

# Laser Safety Guideline

## Section 1 - Purpose and Scope

(1) This Guideline provides guidance of safe use of lasers for the workers in The University of Queensland (UQ). The purpose is to provide further information to the [Laser Safety Procedure](#).

(2) This Guideline applies to all UQ workers. The definition of UQ workers is provided in the Appendix.

## Section 2 - Key Requirements

(3) Lasers generate visible, ultraviolet radiation (UVR) or infrared (IR) emissions usually in a narrow beam of a single wavelength. The energy carried by the beam is therefore concentrated and can travel significant distances and penetrate human tissue - there is potential to cause injury with laser beams. Lasers have multiple uses at UQ including scientific research, medical and dental applications.

(4) The [Work Health and Safety Regulation 2011](#) requires lasers be designed, constructed and installed so no person is exposed to accidental irradiation. Laser equipment on plant must also be protected so that any operator of the plant or any other person is not exposed to direct radiation, radiation produced by reflector or diffusion of secondary radiation. Also, any visual equipment that is used for the observation or adjustment of laser equipment on plant must not create a health and safety risk from the laser rays. Lasers capable of producing hazardous diffuse reflections or that may constitute a fire hazard, that is laser Classes 3B and 4 within the meaning of [AS 2397:2015 Safe Use of Lasers in the Building and Construction Industry](#) (access via [Standards Databases through UQ Library](#)), must not be used in construction work.

### Part A - Laser Classification

(5) Lasers are divided into classes depending upon the power or energy of the beam and the wavelength of the emitted radiation. Laser classification is based on the laser's potential for causing immediate injury to the eye or skin and/or potential for causing fires from direct exposure to the beam or from reflections from reflective surfaces. Commercially produced lasers are classified and identified by labels affixed to the laser.

(6) It is the responsibility of the laser manufacturer to ensure that lasers are classified according to [AS/NZS IEC 60825.1:2014 Safety of Laser Products Part 1: Equipment Classification and Requirements](#) (access via [Standards Databases through UQ Library](#)), while as laser users, workers must ensure the label on the laser remains in place.

Table 1: Laser classification (as per [AS/NZS IEC 60825.1:2014 Safety of Laser Products Part 1: Equipment Classification and Requirements](#))

Class	Potential hazards and/or controls
1	Safe for skin and eye exposure under normal conditions Dazzling visual effects may be caused by exposure to the direct beam of the laser, particularly in low ambient light.

Class	Potential hazards and/or controls
1M	<p>Safe for skin and eye exposure under normal conditions</p> <p>Dazzling visual effects may be caused by exposure to the direct beam of the laser, particularly in low ambient light.</p> <p>Eye injury may occur when using optical instruments (telescope, microscope, etc.).</p>
1C	<p>Eye injury is prevented by engineering means</p> <p>Exposure of the skin depends on how the laser is used.</p>
2	<p>Safe for skin exposure</p> <p>Eye damage is prevented by the blink reflex (0.25 seconds exposure). Forced suppression of the blink reflex can cause eye damage</p> <p>Dazzle, flash-blindness and afterimages may be caused by exposure to the direct beam of the laser, particularly in low ambient light.</p>
2M	<p>Safe for skin exposure</p> <p>Eye damage is prevented by the blink reflex (0.25 seconds exposure). Forced suppression of the blink reflex can cause eye damage.</p> <p>Dazzle, flash-blindness and afterimages may be caused by viewing a beam from the laser, particularly under low ambient light conditions</p> <p>Eye injury may occur when using optical instruments.</p>
3R	<p>Safe for skin exposure</p> <p>Eye damage may result from viewing direct and reflected beams. Normally not a diffuse reflection hazard (light reflects at many angles)</p> <p>Dazzle, flash-blindness and afterimages may be caused by viewing a beam from the laser, particularly under low ambient light conditions.</p>
3B	<p>Minor skin damage is possible</p> <p>Eye damage may result from viewing direct and reflected beams. Normally not a diffuse reflection hazard (light reflects at many angles).</p>
4	<p>Skin and eye hazards from exposure to direct and reflected beams</p> <p>Eye hazard from diffuse reflections (light reflects at many angles)</p> <p>Potential fire hazard when in contact with combustible materials. Production of laser generated air contaminants is possible (for example, chemical fumes).</p>

## Part B - Laser Labelling

(7) Laser labelling should meet the requirements in [AS/NZS IEC 60825.1:2014 Safety of Laser Products Part 1: Equipment Classification and Requirements](#).

(8) All laser equipment requires three types of radiation hazard labels:

- Warning label (hazard symbol).
- Explanatory label (a written description of the hazard, which may include directions to avoid exposure).
- Aperture label (to identify where the radiation is being emitted).

(9) Labels must be:

- Yellow background with black text, borders and symbols.

- b. Durable and permanently fixed to the equipment.
- c. Legible and clearly visible during operation of the equipment.
- d. Able to be seen without needing to be exposed to radiation.

(10) Larger lasers with a generator that is separate from the handpiece should have:

- a. A warning label and explanatory label on the control panel.
- b. An aperture label on the handpiece (close to where the radiation is emitted).

