LASER SAFETY PROGRAM

Contents

UNIVERSITY OF WATERLOO

1.0 PURPOSE

The objective of this program is to provide guidance and practices for the safe operation of lasers and laser systems. It is based upon elements in ANSI Z136.1-2022 and Z136.8-2021.

2.0 SCOPE

This program covers the use of class 3B and 4 lasers and laser systems that operate at wavelengths between 180 nm and 1000 um on University property and during activities or events (including field work) sanctioned by University officers, units, or department heads. This program is intended to prevent unintended exposure to laser radiation and the associated non-beam hazards.

Research that involves the intentional exposure of lasers to individuals' eyes or skin (such as ophthalmic research) must meet the requirements of this program for the protection of those using the lasers, and the researcher must independently provide evidence that the laser will not cause damage or harm to the individual or individuals that will be exposed to the beam.

3.0 LASER CLASSIFICATION

In Canada, lasers are classified based on their relative hazards and safety controls. Classes 1, 1M, 2, 2M, and 3R are largely considered safe to use under normal viewing conditions (i.e., not viewed through optical devices) and as per the manufacturer's instructions. These lasers are considered safe due to their manufacturer provided engineering controls and interlocks (i.e., Class 1) or the blink reflex of the eye is sufficient to protect the eye when using a visible, low powered laser (e.g. Class 2). More information on these classes can be found on the ANSI website.

Classes 3B and 4 are more dangerous and are defined below.

3.1 CLASS 3B

May be hazardous under direct and specular reflection viewing conditions, but are normally not a fire hazard, diffuse reflection hazard, or a laser-generated air contaminant production hazard.

3.2 CLASS 4

Are hazardous to the eye or skin from the direct beam, may pose a fire hazard or a diffuse reflection hazard, and at very high power may also produce laser-generated air contaminants and hazardous plasma radiation.

4.0 ROLES AND RESPONSIBILITIES

In addition to the roles and responsibilities in the Health, Safety and Environment Management System the following roles and responsibilities apply for laser permits.

4.1 SUPERVISOR/MANAGER

Supervisors of work involving Class 3b or Class 4 lasers shall:

- Complete a risk assessment to identify all laser hazards prior to commencing work with the system.
- Develop standard operating procedures for the use, alignment and maintenance of the system.
- Verify systems conform to the ESA certification requirements prior to use.
- Verify all workers have completed SO1066 prior to permitting them access to laser systems.
- Provide and document practical training for all workers that is based on the hazards identified and the SOPs developed prior to permitting access.
- Report all incidents involving laser systems to the Laser Safety Officer (LSO) immediately, and complete any investigations required as directed by the LSO or Safety Office.

4.2 WORKERS

- Complete SO1066 and any other training deemed relevant by the PI, supervisor, or LSO prior to operating a laser system.
- Follow all guidance within this program regarding laser use.
- Immediately report any malfunction or problem to the PI and identify the system as “out of order” until it can be repaired by a competent person.

4.3 SAFETY OFFICE - LASER SAFETY OFFICER (LSO)

The LSO is directed by the Laser Safety Committee and must be knowledgeable in evaluation and control of laser hazards. The LSO also has the following responsibilities:

- Establish and maintain the laser safety program that outlines the policies and procedures for the control of laser hazards.
- Issue permits authorizing the use of Class 3B and Class 4 lasers.
- Maintain an inventory of all Class 3B and Class 4 lasers. Classify or verify classification if necessary.
- Complete an initial inspection of laser work areas and establish nominal hazard zones as required.

- Review incident investigations to ensure adequate controls and prevention of future accidents.
- Approve SOPs, alignment procedures, and other control measures.
- Provide consultative services on evaluation and control of laser hazards and worker training programs.
- Inspect all active Class 3B and Class 4 lasers at least annually for compliance with this Laser Safety Program. Ensure any required corrective action is taken.
- Suspend, restrict, or terminate the operation of a laser or laser system that does not have adequate hazard controls; and advise the Laser Safety Committee of such action.
- Approve wording on area signs and equipment labels.

5.0 LASER PERMITS

5.1 PERMIT APPLICATION (FOR NEW PERMIT HOLDERS)

A permit is required for using Class 3B and Class 4 lasers. To obtain a permit:

1. The principal investigator (PI) should complete the webform to request a permit on the Safety Office's Laser Safety website. The webform collects basic specifications on the lasers as well as the labs completed documents including the Laser Risk Assessment, SOP, and laser manual.
2. For new permits, once the PI has completed the webform, the LSO will contact the researcher to provide them with a permit number and any feedback or edits to the documents submitted. The LSO then sets up a folder in the Laser SharePoint site with appropriate permissions for the PI to populate with required SOPs and other documentation as necessary.
3. A preliminary inspection is scheduled to confirm that appropriate signage, if an alternative Nominal Hazard Zone (NHZ) is required (See Section 5.5), and that controls installed are sufficient for research to commence.

