



Laser Safety Manual

Southern Illinois University

Carbondale, Illinois

1st Edition

2007

Prepared by:
Laser Safety Committee
Southern Illinois University
Carbondale, Illinois

TABLE OF CONTENTS

<u>LASER SAFETY MANUAL</u>	<u>PAGE</u>
Emergency Information	4
Foreword	5
Abbreviations	6
 <u>LASER SAFETY PROGRAM</u>	
1.0 Introduction	7
1.1 Regulatory Authority	7
1.2 Program Authority	7
2.0 Laser Safety Committee (LSC)	7
3.0 Laser Safety Officer (LSO)	8
4.0 Department Chairperson	8
5.0 Principal Investigator (PI)	8
6.0 Residents	9
7.0 Laser Operator	9
8.0 Laser Use Registration	10
8.1 Acquisitions, Modification, Sale or Transfer of Lasers	10
9.0 Maximum Permissible Exposure and Nominal Hazard Zone	10
10.0 Standard Operating Procedures	10
11.0 Laser Safety Training	10
11.1 Physician Training	11
12.0 Safety Interlocks	11
12.1 Safety Interlocks – Alternatives	12
13.0 Personal Protective Equipment	12
14.0 Eye Examinations	13
15.0 Warning Systems	13
16.0 Controlled Areas	13
16.1 Posting and Labeling	13
17.0 Skin Protection	13
18.0 Control Measures for Medical Applications	14
19.0 Fiber Optic Transmission	14
20.0 Infrared Lasers	14
21.0 Magnification of Laser Beam	14
22.0 Viewing Optics and Windows	14
23.0 Laser Safety Inspections	15
24.0 Incident Reporting	15
25.0 Laser Hazard Classification	15
25.1 Class 1	15
25.2 Class 2	15
25.3 Class 3a	16
25.4 Class 3b	16
25.5 Class 4	16
26.0 References	16

TABLE OF CONTENTS

<u>APPENDIX I</u>	Beam Control Precautions	18
<u>APPENDIX II</u>	General Safety Considerations Regarding Laser Usage	19
<u>APPENDIX III</u>	Emergency Procedure for Laser Accidents	21
<u>APPENDIX IV</u>	Laser Warning Sign	22
<u>APPENDIX V</u>	SIU Laser Safety Program Forms	23
	SIULaser1 Registration Information	24
	SIULaser2 Laser User Statement of Training and Experience	26
	SIULaser3 Laser Safety Standard Operating Procedure	28

EMERGENCY INFORMATION

In the event of an accident involving a laser producing device, contact:

(During regular hours)

Office of Radiological Control **618-536-2015**

(After hours, weekends, and holidays)

SIUC Police Department **618-453-3771**

If the accident involves **personal injury** or **fire**, immediately call: **911**

for assistance and then notify the Laser Safety Officer (LSO) and SIUC Police as soon as possible.

FOREWORD

This first edition of the “Laser Safety Program (LSP),” was prepared by the Southern Illinois University – Carbondale Laser Safety Committee (LSC). The following procedures and/or regulations are promulgated to assure the safe utilization of laser systems on all properties under the control of Southern Illinois University – Carbondale.

The Southern Illinois University – Carbondale Laser Safety Program contains the rules, regulations and procedures necessary to ensure compliance with State regulations of the State of Illinois, Division of Nuclear Safety. It also includes the rules and procedures which the LSC has deemed necessary in order to safeguard personnel, property and the community-at-large from possible exposure to hazardous levels of laser radiation.

The purpose of the Laser Safety Program is to supplement State regulations for the control of laser radiation but in no case is intended to replace these regulations. In the event that future State regulations are found to differ from the requirements herein, the regulatory body’s regulations shall be adhered to unless the rules and regulations contained herein are the most stringent.

Note: In the context of this Manual, when the terms **shall**, **should**, and **may** are designated by underscoring:

1. The term **shall** indicates a mandatory regulation which is necessary and/or essential to meet currently accepted standards of protection.
2. The term **should** indicates a recommendation which must be adhered to unless there are valid reasons for its exclusion.
3. The term **may** indicates a recommended practice of a more optional nature.

The LSC shall review this Laser Safety Program annually and update as occasion demands. Changes may be made to the Manual to facilitate administration of the Laser Safety Program. If these changes do not affect the safe operation of lasers or laser systems, these changes will not be submitted as a separate license amendment. Revisions will be circulated after approval by the LSC and appropriate regulatory authorities has been obtained, and shall be immediately incorporated into the Laser Safety Manual. The obsolete pages shall be promptly destroyed upon substitution of the revisions.

ABBREVIATIONS

ANSI – American National Standard Institute

CFR – Code of Federal Regulations

FDA – Food and Drug Administration, United States

IDNS – Illinois Divivison of Nuclear Safety

LSC – Laser Safety Committee

LSO – Laser Safety Officer

LUR – Laser Use Registration

MPE – Maximum Permissible Exposure

MW – Milliwatt

NHZ – Nominal Hazard Zone

ORC – Office of Radiological Control

P – Physician

PI – Principal Investigator

RCC – Radiological Control Committee

SIU – Southern Illinois University

SOP – Standard Operating Procedures

Laser Safety Program

1.0 Introduction

The Southern Illinois University (SIU) has established a Laser Safety Program to provide controls and safety guidance to personnel for activities involving the use of Class 3b and 4 lasers or laser systems. This manual was written to provide SIU laser safety policies and procedures on maintaining and documenting the Program. The manual also serves as a reference source for laser users.

