THE UNIVERSITY OF TEXAS
RIO GRANDE VALLEY
LASER SAFETY MANUAL

August 2016

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A. Introduction

The Department of Environmental Health, Safety and Risk Management (EHSRM) has established a Laser Safety Program to provide controls and safety guidance to relevant research and educational activities involving lasers. This program is established to meet the requirements of Title 25, Texas Administrative Code, §289.301 (25 TAC §289.301) and prudent safety practice. If any conflict occurs between this Program and the Code, the latter shall prevail.

B. Definitions

The following words and terms, when used in this program, shall have the following meanings.

(1) **Accessible emission limit (AEL)** – the maximum accessible emission level permitted within a particular class.

(2) **Aperture** – an opening through which radiation can pass.

(3) **Apparent visual angle** – the angular subtends of the source as calculated from the source size and distance from the eye. It is not the beam divergence of the source.

(4) **Attenuation** – the decrease in the radiant flux of any optical beam as it passes through an absorbing or scattering medium.

(5) **Beam** – a collection of rays that may be parallel, divergent, or convergent.

(6) **Class I laser** – any laser that does not permit access during the operation to levels of laser radiation in excess of the accessible emission limits.

(7) **Class II laser** – any laser that permits human access during operation to levels of visible laser radiation in excess of the accessible emission limits contained in 25 TAC §289.301(cc)(1), but does not permit human access during operation to levels of laser radiation in excess of the accessible emission limits contained in 25 TAC §289.301(cc)(2).

(8) **Class IIIa laser** – any laser that permits human access during operation to levels of visible laser radiation in excess to the accessible emission limits contained in 25 TAC §289.301(cc)(2), but does not permit human access during operation to levels of laser radiation in excess of the accessible emission limits contained in 25 TAC §289.301(cc)(3).

(9) **Class IIIb laser** - any laser that permits human access during operation to levels of laser radiation in excess to the accessible emission limits contained in 25 TAC §289.301(cc)(3), but does not permit human access during operation to levels of laser radiation in excess of the accessible emission limits contained in 25 TAC §289.301(cc)(4).

(10) **Class IV laser** – any laser that permits human access during operation to levels of laser radiation in excess of the accessible emission limits contained in 25 TAC §289.301(cc)(4).

(11) **Collateral radiation** – any electromagnetic radiation, except laser radiation, emitted by a laser that is physically necessary for its operation.

(12) **Controlled area** – an area where the occupancy and activity of those within is subject to control and supervision by the registrant for the purpose of protection from radiation hazards.

(13) **Electromagnetic radiation** – the flow of energy consisting of orthogonally vibrating electric and magnetic fields lying transverse to the direction of propagation. X-ray, ultraviolet, visible, infrared, and radio waves occupy various portions of the electromagnetic spectrum and differ only in frequency, wavelength, or photon energy.

(14) **Electronic product** – any product or article defined as:
  (a) any manufactured or assembled product that, when in operation:
    (i) contains or acts as part of an electronic circuit; and
    (ii) emits, or in the absence of effective shielding or other controls would emit, electronic product radiation; or
  (b) any manufactured or assembled article that is intended for use as a component, part, or accessory of a product described in subparagraph (a) and that when in operation emits, or in the absence of effective shielding or other controls would emit, such radiation.

(15) **Entertainment laser** – any laser manufactured, designed, intended, or promoted for purposes of entertainment, advertising display, or artistic composition.

(16) **Infrared radiation** – electromagnetic radiation with wavelengths that lie within the range 700 nm to 1 mm.

(17) **Laser** – a device that produces an intense, coherent, directional beam of light by stimulating electronic or molecular transitions to lower energy levels. "Laser" is an acronym for light amplification by stimulated emission of radiation. The term "laser" also includes the assembly of electrical, mechanical, and optical components associated with the laser.

(18) **Laser product** – any manufactured product or assemblage of components that constitutes, incorporates, or is intended to incorporate a laser and is classified as a class I, II, IIIa, IIIb or IV laser product according to the performance standards set by the United States Food and Drug Administration (FDA). A laser that is intended for use as a component of an electronic product shall itself be considered a laser product. A laser product contains an enclosed laser with an assigned class number higher than the inherent capability of the laser in which it is incorporated and where the product's lower classification is appropriate due to the engineering features limiting accessible emission.

