Research Safety
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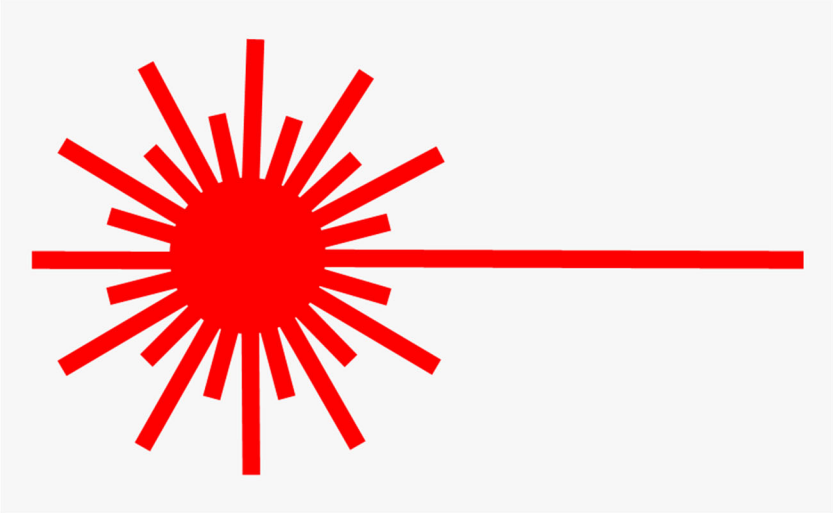
LASER SAFETY MANUAL



Laser Safety Program | 706-542-0526 | https://research.uga.edu/safety/laser

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PREPARED BY: **Brian P. Herndon** **DATE:** 12/14/2023
Safety & Compliance Officer

APPROVED BY: **Brandon H. Jordan** **DATE:** 12/14/2023
Senior Radiation Safety Officer

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INTRODUCTION TO LASER SAFETY MANUAL

This Laser Safety Manual was written to fulfill the purpose and achieve the objectives of UGA's Laser Safety Program, which are described in detail in chapter 1 of this manual. This manual applies to all students, staff, faculty, and visitors using lasers or laser systems on campus and is considered the primary reference and compliance document for the program. The manual is organized in such a way that follows the guidance in *Appendix A, Supplement to Section 1 – Laser Safety Programs* found within the ANSI Z136.1 Standards.

This manual and all other Laser Safety Program documents and information can be found at:

https://research.uga.edu/safety/laser

CHAPTER 1 LASER SAFETY PROGRAM

1.0 PURPOSE OF THE LASER SAFETY PROGRAM

The purpose of the University of Georgia's (UGA) Laser Safety Program (LS) is to protect faculty, staff, students, and visitors from potential hazards associated with laser usage. The program is designed to both comply with the State of Georgia laws governing the use of lasers found in §111-8-91-.01 through §111-8-91-.06 of the Georgia statutes as well as adhering to the widely accepted guidelines of the American National Standard for Safe Use of Lasers; ANSI Z136.1-2022.

1.1 OBJECTIVES OF THE LASER SAFETY PROGAM

The objectives of the Laser Safety Program are as follows:

1. To encourage responsible behaviors that will promote safe laser use on UGA's campus.
2. To follow ANSI Z136.1-2022 as a guideline for safe laser use and injury prevention.
3. To comply with the State of Georgia Rules and Regulations: § 111-8-91-.01 through § 111-8-91-.06.
4. To ensure timely registration and tracking of all new, relocated, transferred, or disposed lasers and reporting of major modifications of laser systems that may introduce new safety issues.
5. To ensure reporting of any exposure or injury due to laser radiation.
6. To ensure that basic laser safety training is accessible and that all personnel operating Class 3B and Class 4 lasers are adequately trained for the appropriate laser system.
7. To provide objective and reliable laser safety information and guidance to all laser users.
8. To encourage cooperation and networking among faculty, staff, researchers, students, and laser safety professionals.

1.2 ADMINISTRATION AND ORGANIZATION OF LASER SAFETY PROGRAM

The Laser Safety Program is administered through UGA's Radiation Safety Office (RSO) which is part of UGA's Office of Research Safety (ORS). The Office of Research Safety provides guidance to UGA faculty, staff, and students on the safe use of chemicals, radiation safety, laser safety, and strong magnetic fields. The program is committed to safety, health, environmental protection, and compliance based on current government regulations, guidelines, and best practices.

1.3 PURPOSE OF A LASER SAFETY OFFICER

The overall purpose of a Laser Safety Officer (LSO) is to have someone within an organization that has the authority and responsibility to affect the knowledgeable evaluation and control of laser hazards, and to monitor and enforce the control of such hazards. The LSO has the authority to suspend, restrict, or terminate the operation of a laser system if it is determined that laser hazard controls are inadequate or when users consistently fail to comply with the policies and rules set forth in this manual.

CHAPTER 2 RESPONSIBILITIES

2.0 INTRODUCTION

Though not comprehensive, outlined below are the primary responsibilities based on individual roles. The subsequent chapters of this manual provide further information and details on these responsibilities.

