

# Laser Safety Manual

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All users of Class 3b and Class 4 lasers are expected to follow the policy, procedures, and guidelines contained in this manual, which was established by the Oklahoma State University (OSU) Laser Safety Officer (LSO) and the Laser Safety Committee (LSC).

[Section 1.0] - Policy and Scope

[Section 2.0] - Procedures: Administration and Evaluation

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[Section 5.0] - Safety & Control Measures Engineering, Administrative & Procedural Measures, Special Measures for Medical Applications, Other Special Control Measures, Applicable Standards

[Section 6.0] - Training Introduction, Laser Safety Officer, Laser Users & Supervisors, Implementation & Administration of Training Program, Applicable Standards

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Section 8.0 OSU Laser Safety Plan

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## **SECTION 1.0 - POLICY AND SCOPE**

### **A. Policy**

Laboratories in general require precautions to limit associated hazards. Laboratories with high-powered (Class 3b and Class 4) lasers require special safety procedures to ensure a safe environment. It is the policy of Oklahoma State University to provide its employees, students and visitors with the safest work environments possible. Therefore, the University requires conformance with these safety standards. In order to promote this policy, the University will provide the necessary materials and support needed to implement the safety and control measures required by the LSO and LSC to ensure a safe environment.

### **B. Scope**

This manual describes reasonable and necessary policies and a procedure for the safe use of lasers, which applies to any and all facilities, departments, and employees who are associated in any manner with the use and/or handling of high-powered (Class 3b and Class 4) lasers.

The safety standards contained herein are based primarily on the American National Standards Institute *Guide for the Safe Use of Lasers* (ANSI Z136.1-2007); *Guide for the Safe Use of Lasers in Health Care Facilities* (ANSI Z136.3-2005); and *Guide for the Safe Use of Lasers in Educational Institutions* (ANSI Z136.5-2000); or the most recent guide(s) if an update has been adopted. This manual represents the generally accepted standards for the safe use of lasers within the fields of industry, education, research, and medicine.

## **SECTION 2.0: PROCEDURES**

### **A. Administration**

Responsibility for the administration of the safety standards contained herein rests with the Vice President for Research and Technology Transfer (VPRTT). The VPRTT will designate a Laser Safety Officer (LSO) who is responsible for the implementation of the appropriate safety standards (e.g., ANSI Z136.1-2007; ANSI Z136.3-2005; ANSI Z136.5-2000). The LSO shall be an individual "with the authority and responsibility to monitor and enforce the

control of laser hazards, and to effect the knowledgeable evaluation and control of laser hazards" The LSO is assisted by a Laser Safety Committee (LSC). The Vice President for Research and Technology Transfer, in consultation with the LSO and the Director of the Office of University Research Compliance (URC), appoints members to this committee from representatives from the campus community. The committee includes a general University administrator, a laser-user scientist or engineer, a medical laser-user, a safety expert, and any other members felt needed to comprise a panel capable of effective evaluation of laser safety standards. The LSC shall be chaired by a member of the OSU faculty and an OSU faculty member shall serve as Vice Chair of the LSC. Both the Chair and the Vice Chair, who must be knowledgeable in the safe use of lasers, will be appointed by the VPRTT.

The LSO shall not delegate the authority to approve a Laser Safety Plan (see Section 8.0), but may delegate such functions as evaluations, audits, and training. The LSC will meet at least annually, or more frequently as deemed necessary by the LSO.

## **B. Evaluation Procedures**

When any individual or unit initiates or significantly modifies an operation (research, demonstration or conventional) that involves the use of Class 3b or Class 4 laser systems the individual or unit must, at the same time, submit a "[Laser Safety Plan](#)" form, which includes standard operating procedures (SOPs), to the LSO. Standard laser copiers, laser printers, optical scanners, or equivalent equipment will be assumed to be class 1 lasers enclosed in a protective housing and will be exempt from filing a Laser Safety Plan unless the individual or unit knows of any reason that the equipment would not be considered a class 1 laser. Laser pointers and similar "low power" laser systems do not require a Laser Safety Plan. However, users of "low power" laser systems should read the safety precautions in the manufacturer's literature.

The LSO, along with the LSC, has the authority to request supplemental information in addition to the Laser Safety Plan as needed to accomplish a thorough and complete evaluation of the laser hazards and the control measures required to ensure safety.

