



**DALHOUSIE  
UNIVERSITY**

# **LASER SAFETY PROGRAM**

Prepared by the  
**Environmental Health and Safety Office**  
Dalhousie University

2019

Date Issued:	2015-XX-XX	<b>Laser Safety Program</b>	Doc. No.	
Date Revised:	2019-01-XX		Version No.	2

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## 1. Introduction and Scope

A number of teaching and research activities at Dalhousie University employ the use of lasers. The policies and procedures described in this manual are designed to provide a reasonable and practical standard for the safe use of these lasers.

Dalhousie University is committed to providing a safe and healthy environment in its research and teaching laboratories. Providing such an environment is a shared responsibility of all those involved, including the University, departmental chairs, laboratory supervisors, staff and students.

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

The basic elements of the program are:

- Registration of all Class 3B and Class 4 lasers/laser systems
- Provision for the inspection of all Class 3B and Class 4 lasers/laser systems
- Provisions for the training and education of laser operators
- Requirements for reporting accidents/incidents involving Class 3B and Class 4 lasers/laser systems
- Requirements for proper personal protective equipment
- Requirements for engineering controls
- Requirements for administrative and procedural controls

### Objective of the Laser Safety Program

Under the safety guidelines established established by the American National Standards Institute (ANSI), it is the objective of this laser safety program to:

- Identify potential hazards to health and safety associated with lasers, laser systems, and laser operations.
- Prescribe suitable means for the evaluation and control of identified hazards.
- Investigate all accidents involving the use of lasers and institute corrective active to prevent a reoccurrence.

### Scope

This program applies to all Class 3B and Class 4 laser and laser systems in controlled areas (indoors) under the jurisdiction of Dalhousie University for non-human use, and to all those identified as principle investigators, laser supervisors, and laser workers (see definitions).

## 2. Definitions

### Continuous Wave (CW)

The output of a laser, which is operated in a continuous rather than a pulsed mode. A laser operated with a continuous output greater than or equal to 0.25s is regarded as a CW laser.

### Controlled Area

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

### Education Research Laboratories

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

### Hazard Assessment Form

A written assessment of hazards in the education research laboratory that must be completed with the standard operating procedure upon laser registration.

### 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.

### Laser Permit

A Dalhousie University document issued by the LSO to all Principal Investigators who are in charge of open beam class 3B or class 4 lasers

### Laser Permit Holder

See “Principal Investigator”

### 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 that exceed the Class 3R AEL (5 times Class 1 AEL for invisible lasers, and 5 mW for visible). Class 3B lasers cannot exceed 500 mW for continuous wave. 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

Class 4 lasers are high power lasers that include all lasers with beam power greater than class 3B (exceeding 500 mW). A Class 4 laser can burn the skin, and cause permanent eye damage as a result of direct or diffuse beam viewing. These lasers may also ignite combustible materials, and thus may represent a fire risk. 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 Principal Investigator for Class 3B and Class 4 laser/laser systems and laser workers.

#### Laser Worker

One who operates or works in proximity to Class 3B or Class 4 laser/laser systems.

#### Laser Safety Officer

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

#### Maximum Permissible Exposure (MPE)

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

#### Nominal Ocular Hazard Distance (NOHD)

The distance along the axis of the unobstructed beam from a laser, fiber end, or connector to the human eye beyond which the irradiance or radiant exposure does not exceed the applicable MPE.

#### 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.

#### Principal Investigator

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

### Standard Operating Procedures (SOPs)

A written procedure that 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 Dalhousie University.

### 3.1. Laser Safety Advisory Group

The Laser Safety Advisory Group is comprised of laser permit holders and laser users, who correspond on an as needed basis on any information regarding the safe housing and operation of laser on Dalhousie University campuses, including updates to the Laser Safety Program.

### 3.2. Laser Safety Officer

The Laser Safety Officer (LSO) is one who is directed by the EHS Office to oversee the entirety of the laser safety program, and is knowledgeable in the evaluation and control of laser hazards.

