

Idaho State University

LASER Safety Manual



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1. Introduction

This manual outlines Idaho State University's commitment to performing work with Light Amplification by Stimulated Emission of Radiation (Laser) systems in a safe and compliant manner. The University has adopted the American Standard for the Safe use of Lasers, ANSI Z136.5 2020, as a guiding document.

The manual is topic driven. If there are any questions regarding the manual, contact the Laser Safety Officer, the Chairman of the Laser Safety Committee, or any member of the Radiation Safety Department. Additional information on Laser safety or specific contact information is available on the ISU Radiation Safety Department Website.

<https://www.isu.edu/radiationsafety/>

2. Safety Conscious Work Environment

Any Laser worker may communicate directly, in confidence and without prejudice, with any of the following persons or organizations.

- Their Supervisor
- The Authorized User
- The Laser Safety Officer
- The Laser Safety Committee Chair
- Any member of the Laser Safety Committee
- Any Member of the Radiation Safety Department

In addition, anyone also may anonymously report safety concerns or non-compliance by calling 1-800-716-9007 or by visiting the Convercent website,

<https://app.convercent.com/enus/Anonymous/IssueIntake/IdentifyOrganization>.

Convercent is a service that is available 24 hours a day, seven days a week, on any matter concerning non-ionizing radiation protection.

3. Laser Safety Policy

The objective of the laser safety program is to ensure the safe use of class 3B and 4 laser systems at Idaho State University.

The laser safety program consists of the following elements:

- A. Training:** A laser safety training program is provided by the Radiation Safety Department. The goal of this program is to train those individuals who may come in contact with lasers or laser systems to identify the hazards and know how to safely work with and around lasers. Laboratory specific training is provided by the Laser Authorized User (LAU) or authorized designee, detailing the standard operating procedures and laser specific requirements of that laboratory.

B. Safety Reviews: The Laser Safety Officer (LSO) and the Laser Safety Committee (LSC) review and approve new laser users, laser systems, and laser use laboratories. The LSO approves minor alterations to an already approved laser laboratory in which the potential for laser injury increases or the laser system will be altered.

4. Organization Structure and Authority

The Laser Safety Committee (LSC) has authority over all Laser usage at Idaho State University. In addition, the LSC may call ad-hoc committees as necessary to deal with specific requests.

The Laser Safety Officer (LSO) is generally a role held by the Radiation Safety Officer (RSO), however the role of the LSO may be delegated to other qualified personnel. The LSO directs activities necessary to implement and enforce the Laser Safety Program established by the LSC. The LSO is provided the administrative authority by the Vice President for Research (VPR) to enforce procedures pertaining to the Laser Safety Program, including the authority to temporarily suspend activities involving Lasers deemed to be unsafe.

5. Roles and Responsibilities

This section identifies the roles and responsibilities of the Laser Safety Committee, Laser Safety Officer, and the Laser Authorized User.

5.1. LASER Safety Committee

The Laser Safety Committee is assembled of members who are involved in the usage of Lasers, or who have extensive knowledge of the subject. The Committee should meet at least annually but more often if deemed necessary. The LSC will review plans for usage of all Class 3b and 4 Lasers.

5.2. LASER Safety Officer

The LSO is appointed to enforce the safe usage of Lasers at Idaho State University. The LSO is responsible for enforcing the current standards of Laser usage and for introducing changes to the Laser Safety Manual or procedures to the LSC. The LSO is additionally responsible for the following:

- Ensuring compliance with rules and regulations, and the conditions of project approvals.
- Informing the LSC of safety actions taken.
- Conducting inspections of the Laser use areas for Class 3B and 4.
- Consulting with ISU personnel about Laser safety.
- Maintaining an inventory of Lasers in use.
- Maintaining the Laser Safety Training Program

- Ensuring that the appropriate records are maintained.
- Investigating any reported Laser related accident or injury, performing a hazard evaluation of the laser system, and implementing any corrective actions.

5.3. LASER Authorized User

The Laser Authorized User (LAU) is a faculty or staff member from ISU or affiliated organization (e.g. UI, BSU, or INL) authorized by the LSC to use a Class 3B or Class 4 Lasers.

5.3.1. Requirements for Authorization

The prospective LAU must submit a written plan of usage to the LSO by utilizing the LPR-1, Application for the use of Lasers form, which must be reviewed and approved by the LSC. The LAU must also have training and experience commensurate with the scope of the proposed activities. Training should include:

- Characteristics of non-ionizing radiation,
- Laser protection principles and controls,
- Laser beam measurements and monitoring, units of laser quantities,
- Biological hazards of lasers,
- Hands-on use of lasers and laser measurement.

