University of Toronto

Environmental Health and Safety

LASER SAFETY PROGRAM

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1 INTRODUCTION AND SCOPE

Under its Health and Safety Policy and the general provisions of the Occupational Health and Safety Act of Ontario, the University of Toronto (U of T) is committed to taking every reasonable precaution for the health and safety of its employees, students, patients, and visitors

The Laser Safety Program is intended to assist the U of T community in the effective control of laser hazards.

The basic elements of the control program are:

a. registration of all Class 3B and Class 4 laser/laser systems regardless of the origin (bought, gift, borrowed, etc.). This includes lasers embedded in homemade enclosures;

b. Implementing a laser safety permit system for all class 3B and class 4 lasers;

c. the requirement for inspections of Class 3B and Class 4 laser/laser systems;

d. the requirement for training and education of laser users;

e. the requirement for reporting accidents/incidents involving all Class 3B and Class 4 laser/laser systems;

f. provision of medical surveillance;

g. the requirement for personal protective equipment;

h. the requirement for engineering controls;

i. the requirement for administrative and procedural controls;

j. the requirement for auditing the implementation and effectiveness of the program.

The objective of the Laser Safety Program

It is the objective of this laser safety program to effectively control laser hazards following the U of T Health and Safety Policy and the general provisions of the Occupational Health and Safety Act of Ontario.

Scope

This program applies to all Class 3B and Class 4 laser and laser systems in controlled areas under the jurisdiction of U of T for non-human use, and all those identified as Permit Holders, laser supervisors, laser users, and other persons present in the laser laboratory (see section **2 DEFINITIONS**).

2 DEFINITIONS

Continuous Wave (CW)

A laser operated with a continuous output longer than or equal to 0.25 s.

Controlled Area

An area where the occupancy and activity of those within are subject to control and supervision for protection from laser hazards.

Education Research Laboratories

Laboratories that are devoted to continuing research projects using Class 3B and 4 laser or laser systems.

Laser

A device, which produces an intense, coherent, directional beam of light by stimulating electronic or molecular transitions to low energy levels. An acronym for Light Amplification by Stimulated Emission of Radiation. It can deliver radiation continuously or in pulses.

Laser Permit

A document issued by U of T - Environmental Health and Safety to all Permit Holders who are in charge of the open beam and homemade enclosed class 3B or class 4 lasers.

Laser Permit Holder

An individual who is in charge of a laser laboratory and/or principal authority for Class 3B or Class 4 laser/laser systems.

Laser System

Assembly of electrical, mechanical, and optical components, which includes one or more lasers.

Laser/Laser Systems - Class 3B

These are moderate power lasers (continuous wave: 5 - 500 mW). In general, Class 3B lasers will not be a fire or skin hazard. As well, they are not capable of producing a hazardous diffuse reflection except for conditions of intentional staring done at distances close to the diffuser. For further details, consult the American National Standard for Safe Use of Lasers (ANSI Z136.1-2014).

Laser/Laser Systems - Class 4

These are high-power lasers (continuous wave: > 500 mW). In general, Class 4 lasers are hazardous to view under any condition (directly, specular or diffusely scattered) and are a potential fire and a skin hazard. For further details, consult the American National Standard for Safe Use of Lasers (ANSI Z136.1-2014).

Laser Supervisor

An individual who has been delegated supervisory responsibilities by a Permit Holder for Class 3B and Class 4 laser/laser systems and laser workers.

Laser User

- **Open-Beam Laser User**: one who operates an open-beam and homemade enclosed Class 3B or Class 4 laser/laser system. The open-beam laser user must have full laser safety training and laser safety refresher training every 3 years.

- **Fibre-Coupled Laser User:** one who operates a Class 3B or Class 4 laser coupled through a fibre optic. The fibre-coupled laser user must have fibre-coupled laser user safety training and laser safety refresher training every 3 years.

Laser Laboratory Worker

One who works in the Nominal Hazard Zone but does not operate the laser (e.g. one who is preparing samples, performs computer work in the laser laboratory, etc.). The laser laboratory worker must have laser safety awareness training.

Laser Laboratory Visitor

One who is present inside the Nominal Hazard Zone but does not operate the laser and does not perform work inside the laser laboratory. The visitor must have the approval of the Permit Holder, must be informed about all beam and non-beam hazards, and must wear the appropriate personal protective equipment.

Laser Safety Officer

One who has the authority and responsibility to effect the knowledgeable evaluation and control of laser hazards, and the authority to monitor and enforce the laser safety program.

Maximum Permissible Exposure (MPE)

The level of laser radiation to which a person may be exposed without hazardous effects or adverse biological changes in the eyes or skin.

Nominal Hazard Zone (NHZ)

The nominal hazard zone describes the space within which the level of the direct, reflected or scattered radiation during operation exceeds the applicable MPE. Exposure levels beyond the boundary of the NHZ are below the applicable MPE level.

Optical Density (OD)

Logarithm to the base 10 of the reciprocal of the transmittance. The optical density (attenuation) at a specific wavelength shall be specified for laser protective eyewear.

Pulsed Laser

A laser operated with pulsed output of radiation shorter than 0.25 s.

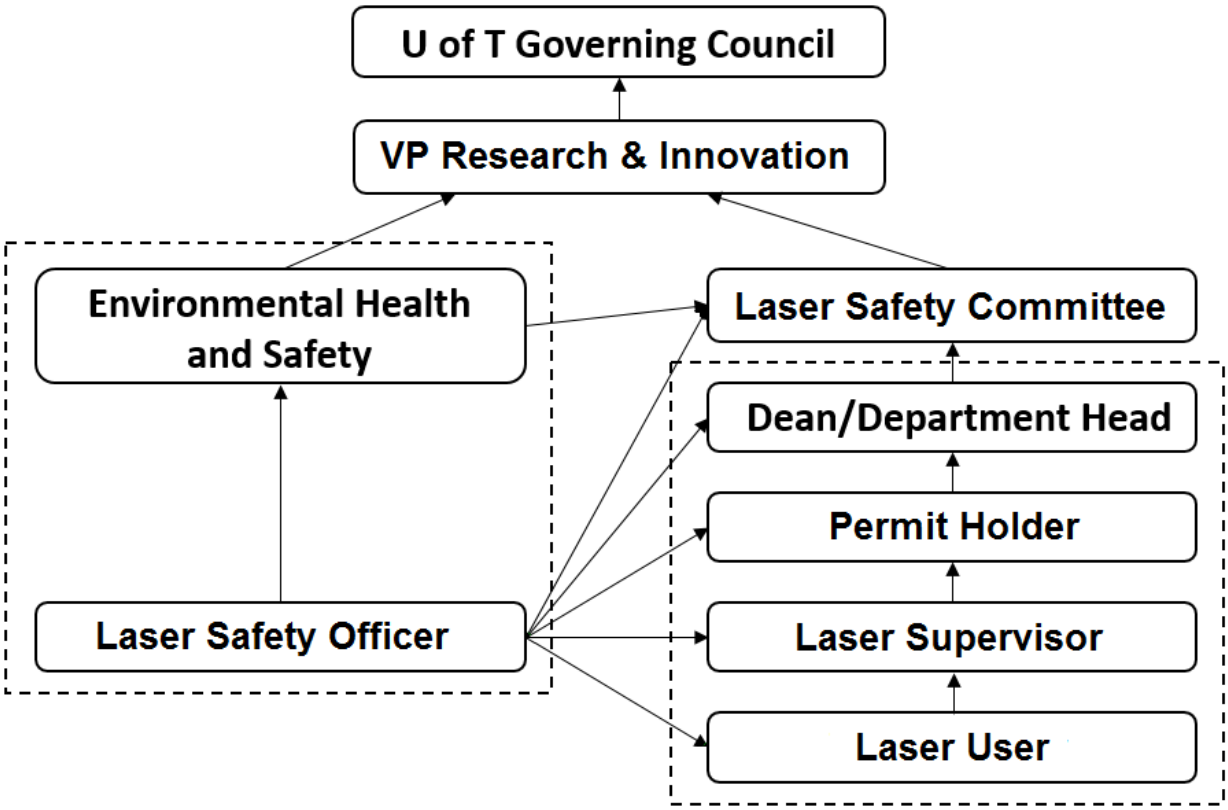
Standard Operating Procedures (SOPs)

A written procedure defines the standard way in which a laser or laser system will be operated.

