UNIVERSITY OF SOUTH ALABAMA

LASER SAFETY PROCEDURES MANUAL

Revised: April 30, 2018

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Introduction

The University of South Alabama Laser Safety Procedures manual is intended to provide staff, researchers, students, and visitors with instructions for a safe laser use environment. This manual was written to outline the University of South Alabama's laser safety policy and to serve as a reference source for laser users.

Program Authority

The Radiation Safety Officer and the University of South Alabama Laser Safety Committee have adopted the following procedures to ensure laser safety at the University of South Alabama. Adherence to these procedures is necessary to continue advancing in our laser activities. The Laser Safety Program shall be administered under the authority granted to the Laser Safety Committee by the President of the University of South Alabama. The Committee shall have the authority to authorize, suspend, and specify conditions of use for all lasers at facilities of, and areas of administration by, the University of South Alabama.

This manual may not be changed without the approval of the University of South Alabama Laser Safety Committee. This manual establishes specific procedures to be followed by all individuals at the University of South Alabama to assure that our laser safety program complies with the American National Standards Institute (ANSI) Z136.1 Standard for the Safe Use of Lasers. The ANSI Z136.1 Standard for the Safe Use of Lasers is the accepted safe and healthy work practice to use in inspecting laser facilities. In addition, standards for lasers used in a medical setting are based on ANSI Z136.3 Standard for the Safe Use of Lasers in Health Care Facilities.

It is also very important to understand that these rules were established primarily to protect all persons' health and safety. PROCEDURES IN THIS MANUAL SHALL BE FOLLOWED. Compliance with these procedures is the responsibility of all persons at the University of South Alabama. Violation of these procedures may result in the cessation of all laser related activities within your department.

If you do not understand any requirements outlined in this manual, assistance can be obtained by contacting our Laser Safety Officer, David Wiik at (251) 460-7063.

6-13-18
Date

Tony G. Waldrop, PhD
President
University of South Alabama

Applicability / Scope

This program applies to all lasers and laser systems operated under the authority of the University of South Alabama. This includes acquisition, manufacture, registration, use, monitoring, transfer, and disposal of lasers. The proper implementation of this program will ensure that laser exposures are always below the maximum permissible exposure (MPE) limits. The laser safety program applies to all persons: faculty, staff, students, vendors and visitors operating with or working in close proximity to lasers.

Laser Classifications

The laser's hazard class is very important in determining appropriate controls to make your laser use compliant with the standard. The Laser Safety Officer (LSO) must assure that all lasers are properly designated within their appropriate hazard class. All commercially manufactured lasers come marked with the hazard class as required under the FDA. All modified lasers must be evaluated by the LSO and appropriately classed. It is the responsibility of the Authorized Laser User to assist the LSO by supplying the appropriate radiometric parameters of the laser system.

The classes of lasers are as follows:

Class 1 laser systems are incapable of producing damaging radiation levels during normal operation and are exempt from any control measures. Class 1 laser products or devices contain embedded lasers of a higher class that are surrounded by protective housings to prevent laser radiation from escaping while the laser is energized. Those protective housings must be interlocked so as to prevent laser operation when removed or disturbed. Class 1 laser devices can produce laser hazards if operated with interlocks defeated. Only authorized service engineers may remove protective housings that shield the higher classed lasers inside if the system is registered as a Class 1 laser system at USA.

Class 1 laser products such as confocal microscopes and flow cytometers might contain Class 3B or higher lasers inside of their protective housings and are subject to rules in this manual. However, the only requirement is to simply register the equipment and notify us if the housing is modified. The owner/user must notify us of any transfer of ownership or location. If the class 1 device is transferred to the USA Property Office at end-of-life and is subject to auction, we must know the buyer's intentions and understanding of the equipment. If being sold as scrap, we must destroy the class 3B or higher laser inside.

Class 1M laser systems are incapable of producing hazardous exposure conditions during normal operation unless the beam is viewed with optical instruments.

Class 2 laser systems emit visible light only at a power level of 1 milliwatt or less. The normal aversion response to bright light is adequate protection. Forced staring into the beam of a class 2 laser is hazardous.

Class 2M laser systems emit visible light only. The normal aversion response to bright light is adequate protection for unaided viewing. However, viewing the beam of a Class 2M laser with optical aids like a magnifier is potentially hazardous.

Class 3R laser systems are potentially hazardous under some viewing conditions, but the probability of an actual injury is small, and the control measures for safe use are straightforward. (Most lasers previously classified as class 3a fall in this category.) Depending on power and beam area, they can be momentarily hazardous when directly viewed or when staring directly at the beam with an unaided eye. Risk of injury increases when viewed with optical aids.

