

LASER SAFETY PROGRAM

Health, Safety and Environment Division
Safety, Security and Emergency Management

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REVISION HISTORY

Date	Description	Author
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1 INTRODUCTION

1.1 Policy

The British Columbia Institute of Technology (BCIT) is committed to conducting all work activities in a manner that protects the health and safety of employees, students, contractors, and visitors. The institute endeavors to provide safe tools, materials, equipment, and processes for work and study by meeting or exceeding regulatory requirements for occupational health and safety, and by establishing effective occupational health and safety systems, policies, and programs.

1.2 Objectives

The Laser Safety Program is intended to assist Laser users at BCIT in implementing effective controls of laser hazards. The purpose of this program is to ensure the safe use of lasers in research and instruction. To achieve this goal, BCIT has adopted the American National Standard for Safe Use of Lasers, ANSI Z136.1-2022 as required by WorkSafe BC.

1.3 Scope

This policy applies to all members of the BCIT community, including all BCIT employees, students, contractors, and visitors

2 REFERENCE MATERIALS & APPLICABLE LEGISLATION

WorkSafeBC Workers Compensation Act Part 7

Canadian Standards Association (CSA) Standards - Z386-20 Safe Use of Lasers in Health Care Facilities

American National Standards Institute (ANSI) Standard- Z136.1-2022: Safe Use of Lasers

American National Standards Institute (ANSI) Standard- Z136.3-2024: Safe Use of Lasers in Health Care Facilities

3 ROLES AND RESPONSIBILITIES

3.1 *BCIT Radiation Safety Committee*

- Classification of Class 3B and 4 lasers/laser systems used
- Verifying manufacturer classifications of lasers/laser systems
- Approval of work for new Class 3B and 4 lasers
- Commissioning and decommissioning Class 3B and Class 4 laser and laser systems
- Inspection of Class 3B and 4 laser and laser systems
- Recommendation and approval of protective equipment, laser working area signs and equipment labels
- Investigation of the laser related incidents and accidents, analysis of the causes, ensuring corrective actions are taken as required
- Register new laser and laser systems with the LSO (Laser Safety Officer)
- Identify all Class 3B and Class 4 laser workers

3.2 *Laser Safety Officer*

- Maintain and update the laser inventory of the Class 3B and Class 4 laser systems
- Maintain and update the list of all 3B and Class 4 laser workers
- Perform laser safety inspections
- Maintain laser safety training records
- Participate/Coordinate/Facilitate in laser incident/accident investigation
- Provide training in the safe use of lasers
- Laser safety program review
- Hazard evaluation of laser work area
- Ensure laser safety controls such as reflection blankets, safety glasses and safety signs comply with regulations and are appropriate for the class of laser used.
- Participate in routine inspections and regular audits of the Laser Safety Program.
- Where incidents or near-misses occur, they shall participate in investigations as Subject Matter Experts (SMEs). The LSO shall ensure safety glasses are of sufficient Optical Density (OD) to filter the specific power/wavelength of laser energy encountered.

3.3 Supervisor

- Ensure that laser workers in their area of supervision follow the lab specific laser safety procedures
- Provide and enforce the use of appropriate personal protective equipment when required
- Ensure that each laser 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
- Ensure that all administrative and engineering controls are followed
- Correct unsafe conditions in a timely manner
- Ensure that all spectators are properly informed of and protected from potential laser hazards
- Ensure laser signage is posted

3.4 Laser Worker

- To participate in the Laser Safety training prior to operating or working in proximity to Class 3B or Class 4 laser/laser systems; if this is not possible, to accept appropriate instruction and supervision from the Laser Safety Officer until such training is available
- To be familiar with all operational procedures and specific safety hazards of the Class 3B or Class 4 laser/laser systems that they 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 procedures
- To operate Class 3B and Class 4 laser/laser systems only under the conditions authorized by the Laser Safety Officer
- Laser workers are encouraged to consult with the Laser Safety Officer if a medical condition or medication may increase their susceptibility to laser exposure (e.g., photosensitivity). Disclosure of medical information is voluntary and will be handled confidentially. To promptly report known or suspected accidents or near misses and unsafe conditions to the Laser Safety Officer
- Laser operators shall wear appropriate PPE during operations and shall return items when not in use to designated storage areas post-work.
- Laser operators shall not operate the laser knowingly with unprotected workers or bystanders within the LCA – work shall be stopped if persons enter the area unprotected.