3 RESPONSIBILITIES

This section outlines the responsibilities for the implementation of the laser safety program within the U of T.

Figure 1: Chart of Responsibilities



3.1 Laser Safety Committee (LSC)

Academic members are appointed to the LSC for terms of not less than two years and not more than four years (renewable) by the Vice-President, Research, and Innovation. The LSC membership consists of, at a minimum:

- Six (6) faculty members with expertise in laser technology and/or assessment of laser hazards,
- One (1) student and laser user,
- Director of Research Safety and Compliance, Environmental Health and Safety (*ex officio*),
- U of T Laser Safety Officer (*ex officio*).

The committee has the following responsibilities:

a. Approving the U of T Laser Safety Program and periodically assessing the effectiveness of the program and recommending changes;
b. Establishing and maintaining standards and guidelines for the safe use of lasers within the University;

c. Providing recommendations for implementation by the Laser Safety Officer (LSO);
d. Providing expert advice on laser safety hazards;
e. Approving appropriate laser safety training program materials;
f. Reviewing and acting on the recommendation of the LSO to suspend, restrict or terminate the operation of a laser or laser system;
g. Reconsidering decisions concerning suspension, restriction or termination of the operation of a laser or laser system;
h. Reporting annually to the Vice-President, Research, and Innovation on the operation of the Laser Safety Program.

3.2 Environmental Health and Safety

U of T - Environmental Health and Safety has the following responsibilities within the Laser Safety Program:

a. To issue a laser safety permit (see Appendix A - Laser Safety Permit System) to all Permit Holders who are in charge of an open beam and homemade enclosed class 3B or 4 laser/laser system

b. To update and present the U of T Laser Safety Program for approval of the LSC

c. To provide a Laser Safety Officer to fulfil the requirements of the Laser Safety Program;

d. To notify Permit Holders of the laser safety program training and medical surveillance of all laser supervisors/users/workers under their authority;

e. To provide administrative support to the Laser Safety Committee;

f. To audit the implementation and effectiveness of this program on an ongoing basis.

g. To report critical injuries to the Ministry of Labour, Training and Skills Development. According to Ontario's legislation, critical injuries are those resulting in fatal injuries or permanent disability. See definition of **Critical Injury** .

3.3 Laser Safety Officer

The LSO has the following responsibilities in his/her jurisdiction:

a. Classification or verification of classifications of Class 3B and 4 lasers/laser systems used in areas controlled by U of T

b. Hazard evaluation of laser work area, including the establishment of Nominal Hazard Zones (NHZs)

c. Approval, or recommending for approval, the beginning of work for new facilities involving the usage of Class 3B and 4 lasers, commissioning and decommissioning of the Class 3B and Class 4 laser and laser systems

d. Developing and maintaining policies and procedures for engineering and

administrative control of laser hazards. LSO is also responsible for ensuring that the prescribed controls are in effect.

e. Verification of SOPs, alignment/maintenance and other procedures connected with laser operation that may be subject to administrative and procedural control

f. Inspection of Class 3B and 4 laser and laser systems according to the Laser Safety Program

g. Recommendation and approval of protective equipment, laser working area signs and equipment labels

h. Ensuring safe operation through the authority to suspend, restrict or terminate operations; stopping individual/laboratory work when the safety of workers, the public or the environment is at risk; documenting the technical reasons for the above decision and reporting to the LSC

i. Investigation of the laser-related incidents and accidents, analysis of the causes, ensuring corrective actions are taken as required

j. Maintenance and updating Laser Safety Database:

- Lasers registrations and de-registrations
- Lasers loans
- Inspection reports
- Training records
- List of authorized users
- Medical surveillance records

k. Provides the appropriate Laser Safety Training to all categories of personnel according to the Laser Safety Program

l. Reports on all aspects of the Laser Safety Program to the LSC regularly.

3.4 Department Head

The Department Head has the following responsibilities within this program:

a. To identify all Permit Holders under his/her authority and ensure that they clearly understand their duties and responsibilities as individuals with principal authority for Class 3B and Class 4 laser and laser systems;

b. To ensure that all components of the U of T Laser Safety Program are implemented in the department.

3.5 Permit Holder

The Permit Holder (PH) may **delegate** some or all of his/her responsibilities to a laser supervisor. However, the PH cannot **discharge** these responsibilities to a laser supervisor.

The Permit Holder has the following responsibilities:

a. To register all Class 3B and Class 4 lasers and laser systems before use and to deregister the decommissioned ones with U of T - Environmental Health and Safety;

b. To identify all Class 3B and Class 4 laser supervisors and users/workers under his/her authority to the LSO;

c. To ensure that laser supervisors and laser users and laser laboratory workers participate in the U of T's Laser Safety Program training before operating or working in proximity to Class 3B or Class 4 lasers/laser systems;

d. To provide and enforce the use of appropriate personal protective equipment when required;

e. To provide written standard operating procedures (SOPs) and alignment/maintenance procedures for all Class 3B and Class 4 laser/laser systems and to ensure that each laser is used only under conditions and in locations that meet the requirements of the SOP(s);

f. To ensure that each laser supervisor/worker is trained in the safe operation of the specific Class 3B and/or Class 4 laser and laser systems that he/she will operate;

g. To ensure that all Class 3B and Class 4 lasers and laser systems are stored securely and safely when not in use so that they are not usable by unauthorized personnel or under unauthorized conditions;

h. To permit only trained laser supervisors/workers to operate or work in proximity to Class 3B or Class 4 lasers or laser systems;

i. To ensure that at least one person has full laser safety training and laser safety refresher every 3 years;

j. To ensure that all administrative and engineering controls are followed;

k. To correct unsafe conditions on time;

l. To ensure that all laser supervisors/workers participate in the U of T's medical surveillance program;

m. To ensure that all visitors are properly informed and protected from potential laser hazards;

n. To cancel laser supervisor/worker privileges until satisfied that he/she fully meets the requirements of this control program;

o. To report known or suspected accidents to the Laser Safety Officer/U of T - Environmental Health and Safety within 24 hours of the accident;

p. To inform the U of T LSO when a laser is loaned to another U of T laboratory and to fill the Appendix C – Laser Loan Form when a laser is loaned outside the U of T;

q. To inform the U of T LSO about class 3B and class 4 lasers that need to be decommissioned and to follow the laser decommissioning procedure (Appendix G – Decommissioning Class 3B and 4 lasers);

r. Ensure that **Appendix H – External Contractors** is completed and signed before hiring a contractor to work in the laser laboratory

3.6 Laser Supervisor

The laser Supervisor has the following responsibilities:

a. To participate in the U of T's Laser Safety Program training before operating or working in proximity to Class 3B or Class 4 laser/laser systems;

b. To be familiar with all operational procedures and specific safety hazards of the Class 3B or Class 4 laser/laser systems that he/she will operate/oversee;

c. To operate Class 3B and Class 4 laser/laser systems safely and in a manner consistent with safe laser practices, requirements and written SOPs;

d. To operate Class 3B and Class 4 laser/laser systems only under the conditions authorized by the Permit Holder;

e. To report all unsafe conditions to the Permit Holder;

f. To report to the Permit Holder any medical conditions that could cause him/her to be at increased risk for chronic exposure, e.g. photosensitivity of the skin, use of photosensitizing medications, and dermatological abnormalities of the skin;

g. To participate in the U of T's medical surveillance program;

h. As directed by the Permit Holder, to provide instruction and supervision to laser users;

i. As directed by the Permit Holder, to conduct other activities associated with the U of T's Laser Safety Program;

j. To promptly report known or suspected accidents and unsafe conditions to the Permit Holder.