The requirements and guidelines presented herein are **not intended** to restrict or limit in any way the use of laser radiation which may be intentionally administered to a patient for diagnostic, therapeutic or research purposes by qualified and trained health care professionals engaged in medical health care. These individuals retain the ultimate responsibility for the safe use of lasers and laser systems with patients at SIU.

Safety is everyone's concern. Physicians operating lasers in Clinical areas must be familiar with University policies and insist on compliance by all personnel. Faculty conducting or supervising research, which involves lasers, are likewise responsible for all personnel within the laser use environment. The skill and safety awareness of the laser operator are the most important aspects of a laser safety program. Similarly, for individuals assisting the laser operator, knowledge and the consistent application of laser safety practices will ensure a safe working environment with lasers.

1.1 Regulatory Authority

The safety standards contained herein are based primarily on the Illinois Division of Nuclear Safety (IDNS) regulations Part 315, "Standards for Protection Against Laser Radiation." Pursuant to provisions of the Laser Safety Act of 1997, these requirements address issues of laser safety for use of Class 3b or Class 4 lasers and incorporate references from Title 21 of the Code of Federal Regulations, the American National Standard for the Safe Use of Lasers, ANSI Z136.1-2000 and the American National Standard for the Safe Use of Lasers in Health Care Facilities, ANSI Z136.3-1996.

1.2 Program Authority

Lasers used at SIU are governed by the policies and procedures approved by the Laser Safety Committee. The Laser Safety Officer is responsible for implementing the policies and procedures approved by the Laser Safety Committee. The Principal Investigator is responsible for using lasers according to the policies and procedures approved by the Laser Safety Committee. See below for more details.

2.0 Laser Safety Committee (LSC)

The Laser Safety Committee (LSC) shall administer the Laser Safety Program under the authority granted to the Radiological Control Committee (RCC) by the Dean and Provost of the University. The LSC is responsible for laser protection oversight at SIU. The LSC shall have the authority to authorize, suspend, and specify conditions of use of all lasers at facilities of, and areas of administration by, the Southern Illinois University – Carbondale. The LSC is responsible for:

- a) Reviewing internal policies/procedures to ensure they comply with applicable regulations and standards.
- b) Approving all Standard Operating Procedures for laser usage.
- c) Establishing enforcement action by the LSC and the Laser Safety Officer for deficiencies in practices of the Physician/Principal Investigator and other authorized Laser Users.
- d) Performing annual program reviews.

3.0 Laser Safety Officer (LSO)

The Laser Safety Officer (LSO) is responsible for Laser Safety Program development, program implementation, and program compliance. The LSO shall be provided with administrative support and adequate resources as are required to carry out the provisions of the Program. The LSO shall report to the LSC on a regular basis with material information about the operation of the Program as required by the LSC. Duties of the LSO include but are not limited to the following:

- a) Administering the overall Laser Safety Program.
- b) Maintaining a current inventory of Class 3b and 4 lasers.
- c) Functioning as liaison between the Physician/Principal Investigator, laser users and the LSC.
- d) Making recommendations to improve laser safety.
- e) Reporting problems of non-compliance with laser safety to the LSC.
- f) Restricting or terminating use of lasers that present an imminent danger or excessive hazard.
- g) Review/inspect protective equipment (i.e., eyewear, clothing, etc.) at intervals not to exceed six (6) months.
- h) Ensure that adequate safety education and training is available.
- i) Participating in accident investigations involving lasers.
- j) Maintain records as required by the IDNS and SIU.

4.0 Department Chairpersons

Department chairpersons are responsible for assuring their Physicians/Principal Investigators who use lasers operate those lasers safely and implement the Laser Safety Program.

5.0 Physician / Principal Investigator (P/PI)

The Physician and/or Principal Investigator (P/PI) is directly responsible for implementing the SIU Laser Safety Program to the operation of lasers or laser systems. The P/PI must be permanent faculty or staff (i.e., not a postdoctoral or graduate student) and are responsible for:

- a) Ensure that they are appropriately credentialed for medical or approved for research use of lasers at SIU.
- b) Registering all lasers with the LSO by completing a Laser Registration Form for each laser within clinical or laboratory areas (See Section 7.0).
- c) Providing, implementing, and enforcing the Laser Safety Program specific to the clinical or laboratory laser.

- d) Ensuring that Standard Operating Procedures (SOP) are written for all Class 3b and 4 laser activities and available to Laser Operators under their supervision, and that such procedures have been approved by the LSC (See Section 10.0).
- e) Ensuring that Laser Operators, prior to operating or working in proximity to Class 3b and 4 lasers participate in the Laser Safety Program training and complete and submit the Laser User Statement of Training and Experience form SIULaser2 (See Appendix V).
- f) Supervising the safe use of lasers in the laser environment.
- g) Ensuring the availability of correct protective eyewear (See Section 13.0)
- h) Notifying the University LSO immediately if an exposure or suspected accident occurs (See Section 25.0).
- i) Notifying the LSO when acquiring a new laser by purchase or transfer, or when the location of a laser has changed by relocation or transfer (See Section 8.0).
- j) Assist the LSO in the scheduled inspection of lasers and protection equipment under their control.