(11) Lasers with control switches and aperture on the same device should have all labels placed on the device.

(12) Some labelling examples can be found at [Queensland Health - Labels for Laser Equipment](#).

(13) For very small laser components, where it is not feasible to attach any labels directly, appropriate labels must be attached to container where they are stored or the adjacent area when they are used.

## Part C - Controlled Area with Warning Signage

(14) For Class 3 and 4 laser use, a controlled area must be clearly sign posted with warning signs with appropriate wording as prescribed for the class of the laser.

See linked image: [An example of warning signs](#)

(15) The Hazardous Room Record in [Archibus](#) (facilities database) should be updated by the Work Health and Safety Coordinator (WHSC) to include the laser hazard. The name of the Laser Safety Officer (LSO) should be added to the record.

(16) The door/s to each area where the laser is used are to be sign posted with details of the minimum personal protective equipment (PPE) required to enter the laser work area.

## Part D - Laser Safety Training

(17) Training for Class 3 and Class 4 laser users must be provided. The training should include a thorough review of hazards associated with each laser that a person may use and the protective methods employed. At a minimum, the training must include instruction on the following:

- a. The biological effects of laser radiation.
- b. Laser optical and non-optical hazards.
- c. The physical properties of lasers, including specular and diffuse reflection.
- d. Access control.
- e. Use of protective eyewear.
- f. Control of related non-beam hazards, including electrical safety, fire safety, and chemical safety related to handling and storage and any other controls as reflected in the relevant risk assessment.
- g. The UQ [Laser Safety Procedure](#) and Guideline.
- h. The correct use and operation of the laser equipment, and of associated equipment, including personal protective equipment (where applicable).
- i. Safe working procedures and local requirements.
- j. Any specific requirements for the laser to be used by the worker.
- k. Emergency response procedures.

(18) Training can be provided by approved external service providers or internal experienced users. Upon completion of the training, the trainer must be confident the worker is competent to use the laser safely and independently. Training records must be kept for each user by the local Organisational Unit.

## Part E - Risk Assessment

(19) A risk assessment must be completed in [UQSafe](#). The hazard identification and control process must be undertaken in consultation with the local LSO and/or the local Health, Safety and Wellness staff for the relevant Organisational Unit and the Radiation Protection Consultant (RPC). The hierarchy of controls must be used to mitigate the risks as far as reasonably practicable.

(20) The risk assessment must assess the risks associated with the following hazards, for example:

- a. direct exposure of the eyes or skin to a laser beam;
- b. other hazards incidental to laser operation;
- c. electrical hazards;
- d. vaporised target material and reaction products such as fume;
- e. noise;
- f. cryogenic coolants;
- g. heat and cold;
- h. fire and explosion;
- i. harmful substances;
- j. identify appropriate control measures as necessary.

(21) risk assessments must be reviewed regularly, depending on the risk level; and

- a. when significant changes (e.g., increasing or decreasing power, removing or bypassing interlock) are made to the laser equipment;
- b. when there is an injury or incident as a result of laser exposure; or
- c. at least every five years.

## Exposure Controls

(22) Controls must be in place so people are not adversely affected by the use of lasers. Control measures are classified into five groups under the hierarchy of controls: elimination, substitution, engineering controls, administrative controls and PPE. When feasible, engineering controls are always the preferred method to provide safe laser work environment.

## Engineering Controls

(23) If the use of the laser cannot be eliminated or substituted with an alternative, then engineering controls are the most important control. The following should be considered and included to mitigate the risk of harm:

- a. Whenever possible, confine (enclose) the laser and its beam to minimise the risk of accidental exposure.
- b. The beam should remain within the bench and screens and where feasible a fail-safe should be in place.
- c. The laser must be operated at the minimum power necessary for any practice. Beam shutters and filters can be used to reduce the beam power. Use a lower power or lower-class laser when possible, during alignment procedures.
- d. Interlocks incorporated into the laser system to shut off the laser automatically or have a mechanical shutter that blocks the beam when the interlock is triggered.

- e. The key used to enable or disable the operation of laser is in place and used.
- f. Emergency shutoff button is available.

## **Administrative Controls**

(24) These should be used in conjunction with higher order controls and include:

- a. Appropriate and adequate training provided to workers.
- b. Risk assessments and procedures, including normal operation procedure, emergency procedure, alignment procedure, etc., are in place prior to work commencing and all workers are aware of these.
- c. Authorised personnel access only to the laser operation area and to operate the laser.
- d. warning signs and labels on entry doors and equipment (see [Queensland Health - Labels for Laser Equipment](#)).

## **Personal Protective Equipment (PPE)**

(25) PPE should only be used in conjunction with high order controls and never as the only control used to prevent injury or harm. The type of PPE appropriate to the task will be assessed through the risk assessment process. Australian Standards, the manufacturing information and specific codes and standards released through government agencies must be consulted.

(26) Generally, PPE includes lab coats, gloves appropriate to the chemical and/or physical hazard and appropriate laser safety glasses.