2.1 RESPONSIBILITIES UGA's LASER SAFETY OFFICER

(reference: ANSI Z136.1-2022, *Normative Appendix A1.2*)

1. Establish and maintain adequate policies and procedures for the control of laser hazards.
2. Classify or verify classifications of lasers and laser systems.
3. Perform hazard evaluation of laser work areas.
4. Ensure prescribed control measures are implemented and maintained in effect.
5. Ensure laser operators have access to laser manufacturer's manuals or other developed procedures.
6. Inspect protective equipment and assure proper working order.
7. Generate or approve signs and labels.
8. Review laser installations, facilities, equipment, and modifications prior to use.
9. Ensure adequate safety education and training are provided to laser personnel.
10. Provide accident medical guidance when necessary.
11. Ensure a records management system exists to support the program.
12. Periodically perform audits, surveys, or inspections.
13. Develop a plan to respond to notifications of incidents or suspected exposure to laser radiation.
14. Advise on laser systems operations.

2.2 RESPONSIBILITIES OF PRINCIPAL INVESTIGATORS AND LASER SUPERVISORS

(reference: ANSI Z136.1-2022, *Normative Appendix A3.1*)

1. Be responsible for the issuance of instructions or access to training materials on laser hazards to all personnel working with lasers within their jurisdiction.
2. Not permitting the operation of a laser unless there is adequate control of laser hazards.
3. Maintain records of individuals working with lasers and any information requested by the LSO.
4. Notifying the LSO immediately when becoming aware of a laser accident.
5. If necessary, assist in obtaining appropriate medical attention for anyone involved in a laser accident.
6. Do not permit operation of a new or modified Class 3B or Class 4 laser without LSO approval.
7. Notify LSO if any major modifications have been applied to any existing laser system.
8. Maintain maintenance records.

2.3 RESPONSIBILITIES OF INDIVIDUALS WORKING WITH LASERS

(reference: ANSI Z136.1-2022, *Normative Appendix A3.2*)

1. Do not work with or near a laser unless authorized to do so by the supervisor for that laser.
2. Comply with safety rules and procedures prescribed by the laser supervisor and the LSO.
3. When becoming aware of a laser accident, immediately notify supervisor or PI.

CHAPTER 3 REGULATIONS AND STANDARDS

3.0 OVERVIEW OF REGULATIONS AND STANDARDS

There are several regulations and standards that apply to lasers and their use on UGA's campuses. This chapter details those that are given priority for compliance and provides the core sources of information for this handbook.

3.1 ANSI Z136

The American National Standard for Safe Use of Lasers; ANSI Z136.1 is used as the primary guidance document for the development of UGA's Laser Safety Program. The following ANSI standards are also used as reference and guidance documents:

ANSI Z136.3: Safe Use of Lasers in Health Care (includes guidance for veterinarian medicine)
ANSI Z136.5: Safe Use of Lasers in Educational Institutions
ANSI Z136.8: Safe Use of Lasers in Research, Development, and Testing

The standards are periodically revised and updated as new information and experiences in the use of lasers are gained.

3.2 STATE OF GEORGIA RULES AND REGULATIONS

The State of Georgia Department of Community Health (DCH) has rules and regulations regarding registration, injury reporting, reporting of discontinuance of lasers, laser system exemptions, and definitions. The Rules and Regulations for Laser Radiation can be found in Georgia Statute: *§ 111-8-91.01 through § 111-8-91.06.* Pertinent information and details on how these rules apply to laser usage at UGA are described within this chapter.

Registration: *§ 111-8-91.02*

The rules and regulations in this section require that no person may acquire, possess, or operate a laser system without first registering the laser within 30 days after acquisition. All applications for registration shall be in writing, on forms provided by the Radiation Safety Office, to include the following:

1. Name and address of person possessing or operating the laser system.
2. Identification and type of the laser system.
3. Location of the laser system.
4. For continuous-wave lasers, the maximum power level at which the laser can be operated.
5. For pulse lasers, the maximum energy per pulse, pulse duration, and the maximum pulse repetition rate at which the laser can be operated.
6. The wavelength at which the laser can be operated.
7. Other pertinent information that may be required by the department to ascertain the identification, type, location, purpose, and operational characteristics of the laser system.

In order to comply with the Class 3B and Class 4 laser registration requirements, a Laser Registration Form has been created. The form can be found in Appendix A and on the Office of Research Safety's website.

Injury Reporting: ***§ 111-8-91.03***

'*Any person possessing or operating a laser system shall report, in writing, to the department within 15 days of detection of any injury to an individual, regardless of severity or extent, in the course of operating, handling, servicing, or manufacturing a laser system'*

Chapter 10 of this handbook goes into further details regarding accidents and injuries.

Report of Discontinuance: ***§ 111-8-91.04***

'Every person who has registered a laser system and who permanently discontinues the operation of, or permanently disposes of, the laser system shall notify the department, in writing, within thirty days of such action.'

Chapter 9 of this handbook goes into further details about this process.

Laser System Exempt from Registration ***§ 111-8-91.05***

'No person may be required to register a laser system which cannot be energized or which is in transit'.

Exemption status will be determined the Laser Safety Officer.

3.3 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

The IEC is a global organization that prepares and publishes international standards for all electronic and related technologies. The IEC document 60825-1 is the primary standard that outlines the safety of laser products and establishes protocols for determining laser classification at the manufacturing level. It's important to note that the standard labeling found on instruments (see examples below) is the primary determinant in how the laser is classified under UGA's program.