(19) **Laser safety officer** – an individual who has a knowledge of and the authority and responsibility to apply appropriate laser radiation protection rules, standards, and practices, and who must be specifically authorized on a certificate of laser registration.

(20) **Maximum permissible exposure (MPE)** – the level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin.

(21) **Protective housing** – an enclosure surrounding the laser that prevents access to laser radiation above the applicable MPE level. The aperture through which the useful beam is emitted is not part of the protective housing. The protective housing may enclose associated optics and a workstation and shall limit access to other associated radiant energy emissions and to electrical hazards associated with components and terminals.

(22) **Pulsed laser** – a laser that delivers its energy in the form of a single pulse or a train of pulses. The duration of a pulse is <0.25 seconds in a pulsed laser.

(23) **Service** – the performance of those procedures or adjustments described in the manufacturer's service instructions that may affect any aspect of the performance of the laser.

(24) **Source** – a laser or laser-illuminated reflecting surface.

(25) **Transmission** – passage of radiation through a medium.

(26) **Ultraviolet radiation** – electromagnetic radiation with wavelengths smaller than those of visible radiation; for the purpose of this manual 180 to 400 nm.

(27) **Visible radiation (light)** – electromagnetic radiation that can be detected by the human eye.

C. Applicability of 25 TAC §289.301

Classification of lasers will be in accordance with the latest version of the American National Standards Institute (ANSI) specifications, ANSI Z136.1. Each class IIIb or IV laser at the University of Texas Rio Grande Valley shall be registered with the State of Texas, and shall have a permit issued by the Laser Safety Officer. Each IIIa laser or lower class laser that is not a semiconductor laser should be permitted. Semiconductor lasers may be permitted, and should have positive location control. Arrays of semiconductor lasers shall be permitted. Lasers which are classified as IIIa or lower, but which contain a IIIb or IV laser, shall be controlled as the higher classification. Each Registrant shall be responsible for establishing and supporting laser safety for the permitted laser(s).

The following are exempt from the code:

(1) Lasers in transit or in storage incident to transit. This exemption does not apply to the providers of lasers.

(2) Inoperable lasers.

(3) Class I, class II, and class IIIa lasers or products.

(4) Class III mobile lasers are exempt from registration only if they are continuous wave (CW) in wavelength range of greater than 400 nm but less than or equal to 700 nm and have a peak radiant power of less than or equal to 5×10^3 watts.

D. Responsibilities

1. Laser Safety Officer

The Laser Safety Officer (LSO) oversees the daily activities regarding the safe use of lasers on the University of Texas Rio Grande Valley (UTRGV) campus. The LSO also serves as the liaison between the UTRGV and the Texas Department of Health.

The LSO is ultimately responsible for the following:

- Terminating any operations that are deemed laser radiation hazards.
- Performing periodic inspections of areas where lasers are stored and used.
- Notifying the UTRGV EHSRM when lasers are present on campus.
- Maintaining records of equipment surveys.
- Ensuring laser users receive the proper laser safety training.
- Specifying whether changes in control measures are needed following:
  - (a) any service or maintenance that may affect the output of power or operating characteristics; or
  - (b) whenever deliberate modifications are made that could change the laser class and affect the output power or operating characteristics.
- Ensuring maintenance and other practices required for safe operation of the laser(s) are performed.
- Ensuring personnel working with lasers use the proper personal protective equipment and other safety measures.
- Advising and assisting University personnel in matters of laser safety.
- Ensuring all lasers and their components are properly labeled.
- Preparing instructions that ensure adequate protection of University personnel in compliance with all state and federal regulations.
- Annually reviewing the UTRGV Laser Safety Program and revising the Program as needed to comply with all state and federal regulations.
- Providing overall administrative direction of the UTRGV Laser Safety Program.

2. Registrant

The registrant must comply with the conditions of their authorization and the Certificate(s) of Laser Registration. The Registrant is the person whose name appears on the permit for the laser with the Laser Safety Officer. Typically, this is the Principal Investigator (PI), and must be permanent faculty or staff member (Not a postdoc or graduate student). The Registrant may designate any of these responsibilities to a Laser Safety Supervisor.

