STONY BROOK STATE UNIVERSITY OF NEW YORK	Environmental Health and Safety Manual Policy Number: EH&S **6-8**	
Title: **Laser Safety**		
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PURPOSE: To protect University employees against health hazards associated with the operation of lasers. Guidelines are provided to ensure the safety and health of laser operators and other personnel likely to be exposed to its hazards. A practical means for both evaluation and control of laser radiation hazards is to first classify laser systems according to their relative hazards, and then to specify appropriate controls for each classification.

SCOPE: University wide.

INTRODUCTION:

Laser (or light amplification by stimulated emission of radiation), is a source of intense, coherent, directional beams of electromagnetic radiation. Laser generally refers to coherent optical sources emitting ultraviolet (200-400 nanometers, (nm), visible (400-700 nm), and/or infrared (700-1,000 nm) radiation. Exposure to laser radiation of high intensity can cause eye or skin damage. Light directly from the laser, or from a mirror like reflection entering the eye, can be focused on an extremely small image on the retina. The incident radiation exposure will be increased approximately 100,000 times at the retina due to the focusing effects of the lens. Additionally, there are other hazards involved in the use of lasers such as electrical shock, atmospheric contamination, fire, and exposure to cryogenic fluids.

Laser Classification

The following classification of laser devices derived from American National Standards Institute, ANSI Z136.1-1993, "Safe Use of Lasers", has been adopted at this University for determining relative laser hazards. For examples of typical laser classifications see Charts in Appendix A.

1. Class 1 Exempt Lasers.

   Lasers or laser systems that cannot, under normal operating conditions, produce a hazard.

2. Class 2a Low Power Visible Lasers.

Low power visible lasers or laser systems that are not intended for prolonged viewing, and under normal operating conditions will not produce a hazard if viewed directly for periods not exceeding 1,000 seconds.

3. Class 2 Low Power Visible Lasers.

   Low power visible lasers or laser systems, which, because of the normal human aversion responses, do not normally present a hazard, but may present some potential for hazard if viewed directly for extended periods of time (like many conventional light sources).

4. Class 3a Lasers.

   Lasers or laser systems that normally would not produce a hazard if viewed for only momentary periods with the unaided eye. They may present a hazard if viewed using collecting optics. It has a power output from one to five times the lower limit.

5. Class 3b Lasers.

   Lasers or laser systems that can produce a hazard if viewed directly. This includes intrabeam viewing of specular reflections. Except for the higher power Class 3b lasers, this class laser will not produce a hazardous diffuse reflection.

6. Class 4 Lasers.

   Lasers or laser systems that can produce a hazard not only from direct or specular reflections, but also from a diffuse reflection. In addition, such lasers may produce fire hazards and skin hazards.

PROCEDURES:

I. Responsibilities

A. Principal Investigators (Chairpersons)

1. Assure that a preliminary review prior to purchase is conducted with a Radiation Protection Services representative in order to classify the laser and determine the required safeguards. The following necessary information will be provided on the appropriate forms enclosed:

    a. Names of responsible persons and operators.

    b. Manufacturer's name.

    c. Laser classification (if known).

    d. Intended use of device.

    e. Technical information -

        i. Type of laser - medium and operating mode (continuous wave or pulsed).
        ii. Maximum beam power.
        iii. Wavelengths (power emitted at each wavelength).
        iv. Emission duration.
        v. Beam divergence.
        vi. Aperture diameter.

2. Assure that a final review is conducted with a Radiation Protection Services representative prior to initial operation.

3. Assure that the facility is operated as initially approved. Any modification or changes will be reviewed with the Radiation Protection Services representative.

B. Users of Lasers

1. Are responsible for operating lasers in a manner consistent with the requirements of the

final safety review.

C. Department of Environmental Health and Safety Radiation Protection Services

1. Provide technical assistance in the determination of laser classification and required safeguards.

2. Maintain a current register of all lasers at Stony Brook.

3. Assist in laser safety training.

II. Safety Requirements

A. Controls

Specific controls based upon the classification scheme have been adopted as University requirements.

1. Class 1

   "Exempt" lasers, e.g., some small gallium-arsenide lasers, are by definition, devices which cannot be considered hazardous even if all of the laser output were directed into the eye's pupil (if it could get it in) or focused into a 1 mm spot on the skin for a day, hence, there are no safety requirements.

   A warning sign should be located at an access panel to alert a user that more hazardous laser radiation is contained therein. Another panel covering the warning sign and access panel is permitted.

   Each enclosed laser or laser system will be provided with safety interlocks for any portion of the protective housing that allows access to radiation in excess of the applicable Maximum Permissible Exposure (MPE) limits when removed or displaced.