3.7 Laser User

The laser user has the following responsibilities:

a. To participate in the U of T's Laser Safety Program training before operating or working in proximity to Class 3B or Class 4 laser/laser systems;

b. To be familiar with all operational procedures and specific safety hazards of the Class 3B or Class 4 laser/laser systems that he/she will operate;

c. To operate Class 3B and Class 4 laser/laser systems safely and in a manner

consistent with safe laser practices, requirements and written SOPs;

d. To operate Class 3B and Class 4 laser/laser systems only under the conditions authorized by the laser supervisor/Permit Holder;

e. To report all unsafe conditions to the laser supervisor/Permit Holder;

f. To report to the laser supervisor/Permit Holder any medical conditions that could cause him/her to be at increased risk for chronic exposure, e.g. photosensitivity of the skin, use of photosensitizing medications, and dermatological abnormalities of the skin;

g. To participate in the U of T's medical surveillance program;

h. To promptly report known or suspected accidents to the laser supervisor/Permit Holder.

3.8 Laser Laboratory Worker

The laser laboratory worker has the following responsibilities:

a. To participate in the U of T laser safety awareness training before working inside the NHZ

b. To report all unsafe conditions to the laser supervisor/Permit Holder;

c. To report to the laser supervisor/Permit Holder any medical conditions that could cause him/her to be at increased risk for chronic exposure, e.g. photosensitivity of the skin, use of photosensitizing medications, and dermatological abnormalities of the skin;

d. To participate in the U of T's medical surveillance program;

e. To promptly report known or suspected accidents to the laser supervisor/Permit Holder.

4 Class 3B and Class 4 Lasers Registry

There are two primary reasons for preparing and maintaining a record of all Class 3B and Class 4 laser and laser systems. These are:

a. To identify areas where Class 3B and Class 4 lasers are present so that appropriate administrative and engineering controls may be put in place.

b. To enable the laser and laser systems to be inspected regularly for compliance with the U of T's Laser Safety Program.

The record shall contain the following information (see Appendix E – Laser Registration):

a. The Permit Holder's name and title

b. The Permit Holder's department

c. The location of the laser (building and room #)

d. Type of laser (CO_2, Nd: YAG, He-Ne, etc).

e. Production class (commercial, modified, "home-built")

f. Laser classification (Class 3B or Class 4)

g. The proposed use (research, medical or therapeutic application, undergraduate teaching, etc.)

The Permit Holder is responsible for the registration of all Class 3B and Class 4 laser/laser systems and the deregistration of decommissioned ones.

Open beam and homemade enclosed class 3B and class 4 lasers must be used only in rooms/areas commissioned by the U of T LSO according to Appendix F – Laser Room Commissioning of this program.

Lasers no longer in use must be decommissioned according to Appendix G – Decommissioning Class 3B and 4 lasers, before disposal.

The laser Permit Holder must inform the U of T LSO before a loan or donation of an open beam and homemade enclosed class 3B or class 4 laser to a different U of T laboratory.

The laser Permit Holder must complete and submit to the U of T LSO the “Laser Loan Form” (Appendix C – Laser Loan Form) when a laser is a loan or donated to a different institution.

The LSO is responsible for the preparation and maintenance of the laser registry.

5 LASER SAFETY INSPECTIONS

Periodic inspections of Class 3B and Class 4 laser/laser systems are an integral part of the laser safety program; inspections provide some indication as to whether or not these laser/laser systems are being operated safely.

The LSO is responsible for inspecting all-new Class 3B and Class 4 laser/laser systems and also (at least annually) all Class 3B and Class 4 laser/laser facilities for compliance with the U of T's Laser Safety Program and to report to U of T - Environmental Health and Safety and the Laser Safety Committee. The forms (one for class 3B and one for class 4 lasers) that will be used in these inspections are attached as Appendix B – Laser Inspection Checklists.

An inspection report will be sent by the LSO to the Permit Holder and copied to the Laser Supervisor (if necessary).

The report will contain at least:

- The date of the inspection
- The name of the person who accompanied the LSO
- The non-compliances found
- Recommendations to fix the non-compliances
- A time limit to implement the necessary corrections

6 TRAINING AND EDUCATION

All laser users and laser supervisors must participate in the U of T's Laser Safety Program training before operating or working in proximity to Class 3B or Class 4 laser/laser systems;

This full laser safety training will include the following:

a. Laser basics
b. Laser hazards, bio-effects
c. Non-beam hazards
d. Laser system classification
e. Control measures
f. Laser eye protection
g. Legislation and U of T Laser Safety Program
h. Responsibilities
i. Laser incidents and accidents
j. Quiz

On Job training

The on-job training will include the following parts:

- General awareness of the hazards in laser laboratories or other areas where lasers are used
- An experienced laser user will demonstrate the safe use of a laser to the new user
- The new user will operate the laser in the presence of the experienced user
- The experienced user or the permit holder will evaluate the practical knowledge of the new user and will allow the new user to work without supervision

All laser users and laser supervisors must be familiar with all standard operating procedures and specific safety hazards of the Class 3B and Class 4 laser/laser systems that he/she will operate/oversee.

U of T - Environmental Health and Safety is responsible for maintaining records of all laser supervisors and laser users and laser laboratory workers who have participated in the laser safety program training and for notifying PHs of this participation.

A current copy of the authorized user list for each laser permit will be maintained in the U of T - Environmental Health and Safety database.

The laser safety training is valid for 3 years. After this period the user must take the online safety refresher.

The laser safety refresher will include:

- Basics of laser safety
- Recent examples of laser accidents and lessons learned
- Changes in the legislation or the U of T laser safety program
- Quiz

If the user fails the quiz twice, he/she will take the full laser safety training.

All laser laboratory workers must have laser safety awareness training. The laser safety awareness training will include the following:

- Laser classification
- Laser beam and non-beam hazards
- Laser hazard controls
- Laser goggles
- Laser accidents and emergency preparedness
- Quiz

The laser laboratory workers are not trained to use the lasers or to give advice on laser use.

The users of fibre-coupled lasers must have full laser safety training or fibre-coupled laser safety training. The fibre-coupled laser safety training will contain:

- Laser principles
- Fibre optics
- Laser classification
- Laser beam and non-beam hazards for lasers coupled with fibre optics
- Laser goggles
- Laser hazard controls when the fibre-coupled laser is used
- Laser accidents and emergency preparedness
- Quiz

7 ACCIDENT/INCIDENT REPORTING AND EMERGENCY RESPONSE

U of T policy requires the reporting of all accidents/incidents, which **result in** or have the **potential to result in** personal injury.

Reporting of accidents involving death, critical injury, lost time or health care is required for **employees** under the Occupational Health and Safety Act and the Workplace Safety and Insurance Act, while U of T policy requires the reporting of accidents/incidents involving **students and visitors and other persons on U of T premises**.

Therefore, **reportable accidents/incidents** are those which:

a. Result in personal injury (including those requiring first aid) or property damage; **or**

b. Have the potential to result in significant personal injury or property damage even though no injury or damage occurred; **and**

c. Occur to any person on U of T premises; **or**

d. Occur to a U of T employee during his/her work either on or off U of T premises.

The Permit Holder is responsible for reporting all accidents/incidents involving Class 3B and Class 4 laser/laser systems:

a. For incidents involving employees, the Permit Holder must complete, and sign, the online U of T workplace accident/incident form is available at https://ehs.utoronto.ca/report-an-incident/online-accidentincident-eform-for-employees/

b. For incidents involving students, visitors and others, the Permit Holder must complete and sign the online Accident/Incident Form available at https://ehs.utoronto.ca/report-an-incident/online-accidentincident-eform-for-students-contractors-and-visitors/

All reportable accidents/incidents must be reported to U of T - Environmental Health and Safety within 24 hours so that the appropriate report is filed with the Workplace Safety and Insurance Board.