The Registrant is responsible for:

- Providing instruction on safe and proper laser practices to all persons working within the facilities of the Registrant.
- Assuring that areas beyond the control of the Registrant are not affected by the use of any laser under their control.
- Providing necessary equipment, including protective eyewear, to work safely with lasers.
- Ensuring proper training in laser operation and safety.
- Classifying and labeling all lasers in the laboratory.
- Completing laser permitting with the LSO.
- Ensuring medical surveillance occurs, if required.
- Notifying the Laser Safety Officer (LSO) of any accident or abnormal incident involving or suspected of involving lasers.
- Complying with 25 TAC §289.301, the conditions of the UTRGV Certificate of Laser Registration, and policies of the Institutional Radiation Safety Committee (IRSC).
- Notify the LSO, in writing, within 30 days of a change in any of the following:
    - name and mailing address;
    - laser safety officer (LSO); or
    - name of facility contracted for “provider of services”, if applicable
- Submit an annual inventory of lasers possessed and used, including the purpose of laser.
- Notifying the LSO if a laser is decommissioned, sold, or transferred.

3. Laser Safety Supervisor

Each laboratory shall designate a Laser Safety Supervisor (LSS) and shall identify the LSS to the LSO. This person may be the Registrant or a delegate, but shall be a permanent full-time employee of the University. The LSS shall maintain the Laser Safety Program for the individual lasers in the laboratory, and may call on the LSO for assistance as needed.

4. Laser Operator/User

The laser operator or user is the person who sets up, aligns, and operates the laser, along with other assigned laser duties. The laser operator/user is responsible for:

- Following laboratory administrative, alignment, safety, and standard operating procedures while operating the laser.
- Keeping the Laser Safety Supervisor fully informed of any deviation from established safety procedures.
- Attending all training and medical surveillance activities that are required.

5. Institutional Radiation Safety Committee

The Laser Safety Program will be administered under the authority granted to the Institutional Radiation Safety Committee (IRSC) by the University President. The IRSC will have the authority to authorize, suspend, and/or specify conditions of use for all lasers at the University of Texas Rio Grande Valley (UTRGV).

In fulfilling this responsibility, the IRSC:

- Formulates general policy governing the use of lasers.
- Determines that all individuals authorized to use lasers have sufficient training and experience to enable them to perform their duties safely.
- Establishes a program to ensure that all individuals who may be required to work in the vicinity of lasers are properly instructed on all appropriate health and safety matters.
- Conducts an annual review of the UTRGV Laser Safety Program to determine that all activities are being conducted safely and in accordance with 25 TAC §289.301 and the conditions of the UTRGV Certificate(s) of Laser Registration.

6. Department of Environmental Health and Safety

The UTRGV EHSRM provides support to the UTRGV Laser Safety Program.

The EHSRM provides support by:

- Working closely with the LSO and the IRSC to ensure all precautions are taken to limit the exposure on individuals to lasers.
- Ensuring proper laboratory practices are followed.

E. Registration Information

1. General Registration

Each laser that is possessed, purchased, donated, or otherwise received by any person or entity at the University must have a permit. Application for the permit (Appendix I) must be tendered to the Laser Safety Officer (LSO) by the receiving party as soon as is practicable, but in no case longer than 10 days following receipt of the laser. The following information, at a minimum, must be provided with the permit application:

(a) The name and position of the applying Registrant, including department and contact information,
(b) The location of the laser,
(c) The manufacturer of the laser (If the laser is manufactured by University personnel, state as such),
(d) The model and serial number of the laser,
(e) The general type of laser (Dye, Gas, Solid State, Semiconductor, etc.),
(f) The specific type of laser active material,
(g) The operating wavelength(s) of the laser,
(h) The excitation mechanism (Optical, electrical, chemical, etc.),
(i) The time-dependent operating properties of the laser (CW, Pulse, Repetitively Pulsed, mode-locked, etc.),
(j) The minimum pulse duration, if the laser is a pulsed laser,
(k) The maximum pulse frequency per second,
(l) The maximum capable energy level of the laser in joules. This shall include any modifications which have been made to the equipment since its original manufacture or assembly,
(m) The beam diameter at the exit from the laser,
(n) The beam divergence, if known,
(o) The signature of the Department Chair.

