University Occupational Health and Safety Guidance Note

SAFE USE OF LASERS AND LASER DEVICES

1. PURPOSE

The University is committed to meeting its legal obligations by ensuring that it has adequate arrangements, facilities and trained personnel to reduce the risk of injury or ill health from work activities involving artificial optical radiation hazards.

This document sets out the minimum requirements to control risk associated with work activities involving laser and laser devices at the University of Strathclyde, in order to comply with relevant legislative obligations and University requirements.

2. SCOPE

3. ABBREVIATIONS

AEL	Accessible Exposure Limit
AOR	Artificial Optical Radiation
CAORW10	Control of Artificial Optical Radiation 2010
DLPS	Departmental Laser Protection Supervisor
HoD	Head of Department
LCA	Laser Controlled Area
MPE	Maximum Permissible Exposure
SHaW	Safety, Health and Wellbeing
URPO	University Radiation Protection Officer

4. DEFINITIONS

4.1 Consumer Type Laser Device – is any device which is intended for consumer use, and can be found for sale to the public. Examples include DVD players or laser printers.

4.2 Hazardous Laser – Any laser, where the engineered controls have not been able to reduce the beam that someone may be exposed too to less than the MPE of a Class 2 laser.

4.3 Laser – a device that is designed to emit a beam of coherent, monochromatic light. These beams typically have a narrow divergence over large distances.

4.4 Laser Device – any piece of equipment that contains a laser of any given type, but is of such construction that under normal use, no person is likely to be exposed to laser radiation.

4.5 Laser Controlled area – any area where a Class 3B or Class 4 laser is in use and the engineering control measures that are in place do not entirely remove the risk of persons being exposed to hazardous levels of laser light.

4.6 Non-consumer type laser devices – is any device which is not intended for normal consumer use, even though they may be found for sale to the public. Examples include laser cutters or laser engravers.

5. ROLES AND RESPONSIBILITIES

The University OHS Standard for Roles, Responsibilities and Accountabilities document defines the roles, responsibilities and accountabilities necessary to implement the Occupational Health, Safety and Wellbeing Policy Statement at each level of the organisation.

Specific roles, responsibilities and duties for the safe operation of lasers and laser devices are detailed in the OHS Standard for Artificial Optical Radiation.

6. REQUIREMENTS FOR THE SAFE USE OF LASERS

6.1 Designation of Laser Areas

Any area where a laser is in use must be identified, appropriately designated, and recorded in the department's local safety management arrangements.

All access points to laser areas must have the appropriate warning labels clearly displayed so that anyone entering the area is immediately aware that lasers may be operating in the area. Information on warning signage for laser areas can be found in Section 6.2.6.

There are two categories of area for laser use:

6.1.1 General Use Area

A general use area is where lasers with an MPE less than that of a Class 2 laser are in use, where class 3R lasers are in use, or where the risk from a hazardous laser has been controlled and the safeguards in place prevent the potential for an accidental or deliberate exposure to laser radiation in excess of the MPE for a Class 2 laser.

Typically, general use areas are designated areas within a larger lab, but they may be dedicated areas, depending on the equipment present and individual requirements.

Whilst these areas will be typically low risk, the use of the laser must still be subject to a suitable and sufficient risk assessment to ensure that adequate risk control measure are in place.

6.1.2 Laser Controlled Area (LCA)

An LCA is intended for work with hazardous lasers, which are being operated in a situation where the controls have not entirely eliminated the risk of exposure (such as where there is a need for an open portion of the beam path), or where the laser has been completely contained, but where it may still present a risk due to its power output.

An LCA must be entirely separated from any other area and must have suitable access controls in place that will prevent unauthorised access to an operating beam. See Section 6.5 for details on appropriate access controls needed to prevent access or exposure to hazardous lasers.

Where there is the intent to work with an applicable laser, the Line Manager, Principal Investigator or Academic Supervisor responsible must contact the DLPS for advice on the required controls. If the department has no DLPS, then the department must contact the URPO for advice, and must arrange for the appointment of a DLPS.

6.2 Design of Laser Areas

The overall design of the work area must be considered during the planning of projects involving lasers, to ensure that the lasers can be operated safely.

6.2.1 Illumination

All laser areas must be as brightly illuminated as possible, without impacting on the work being done. A brightly lit area will reduce the diameter of the pupils of any person working inside the area, reducing the potential that a laser beam will be able to enter the eye.