4 HAZARD IDENTIFICATION

In addition to common workplace hazards, Laser systems can introduce unexpected hazards to workers that must be suitably controlled.

Beam Hazards	Physical Hazards
• Eye ○ Retina & Cornea Damage ○ Lens & Vitreous Damage ○ Macula & Fovea • Skin ○ Thermal ○ Photochemical ○ Mechanical	• Electrical • Fire (from ignition of flammable objects and gases within the vicinity of the laser) • Explosions (from fine airborne particles created when using the cleaning laser reaching an explosive concentration in air or when using the laser on pressurized/sealed containers) • Chemical (from lasing agents, shielding gases, dyes, cryogenics, etc.) • Respiratory hazards (from generated contaminants) • Biological agents • Radiation • Ergonomics and Strains (equipment handling, setup, movement, repetitive use, etc.) • Trip Hazards (power cables and fiber optic delivery cables)

4.1 Class 1 Laser Hazards

There is no known hazard for exposure to the output from a Class 1 laser or laser product.

Class 4 lasers contained within a protective housing would be classified as Class 1 laser under normal operation. The access panels have warning labels alerting the user of a higher power embedded laser, and/or a safety interlock preventing exposure to hazardous levels of laser radiation.

4.2 Class 2 Laser Hazards

An ocular hazard can only exist if an individual overcomes their natural aversion to bright light and stares directly into the laser beam. Class 2 lasers do not pose a hazard to the skin.

4.3 Class 3 Laser Hazards

Class 3 lasers, particularly Class 3B lasers, present potential for serious eye injury resulting from intrabeam viewing, they generally do not represent a diffuse reflection hazard, a skin hazard, or a fire hazard.

4.4 Class 4 Laser Hazards

The “high-power” lasers present the most serious of all laser hazards. Besides presenting serious eye and skin hazardous, these lasers may ignite flammable targets, create hazardous airborne contaminants, and may also have a potentially lethal, high current/ high voltage power supply.

5 RISK ANALYSIS AND EVALUATION

Before class 3 or 4 laser work is approved, the laser safety officer will perform a risk analysis in accordance with the BCIT Risk Assessment Procedure. The BCIT Risk Assessment Template and the BCIT Risk Assessment Matrix will be used when performing risk analysis.

A copy of the Risk Analysis will be forwarded to BCIT HSE Division and the supervisor/manager for the laser area.

6 CONTROL MEASURES

6.1 Class 1 Laser

There is no known hazard for exposure to the output from a Class 1 laser or laser product.

6.2 Class 2 Laser

The two operational safety rules are:

- Do not stare into the laser beam
- Do not overcome the aversion response and stare into the laser beam
- Do not point the laser at a person's eye

6.3 Class 3 Laser

Safety procedures for Class 3 lasers are concentrated on eliminating the possibility of intrabeam viewing by:

1. Never aim a laser at a person's eye.

2. Use proper laser safety eyewear if there is a chance that the beam, or a hazardous specular reflection, will expose the eyes.
3. Avoid placement of the unprotected eye along or near the beam axis. Some alignment procedures may place personnel at risk by requiring close proximity to the beam where the chance of hazardous specular reflections is greatest.
4. Attempt to keep laser beam paths above or below eye level for either sitting or standing positions.
5. Assure that individuals do not look directly into a laser beam with optical instruments unless an adequate protective filter is present within the optical train.
6. Eliminate unnecessary specular (mirror-like) surfaces from the vicinity of the laser beam path or avoid aiming at such surfaces.
7. Do not aim at doorways or windows.