6.0 Residents

Residents are employees who are still in training and cannot meet the requisite training requirements for formal approval or credentials to use laser devices unsupervised at SIU. Therefore, each resident who may use laser devices must:

- a) Ensure that they are fully compliant with the departmental criteria for laser use as established by the Departmental Chairperson and their immediate supervisor.
- b) Maintain a use log, which documents the number and type of procedures performed, type of laser and wavelength used and the supervising physician. Note that it will be necessary for the supervising physician to verify completed training of each resident.
- c) Provide the LSO with all appropriate documentation upon request for laser privileges at the completion of training.

7.0 Laser Operator

Laser operators are responsible for their own safety during laser operations. All Laser operators must meet the laser safety training requirements prior to use of Class 3b or 4 lasers. All laser operators are responsible for following established safety procedures of the Laser Safety Program and will promptly report known or suspected accidents to the P/PI and the Laser Safety Officer. Laser Operators are responsible for:

- a) Participating in the Laser Safety Training Program.
- b) Following Standard Operating Procedures (SOP's) while operating lasers.
- c) Using the required personal protective equipment when using a laser.
- d) Ensuring familiarity with the specific safety hazards of lasers they are operating or working in proximity to.
- e) Operating a Class 3b or 4 laser only if authorized by the P/PI and/or the LSO and only after completing and submitting the Laser User Statement of Training and Experience form SIULaser2 (See Appendix V).
- f) Reporting known and suspected accidents to the P/PI and the LSO.
- g) Ensuring that all patients, spectators or visitors are properly informed of and protected from potential laser hazards.

8.0 Laser Use Registration

All laser systems that include a laser categorized as Class 3b or 4 shall be registered with the Office of Radiological Control (ORC) prior to their operation. The P/PI is required to submit a completed Laser Use Registration (LUR) form SIULaser1 to the LSO (See Appendix V). Purchasing has been instructed to notify the ORC whenever a Class 3b or 4 laser or laser system purchase request is received.

8.1 Acquisitions, Modification, Sale or Transfer of Lasers

The campus LSO must be informed of the acquisition, modification, sale, or transfer of any Class 3b or 4 lasers. Whenever any Class 3b or Class 4 laser system is to be brought into this State, for any temporary use, the LSO must be notified and the equipment registered within thirty (30) days prior to its use. It is the responsibility of the P/PI to inform the LSO whenever acquisition, modification, sale, or transfer of a laser or laser system occurs.

9.0 Maximum Permissible Exposure and Nominal Hazard Zone

For all open beam Class 3b or 4 lasers the Maximum Permissible Exposure (MPE) will be assumed to be exceeded and appropriate precautions taken. The Nominal Hazard Zone (NHZ) will therefore comprise the enclosure (room or area the beam is restricted to by virtue of walls, curtains or other barriers) in which the laser(s) is operating. The P/PI may for specific conditions determine the NHZ by using information supplied by the laser manufacturer, by measurement, or by using the appropriate laser range equation or other equivalent assessment. The P/PI shall not allow persons to be exposed to levels of laser radiation exceeding the MPE.

10.0 Standard Operating Procedures

Each Class 3b and 4 laser under the control of the P/PI shall have a Standard Operating Procedure (SOP) written for its operation. An SOP specifies the safe use and operating procedures for the laser system. The **SOP must be present at the operating console or control panel of the laser.** The SOP shall include at a minimum, operating instructions, safety eyewear parameters and instructions for proper laser use. The SOP shall include clear warnings to avoid possible exposure to laser and collateral radiation in excess of the MPE. The SOP shall be available for inspection by the LSO at any time. A template for Laser Safety Standard Operating Procedures, form SIULaser3, is attached to this document (See Appendix V).

11.0 Laser Safety Training

All P/PI's, nurses, nurses' aids, technicians, biomedical engineers, and other personnel associated with medical or research laser procedures must have the appropriate training before beginning work. Records of this training must be maintained for the duration of employment and will be reviewed during the annual safety assessment of the laser area.

Each person who operates or assists with the operation of Class 3b or 4 lasers must initially read both the Laser Safety Manual and the Laser Safety Training Module. To verify that these documents have been reviewed and understood, the laser operator must complete a short quiz, sign a training certificate, and submit the quiz and the certificate to the LSO for review and filing. The quiz and training certification document can be found in the Laser Safety Training Module.

The LSO is responsible for maintaining a file of the quizzes and training certificates. No person may work in the NHZ prior to completing laser safety training.

Initial laser safety training and annual refresher training will include the following information as it applies to the duties and responsibilities of the particular individual:

- a) Understanding laser warning signs.
- b) Identification of the hazards associated with laser use.
- b) Identification of basic methods to reduce the risks related to laser use.
- c) Following Standard Operating Procedures.
- d) Use of eye protection and other safety equipment.
- e) Electrical safety.
- f) Concerns related to the use of hazardous materials such as dyes and solvents.
- g) Accidents and emergency procedures

11.1 Physician Training

Physicians, as with Principal Investigators, are ultimately responsible for safety compliance in the use of a laser system in their work areas. Additional training requirements for physicians should include:

- a) **Manufacturer Training:** This is the hands-on training offered by the manufacturer detailing the appropriate operation of a specific medical laser. The training material and all records must be available to the LSO upon request.
- b) **Preceptorship:** This training is provided by a surgeon experienced on the applications of a particular laser system. In addition to learning the material, the surgeon-trainee must demonstrate proficiency in the use of the device in solo procedures. Records of the preceptorship detailing the laser and procedures, which the surgeon-trainee has mastered, must be maintained. These records will be reviewed during the annual facility safety assessment.

