

**CALIFORNIA STATE UNIVERSITY,
LOS ANGELES**

LASER SAFETY PROGRAM

GUIDE FOR THE SAFE USE OF LASERS

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PROGRAM APPROVAL AND AUTHORIZATION

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TABLE OF CONTENTS

TITLE	SECTION
PURPOSE	1.0.
AUTHORITY	2.0.
ORGANIZATIONS AFFECTED	3.0.
REFERENCES	4.0.
POLICY	5.0.
DEFINITIONS	6.0.
RESPONSIBILITES	7.0.
HAZARD CLASSIFICATION	8.0.
CONTROL MEASURES	9.0.
GENERAL LASER SAFETY PRINCIPALS	10.0.
TRAINING	11.0.

1.0. PURPOSE:

California State University, Los Angeles' (Cal State LA) Laser Safety Program is intended to reduce the risk of injuries associated with the use of lasers by establishing procedures for working with lasers at Cal State LA. This document details the equipment, work practices and procedures that will be utilized at Cal State LA to provide faculty, staff and students a safe working environment.

2.0. AUTHORITY:

California Code of Regulations (CCR), Title 8, Subchapter 7, General Industry Safety Orders, Section 3203, requires all employers to "...include a system for ensuring that employees comply with safe and healthy work practices...". At this time, CAL-OSHA has not developed specific laser safety regulations, but they train their inspectors in the ANSI Z136.1 Standard for the Safe Use of Lasers as the accepted "...safe and healthy work practice..." to use in inspecting laser facilities.

3.0. ORGANIZATIONS AFFECTED:

The policies and procedures set forth in this Laser Safety Program are applicable to all users of lasers at Cal State LA.

4.0. REFERENCES:

4.1. [American National Standards Institute \(ANSI\) Z136.1 - 2007 Standard for the Safe Use of Lasers.](#)

4.2. [Title 8, California Code of Regulations \(CCR\), Section 3382 - Eye and Face Protection.](#)

5.0. POLICY:

It is the policy of California State University, Los Angeles to provide for the safety of the campus community. To that end, Cal State LA is implementing the ANSI Z136.1 - 2007 Standard for the Safe use of Lasers. The following guidelines are based on the ANSI Standard. For further clarification of the procedures being implemented refer to the above specified standard.

6.0. DEFINITIONS:

6.1. Accessible Laser Radiation - Laser radiation that is not blocked by barriers or filters.

6.2. Beam - A collection of light rays characterized by direction, diameter (or dimensions) and divergence (or convergence).

6.3. Collateral Radiation - Any electromagnetic radiation, except laser radiation, emitted by a laser or laser system, which is physically necessary for its operation.

6.4. Continuous Wave (CW) - A laser operating with a continuous output for a period ≥ 0.25 seconds is regarded as a CW laser.

6.5. 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 radiation.

6.6. Electromagnetic Radiation - The flow of energy consisting of orthogonally vibrating electric and magnetic fields lying transverse to the direction of propagation (e.g., Gamma rays, x-rays, visible and invisible light).

- 6.7. Energy - The capacity for doing work. Energy is measured in Joules (J) and used to describe pulsed lasers.
- 6.8. Joule - A unit of energy. 1 joule = 1 watt · second.
- 6.9. LASER - A device that produces a coherent beam of radiant energy by stimulated emission. An acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.
- 6.10. Maximum Permissible Exposure (MPE) - The level of laser radiation to which an unprotected person may be exposed without adverse biological changes to the eye or skin.
- 6.11. Nominal Hazard Zone (NHZ) - The space within which the levels of laser radiation may exceed the MPE. Exposure levels outside of the NHZ are below MPE.
- 6.12. Optical Density (OD) - A numerical value that indicates the amount of beam attenuation provided by laser eyewear and filtered viewing windows. This number is imprinted or otherwise written on laser eyewear by the manufacturer and is specific to the wavelength(s) indicated next to the OD rating.
- 6.13. Protective Housing - An enclosure that surrounds the laser or laser system and prevents access to laser radiation in excess of the MPE.
- 6.14. Pulse Duration - The duration of a laser pulse. Usually measured in seconds (s), microseconds (μ s), nanoseconds (ns), etc.
- 6.15. Pulsed Laser - A laser that delivers its energy in the form of a pulse or series of pulses.
- 6.16. Transmission - Passage of radiation through a medium.
- 6.17. Ultraviolet Radiation (UV) - Electromagnetic radiation with wavelengths between 180 and 400 nanometers (nm).
- 6.18. Watt - The unit of power. 1 watt = 1 joule-per-second.
- 6.19. Wavelength - The distance in line of advance of a sinusoidal wave from any one point to the next point of corresponding phase. For example, the distance from one peak to the next.