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

- **Safety Program.** To provide and update the Dalhousie University Laser Safety Program as well as fulfil the requirements of the Laser Safety Program. To communicate all laser safety updates to the Laser Safety Advisory Group and notify all principal investigators and the Laser Advisory Group of the laser safety program training and Dalhousie University Laser Safety Program 2019
- **Hazard Evaluation.** To perform hazard evaluation of laser work area, including establishment of Nominal Hazard Zones (NHZs)
- **Classification.** To classify or verify classifications of Class 3B and 4 lasers/laser systems used in areas controlled by Dalhousie University
- **Control Measures.** To ensure prescribed control measures are implemented and maintained.
- **Procedure Approval.** To approve Class 3B and Class 4 SOPs as well as to issue a laser safety permit ([Appendix A](#)) to all principal investigators who are in possession of an open beam class 3B or Class 4 laser/laser system
- **Protective Equipment.** To ensure protective equipment (such as eyewear) is audited periodically to assure proper working order and worker compliance

- **Training.** To ensure laser safety education and training are provided to laser users.
- **Audits, Surveys and Inspections.** To audit the implementation and effectiveness of this program on an on-going basis. Ensure corrective action is taken on noted deficiencies.
- **Facility and Equipment.** To approve new laser installations (and modifications), facilities, and laser equipment prior to use.
- **Accidents.** To develop a plan to respond to laser incidents (suspected or actual).

### 3.3. Department Head

The Department Head has the following responsibilities:

- To identify all principal investigators 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 lasers/laser systems.
- To ensure that all components of the Dalhousie University Laser Safety Program are implemented in the department.

### 3.4. Principal Investigator

One who has charge of a laser laboratory and/or principal authority for Class 3B or Class 4 laser/laser systems.

The Principal Investigator may **delegate** some or all of his/her responsibilities to a laser supervisor. However, the Principal Investigator cannot **discharge** these responsibilities to a laser supervisor.

The Principal Investigator has the following responsibilities:

- To register all Class 3B and Class 4 lasers and laser systems before use, and to deregister the decommissioned ones with the LSO
- To identify all Class 3B and Class 4 laser supervisors and workers under his/her authority to the LSO
- To ensure that laser supervisors and laser workers participate in Dalhousie University's Laser Safety Program training prior to operating or working in proximity to Class 3B or Class 4 laser/laser systems.
- To provide and enforce the use of appropriate personal protective equipment when required
- 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 which meet the requirements of the SOP(s)

- 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
- To ensure that all Class 3B and Class 4 laser 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
- To permit only trained laser supervisors/workers to operate or work in proximity to Class 3B or Class 4 laser or laser systems
- To ensure that all administrative and engineering controls are followed
- To correct unsafe conditions in a timely manner
- To ensure that all spectators are properly informed of and protected from potential laser hazards
- To report known or suspected accidents to the LSO at the EHS Office, or in his/her absence the Director of EHS within 24 hours of the accident
- To inform the LSO when a laser is loaned to another laboratory
- To inform the LSO about class 3B and class 4 lasers that need to be decommissioned and to follow the laser decommissioning procedure ([Appendix E](#))

### 3.5. Laser Supervisor

An individual who has been delegated supervisory responsibilities for Class 3B and Class 4 laser/laser systems and laser workers. He/she has the following responsibilities:

- To participate in Dalhousie's Laser Safety Program training prior to operating or working in proximity to Class 3B or Class 4 laser/laser systems
- 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
- To operate Class 3B and Class 4 laser/laser systems safely and in a manner consistent with safe laser practices, requirements and written SOPs
- To operate Class 3B and Class 4 laser/laser systems only under the conditions authorized by the Principal Investigator
- To report all unsafe conditions to the Principal Investigator
- As directed by the Principal Investigator, to provide instruction and supervision to laser workers
- As directed by the Principal Investigator, to conduct other activities associate with the Dalhousie's Laser Safety Program
- To promptly report known or suspected accidents and unsafe conditions to the Principal Investigator.

