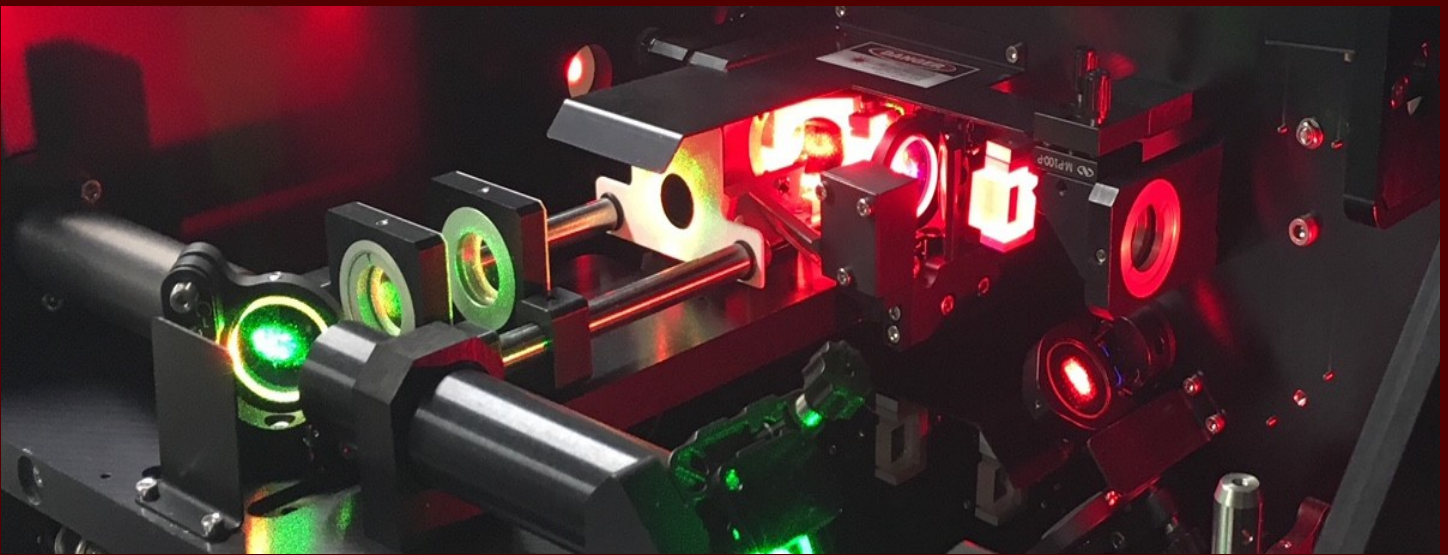


Laser Safety Program Manual

**Radiological Safety Program Manual
(Part Three)
Radiological Safety**



**Environmental Health and Safety
Texas A&M University
4472 TAMU
College Station, TX 77843-4472
Telephone: (979) 845-1361
Fax: (979) 862-7804
Website: <http://ehs.tamu.edu>
Email: radiological-safety@tamu.edu**

Introduction

The Texas A&M University Laser Safety Program Manual sets forth controls and safety guidance for research and educational activities involving lasers. The laser safety program protects personnel from the hazards associated with laser radiation and adheres to the requirements of 25 Texas Administrative Code §289.301. If any conflict occurs between this Program Manual and the Code, the latter shall prevail unless the manual is more restrictive.

This manual is not intended to be an exhaustive or fully comprehensive reference, rather a guide for registered users. Further advice concerning hazards associated with specific substances, devices, and the development of new or unfamiliar activities should be obtained through consultation with the Laser Safety Officer (LSO).

