**Laser Safety**

Lasers are capable of producing intense, collimated beams of light at specific wavelengths (visible, ultra violet and infrared). While lasers vary greatly in power output, wavelength and purpose, the hazard potential for eyes and skin can be significant due to the concentrated energy density. AS/NZS IEC 60825.1:2014 Safety of laser products Part 1: Equipment classification and Requirements and AS/NZS IEC 60825.14:2011 Safety of laser products Part 14: A user's guide are the principal documents for laser safety.

1. Laser classification

Lasers are divided into seven classes according to accessible emission limits.

NB Modifications can increase the class and subsequent hazard of a laser.

|  |  |
| --- | --- |
| **Class 1** | Are safe under most circumstances and are incapable of damaging the eyes or skin because of either engineered design or inherently low power output |
| **Class 1M** | Emit in the wavelength range 302.5 - 4000nm and may be hazardous if optics are used in the beam |
| **Class 2** | Emit in the visible wavelength range 400 - 700nm and have sufficient power output to cause damage to the eyes if viewed continuously. However, their outputs are low enough where eye protection is afforded by the blinking reflex. Additional hazard control measures take the form of cautionary signs or labels |
| **Class 2M** | Are similar to Class 2 however viewing may be more hazardous if the user employs optics within the beam |
| **Class 3R** | Emit in the wavelength range 302.5 - 106 nm and have the potential to cause damage to the eyes from intra-beam viewing but the risk is lower than for Class 3B lasers. Precautions are required to prevent both direct viewing and viewing with optical instruments |
| **Class 3B** | Are more hazardous because of either higher output or operation outside visible wavelengths. In addition, beam reflections may also be hazardous. More stringent controls are needed to prevent exposure than with lower power lasers. |
| **Class 4** | Are high power devices capable of producing eye damage even from diffuse reflection. They may cause skin injuries and could also constitute a fire hazard. |

2. Health effects of laser use

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| --- | --- |
| **Eye** | Eyes are the most susceptible to damage from lasers. Different parts of the eyes are susceptible to different wavelengths. Damage can occur from heating, photochemical reactions and explosive rupture. Appropriate controls are essential to prevent ocular damage |
| **Skin** | Skin is less at risk from damage caused by lasers, but exposure to lasers still need to be managed appropriately to minimise the potential for skin burns |
| **Other** | In addition to laser radiation, there are additional hazards such as collateral radiation, electrical shock, fire, cryogenics, mechanical hazards, vapours and chemicals, which all need to be considered when completing a risk assessment |

3. [Risk Management](https://www.monash.edu/__data/assets/pdf_file/0019/126082/risk-management-program.pdf)

A documented risk assessment process (WHS F020) using engineering controls, administrative controls and personal protective equipment, either singly or in combination, shall control laser hazards. As a general principle, engineering controls are preferred where appreciable hazards exist, although these may need to be supplemented by the use of appropriate eye protection and adequate signage.

To assist the risk assessment process, the table below based on AS/ NZS 60825.14 outlines a number of potential hazards associated with laser use and possible control solutions.