CHAPTER 4 CLASSIFICATION OF LASERS

4.0 PURPOSE OF LASER CLASSIFICTION

The purpose of laser classifications is to quickly understand the potential hazard of the laser system just by the classification without detailed knowledge of that laser. The classification system serves as a standardized means of hazard communications. The hazard class of a laser depends on wavelength(s) or wavelength range, the effective output energy or effective output power of the laser, and the corresponding accessible emission limit. Laser systems are classified at the manufacturer level through a product certification process administered by the International Electrotechnical Commission (IEC). *Refer to chapter 3 for pictures of standardized IEC labeling found campus lasers.*

Below are general characteristics for each laser class. Table 1 lists common examples of each laser type and associated products.

4.1 GENERAL CHARACTERISTICS OF EACH LASER CLASS

Class 1 Laser Systems: These systems are considered to be incapable of producing damaging radiation levels during operation and are exempt from any control measures. The most common example of a Class 1 laser system is one that has an embedded higher classified laser(s) that is completely enclosed within the system. Only during maintenance of the embedded lasers are control measures required.

Class 1M Laser Systems: These systems are considered to be incapable of producing damaging radiation levels during normal operation unless the beam is viewed with collecting optics. The only control measures are then to prevent potential hazards from any optically aided viewing which then may require eye protection.

Class 2 and Class 2M Laser Systems: These systems operate in the visible spectrum (400-700 nm) under very low power conditions of less than 1 mW. The eye protection control measure is considered the normal aversion response by an individual such as turning one's head or closing one's eyes.

Class 3R Laser Systems: These systems typically operate at power ranges of 1-5 mW and are potentially hazardous under some direct and specular reflection viewing conditions if the eye is appropriately focused and stable; but the probability of injury is small. These lasers will not pose either a fire hazard or diffuse reflection hazard.

Class 3B Laser Systems: These systems operate at power ranges between 5mW and 500 mW. They can operate in both the visible non-visible spectrum. Lasers may be hazardous under direct and specular reflection viewing conditions but are normally not a skin hazard, fire hazard, diffuse reflection hazard, nor a laser generated air contaminant (LGAC) production hazard. Various control measures are required, and these lasers must be registered with the Radiation Safety Office.

Class 4 Laser Systems: These systems typically operate at power ranges above 500mW and many can produce peak pulses at the femtoseconds (10^{-15}) unit. They are hazardous to both skin and eyes from direct beams, specular, and diffuse reflections. Various control measures are required, and these lasers must be registered with the Radiation Safety Office.

Class FDA	Class IEC	Laser Product Hazard	Product Examples
I	1, 1M	Considered non-hazardous. Hazard increases if viewed with optical aids, including magnifiers, binoculars, or telescopes.	• laser printers • CD players • DVD players
IIa, II	2, 2M	Hazard increases when viewed directly for long periods of time. Hazard increases if viewed with optical aids.	• bar code scanners
IIIa	3R	Depending on power and beam area, 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.	• laser pointers
IIIb	3B	Immediate skin hazard from direct beam and immediate eye hazard when viewed directly.	• laser light show projectors • industrial lasers • research lasers
IV	4	Immediate skin hazard and eye hazard from exposure to either the direct or reflected beam; may also present a fire hazard.	• laser light show projectors • industrial lasers • research lasers • medical device lasers for eye surgery or skin treatments

Source: US Food & Drug Administration website

CHAPTER 5 BEAM AND NON-BEAM HAZARDS

5.0 LASER HAZARDS

Lasers can pose health risks if used incorrectly or in a careless manner. Laser hazards can be a result of direct or reflected beam exposure or from ancillary sources. All precautions must be taken to prevent potentially dangerous exposures.

5.1 BEAM HAZARDS

Beam hazards are those from direct and indirect beam exposures which can result in damage to the eyes and skin. Although the skin is more susceptible to exposure due to a larger surface area, the eyes are more vulnerable to laser radiation. Biological effects due to laser radiation differ according to the exposure duration, irradiance, wavelength, or pulse duration. **NOTE**: Pulsed lasers pose a greater danger than continuous wave lasers. This is because the peak power is extremely high in short pulses. Lasers with pulses as short as femtoseconds (10^{-15}) are becoming increasingly available, reliable, more affordable, and more commonly found on campus.

There are several means to prevent exposure to laser radiation primarily based on engineering, procedural, and administrative controls; all of which will be covered in other sections of this handbook.

Eyes

The greatest hazard from laser radiation is damage to the eyes from intrabeam viewing, specular, or diffuse reflections. Structures susceptible to injury are the iris, cornea, lens, retina, and optic nerve. Eye exposure can result in temporary impairment, hemorrhaging, scarring, erythema, photokeratitis, retinal images and burns, cataracts, and corneal burns.

Skin

Laser radiation can induce multiple reflections in addition to being absorbed and transmitted into the skin due to the diverse composition of the skin structures. The extent of absorption is related to the wavelength, exposure duration, and location (to some extent). Lasers within certain wavelengths and peak power outputs can deeply penetrate the skin and cause thermal effects such as warmth, pain, swelling, whitening of the skin, or burns.

5.2 NON-BEAM HAZARDS

Non-beam hazards are those hazards not associated with direct human exposure to the laser beam. These hazards can be a result of: exposure of a material to a laser beam, components of the laser system, materials used to generate the laser beam, or where and how the laser system is used. Non-beam hazards can be life threatening in some cases, so control measures should be carried out and taken seriously.

