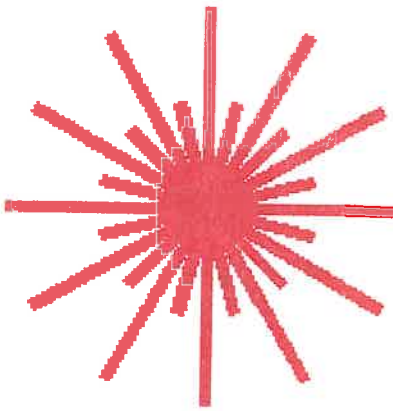

Laser Safety Manual

Alabama A & M University
Radiation Safety Office

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1. Introduction

The purpose of this manual is to insure the safe use of lasers at Alabama A & M University by identifying hazards, providing recommendations for proper use, providing for medical surveillance and for laser safety training for individuals using lasers. To achieve these goals, the University has adopted the American National Standard for the Safe Use of Lasers, ANSI Z136.1-1993. ANSI Z136.1-1993 is recognized as a minimum standard for laser safety.

Most lasers are capable of causing eye injury to anyone who looks directly into the beam or specular reflections. In addition, diffuse reflection of a high-power laser beam can produce permanent eye damage. High-power laser beams can burn exposed skin, ignite flammable materials, and activate toxic chemicals that release hazardous fumes, gases, debris, and radiation. The equipment and optical apparatus required to produce the lasing action and control and direct the laser beam also introduce additional hazards associated with high voltage, high pressure, cryogenics, noise, radiation, and toxic gasses.

2. Scope

The requirements and recommended details of this program are applicable to all lasers used in research and instructional laboratories at Alabama A & M University.

3. Administration

Responsibility for the administration of the safety standards contained herein rests with the President of Alabama A & M University. The President has designate a Radiation Safety Officer (RSO), who is responsible for the implementation of the appropriate safety standards. The RSO shall be an individual "with the authority and responsibility to monitor and enforce the control of laser hazards, and to effect the knowledgeable evaluation and control of laser hazards" (ANSIZ 136.1-1993). The laser program will be the responsibility of the University Radiation Safety Committee, (URSC). The URSC will review and approve all principal investigators, laser registry forms, laser acquisition forms, will provide a comprehensive laser safety program, and make policy recommendations to the University administration.

4. Responsibilities

4.1. Principal Investigators are responsible for:

a. The immediate supervision of lasers in the laboratory
b. Providing, implementing, and enforcing the safety recommendations and requirements prescribed in this program.
c. Providing laser operators with training in the administrative, alignment and standard operating procedures.
d. Classifying and labeling all of their lasers.
e. Completing a **Laser Registration Form**, (APPENDIX B) and submit to OEHS
f. Train ALL employees who work with and around Class 2a, 2 and 3 a) lasers in the safe use of lasers. The training must be documented throughout the University to (OEHS).
g. Attending the University's Laser Safety Training program for users of Class 3b lasers and above.
h. Registering for the Medical Surveillance program for users of Class 3b and Class 4 lasers.
i. Notifying OEHS, **immediately** in the event of an exposure to a Class 3b or Class 4 laser.
j. Make a drawing of the room where the lasers are being used.

4.2. Laser Operators are Responsible for:

a. Following laboratory administrative, alignment and standard operating procedures while operating lasers.
b. Keeping the Principal Investigator fully informed of any departure from established safety procedures. This includes notification of an exposure incident.
c. Attending the University's Laser Safety Training Program for users of Class 3b lasers and above.
e. Registering for the Medical Surveillance program for users of Class 3b and Class 4 lasers.

4.3 The Office of Environmental Health and Safety will:

a. Conduct annual lab inspections to ensure that safety requirements are followed.
b. Provide assistance in evaluating and controlling hazards.

c. Update Alabama A & M University Laser Safety Manual.
d. Maintain all training records of lasers and laser operators.
e. Coordinate laser safety training for personnel who are assigned to an area where lasers are operated.
f. Participate in accident investigations involving laser
g. Coordinate the Medical Surveillance Program.

5. Personnel Training and Qualification

5.1 All staff and students operating lasers (Class 3b and above) are required to attend a Laser Safety training course coordinated by the Office of Environmental Health and Safety

5.2 Only a qualified and authorized person is permitted to operate a laser. The Principal Investigator determines the employee's operational qualification from departmental or technical training or other acceptable experience.