6.2.2 Windows / Apertures

The level of illumination above must be achieved via the use of internal lights, and not the use of windows or other openings. Where windows or door cut outs are installed, these must be covered or protected by suitable blinds which are fixed in place. These materials may need to be burn resistant in the event of exceptionally high-powered lasers being operated in the area.

6.2.3 Paint / Wall Coverings

Walls, ceilings and fittings must be covered with a matt finished paint. This will enhance the effect of the illumination listed above, and will also reduce the potential for the generation of specular reflections from improperly aligned beams.

6.2.4 Ventilation

The use of lasers can lead to the generation of noxious fumes where the beam is used to ablate a target material, or where there may be the need to use cryogens to cool connected components. The generation of fumes from these sources needs to be controlled, as they may quickly lead to the creation of an inhospitable atmosphere in a confined space.

Ventilation extraction (Local Rule – Installation and use of Local Exhaust Ventilation) must be located as close as possible to the source of generation and must be tested frequently to ensure that it functions correctly.

6.2.5 Fire

Lasers above a certain level present an ignition risk, and as such, suitable firefighting controls must be in place in the event of a fire.

Good lab housekeeping will reduce the fire loading within a given area and minimise the risk of a fire being started by a mis-aligned beam.

Firefighting equipment must be available in the area, suitable for the types of fire that may be expected within the area, and the risk of fire generation must be included in the risk assessment for the activity.

6.2.6 Area Signage

Given the hazards presented by the operation of lasers, suitable signage must be displayed outside of the working area, so that anyone entering is aware of the hazard present.

The laser “Starburst” hazard symbol must be displayed at all access points to any area where a hazardous laser or non-consumer type laser device is in operation.

This symbol is to be displayed at all times an applicable laser is present, and not just when the laser is in operation.

Along with the laser starburst symbol above, the following information is required:

- Name of Person responsible for the area
- Contact details for the responsible person

This signage may only be removed when all lasers have been removed from the area. Signage must not be removed simply because the lasers have been depowered. Anyone wishing to remove laser hazard signage is to ensure that they have spoken with their DLPS to ensure that all necessary actions have been taken.

6.3 Labelling of Lasers / Laser Devices

All lasers and laser devices are required to be marked to indicate the presence of a laser, regardless of classification. The specific markings that each laser must carry depend on the classification.

The most commonly used symbol to warn of the presence is the laser starburst symbol:

All lasers within the University must bear the laser starburst symbol. This symbol must be displayed on all lasers in a prominent position, which must be visible without the user placing themselves in the path of the beam. Where the laser is embedded in a laser device or is contained in a fully sealed enclosure, all access panels must bear the same warning markings.

Depending on the class of lasers or laser devices, there are additional labelling requirements.

For further information on laser hazard warning signs see Information Sheet on Laser Warning Signs and Labelling Requirements.

6.4 Experiment layout

It is essential to plan the layout of the equipment that is to be used in an LCA. The correct set up will minimise the risk of any injuries caused by the laser, and will also assist in improving the ergonomics of the area, increasing the likelihood that the controls in place will be used appropriately.

Points to consider when designing the layout for an experiment include:

- Can the laser be operated entirely contained? Is there justification for any open beams?
- Can the laser be used in a screened off area? Can the area be set up in a labyrinth format where a solid wall divides the access door from the main operating area?
- Is the beam path properly managed? When elevating or lowering the beam, are periscopes used?
- Are all optical devices and components secured appropriately to prevent the accidental generation of unintended beam paths?
- Is the laser pointed away from the access door, with suitable material behind the target to prevent the exposure of anyone entering the area from direct exposure or reflected beams?
- Are all reflective surfaces covered? Is there space set aside for the storage of reflective materials (equipment, rings, watches)?

6.5 Engineered Controls

All steps must be taken to prevent access to any laser radiation equal to, or in excess, of the AEL of a Class 2 Laser (1mW).

Engineering controls provide automatic or passive protection from the beam that require no or limited human intervention to ensure they function, provided that they are used properly.

6.5.1 Beam Access Prevention

The use of barriers or enclosures must be considered the default whilst working with hazardous lasers within the University.

The use of table edge guards and flight tubes must always be considered as the minimum required when operating hazardous lasers, and their use must be detailed in the accompanying risk assessment.