The Preceptor must also have the appropriate certification (training) in the applications being taught before teaching other users. Records of the Preceptor's experience must be properly maintained and available to the LSO upon request.

12.0 Safety Interlocks

Each Class 3b and 4 laser shall have safety interlocks, to ensure radiation is not accessible above MPE limits for any portion of the protective housing that by design can be removed or displaced without the use of tools during normal operation or maintenance. Pulse laser interlocks shall be designed to prevent inadvertent firing of the laser. Continuous wave lasers shall employ interlocks to disrupt the power supply or interrupt the beam.

Adjustment during operation, service, testing, or maintenance of a laser containing interlocks shall not cause the interlocks to become inoperative except where a laser controlled area is specified as in 32 Ill. Adm. Code 315.100 (a)(5) of the referenced regulation.

12.1 Safety Interlocks – Alternatives

The regulations recognize that in situations where an engineering control may be inappropriate the LSO shall specify alternate controls to obtain equivalent laser safety protection. Alternate controls may be submitted in writing to the LSO and, if accepted, will be documented in the SOP.

Where safety latches or interlocks are not feasible or are inappropriate, the following shall apply:

- a) All authorized personnel shall be trained in laser safety and appropriate personal protective equipment shall be provided upon entry.
- b) A door, blocking barrier, screen, or curtains shall be used to block, screen, or attenuate the laser radiation at the entryway.
- c) The level at the exterior of these devices shall not exceed the applicable MPE, nor shall personnel experience any exposure above the MPE immediately upon entry.
- d) At the entryway there shall be a visible or audible signal indicating that the laser is energized and operating at Class 3b or 4 levels.
- e) A lighted laser warning sign, flashing light and other appropriate signage are acceptable methods to accomplish this requirement. As an alternative, an entryway warning light assembly may be interfaced to the laser in the following manner: one light will indicate when the laser is not operational (high voltage off) and by an additional light when the laser is powered up (high voltage applied, but no laser emission) and by an additional (flashing optional) light that activates when the laser is operating.

13.0 Personal Protective Equipment

Each P/PI shall provide protective eyewear that meets the requirements of 32 Ill. Adm. Code 315.100 (b)(5). The eyewear shall be located where persons who operate the laser have unrestricted access to the eyewear. The eyewear shall be worn for alignment and operations where the laser beam is not enclosed where the potential exists for exposure to the laser beam, scattered or reflected radiation. No person shall operate a Class 3b or 4 laser without protective eyewear specific for the laser and the appropriate training for the specific eyewear. Protective eyewear shall meet the following requirements:

- a) Provide a comfortable and appropriate fit all around the area of the eye.
- b) Be in proper condition to ensure the optical filter(s) and holder provide the optical density or greater at the specific wavelength to reduce the incident energy to less than the MPE of the laser, and retain all protective properties during its use.
- c) Have the optical density or densities and associated wavelengths permanently and prominently labeled on the filters or eyewear.
- d) Be examined at intervals not to exceed 6 months, to ensure the reliability of the protective filters and integrity of the holders. Unreliable eyewear shall be discarded and replaced.
- e) When an individual who needs to wear prescription glasses is required to wear eye protection routinely, the required eye protection shall accommodate the

prescription glasses or be equipped with lenses that have the appropriate correction.

- f) Eye protection is required when there is a potential for eye injury due to projectiles or chemicals. Safety goggles shall be worn while performing any work that generates debris or chemical hazards to the eye. This includes the use of power tools, any construction, soldering, and the use of chemicals.

14.0 Eye Examinations

Personnel working with Class 3b or Class 4 lasers are not required to obtain either a pre- or post-employment medical examination specific to laser use. Following any suspected laser injury, employees must report to the P/PI and the LSO if they believe an injury has occurred.

15.0 Warning Systems

Each Class 3b or 4 laser shall provide visual or audible indication during the emission of accessible laser radiation. The indication shall occur prior to emission of radiation with sufficient time to allow appropriate action to avoid exposure. Any visual indication shall be visible through protective eyewear for the wavelength of the laser.

16.0 Controlled Areas

Each Class 3b or 4 laser shall only be operated in a Controlled Area. The P/PI shall establish a Controlled Area to limit access of personnel to laser radiation. Access to the Controlled Area shall be controlled by a door, blocking barrier, screen, or curtain, which attenuates the laser radiation to below the MPE, and individuals who enter the Controlled Area shall not experience radiation above the MPE immediately upon entry.

16.1 Posting and Labeling

Each Controlled Area utilizing a Class 3b or 4 laser system shall be posted conspicuously with signs as specified in 32 Ill. Adm. Code 315.150 (b). Laser enclosures must be labeled to alert operators and/or visitors to laser hazards. Labels, laser hazard signs, and advice on their use are available from the LSO.