The Workplace Safety and Insurance Board levies a fine for late reporting of **lost time or health care claims**. Where this late reporting is a result of the failure of a department to report the incident to U of T - Environmental Health and Safety within the required time, the fine will be charged to that department.

In addition to the reporting requirements previously outlined, all **Critical Injury** to employees must be reported immediately to the Ministry of Labour, Training and Skills Development. The Permit Holder is therefore responsible for taking the following steps:

a. Procure immediate medical attention

b. Notify the U of T Campus Police

c. Notify U of T - Environmental Health and Safety

d. Notify the appropriate Joint Health and Safety Committee for the workplace

e. Notify the appropriate union (if any) representing the injured employee

f. Ensure that the site of the accident remains undisturbed until a Ministry of Labour, Training and Skills Development inspector has arrived

g. Investigate and prepare a written report on the circumstances of the accident.

***<u>Critical Injury</u> is defined as an injury of a serious nature that:**

- **Places life in jeopardy**
- **Produces unconsciousness (or an altered state of consciousness)**
- **Results in substantial loss of blood**
- **Involves the fracture of a leg or arm, but not a finger or toe**
- **Involves the amputation of a leg, arm, hand or foot, but not a finger or toe**
- **Consists of burns to a major portion of the body, or**
- **It causes the loss of sight in an eye.**

When a known or suspected accident is reported to the Permit Holder/laser supervisor or U of T - Environmental Health and Safety, the laser user with a suspected injury will be referred to the appropriate U of T Health Service or hospital/physician/ophthalmologist.

8 MEDICAL SURVEILLANCE

All Class 3B and Class 4 open-beam and homemade enclosed laser users are required to participate in the U of T's laser medical surveillance program.

The purpose of laser medical surveillance is twofold:

a. To establish a baseline of ocular conditions before exposure to laser radiation.

b. To detect early signs of any ocular damage and to initiate prompt treatment.

A pre-assignment medical assessment is required before an open-beam and homemade enclosed laser user begins work in an area involving Class 3B and Class 4 laser/laser systems. This assessment will include:

a. Medical history pertinent to conditions that can involve the eyes;

b. Medical history and physical examination for individuals working with systems
c. that operate in the ultraviolet region of the electromagnetic spectrum;

d. Measures of visual function related to the different parts of the eye: cornea, iris, lens, macula, retina, etc.;

e. Visual acuity (laser workers must bring their prescription glasses to the doctor's appointment);

f. Colour vision;

g. Amsler Grid (to assess blind spots and distortions)

h. Individuals with significant eye problems or who are functionally one-eyed will be referred to an ophthalmologist.

Individuals will be counselled regarding common medicines that are "photoactive".

Periodic medical assessments are not required by this program unless required as a result of medical status, ocular illness or injury.

All medical records will be kept in strict confidence. Status reports regarding fitness to work will be provided to the laser user, the Permit Holder/laser supervisor and on file in U of T - Environmental Health and Safety.

When a known or suspected accident is reported to the Permit Holder/laser supervisor or U of T - Environmental Health and Safety, the laser user/laser laboratory worker with a suspected injury will be referred to the appropriate U of T Health Service or hospital/physician/ophthalmologist.

Permit Holders are responsible for ensuring that all Class 3B and Class 4 open-beam and homemade enclosed laser users under their authority participate in the medical surveillance program by submitting the names of these individuals to U of T - Environmental Health and Safety.

U of T - Environmental Health and Safety is responsible for maintaining records of all laser supervisors and laser users/laser laboratory workers who have participated in the medical surveillance program and for notifying Permit Holders of this participation.

9 PERSONAL PROTECTIVE EQUIPMENT

Enclosing the laser equipment or beam path is the preferred method of control since the enclosure will isolate or minimize the hazard. If this is not entirely feasible and other control measures do not adequately prevent access to direct or reflected beams at levels above the **Maximum Permissible Exposure (MPE)**, it may be necessary to use personal protective equipment.

The Permit Holder shall ensure that laser protective eyewear is available and worn by all people within the Nominal Hazard Zone of Class 3B and Class 4 laser/laser systems where the exposures above the **MPE** may occur.

The Permit Holder shall provide laser protective eyewear that is clearly labelled with the optical density and the wavelength for which protection is afforded.

Laser users/laser laboratory workers shall wear protection as required and shall inspect laser protective eyewear for damage before use, replacing eyewear, if faulty. Also, protective eyewear shall be cleaned periodically, according to the manufacturer's instructions.

For Class 3B or Class 4, laser/laser systems operating in the **ultraviolet**, skin protection shall be utilized if chronic (repeated) exposures are anticipated at or near the applicable **MPE** for the skin.

If engineering controls are not entirely feasible, then skin covers and/or "sunscreen" creams are recommended. Most gloves will provide some protection against this radiation. Tightly woven fabrics and opaque gloves provide the best protection. A laboratory coat can protect the arms.

The use of other personal protective equipment (e.g. respirators, hearing protection) or fire extinguishers, and additional local exhaust ventilation may be required whenever engineering controls cannot protect a potentially harmful environment.

10 ENGINEERING CONTROLS

Appropriate control measures are devised to reduce the possibility of exposure of the eye and skin to hazardous levels of laser radiation and other hazards associated with the laser/laser systems during operation and maintenance.

Commercial laser products will be certified by the manufacturer and will incorporate some engineering controls. Additional controls such as those outlined in this section shall be considered to reduce the potential for hazards associated with some applications of Class 3B and Class 4 laser/laser systems.

In some research and development applications, **some of these engineering controls may be impractical** and it will be necessary to substitute administrative and procedural controls (see section 11) to provide equivalence in protection. For these applications, a hazard analysis shall be conducted. To ensure safe operation, this must be done in conjunction with the Laser Safety Officer (LSO) who must approve these control measures.

The following are the control measures that are normally required for Class 3B and Class 4 laser/laser systems:

10.1 Protective Housing

The protective housing is a physical barrier preventing laser radiation above the MPE from exiting the laser. The aperture through which the useful beam is emitted is not part of the protective housing. The protective housing limits access to other associated radiant energy emissions and electrical hazards. Normally, this protective housing is provided by the manufacturer.

10.2 Laser Use without Protective Housing

In some applications of research and development, the operation of lasers or laser systems without a protective housing may become necessary. In such cases, the LSO shall determine the hazard and ensure that controls are appropriate to the class of maximum accessible emission to ensure safe operation. These controls may include, but are not limited to:

a. Access restriction
b. Eye protection
c. Area controls
d. Barriers, shrouds, beam stops, etc.
e. Administrative and procedural controls
f. Education and training

10.3 Interlocks on Protective Housing

Protective housings will have an interlock system, which is activated when the protective housing is opened during operation and maintenance. The interlock prevents exposure

to laser radiation above the MPE.

The protective housing interlock shall not be defeated or overridden during operation unless the provisions of **"Laser Use without Protective Housing**" (page 22) have been fully implemented.

10.4 Service Access Panels

These panels are part of the protective housing, which is intended to be removed by service personnel only and permit direct access to laser radiation. They must either: 1) be interlocked (fail-safe interlock not required), or 2) require a tool for removal and shall have an appropriate warning label.

10.5 Key Control

All Class 4 lasers shall be provided with a master switch which is operated by a removable key or coded access (such as a computer password).

10.6 Viewing Portals and Display Screens

All viewing portals and/or display screens included as an integral part of a laser shall incorporate a suitable means (such as interlocks, filters, attenuators) to maintain the laser radiation at the viewing position at or below the applicable MPE for all conditions of operations and maintenance.