Class 3B laser systems are eye hazards for intrabeam viewing and specular reflections, even for momentary exposures, but diffuse reflections are not usually hazardous. Class 3B laser systems shall be operated only in laser controlled areas by Authorized Laser Users or their designated Laser Users. Operators of class 3B laser systems shall receive approved laser safety training. A written Standard Operating Procedure (SOP) is required for class 3B laser operation.

Class 4 laser systems are eye, skin, and deeper tissue hazards for intrabeam exposures, specular reflections, and diffuse reflections. They are also fire hazards and may produce laser generated air contaminants. Class 4 laser systems shall be operated only in laser controlled areas by Authorized Laser Users or their designated Laser Users. Operators of class 4 laser systems shall receive approved laser safety training. A written Standard Operating Procedures (SOP) is required for class 4 laser operation.

If any laser has been altered or had safety controls defeated, it shall be brought to the attention of the LSO to determine safety requirements.

Roles / Responsibilities

Laser safety is the responsibility of all faculty, staff and students who are directly or indirectly involved in the use of lasers.

The Dean of the College of Medicine of the University of South Alabama appoints members to serve on the University of South Alabama Laser Safety Committee based on recommendation from the Radiation and Laser Safety Officer. Members are selected from among laser users to ensure representation for each type of laser application used at USA. Other members may include managers or safety staff. The Laser Safety Committee reports to the Radiation Safety Committee and is responsible for the review and approval of policies and practices regarding the acquisition, manufacture, registration, use, monitoring, transfer, and disposal of lasers at the University of South Alabama. The Laser Safety Committee shall meet twice a year. Four members shall constitute a quorum.

The responsibilities of the **University of South Alabama Laser Safety Committee** are to:

a. establish the laser safety policies and procedures to be employed at the University of South Alabama;
b. enforce the laser safety policies and procedures as outlined in the University of South Alabama Laser Safety Procedures Manual;
c. develop criteria to evaluate qualifications of all individuals working with lasers;
d. approve or disapprove applications for use of class 3B and class 4 lasers, which consist of a Laser Use Registration form combined with an in-depth Standard Operating Procedure (SOP) form, both of which can be obtained by calling the Radiation Safety Office at (251) 460-7063 or on our website at http://southalabama.edu/colleges/com/administration/radiation-safety.html ;
e. review compliance of Laser Use Authorizations;
f. comply with ANSI Z136.1 and ANSI Z16.3 for laser safety;
g. maintain records of the Committee actions and meetings;
h. review all new locations and modifications of existing locations where lasers are to be used;
i. maintain a laser safety training program dedicated to teaching the fundamentals of laser safety to all individuals working with lasers; and
j. review and approve or disapprove the qualifications of all individuals working with lasers.

The Committee shall have final authority in determining laser control measures and may approve alternate controls when appropriate.

Laser Safety issues found by the University of South Alabama's Radiation Safety Office are routinely communicated to the Authorized Laser User. If the Authorized Laser User's response is unsatisfactory, the department chairperson is included in the interaction. If the response remains unsatisfactory, cooperation is solicited from the appropriate Dean of the College under which the Authorized Laser User works. When routine procedures fail or in the instance of an emergency, the University of South Alabama Laser Safety Committee shall have direct access to the President of the University of South Alabama.

Laser Safety Officer

The Laser Safety Officer (LSO) shall have the responsibility and authority to ensure compliance with this program. The LSO shall:

a. ensure the proper classification of all lasers, including user modifications:
b. perform hazard evaluations for all class 3B and 4 lasers and laser work areas;
c. specify control measures for all class 3B and 4 lasers and ensure implementation;
d. approve procedures, SOPs, laser eyewear, protective equipment, signs and labels;
e. inspect laser eyewear and other equipment, for proper condition and function;
f. ensure that all laser personnel receive appropriate safety training;
g. maintain accurate inventory of class 3B and 4 lasers;
h. monitor the program and ensure compliance with safe practices; and
i. maintain program records for 5 years.

Class 3B and class 4 lasers shall be operated only with the written approval of the LSO. The LSO shall have the authority to terminate laser operations at any time.

Department Chairpersons

Department chairpersons are responsible for assuring that Authorized Laser Users utilizing lasers within their department operate those lasers in compliance with the laser safety program.

Laser Use Registration (LUR)

Anyone bringing a Class 2* or greater laser onto campus must submit a Laser Use Registration (LUR) form to the Radiation Safety Office. The LUR is the mechanism by which the USA Radiation Safety Office tracks lasers on campus. Handheld laser pointers will not be registered.

Laser Use Application (LUA)

A Laser Use Application (LUA) shall be completed by those seeking to use a Class 3B or 4 laser at The University of South Alabama and must be accompanied by a specific SOP.