7.0. RESPONSIBILITIES:

- 7.1. The Director of Risk Management and Environmental Health and Safety provides support for implementation and maintenance of the Laser Safety Program and is ultimately responsible for laser safety on campus. Implementation of the plan is delegated to the Radiation Safety Officer and the Environmental Health and Safety Office as well as Department Administrators.
- 7.2. The Risk Management and Environmental Health and Safety Office (RM/EHS) administers the Laser Safety Program and promotes the health and safety of laser users by providing:
 - 7.2.1. Policies and procedures that promote the safe use of lasers at Cal State LA.
 - 7.2.2. Staff and support to implement the Laser Safety Program.
- 7.3. The Laser Safety Officer (LSO) is the University Radiation Safety Officer (RSO) in RM/EHS responsible for:

- 7.3.1. Consultation - Makes recommendations to laser Principal Investigators and laser users concerning laser eyewear, engineering controls, and laser laboratory procedures.
- 7.3.2. Laser Registrations - Approves applications and renewals of Laser Registrations. Approved registrations and approved modifications of existing registrations are submitted by the LSO to the Radiation Safety Committee (RSC) for final authorization.
- 7.3.3. Laser Safety Program - Administers the Laser Safety Program.
- 7.3.4. Training - Provides laser safety training for users of Class 3B and 4 lasers.
- 7.3.5. Documentation - Maintains records pertaining to Class 3B and 4 lasers at Cal State LA.
- 7.3.6. Inspections - Performs periodic inspections of all labs in which Class 3B and 4 lasers are used.
- 7.4. College and Department Administrators are responsible for incorporating provisions of the Laser Safety Program into the laboratory areas that they oversee. These duties include:
 - 7.4.1. Training - Ensure that all laboratory personnel are properly trained. This must include training programs specific to their laboratories and laboratory procedures as well as the appropriate training provided by RM/EHS.
- 7.5. The Principle Investigators (PI)/Laboratory Supervisors are responsible for implementing the Laser Safety Program in the laboratory or laboratories assigned to them. Responsibilities include:
 - 7.5.1. Training - Ensure that all laboratory personnel under his/her supervision receive laser safety training. This must include training programs specific to their laboratories and laboratory procedures as well as laser safety training provided by RM/EHS. Document and maintain records of laboratory specific training.
 - 7.5.2. Laboratory Procedures - Develop procedures that minimize or eliminate the risk of exposure to laser radiation and any non-beam hazards resulting from the use of lasers.
 - 7.5.3. Engineering Controls - Implement the use of engineering controls as outlined in section 9.2. of this document.
 - 7.5.4. Laser Registration - Register all Class 3B and 4 lasers with RM/EHS. Notify the LSO of any changes to the laser registration. These changes include: acquisitions of new lasers; modifications; and, relocations and transfers of lasers.
- 7.6. Laser Users - Demonstrate an understanding of the Laser Safety Program by these actions:
 - 7.6.1. Safety Practices - Follow safety guidelines and procedures identified in the Laser Safety Program.
 - 7.6.2. Personal Protective Equipment (PPE) - Use PPE, such as laser eyewear, and take necessary precautions to avoid exposures to laser radiation and non-beam hazards.
 - 7.6.3. Unsafe conditions - Report unsafe conditions to the Laboratory Supervisor, RM/EHS and/or the LSO.

7.6.4. Training - Attend all training courses that are deemed appropriate by the Principal Investigator and RM/EHS.

8.0. HAZARD CLASSIFICATIONS:

The following is a guideline for classifying lasers and laser systems. For official guidelines on the classification of lasers, please consult American National Standards Institute (ANSI) Z136.1 Standard for the Safe Use of Lasers.

8.1. Class 1 and 1M

8.1.1. Any laser or laser system that cannot emit accessible laser radiation levels during operation that are in excess of the MPE is classified as Class 1. These lasers cannot cause injury to the skin or eye.

8.1.2. Any laser or laser system that does not meet the above criteria under telescopic viewing conditions and does not exceed the criteria for classification as a Class 3B laser is classified as a Class 1M.

8.2. Class 2 and 2M

8.2.1. This classification is only applicable to lasers that emit visible light.

8.2.2. Any laser or laser system that emits visible light in excess of the criteria for Class 1 classification and emits less than 1 mW of average radiant power is classified as Class 2. The aversion response of the human eye is sufficient to protect the eye from damage from Class 2 lasers.

8.2.3. Any laser or laser system that emits visible light that does not meet the above criteria under telescopic viewing conditions and does not exceed the criteria for classification as a Class 3B laser is classified as a Class 2M laser.

8.3. Class 3R (formerly Class IIIa)

8.3.1. Any laser or laser system that exceeds the above criteria and emits less than 5 times the criteria for classification as a Class 1 laser for invisible wavelengths and less than 5 times the criteria for classification as a Class 2 laser for visible wavelengths is classified as Class 3R. Class 3R lasers are potentially hazardous if the eye is appropriately focused and stable. The probability of injury is small.