10.7 Collecting Optics

Optical instruments intended for viewing a laser or laser system must be equipped with suitable means (e.g. filters, attenuators, or interlocks) to preclude the transmission of laser light above the MPE under all conditions of operation and maintenance.

10.8 Enclosed Beam Path

In applications of Class 3B or Class 4 lasers or laser systems where the entire beam path is enclosed, and the enclosure fulfils all the requirements of a protective housing (i.e. limits the laser radiation exposure at or below the applicable MPE), no further controls are required.

10.9 Limited Open Beam Path

There are some applications where the major part of the laser system is enclosed, allowing only a very small area of the beam to remain accessible. In such instances, hazard analysis is required (in conjunction with the LSO) to establish the Nominal Hazard Zone (NHZ). The analysis will define the area where laser radiation is accessible at levels above the appropriate MPE and will define the zone requiring control measures. Controls must be established that are appropriate to the magnitude and extent of the accessible radiation. Frequently, the hazard analysis will define an extremely limited NHZ and **procedural controls** can provide adequate protection.

10.10 Completely Open Beam Path

In applications of Class 3B or Class 4 lasers or laser systems where the entire beam path

is unenclosed, a laser hazard analysis is required (in conjunction with the LSO) to establish the NHZ. The analysis will define the area where laser radiation is accessible at levels above the appropriate MPE and will define the zone requiring control measures. A **laser-controlled area** shall be established in this zone and appropriate control measures shall be implemented within the NHZ based on the classification associated with the maximum level of accessible laser radiation.

10.11 Remote Interlock Connector

The remote interlock connector (e.g. "Panic Button") deactivates the laser or reduces the accessible radiation to levels at or below the applicable MPE.

10.12 Beam Stop or Attenuator

Each Class 4 laser or laser system must be provided with a permanently attached beam stop or attenuator capable of preventing the emission of laser light above the MPE when the beam is not required.

10.13 Activation Warning Systems

An activation warning system is required on all Class 4 lasers or laser systems. This could be an audible system e.g. an alarm, a warning light (visible through protective eyewear), or a verbal "countdown" command during activation or start-up of the laser.

10.14 Emission Delay

This is a warning system, which provides sufficient time before the emission of laser radiation to allow appropriate action to be taken to avoid exposure to laser radiation.

10.15 Equipment Labels

All commercial Class 3B and Class 4 lasers are labelled. Home-built Class 3B and Class 4 lasers shall have appropriate warning labels affixed to a conspicuous place on the laser housing or control panel.

10.16 Area Posting

An area, which contains a Class 3B or Class 4 laser or laser system shall be posted with appropriate signage. Also, a notice sign shall be posted outside a temporary laser-controlled area.

10.17 Indoor Laser Controlled Area

When the beam path of a Class 3B or Class 4 laser or laser system is **completely open**, a laser-controlled area must be established, and adequate control measures must be implemented.

Control measures that are normally required for both Class 3B and Class 4 Lasers

a. Posting with appropriate warning signs. The sign must be posted at the entryway and, if necessary, within the laser-controlled area.

b. Operation by authorized personnel only.

c. Operation or attendance by appropriately trained personnel only.

d. Limitation of the path beyond the indoor controlled area.

Control measures are <u>recommended</u> for Class 3B but <u>normally required</u> for Class 4 lasers

a. Direct supervision by an individual knowledgeable in laser safety.

b. Access to the area by spectators is limited and requires approval.

c. Any potentially hazardous beam must be terminated in a beam stop of appropriate material.

d. Only diffusely reflecting materials are allowed in or near the beam path, where feasible.

e. Personnel within the laser-controlled area must be provided with the appropriate eye protection.

f. The laser must be secured such that the exposed beam path is located above or below the normal eye level of a person in any standing or seated position.

g. All windows, doorways, open portals, etc. from an indoor facility must be either covered or restricted to reduce the transmitted laser radiation to or below the applicable ocular MPE level.

h. Require storage or disabling (for example, removal of the key) of the laser or laser system when not in use to prevent unauthorized use.

Control measures that are <u>normally required</u> for Class 4 lasers

a. All personnel entering a Class 4 NHZ must be appropriately trained, provided with appropriate protective equipment, and follow all applicable administrative and procedural controls.

b. All Class 4 area/entryway safety controls must allow both rapid entrance and exit to the laser-controlled area under any conditions.

c. For emergency conditions, there must be a marked "Panic Button" (switch or equivalent device) to quickly deactivate the laser or reduce the output to safe levels.

In addition, the Class 4 laser-controlled area must incorporate **<u>one of the following options</u>** for area or entryway safety controls:

- Non-defeatable <u>(non-override) Area or Entryway Safety Controls.</u>

These may be safety latches, entryway or area interlocks (e.g., electrical switches, pressure-sensitive floor mats, infrared detectors) used to deactivate the laser or reduce

the output to safe levels when the door is open; **or**

- Defeatable Area or Entryway Safety Controls.

Defeatable safety latches, entryway or area interlocks may be used if undefeatable controls limit the intended use of the laser when operation without interruption is necessary, for example, during long-term testing. These safety controls may be overridden to allow access if it is evident that there is no laser hazard at the point of entry. The authorized personnel requiring entry must be adequately trained and provided with adequate personal protective equipment: **or**

- Procedural Area or Entryway Safety Controls.

Where door interlocks are not feasible or are inappropriate, the following procedural controls apply:

a. All authorized personnel must be adequately trained and provided with adequate personal protective equipment upon entry.

b. A door blocking barrier/screen/curtain, etc., must be used to block or attenuate the laser beam at the entryway to ensure that laser radiation outside the area does not exceed the MPE and that no one receives exposure above the MPE immediately upon entry.

c. In this case, there shall be a warning light or sound at the entryway indicating that the laser is energized and operating.

A lighted warning sign or a flashing light are two examples of methods to appropriately accomplish this requirement. Alternatively, a light assembly may be interfaced with the laser in such a manner that: one light indicates when the laser is not operational, a second light indicates when the laser is powered up (but there is no laser emission), *and* a third light (flashing optional) indicates when the laser is operating (emission ON).

10.18 Temporary Laser Controlled Area

Where the removal of panels or protective housings, over-riding of protective housing interlocks, or entry into the NHZ becomes necessary (such as for service or research activities), and the accessible laser radiation exceeds the applicable MPE, a temporary laser-controlled area shall be set up. This area shall provide all safety requirements for all personnel, both within and outside the area and a sign shall be posted outside the temporary laser-controlled area to warn of the potential hazard.

10.19 Lasers Coupled with Optical Fibre

Based on the type of optical fibre, the NHZ can be very different (regularly smaller) than when the laser is used as an open beam. The LSO will estimate the NHZ and will decide the control measures required.

Table 1: Engineering control measures that are normally required for Class 3B and Class 4

ENGINEERING CONTROL MEASURES	CLASSIFICATION	
	3B	4
Protective Housing	**Y**	**Y**
Without Protective Housing	**LSO to determine**	
Interlocks on Protective Housing	**Y**	**Y**
Service Access Panel	**Y**	**Y**
Key Control	**O**	**Y**
Viewing Portals (reduce exposure below MPE)	**Y**	**Y**
Collecting Optics (reduce exposure below MPE)	**Y**	**Y**
Enclosed Beam Path	**NC**	**NC**
Limited Open Beam Path	**NHZ**	**NHZ**
Totally Open Beam Path	**NHZ**	**NHZ**
Labels	**Y**	**Y**
Area Posting	**Y**	**Y**
Indoor Laser Controlled Area	**Y**	**Y**
Temporary Laser Controlled Area	**Y**	**Y**
A laser used through optical fibre	**LSO will decide on necessary controls**	

LEGEND

Y --- Normally required
O --- Optional
X --- Not required
NC --- No further controls are required
NHZ --- Nominal Hazard Zone analysis required

11 ADMINISTRATIVE AND PROCEDURAL CONTROLS

Engineering controls must be given primary consideration in instituting a control measure program for limiting access to laser radiation. If some of these engineering controls are impractical or inadequate, then administrative and procedural controls that provide equivalent protection shall be used.

