Laser Safety Manual
The University of Texas at El Paso

Revised February 2007

Introduction

The University of Texas at El Paso (The University) 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 25 Texas Administrative Code 289.301 and prudent safety practice. If any conflict occurs between this Program and the Code, the latter shall prevail.

Additional Guidance documents are available from ANSI (American National Standards Institute)

Safe Use of Lasers (Z-136.1)
Safe Use of Optical Fiber…Diodes…LEDs (Z-136.2)
Safe Use of Lasers in Health Care Facilities (Z-136.3)

1.0 Organization and Authority

The Laser Safety Program shall be administered under the authority granted to the Environmental Health and Safety Office by the President of The University. EH&S shall have the authority to authorize, suspend, and specify conditions of use of all lasers at facilities of, and areas of administration by, The University of Texas at El Paso.

2.0 Laser Safety Officer

EH&S under authority of the President shall appoint a Laser Safety Officer (LSO) per requirements of the Code, and shall delegate such authority to the LSO as is required to administer specific provisions of the Program. The LSO shall be provided with administrative support and adequate resources as are required to carry out the provisions of the Program. The LSO shall report to the Director of EH&S on a regular basis with material information about the operation of the Program as required by EH&S. The LSO may appoint Deputy LSOs as the LSO deems necessary to assist with execution of the Program. Deputy LSOs shall have such authority as is delegated by the LSO to ensure provisions of the Program are successfully carried out. The LSO or Deputy LSO shall have the authority to institute corrective actions including shutdown of laser operations when necessary due to unsafe conditions.

3.0 Classification and Registration

Classification of lasers shall be in accordance with US Food and Drug Administration (FDA) or American National Standards Institute specification ANSI Z136.1, of the latest version. Each laser at The University of Texas at El Paso of Class IIIb or IV shall be registered with the State, and shall have a Permit issued by the LSO (Permitted). Each IIIa laser or lower class laser may be Permitted, and should have positive location control, sufficient to prevent unauthorized removal from the controlled location. Arrays of semiconductor lasers shall be Permitted if the cumulative power meets or exceeds Class IIIa limits. Lasers which are classified as IIIa or lower, but which contain a IIIb or IV laser, shall be controlled as the higher classification if the Class IIIb or IV laser is accessed. Each Permittee shall be responsible for establishing and supporting laser safety for all their lasers.

3.1 Registration Information

Each laser which is possessed, purchased, donated, or otherwise received by any person or entity at The University shall have a Permit. Application for the Permit shall be tendered to the LSO by the receiving party as soon as is practicable, **but in no case longer than 10 days following receipt of the laser**.

A Laser Permit Application (Form Laser1) is provided as an attachment to this document. Information which shall be provided with the Permit application information shall include at a minimum (See Form Laser1):

The name and position of the applying Permittee, including department and contact information.
The name and position of the Laboratory Laser Safety Supervisor (LSS) if different from the Permittee.
The location of the laser, with room number or lab and a drawing if required.
The manufacturer of the laser. (If the laser is manufactured by University personnel, state as such).
The model and serial number of the laser.
The general type of laser (Dye, gas, solid state, semiconductor, etc.).
The specific type of laser active material.
The operating wavelength(s) or wavelength range (nm) of the laser.
The excitation mechanism (optical, electrical, chemical, etc.).
The time-dependent operating properties of the laser (CW, pulse, repetitively pulsed, mode-locked, etc.).
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.
If the laser is a pulsed laser:
The minimum pulse duration if the laser is a pulsed laser.
The maximum pulse frequency per second.
The maximum capable energy of the laser in Joules.
The beam diameter at the exit from the laser.
The beam divergence, if known.
The designated controlled area for laser operation (add sketch if useful)
The method of safety compliance expected (interlocks, enclosure, etc.)
The signature of the Department Chair.
Other information. This should include a brief description of the purpose of the laser (Doppler measurements, fluorescence, etc.), frequency of use, expected primary users, etc. Include any information which may have a bearing on safety related issues.

Any request for exemption of a Permit or waiver of these information requirements shall be addressed by the LSO on a case-by-case basis upon petition in writing from the person who possesses the laser. Semiconductor lasers may be registered as an array. Class IIIb or IV semiconductor lasers must be individually Permitted, and a means for controlling the location of and access to these lasers must be provided. The Permittee shall provide a means for controlling the location and owner of the laser if changed from original permit.

3.2 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**. The Permittee shall provide disposition information to the University LSO prior to leaving The University.

3.3 Manufacture/Construction

(Reference) 25 TAC 289.301(b)(2)

Each laser which is manufactured from components for formal transfer to an entity outside The University shall meet US 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.

4.0 Laboratory Personnel

4.1 Permittee

The Permittee is the person whose name appears on the Permit for the laser with the Laser Safety Officer. Typically, this is the Principal Investigator, must be permanent faculty or staff (Not a postdoc, not a graduate student). The Permittee is responsible for:

a) Laser Safety in the laboratory
b) Ensuring the availability of correct protective eyewear (See Section 6.5)
c) Providing a Standard Operating Procedure (See Section 6.1)
d) Providing, implementing, and enforcing the Laser Safety Program specific to the laboratory/laser
e) Ensuring proper training in laser operation and safety
f) Classifying and labeling all lasers in the laboratory
g) Completing laser Permitting with the LSO
h) Notifying the University LSO immediately if an exposure incident occurs
i) Notifying the University LSO if a laser is decommissioned, sold, or transferred.

The Permittee may designate any of these responsibilities to a laboratory Laser Safety Supervisor.

4.2 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 Permittee or a delegate, but shall be a budgeted employee (Staff or faculty, not a graduate student or postdoctoral worker) 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. The LSS assumes control and has the authority to institute corrective actions including shutdown of laser operations when necessary due to unsafe conditions.

4.3 Laser Operator or User

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

a) Following laboratory administrative, alignment, safety, and standard operating procedures while operating the laser
b) Keeping the Laser Safety Supervisor fully informed of any departure from established safety procedures
c) Attending such training and Medical surveillance activities as are required.