Electrical Hazards

Shock and electrocution are the primary hazards associated with lasers and laser systems, especially those associated with high voltage power supplies. In order to avoid electrical hazards, care should be taken during servicing, testing, modification, maintenance, or any other activity that requires contact with energized components of the laser system. Electrical protection parameters, connection to the utilization system, and safety training should comply with OSHA, the National Electric Code (NEC), National Fire Protection Association (NFPA), and any other applicable state and local laws and regulations.

Fire/Explosion Hazards

Fires can result due to contact of a laser beam with lasing material, gases, materials used in generation of the laser beam, laser curtains, unprotected wire insulation, plastic tubing, and other materials. While Class 4 laser beams present the highest hazard potential for fire (irradiance exceeding 10 $W \cdot cm^{-2}$ or beam power above 0.5 W) Class 3B lasers may pose a hazard under some conditions.

High-pressure lamps, and capacitor banks of laser systems can pose explosion hazards in addition to laser target materials. When laser system components pose explosion hazards, they should be enclosed in housing that can withstand the maximum explosive pressure. Laser target materials and other elements should also be enclosed or shielded to protect workers when an explosion hazard exists.

Laser Generated Air Contaminants (LGAC's)

LGAC's are fumes, gases, vapors, or other particulates generated from a material coming into contact with a Class 3B or 4 laser beam. Composition of the LGAC's can vary and depend mainly on the material, gases present, and the beam irradiance. Welding may yield higher concentrations of LGAC's than cutting. Care should be given in medical or veterinarian applications of lasers due to hazards of vaporized tissue plumes that may release plasmas, cell and viral fragments.

Safety Data Sheets (SDSs) usually provide useful information on decomposition products of the material, but little information on the biological effects of the actual contaminant. A qualified safety officer should determine what contaminants might be present, their concentrations, effects, and the appropriate control measures that are needed.

Laser Dyes and Solvents

Several dyes that are used as lasing mediums are toxic, carcinogenic, or flammable. Caution must be taken when handling or preparing these chemicals, or operating dye lasers. Laser dyes should be prepared in a fume hood to prevent exposure. Dye pumps and reservoirs should be placed in a secondary containment unit to minimize the threat of leakage. SDSs shall be made available to all workers that may come into contact with these chemicals. Chapter 9 includes guidance on how to clean and rinse dye units and equipment prior to surplus or disposal.

Compressed Gases

There are risks of exposure to toxic chemicals as well as explosion hazards associated with use of pressure cylinders. UGA's Chemical and Laboratory Safety Manual provides guidance and rules regarding the proper way to safely use, handle, store, transport, and removed compressed gas cylinders.

Radiation

Collateral and plasma radiation (other than that associated with the laser beam itself) may be produced by system components or be generated when focused on a target. Ultraviolet, visible, infrared, microwave, X rays, and radio frequencies are all forms of radiation that may be emitted from the target or system components.

Noise

Noise levels from certain high intensity lasers or vacuum pumps may reach levels that require controls. Where potential for hearing loss is suspected, an industrial hygienist or one competent in audiometric testing should perform such testing. If the calculated dose exceeds the OSHA action level, a hearing conservation program must be employed.

CHAPTER 6 ADMINISTRATIVE CONTROLS

6.0 PURPOSE OF ADMINISTRATIVE CONTROLS

Administrative controls are necessary for any laser safety program. They contribute to consistency by establishing official policies, resources, and information that is conveyed and applied equally across campus. This chapter covers the primary administrative controls used in UGA's Laser Safety Program.

6.1 LASER SAFETY MANUAL

As stated in the introduction, this manual is the primary reference and compliance document for UGA's Laser Safety Program. It is an evolving document intended to be comprehensive but not expected to be all encompassing. Deviations from established policy or guidelines must be approved by the LSO. Routine review of this handbook will occur using both feedback from laser users, lessons learned, and new information that becomes available. Access to this manual shall be provided to all users whether in print or digital form.

6.2 TRAINING

Any student, staff, faculty, or visitor who will be operating lasers or will be routinely working in the Nominal Hazard Zone (NHZ) are considered 'laser workers' and are required to complete the three main training components for UGA's Laser Safety Program. Individuals who are observing or learning about laser operations in settings such as classrooms are exempt from needing to complete these training requirements. However, in these settings the practice of providing general or supplemental training is strongly encouraged.

1. All laser workers must read and familiarize themselves with UGA's Laser Safety Manual.
2. All laser workers must complete the Laser Safety Training Course found online in UGA's Professional Education Portal (PEP).
3. All laser workers must receive safety and operational training specific to lasers and the systems used in their work areas.

All laser workers must have a completed and signed *Laser Worker Certificate* prior to operation or exposure to laser radiation. The form must be completed and signed by both the worker and the PI. The form can be signed electronically or by hand and emailed to: *radiation-safety@uga.edu*
This form is available in Appendix A.
There is no requirement for a notification of completion of the online training module. The Office of Research Safety is capable of tracking training through PEP. See section 6.6 regarding record keeping of *Laser Worker Certificates.*

6.3 SIGNAGE

Danger and Warning signs must be posted on all doors that allow access to areas where individuals could be exposed to laser radiation above the MPE. The LSO is responsible for creating and placarding these and any other necessary hazard signs. Examples of applicable danger and warning signs are found in Appendix B.