Administrative and procedural controls are methods or instructions which specify rules, work practices or both, which implement or supplement engineering controls and which may specify the use of personal protective equipment.

The following are the administrative and procedural controls that are normally required for Class 3B and Class 4 laser/laser systems:

11.1 Standard Operating Procedures (SOPs)

Standard operating procedures (SOPs) for Class 4 laser/laser systems shall be maintained with the laser equipment and must always be available as a reference for all laser users; SOPs may include the laser instruction manual (prepared by the manufacturer) and as appropriate, additional written information to ensure compliance with good work practices and safety.

SOPs are required for the following Class 4 laser/laser systems:

a. Experimental Set-up and System Alignment;

b. Routine Operation;

c. Laser Maintenance and Set-up; and

d. Non-standard/modified laser/laser systems.

11.2 Output Emission Limitations

If excessive power or radiant energy is accessible during the operation or maintenance of a Class 3B or Class 4 laser or laser system, the laser user must take action as required to reduce the levels of accessible power or radiant energy to that which is commensurate with the required application.

11.3 Modification of lasers, laser systems and optical setups

Any modifications to the laser/laser system must be approved by the LSO.
Any modifications to the experimental settings must be approved by the laser supervisor/laser permit holder.

11.4 Laser Worker Training

Education and Training shall be provided for all laser users (see section 6 of this program). The level of training shall be commensurate with the level of the potential hazard.

11.5 Authorized Personnel

Lasers shall be operated, maintained or serviced by authorized personnel.

11.6 Alignment Procedures

Laser incident reports have repeatedly shown that an ocular hazard may exist during beam alignment procedures. Alignment shall be performed in such a manner that the primary beam, or a specular or diffuse reflection of a beam, does not expose the eye to a level above the applicable MPE. Written SOPs outlining alignment methods shall be available.

11.7 Protective Equipment

Eye protection (goggles or spectacles) or skin protection (clothing and gloves) and other devices that have been specifically selected for suitable protection against laser radiation may be required when other control measures are inadequate to eliminate potential

exposure above the applicable MPE.

11.8 Spectator Control

Spectators shall not be permitted within a laser-controlled area unless:

a. Appropriate approval from the supervisor has been obtained

b. The degree of hazard and avoidance procedure has been explained

c. Appropriate protective measures are taken

Table 2: Administrative and procedural control measures that are normally required for Class 3B and Class 4 lasers/laser systems

ADMINISTRATIVE AND PROCEDURAL CONTROL MEASURES	CLASSIFICATION	
	3B	4
Standard Operating Procedures	O	Y
Output Emission Limitations	LSO to determine	
Laser Worker Training	Y	Y
Authorized Personnel	Y	Y
Alignment Procedures	Y	Y
Eye Protection, if MPE is exceeded	Y	Y
Skin Protection, if MPE is exceeded	Y	Y
Spectator Control	O	Y
Homebuilt/Modification of Laser Systems	LSO will classify	
Entryway Controls	X	Y
Laser Controlled Area Warning Signs	Y	Y
Area Warning Device	O	Y
Protective Barriers and Curtains	O	Y
A laser used through optical fibre	LSO will decide on necessary controls	

LEGEND

Y --- Normally required
O --- Optional
X --- Not required

12 PROGRAM AUDIT

U of T - Environmental Health and Safety shall audit various components of the laser safety program (in conjunction with the LSO) on an annual basis and prepare a report to the Laser Safety Committee.

The audit may consist of but is not limited to the following:

a. Review of the inspections' records of Class 3B and Class 4 laser facilities for compliance with the U of T's Laser Safety Program;

b. Review of training records to confirm that laser users/laser laboratory workers have had appropriate training to work with Class 3B and Class 4 laser/laser systems;

c. Review of medical surveillance records to confirm that open-beam and homemade enclosed laser users have participated in the U of T's medical surveillance program;

d. Review of records vs. inspections to confirm that the registration/deregistration process is working effectively.

A Joint Health and Safety Committee may, as part of its inspection of the workplace and subject to access control procedures, inspect Class 3B and Class 4 laser facilities.

Appendix A - Laser Safety Permit System

U of T - Environmental Health and Safety will issue to all Permit Holders who are in charge of a laser laboratory and/or principal authority for Class 3B or Class 4 laser/laser systems a laser safety permit.

Procedure for issuing, renewing and archiving the permit

1. The Permit Holder (PH) who acquires (purchases, receives as a gift or loan, etc.) an open beam and homemade enclosed class 3B or 4 laser/laser system must register the laser with the LSO;

2. PH and all users of the laser must take, or have taken, the laser safety training;

3. The LSO commission the room in which the laser is used;

4. U of T - Environmental Health and Safety issues a laser permit. If the PH already has a laser safety permit, the LSO will revise the permit by adding the new laser and, if required the new room, on the permit;

5. The laser permit is valid for 3 years and can be revised as often as necessary and renewed at the expiration date;

6. When all the lasers under a permit are decommissioned, sold, donated, etc., the permit will be archived by the LSO.

The laser safety permit will contain the following:

U of T - Office of Environmental Health and Safety

LASER PERMIT

1. NAME OF PERMIT HOLDER: Laser Permit No.:
Department: Position: Revision No.:

2. PERIOD: This permit is issued for:

3. PERMITTED LOCATIONS

Room No.	Type	Building
	Research	
	Teaching	

4. EQUIPMENT

Serial Number	Manufacturer	Model	Type	Bldg/Room	Maximum output	Wavelength	Class
			Nd-YAG				
			Diode				

5. LASER PERMIT CONDITIONS

01. The Permit Holder will ensure that the location of the class 3B and call 4 lasers are approved by the LSO before use.
02. The Permit Holder will inform LSO about any change in the location or design modifications of each class 3B and class 4 laser.
03. All class 3B and class 4 laser users must participate in the laser safety training organized by the U of T Laser Safety Committee.
04. The Permit Holder will designate laser users for each class 3B and class 4 laser and ensure that all laser users are competent in the use and operation of that laser safely.
05. A list of authorized users, for every class 3B and class 4 laser registered under the permit, must be posted near the equipment.
06. The Permit Holder will ensure that all laser users have received training on the proper operation and hazards appropriate to the laser.
07. The Permit Holder will ensure that the Nominal Hazard Zone (NHZ) is defined for all lasers registered under this permit.
08. Appropriate laser warning signs or warning devices shall be posted to identify the NHZ.
09. The Permit Holder will ensure that appropriate laser safety goggles are always worn by all persons situated in the NHZ when exposure above the Maximum Permissible Exposure (MPE) is possible.
10. The Permit Holder will ensure that all appropriate engineering, administrative and procedural controls are implemented for all lasers registered under this permit.
11. The Permit Holder will ensure that all non-beam hazards are identified and appropriate precautions, including training, engineering, and administrative controls, are taken to control them.
12. The Permit Holder will ensure that Standard Operating Procedures and Alignment Procedures are developed, verified by the U of T Laser Safety Officer, approved by the Permit Holder, posted near the lasers and followed by laser users.
13. For decommissioning of class 3B and class 4 lasers, the Permit Holder will inform the LSO, ensure that the laser was disabled so that it cannot be used and that all laser signs have been removed.
14. The Permit Holder will ensure that visitors of the laser labs are informed about all beam and non-beam hazards and that they wear the appropriate personal protective equipment.
15. The Permit Holder will inform the LSO about the loan of any class 3B or class 4 lasers. The loan is permitted only to another Permit Holder, used in a similar laboratory by appropriately trained personnel.

