

## CHAPTER 34 – LASER SAFETY

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## CHAPTER 34 – LASER SAFETY

### A. INTRODUCTION

1. This Chapter applies to Smithsonian Institution (SI) laboratories, facilities and museums that possess or use lasers (Light Amplification by Stimulated Emission of Radiation).
2. The information contained in this Chapter is based primarily on the American National Standards Institute (ANSI) Standard, Guide for the Safe Use of Lasers, ANSI Z136.1-2000, National Fire Protection Association (NFPA) Standard 115, Standard for Laser Fire Protection and Occupational Safety and Health Administration, Nonionizing radiation, 1910.97. These standards represent generally accepted practices and compliance limits for laser radiation within the fields of industry, education, research, and medicine.

### B. CHAPTER-SPECIFIC ROLES AND RESPONSIBILITIES

1. Safety Coordinator shall:
  - a. Coordinate the activities involving lasers between the supervisor or principal investigator and the Office of Safety, Health and Environmental Management (OSHEM). If necessary or appropriate, a specific individual may be designated to coordinate any of these particular activities. Where such activities involve lasers, this individual may be designated as a Laser Safety Coordinator.
  - b. Monitor the facility for compliance with this Chapter.
  - c. Assist supervisors and principal investigators with an initial Job Hazard Analysis (JHA, refer to [Chapter 4, "Safety Risk Management Program"](#), of this *Manual*) of laser radiation hazards within their areas of responsibility.
  - d. Review and approve each Facility/Project-Specific Laser Safety Plan.
  - e. Assist supervisors with the implementation of the laser safety program and ensure facility lasers are properly classified in conformance with ANSI Z136.1-2000.
  - f. Conduct audits to verify that proper laser safety controls are in place and laser safety procedures are being followed.
  - g. Maintain an inventory of lasers for each facility according to Section C.1.d.
2. Supervisors/Principal Investigators shall:
  - a. Develop a Laser Safety Plan for the use of lasers in associated work.
  - b. Identify employees who are permitted to operate, maintain, or repair lasers, or employees who may be incidentally exposed to laser hazards.

- c. Ensure personnel complete safety training in accordance with Section C.5.
  - d. Ensure personnel receive and use personal protective equipment (PPE) where applicable.
  - e. Provide advance notice to the Safety Coordinator when new sources are acquired through purchase or transfer, or when sources are significantly modified, so potential hazards may be assessed.
  - f. Ensure engineering and/or administrative controls are in place during operations, maintenance, and repair.
  - g. Ensure warning/danger signs are posted in all required areas.
  - h. Notify the Safety Coordinator and OSHEM of any laser related operation or condition that may present a hazard to employees and take interim measures to mitigate the potential hazard.
  - i. Refer personnel to OSHEM/Occupational Health Services Division (OHSD) for medical surveillance in accordance with Section C.3 of this Chapter.
3. Employees shall:
- a. Comply with all elements of the Facility/Project-Specific Laser Safety Plan and this Chapter.
  - b. Attend safety training and wear required personal protective equipment when assigned.
  - c. Notify the supervisor immediately when a change in conditions or practices may result in increased employee exposure to potential hazards.
  - b. Report potential exposure incidents and accidents to the supervisor.
4. Office of Safety, Health and Environmental Management (OSHEM) shall:
- a. Appoint the SI Laser Safety Officer (LSO) who shall be responsible for coordination of the requirements in this Chapter, including:
    - (1) Developing policies and procedures for the safe use of lasers.
    - (2) Providing medical surveillance to affected personnel in accordance with Section C.3.b. of this Chapter.
  - b. Interpret medical surveillance examination results to determine if adverse health effects have resulted from an employee exposure. Maintain records of personnel medical history and medical surveillance examination results.
5. Ancillary Personnel. Personnel visiting or frequenting an area that is restricted due to laser use, shall receive instructions concerning the laser radiation hazards which are commensurate with their activities.