| **Hazard** | **Potential danger** | **Risk controls** |
| --- | --- | --- |
| Laser radiation | * Exposure to radiation from a laser whose emission is potentially hazardous – usually a laser of any class other than 1 or 2
 | * Eliminate by enclosing the radiation at the source
* Use flame retardant screens to isolate users and bystanders from the radiation
 |
| Health hazards | * Direct exposure to the eyes or skin to laser radiation
 | * Appropriate design of equipment; eliminate health hazards by enclosing the radiation at the source
 |
| Electricity | * High voltage electricity
* Capacitors that store significant amounts of charge which can remain after the equipment has been disconnected from the electrical supply
 | * Appropriate design of equipment
* Develop safe work procedures for servicing work that may expose the electrical terminals; precautions must be taken to ensure removal of stored energy
* Interlock systems
 |
| Collateral radiation | * Other types of radiation other than laser radiation produced by the laser equipment
 | * Ensure control measures protect the user from radiation if external laser casing is removed
* PPE
 |
| Hazardous chemicals | * Material used as the active medium in some lasers can be toxic or carcinogenic
 | * Adopt stringent storage, handling and disposal precautions
* Develop safe work procedures to document storage, handling and disposal requirements
 |
| Fume | * Class 4 lasers can release hazardous particulate and gaseous by products through the interaction of the laser beam with target material
 | * Engineer equipment to allow for emergency stop aspects to be built into the design
* Develop safe work procedures that ensure provisions are made to shut down the laser if hazardous particulate and gaseous byproducts are produced due to laser work
 |
| Noise | * Discharge of capacitor banks within the laser power supply can generate hazardous noise levels
* Ultrasonic emissions and repetitive noise from pulsed lasers
 | * Engineering laser design to minimise the impact of noise
* PPE including hearing protection
 |
| Mechanical hazard | * Ancillary items including gas cylinders, trailing cables and water circulation tubing can cause trip hazards
 | * Engineer gas supply systems into building services
* Substitute large gas bottles for smaller gas bottles
* Tie up loose wires and pipes
 |
| Fire, explosion and thermal damage | * High power laser emissions can ignite target materials
* Laser emissions from lower class lasers can cause explosions in combustible gases or in high concentrations of airborne dust, especially when concentrated over very small areas
* Internal components can explode (discharge lamps, capacitor banks)
* Faulty equipment can cause flammable components to catch fire
 | * Use filters to reduce heat and radiation emitted from the laser
* Firefighting equipment available
* Develop safe work procedures that require a laser user to always be present in the area lasers are being used
 |
| Heat and cold | * Internal parts may become hot
* Beam steering mirrors used in conjunction with high power lasers can reach high temperatures
* Cryogenic cooling can sometimes be used with or in conjunction with laser equipment
 | * Engineer laser design to isolate users from hot and cold hazards
 |
| Temperature and humidity | * Excessive high or low ambient temperatures can affect the performance of in built laser safety features
* High levels of humidity can affect the performance of in built laser safety features
* Condensation on optical components can affect beam transmission
 | * Use lasers in areas that have strict temperature control; for example air conditioned laboratories and other ventilation systems
 |
| Mechanical shock and vibration | * Can cause misalignment of the optical path generating hazardous errant beams
 | * Engineer laser setup so that the equipment is bolted down to a stable surface
 |
| Atmospheric effects | * High powered laser beams can ignite solvent vapour, dust and inflammable gases
 | * Do not use lasers near flammable or combustible products including open solvent containers
* Use of non-flammable products such as nitrogen to clean systems
 |
| Ergonomic considerations | * Poor arrangement of the physical layout of the laser and associated equipment
 | * Ensure operators are not operating at a level where their eyes are at the same level as the laser beam
* Get a professional ergonomist to conduct an assessment
 |

Control measures and the associated requirements of all laser classifications are listed in detail in AS/NZS IEC 60825.1:2014 Safety of laser products Part 1: Equipment classification and Requirements

*Engineering Controls*

Lasers require certain built-in safety features dependent on their classification. These engineering control measures incorporated into the design of the laser system may include:

* Protective housings
* Remote interlocks
* Access panels
* Master switches
* Enclosed or semi-enclosed beam paths

*Administrative Controls*

To aid in managing the risk associated with the use of lasers, the following controls are to be implemented where lasers are used:

* Appointing a Laser Safety Officer (as required)
* Safe Working Procedures
* User registration (as required)
* Training
* Record Keeping
* Correct Labelling of Device
* Eye and Skin Examinations (as required)

*Personal Protective Equipment (PPE)*

The main form of PPE is protective eyewear, but in the case of class 4 lasers should also include protective clothing and footwear. Details on protective eyewear can be found in AS/NZS 1337.4 and AS/NZS 1337.5.

4. Laser safety officer

A Laser Safety Officer (LSO) is a designated school/departmental staff member who has received training to an appropriate level and is knowledgeable in the evaluation and control of laser hazards. The LSO would have responsibility for the suitable training of laser users and oversight of the control of laser hazards. At UNE, a Laser Safety Officer must be appointed where Class 3R, 3B or 4 lasers are used.