5.3 Laser Safety Training will be conducted by the Departmental Laser Safety Officer (LSO) and or members of the Radiation Safety Committee.

5.4 Before operating a Class 3b or Class 4 laser, or a Class 1 laser system that encloses a Class 3b or Class 4 laser a person **MUST:**

a. Review the Laser Safety Manual.
b. Receive from the lab supervisor or Principal Investigator a thorough review of the laser equipment to be used and the administrative, alignment and standard operating procedures (SOP's)
c. Review the operating and safety instructions furnished by the manufacturer.

6. Medical Surveillance

6.1 Individuals operating Class 1,2,2a and 3a lasers are except from eye exams.

6.2 Laser operators or individuals who will work in areas where there may be exposure to laser radiation from Class 3b or Class 4 laser are required to have a baseline eye examination prior to using the laser. .

6.3 An eye examination is required in the event of exposure or suspected exposure incident.

6.4 An examination is recommended when an individual terminates his or her work in a laser laboratory.

7.0 Exposure Incidents

7.1 If an exposure incident occurs **OEHS (4091)** must be notified by the Principal Investigator or the person operating the laser.

7.2 If the incident causes an injury or could potentially have caused an injury, the person or persons who have received an exposure should inform their supervisor and an eye exam SHALL be performed.

7.3 OEHS will conduct an investigation, and an incident report will be written.

8.0 Laser Hazard Analysis

Before appropriate controls can be selected and implemented, laser radiation hazards must be identified and evaluated.

8.1 Types of hazards include:

a. **Eye:** Acute exposure of the eye to laser of certain wavelengths and power can cause corneal or retinal burns (or both). Chronic exposure to excessive levels may cause corneal or lenticular opacities (cataracts) or retinal injury.

b. **Skin:** Acute exposure to high levels of optical radiation may cause skin burns; while carcinogensis may occur for ultraviolet wavelengths (290-320 nm).

c. **Chemicals**: Some lasers require hazardous or toxic substances to operate (i.e., chemical dye, and Exciter lasers).

d. **Electric Shock**: Most lasers produce high voltages that can be lethal

e. **Fire Hazards:** The solvents used in dye lasers are flammable. High voltage pulse or flash lamps may cause ignition. Flammable materials may be ignited by direct beam or specular reflections from high power continuous wave (CW) infrared lasers.

8.2 Laser and laser systems are grouped according to their capacity to produce injury, and specific controls are then described for each group. Lasers manufactured after August 1, 1976, are classified and labeled by the manufacture. Information on the label must include class, the maximum output power, the pulsed duration (if pulse), and the laser medium or emitted wavelengths.

8.3 **Maximum Permissible Exposure (MPE)**: The level of radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin. The criteria for MPE for the eye and skin are detailed in Section 8 of ANSI Z 136.1-1993.

9.0 Laser Classification

9.1 Lasers are generally classified and controlled according to the following criteria

a. **Class 1:** Low-power lasers and laser systems that cannot emit radiation levels greater than the Maximum Permissible Exposure (MPE). Class 1 lasers and laser systems are incapable of causing eye damage and are therefore exempt from any control measures.

b. **Class 2:** Visible, low power lasers or laser systems that are incapable of causing eye damage unless they are viewed directly fro an extended period (greater than 1000 seconds). See APPENDIX A "Laser Pointers".

c. **Class 3:** Medium-power lasers and laser systems capable of causing eye damage with short-duration (<.25 seconds) exposures to the direct or specularly reflected beam. Includes 3a and 3b lasers

d. **Class 3a**: 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

e. **Class 3b:** Lasers or laser systems that can produce hazards if viewed directly. This included intrabeam viewing of specular reflections.

f. **Class 4:** High power lasers or laser systems capable of causing severe eye damage with short duration (<0.25 second) exposures to the direct, specularly reflected, or diffusely reflected beam. Class 4 lasers and laser systems are also capable of causing severe skin damage, igniting flammable and combustible materials.