Standard Operating Procedures

For lasers, standard operating procedures (SOPs) are required for all active Class 3B and 4 lasers. These SOPs must:

a. describe hazards and corresponding controls associated with the use of the laser;
b. describe procedures for: start up, shut-down, alignments, service, and maintenance;
c. describe safety precautions (stray beam/unwanted reflection checks, beam blocks, avoidance of the beam on a horizontal plane with the users eyes, beam enclosures, eyewear, hands-on training, etc.) to be followed;
d. describe how to respond in an emergency situation;
e. list laser protective eyewear requirements; and
f. be reviewed annually by all users.

Attach the Operator Review documentation to the SOP. The Operator Review must be signed by the Authorized Laser User and all Laser Users named on the permit (found on page five of the SOP). If the SOP changed since permitting or over the year, send a copy to the LSO. If new Laser Users were added, complete a new Laser Use Application (LUA) and forward to the LSO.

* Class 2 lasers other than handheld classroom laser pointers: We issue LURs for Class 2 open lasers used for teaching, alignment & demonstrations to simply inform us so that when concerned individuals report an unposted laser lab, we already have a record of the laser. This information is also of interest to some who want to know the number of lasers on campus (other than handheld pointers).

SOPs are to be reviewed and approved by the LSO and the Committee. A copy of the SOP should be available for review at all times. Authorized Laser Users and Laser Users should review their specific SOP annually or more often, if conditions change. An SOP form can be obtained by calling the Radiation Safety Office at (251) 460-7063 or on our website: http://southalabama.edu/colleges/com/administration/radiation-safety.html.

Laser Use Permit (LUP)

Anyone seeking to use a Class 3B or 4 laser within a lab at the University of South Alabama is required to submit a Laser Use Application (LUA) accompanied by an in-depth Standard Operation Procedure (SOP) form. The completed forms are sent to the LSO who contacts the person to discuss the laser system and application. After the LSO has evaluated the proposed LUA and SOP, the LSO presents it to the Laser Safety Committee for review. After review and approval of the LUA and SOP, a Laser Use Permit (LUP) is issued. The person, now called the **Authorized Laser User**, is notified and compliance with these laser safety procedures is verified prior to use. The LUP may be temporarily suspended by order of the LSO or Committee if they feel that the health or safety of a Laser User or the public is in immediate danger. The LSO maintains documentation of all changes to a LUP.

Any laser/laser system that is intended to be used on a human subject(s) experiment/ protocol is required to undergo additional review and approval by the USA Institutional Review Board (IRB).

Authorized Laser Users

Authorized Laser Users are directly responsible for implementing the laser safety program on their laser. This includes the implementation of specific hazard controls, oversight and management of non-laser hazards, and informing the LSO of any changes that affect the laser users. The Authorized Laser User shall have the responsibility and authority to ensure laser safety compliance for their personnel and equipment. The Authorized Laser User shall:

a. attend campus approved laser safety training program or provide prior training documentation;
b. ensure all lasers have been properly classified;
c. ensure proper registration of all lasers with the LSO by completing a Laser Use Registration form which can be obtained by calling the Radiation Safety Office at (251) 460-7063 or at http://southalabama.edu/colleges/com/administration/radiation-safety.html;
d. have direct accountability for all class 3B and 4 lasers and laser work areas;
e. implement approved control measures for all class 3B and 4 lasers;
f. generate SOPs for laser use and alignment, and submit to LSO;
g. ensure that all laser personnel receive appropriate safety training;
h. actively ensure lab practices are in compliance with safety requirements;
i. maintain records of laser purchases, use, transfer, and disposal; and
j. review the SOP annually.

Attach the Operator Review documentation to the SOP. The Operator Review must be signed by the Authorized Laser User and all Laser Users named on the permit (found on page five of the SOP). If the SOP changed since permitting or over the year, send a copy to the LSO. If new Laser Users were added, complete a new Laser Use Application (LUA) and forward to the LSO.

Laser Users

A Laser User works with lasers under a specific Authorized Laser User. All users must meet the laser safety training requirement prior to operating any Class 3B or Class 4 laser. All Laser Users are responsible for:

a. attending the campus approved laser safety training program or providing prior training documentation,
b. receiving appropriate hands on/on the job training,
c. understanding and signing documentation annually stating comprehension of lab specific laser Standard Operating Procedures (SOPs),
d. wearing appropriate Personal Protective Equipment (PPE) in accordance with the campus laser safety program requirements,
e. immediately reporting any suspected eye exposures to the Authorized User and LSO, and
f. reporting any safety concerns to the Authorize Laser User and/or LSO.

Visitors and Short-Term Researchers

It is the policy of the University of South Alabama to require the same level of laser laboratory safety for all visitors and short-term researchers as is required for Laser Users. All visitors and short-term researchers are to be escorted by a person whose name appears on the Laser Use Permit (LUP) as a Laser User. If it is necessary for a short-term researcher to work alone in the laser laboratory, the individual must be added to the LUP by submission of a Laser Use Application (LUA) by the Authorized Laser User. All Laser Users are required to meet the same level of laser safety training requirement as campus Laser Users. It is the responsibility of the Authorized Laser User to assure that the Laser Users in their facilities are informed of, understand, and follow this visitor policy. It is the responsibility of the visitor's Laser User escort to provide the visitor with an appropriate safety orientation covering the hazards in the laser laboratory. The escort shall also provide appropriate safety equipment and require the visitor to use the safety equipment.