Any request for exemption of a permit or waiver of these information requirements must be addressed by the LSO on a case-by-case basis. A petition, in writing, from the person who possesses the laser must be submitted to the LSO for consideration. Semiconductor lasers may be registered as an array. Class IIIb or IV semiconductor lasers must be individually permitted, and a means for tracking these lasers must be provided by the Registrant.

2. Use of Lasers on Humans or Animals

In addition to the general application requirements, each person having a laser for use in the healing arts (i.e. medicine), or for use on animals must submit an application to the Laser Safety Officer (LSO) within 30 days following the commencement of operation of that laser. An application for healing arts must be signed by a licensed practitioner of the healing arts. An application for veterinary medicine must be signed by a veterinarian. The signature of the administrator, president, or chief executive officer does not relieve the practitioner user or veterinarian user from complying with the requirements of this section.

If a person is furnished a laser by a provider of lasers, that person is responsible for ensuring that a licensed practitioner of the healing arts authorizes intentional exposure of laser radiation to humans.

3. Use of Lasers in Industrial, Academic, and Research and Development Institutions

In addition to the general application requirements, each applicant having a laser(s) for use in industrial, academic, and research and development institutions must submit an application to the Laser Safety Officer (LSO) within 30 days following the commencement of operation.

4. Alignment, Calibration, and/or Repair of a Laser

In addition to the general application requirements, each applicant shall apply for and receive a certificate of laser radiation for alignment, calibration, and/or repair before providing alignment, calibration, and/or repair of lasers.

5. Application for Laser Light Show

Each applicant must apply for and receive a certificate of laser registration for laser light show before beginning any show. Each applicant must submit the following:

(A) a valid variance issued from the Food and Drug Administration (FDA) for the laser intended to be used. The Registrant shall comply with the conditions of the FDA variance.

(B) a written notice of the laser light show to be performed in Texas. The information contained in BRC Form 301-3 shall be provided seven days prior to each show. If, in a specific case the seven working-day period would impose an undue hardship on the applicant, the applicant may, upon written request to the LSO, obtain permission to proceed sooner.

6. Mobile Services Used in the Healing Arts and Veterinary Arts

Each applicant shall apply for and receive a certificate of laser registration for mobile services before beginning to provide mobile services. In addition to the general application requirements, each applicant shall submit the address of the established main location where the laser, records, etc. will be maintained for inspection. This shall be a physical street address, not a post office box number. The application for mobile services of healing arts shall be signed by a licensed practitioner of the healing arts, and the application for mobile services for veterinary medicine shall be signed by a veterinarian.

7. Specific Terms and Conditions of Certificates of Laser Registration

Each person registered by the Laser Safety Officer (LSO) for laser use shall confine use and possession of the laser registered to the locations and purposes authorized in the certificate. No certificate of laser registration issued or granted shall be transferred, assigned, or in any manner disposed of, either voluntarily or involuntarily, to any person unless the LSO authorizes the transfer in writing.

8. Expiration of Certificates of Laser Registration

Each certificate of laser registration that specifies an expiration date expires at the end of the day on that date. Expiration of the certificate of laser registration does not relieve the registrant of the rules and regulations.

If a registrant does not submit an application for renewal, the registrant shall on or before the expiration date specified in the certificate of laser registration terminate use and/or services of laser(s).

9. Termination of Certificates of Laser Registration

Each registrant shall notify the LSO immediately in writing, and request termination of the certificate of laser registration when the registrant decides to terminate all activities involving lasers authorized under the certificate of laser registration. Along with the notification and request for termination of the certificate of laser registration, the registrant shall do the following:

(A) submit a record of disposal of lasers; and

(B) pay any outstanding fees in accordance with 25 TAC §289.204.

10. Renewal of Certificate of Registration

Application for renewal shall be filed in the same manner as the initial laser registration. If a registrant files an application in proper form before the existing certificate of laser registration expires, such existing certificate of laser registration shall not expire until the application status has been determined by the LSO.

11. Removal from Registration

Each laser, which is rendered permanently inoperative by disassembly or destruction, or which is removed from the University's control by gift, surplus designation, or transfer to a non-University entity, shall have information regarding condition or destination provided to the LSO not later than 10 days from its inoperative state or removal. If any researcher or faculty member should depart the University on a permanent basis while maintaining a laser permit, the departing person must provide disposition information to the LSO prior to departure.