9.2 It is the responsibility of the Principal Investigator who operates or supervises the operation of a "**homemade**" laser to classify and label the laser he/she controls. Refer to either ANSI Z136.1-1986, 21 CFR 1040.10 and 1040.11 and 29 CFR 1910, Occupational Safe and Health Standard for General Laboratories, or contact the OEHS for information.

10. General Laser Safety Recommendations and Requirements

10.1 **Eye Protection**: Principal Investigators or staff who operate or supervise the operation of a laser is responsible for determining the need for laser eye protection for a particular laser. If required, the supervisor will provide eye protection for staff and visitors to the area. The booklet "Guide for the Selection of Laser Eye Protection" produced by the Laser Institute of America may provide assistance in eyewear selection. Check with your Principal Investigator or OEHS (4091).

10.2 The minimum laser radiant energy or laser power level required for the application should always be used.

10.3 **Beam Control**: To minimize direct eye exposure, observe these precautions:

a. Do NOT intentionally look directly into the laser beam or at a specular reflection, regardless of its power.

b. Terminate the beam at the end of its useful path.

c. Locate the beam path at a point other than eye level when standing or when sitting at a desk.

d. Orient the laser so that the beam is not directed toward entry doors or aisles.

e. Minimize specular reflections.

f. Securely mount the laser system on a stable platform to maintain the beam in a fixed position during operation and limit beam traverse during adjustments.

g. Confine primary beam and dangerous reflections to the optical table.

h. Clearly identify beam paths and ensure that they do not cross-populated areas or traffic paths.

i. When the beam path is not totally enclosed, locate the laser system so that the beam will be outside the normal eye-level range, which is between 1.2 to 2 meters from the floor. A beam path that exits from a controlled area must be enclosed where the beam irradiance exceeds the MPE.

11. Additional Controls for Class 1 , Class 2 and Class 3a Lasers

11.1 **Warning Signs**: Post at each entrance to the operating is a sign "**CAUTION LOW POWER LASER**".

11.2 Refer to ANSIZ136.1-1993 and APPENDIX B of this manual for further guide lance on control measures for various classifications of lasers.

12. Additional Controls for Class 3b and 4 Lasers

12.1 All Principal Investigators are required to write Standard Operating Procedures (SOP) for all laser operations involving Class 3b and Class 4 lasers detailing alignment, operation and maintenance procedures. The SOP should be posted or attached to the inside surface of the lab door.

12.2 **SOP's:** must include procedures to address when:

a. Use of eyewear, shields and access control is necessary.
b. Two or more Class 3b or Class 4 lasers will be used in the same area different operators without permanent, intervening barriers.
c. An interlock bypass is installed that does not conform to the conditions of the Laser Safety Manual.
d. Class 3b or Class 4 laser will be used by Non-University personnel; (e.g., contact personnel or visiting colleague).
e. Laser installation does not include all the required controls specified in this manual (e.g., temporary operations).
f. Alabama A & M University Class 3b or Class 4 laser or laser system is operated off campus.
g. Other hazards may be involved that require an SOP (e.g., acutely toxic gases, unattended laser operations).

12.3 **For assistance** in completing an SOP, contact the Office of Environmental Health and Safety (4091)

12.4 **A log** must be maintained showing periods of use, service, maintenance and incidents.

12.5 **Labels:** A laser classification label must be conspicuously affixed to the laser housing.

12.6 **Warning Signs:** Each entrance must be posted with a danger sign in accordance with ANSIZ136.1-1993.

12.7 **Warning Devices:** Entrances to laboratories with a Class 3b or Class 4 laser **SHALL** have a lighted warning sign that is fail-safe interlocked with the laser to activate when the laser is energized. The sign **MUST** be tested monthly. A written record must be kept of each test in the log book (see Section 12.4).

12.8 **Safety Interlocks:**

a. Access doors to a controlled laser in which a Class 3b or a Class 4 laser is being operated must be equipped with safety interlocks to prevent laser operation when the interlock circuit is broken.
b. All protective enclosures that surround laser devices and high electrical sources must be equipped with inter-locks to prevent operation of the equipment

c. Interlocks should be tested monthly to ensure that they are operational. A written record must be kept of each test in the log book (see Section 12.4)

d. Interlocks must be designed so that they are actuated. The capacitor banks, shutters or power supplies cannot be re-energized except by manually resetting the system.