### 3.6. Laser Worker

The laser worker is one who operates or works in proximity to Class 3B or Class 4 lasers/laser systems. He/she has the following responsibilities:

- To participate in Dalhousie's Laser Safety Program training prior to operating or working in proximity to Class 3B or Class 4 laser/laser systems
- 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
- To operate Class 3B and Class 4 laser/laser systems safely and in a manner consistent with safe laser practices, requirements and written SOPs
- To operate Class 3B and Class 4 laser/laser systems only under the conditions authorized by the laser supervisor/principal investigator
- To report all unsafe conditions to the laser supervisor/principal investigator
- To promptly report known or suspected accidents and unsafe conditions to the laser supervisor/Principal Investigator.

## 4. Class 3B and Class 4 Laser Registry

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

- i. To identify areas where Class 3B and Class 4 lasers are present so that appropriate administrative and engineering controls may be put in place.
- ii. To enable the laser and laser systems to be inspected on a regular basis for compliance with the university's Laser Safety Program.

The record shall contain the following information:

- i. The Principal Investigator's name and title
- ii. The Principal Investigator's department
- iii. The location of the laser (building and room #)
- iv. Type of laser
- v. Production class
- vi. Laser Classification
- vii. The proposed use

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

Open beam Class 3B and Class 4 lasers must be used only in rooms/areas commissioned by the Dalhousie University LSO according to [Appendix F](#) of this program.

Lasers no longer in use must be decommissioned according to [Appendix F](#), prior to disposal.

The laser Permit Holder must inform the Dalhousie University LSO prior a loan or donation of an open beam Class 3B or Class 4 laser to a different Dalhousie University laboratory or 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 in a safe manner.

The LSO is responsible for inspecting all new Class 3B and Class 4 laser/laser systems and all existing Class 3B and Class 3 laser/laser facilities for compliance with the university Laser Safety Program and to report to the Environmental Health and Safety Office and the Laser Safety Advisory Group. The forms (one for Class 3B and one for Class 4 lasers) that will be used in these inspections are attached (Appendix E).

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:

- i. The date of inspection
- ii. The name of the person who accompanied the LSO
- iii. The non-compliances found
- iv. Recommendations to fix the non-compliances
- v. A time limit to implement the necessary corrections

## 6. Training and Education

### On-line Laser Safety Training

Dalhousie University offers a Laser Safety Training Course to all laser users. The training is available as a self-registered course on Blackboard Learn, which can be accessed through the Environmental Health and Safety website. All potential laser users must pass the course prior to commencing any work with lasers/laser systems on campus.

### Laboratory Specific Training

Before commencement of any work using lasers in a Dalhousie University laboratory, the Principal Investigator is responsible for ensuring the user receives laser training specific to the laser/laser systems that will be used.

While the training is provided by previously trained laboratory personnel, it is required that the Laser Safety Officer is informed of the training. The training shall be documented on the SOP (Appendix D) which must be updated and submitted to the LSO upon each new personnel training.

Refresher training commensurate to the laser class and hazard is also required for all laser users. The frequency of this refresher training should take in account the end goal of laser users being proficient in laser safety awareness and knowledge to continue to work safely with their lasers.

## 7. Accident/Incident Reporting and Emergency Response

Dalhousie University policy requires reporting of all accidents/incidents which result in, or have the potential to result in, personal injury. The Principal Investigator is responsible for reporting all accidents/incidents involving Class 3B and Class 4 laser/laser systems to the LSO and to EHS via usual accident/incident reporting protocol.

In the event of an emergency, Security Services must be immediately contacted at (902) 494-4109. Security Services will contact the appropriate emergency responders as per the situation. In all emergency situations involving lasers/laser systems, the LSO must also be notified at the earliest time possible.

## 8. Personal Protective Equipment

Enclosure of the laser equipment or beam path is the preferred method of control, since 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 Principal Investigator shall ensure that laser protective eyewear is available and worn by all personnel within the Nominal Hazard Zone of Class 3B and Class 4 laser/laser systems where the exposures above the MPE can occur.

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

Laser supervisors/workers shall wear protection as required and shall inspect laser protective eyewear for damage prior to 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 skin.

If engineering controls are not entirely feasible, then skin covers and/or "sun screen" 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 provide protection for the arms.