6.4 HAZARD ASSESSMENTS

Prior to the operation of a new Class 3B or Class 4 laser, the LSO will conduct an initial hazard assessment which includes assessment of possible beam and non-beam hazards, determination of the maximum permissible exposure limit (MPE), necessary optical density (OD) values for safety glasses, and nominal hazard zones (NHZ's). If the laser or laser system has been modified, reclassification should be carried out and hazards reevaluated according to the maximum output available for intended use.

6.5 INSPECTIONS

All approved laser PIs, lasers, and laser laboratories on campus will be routinely inspected. Inspections will verify that the following requirements are being met:

- Inventory, both active and inactive.
    - New lasers have been properly registered with the Radiation Safety Office.
    - Lasers no longer in PI's possession have been properly disposed of via the Radiation Safety Office (or transferred to another PI) and a *Surplus or Transfer Form* was submitted.
- Uses of lasers are consistent with that described in current SOP or manufacturer manuals.
- Operational documents are readily available for reference;
- Protective equipment, as described in SOP, is present, in use, and in good condition.
- Copies of *Laser Worker Certificates* are current and complete, and no unauthorized use is permitted.
- Security of laser(s).
- Proper signage on entryways and/or inspection of operations of illuminated signs.

Upon scheduling your annual inspection, the Laser Safety Officer will send copies of a PIs current inventory, list of users, and any other information that needs verified as still current. The Radiation Safety Office asks that updates be completed prior to the inspection to expedite the inspection process.

6.6 RECORDS MANAGEMENT

Proper record keeping is a necessary function of any safety program and is a shared responsibility between the LSO and principal investigators. One goal of record keeping will be to keep as much of the management as possible in digital format which helps reduce demand on resources and campus spaces. Outlined are the primary records categories and the requirements set within.

<u>Inventory records</u>
Chapter 9 of this handbook goes into further details about inventory management and should be considered the primary source for inventory records; but in summary all records relating to registrations should be as current as possible but no further lapsed than those submitted during the last inspection. All records relating to transferring or disposal of lasers shall be kept for the duration of the PI's research activities with the University of Georgia.

<u>Inspection & Compliance records</u>
Inspections and reports are a necessary component of any safety program. All inspection and

compliance records generated from the LSO to principal investigators should be keep until the end of the Principal Investigator's permanent use of lasers for research or educational purposes. The purpose of keeping these records for this duration is to demonstrate patterns of compliance.

Training records

The specifics of laser safety training can be found in section 6.2. Copies of *Laser Worker Certificates* must be made available within the lab or through the PI for the last 3 completed calendar years or for any active laser user whose tenure precedes that timespan. Tracking online training records is the responsibility of the Radiation Safety Office and not of principal investigators.

As mentioned previously, any laser operator is free to include supplemental training within lab spaces, classrooms, or other locations. The same training records retention rules apply.

Injury and Accident Records

All records related to an injury, or an accident should be kept until the end of the Principal Investigator's permanent use of lasers for research or educational purposes. The Radiation Safety Office will keep injury and accident records permanently. Chapter 10 of this handbook covers accidents.

CHAPTER 7 PROCEDURAL CONTROLS

7.0 PURPOSE OF PROCEDURAL CONTROLS

Procedural controls allow for the standardization of guidance documents, routine maintenance schedule and protocols, PPE management, and other things that allow for consistency in research settings. These procedures are very important to help ensure continuity of operations since the rate of turnout within Universities is high due to graduation and early career advancements.

7.1 STANDARD OPERATING AND ALLIGNMENT PROCEDURES

Standard operating procedures (SOPs) are required whenever there is potential for exposure to hazardous levels of laser radiation and must easily be available and readily accessible. Laser manufacturer's manuals may be used as an SOP and must easily be available and readily accessible. The items below represent information that individuals routinely operating lasers should know and will be incorporated into the inspection process.

- Safety checks prior to powering on
- List and operation of all necessary personal protective equipment
- The process of powering and warming up the laser system
- How to manually shut down the unit and all associated automatic shutdown features
- Alignment protocols that utilize safety features such as attenuators (this can be a separate SOP)
- How to activate emergency warning signs or the posting of any temporary 'in use' signage
- Maintenance procedures (this can be a separate SOP)
- Physical and digital locations of UGA's Laser Safety Manual
- Contact information for principal investigators and laser supervisors

7.2 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment for laser use is required when administrative, procedural, and engineering controls are insufficient to prevent exposures above the MPE. A total hazard evaluation should be established by the registered user and LSO as to what hazards are present, NHZ's, necessary optical densities for eyewear, and any other equipment needed to provide adequate protection. Equipment should be selected to withstand direct or scattered beams, taking the damage threshold into account (should be greater than 10 seconds). Choices of personal protective equipment include but are not limited to eyewear, face shields, attenuating clothing, and gloves. All eyewear protection should be labeled with optical density (OD), wavelength, threshold limit, and exposure time where applicable.

7.3 MAINTENANCE

Principal investigators and laser supervisors should follow all manufacturer maintenance recommendations and requirements and have a system for maintenance tracking. Lack of proper maintenance may be considered a violation of UGA's Laser Safety Program.