5.0 Maximum Permissible Exposure and Nominal Hazard Zone
(Reference) 25 TAC 289.301(d)(43&45), 25 TAC 289.301(u)

For all open beam class IIIb and IV lasers the MPE will be assumed to be exceeded and appropriate precautions taken. The NHZ (nominal hazard zone) will therefore comprise the enclosure (room or area the beam is restricted to by virtue of walls, curtains or other barriers) in which the laser(s) is operating. The Laboratory Safety Supervisor may for specific conditions determine the NHZ by using information supplied by the laser manufacturer, by measurement, or by using the appropriate laser range equation or other equivalent assessment. Permittees shall not allow persons to be exposed to levels of laser radiation exceeding the MPE. (See also 6.3).

6.0 Required Laser Safety Program Features

6.1 Standard Operating Procedure
(Reference)25 TAC 289.301(v)B)

Each laser shall have a Standard Operating Procedure (SOP) written for its operation. An SOP in this use is the same as a laboratory laser research-specific protocol that specifies safe use and procedures for the laser system. 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 checklist for operation. The SOP shall include clear warnings to avoid possible exposure to laser and collateral radiation in excess of the MPE. The SOP shall be available for inspection by the LSO or his/her designate at any time. A template for Laser Safety Standard Operating Procedures is attached to this document as Form Laser3.

6.2 Training

(Reference) 25 TAC 289.301(r)(2)(C)(ii)

Each person who operates or works with a class IIIb or IV laser shall complete training in laser safety provided by The University or LSO-approved equivalent, and shall complete specific campus laser safety training. No person may work in a NHZ prior to completing this laser safety training.

6.3 Master Switch

(Reference) 25 TAC 289.301(r)(2)(E)(iii)(I)

Each class IV laser shall be provided with 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 keyswitch or coded access. Requests for exceptions to this requirement shall be provided in writing and considered by the LSO on a case-by-case basis.

6.4 Safety Interlocks

(Reference) 25 TAC 289.301(r)(2)(B)

Each class IIIb and IV laser shall have an interlock on any safety housing that ensures that laser radiation is not accessible above Maximum Permissible Exposure limits, and which is removable without the use of tools. Pulse laser interlocks shall be designed to prevent inadvertent firing of the laser. Each laser shall have an interlock on any safety housing that ensures that laser radiation is not accessible above MPE limits, and which is removable without the use of tools. Pulse laser interlocks shall be designed to prevent firing of the laser.

Safety interlocks shall be provided for 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 MPE limits.

Adjustment during operation, service, testing, or maintenance of a laser containing interlocks shall not cause the interlocks to become inoperative except where a laser controlled area as specified in subparagraph (E) of the referenced regulation is established.

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 and for CW lasers, the interlocks shall turn off the power supply or interrupt the beam (i.e., by means of shutters).

6.4.1 Safety Interlocks-Alternatives

(Reference) 25 TAC 289.301(r)(2)(E)(II)

The regulations recognize that in situations where an engineering control may be inappropriate the University LSO shall specify alternate controls to obtain equivalent laser safety protection. Alternate controls may be submitted in writing to the University LSO and, if accepted, will be documented in the SOP.

Where safety latches or interlocks are not feasible or are inappropriate, 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. A door, blocking barrier, screen, or curtains shall be used to block, screen, or attenuate the laser radiation at the entryway.

3. The level at the exterior of these devices shall not exceed the applicable MPE, nor shall personnel experience any exposure above the MPE immediately upon entry.

4. At the entryway there shall be a visible or audible signal indicating that the laser is energized and operating at class IV levels.

5. A lighted laser warning sign, flashing light and other appropriate signage are acceptable methods to accomplish this requirement. As an alternative, an entryway warning light assembly may be interfaced to the laser in the following manner: 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.

6.5 Protective Eyewear

(Reference) 25 TAC 289.301(t)(1)

Each Permittee 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:

6.5.1 Provide a comfortable and appropriate fit all around the area of the eye
6.5.2 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
6.5.3 Be of optical density adequate for the laser energy involved
6.5.4 Have the optical density or densities and associated wavelengths permanently and prominently labeled on the filters or eyewear
6.5.5 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.
6.5.6 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

6.6 Miscellaneous Safety Issues

6.6.1 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
6.6.2 Persons working with tunable lasers or 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 operating frequency of the laser.

6.7 Warning Systems

(Reference) 25 TAC 289.301(r)(2)(E)(iii)(II)(-c-)

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.

6.8 Controlled Areas and Posting

(Reference) 25 TAC 289.301(r)(2)(E), 25 TAC 289.301(v), 25 TAC 289.301(r)(2)(E)(iii)(-b-)

Each class IIIb and IV laser shall only be operated in a Controlled Area. A Controlled area shall be established by the Permittee to limit access of personnel to laser radiation. Each Controlled Area shall be posted conspicuously with signs as specified in 25 TAC 289.301(v). Access to the Controlled Area shall be controlled by a door, blocking barrier, screen, or curtain, 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.

6.9 Surveys

(Reference) 25 TAC 289.301(w)

Each Permittee shall survey the laboratory containing the laser(s) for which the Permittee is responsible. The survey shall be performed using form Laser2 or equivalent that meets the requirements of Laser2. The survey shall be performed at least quarterly, and shall be performed prior to operating a laser for the first time after assembly, maintenance, or modification of the beam path, operating wavelength, or power level. Survey records shall be retained for inspection by the Laser Safety Officer.

6.10 Fiber Optic Transmission

(Reference) 25 TAC 289.301(s)(2)

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. 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. *Note*: If the fiber is designed to emit light through the walls of the fiber, the LSS shall notify the LSO and include justification for lack of opaque cover in the SOP.

6.11 Skin protection

(Reference) 25 TAC 289.301(t)(2)

Persons in the controlled area shall wear appropriate clothing, gloves, and/or shields to prevent exposure of the skin to levels exceeding the skin MPE.

6.12 Infrared Lasers

(Reference) 25 TAC 289.301(s)(1)

An infrared laser beam shall be terminated in a fire-resistant material so that the laser beam is not inappropriately reflected. Inspection of the terminating material shall occur at regular intervals not less than monthly, and the inspection shall be recorded.