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

## 9. 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 to other hazards associated with the operation of 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 in order to reduce the potential for hazard 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 (**section 10**) to provide equivalence in protection. For these applications, a hazard analysis shall be conducted. In order to assure 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 required for both Class 3B and Class 4 laser/laser systems:

### 9.1. Protective Housing

A protective housing is a physical barrier preventing laser radiation in excess of 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.

### 9.2. 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 instituted appropriate to the class of maximum accessible emission to ensure safe operation. These controls may include, but are not limited to:

- Access restriction
- Eye protection

- Area controls
- Barriers, shrouds, beam stops, etc.
- Administrative and procedural controls
- Education and training

### 9.3. 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**" (above) have been fully implemented.

### 9.4. Service Access Panels

These panels are part of the protective housing, which are 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.

### 9.5. 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 code).

### 9.6. 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.

### 9.7. Collecting Optics

All 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 in excess of the MPE under all conditions of operation and maintenance.

## 9.8. 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.

## 9.9. 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, a 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.

## 9.10. Totally 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.

## 9.11. 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.

## 9.12. 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 in excess of the MPE when the beam is not required.

### 9.13. 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, or a warning light (visible through protective eyewear), or a verbal "countdown" command during activation or start-up of the laser.

### 9.14. Emission Delay

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

### 9.15. 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.

### 9.16. 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.

### 9.17. Indoor Laser Controlled Area

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

#### Control measures required for both Class 3B and Class 4 Lasers

- Posting with appropriate warning signs. Sign must be posted at the entryway and, if necessary, within the laser controlled area.
- Operation by authorized personnel only.
- Operation or attendance by appropriately trained personnel only.
- Limitation of path beyond indoor controlled area.
- Personnel within the laser-controlled area must be provided with the appropriate eye protection and their use enforced when working within the NHZ/NOHD

#### Control measures recommended for Class 3B but required for Class 4 lasers

- Direct supervision by an individual knowledgeable in laser safety.
- Access to the area by spectators is limited and requires approval.
- Any potentially hazardous beam must be terminated in a beam stop of appropriate material.
- Only diffusely reflecting materials are allowed in or near the beam path, where feasible.
- 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.
- 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.
- 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 required for Class 4 lasers

- All personnel entering a Class 4 NHZ must be appropriately trained, provided with appropriate protective equipment, and follow all applicable administrative and procedural controls.
- All Class 4 area/entryway safety controls must allow both rapid entrance and exit to the laser controlled area under any conditions.
- For emergency conditions there must be a clearly 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 **one of the following options** for area or entryway safety controls:

#### Non-Defeatable (non-override) Area or Entryway Safety Controls

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 non-defeatable 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 clearly 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:

- All authorized personnel must be adequately trained and provided with adequate personal protective equipment upon entry.
- A door blocking barrier/screen/curtain, etc., must be used to block or attenuate the laser beam at the entryway to assure that laser radiation outside the area does not exceed the MPE and that no one receives exposure above the MPE immediately upon entry.
- 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 (high voltage off), *and* a second light indicates when the laser is powered up (high voltage applied - but no laser emission), *and* a third light (flashing optional) indicates when the laser is operating (emission on).

### 9.18. Lasers used through Optical Fiber

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

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

ENGINEERING CONTROL MEASURES	CLASSIFICATION	
	3B	4
Protective Housing	Y	Y
Without Protective Housing	LSO will determine	
Interlocks on Protective Housing	Y	Y
Service Access Panel	Y	Y
Key Control	Optional	Y
Viewing Portals	Y	Y
Collecting Optics	Y	Y
Enclosed Beam Path	No further controls	
Limited Open Beam Path	NHZ analysis required	
Totally Open Beam Path	NHZ analysis required	
Labels	Y	Y
Area Posting	Y	Y
Indoor Laser Controlled Area	Y	Y
Temporary Laser Controlled Area	Y	Y
Laser used through Optical Fiber	LSO will decide	

## 10. 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, or 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:

### 10.1. Standard Operating Procedures (SOPs)

Standard Operating procedures (SOPs) for Class 3B and Class 4 laser/laser systems shall be maintained with the laser equipment and must always be available as a reference for all laser workers. SOPs may include the laser instruction manual (prepared by manufacturer) and as appropriate, additional written information to ensure compliance with good work practices and safety.