Program Requirements / Procedures

Authorized Laser Users must notify the LSO of all Class 3B or Class 4 laser/laser system acquisitions, modifications, sales, or disposals.

Laser Safety Training Requirements

Initial & Refresher Training

All people seeking to use a Class 3B or 4 lasers are designated as "Laser Users" (including Authorized Laser Users) and are required to meet the campus laser safety training requirements by completing a campus approved laser safety training program or providing prior training documentation. Laser users can obtain course material and schedule to complete a test by calling the Radiation Safety Office (251) 460-7063. All laser users, including Authorized Laser Users, are required to retest every three years (from initial training).

Suspected Laser Incidents

Notification of laser injuries will be made to the Authorized Laser User and LSO by telephone as soon as practical, but not to exceed 24 hours from the time of the incident. Following a laser accident, the Authorized Laser User is responsible for filing a USA Incident Report by following the USA Incident Reporting Instructions preferably within 72 hours or as soon as possible after appropriate medical care is sought. Possible reimbursement for personal property damage or medical expenses is not authorized until the USA Incident report is completed and reviewed by Risk Management and the University Attorney's Office. The LSO is responsible for investigating laser incidents and maintaining records on incidents. After an incident, the laser system shall not be used until the LSO has reviewed the incident, approved corrective actions and approved the restart in writing.

USA Incident Report: https://jagasp.southalabama.edu/incident/logon.aspx

Incident report instructions:
https://www.southalabama.edu/departments/financialaffairs/riskmanagement/resources/Incident%20Reporting%20Instuctions.pdf

Baseline eye exams are no longer required since their medical and legal value has been shown to be of limited value according to ANSI Z136.1-2014. However, eye examinations shall be performed whenever a laser eye exposure is suspected.

Laser Safety Inspections

All laser facilities are inspected annually by the LSO or designee to assure that the lasers are operated in a safe manner. The LSO maintains records for 5 years of all inspections performed. If there is an imminent hazard, the LSO is authorized to stop the operation and will advise the Authorized Laser User and the Committee of this action. The Authorized Laser User is responsible to correct unsafe conditions in a timely manner. The LSO or their designee will re-inspect the laser facility to verify resolution of unsafe conditions. The LSO will inform the Committee if continued unsafe conditions exist and the Authorized Laser User will be asked to attend a Committee meeting to brief members on the issue.

Consequences of Non-Compliance

When problems are identified during an inspection of a laser or its method of operation, the LSO or designate will prepare a report detailing the issues(s) and recommended corrective action(s). All non-compliant items shall be corrected in a timely manner or as communicated in the report. The LSO or designate may either perform a follow-up inspection or request confirmation of compliance.

In the event of any serious violation or discovery of unsafe conditions, the LSO will bring the matter to the attention of the Authorized Laser User. The LSO may take action to prevent any imminent danger by stopping work. The LSO will inform the Committee after taking such action. The LSO may also refer the matter to the Committee to address.

Serious or chronic non-compliance issues can result in review by the Committee and may lead to restrictions, more frequent audits, additional training, or in severe cases, suspension or termination of the LUP.

If at any time the LSO is not satisfied with a user's safety and health practices, the project may be halted (with Committee approval) until corrections have been made. The LSO's action(s), other than stop work orders, may be appealed to the Committee.

Personal Protective Equipment (PPE)

The Authorized Laser User shall provide their laser users with the appropriate laser eye protection. See Appendix B for an eyewear selection guide. Appropriate laser eye protection must be used for beam alignments or anytime an open beam exceeds the ANSI Z136.1 maximum permissible exposure (MPE) value. The LUP will detail the MPE and the required minimum optical density (OD) for laser protective eyewear. The LSO should be consulted prior to purchasing any laser protective eyewear. Eyewear shall be inspected annually to ensure that the protection level has not degraded through use and beam exposure.

Some ultraviolet (UV) laser uses may require the use of skin protection. Any need for skin protection will be identified by the LSO and communicated to the Authorized Laser User. Additional PPE such as respirators, face shields, gloves, lab coats and hearing protection, etc. may be required whenever engineering controls cannot provide protection from harmful ancillary hazards and is warranted by the campus PPE criteria or policy.

Beam Management

Laser beam(s) must be restricted to the immediate location of use. Beam paths should be enclosed whenever practical. Beam stops/barriers must be used to terminate beams. The use of shutters, curtains, beam tubes, and other beam control devices are strongly encouraged. It is the responsibility of the Authorized Laser User and their Laser Users to verify through survey that appropriate beam management is being practiced.