2. Class 2

   Precautions are required to prevent continuous staring into the direct beam or a beam reflected from a mirror-like surface. Momentary (0.25 second) exposure, as would

occur in an unintentional viewing situation, is not considered harmful. All Class 2 lasers will meet the following requirements:

a. The laser will never be directed toward the eyes of any person.

b. A warning label reading "CAUTION - DO NOT STARE INTO LASER BEAM" will be placed in a conspicuous location on the laser.

3. Class 3

These lasers are potentially hazardous if the direct beam (or a beam reflected from a mirror like surface such as watches, rings, pens, etc.) is intercepted by the unprotected eye. Such lasers require the following in addition to the requirements for Class 2:

a. The laser will be operated in a location where only authorized personnel have access.

b. The laser beam will be terminated, when feasible, at the end of its useful beam path by a material that is diffuse and of such color or reflectivity to allow beam positioning with minimal reflection.

c. Eye protection is required if accidental interception by the eye is possible.

4. Class 4

Lasers in this classification possess all the potentially hazardous properties of Class 3 lasers. In addition, eye injury from any reflections of the beam, potential fire hazard, and skin injury must be prevented. Special precautions will include appropriate engineering designs so that the entire beam path is controlled. Such lasers require the following regulations in addition to the requirements for Class 3.

a. The laser will be operated in an area dedicated to its use when capable of emission. Safety interlocks will be used to prevent unexpected entry into the controlled area and access will be limited to persons wearing proper laser protection eye wear when the laser is capable of emission.

b. To insure maximum protection to individuals within the controlled area, the entire beam path, including the irradiation area, should be enclosed. Systems enclosures should be equipped with interlocks so that the laser system will not

operate unless such enclosures are properly installed.

c. For pulsed systems, interlocks will be designed to prevent the firing of the laser by dumping the stored energy into a dummy load. For continuous wave lasers, the interlocks will turn off the power supply or interrupt the beam by means of shutters.

d. These lasers will be provided with a keyed master interlock or switching device. The key will be controlled by an authorized user.

B. Laser Protective Eyewear

1. Approved protective eyewear will be worn whenever hazardous conditions may result from laser operations. Assistance in selecting eyewear may be obtained from the Department of Environmental Health and Safety Radiation Protection Services representative.

C. Visual Warnings

1. Appropriate warning labels will be conspicuously displayed on the laser system. Appropriate warning signs will be posted outside the operating area.

   a. The signal word "CAUTION" will be used on all signs and labels associated with Class 2 lasers and certain Class 3a lasers.

   b. The signal word "DANGER" will be used on all signs and labels associated with Class 3 and Class 4 lasers.

2. Contact the Department of Environmental Health and Safety Radiation Protection Services for information on warning labels and signs.

D. Associated Hazards

Depending on the type of laser used, associated hazards involved in laser operations may include:

1. Atmospheric Contamination in the form of:

a. Vaporized target material from high energy laser cutting, drilling, and welding operations. Materials involved may include asbestos, carbon monoxide, carbon dioxide, ozone, lead, mercury, and other metals.

b. Gases from flowing gas lasers or byproducts of laser reactions; such as bromine, chlorine, hydrogen-cyanide, and many others.

c. Gases or vapors from cryogenic coolants.

d. Vaporized biological target materials from high energy lasers used in biological or medical applications.

2. Ultraviolet Radiation

a. Either direct or reflected from flash lamps and Continuous Wave (CW) laser discharge tubes, ultraviolet radiation is generally of concern only when quartz tubing is used.

3. Visible Radiation (non laser)

a. High luminance radiation emitted from unshielded pump lamps.

4. Electrical Hazards

a. The potential for electrical shock is present in most laser systems. Pulsed lasers use capacitor banks for energy storage, and CW lasers generally have high voltage direct current or radio-frequency electrical power supplies. Solid conductor grounding rods (connected first to a reliable ground) will be used to discharge potentially live circuit points prior to maintenance.

5. Cryogenic Coolants

a. Cryogenic liquids may cause burns. Examples are: liquid nitrogen, liquid helium, and liquid hydrogen.

6. Other Hazards

a. The potential for explosions at the capacitor banks or optical pump systems exists during the operating of some high power lasers or laser systems. The possibility of flying particles from target areas in laser cutting, drilling, and welding operations may exist. Explosive reactions of chemical laser reactants or other gases used within the laser laboratory are a concern in some cases.

7. X-Rays

a. Potentially hazardous x-radiation may be generated from high voltage (over 15 KV) power supply tubes.

8. Jewelry

a. Jewelry is often an overlooked source of exposure from a beam reflected by a mirror like surface and should be controlled.

INQUIRIES/REQUESTS: Environmental Health and Safety
110 Suffolk Hall
Zip 6200
Main Office: 632-6410
FAX: 632-9683

RELATED FORMS:

RELATED DOCUMENTS: 29 CFR 1910.97 *Nonionizing Radiation*
ANSI Z136.1-1993 *Safe Use of Lasers*

-Rev. 2/97-