SOPs are required for:

- Experimental set-up and system alignment
- Routine operation
- Laser maintenance and set-up
- Non-standard/modified laser/laser systems

Before completing an SOP, a Hazard Assessment Form must be completed (Appendix C). The Hazard Assessment Form and SOP must be submitted to the LSO for approval. All updated versions of SOPs also must be submitted to the LSO.

### 10.2. Output Emission Limitations

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

### 10.3. Laser Worker Training

Education and training shall be provided for all laser workers (**section 6**). The level of training shall be commensurate with the level of potential hazard.

### 10.4. Authorized Personnel

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

## 10.5. 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.

## 10.6. Protective Equipment

Eye protection or skin protections and other devices which have been specifically selected for suitable protection against laser radiation may be required when other control measures are inadequate to eliminate potential exposure in excess of the applicable MPE. The optical density and wavelength will be specified on the laser protective eyewear and should be appropriate for the wavelength and power of laser being used.

## 10.7. Spectator Control

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

- Appropriate approval from the supervisor has been obtained
- The degree of hazard and avoidance procedure has been explained
- Appropriate protective measures are taken

## 10.8. 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.

The following table summarizes the administrative and procedural control measures that are required for Class 3B and Class 4 laser/laser systems:

ADMINISTRATIVE AND PROCEDURAL CONTROL MEASURES	CLASSIFICATION	
	3B	4
Standard Operating Procedures	Y	Y
Output Emission Limitations	LSO will determine	
Laser Worker Training	Y	Y
Authorized Personnel	Y	Y

Alignment Procedures	Y	Y
Eye Protection	Y	Y
Skin Protection	Y	Y
Spectator Control	optional	Y
Homebuilt/Modification of Laser Systems	LSO will classify	
Entryway Controls	N	Y
Laser Controlled Area Warning Signs	Y	Y
Area Warning Device	optional	Y
Protective Barriers and Curtains	optional	Y
Laser used through Optical Fiber	LSO will decide	

## 11. Program Audits

The Environmental Health and Safety office shall audit various components of the Laser Safety Program on an annual basis. The audit may consist of:

- i. Review of the inspections records of Class 3B and Class 4 laser facilities for compliance with the Dalhousie University Laser Safety Program
- ii. Review of training records to confirm that laser supervisors/workers have had appropriate training to work with Class 3B and Class 4 laser/laser systems
- iii. Review of records vs. inspections to confirm that the registration process is working effectively

## Appendix A – Laser Permit System

The Environmental Health and Safety Office will issue to all Principal Investigators who have charge of a laser laboratory and/or principal authority for Class 3B or Class 4 lasers/laser systems a Laser Permit.

### Procedure

- i. The Principal Investigator (PI) who acquires an open beam Class 3B or 4 laser/laser system must register the laser with the LSO. The Laser Registration Form (Appendix B), Hazard Assessment Form (Appendix C), and Standard Operating Procedures (Appendix D) must be completed for registration.
- ii. PI and all users if the laser must take, or have taken, the online laser safety training
- iii. PI and all users must read the Laser Safety Program 2019
- iv. The LSO commissions the room in which the laser is used.
- v. The LSO issues a Laser Safety Permit
- vi. The Laser Safety Permit is valid for two years and should be revised as often as necessary
- vii. The Laser Safety Permit will be renewed at the expiry time by the LSO after a request is made by the PI. If no request is made, the laser/laser system cannot be operated.
- viii. When all lasers under a permit are decommissioned, the permit will be archived by the LSO.

### Contents of Laser Safety Permit

- i. Registration date
- ii. Expiration date
- iii. Department
- iv. Building
- v. Room
- vi. Principal Investigator
- vii. Laser Inventory
- viii. List of Authorized Users
- ix. Acknowledgment of Training
- x. PI Signature
- xi. LSO Signature

## Appendix B – Laser Registration Form



### Laser Registration Form

All Class 3B and 4 lasers on a Dalhousie University campus must be registered and permitted by the Laser Safety Officer at the Environmental Health & Safety Office.