No unit within the University may install, significantly modify or operate a high-powered laser unless a Laser Safety Plan has been approved by the LSO. Once granted, the approval of the Laser Safety Plan remains in force until withdrawn by request of the

applicant or by notification by the LSO. The LSO has the authority to suspend, restrict, or terminate the operation of a laser if, at any time, he/she determines that the laser hazard controls are inadequate. Once approval is obtained, the individual/unit is responsible for complying with the proper installation of the laser and maintenance of the required safety features. The LSO is available for consultation and to assist users with meeting these requirements.

Evaluation of a Laser Safety Plan and a laser acquisition is based on three primary considerations:

1. The laser classification,
2. The facility/environment where the laser will be used, and
3. The personnel operating the laser or otherwise within the vicinity of the laser.

## **C. Audits and Inspection**

Existing laser safety plans will be routinely audited and the facility inspected. The frequency of audits and inspections will vary depending on risks that are identified. At a minimum, all laser safety plans will be audited annually. Audits will be performed by the LSO or members of the LSC. Documentation of all audits will be maintained by the LSO.

# **SECTION 3.0: LASER HAZARDS AND HAZARDS EVALUATION**

## **A. Introduction**

The use of lasers is becoming increasingly widespread in all walks of life, especially in education and research conducted at Oklahoma State University. Lasers can present a variety of serious hazards. Lasers can cause injury to the eyes and the skin. Lethal electrical and fire hazards can also be present with high-powered lasers. Chemicals that are used in conjunction with lasers, can also present a variety of serious hazards.

Each individual or unit operating lasers or laser systems will document to the LSC that the appropriate control measures are implemented to reduce the possibility of exposure to these hazards (see [Safety and Control Measures](#) in Section 5).

## B. Eye and Skin Hazards

Hazardous effects can occur to various parts of the eye depending on the wavelength of the laser. The injuries can vary due to the variance in how tissues absorb energy. The following are some examples of hazards that can affect the eye:

- Radiation at the visible and near-infrared wavelengths is absorbed and can have hazardous effects on the retina.
- Radiation at the near-ultraviolet and middle infrared wavelengths is absorbed and can injure the lens.
- Corneal absorption and associated effects can occur with far-infrared and middle-ultraviolet wavelengths.
- Corneal lesions and retinal lesions can occur from the heat resulting from the energy absorption and from photochemical reactions.
- Some transitional wavelength zones can result in both corneal and retinal damages.

## C. Associated Hazards

Although less frequent, the potential for injuries resulting from skin exposure to a laser beam should be treated just as strictly as the potential for eye injuries. In certain situations where eye protection is worn, skin exposure could represent the more significant hazard.

Although eye and skin exposure to laser radiation represent the primary hazard associated with laser use, ancillary hazards associated with the use of lasers can be significant. Electrical shock, fire, injuries from cryogenics and chemicals are all potential hazards associated with laser use.

### 1. Electrical Hazards

Next to skin and eye exposure, electrical shock represents the highest potential for injuries from laser use, especially with the newer, high-powered lasers. The potential for electrical hazards most commonly results from inappropriate electrical installation, grounding, or handling of the high voltage associated with many lasers. Any University unit responsible for the operation of any laser shall ensure the necessary protective electrical circuit design. The laser resonator and electro-optical elements should also be designed so that no exposed metallic

element is above ground potential. All electrical installations must comply with NEC.

2. **Fire and Explosion Hazards**

High-pressure arc lamps, filament lamps, and associated optics can shatter or explode during laser operation. These components must be enclosed in housings that can withstand the maximum explosive pressures. The proper installation of the electrical power supply discussed in the above section is also important to reduce the potential for electrical fire. Any enclosures, barriers or baffles must comply with "Polymeric Materials for Use in Electrical Equipment," Underwriters Laboratories Standard, UL 746C.

3. **Other Associated Hazards**

Consideration should be given to other hazards that may be associated with laser use, including the presence of compressed gases (e.g. [excimer gas lasers](#)), dyes, cryogenic liquids, toxic fumes and gases, ionizing radiation, and toxic materials. Consideration should also be given to the proper disposal of any hazardous materials in accordance with the appropriate OSU policies.

## D. Hazard Evaluation

Three primary elements influence the evaluation of laser hazards:

- The laser or laser system,
- The environment in which the laser is used, and
- The personnel operating the laser or exposed to the laser hazards.