F. Laser Safety Program Features

1. Standard Operating Procedures

Each laser must have a written Standard Operating Procedure (SOP). The SOP must be present at the operating console or control panel of the laser. The SOP shall include, at a minimum, operating instructions, safety eyewear parameters and instructions for proper use, interlock instructions, and a checklist for operation. The SOP must include clear warnings to avoid possible exposure to laser and collateral radiation. The SOP must be available for inspection by the Laser Safety Officer (LSO) or designate at any time.

2. Master Switch

Each class IV laser must have a master switch. This master switch shall be operated by a key, or by a coded access (such as a computer code). Each class IIIb should be provided with a key switch or coded access. Requests for exceptions to this requirement shall be considered by the LSO on a case-by-case basis.

3. Protective Housing

Each laser shall have a protective housing that prevents human access during the operation of the laser wherever and whenever such human access is not necessary in order for the laser to perform its intended function.

A. Safety Interlocks

(1) Each class IIIb and IV laser shall have a safety interlock on any portion of the protective housing that by design can be removed or displaced without the use of tools during normal operation or maintenance, and thereby allows access to radiation above Maximum Permissible Exposure (MPE) limits.

(2) Adjustment during operation, service, testing, or maintenance of a laser containing interlocks shall not cause the interlocks to become inoperative or the radiation to exceed MPE limits outside protective housing except where a laser controlled area is established.

(3) For pulsed lasers, interlocks shall be designed so as to prevent firing of the laser; for example, by dumping the stored energy into a dummy load.

(4) For continuous wavelength (CW) lasers, the interlocks shall turn off the power supply or interrupt the beam; for example, by means of shutters.

(5) An interlock shall not allow automatic accessibility of radiation emission above MPE limits when the interlock is closed.

(6) Either multiple safety interlocks or a means to preclude removal or displacement of the interlock portion of the protective housing upon interlock failure shall be provided, if a failure of a single interlock would allow the following:
    a. human access to levels of laser radiation in excess of the radiant power accessible emission limit of class IIIa laser radiation; or
    b. laser radiation in excess of the accessible emission limits of class II to be emitted directly through the opening created by removal or displacement of that portion of the protective housing.

4. Maximum Permissible Emission (MPE)

Each registrant or user of any laser shall not permit any individual to be exposed to levels of laser or collateral radiation higher than are specified below:

(A) Accessible emission limits for collateral radiation having wavelengths greater than or equal to 180 nm but less than or equal to 1 mm are identical to the accessible emission limits of class I laser radiation as determined from Figure: 25 TAC §289.301(cc)(1) for the appropriate wavelength(s) and emission duration.

(B) Accessible emission limit for collateral radiation within the x-ray range of wavelengths is 0.5 milliroentgen in an hour, averaged over an area of 10 square centimeters with no dimension greater than 5 centimeters.

5. Viewing Optics and Windows

All viewing ports, viewing optics, or display screens included as an integral part of an enclosed laser or laser shall incorporate suitable means to attenuate the laser and collateral radiation transmitted through the port to less than the MPE and the limits listed in Figure: 25 TAC 289.301(cc)(5), (6) & (7) under any conditions of operation of the laser. Optical systems such as lenses, telescopes, and microscopes may increase the hazard to the eye or the skin, the potential hazard and specific administrative procedures and the use of controls such as interlocks or filters shall be determined.

6. Warning Systems

Each class IIIB or IV laser shall provide visual or audible indication during the emission of accessible laser radiation. The indication shall occur prior to emission of radiation with sufficient time to allow appropriate action to avoid exposure. Any visual indication shall be visible through protective eyewear for the wavelength of the laser. If the laser and laser energy source are housed separately and can be operated at a separation distance of greater than two meters, both laser and laser energy source shall incorporate visual and audible indicators. The visual indicators shall be positioned so that viewing does not require human access to laser radiation in excess of the MPE.

7. Protective Eyewear

Each Registrant shall provide protective eyewear that meets the requirements of 25 TAC §289.301(t)(1). The eyewear shall be located where persons who operate the laser have unrestricted access to the eyewear. The eyewear shall be worn for alignment and operation where the laser beam is not enclosed. No person shall operate a class IIIb or IV laser without protective eyewear specific for the laser and the appropriate training for the specific eyewear.