<u>The Permit Holder must abide by the terms and conditions of this permit, the policies and procedures of the U of T Laser Safety Committee and the requirements of the Ontario Ministry of Labour, Training and Skills Development.</u>

Appendix B – Laser Inspection Checklists

U of T Environmental Health and Safety

LASER INSPECTION FORM
Class 3B laser/laser systems

Inspector: _____Date of Inspection: _____ Location (Building/Room): _____

Permit Number: _____ Accompanied by: _____

Laser Type:_____ Model # _____ Serial # _____

Other Information:_____

LASER POSTING, LABELING AND ROOM SECURITY MEASURES:

Entrances properly posted: Y N Comments: _____

Room security adequate: Y N Comments: _____

Windows/doorways/open portals in room covered: Y N NR Comments: _____

Laser class/hazard label in place: Y N Comments: _____

LASER UNIT SAFETY CONTROL MEASURES:

Protective housing in place: Y N Comments: _____

Interlock on housing: Y N Comments: _____

Interlock on housing functioning: Y N Comments: _____

Beam shutter present: Y N NR Comments: _____

Key control: Y N NR Comments: _____

ENGINEERING SAFETY CONTROL MEASURES:

Laser secured to table: Y N Comments: _____

Laser optics secured to prevent stray beams: Y N Comments: _____

Exposed beam path at normal eye level: Y N Comments: _____

Enclosed beam path: Y N Comments: _____

Limited open beam path: Y N Comments: _____

Totally open beam path: Y N Comments: _____

Beam barriers in place: Y N NR Comments: _____

Beam stops in place: Y N NR Comments: _____

Beam intensity reduced through filtration: Y N NA Comments: _____

Remote viewing of beam: Y N Comments: _____

Reflective materials kept out of beam path: Y N Comments: _____

Laser user checking for stray beams: Y N Comments: _____

Physical evidence of stray beams: Y N Comments: _____

ADMINISTRATIVE AND PROCEDURAL SAFETY CONTROL MEASURES:

Alignment procedures are available: Y N Comments: _____

Laser operated by authorized personnel: Y N Comments: _____

Excessive power/radiant energy accessible for required application: Y N Comments: _____

All supervisors/users/workers have laser safety training: Y N Comments: _____

Has homebuilt/modified laser/laser system been classified: Y N Comments; _____

Proper laser eye protection available: Y N NR Comments: _____

OTHER SAFETY MEASURES:

All Class 3B/4 lasers under the jurisdiction of this PH have been registered: Y N Comments: _____

All supervisors/users/workers have medical surveillance: Y N Comments: _____

Accident forms are available and accidents are reported: Y N Comments: _____

NON BEAM HAZARDS:

Toxic laser media in use: Y N Comments: _____

Hazardous laser media stored properly: Y N Comments: _____

Cryogens in use: Y N Comments: _____

Compressed gas in use: Y N Comments: _____

Gas cylinders properly restrained: Y N Comments: _____

Fume hood for dye mixing: Y N Comments: _____

Laser Generated Air Contaminant (LGAC) production: Y N Comments: _____

High voltage power hazard: Y N Comments: _____

Other electrical hazards: Y N Comments: _____

Collateral and plasma radiation hazard: Y N Comments: _____

Fire hazard: Y N Comments: _____

Explosion hazard: Y N Comments: _____

Mechanical hazards: Y N Comments: _____

Noise/Vibration hazards: Y N Comments: _____

Proper disposal of chemical wastes: Y N Comments: _____

ADDITIONAL COMMENTS:

_____

_____

SUMMARY OF ACTION REQUIRED

☐ Acceptable Safety Practices

☐ Improved Safety Measure(s) Required --- **minor issue(s)** to be addressed

☐ Improved Safety Measure(s) Required --- **major issue(s)** to be addressed

☐ Unacceptable Safety Practice(s) --- Requires action by following date(s):

_____

Legend: **Y** -- Yes, **N** -- No, **NA** -- Not Applicable, **NR** -- Not Required

LASER INSPECTION FORM
Class 4 laser/laser systems

Inspector: _____Date of Inspection: _____ Location (Building/Room): _____

Permit Number: _____ Accompanied by: _____

Laser Type: _____ Model # _____ Serial # _____

Other Information: _____

LASER POSTING, LABELING AND ROOM SECURITY MEASURES:

Entrances properly posted: Y N Comments: _____

Room security adequate: Y N Comments: _____

Windows/doorways/open portals in room covered: Y N NR Comments: _____

Entryway interlock system: Y N NR Comments: _____

Interlock functioning: Y N NR Comments: _____

A door, blocking barrier, curtain, etc. at entryway: Y N NR Comments:_____

Laser status indicator outside room: Y N NR Comments: _____

Laser class/hazard label in place: Y N Comments: _____

LASER UNIT SAFETY CONTROL MEASURES:

Protective housing in place: Y N Comments: _____

Interlock on housing: Y N Comments: _____

Interlock on housing functioning: Y N Comments: _____

Beam shutter present: Y N NR Comments: _____

Key control: Y N NR Comments: _____

Laser activation warning system (with emission delay) in place: Y N NR Comments: _____

Remote interlock connector (emergency shutoff) available: Y N NR Comments: _____

ENGINEERING SAFETY CONTROL MEASURES:

Laser secured to table: Y N Comments: _____

Laser optics secured to prevent stray beams: Y N Comments: _____

Exposed beam path at normal eye level: Y N NR Comments: _____

Enclosed beam path: Y N Comments: _____

Limited open beam path: Y N Comments: _____

Totally open beam path: Y N Comments: _____

Beam barriers in place: Y N NR Comments: _____

Beam stops in place: Y N NR Comments: _____

Beam intensity reduced through filtration: Y N NA Comments: _____

Remote viewing of beam: Y N Comments: _____

Reflective materials kept out of beam path: Y N Comments: _____

Laser user checking for stray beams: Y N Comments: _____

Physical evidence of stray beams: Y N Comments: _____

ADMINISTRATIVE AND PROCEDURAL SAFETY CONTROL MEASURES:

Alignment procedures are available: Y N Comments: _____

Laser operated by authorized personnel: Y N Comments: _____

Excessive power/radiant energy accessible for required application: Y N Comments: _____

All supervisors/users/workers have laser safety training: Y N Comments: _____

Has homebuilt/modified laser/laser system been classified: Y N Comments; _____

Proper laser eye protection available: Y N NR Comments: _____

OTHER SAFETY MEASURES:

All Class 3B/4 lasers under the jurisdiction of this PH have been registered: Y N Comments: _____

All supervisors/users/workers have medical surveillance: Y N Comments: _____

Accident forms are available and accidents are reported: Y N Comments: _____

NON-BEAM HAZARDS:

Toxic laser media in use: Y N Comments: _____

Hazardous laser media stored properly: Y N Comments: _____

Cryogens in use: Y N Comments: _____

Compressed gas in use: Y N Comments: _____

Gas cylinders properly restrained: Y N Comments: _____

Fume hood for dye mixing: Y N Comments: _____

Laser Generated Air Contaminant (LGAC) production: Y N Comments: _____

High voltage power hazard: Y N Comments: _____

Other electrical hazards: Y N Comments: _____

Collateral and plasma radiation hazard: Y N Comments: _____

Fire hazard: Y N Comments: _____

Explosion hazard: Y N Comments: _____

Mechanical hazards: Y N Comments: _____

Noise/Vibration hazards: Y N Comments: _____

Proper disposal of chemical wastes: Y N Comments: _____

ADDITIONAL COMMENTS:

_____

_____

SUMMARY OF ACTION REQUIRED

☐ Acceptable Safety Practices

☐ Improved Safety Measure(s) Required --- **minor issue(s)** to be addressed

☐ Improved Safety Measure(s) Required --- **major issue(s)** to be addressed

☐ Unacceptable Safety Practice(s) --- Requires action by following date(s):

_____

Legend: **Y** -- Yes, **N** -- No, **NA** -- Not Applicable, **NR** -- Not Required

Appendix C – Laser Loan Form

U of T Office of Environmental Health and Safety

01. An organization that will receive a class 3B or class 4 laser from the U of T

Legal Name:

Mailing Address:

Model of the laser(s) to be used:

Description of intended use:

02. Designated Laser Safety Officer of the organization that will receive the laser

Name:

Job Title:

Phone: E-mail:

Please attach a certificate of training, or equivalent, from a laser safety training program that satisfies the requirements of the current standard ANSI Z.136.1

By signing below, I certify, that this laser is used in a manner consistent with the requirements of the current ANSI Z 136.1 standard, I will ensure that all persons using this device, or within the Nominal Hazard Zone, have received training commensurate with the type of laser device and the environment in which it is to be used. I hereby accept full responsibility for the safe and proper operation of this device.