## E. Applicable Standards

The LSO and LSC will apply the standards from ANSI Z136.1-2007 or Z 136.3-2005 as appropriate to evaluate potential eye and skin hazards. These standards set Maximum Permissible Exposure (MPE) levels for eye and skin exposure to laser radiation and the control measures required to prevent exposure.

# SECTION 4 - LASER CLASSIFICATIONS

## A. Laser Classifications

All laser and laser systems are classified according to their accessible radiation during normal operation. Lasers should be appropriately labeled by the manufacturer in conformance with the Federal Laser Product Performance Standard. In most cases, this label will determine the laser classification unless the LSO determines that there are special considerations that require the laser be reclassified.

## **B. Applicable Standards**

The LSO and LSC will apply the standards from ANSI Z136.1-2007 to classify lasers and evaluate the related hazards.

# **SECTION 6.5 - SAFETY AND CONTROL MEASURES**

## **A. Engineering Safety and Control Measures**

Based on the laser classification and the hazard evaluation, the LSO and LSC will require certain safety and control measures. These may include engineering control measures incorporated into the laser or laser system, such as, but not limited to:

- Protective housings
- Access panels
- Master switches
- Viewing portals
- Open or enclosed beam paths

## **B. Administrative and Procedural Control Measures**

The LSO and the LSC may require certain administrative and procedural controls that may supplement and/or implement engineering control measures. These administrative and procedural controls include, but are not limited to:

- Standard operating procedures
- Education and training
- Authorized personnel requirements
- Required alignment procedures
- Required eye protection

- The presence of any hazardous materials and their proper disposal
- Ventilation systems

## **C. Special Safety and Control Measures for Medical Applications**

The LSO and LSC may also require special control measures for the use of lasers in medical applications. These may include, but are not limited to:

- Special training requirements
- Special equipment testing requirements
- Special medical surveillance requirements
- Laser treatment controlled areas
- Patient eye protections
- Evaluation of fiber delivery systems
- Ventilation systems

## **D. Other Special Control Measures**

The LSO and the LSC also consider special control measures that may be required as deemed necessary. These may include, but are not limited to:

- Laser demonstrations involving the general public or exposure of the general public to any laser beam hazards
- Laser installation procedures
- Federal, state, or local requirements
- Personal protective equipment
- Warning signs, labels, and signal words in accordance with the appropriate ANSI standards
- Electrical installations in compliance with NEC
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## **E. Applicable Standards**

### **1. Standards**

The LSO and LSC will apply the standards from ANSI Z136.1-2007 (Section 4) to determine the appropriate safety and control measures. The LSO and LSC will apply the standards from ANSI Z136.3-2005 for the use of lasers in medical applications.

## **2. Minimal Control Standards**

The majority of laser and laser systems acquired at Oklahoma State University will be Class 1, 2, or 3A lasers that require only minimal control measures, or will involve an "enclosed beam path." If all requirements for a protective housing are fulfilled, then enclosed beam paths, for lasers of all classes, fulfill the requirements of a Class 1 laser and no further controls are required. As noted in Section 2.0- of these guidelines, standard laser copiers, laser printers, optical scanners or equivalent equipment will be treated as enclosed class 1 lasers unless otherwise noted.

# **SECTION 6.0 - TRAINING**

## **A. Introduction**

The University must provide an adequate training program for the LSO, the LSC, and to each employee routinely working with or around lasers above Class 3A. The level of training will be commensurate with the degree of potential laser hazards. Training is available through the LSO.

## **B. Laser Safety Officer**

The LSO must be provided with extensive training to classify laser and laser systems, evaluate hazards, implement safety and control measures, implement and administer University policy and training programs.

## **C. Laser Users and Supervisors**

Laser users include, but are not limited to, faculty members, researchers, graduate and undergraduate students, operators, technicians, engineers, maintenance and service personnel. All laser users working with lasers above Class 3A shall be provided with a level of training commensurate with the class of laser.

Each supervisor of a facility with laser and laser systems will ensure the names of all personnel involved in working with or around laser and laser systems are submitted to the LSO to obtain the required training.