- a) For Class 3b lasers and laser systems, each entrance must be posted with a sign bearing the word “DANGER” and the laser sunburst. Above the tail of the sunburst, the words “LASER RADIATION – AVOID DIRECT EXPOSURE TO THE BEAM” is to be listed. Below the tail of the sunburst the Class of the laser shall be listed. See Appendix IV.
- b) For Class 4 lasers and laser systems, each entrance must be posted with a sign bearing the word “DANGER” and the laser sunburst. Above the tail of the sunburst, the words “LASER RADIATION – AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION” is to be listed. Beneath the tail of the sunburst the Class of the laser shall be listed. See Appendix IV.

17.0 Skin Protection

Persons in the controlled area shall wear appropriate clothing, gloves, and/or shields to prevent exposure of the skin to levels exceeding the skin MPE.

18.0 Control Measures for Medical Applications

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

- a) Special training requirements
- b) Special equipment testing requirements
- c) Special medical surveillance requirements
- d) Laser treatment controlled areas
- e) Patient eye protection
- f) Evaluation of fiber delivery systems

Medical lasers used for human irradiation shall be calibrated in accordance with the manufacturer's specified calibration procedure at intervals not to exceed those specified by the manufacture.

19.0 Fiber Optic Transmission

Optical cables used for transmission of laser radiation shall be considered part of the laser protective housing. Disconnection of a fiber optic connector, which results in access to radiation in excess of the MPE, shall take place in a controlled area. All connectors shall bear appropriate labels. Optical cables shall be encased in an opaque sleeve to prevent leakage of laser radiation in case of breakage.

Note: If the fiber is designed to emit light through the walls of the fiber, the P/PI shall notify the LSO and include justification for lack of opaque cover in the SOP.

20.0 Infrared Lasers

An infrared laser beam, other than those applied to tissue for surgical or therapeutic purposes shall be terminated in a fire-resistant material so that the laser beam is not inappropriately reflected.

21.0 Magnification of Laser Beam

If at any time a laser beam is optically magnified or concentrated, special precautions shall be taken by the P/PI to prevent specular or diffuse reflection or other exposure greater than the MPE for the laser. The special precautions shall be documented in the SOP for the laser.

22.0 Viewing Optics and Windows

Using optical systems such as cameras, microscopes, etc., to view laser beams may increase the eye hazard. All collecting optics must incorporate suitable means (such as interlocks, filters, or attenuators) to prevent eye exposures above the MPE. When optical systems such as lenses, and microscopes are used, that were not supplied as part of a certified laser product, the LSO shall determine the potential hazard and specify procedures and controls.

23.0 Laser Safety Inspections

Every six (6) months the LSO shall inspect all clinical/laboratory facilities containing the laser(s) for which the P/PI is responsible, to assure that lasers are being operated in a safe manner. The P/PI is responsible to correct unsafe conditions or protection equipment in a timely manner. The LSO will inform the LSC of any uncorrected unsafe conditions. If the P/PI is unable to correct unsafe conditions in a timely manner, he/she may be asked to attend a LSC meeting to brief the LSC on the situation.

24.0 Incident Reporting

Each P/PI shall immediately seek appropriate medical attention for an injured individual and notify the LSO within 24 hours of any exposure injury involving a laser possessed by the University. See Appendix III for emergency procedures and emergency contacts. The LSO shall be notified within 48 hours of any non-injury incident, which involves potential exposure to laser radiation exceeding the MPE. A written summary of an injury or non-injury incident shall be forwarded to the LSO not later than one week following the incident. The LSO is responsible for investigating laser incidents, providing a report to the P/PI and LSC, and maintaining records of incidents.

25.0 Laser Hazard Classification

The hazard class of the laser is extremely important in determining the appropriate hazard controls to make the laser system safe. To provide a basis for laser safety requirements, all lasers and/or laser systems are divided into one of several classes. Corresponding labels are affixed to the laser or laser system to positively identify the class and alert the user to follow the necessary safety precautions. Understanding the laser classification is a fundamental prerequisite for any discussion of laser safety.

All commercially manufactured lasers come marked with the hazard class as required under the FDA Center for Devices and Radiological Health (CDRH) regulations. Lasers made or modified at SIU will need to be evaluated by the LSO and appropriately classed. It is the responsibility of the P/PI to assist the LSO by supplying the appropriate radiometric parameters of the laser system in the LUR.

25.1 Class 1 (Eye Safe Lasers)

Class 1 lasers do not emit harmful levels of radiation during normal operation and are, therefore, exempt from control measures. As a matter of good practice, unnecessary exposure to Class 1 laser light should be avoided. Very few lasers are designated as Class 1, however many laser systems can be made into Class 1 systems by totally enclosing the laser beam and interlocking the enclosure. Class 1 lasers do not require a LUR.

25.2 Class 2 (Safe Through the Aversion Response)

Class 2 lasers emit accessible laser light in the visible region and are capable of creating eye damage through chronic exposure. In general, the human eye will blink within 0.25 second when exposed to Class 2 laser light. This blink reflex provides adequate protection. It is possible, however, to overcome the blink reflex and to stare into a Class

2 laser long enough to cause damage to the eye. Class 2 lasers are commonly found in alignment applications. Class 2 lasers have power levels less than 1.0 milliwatt (mW).

25.3 Class 3a Lasers

Class 3a lasers and laser systems are normally not hazardous when viewed momentarily with the unaided eye, but they pose severe eye hazards when viewed through optical instruments (e.g., microscopes and binoculars). Class 3a lasers have power levels of 1.0 – 5.0 mW.