8.4. Class 3B

8.4.1. Any laser or laser system that exceeds the above limits, but cannot emit more than 0.5 watts (or 0.125 joules with a pulse duration of less than 0.25 seconds) for wavelengths less than 400 nm or greater than 1400 nm is classified as Class 3B. Class 3B lasers may be hazardous under direct and specular reflection viewing conditions.

8.4.1.1. CW lasers and laser systems that emit light between 400 and 1400 nm and cannot emit more than 0.5 watts, but exceed the criteria for classification as a Class 3R laser are also classified as a Class 3B lasers. Pulsed lasers and laser systems that emit light between 400 and 1400 nm that exceed the classification criteria for Class 3R lasers and emit less than 0.03 joules-per-pulse times a correction factor specified in ANSI Z136.1 - 2007 are classified as Class 3B.

8.5. Class 4

- 8.5.1. Any laser or laser system that exceeds the above criteria is classified as Class 4. Class 4 lasers are hazardous to the eyes and skin, and may pose fire hazards. Diffuse reflections may also be hazardous to the eyes and skin.

9.0. CONTROL MEASURES:

The following is a guideline for control measures required when operating lasers and laser systems. For full descriptions of the laser control measures please consult the American National Standards Institute (ANSI) Z136.1-2007 Standard for the Safe Use of Lasers.

9.1. Administrative & Procedural Controls

The following administrative and procedural controls are required for all Class 3B and 4 lasers:

- 9.1.1. Procurement - All acquisitions must be approved by the LSO.
- 9.1.2. Signage - Laser control areas must have appropriate signage on all entrances.
- 9.1.3. Registration - Use of Class 3B and 4 lasers at Cal State LA must be registered with the Radiation Safety Office. Registration must be approved by the LSO and authorized by the RSC.
- 9.1.4. Inspections - All Class 3B and 4 laser use areas will be inspected periodically by the LSO.
- 9.1.5. Alignment - Alignments may only be performed by properly trained personnel. Always perform alignments at the lowest possible setting. Appropriate PPE must be used and alternative viewing methods (e.g., phosphor cards, video monitors, etc.) must be used to determine the location of the beam. **DIRECT VIEWING OF THE BEAM IS NOT PERMITTED.**
- 9.1.6. Human Subjects - Deliberate exposure of humans to laser radiation is not permitted, unless authorized by the Institutional Review Board (IRB) or performed by medically licensed personnel.
- 9.1.7. Animal Subjects - The exposure of animals to laser radiation must be authorized by the Institutional Animal Care and Use Committee (IACUC).

9.2. Engineering Controls

Engineering controls are only required for Class 3B and 4 lasers. Administrative and procedural controls may be substituted for engineering controls with the approval of the LSO.

9.2.1. Class 3B Engineering Control Measures

- 9.2.1.1. Interlocks on Protective Housings - Removable protective housings must be equipped with interlock devices that prevent access to laser radiation above MPE. For example, removal of the protective housing will activate the interlock and result in a shutter being closed that interrupts the beam or it may break the circuit that powers the laser.

- 9.2.1.2. Beam Stops/Attenuators (recommended) - Should be used to terminate a beam when the laser or laser system output is no longer required.
- 9.2.1.3. Key Control (recommended) - The laser or laser system should be equipped with a master switch. This master switch shall effect beam termination and/or system shutoff and shall be operated by key or access code. Only authorized laser users listed in the laser registration shall have access to the key/access code.
- 9.2.1.4. Beam Path Enclosures (recommended) - Whenever possible, the beam path should be enclosed to prevent access to the beam above MPE. When the beam path is fully enclosed no other control measures are required.
- 9.2.1.5. Activation Warning System (recommended) - Should be used to indicate activation or start up of the laser or laser system. These systems may be in the form of a single red light or a lighted laser warning sign that is visible through protective eyewear and viewable within the control area.

9.2.2. Class 4 Engineering Control Measures

- 9.2.2.1. Interlocks on Protective Housings/Controlled areas - Removable protective housings and controlled areas must be equipped with interlock devices that prevent access to laser radiation above MPE. For example, removal of the protective housing or opening the entrance to the controlled area will activate the interlock and result in a shutter being closed that interrupts the beam and/or it may break the circuit that powers the laser.
- 9.2.2.2. Beam Stops/Attenuators (required) - Must be used to terminate a beam when the laser or laser system output is no longer required.
- 9.2.2.3. Beam Path Enclosures (required) - Whenever possible, the beam path shall be enclosed to prevent access to the beam above MPE. When the beam path is fully enclosed, no other control measures are required.
- 9.2.2.4. Activation Warning System - Must be used to indicate activation or start up of the laser or laser system. These systems may be in the form of a single red light or a lighted laser warning sign that is visible through protective eyewear and viewable within the control area.
- 9.2.2.5. Key Control (recommended) - The laser or laser system should be equipped with a master switch. This master switch shall effect beam termination and/or system shutoff and shall be operated by key or access code. Only authorized laser users listed in the laser registration shall have access to the key/access code.