For further information, please contact WHS:

* Telephone: 02 6773 3705
* Email: whs@une.edu.au

5. Laser Safety Training

Users of Class 3R, 3B or 4 lasers shall complete suitable training approved by a competent person or authority. Written records of this training shall be kept and, if required, made available on request (example: Power Point based presentation available from UNESAFE Learning in Skytrust).

Undergraduate students (example: Physics 313) are exempted from this training requirement. UNE considers students are supervised during practicals and have already covered appropriate laser theory in coursework.

6. Laser Pointers and Prohibited Weapons

Laser pointers are hand-held, battery-operated articles designed or adapted to emit a laser beam. With sufficient power, laser pointers can caused serious, irreversible eye damage and are classed as Prohibited Weapons under the Weapons Prohibition Regulation 2017 (NSW).

**Legal Laser Pointers**

Most laser pointers that are commercially available are limited to safe power levels (1 milliwatt or less). Laser pointers that are rated as Class 1 are safe. Laser pointers that are Class 2 are hazardous if the beam is stared into, but for the most part are still safe.

**Prohibited Weapons**

Laser pointers that are Class 3R, Class 3A (outdated classification), Class 3B or Class 4 are capable of doing severe damage to the eye. Class 4 laser pointers are now commercially available from overseas suppliers, and have sufficient power to cause skin burns and instantaneous, irreversible eye damage.

Laser pointers that emit with a power greater than 1 milliwatt (i.e. Class 3R, 3A, 3B and 4) are classified as Prohibited Weapons and it is an offense to import, sell, manufacture, possess and user laser pointers of these type.

**Exemptions for Research Purposes**

UNE strictly prohibits the use of laser pointers that are not Class 1 and Class 2 on all of its premises without an appropriate permit/ written exemption and risk controls.

A [permit](https://ablis.business.gov.au/service/nsw/prohibited-weapons-laser-pointer-permit/38066) can be applied for from the NSW Police Force. Depending on the type of use, an exemption may apply.

7. Laser purchase considerations

Prior to the purchase of any laser equipment the user shall exercise appropriate due diligence. This shall include considering risk implications, experimental design, legal requirements, permits, and implementing UNE purchase protocols.

Further Information

[NSW Police Prohibited Weapons](https://www.police.nsw.gov.au/__data/assets/pdf_file/0018/133191/Prohibited_Weapons_Schedule.pdf)

[NSW Police laser pointer FAQ’s](https://www.police.nsw.gov.au/online_services/firearms/laser_pointers/laser_pointers_-_questions_and_answers)

WHS

References and Additional resources

* AS/NZS IEC 60825.1:2014 Safety of laser products Part 1: Equipment classification and Requirements
* AS/NZS IEC 60825.14:2011 Safety of laser products Part 14: A user's guide
* AS/NZS 1337.4 Personal eye-protection - Filters and eye-protectors against laser radiation (laser eye-protectors)
* AS/NZS 1337.5 Personal eye-protection - Eye-protectors for adjustment work on lasers and laser systems (laser adjustment eye-protectors)
* AS/ NZS 2243.5:2004 Safety in Laboratories Part 5: Non ionising radiations – Electromagnetic, sound and ultrasound (Section 7: Lasers)
* WHS OP008 Risk Assessment Operating Procedure
* WHS F020 Risk Assessment
* [University of Queensland, Laser Safety Guidelines](https://staff.uq.edu.au/files/6782/laser-safety-guideline.pdf)
* [University of Wollongong, Laser Safety Guidelines](https://documents.uow.edu.au/content/groups/public/%40web/%40ohs/documents/doc/uow017039.pdf)
* [RPS 18 Safety Guide for the Use of Radiation in Schools, Part 2: Lasers (ARPANSA)](https://www.arpansa.gov.au/sites/default/files/legacy/pubs/rps/rps18.pdf)