## C. HAZARD IDENTIFICATION

### 1. Initial Assessment

- a. The primary hazard associated with laser operations is the laser beam, which is capable of inflicting serious injury, particularly to the unprotected eye. Laser exposure may cause permanent eye damage and skin burns if laser safety procedures are not followed.
- b. Prior to starting each new project or task involving laser hazards not previously evaluated, a JHA shall be prepared by the supervisor and reviewed by the Safety Coordinator. The JHA shall evaluate the laser operation and its potential/known safety and health hazards, and the control measures recommended to eliminate or reduce each hazard to an acceptable level of risk. Information used to conduct the JHA shall identify potential hazards and where necessary, will be developed into a Facility/Project-Specific Laser Safety Plan to outlined planned use and may include:
  - (1) Laser specifications;
  - (2) A description of the project plan and laser usage
  - (3) Standard operating procedures (SOP) for laser use;
  - (4) Documentation on laser protective eyewear;
  - (5) Determination of the nominal hazard zone (NHZ);
  - (6) Administrative and engineering controls;
  - (7) Special considerations or needs required of the host facility by the project non-beam hazards; and
  - (8) Principle researchers or project engineers along with their prior laser experience. [Attachment 1](#) contains a sample Facility/Project-Specific Laser Safety Plan.
- c. JHAs shall be reviewed and modified to address changing site conditions or laser operations. OSHEM is available to conduct work place monitoring and to provide the Safety Coordinator and supervisors with assistance in the evaluation of laser hazards.
- d. Supervisors shall maintain a copy of JHAs performed in their workplace. JHAs shall be kept on file until superseded by a new JHA, a JHA that has been modified to address a change, or the project/task is no longer performed.
- e. An inventory of lasers will be maintained by the Safety Coordinator and include the following information:
  - (1) Laser specifications;
  - (2) Manufacturer;
  - (3) Location;

(4) Purpose; and

(5) Class.

2. Laser Classifications. Lasers are classified according to their potential to cause biological damage. The ANSI Standard Z136.1-2000, "Guide for the Safe Use of Lasers," may be used to signify the level of hazard inherent in a laser system and the extent of safety controls required. These classifications range from Class 1 lasers (which are inherently safe for direct beam viewing under most conditions), to Class 4 lasers (which require the most strict controls). The Laser Hazard Classifications are described below:
- a. Class 1 - Exempt Lasers. Under normal operating conditions, Class 1 lasers cannot produce damaging radiation levels. These lasers must be labeled, but are exempt from the requirements of a Facility/Project-Specific Laser Safety Program. A laser printer is an example of a Class 1 laser.
  - b. Class 2 - Low Power Visible Lasers. Class 2 lasers are low power lasers or laser systems in the visible range, 400 - 700 nanometer (nm) wavelength that may be viewed directly under carefully controlled exposure conditions. Because of the normal human aversion responses, these lasers do not normally present a hazard, but may present some potential for hazard if viewed directly for long periods of time. A continuous wave (CW) Helium-Neon (HeNe) laser above Class 1, but not exceeding 1 milliwatt (mW) radiant power is an example of a Class 2 laser.
  - c. Class 3 - Medium Power Lasers and Laser Systems. Class 3 lasers are medium power lasers or laser systems that require control measures to prevent viewing of the direct beam. Control measures emphasize preventing exposure of the eye to the primary or specularly reflected beam.
    - (1) Class 3a denotes lasers or laser systems that normally would not produce a hazard if viewed for only momentary periods with the unaided eye. Class 3a lasers may present a hazard if viewed using collecting optics. A visible CW HeNe laser above 1 mW, but not exceeding 5 mW radiant power, is an example of this class.
    - (2) Class 3b denotes lasers or laser systems that can produce a hazard if viewed directly, including intra-beam viewing or specular reflections. Except for the higher power Class 3b lasers, this class of laser will not produce diffuse reflections. A visible CW HeNe laser above 5 mW, but not exceeding 500 mW radiant power, is an example of this class.
  - d. Class 4 - High Power Lasers and Laser Systems. Class 4 lasers are high power lasers or laser systems that can produce a hazard not only from direct or specular reflections, but also from a diffuse reflection. In addition, Class 4 lasers may produce fire and skin hazards. Class 4 lasers include all lasers in excess of Class 3 limitations.