Complete all information and submit to the Laser Safety Officer (LSO) by email, fax, or interdepartmental mail. Please ensure a completed Hazard Assessment Form and SOP are attached (templates are available at [www.dal.ca/safety](http://www.dal.ca/safety)).

#### Laser Safety Contact

Jill Robertson, LSO  
[j.roberston@dal.ca](mailto:j.roberston@dal.ca) (e)  
(902) 494-1398 (p)  
(902) 423-5242 (f)  
1391 Seymour St

#### Contact Information

Principle Investigator	
Phone No.	
Email	
Contact Name	
Contact Phone No.	
Contact Email	
Building	
Department	
Room No.	

#### Laser Information

Laser Manufacturer	
Model No.	
Serial No.	
Laser Type	
Classification (3B or 4)	
Optical Wavelength (nm)	
Beam Diameter (nm)	
Beam Divergence (nm)	

Mode

<input type="checkbox"/> Continuous Wave		Average Power (watts)	
<input type="checkbox"/> Pulsed	Joules/pulse	Repetition frequency	
<input type="checkbox"/> Q-switched		Pulse width	

Purpose or Use


Laser Operators

1.	2.
3.	4.
5.	6.
7.	8.
9.	10.
11.	12.
13.	14.
15.	16.
17.	18.
19.	20.

PI Signature \_\_\_\_\_ Date \_\_\_\_\_

LSO Signature \_\_\_\_\_ Date \_\_\_\_\_

## Appendix C – Hazard Assessment Form Template



**NAME OF DEPARTMENT**  
**Laser Hazard Assessment Form**

**Task / Description:** \_\_\_\_\_

**Laser Class**

Class 3B  Class 4

**Wavelength**

<400 nm (cornea/lens/skin hazard)  400-1400 nm (retinal hazard)  >1400 nm (cornea/lens hazard)

**Potential Beam Hazards**

Open Beam  Specular Surfaces  Diffuse Surfaces (Class 4)  
 Viewing Windows  NHZ/NOHD defined  Fiber Laser  
 Other: \_\_\_\_\_

Describe the identified potential hazards. Attach additional sheets as necessary.

**Potential Non-Beam Hazards**

Chemical (contact/vapor/dust)  Noise  Thermal  
 Fire/Explosion  Biological  Electrical/High Voltage  
 LGACs (irradiance > 10<sup>3</sup> W/cm<sup>2</sup>)  Ionizing Radiation  Mechanical (pinch, crush, etc.)  
 Other: \_\_\_\_\_

Describe the identified potential hazards. Attach additional sheets as necessary.

**Personal Protective Equipment Required**

Eye Protection (OD and  $\lambda$ : \_\_\_\_\_ )  Gloves (type: \_\_\_\_\_ )  Respirator<sup>1</sup>  
 Face Shield  Lab Coat (type: \_\_\_\_\_ )  
 Other: \_\_\_\_\_

Describe the personal protective equipment required. Attach additional sheets as necessary.

**Accident Procedures**

Describe any procedures to take in the event of an accident. Attach additional sheets as necessary.

**Further Requirements**

- |                                      |   |  |
|--------------------------------------|---|--|
| <input type="checkbox"/> Shielding   | <input type="checkbox"/> Special Training         | <input type="checkbox"/> Standard Operating Procedure <sup>2</sup> |
| <input type="checkbox"/> Ventilation | <input type="checkbox"/> Waste Disposal Procedure | <input type="checkbox"/> Contingency Plan (power/ventilation, etc) |
| <input type="checkbox"/> MSDS        | <input type="checkbox"/> Transportation / Storage | <input type="checkbox"/> Designated Area (e.g. Fume Hood)          |

Explain any further requirements. Attach additional sheets as necessary.

Approved By: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

<sup>1</sup>Must be approved by EH&S prior to use.

<sup>2</sup>Written SOP's are required when this assessment identifies the potential for a serious injury.