5.2 ADDING LASERS TO EXISTING PERMITS

1. The principal investigator should complete the webform to request a permit on the Safety Office's Laser Safety website. The webform collects basic specifications on the lasers as well as the labs completed documents including the Laser Risk Assessment, SOP and laser manual.
2. The LSO will review the documents and, if necessary, provide feedback and edits.

3. A preliminary inspection is scheduled to confirm that appropriate signage, if an alternative NHZ is required (See Section 5.5), and that controls installed are sufficient for research to commence.

5.3 PERMIT EXEMPTIONS

Following the completion of the permit application some permits may be exempted by some portions of this program by the LSO. Exemptions may be put in place for low-risk lasers such as commercially available microscopes or undergraduate labs. Any exemptions provided by the LSO will be listed on the laser permit.

5.4 OUTDOOR LASER OPERATION

Outdoor use of lasers will require advanced notice to the LSO as additional licenses may be required and additional considerations such as planes, windows, and working near the public must be considered.

5.5 LASER CONTROL AREA AND NOMINAL HAZARD ZONES

Each permit will have a defined laser control area. Unless otherwise agreed upon between the supervisor and the LSO, the laser control area will be the room the laser is located in. The laser control area defines the area where occupancy and the activity of those within the area is controlled and supervised as potentially hazardous beam exposure is possible.

Nominal Hazard Zones (NHZs) are defined as the area where the exposure of the laser beam can exceed the maximum permissible exposure. Laser NHZs are considered to be the entire room unless the laser is enclosed. As a result, laser controls such as limiting access, wearing goggles, and training are required for all individuals in the room. If a laser's NHZs is believed to be smaller than the room (e.g., laser is enclosed or laser is in fiber) the NHZ can calculated in cooperation between the laboratory and the LSO.

6.0 RISK ASSESSMENT

Several aspects of the application of a laser or laser system influence the total laser risk assessment and application of control measures:

- The laser or laser system's capability of injuring or interfering with task performance
- The environment in which the laser is used, including access to the beam path (e.g., considering enclosures, baffles, beam)
- The personnel who may use or be exposed to laser radiation
- Non-beam hazards

Risk Assessment must be completed for all Class 3B and Class 4 lasers purchased after the release of version 3 of the Laser Safety Program. The Laser Risk Assessment may be found on the Safety Office's Laser Safety website.

7.0 CONTROL MEASURES

Class 3B and Class 4 laser systems require approval of control measures by the LSO.

Laser control measures are implemented based on the Laser Risk Assessment, ANSI Z136 series, and LSO inspection results.

Commercial lasers such as laser printers and microscopes should be used as per the manufacturer's instructions and may be exempt from some of the requirements if their design prevents access to the laser beam.

7.1 ENGINEERING CONTROLS

Engineering controls are control measures designed or incorporated into the laser system. These include interlocks, shutters, timers, barriers, area warning devices, entryway interlocks, and emergency stop buttons. Engineering controls are the preferred method for controlling laser hazards.

Laboratories and individuals that purchase Class 4 lasers should be aware that expensive controls are often required for lasers to be permitted. These controls can include but are not limited to laser curtains, door interlocks and laser lights. As such, supervisors are encouraged to consult with the LSO prior to purchasing a laser system. Lack of funds to support the cost of implementing appropriate control measures for safe operation will only delay permit approvals.

7.2 ADMINISTRATIVE CONTROLS

Administrative controls require some sort of administrative/people-based coordination. These include training, safety approvals, standard operating procedures and risk assessment to control laser hazards. Several administrative controls are mandatory as per this program. Note that older versions of these templates will be accepted for lasers that were purchased prior to the release of this program update.

7.2.1 LASER RISK ASSESSMENT

The Laser Risk Assessment must be completed as part of the permit/new laser application process. Laboratories must determine what hazards are present and how they will be controlled.

7.2.2 SAFE OPERATING PROCEDURES

Safe operating procedures (SOP) must be submitted to the LSO for review for all lasers. The SOP must include at a minimum:

- A detailed step-by-step process describing how to use the system
- Limitations of the current system, or situations where additional supervisor support is necessary (e.g., students may not align this system without the supervisor present)
- Alignment instructions
- Required training for all hazards in the process

7.2.3 TRAINING

Both online training and in-person practical training are required for all laser users. Refer to section 8.0 Training for more information.