25.4 Class 3b Lasers (Intrabeam/Specular Reflection Hazard)

Class 3b laser light will cause injury upon direct viewing of the beam and specular reflections. The power output of Class 3b lasers is 5.0 – 500 mW. All of the control measures covered in the Laser Safety Program must be implemented. All Class 3b lasers require a LUR.

25.5 Class 4 Lasers (Diffuse Reflection and Fire Hazard)

Class 4 lasers include all lasers with power levels greater than 500 mW. They pose eye hazards, skin hazards, and fire hazards. Viewing of the beam and of specular reflections or exposure to diffuse reflections can cause eye and skin injuries. All of the control measures explained in this Laser Safety Program must be implemented. All Class 4 lasers require a LUR.

26.0 References

1. Illinois Division of Nuclear Safety, 32 Ill. Adm. Code: Chapter II, Part 315, “Standards for Protection Against Laser Radiation – 2001.
2. American National Standard for the Safe Use of Lasers, ANSI Z136.1–2000.
3. American National Standard for the Safe Use of Lasers in Health Care Facilities, ANSI Z136.3–1996.
4. U.S. Department of Labor, Occupational Safety and Health Administration Instruction Publication 8-1.7, "Guidelines for Laser Safety and Hazard Assessment"

Your suggestions for additions or deletions to these documents, as well as any comments you care to make, are welcome. Please make such notations below (attach extra sheets if necessary) and send to:

Laser Safety Officer
Southern Illinois University – Carbondale
Center for Environmental Health and safety
c/o Office of Radiological Control
1325 Radio Drive
Carbondale, Illinois 62901 – 6898

Appendix I

Beam Control Precautions

- 1.** Do not look directly into the beam or at a specular reflection, regardless of its power.
- 2.** Terminate the beam at the end of its useful path.
- 3.** Locate the beam path at a point other than eye level when standing or sitting at a desk at all times.
- 4.** Orient the laser so that the beam is not directed toward entry points to the Controlled Area or toward aisles or hallways.
- 5.** Minimize specular reflections.
- 6.** Securely mount the laser on a stable platform, if applicable.
- 7.** Limit beam traverse during adjustments.
- 8.** Clearly identify beam paths. Ensure the path does not cross to populated areas, study areas, desk areas, or traffic paths.
- 9.** A beam path that exits from a Controlled Area must be enclosed wherever the beam irradiance exceeds the MPE.
- 10.** Minimize unnecessary reflective objects in the clinical/laboratory area.
- 11.** Monitor for condensation on cooled systems. Condensate can provide a specular reflective surface.
- 12.** Utilize appropriate eye protection at all times when the laser is in operation, including during beam alignment.

Appendix II

General Safety Considerations Regarding Laser Usage

The following are considered basic to the safe laser operation, but apply specifically to Class 3b and 4 lasers:

1. Only individuals with proper qualifications and training shall operate lasers and associated equipment.
2. Follow approved Safety Operating Procedures (required for classes 3b & 4).
3. Utilize all required safety features/interlocks.
4. Areas where lasers are used shall be posted with standard laser warning signs, as required.
5. The laser beam shall not be directed at a person (unless as prescribed for medical purposes).
6. Do not allow chairs or stools in the laser area that place the eye at laser height.
7. Beam shutters or caps shall be utilized, or the laser turned off, when laser transmission is not actually required.
8. Lasers shall be turned off when unattended for a substantial period of time.
9. When feasible, only remote or electronic means shall be used to guide the laser beam during alignment.
10. Stray beams shall not be allowed to pass outside the Controlled Area through doors/openings. The relevant doors/openings must be closed whenever lasers or laser systems are activated.
11. When possible, the optical setup must be designed so beams are either parallel to or perpendicular to the optical table. Tilted beams may reach eye height at other locations in the area.
12. When possible, beams should be contained in beam tubes or enclosures.
13. All non-essential reflective material (e.g. jewelry, watches, belt buckles) must be eliminated from the beam area.
14. Beams used in research areas will be terminated with beam blocks that are constructed of a material that will minimize reflection and that is appropriate for the beam being terminated.
15. Beam stops will be secured with strong mechanical mounts to avoid the possibility of beam blocks dropping and exposing individuals to high intensity beams.
16. Unless personnel are out of range, lasers should not be used in areas where there is significant dust and/or mists.
17. A safety review should be conducted by the LSO when a Class 3b or 4 laser is significantly modified or moved to a new location that may require different control methods.

Electrical Safety:

The high voltages and electrical currents that may be associated with lasers present a serious hazard to personnel if proper safety precautions are not followed. The following basic principles apply:

1. Electrical circuit breakers will be clearly marked and each worker shall be instructed as to the location and procedure for turning off specific breakers in an emergency situation.

2. All modifications to power lines or power supplies shall be performed with circuit breakers off. For those times when live high current or high voltage power supplies are inspected, two members shall be present in the laboratory. Both members should be trained in emergency procedures involving electrical hazards.
3. Lockout and tag-out of electrical sources may be necessary in some circumstances, contact the LSO for details.

Hazardous Material/Biohazard Safety:

Hazardous and bio-hazardous materials are sometimes used either in conjunction with laser operation or are produced during their use. Special safety precautions may be necessary to protect people from the risks associated with these special hazards.