# Appendix D – Standard Operating Procedure (SOP) Template



**NAME OF DEPARTMENT**  
**Standard Operating Procedure**

<b>SOP Title:</b>	Enter SOP Title
-------------------	-----------------

<b>SOP Author:</b>		<b>Lab Supervisor:</b>	
--------------------	--	------------------------	--

<b>Approved By:</b>			
---------------------	--	--	--

<b>Signature:</b>		<b>Date:</b>	
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**Standard operating procedures having potential hazards must be preceded by a Hazard Review.**

<b>Hazard Review Approved By:</b>		<b>Date:</b>	
-----------------------------------	--	--------------	--

### 1. Description

Provide a brief description of the procedure, including its purpose. Do not enter detailed process steps (to be entered in section 12).

--

### 2. Hazardous Materials Used

List any hazardous materials used as identified by a hazard review.

--

### 3. Potential Beam Hazards

List potential hazards as identified by a hazard review.

--

### 4. Potential Non-Beam Hazards

List potential hazards as identified by a hazard review.

--

**5. Approvals Required**

Describe any approvals necessary for the authorization of persons undertaking this procedure.

**6. Designated Area**

Describe where this procedure may be undertaken.

**7. Special Handling Procedures and Storage Requirements**

List any specialized handling procedures / storage requirements as specified in a hazard review.

**8. Personal Protective Equipment**

List any personal protective equipment required as specified in a hazard review.

**9. Engineering/Ventilation Controls**

List any engineering/ventilation controls required as specified in a hazard review.

**10. Spill and Accident Procedures**

List any spill and accident procedures required as specified in a hazard review.

**11. Waste Disposal**

List any waste disposal procedures required as specified in a hazard review.

**12. Training Requirements**

List any waste training requirements required as specified in a hazard review.

**13. Detailed Procedure**



# Appendix E – Laser Inspection Form



## Laser Inspection Form

Inspector's Name: \_\_\_\_\_ Date of Inspection: \_\_\_\_\_

Location of Laser: \_\_\_\_\_

Principal Investigator: \_\_\_\_\_ Phone No. \_\_\_\_\_

Lab Contact: \_\_\_\_\_ Phone No. \_\_\_\_\_

Laser Inspected: \_\_\_\_\_

Laser Inventory up to date

New Inspection       Follow-up Inspection

### Laser Posting, Labelling and Security

1. Entrance properly posted	YES	NO	N/A
2. Security adequate	YES	NO	N/A
3. Entryway Controls (Interlock system)	YES	NO	N/A
4. Interlock functioning	YES	NO	N/A
5. Laser status indicator in place	YES	NO	N/A
6. Laser class label posted	YES	NO	N/A
7. Laser hazard label posted	YES	NO	N/A
8. Laser aperture label in place	YES	NO	N/A
9. Visible/audible warning devices	YES	NO	N/A
10. Equipment label on housing/control panel	YES	NO	N/A
11. Spectator access is limited	YES	NO	N/A

### Laser Unit Safety Controls

12. Protective housing in place	YES	NO	N/A
13. Interlock on housing	YES	NO	N/A
14. Interlock on housing operational	YES	NO	N/A
15. Service panel interlocked or requires tool	YES	NO	N/A
16. Beam shutter present	YES	NO	N/A
17. Key operation	YES	NO	N/A
18. Laser activation indicator on console	YES	NO	N/A
19. Beam power meter available	YES	NO	N/A
20. Emergency shutoff available	YES	NO	N/A

### Engineering Safety Controls

21. Laser secured to table	YES	NO	N/A
22. Laser optics secured	YES	NO	N/A
23. Beam path not at eye level	YES	NO	N/A
24. Beam is enclosed fully	YES	NO	N/A
25. Beam barriers in place	YES	NO	N/A
26. Beam stops in place (fire resistant material)	YES	NO	N/A
27. Remote viewing of beam <MPE	YES	NO	N/A
28. Beam condensed or enlarged	YES	NO	N/A
29. Beam focused	YES	NO	N/A
30. Beam intensity filtered	YES	NO	N/A
31. Fiber optics used	YES	NO	N/A
32. Windows in room covered	YES	NO	N/A
33. Reflective materials not in beam path	YES	NO	N/A
34. Check for stray beams	YES	NO	N/A
35. Diffuse reflection hazard (Class 4)	YES	NO	N/A