6.13 Magnification of Laser Beam

If at any time a laser beam is optically magnified or concentrated, special precautions shall be taken by the Permittee to prevent specular or diffuse reflection or other exposure greater than the MPE for the laser. The special precautions shall be documented in the SOP for the laser.

7.0 Records

(Reference) 25 TAC 289.301(ee)

Records of Surveys, Training, NHZ and MPE calculations, and other Laboratory-specific information shall be maintained in the laboratory, and shall be available for inspection/review by the LSO at any time. Records shall be maintained for a period of not less than 5 years after the record date while the laser is in operation and for a period of 7 years after the laser is no longer in operation. Records may be shipped to the LSO for storage when the laser is taken out of service.

8.0 Non-Radiation Hazards

(Reference) Appendix 2

Each laser shall, as part of the NHZ and MPE determination, have an evaluation made of non-radiation hazards which may be present as part of the laser's construction or operation. 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. (See form Laser4).

9.0 Incident Reporting

(Reference) 25 TAC 289.301(z), -(bb)

Each Permittee shall immediately seek appropriate medical attention for an injured individual and notify the LSO by telephone within 24 hours of any exposure injury involving a laser possessed by The University. The LSO shall be notified within 48 hours of any non-injury incident which involves potential exposure to laser radiation exceeding the MPE. A written summary of an injury or non-injury incident shall be forwarded to the LSO not later than one week following the incident. Records of the incident shall be maintained by the laboratory.

Appendix 1

Beam Control Precautions

1. Do not look directly into the beam or at a specular reflection, regardless of its power.

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

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

4. Orient the laser so that the beam is not directed toward entry points to the Controlled Area or toward aisles or hallways

5. Minimize specular reflections

6. Securely mount the laser on a stable platform.

7. Limit beam traverse during adjustments

8. Clearly identify beam paths. Ensure the path does not cross populated areas, study areas, desk areas, or traffic paths.

9. A beam path that exits from a controlled area must be enclosed wherever the beam irradiance exceeds the MPE

10. Minimize unnecessary reflective objects in the laboratory

11. Monitor for condensation on cooled systems. Condensate can provide a specular reflective surface

12. Utilize appropriate eye protection at all times when the laser is in operation, including during beam alignment.

Appendix 2

Non-beam Control Precautions

This section references ANSI Z136.1 "For the Safe Use of Lasers" Section (7). Non-beam controls refer to hazard controls associated with:

- **electricity**
- **noise,**
- **chemicals**
- **cryogenics**
- **other hazards.**

Until this appendix is completed in more detail the primary interim reference is *The Laser Safety Institute of America Guide to Non-beam Hazards Associated with Laser Use*, 1999. A copy of this reference is available with the University LSO and can be ordered through the Laser Safety Officer.

Special note: the only fatalities associated with the use of lasers are electrocution, even though most of the emphasis of the regulations and policy is eye damage.

Warning!
During periods of installation, maintenance, repair, calibration and any other procedures which result in the accessibility to high-voltage components, the concern for electric shock is paramount !

See Section 8.0 of this Laser Safety Manual and form Laser4

ACRONYMS

ASAP As Soon As Possible

FDA Food and Drug Administration, United States

LED Light-emitting Diode

LSO Laser Safety Officer, the one University person in charge of The University's Laser Safety Program

LSS Laser Safety Supervisor, the one person in a laser laboratory in charge of the lab's Laser Safety Program

MPE Maximum Permissible Exposure, the maximum amount of laser energy allowed to enter the eye of an observer

NHZ Nominal Hazard Zone, the area around or near a laser which contains an MPE of laser energy

OD Optical Density, the transmissibility of laser light at a given frequency

PPE Personal Protective Equipment, eyewear or other garments used to protect an individual, in this case from laser radiation

SOP Standard Operating Procedure, the document which describes how to operate a laser and conduct a Laser Safety Program

The University of Texas at El Paso Laser Safety Program

Form Laser2

Laboratory Laser Survey

Yes-No-N/A

1. Labels and Signs

Is the correct warning label affixed to the laser? ___________ ______________

Are signs posted clearly near the laser ___________ ______________

Is the room posted? ___________ ______________

Is a label, sign, or warning posted near the aperture? ___________ ______________

Is a label or warning posted near an interlock? ___________ ______________

2. Engineering Controls

Does each laser have a keyswitch or code? ___________ ______________

Is appropriate Safety eyewear provided and present? ___________ ______________

Is the eyewear permanently and prominently labeled
for optical density and wavelength? ___________ ______________

Do Safety Covers have interlocks? ___________ ______________

Are latches or interlocks provided to restrict access
to the Controlled Area? ___________ ______________

Are all warning devices functioning within design
specifications? ___________ ______________

Are any items in or near beam paths which could cause
specular reflections? ___________ ______________

Is a physical barrier present at the Controlled Area entry? ____________ ______________

3. Procedural Controls

Is each laser registered properly? ___________ ______________

Is a Laser Safety Supervisor present? ___________ ______________

Is access to the Controlled Area restricted? ___________ ______________

Does each person have required training? ___________ ______________

Is the SOP for the laser present at the control? ___________ ______________

Are curtains in place and used (If required)? ___________ ______________

Is documentation available? ___________

Laser Registration Guidelines

Permittee — for the purposes of laser registration this is a faculty or staff member at UT El Paso (excluding post-doctoral, graduate student, and undergraduate student appointments)

Laser Safety Supervisor (LSS) — this individual is the liaison between EHS and the laser users. The LSS may be the Permittee or a knowledgeable designee.

1. Each Class 3b and Class 4 laser in the possession of The University of Texas at El Paso (regardless of the actual owner of the laser) must be registered with UT El Paso's Environmental Health and Safety (EHS). The laser class is typically determined by the laser manufacturer and can be found on a label on the laser. If the laser is missing the label or it is "homemade," contact EHS to determine the classification.
2. Multiple lasers may be registered to a single Permittee. However, a single laser may not be registered to multiple Permittees. If a laser is to be transferred to another UT El Paso Permittee (or another institution), inform EHS of the change.
3. Class 3b and Class 4 lasers that are an integral part of a product that is classified as a Class 1, Class 2, or Class 3a laser product do not need to be registered.
4. Unique "Z" numbers will be assigned to Permittees by EHS. This Z number can be used in lieu of reentering Permittee and LSS information when registering multiple lasers to a single Permittee.
5. Contact EHS before sending any laser (all classes) to Surplus Property.

