

Laser Safety Program Manual

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Prepared by:

Heather McClary, EdD, MPH, CPH

Associate Director, Environmental Health & Safety

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Introduction

The American University Laser Safety Program Manual sets forth controls and safety guidance for research and educational activities involving lasers. Additional guidance is available from the American National Standards Institute (ANSI) Safe Use of Lasers (Z136.1). For the purpose of this document, Laser shall refer to only class 3B and class 4 lasers.

1.0 Organization

The Laser Safety Program shall be administered by the University Laser Safety Officer (ULSO) within the Environmental Health & Safety group.

2.0 University Laser Safety Officer

The University Laser Safety Officer is an EH&S staff member who has the knowledge and responsibility to oversee appropriate laser radiation protection rules, standards, and practices.

3.0 Laboratory Personnel

3.1 Registrant

The Registrant is the person whose name appears on the Registration for the laser. Typically, this is the Principal Investigator or Teaching Laboratory Supervisor and must be permanent faculty or staff (not a postdoctoral fellow or a graduate student). The Registrant is responsible for:

1. Laser safety in the laboratory
2. Ensuring the availability of correct protective eyewear. (See Section 6.6)
3. Providing a Laser Safety Standard Operating Procedure (SOP). (See Section 6)
4. Providing, implementing, and enforcing the laser safety principles specific to the laboratory's laser(s).
5. Ensuring proper training in laser operation and safety.
6. Classifying and labeling all lasers in the laboratory.
7. Completing laser registration with the ULSO.
8. Notifying the ULSO immediately if an exposure incident occurs.
9. Notifying the ULSO if a laser is acquired, decommissioned, sold, or transferred.

The Registrant may designate any of these responsibilities to a Laboratory Laser Safety Officer.

3.2 Laboratory Laser Safety Officer (LLSO)

Each Registrant may designate a Laboratory Laser Safety Officer (LLSO) and identify the LLSO to the ULSO. This person may be the Registrant or a delegate but shall be a budgeted employee (staff or faculty; not a graduate student or postdoctoral fellow) of the University. (Normally the Registrant retains the function and title of the LLSO.) The LLSO shall maintain the laser safety program for the individual laser(s) in the laboratory and may call on the ULSO for assistance as needed. The LLSO, acting under the

Registrant's authority, has the responsibility to institute corrective actions including shutdown of laser operations when necessary due to unsafe conditions.

3.3 Laser Operator

The Laser Operator is a person who sets up, aligns, operates, or uses the laser for experimental, research, or teaching purposes, or has other assigned laser duties. Laser Operator training records shall be documented. An example of appropriate documentation can be found in Appendix A. The Laser Operator is responsible for:

1. Following laboratory administrative, alignment, safety, and standard operating procedures while operating the laser.
2. Keeping the LLSO fully informed of any departure from established safety procedures.

4.0 Laser Classification and Registration

Classification of lasers shall be in accordance with American National Standards Institute specification ANSI Z136.1. All class 3B and class 4 lasers shall be registered at AU. Lasers which are classified as 3R or lower, but which contain a class 3B or class 4 laser, shall be controlled at the higher classification if the class 3B or class 4 laser is accessed. Any class 3B and class 4 laser will henceforth be referred to as "laser" unless otherwise noted. Each Registrant shall be responsible for establishing and supporting laser safety for the Registered laser.

4.1 Registration Information

Each laser which is possessed, purchased, donated, manufactured, created, assembled, or otherwise received by any person or entity at the University shall be registered with AU. A Laser Registration Form is provided as Appendix B to this document.

4.2 Removal from Registration

When a laser is rendered permanently inoperative by disassembly or destruction, or is removed from the University's control by gift, surplus designation, or transfer to a non-University entity, the Registrant shall:

- Provide information regarding the condition or destination to the ULSO not later than 10 days from its inoperative state or removal.
- Provide disposition information to the University LSO prior to leaving the University.

