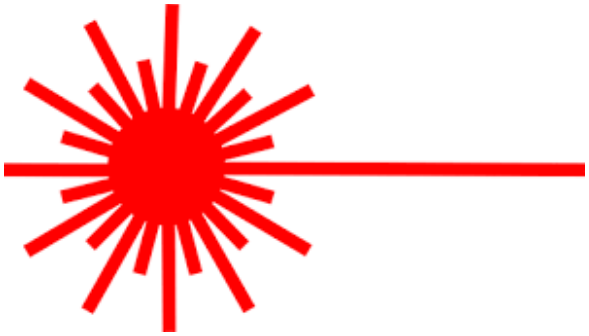
UNT | HEALTH SCIENCE CENTER

Laser Safety Manual



Developed in January 2017.

Revised in January 8, 2019

PURPOSE

It is essential that faculty, staff and students have enough information available to aid them in the safe conduct of their daily work activities relating to lasers and laser-producing devices. In view of this, the objective of The University of North Texas Health Science Center Laser Safety program is to assist all levels of management in fulfilling the university commitment to ensure safe working environment from laser hazards. Also, the Laser Safety Manual will assist both personnel and management in complying with the objectives of the Texas Department of State Health Services, Radiation Control regulations (25 TAC §289.301) and the UNTHSC Health and Safety Policies. This manual is not intended to be a fully comprehensive reference, rather a guide for registered users and other technically qualified individuals. Further advice concerning hazards associated with specific substances, devices and the development of new or unfamiliar activities should be obtained through consultation with the Radiation Safety Committee, the Radiation Safety Program.

Therefore, all users of lasers and laser-producing devices must be familiar with the requirements set forth in this manual and applicable regulations of the Texas Department of State Health Services Radiation Control, and must conduct their operations in accordance with them.

INTRODUCTION

LASER is an acronym for Light Amplification by Stimulated Emission of Radiation.

Laser is another form of radiation. The light energy generated by a laser is in or near the optical spectrum of light and amplified to extremely high intensity. This light energy is expressed as a laser's wavelength in nanometers (nm). The laser radiation is an intense, highly directional beam of light that can be directed, reflected, or focused on an object. The object will partially absorb the light, raising the temperature of the surface and/or interior of the object, and causing changes in the object. The primary mechanism of beam damage for most lasers therefore, is thermal. This is the primary hazard when using an infrared (IR) or visible laser. When the wavelength of the laser is in the ultraviolet (UV) region, then photochemical effects can occur in the object. The intensity of the radiation that may be emitted and the associated potential hazards depend upon the type and classification of laser, the wavelength of the energized beam, and the proposed uses of the laser system. The safe use of laser systems depends upon the basic principles of

recognition, evaluation, and control of potential hazards. This program will review laser operations, the associated potential hazards, responsibilities of the laser user community, and the services provided by the Radiation Safety Program to help in the safe use of laser radiation.

Classification

Lasers are divided into a number of classes depending upon the power or energy of the beam and the wavelength of the emitted radiation. Laser classification is based on the laser's potential for causing immediate injury to the eye or skin and/or potential for causing fires from direct exposure or reflection off diffuse and reflective surfaces. The various classes include: class 1, class 1B, class 2, and class 2M, class 3, class 3R, class 3B and Class 4 lasers. The class of concern in UNTHSC campus is class 3B and Class 4, because there are the class currently been used on this campus.

Class 3B - lasers are hazardous for direct eye exposure to the laser beam, but diffuse reflections are not usually hazardous (unless the laser is near the class limit and the diffuse reflection is viewed from a close distance). This subclass includes continuous wave (CW) or repetitive pulse lasers with a maximum average power of 0.5 W. The maximum pulse energy for a single pulse class 3B laser in the visible and near IR varies with the wavelength. For visible lasers the maximum pulse energy is 30mJ. It increases to 150 mJ per pulse in the wavelength range of 1050-1400 nm. For UV and the far Infrared (IR) the limit is 125 mJ. Class 3B lasers operating near the upper power or energy limit of the class may produce minor skin hazards. Most Class 3B lasers do not produce diffuse reflection hazards. However, single pulse visible or near IR class 3B lasers with ultra-short pulses can produce diffuse reflection hazards at more than a meter from the surface. Eye protection may be needed while the laser is operating. The Lasor Safety Officer (LSO) must perform a hazard analysis on the lab before operation of the laser.

Class 4 laser- any that exceeds the Annual Exposure Limit (AEL) of a Class 3 device. Class 4 lasers have an average power level greater than 0.5 W. The lower power limit for single pulse Class 4 lasers varies from 0.03 J for visible wavelengths to 0.15 J for some near IR wavelengths. These lasers are powerful enough to be a fire, skin, and diffuse reflection eye hazard. Class 4 lasers require the use of eye protection, facility interlocks, and special safeguards. The LSO must perform a hazard analysis on the lab before operation of the laser.

LASER REGISTRATION

The Principle Investigator is responsible for all safety precautions described in this manual that pertain to his/her laser systems. A Laser Registration Form must be completed and returned to the LSO for each Class 3B, and 4 laser systems. The use of Class 3B or 4 lasers in animals and/or humans requires the review and approval by the UNTHSC Radiation Safety Committee. Any changes in the use of the laser, laser location, and/or transfer of a laser require notification to the Radiation Safety Program. If you have any question about completing the laser registration form or any question about laser safety please contact the LSO by email maya.nair@unthsc.edu.