## D. Implementation and Administration of Training Program

The LSO has the responsibility of implementing and administering a University-wide training program and may determine if a commercial training program, or a program developed in-house, or a combination thereof will be utilized. The LSO will determine the specific procedures for initial orientation and for the periodic retraining of laser users. Safety training will be reviewed and endorsed by the Laser Safety Committee to ensure that needs of various constituencies of the university are addressed.

## E. Applicable Standards for Training

The following table provides a summary of recommended training levels and methods. The LSO and LSC will apply the standards from ANSI Z136.1-2007 (Section 5). Special training for users of medical lasers will be in accordance with the standards from ANSI Z136.3-2005 (Section 5.2). Contact the LSO for a copy of the ANSI standards.

<b>Recommended Training for LSO's and Employees (Including, but Not Limited to, Operators, Maintenance Personnel, and Service Technicians) Routinely Working with or around Lasers</b>						
<b>Method of Training</b>	<b>Highest-Class Laser</b>					<b>LSOs</b>
	<b>1</b>	<b>2a/2</b>	<b>3a</b>	<b>3b</b>	<b>4</b>	
<b>Manufacturer's Guide and Operating Manuals</b>	R	SR	SR	SR	SR	n/a
<b>Safety Guide Literature</b>	n/a	R	SR	SR	SR	SR
<b>Film &amp; Slide/Audio Programs</b>	n/a	n/a	R	SR	SR	SR
<b>Laser Safety Orientation</b>	n/a	n/a	n/a	SR	SR	SR
<b>Short-Term Course</b>	n/a	n/a	n/a	n/a	R	SR
<b>Review of Applicable Standards</b>	n/a	n/a	n/a	n/a	n/a	SR

n/a (not applicable)    R (recommended)    SR (strongly recommended)

Adapted from ANSI Z136.1-2000

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## **SECTION 6.7 - ACCIDENT REPORTING AND MEDICAL SURVEILLANCE**

### **A. Accident Reporting**

Any employee must report any suspected or known accident involving a laser or laser system to their direct supervisor who is responsible for transmitting the information to the LSO. In the absence of the supervisor, the employee will notify the LSO directly. This requirement will be clearly communicated in the laser safety-training program. Incidents (near misses) are those occurrences where there was no injury or significant property damage but where investigation could help diagnose causal factors that would prevent a serious accident. Employees are encouraged to report near misses to their supervisor and the LSO.

The LSO will immediately notify the Director of University Research Compliance in the Office of the Vice President for Research of all incidents and accidents reported and investigated. In the absence of the LSO, the supervisor will notify the Director of University Research Compliance in the Office of the Vice President for Research directly. An incident report will be filed in the Office of University Research Compliance. The employee will initiate this report. Additional signatures on the report will be required from the employee's immediate supervisor, the department head (if different), and the college research officer. In consultation with the LSO and Committee, the Director of University Research Compliance will initiate further investigative actions, as appropriate. The Vice President for Research has final authority over any actions taken. A formal report of actions taken will be filed with the Office of University Research Compliance, with copies distributed to the department and college.

The LSO will review and evaluate all accidents; initiate investigative boards as necessary and will file a report with his/her findings with appropriate copies to the Vice-President for Research, Compliance Programs, and appropriate university management.. The LSO/LSC will determine any further actions deemed necessary as a result of the accident. Manufacturers of lasers are required by the FDA to report information that reasonably suggests that one of their devices may have caused or

contributed to a serious injury. The LSO has the sole responsibility for determining when an accident report should be forwarded to the laser manufacturer.

## **B. Medical Surveillance**

No pre-assignment medical examination is required before an employee may work in an area involving lasers. Employees are expected to schedule a visual acuity examination with University Health Services when initially assigned to work with class 3B or Class 4 laser systems. The employee is required to report to the supervisor any medical conditions that could cause the laser user to be at an increased risk for chronic exposure. These conditions could include, but are not limited to, photosensitivity of the skin, use of photosensitizing medications, and dermatological abnormalities of the skin.

When there is a known or suspected accident, the accident is to be reported to the supervisor and the LSO. The LSO will immediately notify the Director of University Research Compliance in the Office of the Vice President for Research of all incidents and accidents reported and investigated. In the absence of the LSO, the supervisor will notify the Director of University Research Compliance in the Office of the Vice President for Research directly (See Section 6.7). Any employee with a suspected injury must be referred to a physician for evaluation and treatment, as appropriate. The LSO and the LSC will convene a board of investigation to determine the causal factors and recommend appropriate corrective action. The employee must provide the LSC with a record of the medical examination and treatment, for the purposes of the investigation. The LSO is responsible for the confidential maintenance of these records in accordance with privacy laws .