Posting and Signs

All access points to the laser facility must be marked with an ANSI standard laser hazard warning signs. Laser enclosures must be labeled to alert users to laser hazards as per the ANSI standard. Labels, laser hazard signs, and advice on their use are available from the LSO. See Appendix C for the approved ANSI laser warning signs. New or renovated campus laser facilities will be required to meet the campus laser safety design requirements.

Access Control

Whenever a Class 3B or 4 laser is operated, access to the laser facility is restricted to Laser Users or persons escorted by Laser Users. Access control must be sustained by a positive means such as locked or interlocked doors. Laser warning signs alone are not considered sufficient to control access. For the entryway to Class 3B and Class 4 laser facility, a door blocking barrier such as a heavy screen or curtain shall be used to block, screen, or attenuate the laser radiation *inside* the door. The level of laser radiation at the exterior of these devices shall not exceed the applicable MPE, nor shall personnel experience any exposure above the MPE immediately upon entry. Appropriate PPE should be kept on the distal side of the barrier inside of the door and available prior to entry into the laser use area.

Substitution of Alternate Control Measures (Class 3B or 4)

The ANSI Z136.1 Laser Standard (4.2) provides the LSO authority to substitute control measures specified in the standard for Class 3B and Class 4 laser or laser systems with other procedural, administrative, or alternate engineering control measures which provide equivalent protection.

Administrative Control Measures for Class 3B and Class 4 lasers

The following administrative controls are used for Class 3B and 4 lasers:

Laser Class	Control Measures
Class 3B & 4	Limit access to laser users by a locked door when the laser beam is energized. Ensure current laser safety training for all users. Have Standard Operating Procedure on file and review them periodically. Perform and document stray beam/unwanted reflection checks. Establish a Nominal Hazard Zone (NHZ). Post an appropriate laser hazard warning sign. Provide appropriate laser eye protection to all occupants of the area. The LSO may require additional control measures as needed.

Engineering Control Measures for Class 3B and Class 4 lasers

The following engineered controls are used for Class 3B and 4 lasers:

Laser Class	Control Measures
Class 3B & 4	Use appropriate beam stops or attenuators and beam enclosures. Use an appropriate door blocking barrier (e.g. screen, curtain, etc.) to block, screen, or attenuate the laser radiation at the entryway. Cover or otherwise restrict all windows, doorways, open portals, etc., from an indoor facility to contain beams within the laser use area. Use a lighted "Laser On" sign outside the door that is either interlocked with the laser's low-voltage power circuit or switch operated from inside the room. The LSO may require additional control measures as needed

Record Keeping Requirements

The LSO will maintain all records or documents (paper and electronic) pertaining to the campus laser safety program for 5 years.

Non-Beam /Ancillary Hazards

It is important to consider and address other hazards associated with the use of lasers beyond eye or skin hazards. Non-beam hazards may include physical and chemical hazards. The LSO and/or Safety and Environmental Compliance Department (460-7070) should be contacted to evaluate any potential non-beam/ancillary hazard conditions. The appropriate USA safety policy shall be consulted and followed. If a policy for your situation isn't posted on the Department of Safety and Environmental website, consult them by calling the number above. A summary of the most prominent non-beam hazards include:

Electrical Hazards- Laser systems have power supplies that may require thousands of volts and tens of amperes to operate. The electrical needs associated with laser use present inherent electrical safety hazards. These hazards are normally mitigated by the engineering controls (enclosures, interlocks, grounding, etc.) built into the laser systems. However, if these engineering controls are defeated during tuning or maintenance, live contacts can be directly accessed. Touching them may cause any number of adverse bio-effects, up to and including death by electrocution. Work on electrical equipment can only be performed by qualified personnel. These personnel must be properly trained in electrical safety practices and procedures and must be approved by their department to work on electrical equipment. It is essential that you do not work on high voltage electrical connections to your equipment until you contact your department safety coordinator for specific information on your department's electrical safety policies and resources. For more information and assistance with high voltage connections, contact USA Renovations at (251) 460-7480 to discuss your electrical supply needs.

Collateral Radiation Hazards- Laser excitation systems and power supplies may produce hazardous collateral radiation of various types. These hazards are normally controlled by the equipment housings and are usually a problem only if the protective housings are removed. The laser excitation device may produce very intense UV/Visible/IR radiation that can be hazardous. Collateral ultraviolet radiation may injure both the eye and the skin if the exposure duration is long enough. Blue light presents a special hazard because of its ease of absorption by the retina and is thought to create photochemical injury. Exposure to any very intense visible light source can seriously degrade color vision and night vision capabilities. Exposure to these intense light sources should be carefully controlled or eliminated by leaving the housings in place. Laser power supplies capable of creating potentials greater than 15 kV peak may be a source of x-rays if they contain high voltage vacuum tubes. Electric discharge excitation sources in lasers may also be a source of low energy x-rays that are generally shielded by the equipment housings.