12.9 The responsible individual in a laser area controlled by a warning light is permitted to momentarily override (bypass) door interlocks to allow access of authorized persons if all of the following conditions are met:

a. There is no laser radiation hazard at the point of entry.

b. The necessary protective devices are worn by the personnel entering the area.

c. An interlock bypass circuit is designed into the interlock control system. This bypass circuit **MUST** only be operated from inside the interlocked area. It must delay no more than 15 seconds before shutting down the system.

12.10 If interlocks are not feasible, the Principal Investigator may consider the use of alarms or voice warning. The Office of Environmental Health and Safety **must** be consulted.

12.11 Laser laboratories and controlled areas must be designed so that personnel can enter and leave under emergency conditions.

12.12 Lasers **MUST** have a master switch with a key or coded access that prevents use once the key has been removed or a code has been entered. The key **MUST** not be left in the control panel when the laser is not in use.

12.13 Laser Activation Warning Systems: An Alarm, a warning light, or a verbal "countdown" command must be used during activation and start up.

12.14 Lasers must have a permanently attached beam stop or attenuator and emission delays.

12.15 Laser controlled area shall be established which have limited access, covered windows and doors, and only diffuse reflective material. The facility must be a fully enclosed room or laboratory with floor-to-ceiling walls. Access to the area during laser operation requires the permission of the responsible operator.

12.16 Class 3b and Class 4 infrared beams with a wavelength greater than or equal to 710 nm **MUST** be terminated with fire resistant materials.

12.17 Securely fasten all mirrors, prisms, beam stops, etc. in the beam path. Ensure that the laser is also securely fastened.

12.18 Circuit breakers must be identified for each laser.

12.19 **Beam Enclosure:** The entire beam path of Class 3b and Class 4 lasers, including the target area, should be surrounded by an enclosure equipped with interlock that prevents operation of the laser system unless the enclosure is properly secured. When total enclosure of the laser beam path is not practical, both the non-enclosed beam and any strong reflections must be terminated at the end of their useful path using such as backstops, shields or beam traps.

12.20 **Reflection Control**

a. Materials that diffusely reflect laser radiation must be used in place of specularly reflective surfaces whenever possible.
b. To minimize personnel exposure, specularly reflecting surface that are needed for beam-path control should be enclose shielded.

12.21 **Invisible Beams:** Ultraviolet (UV) and infrared (IR) lasers that emit invisible beams require several additional controls.

a. Visual or audible beam-warning devices must be installed in areas where personnel may be exposed to radiation in excess of the MPE. These warning devices must be clearly identified and visible from all areas of potential exposure.
b. Shielding must be installed that will attenuate UV radiation to levels below the MPE for the wavelength being used.
c. Hazardous concentrations of by-products formed by the reaction of intense UV radiation with materials in the area must be controlled.
d. IR beam enclosures and backstops must be fabricated of IR-absorbent material. For Class 4 lasers, the absorbent material must also be fire-resistant.

12.22 **Beam Mapping:** Controlled laser areas must be surveyed with appropriate measuring devices to locate and identify direct and reflected beams that exceed the MPE; shielding may be required to limit unwanted radiation.

12.23 Direct Viewing

a. Personnel **MUST** never look directly into any laser beam unless such action is specifically approved by OEHS.

b. The primary beam and specular reflections of Class 3b or Class 4 lasers are particularly hazardous. In those cases where it is necessary to directly view a beam from a Class 3b or Class 4 laser, special provisions, such as filters, are mandatory.

c. An SOP must be prepared for operations where the beam of a Class 3 or Class 4 laser must be viewed directly or where it is necessary with optical viewers in close proximity to the laser beam.

12.24 Alignment

a. High-power laser optical systems must never be aligned by direct beam viewing if the radiant exposure or irradiance exceeds the MPE.

b. Use low-power lasers, diffuse reflectors, image-retaining screens, exposed Polaroid film and other devices that will minimize eye exposure.

12.25 Optical Viewing Aids Using optical systems such as cameras, telescopes, microscopes, etc., to view laser beams may increase the eye hazard. Therefore, all collecting optics must incorporate suitable means (such as interlocks, filters, or attenuators) to prevent eye exposure above the MEPE.