### Administrative Controls

36. SOP's up to date	YES	NO	N/A
37. SOP posted	YES	NO	N/A
38. SOP for alignment procedures	YES	NO	N/A
39. Laser users remove jewellery/watches	YES	NO	N/A
40. Emergency contacts posted	YES	NO	N/A
41. Emergency procedures posted	YES	NO	N/A
42. All users reviewed safety procedures	YES	NO	N/A
43. List of authorized laser users	YES	NO	N/A
44. Users have received laser safety training	YES	NO	N/A
45. Training has been documented	YES	NO	N/A
46. Nominal Hazard Zone (NHZ) defined	YES	NO	N/A

### Other Laser Safety Measures (Personal Protective Equipment)

47. Baseline eye examination performed	YES	NO	N/A
48. Proper eye protection available	YES	NO	N/A
49. Laser eyewear properly stored	YES	NO	N/A
50. Laser protective eyewear suitable OD & $\lambda$	YES	NO	N/A
51. Eye protection used inside NHZ	YES	NO	N/A
52. Proper skin protection in use	YES	NO	N/A

Non Bean Hazards

53. Toxic laser media in use	YES	NO	N/A
54. Hazardous media properly stored	YES	NO	N/A
55. Fume hood for dye mixing	YES	NO	N/A
56. Cryogens in use	YES	NO	N/A
57. Compressed gas in use	YES	NO	N/A
58. Gas cylinders restrained	YES	NO	N/A
59. All belts, pulleys, fans guarded	YES	NO	N/A
60. High voltage power hazard	YES	NO	N/A
61. Electrical panels obstructed	YES	NO	N/A
62. Optical tables grounded	YES	NO	N/A
63. Non-laser radiation hazard	YES	NO	N/A
64. Explosion hazard	YES	NO	N/A
65. Fire hazard	YES	NO	N/A
66. Laser Generated Air Contaminant production	YES	NO	N/A

Additional Comments

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Inspected By:	Signature:	Date:
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## Appendix F – Laser Room Commissioning and Decommissioning

### **Class 3B Laser Room Commissioning**

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

- i. Class 3B laser sign on all entrances to the room
- ii. Laser beam is enclosed as much as possible
- iii. The laser and the optics are fixed on the table
- iv. Laser beam does not leave the optical table. All laser beams and stray beam are terminated with a stop
- v. 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
- vi. Laser beam must not be directed toward windows. If this is necessary, the windows must be covered
- vii. Laser beam is not at eye level

### **Class 4 Laser Room Commissioning**

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

- i. Class 4 laser sign on all entrances to the room
- ii. All entrances to the room must: 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 a blocking barrier/curtain and a laser warning light that indicates when the laser is operating
- iii. All entryway must allow both rapid entrance and exit to the laser controlled area under any conditions
- iv. All windows are covered
- v. Laser beam is enclosed as much as possible
- vi. The laser and the optics are fixed on the table
- vii. Laser beam does not leave the optical table. All laser beams and stray beams are terminated with a stop
- viii. Flammable materials are kept out of the laser beam
- ix. 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 fiber optics” Commissioning**

If the beam is totally enclosed in the fiber and the sample, no further requirements are necessary. If the laser beam can, at any time, exit the fiber in free space, the LSO will determine the NHZ for the laser and the particular fiber used. 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 the 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.

### **Decommissioning of Class 3B and Class 4 Lasers**

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

- i. Laser must be made inoperative by removing/destroying mirrors from the optical cavity
- ii. For lasers with toxic active medium (toxic gases or dyes), the laser active medium must be removed, and the optical cavity cleaned
- iii. All toxic materials must be disposed according to the applicable regulations
- iv. All laser signs must be removed
- v. The electrical power supply must be disposed of as any other electrical equipment