3. Additional Ancillary Hazards. Although eye and skin exposure to laser radiation represent the primary hazard associated with laser use, ancillary hazards may be associated with the use of lasers and should be included in a job hazard analysis. Such hazards may include:
  - a. Electrical Hazards. Electrical shock represents the next highest potential for injuries from laser use. The potential for electrical hazards most commonly results from inappropriate electrical installation, grounding, or handling of the high voltage associated with many lasers.
  - b. Fire and Explosion Hazards. High-pressure arc lamps, filament lamps, and associated optics may shatter or explode during laser operation. These components must be enclosed in housings that can withstand the maximum explosive pressures. Flammable solvents and materials used in certain laser operations are also capable of being ignited by a laser beam.
  - c. Compressed Gases. Compressed gases used in certain laser operations may release toxic gases that require their use in alarmed vented cabinets. Refer to [Chapter 20, "Compressed, Liquified and Cryogenic Gases"](#), of this *Manual*.
  - d. Cryogenic Gases. Cryogenic gases (e.g., liquid nitrogen, liquid helium) are sometimes used to cool the crystal in solid-state lasers. These liquefied gases are capable of producing skin burns upon contact. If these gases leak into a closed room, the gases are capable of replacing oxygen in the atmosphere, which may produce an oxygen-deficient atmosphere. Refer to [Chapter 20, "Compressed, Liquified and Cryogenic Gases"](#), of this *Manual*.
  - e. Toxic Materials. Laser use may cause the volatilization or vaporization of target materials, causing inhalation hazards. Ozone may be produced as a result of electrical discharges or ionization of the air surrounding high-power lasers.
  - f. Chemical Hazards. Dyes and chemicals used in association with lasers and electrical systems may represent potential hazards and may need to be considered as hazardous waste for disposal as outlined in [Chapter 29, "Hazardous Waste Management"](#), of this *Manual*.

## D. HAZARD CONTROL

1. The Safety Coordinator has the authority to suspend, restrict, or terminate the operation of a laser if the laser hazard controls are inadequate.
2. Personnel exposures shall not exceed the limits established in ANSI Z136.1-2000, "Guide for the Safe Use of Lasers."
3. Accident Reporting:
  - a. Laser accidents and incidents shall be immediately to the supervisor and to the Safety Coordinator.

- b. Emergency numbers shall be prominently posted near laser equipment.
4. Determine the nominal hazard zone (NHZ) of all lasers prior to/at the start of their operation by SI employees. This is the distance within which the exposure level exceeds the maximum permissible exposure level.
5. The combination of engineering safety and control measures, administrative and procedural control measures, and personal protective equipment (PPE) required to prevent employee exposure in excess of the maximum permissible exposure level shall include (but are not limited to) the following:
6. Class 1 Lasers. Class 1 lasers are exempt from control and surveillance measures, with the exception of embedded lasers. If the system contains an embedded laser, ensure a certification label is posted on the access panel to alert the user of the presence of hazardous laser radiation inside the panel. [Attachment 2](#) contains a sample class 1 laser certification label.
7. Class 2 Lasers
  - a. Label the laser with a yellow "WARNING" sign. Post a work area warning label or sign cautioning users to avoid staring into the beam or directing the beam toward the eye of individuals. [Attachment 2](#) contains a sample Class 2 laser warning label.
  - b. Verify the presence of an indicator light that shows the laser is in operation.
  - c. The laser beam shall not be purposefully directed toward the eye of any person.
  - d. Alignment of the laser optical systems (e.g., mirrors, lenses, beam deflectors, etc.) shall be performed so that the primary beam, or specular reflection of the primary beam, does not expose the eye to a level above the MPE. If the MPE is exceeded, design viewing portals and/or display safety precautions to reduce exposure to acceptable levels.
8. Class 3a Lasers
  - a. Label the laser with a red "DANGER" sign. [Attachment 2](#) contains a sample Class 3a laser danger label.
  - b. Verify the presence of an indicator light that shows the laser is in operation.
  - c. Removable parts of the housing and service access panels shall have interlocks to prevent accidental exposure. A permanent beam stop or attenuator may also be used.
  - d. If the MPE is exceeded, design viewing portals to reduce exposure to acceptable levels. Alignment procedures may be designed to ensure the MPE is not exceeded.
  - e. The laser beam shall be enclosed and operated in a controlled area.