12.26 Protective Equipment

a. Laser protective eye wear **SHALL** be worn whenever MPE levels may be exceeded.

b. However, it is good practice to always wear eye protection when lasers are in use.

c. In general, eye wear provides protection over a narrow range of the laser spectrum. Eye wear designed for protection at one wavelength may afford little or no protection at another wavelength.

d. Consult eye wear manufactures and OEHS for proper selection of protective eye wear (see Section 10.1).

e. Laser protective eye wear must be approved by the American National Standards Institute (ANSI) and clearly labeled with optical densities and wavelength for which protection is afforded. Eye wear must be inspected periodically by the user for pitting and cracking of the attenuating material, for mechanical integrity, and light leaks in the frame.

12.27 Unattended Equipment

a. When lasers are to be left unattended, de-energize the power supplies or capacitor banks and remove the keys from power switches or master interlocks to prevent unauthorized activation of the equipment.
b. The operation of unattended lasers is only allowed when a specific SOP has been written and approved by the Principal Investigator and Radiological Safety Committee.

12.28 Temporary Installations

a. Occasionally, it may be necessary to remove protective enclosures or override equipment interlocks or other safety devices for service adjustment, maintenance, special training exercises, etc.
b. In these instances, a temporary controlled laser area must beset up. Specific methods for handling situations of this type must be described in the SOP.
c. Because the area will not have all the standard safety features, the SOP must describe provisions for protecting personnel who could potentially be exposed.
d. When the entire beam path is not fully enclosed, restrict access into the area to only persons wearing proper protective equipment. Make sure that all optical paths from the restricted access area are adequately covered to prevent escape of laser radiation greater than the MPE for the eye.

13.0 Converting to a Class I Enclosed Laser Any laser or laser system can be converted to a Class I enclosed laser by including all of the following controls in the laser system design. These controls will effectively enclosure the laser, thus preventing personnel contact with the emitted radiation while permitting unrestricted access into the area.

13.1 Protective Housing

a. House the laser system within a protective enclosure to prevent escape of laser radiation above the MPE.

b. The protective housing must prevent personnel access to the laser system during normal operations

c. Personnel entering the enclosure to perform maintenance or adjustment tasks must be made aware of the higher risks and comply with the control measures for the higher risk laser class.

13.2 Safety Interlocks

a. Install safety interlocks wherever the protective enclosure can be opened, removed or displaced.

b. When activated, these interlocks must prevent a beam with a radiant energy above the MPE from leaving the laser or laser system.

c. Service adjustments or maintenance work performed on the laser system must not render the interlock inoperative or cause exposure levels outside the enclosure to exceed the MPE, unless the work is performed in a laser area with limited access and appropriate safeguards, supervision and control.

13.3 Fail-Safe Design The protective enclosure and the laser system must be designed and fabricated so that if a failure occurs, the system will continue to meet the requirements for an enclosure laser operation.

13.4 Modifications to commercial laser systems must be evaluated. Contact OEHS for an evaluation form. If the modification decrease the safety controls, and SOP will be required.

13.5 Attenuated Viewing Windows: Use viewing windows containing a suitable filter material that will attenuate the transmitted laser radiation to levels below the MPE under all conditions of operation.

13.6 Warning Signs and Labels

a. Label the enclosure with "**CAUTION-ENCLOSURE LASER**" signs.

b. Attach a label directly to the laser, which gives the laser classification in the absence of the enclosure. Make sure that the label can immediately be seen when the enclosure is opened.

14.0 Controlling Associated Hazards Many chemical and physical hazards other than laser radiation can be found in the laser area that must also be adequately controlled.

14.1 Electrical Equipment and Systems

a. Always be aware of the high risk of injury and fire in laser operations because of the presence of electrical power source.

b. The installation, operation, and maintenance of electrical equipment and systems must conform to the standards stated in the National electric Code (NFPA 70). Contact Physical Facilities for assistance.

14.2 Lighting

a. Adequate lighting is necessary in controlled areas.

b. If lighting is extinguished during laser operation, provide control switches in convenient locations or install a radio-controlled switch.

c. Luminescent strips should be used to identify table and equipment corners, switch locations, aisles, etc.

d. When natural light is not sufficient for safe egress from a laser area during an electrical power failure, install emergency lighting.