Additional safety procedures for Class 3B lasers include:

1. Assure that individuals who operate Class 3B lasers are trained in laser safety and authorized to operate a laser.
2. A key switch should be used if untrained persons may gain access to the laser.
3. A warning light or buzzer may be used to indicate when the laser is operating.
4. Enclose as much of the beam's path as practical.
5. Terminate the primary and secondary beams, if possible, at the end of their useful paths.
6. Use low power settings, beam shutters and laser output filters to reduce the beam power to less hazardous levels when the full output power is not required.
7. Assure that any spectators are not potentially exposed to hazardous conditions.
8. Attempt to operate the laser only in a well-controlled area.
9. Label lasers and rooms with appropriate Class 3B warning sign.
10. Mount the laser on a firm support to assure that the beam travels along the intended path.

6.4 Class 4 Laser

In addition to control measures for Class 3 lasers, the following rules should be carefully followed for all high-power lasers:

1. Enclose the entire laser beam path if possible.
2. Confine open beam indoor laser operations to a light-tight room.
3. Ensure proper ventilation is present to mitigate LGAC
4. Interlock entrances to ensure that the laser cannot emit when the door is open. Administrative or procedural entryway safety controls may be used

where interlocks are not feasible or are inappropriate upon approval from the LSO.

5. Ensure that all personnel wear adequate eye protection or ensure that a suitable shield is present between the laser beam(s) and personnel.
6. Use remote firing and video monitoring or remote viewing through a laser safety shield where feasible.
7. When the laser is used outdoors, assure that the beam cannot intercept aircraft or navigable airspace and complies with applicable Transport Canada and NAV CANADA requirements.
8. Use lower power settings, a beam shutter or laser output filters to reduce the laser beam irradiance to less hazardous levels whenever the full beam power is not required.
9. Assure that the laser device has a key-switch master control to permit only authorized personnel to operate the laser.
10. Label lasers and room with appropriate Class 4 warning sign.
11. Use dark, absorbing, diffuse, fire resistant target and backstops where feasible.

No one shall be exposed to laser radiation levels exceeding the applicable MPE's under any reasonably foreseeable conditions of operation, therefore control measures appropriate to the hazard must be in place to reduce the risk of eye and skin exposures.

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 approaching the Maximum Permissible Exposure (MPE), it may be necessary to use personal protective equipment.

Engineering Controls consist of housing, apertures, lock-out switches, barriers, etc.

Administrative control measures include training, instruction, and warning signs.

Personal Protective Equipment (PPE) consists of protective eyewear, gloves, protective clothing, screens, etc.

Laser protective eyewear shall be worn by all personnel within the Nominal Hazard Zone of Class 3B and Class 4 laser/laser systems where the exposures above or approaching the MPE can occur.

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

Laser workers shall wear protection as required and should 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 exposures are anticipated to approach half of the applicable MPE for skin.

Skin covers are recommended on exposed skin to prevent against UV exposure where engineering controls do not adequately reduce exposures. Sunscreen may be used as a supplementary protective measure and shall not replace engineering or clothing-based controls. Most gloves will provide some protection against radiation to the hands. Tightly woven fabrics and opaque gloves provide the best protection. A laboratory coat can provide protection for the arms.

Class 4 laser systems require the approval of appropriate control measures by the Laser Safety Officer (LSO) to eliminate the risk of hazardous exposure to the eye or skin from direct, specular, or diffuse beams.

NOTE: laser beams directed into outdoor airspace require additional control measures to avoid interfering with air traffic, surrounding businesses, public spaces, or to avoid interfering with wildlife.

Class 4 laser systems require Control Measures, formal Training, an appointed Laser Safety Officer (LSO) and Engineering Controls be in place.

CONTROL MEASURES ARE DIVIDED INTO 3 CATEGORIES:

- Engineering Controls
- Administrative Controls (Procedural)
- Personal Protective Equipment (PPE)

6.5 Engineering Controls

Engineering Controls are generally more reliable than administrative control. Laser systems shall be enclosed including the laser equipment and beam path. Laser work areas shall be segregated from other areas by proper barriers to control rogue beams.