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

Contents

1.0 Organization	5
1.1 Laser Safety Officer (LSO)	5
1.2 Radiological Safety Committee (RSC).....	5
1.3 Permit Holder	5
1.4 Permit Alternate or Alternate	6
1.5 Authorized User.....	6
2.0 Laser Hazard Classification	6
2.1 Class 1 Laser (I or IEC Class 1 or 1M)	7
2.2 Class 2 Laser (II or IEC Class 2 or 2M).....	7
2.3 Class 3a Laser (IIIa or IEC Class 3R)	7
2.4 Class 3b Laser (IIIb or 3B).....	7
2.5 Class 4 Laser (IV).....	7
3.0 Laser Permit Information.....	7
3.1 Registration of Class 3b and Class 4 Lasers.....	7
3.2 Permit Renewal	8
3.3 Removal from Registration	9
3.5 Inventory of Lasers.....	10
3.6 Laser Services and Repair	10
3.7 Laser Demonstration and Sales	10
4.0 Manufacture/Construction	10
5.0 Maximum Permissible Exposure (MPE) and Nominal Hazard Zone (NHZ).....	10
6.0 Required Laser Safety Program Features	11
6.1 Laser Safety Standard Operating Procedure.....	11
6.2 Key control	11
6.3 Safety Interlocks and Warning Systems.....	11
6.4 Safety Interlocks-Alternatives	12
6.5 Training	12
6.6 Protective Eyewear.....	12
6.7 Miscellaneous Safety and Training Issues	13
6.8 Surveys	13
6.9 Fiber Optic Transmission	14
6.10 Skin protection	14
6.11 Magnification of Laser Beam.....	14
6.12 Viewing Optics and Windows	14
7.0 Records	14
8.0 Non-Radiation Hazards	14
9.0 Laser Security	14
10.0 Inspections of Permit Holder Operations.....	15
10.1 Inspections by Environmental Health and Safety	15

10.2	Inspections by the Texas Department of State Health Services	15
11.0	Incident Reporting	15
12.0	Emergencies	16
	Glossary of Terms	17

1.0 Organization

The Laser Safety Program shall be administered by the Laser Safety Officer (LSO) within Environmental Health and Safety (EHS). The Radiological Safety Committee (RSC) is a peer review committee with at least one member appointed who is a laser user. The RSC advises University Administration and provides guidance regarding the Laser Safety Program. The RSC also considers appeals made by the laser Permit Holders.

1.1 Laser Safety Officer (LSO)

The LSO is an EHS staff member who has the knowledge and responsibility to apply appropriate laser radiation protection rules, standards, and practices. The LSO is named and specifically authorized to perform duties specified on the Certificate of Registration for Lasers issued by the Texas Department of State Health Services (DSHS), Radiation Control Program.

The LSO is responsible for implementing the laser safety program by monitoring and implementing established policies on matters relating to laser safety and is Texas A&M University's authorized representative for laser safety. The LSO shall have the responsibility and authority to investigate incidents, take prompt remedial action and has the authority to stop all laser work without prior approval of the RSC. If such independent action is required, the LSO shall report details of the situation to the RSC at the earliest possible time.

1.2 Radiological Safety Committee (RSC)

The RSC is a peer review committee, appointed by upper administration, with at least one member appointed who is a laser user. This committee is used to provide guidance regarding the laser safety program. The RSC will consider appeals made by the laser Permit Holders.

1. The RSC consists of at least six voting members, including the Chair, appointed by the Vice President of Operations, plus three Ex Officio (nonvoting) members:
 - a. Director, Environmental Health and Safety
 - b. Radiological Safety Officer (RSO)
 - c. Associate Vice President for Safety and Security
2. A quorum shall consist of 50% or more of the voting members.
3. The RSC shall meet at least three times annually and upon request of the Committee Chair. The LSO or designee shall brief the RSC on the status of the laser safety program.

1.3 Permit Holder

The Permit Holder is the person permitted by the LSO and RSC to possess and use lasers. Typically, this is the Principal Investigator and must be permanent faculty or staff (not a postdoctoral fellow or a graduate student). This individual must have stop-work authority over laser use.