LASER HAZARDS

There are different types of hazard caused by laser. This includes:

Beam Hazards- Destruction of tissue can occur to the eye and skin. In the far-UV and far-IR regions of the optical spectrum, the cornea will absorb the laser energy and be damaged. In the near-UV region and near-IR at certain wavelengths the lens may be damaged. The greatest hazards are 400 - 1400 nm wavelengths which can damage the retina. Lasers below the visible spectrum (>1400 nm) are especially dangerous because the eye does not have a natural aversion at these wavelengths. Keep in mind that the light entering the eye from a collimated beam in the retinal hazard region is concentrated by a factor of 100,000 times when it strikes the retina. If the eye is not focused at a distance or if the laser light has been reflected off diffuse surfaces, this hazard is greatly diminished but can still be very dangerous.

Electrical Hazards- The most common hazard encountered in laser use is electric shock. Potentially lethal electrical hazards may be present especially in high powered laser systems. To reduce electrical hazards, high voltage sources and terminals must be enclosed unless the work area is restricted to qualified persons only. Whenever feasible, power must be turned off and all high-voltage points grounded before working on power supplies. Capacitors must be equipped with bleeder resistors, discharge devices, or automatic shorting devices.

Other general guidelines to follow include:

- Never wear jewelry when operating a laser. Metal jewelry can be conductive. Jewelry in general can create a specular reflection hazard. This includes wrist watches.
- Use the one hand rule when working on circuits (make sure not to ground yourself).
- Avoid standing in water and assume that all floors are conductive when working with high voltage.

- Use rubber gloves and insulating floor mats when available.
- Do not work alone.
- Maintain access to main power shutoff

Chemical, fire and compressed gases Hazards- Some material used in laser systems (excimer, dye, chemical lasers) may be hazardous or toxic substances. Also, laser-induced reactions may produce hazardous particles or gases around the laser system.

Solvents used in dye lasers may be extremely flammable. Ignition may occur via high voltage pulses or flash lamps. Direct beams and unforeseen specular reflections of high-powered CW infrared lasers are capable of igniting flammable materials during laser operation. Other potential fire hazards are electrical components and the flammability of Class IV laser beam enclosures. Many hazardous gases are used in lasers may be flammable. Existing protocols about the safety of chemical, fire and gases should be followed.

HAZARD CONTROLS

The hazard controls necessary for the safe use of laser radiation depends upon: The laser classification, the environment where the laser is used, the laser operating characteristics and the persons operating the laser.

Engineering control

Engineering controls are the priority means of minimizing the possibility of accidental exposures to laser hazards. If engineering controls are impractical or inadequate, then safety should be supported through the use of administrative procedures and personnel protective equipment. Engineering controls that may prove useful and effective in improving the safety of class 3B and 4 lasers or laser system are provided in the following list:

Access Restriction- For Class 3B and 4 laser laboratories, access controls are required to prevent unauthorized personnel from entering the area when the laser is in use. Doors must be kept closed when the laser is in operation. Secondary doors that can allow access to a laser in operation must be either locked or interlocked and must have signage similar to the primary entrance. Special cases will be reviewed by the LSO.

Area Control- Class 3B and 4 laser area control measures are used to minimize laser radiation hazards. The area must be posted with the appropriate signage and include a lighted

sign or indicator light at the doorway indicating the "ON" status of a laser system. Only authorized personnel who have been appropriately trained will be allowed to operate the laser.

Administrative control

Warning Signs and Labels- All signs and labels must comply with ANSIZ136.1 (2007) and the Food and Drug Administration Center for Devices and Radiological Health (FDA/CDRH) standards. Entry ways into laboratories containing Class 3B and 4 lasers shall be posted with a "Danger" sign. The signs shall include the type of laser, the emitted wavelength, maximum output, and class.

Personal Protective Equipment

Eye Protection- Eye protection is required for Class 3B and 4 lasers when engineering and administrative controls are inadequate to eliminate potential exposure. The use of laser protective eyewear is especially important during alignment procedures since most laser accidents occur during this process. Protective eyewear must be labeled with the absorption wavelengths and optical density (OD) rating at those wavelengths. The LSO may assist in determine the proper OD for protective eyewear.

Skin protection is required while working with 3b and 4 lasers too, therefore, the use of lab coat is essential. Moreover, a medical evaluation by a licensed practitioner may be done prior to work with Class 3B and 4 lasers, periodically, or after a suspected exposure to assess the health of the eye and potential eye damage and any health measures to alleviate the eye damage.

RESPONSIBILITIES OF THE PRINCIPAL OFFICER

It is important that the principal investigator to perform the following responsible for a safe laser use.

- Notify Radiation Safety officer immediately in the event of an exposure to a Class 3B or 4 laser.
- Register all lasers with LSO by completing a Laser Registration Form for each laser within the laboratory.
- Provide immediate supervision of laser use.
- Maintain an up-to-date list of all laser workers in the laboratory.
- Provide, implement, and enforce the safety recommendations and requirements described in this program.
- Provide appropriate laser safety eyewear if needed. Contact LSO for assistance in selecting appropriate eyewear.
- Maintain a written standard operating procedure (SOP) for laser use.
- Provide training in the administrative, alignment, and standard operating procedures for laser users.

- Attend laser safety training provided or coordinated by the LSO or able to show sufficient training documentation from other institutions.

LASER SAFETY EVALUATIONS

In order to assist and support the safety use of laser producing equipment at University of North Texas Health Science Center, the Radiation Safety Program will conducts routine audits of laser use activities. Radiation Safety Program staff perform routine audits evaluating emergency response information, postings and labels, facilities, records, laser handling and use, and laser safety training