- f. If operated in a public area, the axis of the laser beam shall be directed well above the eye level of the audience, and the laser shall be firmly supported to ensure the beam travels on its intended path.
  - g. As far as possible, specular surfaces shall be removed from the area to eliminate the possibility of reflection.
    - (1) Protective eyewear shall be worn if eye contact with the laser beam is possible.
    - (2) Personnel shall be prohibited from staring at the laser beam. The laser shall never be pointed at a person's eye.
9. Class 3b Lasers. These lasers shall be used in areas where entry by unauthorized individuals can be controlled. [Attachment 2](#) contains a sample Class 3b laser danger label. In addition to the precautions outlined for Class 3a lasers:
- a. If an individual who has not been trained in laser safety must enter the area, the laser operator or supervisor shall first instruct the individual as to safety requirements and must provide protective eyewear, if required.
  - b. If the entire beam is not enclosed or if a limited open beam exists, the LSO shall determine a NHZ.
  - c. An alarm, warning light, or verbal countdown may be used during use or start up of the laser.
  - d. The controlled area shall:
    - (1) Have limited access to spectators;
    - (2) Have beam stops to terminate potentially dangerous laser beams;
    - (3) Be designed to reduce diffuse and specular reflections;
    - (4) Require eye protection for all personnel;
    - (5) Prohibit laser beams at eye level;
    - (6) Have restrictions on windows and doorways to reduce exposure to levels below the MPE; and
    - (7) Require storage or disabling of the laser when it is not in use.
    - (8) Only authorized, trained individuals shall maintain and service the laser.
10. Class 4 Lasers.
- a. Label the laser with a red "DANGER" sign. Attachment 2 contains a sample Class 4 laser danger label.
  - b. Verify the presence of an indicator light that shows the laser is in operation.
  - c. The laser must have its beam enclosed over its entire length if possible.



- d. Access and operation of the laser shall be restricted to authorized personnel. Laser operators shall be responsible for providing information and safety protection to untrained personnel who may enter the laser controlled areas as visitors. The laser area shall be:
  - (1) Restricted to authorized personnel only;
  - (2) Designed to allow for rapid emergency egress;
    - (a) The beam path must be free of combustible objects, and the beam terminated in a non-combustible, non-reflective barrier or beam stop.
    - (b) The laser beam shall be enclosed and operated in a controlled area.
    - (c) Surfaces liable to be contacted by the laser light must be absorbent or darkened, if possible, to prevent reflection.
    - (d) Protective eyewear shall be worn if eye contact with the laser beam is possible.
- e. Engineering control measures such as protective equipment (e.g., beam stops, shields, safety interlocks, warning lights, and horns) shall be maintained in good operating condition and shall be used to prevent harmful exposure to laser radiation. Based on the laser classification and the hazard evaluation, the Safety Coordinator may require additional engineering control measures. These control measures may include:
  - (1) Protective housings;
  - (2) Access panels;
  - (3) Interlock switches;
  - (4) Viewing portals; and
  - (5) Panels to shield incorrect alignments of beam paths.
- f. Administrative and procedural control measures may supplement engineering control measures. These administrative and procedural controls may include (but are not limited to):
  - (1) Facility/Project-Specific Laser Safety Plan (refer to Section C.2.f);
  - (2) Education and training (refer to Section C.5);
  - (3) Authorized personnel requirements;
  - (4) Required alignment procedures;
  - (5) Required eye and skin protection (refer to Section C.4);
  - (6) The identification of hazardous materials and the disposal requirements (refer to Section C.1.f.(7)); and/or
  - (7) Ventilation systems.