5.0 Maximum Permissible Exposure (MPE) and Nominal Hazard Zone (NHZ)

The Maximum Permissible Exposure (MPE) is the level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eye or skin. MPE data may be found in Tables 5a, 5b, and 7 of ANSI Z136.1. The Nominal Hazard Zone (NHZ) is the space within which the level of direct, reflected, or scattered radiation during operation exceeds the applicable MPE.

When any class 3B or class 4 laser is used at levels at or above 3B in an open beam mode (unenclosed), the MPE will be assumed to be exceeded in that room or area and appropriate precautions shall be taken. In other words, the NHZ will comprise the enclosure (room or area to which the beam is restricted by virtue of walls, curtains, or other barriers) in which the laser is operating if operated at or above 3B levels. This is done to account for intentional or unintentional scattered or reflected beam. If the LLSO believes the NHZ does not apply to the whole area, they may justify a more limited NHZ in the SOP by using information supplied by the laser manufacturer, by measurement, or by using the appropriate laser range equations or other equivalent assessments.

6.0 Required Laser Standard Operating Procedure (SOP) Features

6.1 Laser Safety Standard Operating Procedure

Each laser shall have a Laser Safety Standard Operating Procedure (SOP) written for its operation. An SOP is protocol that specifies safe use and procedures for a laser system. **The SOP must be present at the operating console or control panel of the laser and available for inspection by the ULISO at any time.**

The SOP shall include, at a minimum, the following information:

1. Detailed description of the laser system
2. Hazards of the laser (both beam and non-beam), including eye, skin, electrical, biological, and chemical hazards, as well as the MPE and NHZ
3. Operating instructions, including alignment procedures if applicable
4. Control measures for the identified hazards, including (if applicable) work practices, beam enclosure, protective housing, interlock instructions, controlled areas, safety eyewear type(s) and instructions for fit and use, other PPE, signage, access restrictions, emergency shut-off, and survey procedures
5. Training requirements
6. Emergency procedures

6.2 Signage

The LLSO is responsible for ensuring that appropriate signage is displayed at all potential entrances to the area where lasers are in use. The signs must be designed in accordance with ANSI Z535. See Appendix C for a sign example.

- A DANGER sign **must** be used for class 3B and 4 lasers.

Sign information shall conform to the following specifications:

1. Above the sunburst, precautionary instructions or protective action details are inserted such as:
 - a. Laser Protective Eyewear Required
 - b. Invisible Laser Radiation
 - c. Knock Before Entering
 - d. DO NOT ENTER when light is illuminated
 - e. Restricted Area
2. Below the sunburst, the type of laser (e.g., Nd:YAG, Helium-Neon, etc.), the emitted wavelength, pulse duration (if applicable), and maximum output **must** be written

3. The bottom right-hand corner **must** include the class of laser or laser system

6.3 Training

Every person who works in a laser laboratory shall complete training in laser safety provided by the University or a ULISO-approved equivalent. This training is referred to as the **General Laser Safety Training** and is offered as an online course through Environmental Health & Safety. Persons working directly with laser equipment (Laser Operators) shall also complete **Laser-Specific Training** provided by the Registrant or LLSO. No person may work with a laser prior to completing both laser safety training classes. All training must be documented. An example of appropriate documentation can be found in Appendix A.

6.4 Protective Eyewear

Each Registrant shall provide protective eyewear that meets the requirements of ANSI Z136.1. The eyewear shall be located where persons who operate the laser have unrestricted access to the eyewear. The eyewear shall be worn during any operation where a class 3B or 4 beam is not enclosed. This normally includes alignments. Training on identification, proper fit, location, and use of eyewear shall be included in the specific laser safety training.

