used.

Records of all training and instruction must 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 workers. (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 worker's line manager is responsible for managing this.

9. Monitoring and Inspection

In order to ensure high standards of laser safety are maintained, the University policy is to carry out monitoring and inspection in all areas in accordance with the UoN monitoring and inspection policy. 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.

Annual laser surveys are required for Class 3B and 4 laser work unless involving totally enclosed and interlocked equipment (Class 1 in normal operation). 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 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

Action to be taken in case of suspected eye exposure to a laser beam -

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 Advisor and Health and Safety Department. All incidents will be investigated with the aim of identifying lessons learned and preventing similar occurrences in future.

In addition to actual injury incidents, near misses should also be 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.

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, 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 be internal workers or contractors. Where open beam higher class lasers are being worked upon 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 (deemed Class 1 or 2 in normal use) but may be accessed during maintenance or servicing, all those with the exception of the competent person carrying out the maintenance or servicing must be excluded from the area. (Typically a totally enclosed Class 3B or 4 system may be positioned in a laboratory where non-laser workers are present as there is no risk in normal use.)

When employing third parties to undertake work, managers must ensure the third party is inducted in the local safety procedures and make due diligence checks of their competence to undertake the work (verification of them having risk assessments and method statements).

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

University Level

Appointment of Laser Safety Roles

University Laser Safety Advisor

The Director of Health and Safety, in conjunction with the relevant Head of Business Unit will formally appoint the University Laser Safety Adviser (LSA) 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. The LSA will undertake the duties specified in the Laser Safety Policy.

Laser Safety Officer

Each Business Unit operating non-office based laser systems must appoint a Laser Safety Officers (LSOs). LSOs are expected to attend a 1-day 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 which meets twice per year. Membership is made up of the Health and Safety Department Representative, the University Laser Safety Advisor and the Local Laser Safety Officers.

Key points will be fed back to University Safety Committee and University senior management through the Annual Laser Safety Report.

The Committee 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 LSA 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 MOODLE-based introductory training on the safe use of lasers which is suitable for all new laser users. It is mandatory for those using Class 3R lasers and above. There is a module for general safe use of lasers and one for users of confocal microscopes. (For the users of the lower class lasers (1 and 2), it is acceptable to have local training specific to the experiment being undertaken as long as the hazard and risk are explained, e.g. in low risk UG practicals.)

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

Records of Training

All training must be recorded, including an indication of the user's competence to work with specific lasers.

Laser Systems Administration

Registration of Laser Systems

The University Health and Safety (H&S) Office maintains an inventory of Class 3R, 3B and 4 lasers kept at the UK campuses. To enable this, Business Units must notify the Health and Safety Department of all such systems using the Laser Registration Form. The **registration form** is for notifying the acquisition, change of use/location, or cessation of use of lasers.

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 and complete the Laser Registration Form along with a Risk Assessment (the latter must be in place prior to first use but may not have been finalised at the point of registration).

The LSO will then complete a Laser Survey prior to the system being put into use and will forward the registration form to the Health and Safety Department. Work with Class 3B and 4 lasers may not start until the LSO has confirmed, with reference to the Health and Safety Department if deemed necessary, that the safety arrangements are satisfactory.

The LSO should maintain the records for the BU. The Health and Safety Department will maintain records of laser systems for the University as a whole and will request an annual update from each LSO.

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 2) is not necessary. However, records should be kept by the BU of all other lasers. For Class 1 and 2 lasers this should be a list of lasers and their location. It is not necessary to send this information to the Health and Safety Department.

Summary of Paperwork that must be forwarded to the Health and Safety Department in relation to new laser systems:

- Laser registration forms for lasers of Class 3R and above
- Initial laser survey forms for Class 3B and 4 lasers (see below)
- Initial risk assessments for Class 3B and 4 lasers

Laser Users' Registration

All users of Class 3R and above lasers are required to complete a [laser user registration form](#) before they begin work with lasers. This must be signed off by the individual's PI and the LSO. The forms must be submitted and robust records kept by the LSO. (The Health and Safety Department does not maintain a list of users.)

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. For the higher risk laser systems (Class 3B and 4), 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 Moodle course) and specific training relevant to the laser systems they will use.

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).

Eye Health

There is no statutory requirement for medical surveillance of laser workers but the University has an Occupational Health service to whom laser users, who are concerned about their eye health, can be referred (by their Principal Investigator).

University Monitoring

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 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 and procedures and that the reasons for taking precautions are understood by the workers. Unsafe or unhealthy conditions of work or work practices must be identified and remedial action taken if required.