14.3 Ionizing and Non-ionizing Radiation

a. A laser operation may involve ionizing radiation that originates from the presence of radioactive materials or the use of electrical power in excess of 15 kV.

b. Microwave and radio frequency (RF) fields may be generated by laser systems or support equipment.

c. Contact the Radiation Safety Officer (RSO) at (4091) to obtain an evaluation of these hazards before starting an operation.

14.4 Hazardous Materials

a. Bring into the laser area only those hazardous materials that are needed for the operation.

b. All Hazardous materials **MUST** be properly used, stored and controlled. Consult Materials Safety Data Sheet and OEHS for information.

c. Do not allow laser beams and strong reflections to impinge on combustible materials, explosives, highly flammable liquids or gases or substances that decompose into highly toxic products under elevated temperatures, without providing adequate controls.

14.5 Dyes and Solutions

a. Dye lasers normally use a lasing medium composed of a complex florescent organic dye dissolved in an organic solvent. These dyes vary greatly in toxicity, mutagenicity, and potential carcinogenicity.

b. All dyes must be treated as hazardous chemicals. Most solvents suitable for dye solutions are flammable and toxic by inhalation and/or skin absorption.

c. Obtain Material Safety sheets from OEHS for all dyes and solvents.

d. Use and store all dyes and solvents in accordance with Materials Data Sheets.

e. Prepare/handle dye-solutions inside a chemical fume hood.

f. Wear a lab coat, eye protection and gloves. Call **OEHS (4091)** for assistance in glove selection.

g. Pressure-test all dye laser components before using dye solutions. Pay particular attention to tubing connections.

h. Install spill pans under pumps and reservoirs.

i. Be alert to contaminated parts.

j. Keep dye-mixing areas clean.

APPENDIX A

LASER POINTERS

THE SAFE USE OF COMMON LASER POINTERS:

Despite their size, small, widely obtainable batteries power availability, and the fact that most pens sized laser pointers, these pointing devices can cause eye damage if used improperly. The potential hazard is limited to looking directly into the laser beam with unprotected eyes. No hazard to the skin exists.

Pen sized laser pointers have become common presentation aids in recent years. These battery powered laser pointers produce a narrow bright red beam, are convenient to carry and use, relatively inexpensive, and readily available through mail-order catalogs and magazines.

ANSI CLASSIFICATION ADDRESSES POSSIBLE EYE HAZARD:

Two types of these pointer devices are widely used in visual presentations-helium-neon (HeNe) and diode lasers. HenNe laser pointers are classified as Class 2 lasers as defined by the American National Standards Institute (ANSI). A "CAUTION" label for these Class 2 devices are appropriate. Momentary or accidental viewing of the direct beam of Class 2 lasers, for less than 0.25 second, will not cause eye injury. However, ANSI has classified most diode lasers, as Class 3a, these lasers are potentially hazardous, even for **momentary** direct viewing, if the entire beam enters the eye.

Class 3a lasers may be labeled "CAUTION" if they present the same risk to the naked eye as a Class 2 laser. However, if a Class 3a diode laser has a very small beam diameter (less than 7 millimeter[mm]) and a power rating between 1 and 5 milliwatt [mW], it must have a "DANGER" label. Class 3a lasers pose an increased risk if viewed at close distance where the beam is less than 7 mm.

HeNe laser pointers have been available for several years. On a relatively low power level (typically less than 1.0 mW), they produce a bright red (632.8 nanometer [nm]) spot that is easily noticeable on a bright screen. The more recently developed diode lasers are smaller in size and more rugged. The fact that diode lasers cost only about one-third as much as HeNe lasers make them popular.

The diode lasers however, produce a light that is darker (670nm) than the HeNe lasers. To achieve the same effect as the HeNe lasers, the diode laser power level are increased (typically to 5 nW). ANSI has assigned the safety classification described above to these laser pointers in accordance with the level of danger to the eye.

RECOMMENDATIONS FOR USE

Because of safety considerations, laser pointers with a "CAUTION" label should be purchased as opposed to those with a "DANGER" label. In other words, Class 2 lasers are recommended.

Users should also be aware of the manufacture's safety precautions. as looking into any laser beam has the potential to cause eye injury, and thus should be avoided. Thus, the beam from a laser pointer **should never** be directed toward any individual or audience. A mirror-like reflection of the laser beam can be equally hazardous.