Access into laser areas will be restricted by a variety of means, depending on the work areas and work being undertaken.

6.5.1 Laser Curtains & Barriers

Physical protection from lasers is the most effective means of controlling the hazard. Laser curtains and barriers are used to segregate areas and prevent reflective or accidental laser contact.

Based on the recommendations of the LSO, work areas should be set-up with laser curtains blocking all entrance points, penetrations, and gaps between plates to ensure laser light does not inadvertently escape the area.

The laser operator and supervisor shall ensure barriers are effectively established before work begins.

Laser-specific products will be returned to the storage area when not in use.

6.5.2 Access Control

Access to operating areas is restricted to laser operators and critical personnel only. Warning Signs shall be erected outside each entrance to the space including the use of a physical barrier to prevent accidental entry (e.g., laser danger tapes, LCAs, curtain, or barrier walls, etc.).

6.5.3 Beam Enclosures

No person shall open beam enclosures without the approval of Management. Equipment servicing shall be done in accordance with the manufacturer's specifications by the manufacturer or the licensed representative and where appropriate shall include the input and support of the LSO. Routine cleaning or maintenance as defined in the operator's manual may be carried out by suitably trained individuals (typically the LSO or Operator).

6.5.4 Fibre Optic Protection

Fibre optic connectors and damaged fibres may emit hazardous laser radiation and shall be treated as open beam hazards. Fibre Optic cables for the laser system shall be protected from harm. This includes protection from sharp edges, ensuring cables are out of the path of vehicles, and ensuring cables are clear of all Hot Work areas.

Any damage or potential damage to fibre optic cables shall be reported immediately, and the laser removed from service until cable protection can be verified.

6.5.5 Laser Control Area

The LSO, laser operator and/or supervisor, shall establish the necessary LCA for the laser work using the following minimum controls:

- Laser warning signs posted at all entry points.
- Hanging of laser barrier curtains to protect from indirect exposure.

The LCA shall be large enough to enable the workers to perform their tasks, and shall include necessary inspections, and shall be organized to eliminate the risk of laser light escaping.

6.5.6 Ventilation

Adequate Ventilation must be provided and determined by the Supervisor.

Adequate Ventilation shall be defined as the use of air movement to reduce concentration of airborne contaminants below the acceptable exposure limits in the worker breathing zone and work area as determined by WorkSafeBC Regulation.

The adequacy of ventilation is demonstrated by acceptable concentrations of gases and fumes in the worker's breathing zone as determined by a qualified industrial hygienist.

6.6 Administrative Controls

Administrative Controls include items such as operator training, safe work practices, manufacturer's manuals or instructions, pre-use checklists, and laser setup checklist. Administrative Controls are most effective when used in conjunction with Engineering and PPE Controls.

6.6.1 Manufacturer's Manuals

The Manufacturers Manual or Operators Manual for the laser system shall be readily available for operators and emergency responders. This may be a digital copy or a print version. Whenever practical a copy should be kept with the Laser Setup Checklist in SharePoint.

6.6.2 Pre-Use Inspections

Prior to using laser systems, a pre-use checklist shall be completed verifying the function of all hardware, the applications of all safety controls and emergency features, and shall check the integrity of all laser components and electrical systems.

As a minimum, Pre-Use Inspections for laser systems include:

- Beam Enclosures include the integrity of fiberoptic cables for laser beams.
- Area or laser barriers, warning signs, strobe lights, interconnects, etc.
- Electrical systems such as cords, plugs, control panels, plugs, grounding points, etc.
- Function of all safety and emergency devices (e.g., emergency stops, dead-man switches, etc.)
- Surface conditions for planned work area (reflective, diffuse, gaps / holes, access to outdoors, etc.)

6.6.3 Health Monitoring

Operators of Class 4 laser systems may be referred for baseline or post-incident eye examinations where risk assessment, exposure concerns, or incidents warrant medical evaluation.