7.4 LASER DYE HAZARDOUS MATERIALS PROTOCOLS

Some lasers operate by using dyes and solvents that are highly toxic. It is a requirement that both electronic and paper copies of Safety Data Sheets (SDS's) be kept for all lasing medium that is considered hazardous waste by the Environmental Protection Agency (EPA). Access to UGA's

MSDSonline portal can be found on UGA's Environmental Safety Division's (ESD) website.

Handling of these materials must include the following safety controls:

- All handling of dye lasing materials must be done inside a chemical fume hood.
- The material used for the waste storage container should be compatible with the waste dyes, solvents or other hazardous materials. Refer to SDS's for guidance.
- All equipment that contains or transports these hazardous materials must be handled and/or stored inside spill pans.

There are two necessary steps that must occur before the waste is removed from your lab.
One is that all waste containers must have a waste card generated through Chematix. Here are the steps to **Create a Waste Card in Chematix**:

1. Login to https://chematix.uga.edu using your UGA **MyID** and password.
2. Select the **Waste** tab
3. Click the **Create Waste Card** link
4. Choose the **Waste Card** type
5. Enter **all** general information requested (pH is optional) at the top of the page
6. Enter chemical constituents & percentages (if applicable) at the bottom of the page. Use the **Select Chemical** buttons to search for chemicals. The **Barcode** field should only be used if you selected the Pure Chemicals in Individual Containers option. Enter chemicals & percentages (please be as accurate as possible with percentages) until you reach 100% then click **Calculate** to verify. (Call 706-542-5801 for help with unknowns.)
7. Click **Generate Waste Card**
8. **Print** the Waste Card, **sign it**, and adhere it to the waste container **using a plastic pouch**. (Use a rubber band to attach the card to small containers.)
9. Be sure to see the next section on Submitting a Pickup Request when you are ready for a pickup.

The second step is to **Request a Lab Waste Pickup:**

1. Login to Chematix (https://chematix.uga.edu) using your UGA **MyID** and password
2. Select the **Waste** tab
3. Click the **Create Pickup Worksheet** link
4. Select the **lab location**—the available **Waste Cards** for that lab location will appear at the bottom of the page
5. Checkbox (or **Toggle** for all) Waste Cards to be picked up and click **Add Selections to Worksheet**
6. Be sure to add your alternate contact telephone number in the **Instructions** box
7. Click **Save & Submit for Pickup**

When applicable, compliance with all of these required protocols and policies will be evaluated during inspections.

CHAPTER 8 ENGINERRING CONTROLS

8.0 PURPOSE OF ENGINEERING CONTROLS

Engineering controls are physical or mechanical controls that are part of the laser itself or involve a change in the laser system that will reduce/control the hazard it poses and/or its classification. These controls should be the primary means of protection before administrative controls, procedural controls, and personal protective equipment. Engineering controls can include, but are not limited to: interlocks, shutters, alarms, substitution, process change/isolation, source modification, and ventilation. Most lasers engineering controls will be supplied by the manufacturer or designated by the registered user, Unit Safety Officer (USO), or the Laser Safety Officer (LSO).

8.1 TYPES OF ENGINEERING CONTROLS

Enclosed Beam Paths and Protective Housing

Enclosures should be used when possible. A laser or laser system with a fully enclosed beam path fulfills all requirements of protective housing and no further controls are necessary. When operation of a laser without protective housing becomes necessary, a hazard analysis may be necessary to assign appropriate control measures. Curtains, barriers, shrouds, and beam stops are some alternative controls to use with an open laser system.

Beam Height

The laser should be set at a height, angle, and direction that will minimize the chance of eye exposure to the beam. The laser beam should be set either below seated eye level or above standing eye level (avoid heights between 3.5 and 5.5 feet) when possible.

Restricted Access

Labs and areas containing lasers and laser equipment should have doors that can be shut and locked to avoid accidental exposure to hazardous levels of laser radiation or to prevent interruption of research operations. Doors should be locked and/or warning devices employed when the laser system is in use.

Interlocks

Safety interlocks are mechanisms that automatically stop the laser beam, often by either blocking electrical contact or with a beam shutter. Most Class 3B or 4 lasers that have access panels or removeable protective housings have interlocks built into them by the manufacturer. Additional interlock features may be necessary for some lasers based on hazard assessments. Interlocks should never be defeated during operation.

Lockout/Tagout

OSHA 1910.147 applies to lockout/tagout systems for controlling energy release. Lockout/tagout systems are an effective way of safeguarding against accidental start up of a machine or device. Lockout systems use locks to prevent access to the energy-isolating device, and tagout systems use securely fastened signs to warn against reenergizing the equipment. Tagout systems should only be used when lockout systems are not feasible.

Some devices that may be used are chains, locks, tags, wedges, key blocks, adapter pins, and self-locking fasteners. They should be attached in a manner that will hold the isolating device in an “off” position, and substantial enough to prevent inadvertent removal. Only the individual who applied the lockout/tagout device should remove it. The proper lockout procedure sequence for energy control should be followed from preparation for shutdown to device removal.

Lockout/tagout standards do not apply to work on cord and plug connected equipment where unplugging from the energy source will give the individual servicing the equipment exclusive control.