The plan of usage must detail the following:

- The intended use of the Laser(s) including the generation of any non-beam hazards (flammables or laser generated air contaminates)
- A list of all Lasers to be used within the laboratory,
- Laser beam characteristics for each Laser,
- A description of the areas in the laboratory when the Lasers will be used,
- A list of all Laser safety equipment, Administrative, and Engineering controls for each system (beam enclosure, beam dumps, goggles or glasses and their respective OD, interlocks, etc.),
- Details on how laser controls will be used including Operating and Alignment procedures,
- How the disposal of any other hazardous material generated in the usage or disposal might impact the scope of the project.

5.3.2. Responsibilities of a LASER Authorized User

The LAU is responsible for implementing laser safety rules, regulations, and procedures within their assigned laser laboratory and are directly responsible for the following:

- The LAU is responsible for the safety of each person working within their assigned laser laboratory.
- The LAU must verify that lasers are properly stored, used, and disposed.

- The LAU must ensure that appropriate records documenting the safe use of lasers and laser systems are maintained by the laboratory. These records include but are not limited to:
 - Current LAU permit form (LPR-1 Application for Use of a Laser Facility)
 - Current laser inventory
 - Operating procedures and alignment procedures
 - Proof of training
 - Memos documenting laser related issues within the laboratory.
- The LAU is responsible for having their laboratory workers trained in specific laser safety procedures and techniques practiced within the laboratory.
- Submit a proper Laser usage plan for class 3B and 4 Lasers to be approved by the LSC.
- Register all the laser systems with the Radiation Safety Department by using the LPR-2 Laser System Registration form.
- Follow all safety procedures established by the LSC.
- Notify the LSO of the termination or transfer of a Laser in use.
- Inform the LSO if modifications will be made to their approved class 3B or class 4 Laser.
- Inform the LSO of any accidents or Injuries related to the usage of all classes of Lasers by utilizing LPR-4 Laser Accident Incident Report form. A written incident report shall be prepared by the LAU and submitted to the LSO after the incident.

5.4. LASER Operator

A Laser Operator is an individual who is trained and approved to use a Laser at ISU. They have completed the Laser Safety Training and are willing to abide by the safety requirements set forth by the LSC. They are willing to follow all safety procedures and practices and are committed to a safety conscious work environment. The LAU may need to provide system specific Laser safety training. All injuries and accidents shall be reported to the LSO and LAU.

6. LASER Fundamentals

6.1. LASER Basics

The acronym Laser stands for Light Amplification by Stimulated Emission of Radiation. This is a device to produce a beam of monochromatic light in which all the waves are in phase or are coherent. A Laser is an assembly of electrical, mechanical, and optical components which includes a laser and is subject to the provisions of the manual.

6.1.1. LASER Classifications

All commercially purchased lasers will have an appropriate classification label warning. In case where the laser classification is not provided or altered, stop the work, and notify the LSO immediately. Laser work will resume after the classification is performed by the LSO by adhering to the following criteria and ANSI Z136.5 2020 standards.

- A. Wavelength:** If the laser is designated to emit multiple wavelengths, the classification is based on the most hazardous wavelength. For continuous wave (CW) or repetitively pulsed lasers, the average power output (watts) and limiting exposure time inherent in the design are considered. For pulsed lasers, the total energy per pulse (Joule), pulse duration, pulse repetition frequency, and emergent beam radiant exposures are considered.
- B. Class 1:** Class 1 laser systems are incapable of producing damaging radiation levels during operation. They are exempt from any control measures or other forms of surveillance. Class 1 laser systems may contain higher class lasers and may produce laser hazards if operated with interlocks defeated. Only authorized personnel may operate class 1 laser systems with interlocks defeated.
- C. Class 1M:** Class 1M laser systems are incapable of producing hazardous exposure conditions during normal operations unless the beam is viewed with optical instruments. They are exempt from any control measures other than to prevent potentially hazardous optically aided viewing and are exempt from other forms of surveillance.
- D. Class 2:** Class 2 laser systems emit visible portion of the spectrum (0.4 to 0.7 μm). The natural aversion reaction to bright visible light is expected to protect the eyes from damage. Staring into the beam of a class 2 laser is hazardous.
- E. Class 2M:** Class 2M laser systems emit visible portion of the spectrum (0.4 to 0.7 μm). Class 2M lasers are only hazardous when viewed through magnifying optics. The natural aversion reaction to bright visible light is expected to protect the eyes from damage.
- F. Class 3R:** Class 3R laser systems are potentially hazardous under some direct and specular reflection viewing conditions, but the probability of an actual injury is small. Natural aversion is not an adequate protection method. The accessible emission limit (AEL) of a continuous wave 3R lasers is limited to 5 mW.
- G. Class 3B:** Class 3B laser systems are eye hazard for intrateam and specular viewing but aren't normally considered a diffuse reflection or fire hazard. Class 3B lasers are more powerful than 3R lasers. The AEL of a continuous wave 3B visible or invisible laser is normally 500mW.
- H. Class 4:** Class 4 lasers include all lasers with beam power greater than class 3B. A class 4 laser can be damaging to the eye and skin from the direct beam and diffuse

reflections. It is a potential fire hazard and can produce skin burns. The AEL of a continuous wave class 4 laser is normally greater than 500mW.