Signature of the Laser Safety Officer Date:

03. The authorized person of the organization that will receive the laser

Name:

Job Title:

Phone: E-mail:

By signing below, I certify that I am authorized to receive this laser device, I acknowledge that the laser device is dangerous and represents a serious risk to the health and safety of humans if it is not used properly. Our organization will ensure that the laser is not used in a manner that will endanger public safety or violate any Canadian safety regulations. I hereby accept full liability for any litigations or claims resulting from the use of this device.

Signature Date:

Appendix D – List of authorized laser users

U of T – Environmental Health and Safety

Permit Number:

Permit Holder Name:

Date:

Name	Date of last training	Type of training
	10.03.2012	Online laser safety training
	10.03.2015	Online laser refresher
	10.03.2019	Laser safety awareness

Appendix E – Laser Registration

Permit Holder

Name:

Title:

Department:

Phone:

E-mail:

Building and room(s) where the laser is used/stored:

Main Laboratory Contact

Name:

Phone:

E-mail:

Lasers

Production class (commercial, home-built, modified):

Intended use (research, treatment, etc.)

For CW lasers:

Serial number	Manufacturer	Model	Type	Wave-length (nm)	Class	Maximum power (W)	Beam diameter (mm)	Beam divergence (mrad)
			Diode					

For pulsed lasers:

Serial number	Manufacturer	Model	Type	Wave-length (nm)	Energy per pulse (J)	Pulse duration (s)	PRF (Hz)	Beam diameter (mm)	Beam diver-gence (mrad)
			NdYAG	1064	0.004	$5*10^{-9}$	100	2	2
				532	0.002	$5*10^{-9}$	100	2	2
				355	0.001	$5*10^{-9}$	100	2	2
				266	0.0005	$5*10^{-9}$	100	2	2

Appendix F – Laser Room Commissioning

Class 3B Laser Room

The LSO will commission a room in which lasers with maximum class 3B open beam are used by checking the following:

1. Class 3B laser sign on all entrances to the room
2. The laser beam is enclosed as much as possible
3. The laser and the optics are fixed on the table
4. The laser beam does not leave the optical table. All laser beams and stray beams are terminated with a stop
5. Laser direct beam or specular reflections are not directed towards the entrances. If this is necessary, the entrance must be protected with a curtain/barrier
6. The laser beam must not be directed toward windows. If this is necessary, the windows must be covered
7. The laser beam is not at eye level

Class 4 Laser Room

The LSO will commission the room containing class 4 lasers open beam lasers by checking the following:

1. Class 4 laser sign on all entrances to the room
2. All entrances to the room must:
3. Have interlocks (defeatable or non-defeatable) connected with the laser power to shut down the laser or to a shutter to block the beam, or
4. A blocking barrier/curtain and a laser warning light that indicates when the laser is operating
5. All entryways must allow both rapid entrance and exit to the laser-controlled area under any conditions
6. All windows are covered
7. The laser beam is enclosed as much as possible
8. The laser and the optics are fixed on the table
9. The laser beam does not leave the optical table. All laser beams and stray beams are terminated with a stop
10. Flammable materials are kept out of the laser beam
11. The emergency "Panic Button" (switch or equivalent device) is available and in good working condition

Rooms in which class 3B or class 4 lasers are used with fibre optics

If the beam is enclosed in the fibre and the sample, no further requirements are necessary. If the laser beam can, at any time, exit the fibre in free space, the LSO will determine the NHZ for the laser and the particularly used fibre. The area within which the irradiance is above the MPE must be enclosed by curtains/barriers/screens, access must be controlled. Inside this area only authorized trained personnel, wearing protective eyewear must be allowed. If the area is extended to the whole room, controls for the applicable laser class (see above) must be implemented.

Appendix G – Decommissioning Class 3B and 4 lasers

All class 3B and 4 lasers must be decommissioned at the end of their use. The following steps must be followed:

1. The laser must be made inoperative by removing/destroying mirrors from the optical cavity
2. For lasers with toxic active medium (toxic gases or dyes), the laser active medium must be removed, and the optical cavity cleaned
3. All toxic materials must be disposed of according to the applicable regulations
4. All laser signs must be removed
5. The electrical power supply must be disposed of as any other electrical equipment

Appendix H – External Contractors

When an external contractor is involved in the repair/maintenance/alignment of a laser system in a U of T laboratory, the following form must be completed and sent to the office of Environment Health and Safety (attention LSO). The work can start only after the LSO approval is obtained.

01. U of T Laboratory Information

Building/Department:	Lab room number:
Name of the PI:	E-mail address:
Name of the contact person in the lab:	E-mail address:

02. Laser Equipment

Manufacturer:	Model:
Serial Number:	Medium type:
Wavelength:	Maximum power/energy:
Laser class:	Type of work:

03. Contractor's Information

Contractor's name:	Company's name:
E-mail Address:	Phone number:
Years of experience in the field:	Years of experience with this type of laser:

04. Additional Information about work to be performed

Will work require the opening of the housing/enclosure of the laser system?: Yes No
Will work require disabling interlocks of the laser system?: Yes No
Will work require working with an energized open beam?: Yes No

05. Additional Permit Holder conditions:

1. The Permit Holder will ensure appropriate laser warning signs and/or warning devices are posted/installed as required to identify the NHZ.
2. All persons present in the NHZ must have the Permit Holder's approval.
3. All persons must have proper laser safety training and must wear appropriate laser safety goggles.

Permit Holder's name	Permit Holder's signature	Date (DD.MM.YYYY)

06. Laser Safety Condition:

The Contractor(s) will abide by the rules outlined below which are following the U of T Laser Safety Program and American National Standard for Safe Use of Lasers - ANSI Z136.1 (2014).

1. The Contractor(s) must have the safety training and education commensurate with the class of the laser/laser equipment contained inside the housing.
2. The Contractor(s) must be qualified to operate and work in proximity to the lasers identified above.
3. The Contractor(s) will ensure the lasers listed above are operated only in the spaces listed above (and within the nominal hazard zone-NHZ).
4. The Contractor(s) must use appropriate personal protective equipment (PPE), including laser safety eyewear, when the risk of exposure above MPE is present.
5. The Contractor(s) will ensure that while the lasers are being serviced or repaired if she/he needs to leave the NHZ for any time, the beam is terminated, so there is no risk of exposure above MPE.
6. The Contractor(s) will have the necessary procedures to align, operate, service and maintain the lasers being serviced.
7. The Contractor(s) will ensure that appropriate engineering, administrative and procedural controls are implemented and followed for the laser being serviced.
8. The Contractor(s) will ensure all unsafe conditions are corrected promptly.
9. The Contractor(s) will report all accidents/incidents to the U of T LSO without any delays.
10. Decommissioning (where applicable) of Class 3B and Class 4 lasers must be completed as outlined in the U of T Laser Safety Manual, following U of T LSO approval.
11. At the end of the work, all safety enclosures and interlocks will be restored to their original state.

Contractor's name	Contractor's signature	Date (DD.MM.YYYY)

Approved by: U of T LSO	U of T LSO signature	Date (DD.MM.YYYY)