### **Eye Protection**

(27) [AS/NZS IEC 60825.1:2014 Safety of Laser Products Part 1: Equipment Classification and Requirements](#) states that appropriate laser safety glasses, specific to the type of laser, must be available and worn when operating Class 3 or Class 4 lasers.

(28) Some lasers emit more than one wavelength of light, and this may be a particular problem with some laser systems such as frequency-doubled lasers or dye lasers. Appropriate engineering controls must be used for work with such lasers. If higher order controls have not eliminated the risk of injury to eyes, dual-frequency eyewear must be worn during the process.

(29) Factors to consider in selection of laser safety glasses include the following:

- a. wavelength or spectral region of laser radiation;
- b. optical density of the glasses at the particular wavelength(s);
- c. maximum irradiance (W/cm<sup>2</sup>) or beam power (W);
- d. type of laser system;
- e. power mode, single pulse, multiple pulse or continuous wave, and the strength, i.e., both peak and average power;
- f. possibilities of reflections, specular and diffuse;
- g. field of view provided by the design;
- h. availability of prescription lenses or sufficient size of goggle frames to permit wearing of prescription glasses inside of goggles;
- i. comfort;
- j. ventilation ports to prevent fogging; and
- k. the ability to perform required tasks while wearing eyewear.

## **Skin Protection**

(30) The potential for skin injury from the use of Class 3B or Class 4 lasers must be controlled. Exposed skin must be covered using lab coats, appropriate gloves and a face shield can protect against laser radiation.

(31) Fire risk should also be considered when selecting skin protection material - fire-retardant material should be used.

## **Part F - Laser Beam Alignment**

(32) Laser beam alignment must be performed by authorised workers that are required to:

- a. Follow manufacturer's written standard procedures for beam alignment where available, otherwise, the alignment procedure must be assessed and approved by the LSO.
- b. Wear laser protective eyewear during alignment if higher order controls have not eliminated the risk of injury to eyes or skin.
- c. Remove rings, watches and any other jewelry from which a beam may be reflected.
- d. Ensure tools or items used in and around the beam path have non-reflective, diffusing surfaces.
- e. Never look directly into any laser beam even with eye protection.
- f. Use the lowest laser power possible for the beam alignment.
- g. Use beam display devices such as remote viewing devices, thermal paper, when aligning invisible (e.g., UV, IR) beams.
- h. Ensure laser beams are appropriately terminated.

## **Part G - Research Project Involving Class 4 Lasers**

(33) This part only applies to Class 4 lasers used for research purposes in medical, cosmetic or related procedures.

(34) The worker of such lasers must:

- a. Inform local the LSO and HSW Manager or Work Health and Safety Coordinator (WHSC) as early as possible before commencing the project.
- b. Schedule meetings with LSO, HSW Manager or WHSC and RPC to discuss laser use in the project>
- c. Prepare a [Laser Radiation Research Project Assessment Form](#) and submit it to at least one of the following: LSO, HSW Manager or WHSC for approval. The form is then sent to the RPC.
- d. Draft the risk assessment in [UQSafe](#) and Standard Operating Procedure (SOP) and invite the LSO, HSW Manager or WHSC and RPC for peer review before approval from the Supervisor.
- e. Receive approval from the LSO and RPC prior to the commencement of laser use.
- f. Stop the related project if there are abnormal occurrences and report immediately to the LSO, HSW Manager or WHSC and RPC. An incident report must be completed in [UQSafe](#). The project can only resume after approval from the LSO and RPC.

## **Section 3 - Appendix**

### **Definitions**

<b>Terms</b>	<b>Definitions</b>
Controlled Area	In which access is restricted for the purpose of protection from laser radiation.

Terms	Definitions
Laser	A device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The word "laser" is an acronym for "light amplification by stimulated emission of radiation".
Laser Safety Officer (LSO)	A person who is knowledgeable and competent in the assessment and control of laser hazards and has responsibility and authority for oversight of the control of laser hazards.
Radiation Protection Consultant (RPC)	A qualified expert appointed by the responsible person to supervise radiation safety activities and to ensure radiation safety. An RPC is deemed to have the authority to implement procedures and to intervene in situations where safety has been or is being compromised.
SOP	Standard Operating Procedure: A set of step-by-step instructions compiled by an organization to help workers carry out routine operations.
UQ Workers	<p>For the purposes of this Guideline includes:</p> <ul style="list-style-type: none"> <li>• staff – continuing, fixed-term, research (contingent funding) and casual staff members;</li> <li>• contractors, subcontractors and consultants;</li> <li>• visiting academics and researchers;</li> <li>• academic titles holders, visiting academics, Emeritus Professors, adjunct and honorary title holders, Industry Fellows and conjoint appointments;</li> <li>• Higher Degree by Research students;</li> <li>• volunteers and students undertaking work experience.</li> </ul>

## Example of Labels

(35) See [Queensland Health - Labels for Laser Equipment](#).

## Status and Details

<b>Status</b>	Current
<b>Effective Date</b>	4th January 2023
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<b>Enquiries Contact</b>	Health, Safety and Wellness Division