- g. Facility/ Project-Specific Laser Safety Plan
  - (1) When a laboratory or facility purchases or modifies an operation that involves the use of Class 3b or Class 4 laser systems, the laboratory/facility must submit a Facility/Project-Specific Laser Safety Plan to the LSO. [Attachment 1](#) contains a sample Facility/Project-Specific Laser Safety Plan.
  - (2) Standard laser copiers, laser printers, optical scanners, or equivalent equipment shall be assumed to be Class 1 lasers enclosed in a protective housing, and this equipment shall be exempt from filing a Facility/Project-Specific Laser Safety Plan. Laser pointers and similar “low power” laser systems shall also not require a Facility/Project-Specific Laser Safety Plan. However, users of “low power” laser systems shall read the safety precautions in the manufacturer’s information.
  - (3) No unit within SI may install, significantly modify, or operate a high-powered laser unless a Facility/Project-Specific Laser Safety Plan has been approved by the Safety Coordinator.
- h. Other control measures may be considered including (but are not limited to) the following:
  - (1) Operational procedures for laser demonstrations involving the general public;
  - (2) Laser installation procedures;
  - (3) Federal, state, or local requirements;
  - (4) Personal protective equipment (PPE);
  - (5) Warning signs, labels, and signal words in accordance with ANSI standards; and/or
  - (6) Electrical installation in compliance with National Electrical Code (NEC).

## **E. MEDICAL SURVEILLANCE**

- 1. Class 1 and Class 2 laser personnel – no medical surveillance is required.
- 2. Class 3a laser personnel:
  - a. Employees with possible incidental exposure shall be offered a visual acuity examination.
  - b. Laser operators, maintenance personnel, and repair personnel shall be offered the following pre-assignment examinations:
    - (1) Visual acuity examination; and
    - (2) Ocular history.

- c. If visual corrections and central vision field is normal, then no further examination is required. If these examinations are not normal other examinations may be required. Consideration may be given to excluding vulnerable individuals from the laser program.
- 3. Class 3b and Class 4 laser personnel:
  - a. All laser personnel shall be offered the following pre-assignment examinations:
    - (1) Visual acuity examination; and
    - (2) Ocular history.
  - b. If visual corrections and central vision field is normal, then no further examination is required. If these examinations are not normal, other examinations may be required. Consideration may be given to excluding vulnerable individuals from the laser program.
  - c. Skin examinations shall also be offered.
  - d. Additional medical surveillance, such as regular periodic examinations and termination examinations shall be offered at the request of the LSO.
- 4. Employees shall be required to report to their supervisor any medical conditions that may cause the laser user to be at an increased risk for chronic exposure. These conditions may include (but are not limited to):
  - a. Photosensitivity of skin;
  - b. Use of photosensitizing medications; and
  - c. Dermatological abnormalities of the skin.

## **F. PERSONAL PROTECTIVE EQUIPMENT**

- 1. When engineering controls do not provide adequate means to prevent access to direct or reflected beams at levels above the MPE, personal protective equipment (PPE) shall be provided. The use of PPE may have serious limitations when used as the only control measure with higher power Class 4 lasers or laser systems. The PPE may not adequately reduce or eliminate the hazard and may be damaged by incident laser radiation.
- 2. Protective Eyewear shall be used for protection from laser energy where engineering or other administrative and procedural controls are inadequate to eliminate potential exposure in excess of the applicable maximum permissible exposure limit. Eye protection shall be used only at the wavelength and energy/power for which it is intended. Eye protection may also be necessary to protect against physical or chemical hazards. Selection of appropriate laser protective eyewear shall include, but is not limited to, the following factors:
  - a. Laser power or pulse energy;

- b. Wavelength of the laser output;
- c. Potential for multi-wavelength operation;
- d. Radiant exposure or irradiance levels for which protection (worst case) is required;
- e. Exposure time criteria;
- f. Maximum permissible exposure (MPE);
- g. Optical density (OD) requirement of the eyewear filter at laser output wavelength;
- h. Visible light transmission requirement and assessment of the effect of the eyewear on the ability to perform tasks while wearing the eyewear;
- i. Need for side shield protection and peripheral vision.