7.3 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is the last resort for controlling laser hazards and include gloves, long clothing (in the case of UV hazards), and laser goggles. PPE is used when enclosing the beam is not possible. Unless otherwise exempted by the LSO, laser goggles must be worn at all times when working with an open-beam laser by all individuals within the NHZ of the laser.

8.0 TRAINING

All personnel using Class 3B or Class 4 lasers must complete the following training prior to working with these laser systems:

1. Online Laser Safety training course (SO1066)
2. Hands-on practical training must be completed for each laser that will be used. The training is to be delivered by the supervisor (or suitable and designated alternate) and include:
    a. Laser operation as described in the manufacturer's laser operation manual
    b. Specific hazard training related to each laser (e.g., chemical, high voltage) – based upon a risk assessment
    c. Training on the standard operating procedures needed to operate, maintain, and shutdown the laser

The laser permit holder must keep records of online training and hands-on practical training for all workers and students. These records must be easily accessible by the LSO come inspection time.

The University of Waterloo Site-Specific Training Form on the Safety Office's training page may be used by supervisors to document site specific training.

9.0 MEDICAL EXAMINATIONS

Pre-use medical examinations are no longer required prior to the use of lasers. Yet, medical examination must be performed as soon as practically possible when there is a suspected injury or laser exposure.

10.0 COMPLIANCE

The LSO will complete laser safety inspections on an annual basis. This will include, but is not limited to:

- Training verification
- Presence of SOPs
- Visual verification that appropriate controls have been implemented

Failure to meet these criteria can result in research suspension, permit revocation, and re-training.

11.0 RECORD KEEPING

The following records will be kept in relation to this program:

- The Safety Office will maintain records of online training and an inventory of all Class 3B and Class 4 lasers in use on campus.
- The supervisor shall document, maintain, and keep records of:
    - Online and practical training delivered to their researchers
    - Standard operating procedures and risk assessments
    - Permit application

12.0 RECORD OF REVISIONS

Date	Author/ Editor	Change	Version
August 2024	Katelyn Versteeg	▪ Section 3.0 Low-risk classes were removed from the program document. ▪ Section 4.0 Minor changes to responsibilities. ▪ Section 5.0 Restructuring of section. Addition of exemption section. ▪ Section 6.0 Section shortened and some content moved to Section 5.0. ▪ Section 7.0 Section shortened and details of controls added to new risk assessment. ▪ Section 9.0 New	Laser Safety Program_v.4.0 _AUG2024
November 2021	Katelyn Versteeg	▪ Updated section 7.0 Training to indicate that training records (including practical training) are to be maintained by PIs. ▪ Removed inspections for inactive laser permits from the duties of the LSO in section 5.0 Permit Application. ▪ Changed section 6 title from Hazard Assessment from Hazard to Risk Assessment and added a new Risk Assessment Template to the program webpage. ▪ Reworded the PI/LSO responsibilities in calculation of NHZ in section 6.0 Risk Assessment. ▪ Updated Appendices by removing Laser Records of Training and completed a major update to the inspection template.	Laser Safety Program_v.3.0 _NOV2021

November 2020	Douglas Dye	▪ Updated section 2.0 Scope to indicate that this program does not cover research that intentionally exposes people to lasers.
		▪ Added section 3.0 Laser Classification
		▪ Removed medical surveillance and eye exam requirements
		  ▪ Medical surveillance does not add to the safety of the program. Eye exams do not lessen potential injuries. Removal of the eye exam reduces the collection of private medical information and streamlines the application process by reducing the number of requirements an individual must complete to perform research.
		  ▪ Medical surveillance requirements in the ANSI standard have been drastically reduced from previous iterations and have been moved to optional status as the evidence over the years indicates that they do not provide significant benefits to safety.
		▪ Added section 6.0 Hazard Assessment
		▪ Added section 7.0 Compliance
		▪ Added the following appendices:
		  ▪ University Laser Worker Record of Training
		  ▪ Laser Safety Inspection Checklist
		  ▪ Sample Laser SOP
			Laser Safety Program_v.2.0 _OCT2020

November 2019	Douglas Dye	▪ No changes	Laser Safety Program_v.1.0 _OCT2019
November 2018	Douglas Dye	▪ No changes	Laser Safety Program_v.1.0 _OCT2017