Toxic Lasing Media Hazards- Some laser dyes are considered mutagenic and carcinogenic. Halogen gases used in excimer lasers are powerful oxidizers and are toxic if inhaled. Solvents used for mixing dyes may be flammable, toxic, or present other health hazards. Safety Data Sheets (SDS) for dyes or solvents must be kept by the Authorized Laser User. Appropriate PPE (lab coat, disposable gloves, safety glasses or splash goggles, etc.) and a properly functioning chemical fume hood must be used when handling or mixing the dyes.

Compressed Gas and Cryogen Hazards- Compressed gas from a compressed gas cylinder is common in some laser laboratories. Compressed gas cylinders may present a kinetic energy hazard. High gas pressure translates into substantial potential energy stored in the cylinder. Uncontrolled pressure release (such as broken nozzle) might cause the cylinder to become an unguided missile. Compressed gas cylinders must be properly restrained to prevent damage to the nozzle or regulator. Leaking cylinders may present an asphyxiation hazard if ventilation is insufficient. Cryogens can cause burns and eye injuries from contact. Some lasers use either pure gases or gas mixtures as the lasing media. The gases themselves may present a variety of hazards if they leak from the cylinder. Depending on the gas, it may be toxic, corrosive, flammable, etc. Refer to the SDS (previously MSDS) for detailed information on the gas in question. If the hazards are sufficient, it may be necessary to provide a gas cabinet under negative pressure to control the hazard in the case of a leak. Inform your department safety contact if compressed gases are to be used in the laser facility.

Laser Generated Air Contaminates - The interaction of the laser beam with target materials may produce toxic dusts, vapors or gases. This is particularly true during material processing (welding, cutting, vapor deposition, etc.). Toxic products resulting from laser processing must be properly controlled through the use of adequate ventilation and filtration.

Noise - Some laser systems create significant levels of noise in the laboratory. If the noise level seems unpleasant or painful, contact your department safety contact to perform a noise survey.

Fire and Explosion Hazards – Some class 4 lasers can present fire hazards. Lasers operated in continuous wave mode with a beam power that exceeds ½ watt can ignite or cause off-gassing in combustible materials left in the beam path. Beam stops, barriers, and curtains used

with Class 4 lasers must be made of compatible, non-combustible materials. Explosion hazards in the laser lab include: the storage and use of flammable solvents and gases (both compressed and cryogenic), the implosion potential from dewars and excitation flash lamps. Proper storage and control of these sources should reduce the potential hazard.

Laser Applications Outside the Laboratory

Using a laser outside of a controlled area can present special hazards to the campus community and to the general public. These applications may include lasers used for telecommunications, laser research outdoors, and lasers used for entertainment or public viewing.

Prior to ANY outside laser usage for entertainment or public viewing, the Radiation Safety Office SHALL be notified at least 6 months prior to the event.

Appendix A

Laser Pointer Safety Guidelines

Applicability: All class 2 and class 3R laser pointers used for class room instruction or presentations shall be operated under the guidelines established in this document. Class 3B and Class 4 laser devices shall not be used in instruction or presentations.

A class 3R laser pointer (visible light) shall have a power output not to exceed 4.99 milliwatts. This range will not cause eye damage before the 100 ms autonomic blink reflex but may pose severe eye hazards when viewed through optical instruments like microscopes and binoculars. If the blink reflex is delayed longer than 250 ms, such as after general anesthesia, damage may occur. Divergence of a typical 3R laser pointer makes it almost harmless after 52 feet even without a blink reflex, but the risk is not zero.

The intended use of laser pointers carries a very low probability of injury. For this reason, the Laser Safety Committee approved Class 3R laser pointers for their intended purpose as instructional and presentation aids.

Labeling of Pointers: The FDA Center for Devices and Radiological Health requires manufacturers to provide correct labeling for their laser pointers. This includes the laser hazard symbol, laser classification, and maximum power output and laser wavelength. This information should be clearly visible on the laser pointer. The manufacturer should also provide operating and safety instructions.

Operating Safety Guidelines

No person should ever intentionally stare into a laser beam. A laser beam should never be intentionally directed toward oneself or directed toward another person. The beam should be directed towards the instructional subject and directed away from the audience. Mirror-like surfaces (such as glass, metal and other highly reflective materials) should be avoided when directing the laser beam. Indiscriminate use may present an eye hazard. Using a Class 3R laser pointer is prohibited in conjunction with optically aided viewing of the beam. Optical aids include telescopes, binoculars, viewing optics, and similar devices.