6.7 Personal Protective Equipment

Personal Protective Equipment (PPE) is the last line of defence, however, is mandatory to protect workers from accidental or occasional exposure to laser beams.

Laser specific PPE shall be stored properly in the cases provided and shall not be left in the workplace unprotected.

6.7.1 Laser Safety Eyewear

Laser safety eyewear is significantly different from traditional safety eyewear and must be treated carefully. Any defects, damage or cracks to the lenses may allow accidental beam exposure directly into the eyes and may cause permanent damage.

Laser safety eyewear is specifically rated for laser configurations, operators may not substitute other eyewear without the approval of the LSO.

Before every use, operators must inspect for:

- Physical damage including chips, burns, cracks, bends, wear-marks, or deformation.
- Appropriate OD Rating as-per the Laser Safety Setup Checklist.
- Proper rating for beam wavelength (nanometres - nm) as per the Laser Safety Setup Checklist.
- Proper fit in relation to other PPE items such as respirators or hard hats.

Laser safety eyewear must always be worn around laser systems that are:

- 1) Energized, or
- 2) Capable of being energized without warning, or
- 3) Every time you are in the path of the beam.
- 4) Within the Laser Control Area (LCA)

6.7.2 Protective Clothing

Laser operators shall wear proper clothing to protect skin from accidental contact. This will include as a minimum FR-Rated Coveralls, Tyvek Coveralls or equivalent.

Protective clothing must be inspected regularly for damage including excessive wear, cuts holes or other defects that may allow accidental beam exposure from directly contacting skin.

Protective clothing must include hand protection appropriate for the hazard such as tightly woven gloves or laser-specific hand protection.

6.7.3 Defective PPE and Clothing

Defective or damaged laser eyewear must be returned to the LSO – DO NOT DISCARD DAMAGED EYEWEAR DIRECTLY. All eyewear damage will be reviewed and investigated as appropriate to determine the cause of the failure. Where misuse or mishandling is identified, operators may be retrained.

Defective or damaged coveralls must be serviced or replaced.

7 RISK ASSESSMENT REVIEW

Risk Assessments will be reviewed annually or after any incidents to ensure currency and accuracy.

8 TRAINING AND EDUCATION

8.1 *Laser Safety Program Training*

All laser users must participate in the BCIT Laser Safety Program training prior to operating or working in proximity to Class 3B or Class 4 laser/laser systems:

This training will be provided by the Laser Safety Officer and include the following:

- a. Laser basics
- b. Laser hazards, bio-effects
- c. Laser system classification
- d. Control measures
- e. Laser eye protection
- f. Medical evaluation considerations following incidents or elevated exposure risk
- g. Non-beam hazards
- h. Laser safety standards
- i. Legislation and BCIT Laser Safety Program
- j. Responsibilities
- k. Causes of accidents
- l. Laser accident reports
- m. Quiz

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

Refresher training is required when laser systems are modified, new hazards are introduced or following incidents or near-misses.

The LSO is responsible for maintaining records of all laser workers who have participated in the laser safety program training.

9 DOCUMENTATION

All records will be kept by the Laser Safety Officer. Records pertaining to specific instrumentation will be a minimum of the lifetime of that equipment plus 3 years. Records pertaining to training will be kept a minimum of the duration of an individual's employment, plus 3 years.

10 PROGRAM REVIEW

An annual review will be done by the LSO for the following:

- Training of Class 3B and Class 4 Laser Workers

- Inventory of Class 3B and Class 4 Lasers/Laser Systems

APPENDIX A

DEFINITIONS

APPENDIX A: DEFINITIONS

American National Standard for Safe Use of Lasers (ANSI Z136.1-2022). Document that provides guidance for the safe use of lasers and laser systems by defining control measures for each of four laser classifications.

Aversion Response. Closure of the eyelid, eye movement, pupillary constriction, or movement of the head to avoid an exposure to a noxious or bright light stimulant. The aversion response to an exposure from a bright, visible, laser source is assumed to limit the exposure of a specific retinal area to 0.25 s or less.