The Permit Holder is responsible for:

1. Laser safety in the laboratory.
2. Ensuring the availability of correct protective eyewear (*See section 6.6*)

3. Providing a Laser Safety Standard Operating Procedure (SOP). (*See section 6.1*)
4. Providing, implementing, and enforcing the Laser Safety Program specific to the laboratory laser.
5. Ensuring proper training in laser operation and safety.
6. Classifying and labeling all lasers in the laboratory.
7. Completing application for laser permit with the LSO.
8. Notifying the LSO immediately if an exposure incident occurs.
9. Notifying the LSO prior to a laser being decommissioned, sold, or transferred.
10. Providing barriers and beam stops in the laser laboratory.
11. Maintaining all records in regards to the registered laser.

The Permit Holder may designate any of these responsibilities to an alternate.

1.5 Permit Alternate or Alternate

This person is appointed by the Permit Holder. The Alternate shall aid in maintaining the Laser Safety Program for the individual lasers in the laboratory, and may call on the LSO for assistance as needed. The Alternate, acting on behalf of the Permit Holder, has the authority and responsibility to institute corrective actions including shutdown of laser operations when necessary due to unsafe conditions or safety concerns.

1.6 Authorized User

The authorized user is a person who sets up, aligns, operates, uses the laser for experimental or research purposes, or has other assigned laser duties.

The authorized user is responsible for:

1. Following laboratory administrative, alignment, safety, and standard operating procedures while operating the laser.
2. Keeping the Laser Permit Holder fully informed of any departure from established safety procedures.
3. Clearing all non-essential personnel from the established Nominal Hazard Zone.
4. Ensuring the proper use of personal protective equipment during laser use.
5. Assisting in maintaining proper postings of work areas and labeling of laser-producing equipment.
6. Being familiar with laser safety precautions and training required in their specific work areas.
7. Notifying the LSO and Permit Holder immediately of any accidents involving a laser.

2.0 Laser Hazard Classification

To provide a basis for laser safety requirements, all lasers, laser systems, and/or devices in the United States are classified into one of four classes. Classification of lasers shall be in accordance with US Food and Drug Administration (FDA) or American National Standards Institute specification ANSI Z136.1. Each Class 3b or Class 4 laser at the University shall be registered, and shall have a Permit issued by the LSO. For custom built and modified lasers, the Permit Holder must perform measurements (*e.g., power level, wavelength, etc.*) to provide EHS appropriate classification of the system. Arrays of semiconductor lasers shall require a permit if the cumulative power exceeds Class 3a limits. Lasers which are classified as 3a or lower, but which contain a Class 3b or Class 4 laser, shall be controlled at the higher classification if the class 3b or Class 4 laser is accessed. Any class 3b or Class 4 laser will be referred to as “laser” unless otherwise noted.

2.1 Class 1 Laser (I or IEC Class 1 or 1M)

These lasers are considered incapable of producing damaging radiation levels during operation. Class 1 or 1M lasers are exempt from control measures other than to prevent potentially hazardous optically aided viewing.

2.2 Class 2 Laser (II or IEC Class 2 or 2M)

Visible Continuous Wave and Repetitive Pulse lasers (400-700 nm) that operate at less than 1 mW. Eye aversion response is normally considered adequate protection against potentially hazardous radiation. Class 2M lasers are potentially hazardous if viewed using certain optical aids.

2.3 Class 3a Laser (IIIa or IEC Class 3R)

Class 3a/3R lasers are medium powered lasers, operating at less than 5 mW and are potentially hazardous under some direct and specular reflections if the eye is appropriately focused. The probability of actual injury is small.

2.4 Class 3b Laser (IIIb or 3B)

Class 3b lasers are medium powered lasers ranging from 5 to 499 mW and are subject to control measures and regulatory compliance. Direct and specular reflections may be hazardous; however it is not known to be a diffuse reflection hazard.

2.5 Class 4 Laser (IV)

Class 4 lasers are high powered Continuous Wave or Pulse lasers having power outputs of 500 mW or greater. They are hazardous to the eye and skin from the direct beam and are potential diffuse reflection and fire hazards. These lasers may also produce laser generated air contaminants and hazardous plasma radiation. Certain control measures must be applied for these lasers.