## **G. TRAINING**

1. Training shall be provided for the Safety Coordinator and to each employee prior to working with or in the vicinity of lasers. The level of training shall be commensurate with the degree of potential laser hazards. All laser users shall receive initial training, prior to laser operations and refresher training as needed thereafter. Training will include the following topics:
  - a. Fundamentals of laser operation;
  - b. Biological effects of laser radiation on the eye and skin;
  - c. Non-radiation hazards (e.g., fire hazards, chemical exposure);
  - d. Classification of lasers and laser systems; and
  - e. Control measures and PPE.
2. Individuals who work with or in close proximity to Class 3b or Class 4 lasers shall also receive the following additional training, including:
  - a. Relations of specular and diffuse reflections;
  - b. Radiometric units and measurement devices;
  - c. MPE for eye and skin;
  - d. Laser hazard evaluations and range equations; and
  - e. Emergency response.
3. A written record shall be prepared, which includes the name of the employee trained, the date(s) of training, and the signature of the person who conducted the training.
4. Re-training shall be provided when one of the following situations occurs:
  - a. Changes in the work place render previous training obsolete.

- b. Changes in the types of laser or laser systems to be used render previous training obsolete.
  - c. Affected employee's knowledge of lasers is inadequate and indicates that the employee has not retained the required understanding or skill.
5. Refresher training shall be conducted as needed.

## **H. REQUIRED INSPECTIONS AND SELF ASSESSMENTS**

1. The Facility/Project-Specific Laser Safety Plans and Projects shall be reviewed annually by the supervisor or principal investigator and the Safety Coordinator and revised as needed. The review and audit frequency may vary depending on risks that are identified.
2. [Attachment 3](#) contains a "Laser Safety Self-Audit Checklist."

## **I. RECORDS AND REPORTS**

1. Records of laser personnel medical history and medical surveillance examination results shall be maintained by OSHEM for the duration of the employees' tenure plus 30 years.
2. Facility/Project-Specific Laser Safety Plans, JHA's, training records and self inspection audits shall be maintained by the Safety Coordinator for 5 years.
3. Reports of laser exposure incidents and accidents will be maintained by the Safety Coordinator and filed with OSHEM. OSHEM, in conjunction with the Safety Coordinator shall determine any further actions deemed necessary as a result of the accident. Reports shall be maintained for 5 years.

## **J. REFERENCES**

1. American National Standards Institute (ANSI) Standard, "Guide for the Safe Use of Lasers," ANSI Z136.1-2007.
2. National Fire Protection Association (NFPA) Standard 70, "National Electrical Code (NEC)," 2005 Edition.
3. Plog, Barbara A., Editor. Fundamentals of Industrial Hygiene, Third Edition. Published by the National Safety Council, Chicago, Illinois, 1988
4. NFPA Standard 115, "Standard for Laser Fire Protection," 2003 Edition.

## Sample Facility/ Project-Specific Laser Safety Plan

### 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):

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### Laser Classification:

For additional information and guidelines, refer to Smithsonian Institution *Safety Manual*, Chapter ##, "Lasers Safety"

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

Supervisor/Principal Investigator: \_\_\_\_\_

Other: \_\_\_\_\_

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).
  - a. Wavelength(s)
  - b. Continuous Wave Yes ; No
  - c. Pulsed? Yes ; No  Pulse Duration: \_\_\_\_\_
  - d. 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 and other hazards related to system operation. Include maintenance and service procedures if not performed by manufacturer's representatives. Describe safety precautions taken to prevent exposure of personnel to levels above the MPE limits. Describe qualifications and 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 tours) or any other unusual circumstances?  
Yes ; No ; If Yes, please describe.
5. 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.

Please provide the names and signatures of the supervisor/principal investigator, museum/facility director, and/or project lead acquiring the laser or laser system (through purchase or loan).