Directing any laser beam at another person may constitute assault (it suggests the use of a laser gunsight). Directing any laser beam at any moving vehicle is a felony offence. As the widened beam strikes glass it may cause extreme glare that interferes with the operator's vision and ability to avoid a crash. Aiming a laser at an aircraft is a felony offence that carries a maximum penalty of up to five years in federal prison and/or up to a $250,000 fine (for one count). The U.S. Coast Guard considers the act of directing a laser beam at a vessel on the water to be "interfering with the safe operation of a vessel" and could also result in federal prison and/or large monetary fines.

Emergencies

Although the potential for injury from a laser pointer in a classroom is very slight, notify your immediate supervisor and get medical attention if a laser eye injury is suspected. Also notify the Laser Safety Officer, David Wiik at (251) 460-7063 (251-554-4466 cell) as soon as practical.

Appendix B

Selection of Laser Safety Eyewear

Appropriate laser protective eyewear must be worn during beam alignments and anytime an open beam exists if the viewed beam exceeds the ANSI Z136.1 MPE (maximum permissible exposure) value. All eyewear must be labeled with the optical density and blocking wavelength.

Laser protective eyewear is usually not required for Class 2 or 3R lasers or laser systems unless viewed with certain optical aids.

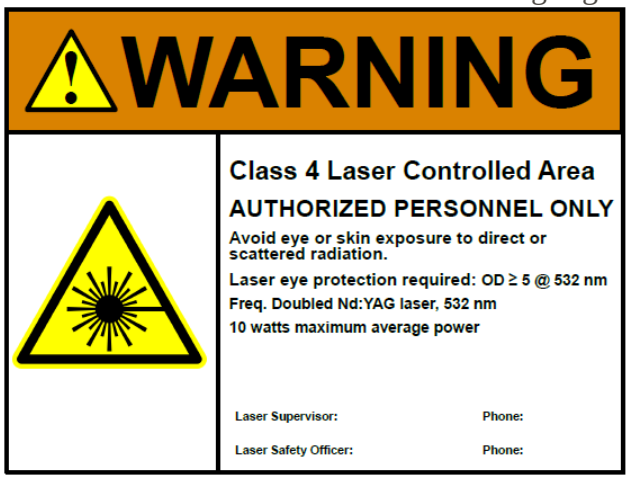
Factors to consider in selecting eyewear are:

a. laser power and/or pulse energy;
b. wavelength(s) of power output;
c. potential for multi-wavelength operations;
d. radiant exposure or irradiance levels for which protection (worst case) is required;
e. exposure time criteria;
f. maximum permissible exposure (MPE);
g. maximum optical density requirement of eyewear at laser output wavelengths for which it provides protection;
h. angular dependence of protection afforded;
i. visible light transmission requirement and assessment of the effectiveness of the eyewear on the ability to perform task while wearing the eyewear;
j. need for side-shield protection and maximum peripheral vision requirement;
k. side shields shall be considered and should be incorporated where appropriate;
l. need for prescription glasses;
m. comfort and fit;
n. degradation of filter media, such as photo-bleaching;
o. strength of materials (resistance to mechanical trauma and shock);
p. capability of the front surface to produce a hazardous specular reflection; and
q. requirement for anti-fogging design and coatings.

Laser protective eyewear should be inspected before each use for damage and cleanliness, and replaced if necessary. Contact the Laser Safety Officer at (251) 460-7063 for assistance in selecting eyewear.

Appendix C

Sample ANSI Z535.2 Compliant Caution Sign for Class 3B Laser Areas.
Class 3B Laser Controlled Area Warning Sign



Sample ANSI Z535.2 Compliant Warning Sign for Class 4 Laser Areas

Sample ANSI Z535.2 Compliant Danger Sign for Class 4 Laser Areas

Glossary

American National Standards Institute (ANSI) – The technical body which releases the Z136.1 Standard for the Safe Use of Lasers and Z136.3 Standard for Safe Use of Lasers in Health Care Facilities. The secretariat for the Z136.X standard series is the Laser Institute of America.

Authorized Laser User – a primary laser user who has been approved by the Laser Safety Committee to work with lasers at the University of South Alabama.

Average Power – The average power of a pulsed laser is the product of the energy per pulse (J/pulse) and the pulse repetition frequency (Hz or pulses/sec). The average power is expressed in watts (J/sec).

Aversion Response – Closure of the eyelid, eye movement, pupillary construction, or movement of the head to avoid an exposure to noxious or bright light stimulant. The aversion response to an exposure from a bright, visible, laser source is assumed to limit the exposure of a specific retinal area to 0.25 s or less.

Blink Reflex – The blink reflex is the involuntary closure of the eyes as the result of stimulation by an external event such as an irritation of the cornea or conjunctiva, a bright flash, the rapid approach of an object, an auditory stimulus or with facial movements. The ocular aversion response for a bright flash of light is assumed to limit the exposure of a specific retinal area to 0.25 s or less.

Coherent Radiation – Radiation whose waves are in-phase. Laser radiation is coherent and therefore very intense.