Warning Devices

Warning devices are one way of communicating the presence of a hazard through an audible or visual message. Laser warning signs should be posted at the exterior boundary or doorway entrance of a laser controlled area and should comply with either ANSI Z535 and/or IEC 60825 design. Activation of a visual, illuminated sign, and/or audible warning device can be coupled with emission of laser radiation to warn personnel in the area when the power supply is charged for operation. Sounds should be distinctive and clearly identifiable.

Equipment Labels

All laser equipment shall have appropriate and standardized warning labels, preferably the original from the manufacturer. Labeling requirements should be in accordance with the Federal Laser Products and Performance Standards (FLPPS). Both the housing and control panel should have labels if they are separated by more than two meters, or the housing is removable.

Beam Stops, Attenuators, and Beam Termination

Class 3B and 4 laser systems should be provided with permanently attached beam stops or attenuators to prevent laser radiation in excess of the MPE from escaping the system when output is not required (during warm up). Temporary beam stops can be used in some instances to reduce the level of laser radiation below the MPE.

A safe, fire-resistant, absorbing material with a low diffuse reflection should be used to terminate the beam path of high-power lasers. Backstops should be used behind mirrors to prevent transmission of laser light during alignment and use. Laser beams should never be directed at windows or doors.

Ventilation and Respiratory Protection

Hazardous vapors, smoke, fumes, and/or dusts can emanate from open cylinders, preparation of dyes and solvents, and LGAC's. Biological agents may also emanate from lasing of tissues. Adequate ventilation systems should be used when contaminants associated with laser use have potential to become hazardous or rise above the permissible exposure limit (PEL). Enclosed hoods should be used where possible, with capture velocity appropriate for the type of contaminants present (vapors, smoke, fumes, dusts).

CHAPTER 9 INVENTORY CONTROLS

9.0 IMPORTANCE OF LASER INVENTORY

It is the Principal Investigator's responsibility to ensure that all Class 3B and Class 4 lasers are registered with the Radiation Safety Office. This is not only a requirement by the State of Georgia regulations but helps ensure that the locations of these lasers are known so that proper health and safety protocols can be effective. Review of registrations and inventories will be part of the inspection process.

9.1 LASER REGISTRATION

The State of Georgia Department of Community Health (DCH) establishes registration requirements in Georgia Statute: *§ 111-8-91.02; Rules and Regulations for Laser Radiation*. Whether acquired new or transferred from elsewhere, all Class 3B & Class 4 lasers need to be registered within 30 days and prior to operation. The Georgia statute also requires re-registration of lasers at intervals determined by DCH. Verification of inventory and registrations will be a routine part of inspections and reviews.

In order to comply with the Class 3B and Class 4 laser registration requirements, a *Laser Registration Form* has been created. The form can be found in Appendix A and on the Laser Safety website.

9.2 LASER TRANSFERS

UGA's Office of Research Safety (ORS) will only allow transfers of operational lasers to and from other organizations; determined based on a review of the recipient by the LSO. Prior to any transfer, a *Surplus or Transfer Form* must be submitted to UGA's LSO. The form can be found in Appendix A and on the Laser Safety website.

All new lasers transferred to UGA must have a completed registration form prior to operation and within 30 days of acquisition.

9.3 LASER SURPLUSING

Due to liability, UGA does NOT allow surplus of an operational laser, therefore the LSO must have verification that laser producing equipment is disabled and inoperable prior to being picked up by UGA's Facility & Management Division. The recommended practice is to disable the unit so that it can no longer be powered up. This should be done by either cutting or removing all power cords. Prior to surplus, a *Surplus or Transfer Form* must be submitted. The form can be found in Appendix A and on the Laser Safety website.

CHAPTER 10 ACCIDENTS

10.0 RECORDS AND REPORTING

Any instance that requires either emergency or urgent care will need to submit a *Safety Incident and Reporting Form* found in Appendix B and on the Laser Safety website. The registered user must report any occupational injuries or illnesses resulting from laser use to the Laser Safety Office and Unit Safety Officer (if applicable) within 24 hours. The LSO recommends that incidences PIs deem "near misses" be reported for use as a learning mechanism.

EMERGENCY CARE

It is at the discretion of the injured and/or principal investigators and laser supervisors as to whether an occurrence or injury requires immediate medical attention. If an occurrence has occurred that is considered an emergency, then the individual should be given the option to go to the closest emergency room or preferred hospital; and by choice of vehicle or through the 911 system.

URGENT CARE

If the injured and/or principal investigators and laser supervisors determine that an occurrence or injury requires prompt, but non-emergency care medical attention, then one of the following options should be chosen.

If the incident occurs during business hours (8am-5pm), the injured should go to the Vision Clinic (VC) in University Health Center (UHC). The VC will conduct eye scans and other evaluations to determine the extent of the injury. The Vision Center will also help with the referral process for retinal or other eye specialists.

Address: University Health Center, 55 Carlton St., Athens, GA 30602. Vision Clinic is on 1st floor.

Phone: (706) 542-5617

If the injured is unable to visit the Vision Center, then Piedmont Hospital's Physicians Occupational Medicine provides many occupational health services including preliminary assessment on an individual's eye health. A doctor will then provide guidance and health recovery options. UGA's point of contact for this facility is Dr. Brian Forrester.