Protective eyewear shall meet the following requirements:

1. Provide a comfortable and appropriate fit all around the area of the eye
2. Be in good physical condition to ensure the lenses retain all protective properties during its use
3. Be of optical density adequate for the laser energy involved
4. Have the optical density or densities and associated wavelengths permanently labeled on the filters or eyewear
5. Be examined at intervals not less than 12 months to ensure the reliability of the protective filters and integrity of the holders. Unreliable eyewear shall be discarded and replaced.
6. The optical density of the protective eyewear shall be appropriate for the specific frequency and pulse length of the laser beam in use and shall provide reduction of the incident energy to less than the MPE of the laser. It is important to include the pulse length and frequency of pulse repetition of pulsed lasers in selecting appropriate protective eyewear

6.5 Surveys

Each Registrant or LLSO shall survey the laboratory containing the laser(s) for which the Registrant is responsible. The survey shall be performed using the Laser Survey Form (Appendix D). The survey shall be performed at least annually and shall be performed prior to operating a laser for the first time after assembly, after maintenance, and after modification of the beam path, operating wavelength, or power level. Survey records shall be retained for inspection by the ULISO. The ULISO or their designee will perform an annual survey as well.

7.0 Records

Records of surveys, training, NHZ and MPE calculations, incidents, and other laboratory-specific information shall be maintained in the laboratory and shall be available for inspection and review by the ULISO at any time.

8.0 Non-Radiation Hazards

Each LLSO shall evaluate or have an evaluation made of non-radiation hazards. This evaluation shall include electrocution, chemical, cutting edge, compressed gases, noise, confined space, fire, explosion, ventilation, and physical safety hazards. The evaluation shall be made part of the SOPs and be available for review.

9.0 Incident Reporting

Each Registrant shall immediately seek appropriate medical attention for the injured individual and notify the ULISO by phone or email of any exposure injury involving a laser possessed by the University. For emergencies, call AUPD at 202-885-3636.

The ULISO shall be notified by phone or email within 48 hours of any non-injury incident (near miss) which involves potential exposure to laser radiation exceeding the MPE.

A written summary of an injury or non-injury incident, using the Incident Report contained in Appendix E, shall be submitted to the ULISO by email not later than three (3) working days following the incident. Records of any incident shall be maintained by the LLSO.

Appendix A – Laser Operator Training Record

Laser Operator Training Record

Record the dates of each training component for each piece of equipment. Maintain this log in laboratory records.

Laser Identification: _____

Operator Name	Trainer Name	General Laser Safety Training (online)	Laser-Specific Training and SOP Review	PPE Assignment and Fitting
<i>Ex: Jane Doe</i>	<i>Dr. Jones</i>	<i>11/10/2023</i>	<i>11/14/2023</i>	<i>11/14/2023</i>

Laser Identification: _____

Operator Name	Trainer Name	General Laser Safety Training (online)	Laser-Specific Training and SOP Review	PPE Assignment and Fitting
<i>Ex: Jane Doe</i>	<i>Dr. Jones</i>	<i>11/10/2023</i>	<i>11/14/2023</i>	<i>11/14/2023</i>

Appendix B – Laser Registration Form

Laser Registration Form

All class 3B and class 4 lasers must be registered with EH&S. Complete this form and return to hmclary@american.edu.

Registrant Information

Registrant:	
Email address:	Phone Number:
Department:	Laser Location:
Laboratory Laser Safety Officer (LLSO):	
Laser Operator(s):	

Laser Information

Manufacturer:		
Model Number:	Serial Number:	
Classification:	<input type="checkbox"/> Class 3B <input type="checkbox"/> Class 4	
Active Medium (e.g., Argon, CO ₂ , ND:Yag, Dye):		
Tunable?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Aligned in-house?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Wavelength(s):		
Beam Diameter (mm):	Beam Divergence (milliradians):	
Beam Delivery (e.g., open, enclosed, fiber, combination):		
Beam Type		
<input type="checkbox"/> Continuous Wave	Average Power (W):	
<input type="checkbox"/> Pulsed	Energy per Pulse (J):	Repetition Frequency (Hz):
<input type="checkbox"/> Other (provide details below)		
Purpose and Frequency of Use:		
Other Comments:		

Appendix C – Laser Sign Example



Appendix D – Laser Survey Form

Laser Laboratory Survey

A laser laboratory self-survey shall be conducted annually by the Registrant or LLSO. Survey records shall be maintained in laboratory records.