Protective eyewear shall meet the following requirements:

- comfortable and appropriate fit all around the area of the eye,
- be in proper condition to ensure the optical filter(s) and holder provide the optical density or greater at the specific wavelength of the laser, and retain all protective properties during its use,
- be of optical density adequate for the laser energy involved,
- have the optical density or densities and associated wavelengths permanently labeled on the filters or eyewear,
- be examined, at intervals not to exceed 12 months, to ensure the reliability of the protective filters and integrity of the holders. Unreliable eyewear shall be discarded and replaced,
- the optical density of the protective eyewear shall be appropriate for the specific frequency and pulse length of the laser beam, and shall provide reduction of the incident energy to less than the MPE of the laser. It is important to include the pulse length and frequency of pulse repetition of pulsed lasers in selecting appropriate protective eyewear.

8. Skin protection

When exposure of skin to levels exceeding the skin MPE for the laser, persons in the controlled area shall wear appropriate clothing, gloves, and/or shields.

9. Controlled Areas and Posting

Each class IIIb and IV laser shall only be operated in a controlled area. A controlled area shall be established by the Registrant to limit access of personnel to laser radiation in excess of MPE limits or the limits listed in Figure: 25 TAC §289.301(cc)(5), (6) and (7). Each controlled area shall be posted conspicuously with signs as specified in Figure: 25 TAC §289.301(dd)(1) and (2). Access to the controlled area shall be restricted. For class IV indoor controlled areas, latches, interlocks, or other appropriate means shall be used to prevent unauthorized entry into controlled areas.

(A) Where safety latches or interlocks are not feasible or are inappropriate, for example during medical procedures, the following shall apply.

(1) All authorized personnel shall be trained in laser safety and appropriate personal protective equipment shall be provided upon entry.
(2) Access to the controlled area shall be controlled by a door, blocking barrier, screen, or curtains, which attenuates the laser radiation to below the MPE, and individuals who enter the controlled area shall not experience radiation above the MPE immediately upon entry.

(3) At the entryway there shall be a visible or audible signal indicating that the laser is energized and operating at class IV levels. A lighted laser warning sign, flashing light (visible through protective eyewear), and other appropriate signage are some methods to accomplish this requirement. Alternatively, an entryway warning light assembly may be interfaced to the laser in such a manner that one light will indicate when the laser is not operational (high voltage off) and by an additional light when the laser is powered up (high voltage applied, but no laser emission) and by an additional (flashing optional) light that activates when the laser is operating.

(B) For class IV indoor controlled areas, during tests requiring continuous operation, the individual in charge of the controlled area shall be permitted to momentarily override the safety interlocks to allow access to other authorized personnel if it is clearly evident that there is no optical radiation hazard at the point of entry and if necessary protective devices are being worn by the entering personnel.

(C) For class IV indoor controlled areas, optical paths (for example, windows) from an indoor facility shall be controlled in such a manner as to reduce the transmitted values of the laser radiation to levels at or below the appropriate ocular MPE and the limits listed in Figure: 25 TAC §289.301(cc)(5), (6) and (7). When the laser beam must exit the indoor controlled area (as in the case of exterior atmospheric beam paths), the operator shall be responsible for ensuring that air traffic is protected from any laser projecting into navigable air space or controlled ground space when the beam irradiance or radiant exposure is above the appropriate MPE and the limits listed in Figure: 25 TAC §289.301(cc)(5), (6) and (7).

(D) When the removal of panels or protective covers and/or overriding of interlocks becomes necessary, such as for servicing, testing, or maintenance, and accessible laser radiation exceeds the MPE and the limits listed in Figure: 25 TAC §289.301(cc)(5), (6) and (7), a temporary controlled area shall be established and posted.

10. Fiber Optic Transmission

Optical cables used for transmission of laser radiation shall be considered part of the laser protective housing. Disconnection of a fiber optic connector which results in access to radiation in excess of the MPE shall take place in a controlled area. Except for medical lasers whose manufacture has been approved by the Food and Drug Administration, the use of a tool shall be required for the disconnection of a connector for service and maintenance purposes when the connector is not within the secured enclosure. All connectors shall bear appropriate labels. Optical cables shall be encased in an opaque sleeve to prevent leakage of laser radiation in case of breakage.