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

Local Level Monitoring

The Laser Survey Form is the standard record form for local level monitoring. The LSO will carry out laser surveys of each experiment/designated laser area involving Class 3B and 4 laser systems to monitor that appropriate control measures are in place and that the supporting safety paperwork is available and up to date. This will be immediately prior to a new laser system being put in to use and a minimum of annually thereafter.

A new survey should be carried out when there are significant changes. 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.

A copy of the most recent laser survey should be given to the relevant PI/manager and be available near to the laser system it refers to. Heads of BU should be advised by the LSO of any problems that the laser surveys reveal and it is the responsibility of the appropriate PI/Manager to address any such problems. The LSO has the authority to recommend to the Head of BU that use of a certain facility should cease until remedial action has been taken.

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

15. 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 and changes to existing systems
 - 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

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 (Class 3R and above)	<ul style="list-style-type: none"> A Laser Registration Form is completed for all new systems and is sent to the LSO. 	PI/LSO
	<ul style="list-style-type: none"> The LSO registers the system on the BU inventory and carries out a Laser Survey prior to the system being put into first use. 	LSO
	<ul style="list-style-type: none"> The registration form is sent to the Health and Safety Department for review and record on the University Inventory. (Risk Assessment and Laser Survey may be included if completed at that point.) 	LSO
Registration of new laser users	<ul style="list-style-type: none"> The laser user completes the University Moodle Laser Safety Introductory Course and all relevant training for the system(s) they are going to use. 	PI/Laser User
	<ul style="list-style-type: none"> This is recorded on the User Registration form for the PI to approve. 	PI
	<ul style="list-style-type: none"> The form is sent to the LSO for them to maintain a list of current laser users. 	PI
Risk Assessment and Standard Operating Procedures	<ul style="list-style-type: none"> The PI ensures that the laser work is covered by an approved suitable and sufficient risk assessment, MPE/ELV calculations and standard operating procedures for the different tasks. 	PI
	<ul style="list-style-type: none"> The latter documents must accompany the laser registration form or at least be sent to the LSO prior to the first use of the laser so that the LSO knows to carry out the initial laser survey which gives formal approval for the system to be put into use. 	PI
Carrying out & recording system-specific training for laser users	<ul style="list-style-type: none"> 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 to evidence 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. 	PI
Monitoring of laser safety standards	<ul style="list-style-type: none"> 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. 	LSO
	<ul style="list-style-type: none"> An annual (state biennial if BU only has low-risk systems) University laser safety inspection is carried out. 	Health and Safety Department /UoN Laser Safety Advisor

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

Guidance

16. 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 general safety precautions fall into a number of 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 3A/R	Class 3B	Class 4
Local Laser Safety Officer	Not essential		Must be appointed to coordinate laser safety compliance		
Designated laser 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
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.		

17. 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/ELV, 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.

18. Maximum Permitted Exposure Levels (MPE)

It is useful to carry out the calculation 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.

Laser	Wave-length	Pulse Duration	MPE	Beam Diameter	Beam Power	Beam Intensity	Factor by which MPE is Exceeded

Examples of MPE Calculations

19. 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 designated laser 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.

20. Related Guidance

Laser Pointers

For information relating to the selection and safe use of laser pointers, please refer to the more [detailed guidance](#).

Laser Interlocks

For information relating to constructing in-house interlocks for laser systems, please refer to the more [detailed guidance](#).

Interlocks of an appropriate standard clearly present a more robust level of control and in relation to local enclosure of hazardous laser beams, interlocking of enclosure access points is to be implemented wherever reasonably practicable to do so.

Confocal Microscopes

There are reduced requirements in relation to confocal microscopes where the power output at the microscope objective has been shown to be below the Class 3B / 4 range. Please refer to the more [detailed guidance](#).

21. Useful Resources

Links to examples of SOPs

[For Use of Class 3B and 4 laser systems](#)

[For Use of Multi-user Laboratories](#)

[For Undergraduate Projects](#)

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](#).

Ten Golden Rules

This is a list of suggested "do's and don'ts" for laser users to bear in mind when working with lasers. It should help users to work safely (it is not an exhaustive list) and can usefully be displayed locally as a reminder.

Forms

1. [Laser Registration Form](#)
2. [Laser User Registration Form](#)
3. [Laser Survey Form](#)
4. [Laser Risk Assessment Form](#)
5. [Open-beam Justification Template](#)