Guarding must be constructed from a suitable material, with the likelihood of burn-through and the need for monitoring having been considered. The risk assessment for the work must include reference to the potential for the laser striking the guarding material, and make allowances for the need to regularly check the guarding, and replace this when necessary.

The movable nature of these guards makes it tempting to temporarily adjust the shielding to make access easier, but this must not be allowed by the department unless:

- the risk assessment and accompanying documentation for the work is reviewed to account for the altered setup;
- the adjustments have been made by a competent member of staff;
- everyone in the area and otherwise associated with the work have been informed of the modified arrangements;
- and the guarding and documentation is restored to its original setup immediately on completion of the work.

Open beam work will only be allowed with hazardous lasers in exceptional situations, and where the justification is robust and has been reviewed by the DLPS.

6.5.2 Personnel Access Control

All areas where hazardous lasers are operated must be secured against access by unauthorised personnel. All access routes into such an area must be strictly controlled.

To ensure that only authorised persons can access an area, a suitable method of securing the area must be employed at each access point. The preferred method of securing such an area is via the use of a non-electrically powered mechanical lock.

When choosing a mechanical locking device, then it must meet the following requirements:

1. **Be secure from the outside**

   Any mechanically operated lock must function so that only those with specific access to the area can enter. The use of a coded lock is preferred as it is simple to use, easy to maintain, and the code easily changed.

2. **Be simple to operate from inside**

   Any mechanical lock must have a single action release from the inside. The need to press a button to disengage a locking mechanism before manipulating a handle would not be considered suitable.

Any mechanically operated lock must be operable by one hand to release the lock and open the door.

The use of any alternative locking devices (electromechanical or magnetic locks) is strongly discouraged. The installation of alternative locks may only be requested via the use of the S34 form which requires authorisation from the University Fire Safety Advisor, as alternative locking devices form part of a buildings fire risk assessment. Estates Services will not install an alternative locking device without this authorisation.

Departments are required to conduct testing of all alternative locking devices to ensure they function as required. Section 6.7.2 –Testing covers the requirements associated with testing safety equipment in laser areas.

Further information on the selection of a suitable locking device can be obtained by contacting the URPO or the University Fire Safety Advisor for advice.

6.5.3 Interlocking

Interlocks are devices that can be used to render a laser safe in the event of activation, with the main function being to prevent inadvertent access of untrained personnel to a hazardous laser beam.

The Interlock will function by either blocking the beam entirely, or by altering the power of the beam so that it is not classed as hazardous.

Interlock detection may be sited at various points throughout a laser area. For example, a laser area may have interlock detection on the area access door and the enclosure doors and lid.

1. **Access panels interlocks**

   Any panel allowing access to the internals of an enclosure must be interlocked so that the emission of a beam in excess of the MPE for a Class 2 laser is not possible if any panel is open.

2. **Area Access Door interlocks**

   Access door interlocks will isolate the intended laser beam in the event that anyone who is not authorised to access the area attempts to do so.

Should any interlock be activated, the laser must not restart immediately when the interlock is reset. Manual activation is required to ensure that the laser does not immediately restart if it has been left in a hazardous state (misaligned, operating at high power etc.).

Interlocks and their associated equipment must be subject to routine testing and maintenance.

Departments are required to conduct testing of all interlocking systems to ensure they function as required. Section 6.7 – Maintenance and Testing of Safety covers the testing requirements associated with laser areas.

6.5.4 Remote viewing

During the operation or alignment of hazardous lasers, it is can be useful to visually inspect the beam. However, errors in the handling of a beam can result in alignment errors, which has the potential to cause significant injuries or damage to equipment. To prevent this, the

use of remote viewing tools must be used. As this will ensure that if there are any issues during operation, then the webcam only is damaged and the worker remains safe behind installed guarding.

6.5.5 System Interruption Devices

Interruption devices physically or electrically prevent the activation of a laser system through the use of cut-off switches.

All non-consumer type laser devices must be equipped with an emergency cut off switch, which will depower the device should the cut-off be activated. When the cut off is reset, the device must require human intervention to restart the emission.

Where a hazardous laser is in use in an area where someone is able to gain physical bodily access, then the following equipment must be installed:

- A means that allows anyone inside the area to prevent, the activation of a laser hazard equal to Class 3B or Class 4;
- A warning device indicating the imminent and current emission of a hazardous laser to anyone who may be inside the area;

Departments are required to conduct testing of all intervention systems to ensure they function as required. Section 6.7 – Maintenance and Testing of Safety Equipment covers the testing requirements associated with laser areas.