If you have comments or questions regarding this form or other laser safety issues, please call 915-747-7124 and ask to speak to someone in Laser Safety or e-mail us.

Laser Permit Application

Please see the Laser Registration Guidelines.

For a printable version of this form, contact us at 915-747-7124 or eh&s@utep.edu.

Permittee

Title: Dr.

Name: First Middle Last

E-mail UT EID

Department

Office Location(Bld & Room) Mail Code

Phone Numbers: Office Home Fax Cell

Alt

Check if your experiments use animal subjects.

Check if your experiments use human subjects.

Comments/Notes

Laser Safety Supervisor (LSS)

Name: First Middle Last

E-mail

Department

Location (Bld. & Room) Mail Code

Phone Numbers: Office Fax Cell

Comments/Notes

Laser Information

Location [ ] Location Phone [ ]

Manufacturer [Coherent ▼]

Model [ ] Serial # [ ] UT Inventory # [ ]

Type: [Argon ▼] Class: [3b (IIIB) ▼] Note:Class 1, 2, and 3a do not require registration.

Operating Wavelengths (nm): Typical [ ] Ranges [ ]

Beam Diameter at aperture (mm) [ ] Beam Divergence (mrad) [ ]

Mode of Operation [CW ▼]

For CW

Power: Typical [ ] Maximum [ ] Minimum [ ] Units [W ▼]

For Pulse

Pulse Duration: Typical [ ] Maximum [ ] Minimum [ ] Units [fs ▼]

Repetition Rate: Typical [ ] Maximum [ ] Minimum [ ] Units [Hz ▼]

Energy/Pulse: Typical [ ] Maximum [ ] Minimum [ ] Units [mJ ▼] Comments / Notes:

[ ]

LASER SAFETY

INTRODUCTION

Lasers have become increasingly important research tools in Medicine, Physics, Chemistry, Geology, Biology and Engineering. If improperly used or controlled, lasers can produce injuries (including burns, blindness, or electrocution) to operators and other personnel, including uninitiated visitors to laboratories, and cause significant damage to property. Individual users of all lasers must be adequately trained to ensure full understanding of the safety practices outlined in The University of Texas at El Paso Laser Safety Manual.

The Laser Safety procedures here at the University follow the requirements of the Texas Department of State Health Services, and the guidelines from the American National Standards Institute (ANSI) as specified in the ANSI Standards Z136.1, "The Safe Use of Lasers."

WHAT IS A LASER?

LASER is an acronym that stands for Light Amplification by Stimulated Emission of Radiation. The energy generated by the laser is in or near the optical portion of the electromagnetic spectrum. Energy is amplified to extremely high intensity by an atomic process called stimulated emission. The term "radiation" is often misinterpreted because the term is also used to describe radioactive materials or ionizing radiation. The use of the word in this context, however, refers to an energy transfer. Energy moves from one location to another by conduction, convection, and radiation. The color of laser light is normally expressed in terms of the laser's wavelength. The most common unit used in expressing a laser's wavelength is a nanometer (nm). There are one billion nanometers in one meter ($1 \text{ nm} = 1 \times 10^{-9} \text{ m}$). Laser light is nonionizing and includes ultra-violet (100-400nm), visible (400-700nm), and infrared (700nm-1mm).

ELECTROMAGNETIC SPECTRUM

Every electromagnetic wave exhibits a unique frequency, and wavelength associated with that frequency. Just as red light has its own distinct frequency and wavelength, so do all the other colors. Orange, yellow, green, and blue each exhibit unique frequencies and wavelengths. While we can perceive these electromagnetic waves in their corresponding colors, we cannot see the rest of the electromagnetic spectrum.

Most of the electromagnetic spectrum is invisible, and exhibits frequencies that traverse its entire breadth. Exhibiting the highest frequencies are gamma rays, x-rays and ultraviolet light. Infrared radiation, microwaves, and radio waves occupy the lower frequencies of the spectrum. Visible light falls within a very narrow range in between.

LASER HAZARDS

BEAM HAZARDS

The laser produces an intense, highly directional beam of light. If directed, reflected, or focused upon an object, laser light will be partially absorbed, raising the temperature of the surface and/or the interior of the object, potentially causing an alteration or deformation of the material. These properties which have been applied to laser surgery and materials processing can also cause tissue damage.

In addition to these obvious thermal effects upon tissue, there can also be photochemical effects when the wavelength of the laser radiation is sufficiently short, i.e., in the ultraviolet or blue region of the spectrum. Today, most high-power lasers are designed to minimize access to laser radiation during normal operation. Lower-power lasers may emit levels of laser light that are not a hazard.

The human body is vulnerable to the output of certain lasers, and under certain circumstances, exposure can result in damage to the eye and skin. Research relating to injury thresholds of the eye and skin has been performed in order to understand the biological hazards of laser radiation. It is now widely accepted that the human eye is more vulnerable to injury than human skin. The cornea (the clear, outer front surface of the eye's optics), unlike the skin, does not have an external layer of dead cells to protect it from the environment. In the far-ultraviolet regions of the optical spectrum, the cornea absorbs the laser energy and may be damaged. At certain wavelength in the near-ultraviolet region and in the near-infrared region, the lens of the eye may be vulnerable to injury. Of greatest concern, however, is laser exposure in the retinal hazard region of the optical spectrum, approximately 400 nm (violet light) to 1400 nm (near-infrared) and including the entire visible portion of the optical spectrum. Within this spectral region collimated laser rays are brought to focus on a very tiny spot on the retina. In order for the worst case exposure to occur, an individual's eye must be focused at a distance and a direct beam or specular (mirror-like) reflection must enter the eye. 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.

Therefore, a visible, 10 milliwatt/cm^2 laser beam would result in a 1000 watt/cm^2 exposure to the retina, which is more than enough power density (irradiance) to cause damage. If the eye is not focused at a distance or if the beam is reflected from a diffuse surface (not mirror-like), much higher levels of laser radiation would be necessary to cause injury. Since this ocular focusing effect does not apply to the skin, the skin is far less vulnerable to injury from these wavelengths.