In addition, when storing pointers, remove the power source or unscrew the case/housing enough to disable the power source.

APPENDIX B

CONTROL MEASURES FOR THE FOUR LASER CLASSES

This summary is taken from the ABSI Z136.1-1993. Reference numbers in the parentheses refer to sections in the standard.

Control Measures	**Classification**					
Engineering Controls	1	2a	2	3a	3b	4
Protective Housing (4.3.1)	X	X	X	X	X	X
Without Protective Housing	LSO Shall establish Alternate Controls					
(4.3.1.1)						
Interlocks on Protective	%	%	%	%	X	X
Housing (4.3.2)						
Service Access Panel	%	%	%	%	X	X
(4.3.3)						
Key Controls (4.3.4)	-	-	-	-	*	X
Viewing Portals (4.3.5.1)	-	-	MPE	MPE	MPE	MPE
Collecting Optics (4.3.5.2)	MPE	MPE	MPE	MPE	MPE	MPE
Totally Open Beam	-	-	-	-	xNHZ	xNHZ
Path (4.3.6.1)						
Limited Open Beam	-	-	-	-	xNHZ	xNHZ
Path (4.3.6.2)						
Enclosed Beam	None Required if 4.3.1 and 4.3.2 are fulfilled					
Path 4.3.6.3)						
Remote Interlock	-	-	-	-	*	X
Connector (4.3.7)						
Beam Stop or	-	-	-	-	*	X
Attenuator (4.3.8)						
Activation Warning	-	-	-	-	*	X
Systems (4.3.9)						
Emission Delay (4.3.9.1)	-	-	-	-	-	X

Indoor Laser Control	-	-	-	-	xNHZ	xNHZ
Area (4.3.10 Class 3b Laser Controlled	-	-	-	-	X	-
Area (4.3.10.1) Class 4 Laser Controlled	-	-	-	-	-	X
Area (4.3.10.2) Laser Outdoors	-	-	-	-	xNHZ	xNHZ
Controls (4.3.11) Laser in Navigable	-	-	-	*	*	*
Airspace (4.3.11.2) Temporary Laser Controlled	%MPE	%MPE	%MPE	%MPE	-	-
Area (4.3.12) Remote Firing and	-	-	-	-	-	*
Monitoring (4.3.13) Labels (4.2.14 and 4.7)	X	X	X	X	X	X
Area Posting (4.3.15)	-	-	-	-	xNHZ	xNHZ
Administrative and Procedure Controls						
Standard Operating	-	-	-	-	*	X
Procedures (4.4.1) Output Emission	-	-	-	LSO Determination		
Limitations (4.4.2) Education and	-	-	*	*	X	X
Training (4.4.4)						
Authorized Personnel (4.4.4)	-	-	-	-	X	X
Alignment Procedures(4.4.5)	-	-	X	X	X	X
Protective Equipment (4.4.6)	-	-	-	-	*	X
Spectator (4.4.7)	-	-	-	-	*	X
Service Personnel (4.4.8)	%MPE	%MPE	%MPE	%MPE	X	X
Demonstration with General Public (4.5.1)	MEP+	-	X	X	X	X
Laser Optic Fiber	MPE	MPE	MPE	MPE	X	X

Systems (4.5.2)						
Laser Robotic	-	-	-	-	xNHZ	xNHZ
Installations (4.5.3)						
Eye Protection (4.6.2)	-	-	-	-	*MPE	xMPE
Protective Windows (4.6.3)	-	-	-	-	xNHZ	xNHZ
Protective Barriers	-	-	-	-	*	*
and Curtains (4.6.4)						
Skin Protection (4.6.5)	-	-	-	-	XMPE	XMPE
Other Protection	Use may be required					
Equipment (4.6.5)						
Warning Signs	-	-	-	-	xNHZ	xNHZ
and Labels(4.7)						
Service and Repairs (4.8)	LSO Determination					
Modification of Laser	LSO Determination					

LEGEND

X	Shall
*	Should
-	No Requirements
%	Shall if enclosed Class 3b or Class 4
MPE	Shall if MPE is exceeded
NHZ	Nominal Hazard Zone analysis required
+	Applicable only to UV and IR Lasers
LSO	Laser Safety Officer (Appointed by the OEH&S)