3.0 Laser Permit Information

3.1 Registration of Class 3b and Class 4 Lasers

Each Class 3b and Class 4 laser which is operated, possessed, purchased, donated, manufactured, created, assembled or otherwise received by any person or entity at the University shall be listed on a valid Texas A&M University Laser Permit before operation. Application for the Permit shall be tendered to the LSO by the receiving party as soon as is practicable, but in no case more than 14 days following receipt of the laser. The addition of any new laser or lab space to an existing laser permit must be done through the submission of a laser amendment form.

Under no circumstances shall a Class 3b or Class 4 laser be used or energized on Texas A&M property before it is listed on valid Texas A&M University Laser Permit unless otherwise authorized by the LSO.

A Laser Permit Application and a Laser Permit Amendment form is provided in the Laser Procedures Manual. This section describes what information must be provided; information shall include:

Required Information:

1. The name and position of the applicant including, department and contact information.
2. For applications, the signature of the Department Head or equivalent. The department head must recognize and acknowledge use of lasers in that department. For amendments, a signature of the Department Head or equivalent is required for the addition of a new laser use location.
3. The physical location of the laser. This is the room number or lab. A schematic of the room is required.
4. The type of laser (Dye, Argon, Diode, Excimer, etc.)
5. The manufacturer of the laser. (Found on the control panel or user manual. If the laser is manufactured by University personnel, so state).
6. The model and serial number of the laser.
7. The inventory number (AMU, RF etc.)
8. The excitation mechanism (Optical, electrical, chemical, etc.).
9. The time-dependent operating properties of the laser (CW, Pulse, Repetitively Pulsed, mode-locked, etc.).
10. If continuous wave (CW), the power in watts.
11. If pulsed:
 - a. The maximum capable energy level of the laser in joules.
 - b. The maximum pulse frequency per second.
 - c. The minimum pulse duration.
12. The operating wavelength(s) of the laser.
13. Lens specification if applicable.
14. Fiber optic specifications if applicable.
15. The size, shape, and divergence of beam.
16. Other information should include a brief description of the purpose of the laser (Doppler measurements, fluorescence, etc.), frequency of use, expected primary users, etc. The LSO should be informed if there is anything that may have a bearing on safety related issues.

Any request for exemption or waiver of these information requirements shall be addressed by the LSO on a case-by-case basis upon petition from the person who possesses the laser. Multiple semiconductor lasers may be registered as an array if so designed. Class 3b or Class 4 semiconductor lasers must be individually permitted, and a means for tracking these lasers must be provided by the Permit Holder.

3.2 Permit Renewal

Texas A&M University Laser Permits are valid for two years. EHS shall send a request for renewal of the laser permit to each Permit Holder. The request shall also include a list of the Permit Holder's inventory. The Permit Holder shall indicate intent of renewal or termination of the laser permit and must return the document including all corrections to inventory and bearing the signature of the Permit Holder to EHS. Upon receipt, EHS will take proper actions whether to issue an updated permit to the Permit Holder or to start the termination process of the laser permit.

3.3 Removal from Registration

Laser Permit Holders of a Class 3b or Class 4 laser that is rendered permanently inoperative by disassembly or destruction, or which is removed from the University's control by disposal or transfer to a non-University entity shall provide information regarding the condition and destination to the LSO prior to its inoperative state or removal.

3.3.1 Transfer of Lasers

"Transfer" of lasers, as used in this section, does not include transfer of lasers to EHS for disposal. "Transfer" refers to a change in custody or control of any laser. Any custom built or modified laser systems cannot be transferred off of TAMU's campus. Those systems **MUST** be disposed of or rendered inoperable by the EHS staff.

3.3.1.1 Within Texas A&M University

1. If a Permit Holder would like to transfer the laser to another registered Permit Holder, the Permit Holder will have to fill out a transfer form which requires the signatures of both Permit Holders. Once approval from the LSO is received, the physical transfer will take place.