General controls			
Are all lasers properly registered with EH&S?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Are equipment-specific SOPs complete and present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Have all laser operators completed all required training?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Is required documentation available and complete?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Is access to the laser or laser area restricted to approved personnel?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Compliance with equipment-specific SOPs			
Are safety interlocks in place per SOP?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Are protective housings and / or beam enclosures in place per SOP?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Are controlled areas properly established and maintained per SOP?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Is signage posted per SOP?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Is laser safety eyewear and other PPE available, used, and maintained per SOP?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Are laser procedures conducted per SOP?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Notes			

Appendix E – Laser Incident Report

Laser Incident Report

Use this form to describe an injury incident or a non-injury incident (near miss). Send a copy of this report to hmclary@american.edu within three (3) working days following the incident and keep a copy for your records.

Name(s) of person(s) involved:		
Supervisor name(s):		
Department:		
Location of incident:		
Date and time of incident:		
Detailed description of incident and the response (attach additional pages if needed):		
Reported to LLSO?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Eye exposure?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Skin exposure?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Medical treatment sought?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Appendix F – Laser Safety Guidelines

Control Measures for all Laser Classes (adapted from ANSI Z136.1)

The purpose of control measures is to prevent exposure to laser radiation above the MPE. Use engineering controls whenever possible. When engineering controls are not able to reduce exposure below the MPE, administrative controls and personal protective equipment should be used.

A. Protective Housing

- a. Place lasers in protective housings whenever practical. When protective housings are not practical, the LLSO shall perform a hazard analysis to ensure that control measures are implemented to ensure safe operation.
- b. Protective housings or service panels enclosing embedded Class 3b and 4 lasers shall be interlocked or fastened closed requiring special tools for removal.
- c. When it is necessary to remove protective housings or service panels, a temporary laser-controlled area shall be established. A temporary laser-controlled area will not have the built-in protective features that are part of a laser-controlled area, but shall provide all safety requirements to protect personnel within and outside the area. Requirements for the temporary laser-controlled area include, but are not limited to:
 - i. Restricted access to the area.
 - ii. Control of the beam to prevent the beam and reflections from extending beyond the area.
 - iii. Removal of reflective materials in and near the beam path. 4. Appropriate laser eye protection if there is a possibility of exposure to laser radiation above the MPE.
 - iv. A warning sign posted outside the area.

B. Collecting Optics

- a. Collecting optics used to view the laser beam or its interaction with a material shall have permanently attached attenuators, filters or shutters to prevent hazardous level of radiation from entering the eye.

C. Beam Control

- a. Ensure the beam height is not at the normal eye position of a person in a standing or seated position.
- b. Position the laser so that the beam is not directed toward doorways or aisles.
- c. Securely mount the laser system to maintain the beam in a fixed position during operation and limit beam movements during adjustments.
- d. Ensure beam path is well defined and controlled.
- e. Terminate the beam at the end of its useful path.
- f. Confine beams and reflections to the optical table. The addition of beam-stopping panels to the sides of the optical table is recommended.
- g. If the beam path extends beyond the optical table, a physical barrier shall be used to prevent accidental exposure.
- h. Have only diffusely reflection materials in or near the beam path, where feasible.
- i. Absorb unwanted reflections. Scatter is not permitted.

D. Additional Requirements for Class 3b and 4 Lasers.

- a. Entryway Controls
 - i. Doors must be closed and locked during operations
 - ii. Doors must be properly posted and warning light energized (if applicable).
 - iii. All windows must be covered unless a beam enclosure is used.
- b. Safety controls must not be overridden. These include:
 - i. Defeating interlocks
 - ii. Removal of shutters
 - iii. Rewiring interlock connectors