A written Standard Operating Procedures (SOP) is required for class 3B and 4 laser operations and subject to be reviewed and approved by the LSC. SOPs should address topics such as Normal Operating Procedures, Maintenance Procedures, Service Procedures, Alignment Procedures.

Note: If there are any manufacturer downgraded lasers, originally class 4 or 3B, after the installation of interlocks, safety features, will be considered as lower classes and therefore not regulated at ISU, so long as safety and interlock features are not bypassed.

7. Training Requirements

All operators of class 3B and 4 lasers shall receive approved laser safety training before operating the laser. Further training should be completed to perform different tasks such as maintenance and repairs. Topics for a laser safety training program for class 3B and class 4 laser may include, but are not limited to the following:

- Fundamentals of laser operation
- Bioeffects of laser radiation on the eye and skin
- Significance of specular and diffuse reflections
- Non-beam hazards of lasers
- Laser and laser classifications
- Control measures
- Overall responsibilities of management and employee
- Medical surveillance practices (if applicable)

8. Medical Surveillance

Baseline eye exams are not required. An eye exam is required immediately following a suspected or actual laser-induced injury. Laser personnel shall report any suspected or actual laser-induced injury to the Laser Authorized User and the Laser Safety Officer immediately. The frequency of medical examinations following any suspected or actual laser injury should be determined by the attending physician.

9. Control Measures

All class 3B and 4 lasers shall be operated in a laser-controlled area. The requirements for individual laser-controlled areas shall be determined by the LSO/LAU. The minimum requirements for laser-controlled areas are:

- An area which contains a Class 3b or Class 4 laser or laser system shall be posted with the appropriate sign.

- Appropriate warning signs should be posted while the instruments are operating. An alarm and warning light can also be used during the operation of lasers.
- Entryway controls allow only authorized personnel or approved spectators to enter the laser control area. Administrative controls can be utilized when possible and are acceptable.
- Beam control such as barriers and beam blocks can be utilized to limit laser hazards within the controlled area.
- Protective housing for class 3B and 4 lasers must have an interlock system which is activated whenever the protecting housing is opened during operation or maintenance.
- The operation of laser or laser system without protective housing is not permitted without the written authorization of LSO. In such cases, the LSO shall determine the extent of the hazard to ensure that the controls instituted are appropriate to the class of maximum accessible emission to ensure safe operation. These controls may include, but are not limited to access restrictions, eye protection, area controls, barriers, shrouds, beam stops etc. Administrative and procedural controls, education and training are also included.
- Laser safety eyewear available in required frequency and used in accordance with the SOP and manufacturer's instructions for class 3B and 4 lasers.
- A temporary laser-controlled area can be set up, when necessary, but requires the LSO approval. The control area shall provide all safety requirements. A sign shall be posted outside the temporary laser-controlled area to warn of the potential hazard.

10. Eyewear Policy

Laser safety eyewear is required for the operation of class 3B and 4 lasers within the nominal hazard zone (NHZ), and their use is enforced when engineering or other procedural and administrative controls are inadequate to eliminate potential exposure. The LSO will perform a hazard analysis for class 3B and 4 lasers to determine the type of eyewear to be worn by adhering to the instrument manual, and ANSI Z136.5 2020 guidelines. It is the responsibility of the AU to ensure that the required eyewear is available and worn by the operators.

11. Visitors Policy

Visitors, including faculty, staff, researcher, and students are allowed to tour the facility with the approval of the LAU. However, a specific briefing about the laboratory and potential hazard must be provided by the LAU/laser operator. Visitors must exit the laboratory while Class 3B and 4 lasers are in-operation. Additionally, the number of visitors in a group shouldn't exceed ten at a time.

12. Laser Safety Program Audits

Annual audits of each class 3B and 4 Laser will be performed by the LSO by utilizing the LPR-3 Laser Inspection form. The audits will look at the usage plan and at a minimum evaluate the following:

- Training records
- Warning signs
- Proper Class labeling
- System operating procedures
- PPE requirements
- Operation logs

13. Decommissioning of Laser Laboratories and Facilities

When a Laser system is decommissioned, proper disposal and disassembly is very important. The manufacturer disposal recommendations should be followed, and the cost associated with disposal should be accounted for in the usage plan. The transfer of a Laser system must be approved by the LSC. Abandoning a lab with a Laser system is prohibited.

14. Records

The LSO and/or the AU shall maintain the records of the Laser Safety Program. These records shall include:

- Laser hazard analysis reports for all class 3B and 4 lasers
- Training records for all operators of class 3B and 4 lasers
- Standard Operating Procedures for all class 4 lasers
- Approvals of alternate laser control measures
- Laser Safety Audit reports
- Accident reports