Supervisor/Principal Investigator: \_\_\_\_\_

Typed Name

Signature

---

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TO BE COMPLETED BY LASER SAFETY COORDINATOR

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

LSO ACTION:

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

COMMENTS:

Laser Safety Coordinator \_\_\_\_\_

Signature

Date

## Sample Laser Safety Labels



Laser Certification Label



Class 2 Label





Class 3a Label



Class 3b Label



Class 4 Label



Laser Repair / Alignment Notice

## Laser Safety Self-Audit Checklist

Building \_\_\_\_\_ Room \_\_\_\_\_

Principal Investigator \_\_\_\_\_

Audit Performed by \_\_\_\_\_ Date \_\_\_\_\_

|   | Y | N | NA | COMMENTS |
|---|---|---|----|----------|
| <b>A. Administrative</b>  |   |   |    |          |
| 1. Lasers are classified appropriately (2, 3a, 3b, 4a, 4b)                  |   |   |    |          |
| 2. Standard operating procedures are available                              |   |   |    |          |
| 3. Alignment procedures are available                                       |   |   |    |          |
| 4. Viewing cards are used for alignment                                     |   |   |    |          |
| 5. Laser users attended appropriate training                                |   |   |    |          |
| 6. Lasers are included in inventory   |   |   |    |          |
| <b>B. Labeling and Posting</b>  |   |   |    |          |
| 1. Certification label present  |   |   |    |          |
| 2. Class designation and appropriate warning label present                  |   |   |    |          |
| 3. Radiation output information on label                                    |   |   |    |          |
| 4. Aperture label present   |   |   |    |          |
| 5. Appropriate warning/danger sign at entrance to laser area                |   |   |    |          |
| 6. Warning posted for invisible radiation                                   |   |   |    |          |
| <b>C. Control Measures</b>  |   |   |    |          |
| 1. Protective housing present and in good condition                         |   |   |    |          |
| 2. Beam attenuator present  |   |   |    |          |
| 3. Laser table below eye level  |   |   |    |          |
| 4. Beam is enclosed as much as possible                                     |   |   |    |          |
| 5. Beam not directed toward doors or windows                                |   |   |    |          |
| 6. Beams are terminated with fire-resistant beam stops                      |   |   |    |          |
| 7. Surfaces minimize specular reflections                                   |   |   |    |          |
| 8. Controls are located so that the operator is not exposed to beam hazards |   |   |    |          |

## D. Personal Protective Equipment

|  |  |  |  |  |
|--|--|--|--|--|
| 1. Eye protection is appropriate for wavelength                    |  |  |  |  |
| 2. Eye protection has adequate OD                                  |  |  |  |  |
| 3. Warning/indicator lights can be seen through protective filters |  |  |  |  |

## E. Class 3b and 4 Lasers

|   |  |  |  |  |
|---|--|--|--|--|
| 1. Interlocks on protective housing   |  |  |  |  |
| 2. Service access panel present   |  |  |  |  |
| 3. Limited access to spectators   |  |  |  |  |
| 4. Nominal hazard zone determined   |  |  |  |  |
| 5. Operators do not wear watches or reflective jewelry while laser is operating |  |  |  |  |
| 6. Viewing portals present where MPE is exceeded                                |  |  |  |  |

## F. Class 4 Lasers

|   |  |  |  |  |
|---|--|--|--|--|
| 1. Failsafe interlocks at entry to controlled area  |  |  |  |  |
| 2. Area restricted to authorized personnel  |  |  |  |  |
| 3. Laser may be fired remotely  |  |  |  |  |
| 4. If present, curtains are fire-resistant  |  |  |  |  |
| 5. Area designed to allow rapid emergency egress  |  |  |  |  |
| 6. <b>Pulsed-</b> interlocks designed to prevent firing of the laser by dumping the stored energy into a dummy load |  |  |  |  |
| 7. <b>CW-</b> interlocks designed to turn off power supply or interrupt the beam by means of shutters               |  |  |  |  |
| 8. Operators know not to wear ties around the laser   |  |  |  |  |

## G. Non-Beam Hazards

|   |  |  |  |  |
|---|--|--|--|--|
| 1. High voltage equipment appropriately grounded                          |  |  |  |  |
| 2. High voltage equipment located away from wet surfaces or water sources |  |  |  |  |
| 3. High voltage warning label in place                                    |  |  |  |  |
| 4. Compressed gases secured   |  |  |  |  |