Examples:

1. Hazardous materials such as dyes (often carcinogens) and solvents used during laser operation shall be handled and disposed properly. Refer to the SIU Chemical Hygiene Plan and/or contact Environmental Health & Safety (EH&S) if there are questions.
2. Fumes, gasses (e.g. ozone), and vapors generated during laser operation may be hazardous chemicals or biohazards that require special management such as exhaust fans, collection devices, personnel protective equipment, etc. Refer to the SIU Chemical Hygiene Plan or contact EH&S if there are questions.

APPENDIX III

Emergency Procedure for Laser Accidents

In the event of a laser accident, immediately do the following:

1. Shut down the laser system.
2. Provide for the safety of personnel (first aid, evacuation, etc.) as needed.

NOTE: If a laser eye injury is suspected, have the injured person keep their head upright and still to restrict any bleeding in the eye. A physician should evaluate laser eye injuries as soon as possible.

3. Obtain medical assistance for anyone who may be injured.

Ambulance (Urgent Medical Care) 9-911

4. If there is a fire, leave the area, pull the fire alarm, and contact the fire department by calling 9-911. Do not fight the fire unless it is very small and you have been trained in fire fighting techniques.
5. Inform the Office of Radiological Control (ORC) as soon as possible.

(During normal working hours, call these numbers)

Laser Safety Officer 536-2015

After normal working hours, call 453-3771 to contact the SIU Police Department.

6. Inform the P/PI as soon as possible. If there is an injury, the P/PI must submit a report of injury to the ORC.
7. After an accident, do not resume use of the laser system until the LSC has reviewed the incident.

APPENDIX IV

Laser Warning Sign



APPENDIX V

Laser Safety Program Forms

**Southern Illinois University
Carbondale Laser Safety Program**

**Form SIULaser1
Registration Information**

All Class 3b and 4 lasers used at Southern Illinois University – Carbondale are required to be registered with the Office of Radiological Control (ORC) [See Section 7.0 Registration Information]. Safe laser use and procedural compliance is the responsibility of the faculty who is assigned as the Physician/Principal Investigator (P/PI). To register your laser, please provide the following information on each laser and send it to:

SIUC Laser Safety Officer, Office of Radiological Control, Mail Code 6898

Please type or print in ink. Do not use pencil.

1. Applicant(s) - _____

For joint registration, underline the name of the person who will be the principal “Laser User” for communications, inspections, etc.

Title: _____ Department: _____

Address: _____ Mail Code: _____

E-Mail: _____ Office Phone/Ext: _____

2. Location Information:

Building: _____ Room #(s): _____

Laser Manufacturer: _____

Model Number: _____ Serial Number: _____

3. Description of Laser:

Laser Classification Marked on Laser (check one): IIIb (3b) _____ IV (4) _____

Laser Type (Nd:YAG, HeNe, etc.): _____

Laser Use (describe briefly): _____

4. Optical Characteristics:

Type (check one): Continuous Wave (CW): _____ Pulsed : _____ Wavelength (nm): _____

(CW): Maximum Power: _____(W) (Pulsed): Pulse duration: _____(sec)

Average Power: _____(W) Pulse frequency: _____(Hz)

Maximum Power: _____(J)

5. Individuals Participating in Operation of Laser:

All participants must have documented training. Examples include P/PI, Faculty, Nurse, Student, Technician. Attach additional names as necessary.

Name:

Title:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Note: Operators of laser equipment must complete Form SIULaser2, Laser User Statement of Training and Experience

6. Designated Controlled Area:

Attach descriptive floor plan/diagram of clinical or laboratory rooms(s) where laser is used and/or stored. Indicate on diagram adjacent rooms and hallways.

7. Certification

I certify I have read and understand the Laser Safety Program requirements as stated in the Laser Safety Program, Section 5.0 (P/PI). I agree to meet the responsibilities and execute my authority per Section 5.0 of the Laser Safety Program. I agree that all uses of lasers will be in accordance with the requirements set forth therein and in this application, and that the Office of Radiological Control will be notified before any changes are made in the use of the laser as herein described.

Signature:

P/PI: _____ Date: _____

Department Chairman: _____ Date: _____

**Southern Illinois University
Carbondale Laser Safety Program**

**Form SIULaser2
LASER USER STATEMENT OF TRAINING AND EXPERIENCE**

(To be completed by ALL SIU personnel who operate lasers)

Name (print): _____ **Department:** _____

Classification (P/PI, Faculty, Technician, etc.): _____

Department Chairman/Supervisor: _____ **Phone:** _____

Type of Laser(s) Used: _____

Location of Laser: Building: _____ **Room:** _____

If additional space is needed, use the back of this sheet. Keep a copy and return original to:
Office of Radiological Control – Mail Code 6898

LASER SAFETY TRAINING

SUBJECT	WHERE TRAINED	DATES AND DURATION OF TRAINING	PRECEPTOR/ ON THE JOB (Circle Answer)	FORMAL COURSE (Circle Answer)
Fundamentals of Laser Operations			Yes No	Yes No
Laser Classifications			Yes No	Yes No
Control Measures			Yes No	Yes No
Bio-effects of Laser Radiation Exposure			Yes No	Yes No
Non-Radiation Hazards Associated with Lasers			Yes No	Yes No
Investigator and User Responsibilities			Yes No	Yes No

LASER USE EXPERIENCE

LASER TYPE: ND: YAG, HENE, ETC.	LASER CLASS	MAX OUTPUT POWER	DATES AND DURATION OF EXPERIENCE	WHERE EXPERIENCE WAS GAINED

Note: In addition to the information request above, please submit to the LSO any training documentation, including certification, specific to the safe operation and/or application of lasers in medical procedures.