Address: 485 Hwy. 29 North, Athens, GA 30601 **Phone**: (706) 353-6000

INJURY INVESTIGATION

The purpose of injury investigation is to find the cause of an accident and prevent its reoccurrence. In the case of an accident or exposure that requires the care listed above, the registered user or unit safety officer shall be notified at once so that an investigation can be done promptly. The Laser Safety Officer should also be notified. The investigation should begin as soon as emergency procedures have been accomplished and the situation is under control. The accident scene should be isolated, evidence recorded, and witnesses interviewed to gather information about details leading to the accident.

APPENDIX A: FORMS

- *Laser Registration Form*
- *Surplus or Transfer Form*
- *Laser Worker Certificate*

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LASER REGISTRATION FORM

All lasers must be registered with the Office of Research Safety.
Please complete a form for each laser and submit to: **radiation-safety@uga.edu**

SECTION A: REGISTRATION INFORMATION			
Principal Investigator:		Department:	
Office Phone No:		E-mail address:	
Laser Manufacturer:		Model Number:	
Serial Number:		UGA Inventory#	
Building Name (Building #)		Room Number:	

SECTION B: LASER SPECIFICATIONS						
Laser Classification (Check One):	☐ Class 3B	☐ Class 4				
Lasing Medium(ex. – Diode,semi-conductor, Nd:YAG):						
Tunable Laser? (Check One)	☐ YES	☐ NO				
Wavelength(s) (nanometers):						
Beam Divergence (milliradians):		Beam Diameter (mm):				
Beam Type:	Continuous Wave ☐	Max. Power Output (W):		Scanning (Check One):	☐ YES ☐ NO	
	Pulsed ☐	Max. Joules per Pulse:		Pulse Repetition Frequency (Hz):		
	Q-Switched ☐	Pulse Width:		Min. Pulse Duration (nsec):		
	Other ☐					

SECTION C: LASER USAGE TYPE (***based on laser registration requirements for Georgia Dept. of Public Health***)

Check all that Apply:

Alignment ☐	Experimental ☐	Readers ☐
Communication ☐	Forensic ☐	Research ☐
Copying ☐	Instructional ☐	Other:
Demonstration ☐	Healing Arts ☐	Other:

COMMENTS

PI Signature: _____ Date: _____

LSO Signature: _____ Date: _____

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SURPLUS OR TRANSFER FORM

The status of all Class 3B and Class 4 lasers must be known by the Office of Research Safety. Please complete this form for each laser that is being surplused or transferred and submit to: radiation-safety@uga.edu *Additional guidance*: *Chapter 9 of the Laser Safety Manual.*

SECTION A: REGISTRATION INFORMATION			
Principal Investigator:		Department:	
Office Phone No:		E-mail address:	
Laser Manufacturer:		Model Number:	
Serial Number:		UGA Inventory#	
Building & (Building#):		Room Number:	

SECTION B: SURPLUS INFORMATION		
IMPORTANT: All lasers must be disabled and non-operational prior to surplus		
Has the laser been disabled so that it is no longer operational?	YES ☐	NO ☐
Has the registered laser been removed from inventory?	YES ☐	NO ☐
Date of inventory removal:		

SECTION C: INTERNAL TRANSFER INFORMATION		
Is laser being transferred to another individual within UGA?	YES ☐	NO ☐
Transferee Name:		
Transferee Department:		

IMPORTANT: If the laser is being transferred within UGA then recipient must complete a new Laser Registration Form

SECTION D: EXTERNAL TRANSFER INFORMATION		
Is laser being transferred to another individual outside of UGA?	YES ☐	NO ☐
Transferee Name:		
Transferee Organization:		
Name of Organization's Laser Safety Officer		

I

ADDITIONAL INFORMATION & COMMENTS

PI Signature: _____ Date: _____

LSO Signature: _____ Date: _____

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Laser Worker Certificate

I, the undersigned, have received training in the following subjects/items:

REQUIRED TRAINING

- ☐ I have been given a copy and/or have reviewed UGA's Laser Safety Manual located on UGA's laser safety website: **https://research.uga.edu/safety/laser/ .**
- ☐ I have completed UGA's Online Laser Safety Course located in PEP**.**

UGA LASER SAFETY PROGRAM KNOWLEDGE

- ☐ I have been shown where to access online information about UGA's Laser Safety Program and contact information for UGA's Laser Safety Officer (LSO) at: **https://research.uga.edu/safety/laser/ .**
- ☐ I have reviewed the responsibilities outlined for the LSO, Principal Investigators & Supervisors, and Individuals Working with Lasers.
- ☐ I know the course of action to take in case of an incident or suspected exposure to laser radiation.

HAZARDS

- ☐ I understand the biological effects for direct laser beam exposure.
- ☐ I understand the ancillary hazards associated with laser systems**.**

CONTROL MEASURES

- ☐ I have been shown the designated Nominal Hazard Zones for each laser system in my assigned work areas.
- ☐ I am aware where the appropriate eyewear protection for each laser system is stored.
- ☐ I have been shown how to safely operate all laser systems in my work areas including all engineering control measures used for each laser system.

Name (printed) _____

Name (signature) _____ **Date:** _____

Principal Investigator (printed) _____

Principal Investigator (signature) _____

Keep the original signed form in the lab and send a copy of signed form to:

radiation-safety@uga.edu

APPENDIX B: SIGNAGE

Below are examples of the two most common warning signs found on campus.