NON-BEAM HAZARDS

In addition to the direct hazards to the eye and skin from the laser beam itself, it is also important to address other hazards associated with the use of lasers. These non-beam hazards, in some causes, can be life threatening, e.g. electrocution, fire, and asphyxiation. The only fatalities from lasers have been caused by non-beam hazards.

CHEMICAL HAZARDS:

- Compressed gases – care should be taken with tanks of compressed gas
- Fumes from lasing of target material – industrial hygiene considerations should be address to determine adequate ventilation
- Laser dyes or solvents – may be toxic or carcinogenic and should be handled appropriately

ELECTRICAL HAZARDS:

- Power supplies – high voltage precautions should be designed to prevent electrocution
- Voltages greater than 15 kV – may generate x-rays

NON – BEAM OPTICAL HAZARDS:

- Ultraviolet radiation – can cause burns to skin or corneas of eyes

EXPLOSION HAZARDS:

- Some lamps and capacitor banks – should be enclosed or protected to avoid injury to personnel in the event of explosion
- Personnel should be protected should lasing of the target material create flying fragments

FIRE HAZARDS:

- Electrical components, gases, fumes and dyes – can constitute a fire hazard; use of flammables should be avoided, and flame resistant enclosures should be used

CLASSIFICATION OF LASERS

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 to the beam or from reflections from diffuse reflective surfaces. Since August 1, 1976, commercially produced lasers have been classified and identified by labels affixed to the laser. In cases where the laser has been fabricated in house or is otherwise not labeled, Radiation Safety should be consulted on the appropriate laser classification and labeling. Lasers are classified using physical parameters of the laser, power, wavelength, and exposure duration.

Class 1 lasers

Class 1 lasers are considered to be incapable of producing damaging radiation levels, and are therefore exempt from most control measures or other forms of surveillance.
Example: Laser printers and CD players.

Class 2 lasers

Class 2 lasers emit radiation in the visible portion of the spectrum, and protection is normally afforded by normal human aversion response (blink reflex) to bright radiant sources. In general, the human eye will blink within 0.25 seconds when exposed to Class 2 laser light. This blink reflex provides adequate protection. However Class 2 lasers emit laser light in the visible range and are capable of creating eye damage through chronic exposure.
Examples: Laser pointers, surveying lasers.

Class 2a laser are special-purpose lasers not intended for viewing. Their power output is less than 1 mW. This class of lasers causes injury only when viewed directly for more than 1,000 seconds. The 1,000 seconds is spread over an 8-hour day, not continuous exposure.
Example: Many bar-code readers fall into this category.

Class 3 lasers

Class 3a laser are those that normally would not produce injury if viewed only momentarily with the unaided eye. They may present a hazard if viewed using collecting optics, e.g., telescopes, microscopes, or binoculars.
Example: HeNe laser above 1 milliwatt but not exceeding 5 milliwatts radiant power, or some pocket laser pointers.

Class 3b laser light will cause injury upon direct viewing of the beam and specular reflections.
Example: Visible HeNe laser above 5 milliwatts but not exceeding 500 milliwatts radiant power.

Class 4 lasers

Class 4 lasers include all lasers with power levels greater than 500 mW radiant power. They pose eye hazards, skin hazards, and fire hazards. Viewing of the beam and of specular reflections or exposure to diffuse reflections can cause eye and skin injuries. All of the control measures explained in this training must be implemented.
Example: Most Nd:YAG Lasers.

EYE PROTECTION

Laser protective eyewear is specific to the types of laser radiation in the lab. Each laser laboratory must provide laser-specific appropriate eye protection for persons working with the laser. Windows where Class 2, 3, or 4 beams could be transmitted causing hazards in uncontrolled areas shall be covered or otherwise protected during laser operation. The following guidelines are suggested for maximum eye protection.

- Whenever possible confine (enclose) the beam, provide non-reflective, nonflammable beam stops, to minimize the risk of accidental exposure or fire. Use fluorescent screens or secondary viewers to align the beam; avoid direct intrabeam exposure to the eyes.

- Use the lowest power possible for beam alignment procedures. Use lower class lasers for preliminary alignment procedures, whenever possible. Keep optical benches free of unnecessary reflective items.

- Confine the beam to the optical bench unless necessary for an experiment, e.g., use barriers at side of benches or other enclosures. Do not use room walls to align Class 3b or 4 laser beams.

- Use non-reflective tools. Remember that some tools seem to be non – reflective for visible light may be very reflective for non – visible spectrum.

- Do not wear reflective jewelry when working with lasers. Metallic jewelry also increases electrocution hazards.

Always wear protective glasses whenever working with Class 4 lasers with open beams or when reflections can occur.

In general, laser glasses may be selected on the basis of protecting against reflections - - especially diffuse reflections, and providing protection to a level where the natural aversion reflex will prevent eye injuries, unless intrabeam viewing is required.

Generally, protective eyewear may be selected to be adequate to protect against stray reflections. Wearing such glasses allows some visibility of the beam, preventing skin burns, making it more likely that persons will wear the eye protection. Also, the increased visibility afforded by this level of protection decreases potential for other accidents in the lab, i.e., tripping, etc. Factors to consider in selection of Laser Protective eyewear include the following:

- Wavelength(s) or spectral region(s) of laser radiation
- Optical density at the particular wavelength(s)
- Maximum irradiance (W/cm^2) or beam power (W)
- Type of laser system
- Power mode, single pulse, multiple pulse, or continuous wave (cw)
- Possibilities of reflections, specular and diffuse
- Field of view provided by the design
- Availability of prescription lenses or sufficient size of goggle frames to permit wearing of prescription glasses inside of goggles.
- Comfort
- Ventilation ports to prevent fogging
- Effect upon color vision
- Impact resistance
- Ability to perform required tasks while wearing eyewear

Since laser protective eyewear is subject to damage and deterioration, the lab safety program should include periodic inspection of these protective items.