Continuous Wave (CW) – A term describing a laser that produces a continuous laser beam versus a pulsed laser beam.

Diffuse Reflection – A term describing reflective scattering in different directions thereby reducing beam intensity. A diffusely reflecting surface will have irregularities larger than the wavelength of the incident radiation beam.

Embedded Laser – An enclosed laser inside of a device. The laser has a higher classification than the laser system in which it is incorporated, where the system's lower classification is appropriate due to the engineering features limiting accessibility to the direct laser beam. Laser printers and CD players contain embedded lasers.

Incoherent Radiation – Radiation whose waves are not in-phase.

Intrabeam Viewing – The viewing condition whereby the eye is exposed to all or part of a laser beam.

Irradiance – The power being delivered over the area of the laser beam. Also called power density, irradiance applies to CW lasers and is expressed in W/cm2.

Laser – Light Amplification by Stimulated Emission of Radiation. A monochromatic, coherent beam of radiation not normally believed to exist in nature.

Laser Controlled Area (LCA) – An area where the occupancy and activity of those within is subject to control and supervision for the purpose of protection from laser radiation.

Laser User – A secondary laser user who works directly under an Authorized Laser User.

Laser Safety Procedures Manual – A document defining the University of South Alabama Laser Safety Program.

Laser Use Registration (LUR) form – The mechanism used by the USA Radiation Safety Office to track lasers on campus.

Laser Use Application (LUA) form – Must be completed by those seeking to use a Class 3B or 4 laser at The University of South Alabama and must be accompanied with a specific SOP.

Laser Use Permit (LUP) – A permit that allows the use of a specific laser by specific individuals, Authorized Laser Users and Laser Users, with a specific Standard Operating Procedure (SOP) within the University of South Alabama. The LUP details the safety requirements for each Class 3B and 4 laser.

Laser Safety Officer (LSO) – A member of the University of South Alabama Radiation Safety Office and Laser Safety Committee who is responsible for implementation of the Laser Safety Program.

Maximum Permissible Exposure (MPE) – The level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eye or skin.

Nominal Hazard Zone (NHZ) – The space within which the level of the direct, reflected, or scattered radiation may exceed the applicable MPE. Exposure levels beyond the boundary of the NHZ are below the appropriate MPE.

Optical Density (OD) – Also called transmission density, the optical density is the base ten logarithm of the reciprocal of the transmittance at a particular wavelength. $D(\lambda) = \log_{10}\left[\frac{1}{\tau(\lambda)}\right]$ where $\tau(\lambda)$ is the transmittance at a wavelength of interest. The symbol for optical density is $D(\lambda)$ or OD. (The OD of 2 = 1% transmittance)

Peak Power – The highest instantaneous power level in a pulse. The peak power is a function of the pulse duration. The shorter the pulse, the greater the peak power.

Radiant Exposure – The energy delivered throughout the laser beam's area. Also called energy density, radiant exposure applies to pulsed lasers and is expressed in J/cm^2.

Retinal Hazard Region – Optical radiation with wavelengths between 0.4 and 1.4 μm, where the principal hazard is usually to the retina.

Specular Reflection – Results when an incident radiation beam is reflected off a surface whose irregularities are smaller than the radiation wavelength. Specular reflections generally retain most of the power present in the incident beam. Exposure to specular reflections of laser beams is similar to intrabeam exposure.

Standard Operating Procedure (SOP) – Formal written description of the safety and administrative procedures to be followed in performing a specific task. For lasers, SOPs are required for all active Class 3B and 4 lasers. These procedures must include all safety precautions (beam blocks, eyewear, hands-on training, etc.) to be followed.

Ultraviolet (UV) Radiation – Invisible radiation with a wavelength between 10 nm and 400 nm. The near ultraviolet (UV-A) range is the 315 to 400 nm band, the mid ultraviolet (UV-B) range is the 280 to 315 nm band, the far ultraviolet (UV-C) range is the 100 nm to 280 nm band, and the extreme ultraviolet range is the 10 to 100 nm band. Note: Wavelengths below 200 nm are absorbed in the atmosphere and are known as the vacuum ultraviolet.

Visible Light – Radiation that can be detected by the human eye. These wavelengths are between 400 and 780 nm.

Emergency Contact Information

Laser Safety Officer
David Wiik

Radiation Safety Department
5795 USA Drive North, CSAB 338
Mobile, Alabama 36688
Department (251) 460-7063
Desk (251) 460-7776
Cell (251) 554-4466

Assistant Laser Safety Officer
Michelle Taylor

Radiation Safety Department
5795 USA Drive North, CSAB 334
Mobile, Alabama 36688
Office (251) 460-7063
Cell (251) 269-8077

For Non-Beam Hazards:
Department of Safety and Environmental Compliance
460-7070

USA Police Department:
460-6312

Authorized Laser User in this lab:

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