Beam. A collection of rays which may be parallel, divergent or convergent.

Collateral radiation. Any electromagnetic radiation, except laser radiation, emitted by a laser system. This does not include laser target interaction radiation (reradiation). Note that reradiation from a target is addressed as a non-beam hazard.

Collecting optics. Lenses or optical instruments having magnification and thereby producing an increase in energy or power density. Such devices may include telescopes, binoculars or loupes.

Continuous wave (CW). The output of a laser that is operated in a continuous rather than a pulsed mode. For purposes of safety evaluation, a laser operating with a continuous output for a period greater than or equal to 0.25 s is regarded as a CW laser.

Controlled area or Laser Controlled Area (LCA). A laser use area where the occupancy and activity of those within is controlled and supervised. That area may be defined by walls, barriers, or other means. Potentially hazardous beam exposure is possible within the LCA.

Diffuse reflection. Change of the spatial distribution of a beam of radiation when it is reflected in many directions by a surface or by a medium.

Embedded Laser. An enclosed laser that has a higher classification than the laser system in which it is incorporated, where the lower classification of the system is appropriate because of the engineering features limiting accessible emission.

Failsafe interlock. An interlock where the failure of a single mechanical or electrical component of the interlock will cause the system to go into, or remain in, a safe mode.

Intrabeam viewing. The viewing condition whereby the eye is exposed to all or part of a laser beam.

Laser: A device that produces radiant energy predominantly by stimulated emission. Laser radiation may be highly coherent temporally, spatially, or both. An acronym for Light Amplification by Stimulated Emission of Radiation.

Laser Generated Air Contaminants (LGAC): Laser-generated air contaminants are produced when Class 3B or 4 laser beams interact with matter. The type of contaminant varies, depending upon the target material, cover gas, and beam irradiance. The target material may be responsible for releasing chemicals that are carcinogenic, toxic, or noxious. These contaminants can include gaseous toxic compounds, bio-aerosols, dead and live cellular material, and viruses (not common in construction applications).

Laser Safety Officer (LSO). One who has the authority to monitor and enforce the control of laser hazards and effect the knowledgeable evaluation and control of laser hazards.

Laser system. An assembly of electrical, mechanical, and optical components that includes one or more lasers.

Laser/Laser Systems, Class 1. These are lasers that are not hazardous for continuous viewing or are designed in such a fashion that prevents access to laser radiation. Class 1 consists of low power lasers and higher-powered embedded lasers (such as those used in laser printers).

Laser/Laser Systems, Class 2 Visible Lasers (400 to 700 nm). These are lasers emitting visible light which, because of normal human aversion responses (blinking), do not normally present a hazard, but which would be dangerous if viewed directly for extended periods of time.

Laser/Laser Systems, Class 2M Visible Lasers (400 to 700 nm). The output of a Class 2M product is potentially hazardous when viewed using an optical instrument.

Laser/Laser Systems, Class 3R. A Class 3R laser is a laser or laser system that emits radiation within the visible or invisible spectrum at power levels up to five times the Accessible Emission Limit (AEL) of Class 2 (visible) or Class 1 (invisible). Class 3R lasers present a low but potentially hazardous risk if the beam is viewed directly under unfavorable conditions, but the probability of injury is relatively low when proper controls are in place.

Laser/Laser Systems, Class 3B. Class 3B lasers are medium-power lasers for which direct intrabeam viewing and specular reflections are hazardous to the eye. Skin injury may occur at higher exposure levels. Diffuse reflections are normally not hazardous but

may be hazardous under certain conditions. Typical CW output powers range from >5 mW to 500 mW.

Laser/Laser Systems, Class 4. Class 4 lasers are high-power lasers (CW output >500 mW or equivalent pulsed energy). They are hazardous to the eye and skin from direct and diffuse exposure and may present fire, explosion, and non-beam hazards.

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

Maximum permissible exposure (MPE). The level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin. MPE is expressed in terms of either radiant exposure (joules/cm²) or irradiance (watts/cm²). The criteria for MPE are detailed in Section 8 of ANSI Z136.1.