ENGINEERING CONTROLS FOR LASER SYSTEMS

It is required at The University of Texas at El Paso that lasers shall not be modified to defeat the engineering safeguards without review and approval of the Laser Safety Officer to ensure that appropriate controls are instituted. Appropriate design standards for laser system are as follows:

- Laser should be equipped with a protective housing, an aperture that is clearly identified, and a clearly marked switch to deactivate the laser or reduce its output to less than maximum permissible exposure (MPE). If this is not possible, Radiation Safety should be consulted to assess the hazards and to ensure that appropriate controls are in place. Such controls may include, but are not limited to the following:

    - Access restriction
    - Eye protection
    - Barriers, shrouds, beam stops, etc.
    - Administrative and/or procedural controls
    - Education and training

- Protective housings should be interlocked for Class 3a, 3b and 4 lasers.
- A keyed master switch or password protected operating computer should be provided for Class 3b and 4 lasers. Lasers should be disabled by removing the key when the laser is not in use for prolonged periods.
- Viewing ports and collecting optics shall provide adequate protection to reduce exposure at viewing position to below the MPE level. (Classes 2, 3a, 3b, or 4).
- If the beam path is not enclosed, then the Nominal Hazard Zone (NHZ), the areas where the exposure level exceeds maximum permissible exposure level, need to be assessed and a controlled area established.
- Commercially manufactured Class 3b and Class 4 lasers must come equipped with a connection for external interlocks.
- Laser beams should be terminated in a suitable “beam stop.” Most laser heads come equipped with a permanently attached stop or attenuator, which will lower the beam power to less than the MPE at the aperture from the housing. Additional beam stops may be needed in the beam path to keep the useful beam confined to the experimental area.

It may not always be possible to equip laboratory-fabricated lasers with single master switches or key switches or other safety devices required for lasers, which are available readily on the market. Fabricators of these devices are expected to incorporate the functional equivalent of such safety features when they build a device.

CONTROL OF LASER AREAS

In many campus research areas the requirements for controlled laser areas have been interpreted to mean that the doors must be locked, or interlocked, and proper warning indication provided at the entrance to the area when the laser is operating, unless the area just inside the door is protected by a barrier as described below. Proper protective eyewear must be available at the entrance.

For Class 4 lasers that have open beams, the ANSI Standards call for interlocked doors or devices that turn-off or attenuate the laser beam in the event of an unexpected entry into an area. An alternative method of protection is to provide a suitable barrier (screen or curtain) just inside the door or wherever most appropriate to intercept a beam or scatter so that a person entering the room cannot be exposed above the MPE limits.

Procedural methods may be used to control entry as an alternative to engineered interlocks, provided the above conditions are met and all personnel have been trained in laser safety, and protective equipment is provided upon entry. Other conditions related to control of laser areas include the following:

- Keep the exposure at the entryway below MPE by use of a barrier inside of the door. Do not direct the laser beam toward the entry.
- Use shields and barriers around the laser work area so that the beam, reflections and scatter are contained on the optical table. Try to keep the unenclosed beam path out of the normal eye-level zone. (The normal eye-range is from 4 to 6 feet from the floor.)
- Ensure that only diffuse reflection materials are in or near the beam path to minimize the chance of specular reflections.
- Ensure that locks or interlocks do not prevent rapid egress from the area in the event of an emergency situation.
- Have lighted warning signs (preferably flashing) and/or audible signals to indicate when a Class 4 laser is energized and operating. Signage must clearly explain the meaning of the lights.

Unauthorized persons are to be prevented from entering an area if the beam is not contained, i.e., exposure levels at the room entrance may exceed the MPE. Locks can be used to secure the room (egress should not be impeded). Locks and warning lights should activate when the laser is “ON.” **It is essential that the locks not impede exit from the room in case of emergency. Therefore, slide bolts and dead bolts are not acceptable locks.**

Many laser systems have an electrical connection for interlocks which can serve as a mechanism to link warnings and door locks to laser operation. The connections can also be used for door interlocks (to shut off the laser beam) if the door is opened. Momentary by-passes and timers can be used to permit controlled entry. The connections between the laser and warnings and lock system should be low voltage. Also, users shall inspect the warning and access control devices periodically as a part of the overall safety program. The University of Texas at El Paso does not require that the laser power supply be shut off by an interlock unless the beam cannot be effectively blocked.

Laser areas shall be designed so that beams cannot exit from the area at levels exceeding the MPE. Provide suitable barriers that will attenuate the beam. Check for leakage of stray beams around doors or barriers.

POSTING AND WARNING SYSTEMS FOR LASER CONTROLLED AREAS

Entrances to laser areas are to be posted in accordance with 25 Texas Administrative Code 289.301. In particular, areas where Class 3b or 4 lasers are used must be secured against persons accidentally being exposed to beams, and be provided with a proper warning indication. All windows, doorways, and portals should be covered or restricted to reduce transmitted laser levels below the MPE. Radiation safety will provide advice on appropriate signs for posting laser areas and controlling laser areas.

The term “proper warning indication” generally means that an illuminated warning sign is outside of the area. Preferably the light should be flashing and lit only when the laser is on. (When a Class 3 or 4 laser is left on and the personnel leave the room, the door shall always be locked.) Lights alone do not suffice as adequate warning, unless the light is clearly posted as to its meaning. A well-designed warning light should have redundancy, e.g., two lights, a “safe” light when the laser is off, or two lamps, wired in parallel, in the “laser on” signal. Personnel who do not read English language, and who may need to enter areas where lasers are used are to be given appropriate instruction as to the meaning of warning signs and labels. Radiation safety will assist in obtaining translations of warning signs.

ANCILLARY HAZARDS

X-rays

Some of the high voltage systems with potentials greater than 15 kV may generate x-rays at significant dose rates. Plasma systems and ion sources operated at high voltages should also be checked for x-rays. High power electron pump excimer lasers can generate significant x-ray levels. These devices need to be checked by Radiation Safety upon installation to ensure adequate shielding is included.

Free electron lasers are driven by powerful devices which are regulated radiation-producing machines. All users of these devices are required to have training addressing the ionizing radiation hazards and the protection systems and procedures associated with these devices.

Plasma radiation

Materials can be made incandescent when exposed to laser radiations. These incandescent spots are very bright and cause serious photochemical injuries to the eyes. The laser protective eyewear may not protect against such exposures. View such spots through suitable filters; use video cameras, etc., as may be appropriate.