6.5.6 Key Control

All Class 4 lasers must have a form of key control as an integral part of their construction. The key is intended to prevent the accidental or malicious powering of a laser.

When a Class 4 laser is left un-attended, all keys must be removed from the device and securely stored in a different location to the laser area. An acceptable example of this would be a central key store under the control of the DLPS, supported by a sign in / sign out book to track the usage of the lasers.

6.6 Personal Protective Equipment

The use of PPE must only be considered where the risk assessment process does not identify controls which are capable of completely controlling the risk. The main aim of using PPE is to prevent the exposure of the skin or eyes to the laser beam.

6.6.1 Clothing

When working in a laser area where there is the risk of exposure to a hazardous laser, all those working in the area must ensure that their skin is covered with as much as possible. The use of long-sleeved lab clothing will ensure that there is at least one layer between a user's skin and any stray beams.

6.6.2 Laser Safe Eyewear

Where there is the potential for exposure to a laser is in excess of the MPE for a Class 2 laser, then the use of laser safe eyewear must be considered but only after collective control measures (protect more than one person at a time) do not eliminate the risk completely.

The appropriate type of goggles for the laser being used must be selected. The selection of eyewear is based on a number of factors:

- Type of Laser – Continuous Wave or Pulsed.
- Laser Wavelength.
- The Optical Density of the laser.
- The level of visible light that needs to be transmitted.

When selecting laser safe eyewear, consideration must be given to the style of eyewear chosen. The preferred style is eyewear that wraps around the head given protection from the front as well as the side.

Where the risk assessment identifies the need for laser safe eyewear, this must be discussed with the DLPS.

6.7 Maintenance and Testing of Safety Equipment

Alternative locking devices and equipment installed to prevent the operation of lasers or laser devices in normal or emergency situations must be routinely tested and maintained to ensure that the correct function is performed.

6.7.1 Maintenance

The maintenance of any installed safety equipment is the responsibility of the department operating the area. This includes emergency cut off devices, door interlocks and locking mechanisms. Any appropriately competent person may carry out this maintenance, but Heads of Departments are responsible for ensuring that this maintenance is conducted.

A record of all maintenance carried out must be kept by the department for the life of the equipment being maintained.

6.7.2 Testing

Testing of equipment must be carried out routinely, with the frequency detailed in the relevant risk assessment. Testing must be thorough and logical to ensure that all parts of the system are tested.

Where the testing identifies a fault or issue with the system, the person conducting the test must ensure that the affected device is immediately placed out of use, with appropriate warnings placed on the device, and that the person responsible for the area is informed. The device must not be operated again without the fault having been investigated, and where necessary, having been repaired by a suitably competent person.

Heads of Departments are responsible for ensuring that suitable processes are in place so that all applicable systems in their areas are routinely tested.

A record of this testing must be kept for at least 2 years from the date the record was made. An example of a routine testing form can be found at Appendix 1 – Example Laser Functional Checklist. This checklist can be amended to fit the requirement of the room or equipment being tested.

Appendix 1 – Example Laser Functional Safety Checklist

DEPARMENTAL FUNCTIONAL LASER SAFETY CHECKS

1.	Interlock System
1A	Do the panel and all associated fittings appear to be in good physical condition?
1B	Does the panel power on?
1C	Does the panel display any fault lights?
1D	Check door is closed and arm interlock system. On opening the door, does the panel correctly display a fault condition?
1E	Check door is closed and arm system. Safely activate low power laser device. Open door. Does panel correctly display a fault condition and does laser deactivate?
1F	Check door is closed and arm system. Safely activate low power laser device. Depress green override button by door. Does system remain active?
1G	Check door is closed and arm system. Safely activate low power laser device. Depress green override button by door, exit room and close door. Wait 30 seconds. Enter access code into keypad and open door. Does the system remain active?

2.	Emergency Stop Buttons
2A	Does the button appear to be in good physical condition?
2B	Plug test device into socket and power on.
2C	Press emergency stop. Does the device deactivate?

3.	Safety and Hazard Warning Signs
3A	Do all hazards identified within the areas risk assessment have associated signage outside the area?

Month of check	1A	1B	1C	1D	1E	1F	1G		2A	2B	2C		3A		All checks completed successfully? *(Person completing to sign)*	Where any check has failed, or there is any cause for concern, give details?
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