9.3. PPE

- 9.3.1. Laser Eyewear - Must be worn at all times during operation of Class 3B and 4 lasers when inside the Nominal Hazard Zone (NHZ). All eyewear must provide the required Optical Density (OD) for the specific wavelengths and power/energy levels of the laser in use. Laser eyewear should fit comfortably and provide adequate coverage of the area around the eye. Consult the manufacturer of the laser or the LSO to determine the necessary OD for laser eyewear.

9.3.1.1. Damage to the optical filters can reduce effectiveness. All damaged laser eyewear will be confiscated. RM/EHS is not responsible for replacing damaged eyewear.

9.3.2. Skin Protection - When there is a possibility of exposure to laser radiation in excess of the MPE for skin, protective clothing, gloves and/or shields must be used. This includes exposure from specular and diffuse reflections.

9.4. Non-Beam Hazards

9.4.1. Electrical Hazards - Power supplies and other electrical equipment associated with lasers must be handled in accordance with Cal State LA's Electrical Safety Program.

9.4.2. Collateral Radiation

9.4.2.1. X-ray Radiation - X-rays can be generated by the high voltage power supplies of some lasers. X-ray producing equipment must be appropriately labeled and measures taken to reduce the risk of exposure. All radiation producing machines must comply with Cal State LA's Radiation Safety Program.

9.4.2.2. Plasma Radiation - Processes that involve the interaction of lasers and materials (i.e., laser cutting) may result in the emission of ultraviolet (UV) radiation. PPE, shielding or a combination of the two must be used to reduce the risk of eye and/or skin injuries.

9.4.3. Fire Hazards - Class 4 lasers can ignite fires when combustible materials are exposed to the beam. Enclose the beam path whenever possible and keep combustible materials away from the beam path.

9.4.4. Explosion Hazards - High pressure arc lamps and other equipment used in the generation of laser light can pose explosion hazards. Protective housings and enclosures must be designed to withstand the maximum explosive pressure resulting from component failure/disintegration.

9.4.5. Chemical Hazards

9.4.5.1. Laser Generated Air Contaminants (LGAC) - When using lasers to cut materials, toxic fumes can be liberated depending on the material being cut. Engineering controls, such as adequate ventilation, or PPE, such as air purifying respirators (APR), must be used to avoid exposure above Cal-OSHA and federal permissible exposure limits (PEL). If APRs are used, the user must comply with Cal State LA's Respiratory Protection Program.

9.4.5.2. Compressed Gases - These are often used to create an inert environment or in the process of generating a laser beam. All compressed gases and toxic gases must be handled and stored in accordance with Cal State LA's Chemical Hygiene Plan.

9.4.5.3. Laser Dyes and Solvents - The dyes and solvents used in dye lasers can be flammable, toxic and/or carcinogenic. Hazardous chemicals must be handled and stored in accordance with Cal State LA's Chemical Hygiene Plan.

10.0. GENERAL LASER SAFETY PRINCIPLES:

- Do not aim ANY laser at an individual's eye.
- Only trained personnel are permitted to operate Class 3B and 4 lasers.
- Whenever possible, enclose the beam path of Class 3B and 4 lasers to avoid accidental exposure.
- Class 3B and 4 lasers must only be used in the location designated in the laser registration.
- Always wear laser eyewear when in the controlled area of Class 3B or 4 lasers that are in operation.
- Skin protection must be used when working with Class 4 lasers with unenclosed beams.
- Keep combustible materials away from the beam path of Class 4 lasers.

11.0. TRAINING:

All personnel working with Class 3B or 4 lasers must be provided with training to ensure that they are apprised of the hazards associated with the lasers in their work area. They also need to be informed of actions to be taken to protect themselves during normal operations and emergency situations.

11.1. Initial Training - Laser safety training is to be provided at the time of initial assignment to an area where lasers are present and prior to assignments involving new exposure situations. Initial training is provided to newly hired personnel by their Supervisor/Principal Investigator. This training is documented on the Cal State LA Supervisor Orientation Checklist or equivalent document and is retained by the department. A copy must be forwarded to the Human Resources Management Department.

11.1.1. RM/EHS' Laser Safety Training must be attended within sixty (60) days of hire for any employee working with Class 3B or 4 lasers. Contact RM/EHS for scheduling.

11.2. Annual Refresher Training - Annual refresher training is accomplished by attending a training session on laser safety provided by RM/EHS. All personnel working with Class 3B or 4 lasers are required to attend refresher training annually.