11. Infrared Lasers

An infrared laser beam shall be terminated in a fire-resistant material. Inspection of the terminating material shall occur at regular intervals, and the inspection shall be recorded.

12. Magnification of Laser Beam

If at any time a laser beam is optically magnified or concentrated, special precautions shall be taken by the Registrant to prevent specular or diffuse reflection or other exposure greater than the maximum permissible emission (MPE) for the laser. The special precautions shall be documented in the Standard Operating Procedure for the laser.

13. Surveys

Each Registrant shall survey the laboratory containing the laser(s) for which the Registrant is responsible. The survey shall be performed using the Laboratory Laser Survey Form (Appendix II) at a minimum. The survey shall be performed quarterly at a minimum, and shall be performed prior to operating a laser for the first time after assembly, maintenance, or modification of the beam path, operating frequency, or power level. Survey records shall be retained for inspection by the Laser Safety Officer.

14. Miscellaneous Safety Issues

Persons working in a laboratory with multiple lasers shall be made aware of the various frequencies and other operating parameters by the laser operator/users. Persons working with any laser which is frequency doubled or frequency tripled shall be aware of the effect of frequency manipulation and shall choose protective eyewear which will provide protection for the effective frequency of the laser.

15. Training

Each person who operates or works with a class IIIb or IV laser shall complete training in laser safety provided by the University or Laser Safety Officer approved equivalent, and shall complete specific campus laser safety training. No person may work with or around a laser prior to completing this laser safety training.

G. Maximum Permissible Exposure Level and Nominal Hazard Zone

Each laser at the University shall have a determination of the Maximum Permissible Exposure (MPE) level performed and documented. The MPE is the level of laser radiation to which a person may be exposed without hazardous effects or adverse biological changes in the eye or skin.

Where applicable, in the presence of unclosed class IIIb and class IV beam paths, a Nominal Hazard Zone (NHZ) shall be established. The NHZ is the space within which the level of direct, reflected, or scattered radiation during operation exceeds the applicable MPE. Exposure levels outside the boundary of the NHZ are below the applicable MPE level. If the beam of an unclosed class IIIb or class IV laser is contained within a region by adequate control measures to protect personnel from exposure to levels of radiation above the appropriate MPE, that region may be considered to contain the NHZ. The NHZ may be determined by information supplied by the laser manufacturer, by measurement, or by using the appropriate laser range equation or other equivalent assessment. Class IIIb and IV lasers shall have the NHZ clearly marked. Registrants shall not allow persons to be exposed to levels of laser radiation exceeding the MPE.

H. Labeling and Posting of Lasers and Laser Facilities

Except as otherwise authorized by the Laser Safety Officer, signs, symbols, and labels stipulated in this section shall use the design and colors specified in Figure: 25 TAC §289.301(dd)(1) and (2).

1. Class IIIb lasers shall have a label and facilities shall be posted with a sign(s) with the warning that includes the following wording: "LASER RADIATION – AVOID DIRECT EXPOSURE TO BEAM. CLASS IIIb LASER (OR LASER PRODUCT)."

2. Class IV lasers and facilities shall have a label affixed and be posted with a sign(s) with the warning that includes the following wording: "LASER RADIATION – AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION. CLASS IV LASER (OR LASER PRODUCT)."

3. Lasers, except lasers used in the practice of medicine, shall have a label(s) in close proximity to each aperture through which is emitted accessible laser or collateral radiation in excess of the limits specified in Figure: 25 TAC §289.301 (cc)(5) with the following wording as applicable.

    A. "AVOID EXPOSURE – Laser radiation is emitted from this aperture," if the radiation emitted through such aperture is laser radiation.

    B. "AVOID EXPOSURE – Hazardous electromagnetic radiation is emitted from this aperture," if the radiation emitted through such aperture is collateral radiation.

    C. "AVOID EXPOSURE – Hazardous x-rays are emitted from this aperture," if the radiation emitted through such aperture is collateral x-ray radiation.

4. Each laser shall state, on the required warning logotype, the maximum output of laser radiation, pulse duration when appropriate, and the laser medium or emitted wavelength(s).

5. Each noninterlocked or defeatably interlocked portion of the protective housing or enclosure that is designed to be displaced or removed during normal operation or servicing, and that would permit human access to laser or collateral radiation, shall have labels as follows.