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

Nominal Ocular Hazard Distance (NOHD). The distance along the axis of the unobstructed beam from a laser, fibre end, or connector to the human eye beyond which the irradiance or radiant exposure does not exceed the applicable MPE.

Protective housing. An enclosure that surrounds the laser or laser system that prevents access to laser radiation above the applicable MPE level. The aperture through which the useful beam is emitted is not part of the protective housing. The protective housing may enclose associated optics and a work station and shall limit access to other associated radiant energy emissions and to electrical hazards associated with components and terminals.

Pulsed laser. A laser that delivers its energy in the form of a single pulse or a train of pulses. The duration of a pulse is regarded to be < 0.25 s.

Pulse duration. The duration of a laser pulse, usually measured as the time interval between the half-power points on the leading and trailing edges of the pulse.

Specular reflection. A mirror-like reflection.

Ultraviolet radiation. Electromagnetic radiation with wavelengths smaller than those of visible radiation; typically 100–400 nm.

APPENDIX B

Laser Inspection Form

APPENDIX B: LASER INSPECTION FORM

Class 3B and Class 4 Lasers and Laser Systems

Inspector: _____	Date of Inspection: _____
Location (Building/Room): _____	Department: _____
Name of Supervisor: _____	Phone # _____
Name of Lab Contact: _____	Phone # _____
Laser Type: _____	Class: _____
Model #: _____	Serial # _____
Production Class: _____	

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 label in place: Y N Comments: _____

Laser 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:

Operating Procedures are available: Y N NR Comments:

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:

Appropriate action taken for spectator control: Y N NR Comments:

All supervisors/workers have met the laser safety training requirement as per section 6 of the laser safety program: Y N Comments:

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

Proper laser eye protection available: Y N NR Comments:

Proper skin protection available: Y N NR Comments:

OTHER SAFETY MEASURES:

All Class 3B/4 lasers and laser have been registered: 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:

Cryogenics 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

Application Form



APPENDIX C: APPLICATION FORM

CLASS 3B & CLASS 4 LASERS/LASER SYSTEMS APPLICATION

Applicant (Person in Charge): _____ Building: _____
Position: _____ Department: _____
Office Telephone: _____ Facility Telephone: _____
Office No: _____ Emergency Telephone: _____
E-mail: _____ Contact Person: _____

Experience and Training of the Applicant and/or Contact Person regarding the Lasers/Laser Systems: _____

(Use separate paper if necessary)

List of Laser Worker(s) lasers/laser systems (Class 3B or Class 4) under your supervision

1. _____ e-mail: _____ Ext: _____
2. _____ e-mail: _____ Ext: _____
3. _____ e-mail: _____ Ext: _____

This application is submitted for the following reason:

- ☐ New application ☐ Renew application ☐ Relocation of sources
☐ Replacement of old sources ☐ Additional sources ☐ Acquisition of existing facility from:

Lasers/Laser Systems Information:

Room #: _____ Building: _____ Manufacturer Model #: _____ Serial #: _____
Laser type: _____ Laser Class: _____ Wavelength: _____(nm) Power: _____(W) Energy: _____(J)

Note:

1. Contact Person will be responsible for the lasers/laser systems when Person in Charge is not available.
2. Laser Worker(s) shall wear appropriate laser safety goggles (where applicable) and receive specific hands-on training from Person in Charge or Contact Person before operating lasers/laser systems.