Signature: _____ **Date:** _____

**Southern Illinois University
Carbondale Laser Safety Program**

**SIULaser3
Laser Safety Standard Operating Procedure (SOP)**

All Class 3b and 4 lasers used at Southern Illinois University – Carbondale are required to have written safety operating procedures available at the instrument for review by the laser operator(s). Complete this form for each laser system. Safe laser use and procedural compliance is the responsibility of the faculty who is assigned as the Physician/Principal Investigator (P/PI).

- This procedure shall be read and signed by all persons who use lasers listed in this SOP.
- This procedure shall be reviewed every two years by the P/PI to ensure it reflects the most current conditions.

Please type or print in ink. Do not use pencil.

1. Location Information:

Department: _____ Date: _____

Building: _____ Room #(s): _____

2. Laser Safety Contacts:

Principal Laser User: _____ Phone: _____

Laser Safety Officer (LSO): _____ Phone: _____

SIUC Police Phone: _____

Medical Emergencies: 1. **911**
 2. Notify P/PI and LSO of all laser-related injuries ASAP

3. Description of Laser:

Laser Manufacturer: _____

Model Number: _____ Serial Number: _____

Laser Classification Marked on Laser (check one): IIIb (3b) ____ IV (4) ____

Laser Type (Nd:YAG, HeNe, etc.): _____

Mode of Operation: Continuous Wave: ____ Pulsed: ____ Wave length: _____(nm)

4. General Operating Procedures:

Enter your operating procedures for this laser system in A – D below. Be brief and concise. If a category is NOT APPLICABLE to your operation, simply leave the area BLANK.

A) Initial preparation of Clinical/Surgical or Laboratory Environment for normal operation (key position, warning light on, interlock activation, warning signs posted, personnel protective equipment available, other):

B) Patient / target area Preparation:

C) Special procedures (alignment, safety tests, maintenance tests, etc.):

D) Operation procedures are as follows:

E) Shutdown procedures for this laser are as follows:

5. General Laser System Control Measures:

Provide some information regarding the general laser safety control mechanisms in place for this laser system in the text boxes below. If a particular control measure is not in place, or it is NOT APPLICABLE to your system, simply leave the corresponding box BLANK.

Check if applicable	CONTROL	COMMENTS
<input type="checkbox"/>	Entryway (door) Interlocks or Controls	
<input type="checkbox"/>	Laser Enclosure Interlocks	
<input type="checkbox"/>	Laser Housing Interlocks	
<input type="checkbox"/>	Emergency Stop Panic Button	
<input type="checkbox"/>	Beam Stops / Attenuator	Infrared laser must terminate in fire resistant material and the absorber must be inspected periodically
<input type="checkbox"/>	Master Switch (operated by key or computer code)	
<input type="checkbox"/>	Laser Secured To Base	
<input type="checkbox"/>	Protective Barriers	
<input type="checkbox"/>	Warning Signs	
<input type="checkbox"/>	References to Equipment Manual	

6. Specific Laser and Collateral Hazards and Control Measures

Provide some information regarding the specific laser and collateral hazards, and the control mechanisms in place, in the text boxes below. If a particular hazard is not present, or is NOT APPLICABLE to your system, simply leave the corresponding box BLANK.

Check if applicable	HAZARD	CONTROL (S)
<input type="checkbox"/>	Unenclosed Beam Access to Direct or Scattered Radiation	
<input type="checkbox"/>	Laser at Eye Level of Person sitting or Standing	
<input type="checkbox"/>	Ultraviolet Radiation	
<input type="checkbox"/>	Reflective Material in Beam Path	
<input type="checkbox"/>	Hazardous Materials (dyes, solvents, etc.)	

<input type="checkbox"/>	Fumes / Vapors	
<input type="checkbox"/>	Electrical	
<input type="checkbox"/>	Capacitors	
<input type="checkbox"/>	Compressed Gases	
<input type="checkbox"/>	Fire (access to alarms, extinguishers, etc.)	
<input type="checkbox"/>	Housekeeping	
<input type="checkbox"/>	Trip / Fall Hazard (cables on floor, etc.)	

7. Personal Protective Equipment

A. Eyewear

For this Laser...			...Wear this Eyewear		
Acquisition date	Type	Wavelength (nm)	Wavelength Attenuated (nm)	Optical Density (OD)	Remarks
Example:	Nd:YAG	1064, 532	1064, 532	5+	UVEX

B. Other Protective Equipment Required within the Controlled Area

Item	Location	Usage Condition

8. Operator Overview

I have read this procedure and understand its contents. I agree to follow this procedure each time I operate the laser or laser system.

Name (print)	Signature	Date
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

RETURN COMPLETED SOP AND ATTACHMENTS TO:

**Office of Radiological Control
1325 Radio Drive
Carbondale, Illinois 62901-6898**

For Committee Use (revised 3/07)

Date App. Received: _____ Committee Action: Approved ___ Rejected ___

RCC Ref. No. _____ Expiration Date: _____

RCC Chairman: _____ Date: _____

Conditions or Remarks: _____