Fires

Keep flammables out of the beam. Segregate and properly store reactive reagents in the lab. Keep a fire extinguisher of the proper class readily accessible in the area.

Chemicals

Fumes produced when laser radiation vaporizes or burns a target material, whether metallic, organic, or biological may be hazardous. Adequate ventilation must be provided. Many dyes and solvents used with lasers are toxic; some may be carcinogenic. Potential exposures to dyes and solvents are most likely to occur during preparation. Failure of the dye laser’s pressure system can also expose personnel, and can cause fires.

- During solution preparation, dye and solvent mixing should be done inside a chemistry fume hood.
- Gloves, lab coats, and eye protection should be worn. Avoid skin contact.
- During dye laser disassembly, use proper personal protective equipment and be alert to contaminated parts, e.g., dye filters. Be sure to cap off dye solution lines.
- Don’t smoke, eat, or drink in chemical use areas.
- Dye pumps and tubing/pipe connections should be designed to minimize leakage. Pumps and reservoirs (notorious for leaking) should be set inside spill pans. Tubing/pipes systems should be pressure-tested prior to using dye solutions and periodically thereafter. Dye solutions can be corrosive. Stainless steel heat exchangers are recommended.
- For waste disposal and spills, emphasis should be placed upon solvent characteristics since dye concentrations are low.
- Keep all containers of solvent, solutions, and dyes tightly closed, clearly labeled, and stored in a cool, dry place. Keep oxidizers away.

Hazardous Gases and Cryogenic Materials

Compressed gases present significant hazards if proper handling, manifolding and storage precautions are not followed. Some gases may also require special ventilation. Gas cylinders must be properly secured to prevent falling. Such tanks can become high velocity projectiles and can cause significant property damage and injuries.

Wear appropriate protective clothing and face shields when handling liquid nitrogen (LN2) or other cryogenic materials. Exposure to the liquid or the cold gas can cause severe frostbite. Liquid nitrogen can condense oxygen from the air and cause enhanced fire or explosion hazards. LN2 and inert gases can displace air in a room or confined area and cause asphyxiation. Good ventilation is required in areas where these gases and cryogenic liquids are used.

Electrical Safety

Most laser systems involve high potential, high current electrical supplies. The most serious accidents with lasers have been electrocutions. There have been several fatalities related to lasers nationwide. Make sure electrical systems are off and locked out and that high-energy capacitors are fully discharged prior to working on a system. The system should be shorted during repair or maintenance procedures to prevent accidental charging and discharge. The discharge of large capacitors requires proper equipment and procedures because significant levels of stored energy can be released as heat or mechanical energy.

- Class 3b and 4 lasers should have a separate circuit and local disconnect switch for the circuit.
- Label and post electrical hazards. Clearly identify the main switches to cut-off power. Before working on the laser, de-energize the machine. Positively disconnect it. If there is more than one source of power, disconnect them all. Lock out and tag the disconnect switches so that power is not reconnected while you are working on the laser.
- It is good practice to have at least two persons in an area while working on high energy power systems.
- Keep cooling water connections away from main power and high voltage outlets and contacts. Use double hose clamps on cooling water hoses. Inspect cooling water hoses and connections, and power cables and connectors periodically as part of a regular equipment inspection.
- In labs where laser power supplies are opened or serviced by lab personnel, staff should be trained in cardiopulmonary resuscitation.

INVENTORY, ACQUISITION AND TRANSFER (DISPOSAL)

Acquisition

Class 3b and 4 lasers must be registered with the Texas Department of State Health Services. Send a copy of purchase order for Class 3b or 4 lasers to Radiation Safety. Radiation Safety has the responsibility to periodically visit laser labs to ensure that regulations are being followed. Radiation Safety also needs to know where such lasers are located. If a Class 3b or 4 laser is fabricated in the lab, send a note describing the laser (See Below) to the Office of Radiation Safety.

Note that laser systems that are purchased (or those that are built in any lab on campus and transferred to other users) must meet manufacturing certification requirements. It is the Registrant’s responsibility to fulfill the certification requirements.

Inventory

Laser Registrants are responsible for keeping a list of Class 3b and Class 4 lasers under their control. This inventory must be forwarded to Radiation Safety.

The inventory requires the following information:

- Manufacturer:
- Model (laser head):
- Serial No:
- Type: (Argon, CO_2, HF, Dye, ect.)
- Power:
- Beam diameter:

- CW:
- Pulsed: (pulse rate)
- Location: (building, room)
- Person Responsible:

Disposal

Lasers cannot be sold, donated, or transferred off campus without prior authorization from Radiation Safety.

Lasers must be rendered inoperative and any hazardous material (contaminated dye cell, etc.) must be removed before disposal.

A note shall be sent to Radiation Safety stating the laser was disposed of on this date and is no longer on campus. This will allow Radiation Safety to take the laser off the inventory for that lab.

Transfer On-campus

Transfer of a Class 3b or 4 laser to a person who does not have appropriate training, who does not understand the hazards of the laser, and who does not have proper protective equipment could result in injuries and is prohibited by Radiation Safety. The transferor should obtain assurance from the recipient that the recipient is qualified to own and safely operate the laser. The parties should consult Radiation Safety for information on laser hazards and safeguards, the necessary qualifications of the recipient, and the transfer on the inventory from transferor to the recipient.

TRAINING

Only qualified and trained employees may operate Class 3b and 4 lasers. To be qualified, a laser operator must meet both the training requirements outlined below, and operational qualifications established by Radiation Safety. The Laser Registrant is responsible for ensuring that all persons who work in areas where Class 3b or 4 lasers are used are provided with appropriate training and written safety instructions (work rules), so that the workers can properly utilize equipment and know and follow safety procedures.

Radiation Safety assesses safety training during periodic site visits. The University of Texas at El Paso requires that appropriate safety training be provided before the persons are permitted to operate a laser without supervision. Completion of the training must be documented. For personnel who work with Class 3b and 4 lasers, the training will included the following topics:

- The biological effects of laser radiation
- The physical principles of lasers
- Classification of lasers
- Basic safety rules
- Use of protective equipment
- Control of related hazards including electrical safety, fire safety, and chemical safety

- Emergency response procedures

Because of the hazard of electrocution, it is a recommendation that the lab personnel take a course in cardiopulmonary resuscitation (CPR) and proper rescue techniques to follow in the event of electrocution.