## **OSU Laser Safety Plan**

A Laser Safety Plan (LSP) is a means for documenting the assessment of the hazards associated with the laser system and its use. The person responsible for the laser system is responsible for completing a hazards analysis and implementing measures to control hazards to levels permitted in ANSI Z136.1-2007. ANSI Z136.3-2005 applies to the medical use of lasers including veterinary medicine. The LSP is submitted to the LSO for approval prior to beginning operation of the system.

The Laser Safety Plan (LSP) is initiated by the Principal Investigator or faculty members responsible for the laboratory or other space where the Class 3b or Class 4 laser will be used. The responsible faculty member requests a Laser User ID from the Office of University Research Compliance (URC) via the Laser Safety Web Pages on the URC Web site (see <http://compliance.vpr.okstate.edu/Laser/index.htm>). This enables the responsible faculty member to enter their Laser Safety Plan online, access audit records, and upload standard operating procedures.

The LSP consists of a description of the laser system, and will initiate a Standard Operating Procedure (SOP) which is a description of the operations involving the laser use, a description of the laser radiation hazard zone(s) and other hazards (such as electrical or toxic substances) associated with the laser system, and the physical and procedural control measures that have been implemented to limit the hazards. Assistance in completing the LSP is available from the LSO. The LSO's contact information is located at <http://compliance.vpr.okstate.edu/Laser/staff.htm>.

The Laser Safety Plan must be kept current and resubmitted for approval when significant modifications are made. These plans must be submitted via the Laser Safety Web Pages on the URC Web site (see <http://compliance.vpr.okstate.edu/Laser/index.htm>) or, in the event that this is not possible, to the LSO at the following campus address:

Laser Safety Officer – 499 Cordell South (4-7228)

### **Class 3b and Class 4 Laser Systems**

**For the operation of...** (Give a brief description of laser or laser system including classification to be acquired or returned to operating status):

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**Laser Classification:**

**For additional information and guidelines, refer to OSU's Guidelines for Laser Safety and the Laser Safety Website (<http://compliance.vpr.okstate.edu/Laser/index.htm>).**

Please provide the names and signatures contact information (address, phone and e-mail) other university officials responsible for the operation of the laser system.

Faculty Member

Department Head

College Official (Dean, Assoc. Dean, etc.)

1. Provide a summary of technical specifications for the laser or laser system and a brief description of the work to be performed with the laser (include a copy of the vendor's specification and classification, if available).
  1. Wavelength (s)
  2. Continuous Wave Yes\_ No \_\_
  3. Pulsed? Yes \_\_ No \_\_\_ Pulse duration \_\_\_\_
  4. Maximum Power or Energy \_\_\_\_\_
2. Describe the facility/environment in which the laser or laser system will be used (research laboratory, teaching laboratory, medical/surgical laboratory, office, etc.)
3. Attach a standard operating procedure (SOP) for general operation including identification of beam hazards, other hazards related to system operation; include maintenance and service procedures if not performed by manufacturer's representatives. Describe precautions taken to prevent exposure of personnel to levels above the MPE (ANSI Z136.1). Describe qualifications training requirements for all personnel including students and observers.
4. Will operation of this laser or laser system involve the presence or any exposure to the general public at any time (such as special tours) or any other unusual circumstances?

**Yes** ,  **No** ; if yes, please describe:

Will operation of this laser or laser system involve using lasers for health care, medical, or surgical applications to animals or human patients?  **Yes** ,  **No** ; if yes, please indicate what institutional reviews (IACUC, IRB, etc.) are required/obtained, and include the procedure(s) for which the laser will be used in the SOP.

### **Signatures**

**Faculty Member** \_\_\_\_\_

**Department Head** \_\_\_\_\_

**College Official** \_\_\_\_\_

**TO BE COMPLETED BY LASER SAFETY OFFICER**

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PLAN NO. \_\_\_\_\_

LSO ACTION:

- Approved
- Approved with Provisions (see comments)
- Deferred for Revision (see comments)
- Disapproved

COMMENTS:

Laser Safety Officer

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