Signed: Applicant Date

Signed: Department Chair Date

Please complete the necessary information and send to: Joe Cortese, Laser Safety Officer



APPENDIX D

Laser Setup Checklist

APPENDIX D: LASER SETUP CHECKLIST

CLASS 3B & CLASS 4 LASERS/LASER SYSTEMS Checklist

Applicant (Person in Charge): _____ Area: _____

Reason for Work: _____

Supervisor: _____ Laser Safety Officer: _____

Hazard Identification and Communication

Task/Control	Completed	N/A
Laser safety program discussed with affected workers		
Personnel appropriately trained for their roles		
Hazard assessment completed and available for the work area/task		
All affected workers and departments notified		
Work area inspected		

Control Measures Implemented/Required

Task/Control	Completed	N/A
Work area signage posted identifying work hazards		
Appropriate firefighting equipment on hand		
Emergency eye wash bottle or station available		
Laser barriers/curtains implemented and in safe operation condition		

Pre-Work Checks

Task/Control	Completed	N/A
Pre-work inspection completed on laser assembly, including all safety features		
Pre-work inspection completed on laser fibre optic assembly		
All necessary PPE is available		
Laser safety eyewear inspected for damage		
Laser safety eyewear properly rated at OD: _____ @ _____ nm		

Authorization and Sign off

Role	Responsibility	Sign off (signature, name, date)	
Supervisor	I confirm the tasks shown on the checklist attached have been completed, and the work can proceed as described.		
Operator	I confirm the operation will be performed following proper equipment operations and the direction of the Laser Safety Officer and task Supervisor		
Laser Safety Officer	I confirm the operation has been prepared in accordance with the Laser Safety Procedures and all necessary paperwork has been received and accepted.		

APPENDIX E

Laser Safety Signs

APPENDIX E: LASER SAFETY SIGNS

Laser Signage Requirements by Class

Laser Class	Equipment Label (Mandatory)	Area / Door Signage	Typical Sign Wording	Notes / When Required
Class 1	Yes	No	Class 1 Laser Product	Inherently safe under normal operation
Class 1M	Yes	No	Laser Radiation – Do not view directly with optical instruments	Hazard only when using optical aids
Class 2	Yes	No (usually)	Laser Radiation – Do not stare into beam	Area signage only if elevated risk (e.g., training, public areas)
Class 2M	Yes	No (usually)	Laser Radiation – Do not stare into beam or view with optical instruments	Similar to Class 2 with added optical hazard
Class 3R	Yes	Sometimes	Laser Radiation – Avoid direct eye exposure	Signage recommended based on risk assessment
Class 3B	Yes	Yes	Laser Radiation – Avoid exposure to beam	Controlled area required; signage at entry points
Class 4	Yes	Yes	Laser Radiation – Avoid eye or skin exposure to direct or scattered radiation	Strict controls, restricted access, fire risk

SAMPLE ANSI Z535.2 COMPLIANT CAUTION SIGN FOR CLASS 2, CLASS 2M, AND CLASS 3B LASERS



SAMPLE ANSI Z535.2 COMPLIANT WARNING SIGN FOR CLASS 3B AND CLASS 4 LASER CONTROLLED AREAS

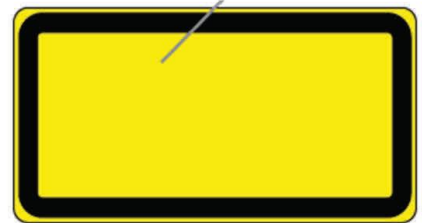
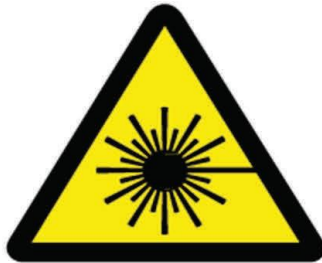
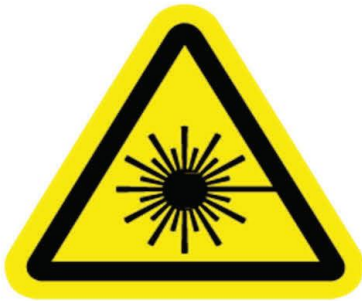


SAMPLE ANSI Z535.2 COMPLIANT CLASS 4 LASER CONTROLLED AREA DANGER SIGN



IEC WARNING LABEL – HAZARD SYMBOL AND EXPLANATORY LABEL

Space for legend



Symbol, Legend and band color: Black

Background and optional outer border color: Yellow