APPENDIX C

ALABAMA A&M UNIVERSITY
RADIATION SAFETY OFFICE

LASER SAFETY
PERSONNEL TRAINING INFORMATION

INSTRUCTIONS: Complete and forward all information requested to the Radiation Safety Office, Attention: Dr. Robert H Lehman, RSO., Carter Hall 208A

NAME _____

DEPARTMENT _____

BUILDING/ROOM # _____

WORK PHONE # _____

PRINCIPAL INVESTIGATOR _____
(PERSON IN CHARGE OF LASER)

List all laser or laser safety training course work you have completed. Not all the titles, dates completed, duration (hours of course) and location.

_____

_____

_____

_____

_____

_____

_____

_____

_____

SIGNATURE _____
(laser operator/user)

SIGNATURE _____
(Principal Investigator)

APPENDIX D

ALABAMA A & M UNIVERSITY
RADIATION SAFETY OFFICE

LASER REGISTRATION FORM

INSTRUCTIONS: Complete the form, and send to the Radiation Safety, Office.Carter Hall 208A

Name (P.I.): _____ Phone # _____

Other Users: _____ Phone # _____

Other Users: _____ Phone # _____

Other Users: _____ Phone # _____

Other Users: _____ Phone # _____

Department: _____ Address: _____

Type of Laser: _____ Manufacturer _____

Power: _____ Class: _____

Wavelength: _____ Location: _____

Use: _____

Current Status: _____

P.I. Signature: _____ Date: _____

For Radiation Safety Office Use:

Comments: _____
_____
_____

APPENDIX E

LASER LIGHT ENTERAINMENT

PURPOSE

The Radiation Safety Office has developed these procedures to ensure safety of Alabama A & M University faculty, staff, students and the general public during performances by companies providing laser light entertainment.

INSPECTIONS

Inspections will be conducted at all performances which use class IIIb or IV lasers at the Alabama A & M Campus whenever the Alabama A & M Laser Safety Officer or Radiation Safety Officer deems necessary.

RESPONSIBILITIES

The Alabama A & M staff member in charge of hosting the laser light performance must:

- Notify the Radiation Safety Office as soon as a laser company is scheduled to provide entertainment on Alabama A & M property.
- Notify the laser company of the Alabama A & M Radiation Safety Office's requirements for notification.
- Provide access to the laser light performance location to representatives of the Alabama A & M Radiation Safety Office prior to and during laser performances.

The laser company must:

- Provide the information outlined in the required information sheet.
- Meet with the Laser Safety Officer prior to the show to discuss laser details.

The laser operator must:

- Provide information to the Alabama A & M Radiation Safety Office prior to the day of the show regarding:

Operator training.

Emission levels of beams.

Type of communication between operator and surveillance personnel.

Name of contact person between the laser company and performers.

Emergency procedures.

Safety procedures.

Briefing of security personnel of hazards associated with lasers.

Detailed description of each effect.

Distance of separation of beams from audience.

Time that the alignment procedure will be performed.

- Demonstrate the effects during alignment at full power with the lights off.
- Perform alignment check between acts (when possible) if more than one act is performing.
- Terminate any effect which the representative of the Alabama A & M Radiation Safety Office feels unsafe.
- Meet with the representative of the Alabama A & M Radiation Safety Office after the show to discuss findings.

The Alabama A & M Radiation Safety Office will:

- Set up an interview with the operator to discuss show details.
- Observe alignment procedures and make recommendations.
- Notify the operator during the show of any unsafe conditions and require the termination of all effects if necessary.
- After the show, discuss with the operator any problems encountered.

REFERENCES

American National Standards Institute, (ANSI) Z136.1-1993 American National Standard for the Safety Use of Lasers.

American National Standards Institute, (ANSI) Z136.2-1988 American National Standard for the Safety Use of Optical Fiber Transmitters.

29CFR 1910, Occupational Safety and Health Standards for General Laboratory.

21 CFR 1040.1 and 1040.11, Federal Laser Products Performance Standard.

National Electric Code (NFPA 70, May 2001.

OSHA Pub 8-1.7 Guidelines for Laser Safety and Hazard Assessment.