    A. For laser radiation in excess of the accessible emission limits of class IIIb, the wording: "DANGER – LASER RADIATION WHEN OPEN. AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION."
    B. For collateral radiation in excess of the emission limits:
        (1) the wording "CAUTION – HAZARDOUS ELECTROMAGNETIC RADIATION WHEN OPEN"; and
        (2) the wording "CAUTION – HAZARDOUS X-RAY RADIATION."
    C. For protective housing or enclosures that provide a defeatable interlock, the words "and interlock defeated" shall be included in the labels.

6. Other required information on labels and signs include:

    A. The word "invisible" shall immediately precede the word "radiation" on labels and signs required by this section for wavelengths of laser and collateral radiation that are outside of the range of 400 to 700 nm.
    B. The words "visible and invisible" shall immediately precede the word "radiation" on labels and signs required by this section for wavelengths of laser and collateral radiation that are both within and outside the range of 400 to 700 nm.

All labels required by this section shall be clearly visible, legible, and permanently attached to the laser and the facility itself.

I. Miscellaneous

1. Non-Radiation Hazards

It is the responsibility of the Principle Investigator, as part of the nominal hazard zone (NHZ) and maximum permissible emission (MPE) determination, to conduct an evaluation of the non-radiation hazards. This evaluation shall include electrocution, chemical, cutting edge, compressed gases, noise, confining space, fire, explosion, ventilation, and physical safety hazards. The evaluation shall be placed with the laser's documentation and be available for review.

2. Manufacturing and Construction of Lasers

Each laser which is manufactured from components for formal transfer to an entity outside the University shall meet U.S. Food and Drug Administration requirements per 21 CFR Part 1040, Federal Laser Product Performance Standard. A laser which is manufactured or assembled for internal University use, or which is designed for specific temporary use at another entity with express intent to return the laser directly to the University, is exempt from this requirement.

J. Incident Reporting

1. Reporting an Injury

Each Registrant shall immediately seek appropriate medical attention for the injured individual and notify the Laser Safety Officer (LSO) by telephone of any exposure injury involving a laser possessed by the University, other than intentional exposure of patients for medical purposes, that has or may have caused:

A. an injury to an individual that involves the partial or total loss of sight in either eye; or
B. an injury to an individual that involves perforation of the skin or other serious Injury exclusive of eye injury.

Each Registrant shall, within 24 hours of discovery of an injury, report to the LSO each injury involving any laser possessed by the University, other than intentional exposure of patients for medical purposes, that may have caused, or threatens to cause, an exposure to an individual with second or third-degree burns to the skin or potential injury and partial loss of sight. Each Registrant shall make a report in writing, or by electronic mail, within 1 week to the LSO of any injury required to be reported. Each report shall include the following:

A. the extent of injury to individual(s) to laser radiation;
B. power output of laser involved;
C. the cause of the injury; and
D. corrective steps taken or planned to be taken to prevent a recurrence.

Any report filed with the LSO shall include the full name of each individual injured and a description of the injury, which should be written on a separate part of the report. It is also the responsibility of the Registrant to notify the individual involved in the injury that the report has been filed. This should be done at the time or before the report is filed. Records of the incident shall be maintained by the laboratory.

2. Medical Event

A medical event is defined as any adverse patient health effect that is a result of failure or misuse of a laser safety equipment. When a medical event occurs, the registrant shall promptly investigate its cause and make a record for the LSO to review.

The registrant shall notify the LSO, by telephone or electronic means, within 24 hours of any injury to or death of a patient. Within 30 days after a 24-hour notification is made, the registrant shall submit a written report to the LSO of the event. The written report shall include the following:

A. the registrant's name;
B. a brief description of the event;
C. the effect on the patient;
D. the action taken to prevent recurrence; and
E. whether the registrant informed the patient or the patient's responsible relative or guardian.

K. Recordkeeping

Records of surveys, medical examinations, training, and other laboratory-specific information shall be maintained in the laboratory, and shall be available for inspection/review by the Laser Safety Officer at any time. Records shall be maintained for a period of not less than 5 years after the record date.

Record Type	Required Time Interval
Eye protection	5 years
Measurements and instrumentation	5 years
Notification of injury other than a medical event	5 years
Report of injury	5 years
Medical event	5 years