The University of Texas at El Paso Laser Safety Program

Laser3

Laser Safety Standard Operating Procedure (SOP)

Department/Laboratory:____________________________ Date:________________

Procedure #:______________________________________ Revision Number:____________

Author:___________________________________

- **This procedure shall be read and signed annually by all persons who use lasers listed in the SOP.**
- **This procedure shall be reviewed every two years by the Permittee/Laboratory LSS to ensure it reflects the most current conditions.**

1. **LASER SAFETY CONTACTS**

- Laboratory Laser Safety Supervisor (LSS)_____________________________________

  Phone number____________________________________
- University Laser Safety Officer ____**Robert Moss**________________

  Phone number__ **(915) 747-7124 (Office)** __ **24 hour on call (915) 747-5611**__
- Maintenance/Repair____

  Phone number____________________________________
- Medical Emergencies
  1. **911**
  2. Notify the Laboratory LSS and University LSO of all laser-related injuries and near misses as soon as possible.

2. **LASER DESCRIPTION**

Attach latest Laser Inventory (available from Laser Safety Supervisor). Update as required.

3. **LASER SAFETY PROGRAM**

See the UT-El Paso Laser Safety Program Manual for:

- Responsibilities of the laser operator/user, Permittee, and Laser Safety Supervisor
- Laser Permit Requirements
- SOP, Training Requirements, and Interlocks
- Eyewear Requirements, including annual eyewear inspections
- Sign and Labeling Requirements
- Non-radiation Hazards

Maintain a copy of the Texas Regulations for Control of Laser Radiation Hazards (§289.301).

4. HAZARDS & CONTROLS

HAZARDS AND CONTROLS		
Check if applicable	**HAZARD**	**CONTROL(S)**
☐	High Voltage	
☐	Capacitors	
☐	Unenclosed Beam Access to Beam	
☐	Fumes/Vapors	
☐	Ultraviolet Radiation or Blue Light	
☐	Compressed Gases	
☐	Hazardous Chemicals/Waste	
☐	Housekeeping	
☐	Reflective Material in Beam Path	
☐	Fire	
☐	Laser at eye level of person sitting or standing	
☐	Infrared Lasers	
☐	Correct Eyewear	

COMMENTS:

ADDITIONAL CONTROLS		
Check if applicable	**CONTROL**	**COMMENTS**
☐	Entryway (door) Interlocks or Controls	
☐	Laser Enclosure Interlocks	
☐	Laser Housing Interlocks	
☐	Panic Button Emergency Stop	
☐	Beam Stops	Infrared Laser must terminate in fire-resistant material and the absorber must be inspected at least quarterly[1]
☐	Master Switch (operated by key or computer code)	
☐	Laser Secured to Base	
☐		
☐		
☐		
☐		

COMMENTS:

[1] Required by 25TAC§289.301(s)(1)

5. PERSONAL PROTECTIVE EQUIPMENT

A. Eyewear

LASER EYEWEAR					
For this Laser…					**…Wear this Eyewear**
Acquisition date	**Type**	**Wavelength (nm)**	**Wavelength Attenuated (nm)**	**Optical Density (OD)**	**Remarks**
(example) Aug 99	CO_2	10,600	10,600	At least 3.5	Glendale-white frames

Identify each set of laser protective eyewear with a unique designation (name or number).

The following check shall be done annually. Discard unfit eyewear. See section 6.5.

Item	Comments	Date/Initial
Adequate pairs of eyewear for all needs.		
Eyewear specific to wavelength		
OD appropriate for full range of power; alignment to power ops		
Fit snugly		
Labeled for wavelength and OD		
Free of damage excessive scratches		

What (item):	And is available from (where)	which must be worn (when):
______________	____________________________	____________________________
______________	____________________________	____________________________
______________	____________________________	____________________________
______________	____________________________	____________________________
______________	____________________________	____________________________
______________	____________________________	____________________________

6. OPERATING PROCEDURES

A. Initial preparation of lab environment for normal operation (key position, warning light on, interlock activated, identification of personnel, other)

B. Target area preparation

C. Operation procedures are as follows:

D. Shutdown procedures for this laser are as follows:

E. Special procedures (alignment, safety tests, interlock bypass, emergency, etc.)

7. **OPERATOR REVIEW (General Laser Safety Training Certificate, System specific training by Laboratory LSS)**

I have read this procedure and understand its contents.

Name (print)	Signature	Date

The University of Texas at El Paso Laser Safety Program

Form Laser4

Non-Radiation Hazards Survey

Item	Yes/No/NA
1. Electrical Are there any exposed wiring terminals or connections? ________________	______________
Is a positive On/off switch available and connected? ________________	______________
Are all connections permanent (Screwed or clamped)? ________________	______________
Are personnel trained in CPR? ________________	______________
Is access to the power supply controlled? ________________	______________
2. Chemical (If applicable) Is personal protective equipment available (Gloves, etc.)? ________________	______________
Is a Material Safety Data Sheet available? ________________	______________
Is absorbent or diluent available? ________________	______________
Are personnel trained in the hazards of the chemical? ________________	______________
3. Cutting Edge (If applicable) Is the cutting edge identified prominently? _________________	______________
Are personnel trained in safety for this hazard? __________________	______________
4. Compressed Gases (If applicable) Is the gas cylinder properly secured and connected? __________________	______________
Is an MSDS available for the gas (If required)? __________________	______________
Are personnel trained in safety for this hazard? _________________	______________
5. Ventilation Is proper ventilation present for the laser space? _________________	______________
6. Noise Are noise levels excessive? _________________	______________
Is hearing protection available? _________________	______________
Are personnel trained in safety for this hazard? _________________	______________
7. Confining Space, Explosion, Physical Safety (As applicable) Is the hazard identified? _________________	______________
Is training provided in safety for this hazard? _________________	______________
Is protective equipment available? _________________	______________