-OR-

2. If the Permit Holder is transferring the laser to another individual without a current permit, the following information must be sent to EHS prior to the transfer:
 - a. A new permit application for the proposed recipient (which must be approved by the RSC)
 - b. Transfer form, requiring both signatures

Once approval from the LSO is given, the physical transfer will take place.

3.3.1.2 To Another Entity

If a Permit Holder would like to transfer the laser to another entity in the state of Texas, the entity must possess a Certificate of Registration for Lasers from the state. A copy of the Certificate of Registration for Lasers must be provided to EHS. The Permit Holder will have to fill out a transfer form which requires the signatures of both the Permit Holder and the registered entity. Once approval from the LSO is received, the physical transfer will take place.

3.3.2 Disposal of Lasers

If the Permit Holder would like to dispose of a laser, the LSO must be notified prior to the physical removal of the laser from the authorized room. Upon notification, EHS will both confirm inoperability of the laser and label the device showing approval to surplus.

3.4 Laser Inventory and Permit Verification Reports

Each permit holder shall maintain accurate inventory records at all times. EHS shall send a laser permit verification report to each permit holder, typically once every six months. The permit holder or the alternate shall physically locate each item on the permit inventory, request any changes to be made on the report, sign, date and return the report bearing the signature, and keep a copy for the permit holder's records until superseded.

3.5 Laser Services and Repair 25 TAC §289.301(g)(6)

EHS must receive a valid certificate of laser radiation from the Texas Department of State Health Services (DSHS) for alignment, calibration, and/or repair from a potential laser service provider before such services may be performed on class 3b or 4 lasers or other lasers that allow access, through alignment, calibration, and/or repair, to class 3b or 4 lasers. If a laser service provider has not been registered with the Texas DSHS for laser alignment, calibration, and/or repair, a Registration for Laser Services form (RC Form 301-4) can be completed by the provider. Information regarding the RC Form 301-4 can be found on the Texas DSHS webpage under the "Laser and Laser Services Registration" tab. <http://www.dshs.state.tx.us/radiation/laser.shtml>

3.6 Laser Demonstration and Sales 25 TAC §289.301(g)(4)

EHS must receive a valid certificate of laser radiation from the Texas DSHS for demonstration and sales from a potential laser service provider before such services may be performed with class 3b or 4 lasers. If a laser service provider has not been registered with the Texas DSHS for demonstration and sales, a Registration for Laser Services form (RC Form 301-4) can be completed by the provider. Information regarding the RC Form 301-4 can be found on the Texas DSHS webpage under the "Laser and Laser Services Registration" tab. <http://www.dshs.state.tx.us/radiation/laser.shtml>

4.0 Manufacture/Construction 25 TAC §289.301(b)(4)

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. The assembler shall provide power, wavelengths, pulse frequency, duration, and any other applicable information requested by EHS (see 3.1).

5.0 Maximum Permissible Exposure (MPE) and Nominal Hazard Zone (NHZ) 25 TAC §289.301(d)(31) and, (34), 25 TAC §289.301(u)

An MPE is the level of laser exposure to which the eye or the skin may be exposed without adverse effects (the skin is usually less limiting than the eye). NHZ is the space within which the level of direct, reflected or scattered radiation during operation exceeds the applicable MPE.

When any Class 3b or Class 4 laser is used at levels at or above Class 3b in an open beam mode (unenclosed) the MPE will be assumed to be exceeded in that room or area and appropriate precautions shall be taken. In other words, the NHZ (nominal hazard zone) will comprise the enclosure (room or area to which the beam is restricted to by virtue of walls, curtains or other barriers) in which the laser is operating if operated at or above class 3b levels.

This is done to account for intentional or unintentional scattered or reflected beam. If the permit holder or alternate believes the NHZ does not apply to the whole area, a more limited NHZ may be justified in the Standard Operating Procedure (SOP) by using information supplied by the laser manufacturer, by measurement, or by using the appropriate laser range equations or other equivalent assessments.

6.0 Required Laser Safety Program Features

6.1 Laser Safety Standard Operating Procedure 25 TAC §289.301(r)(2)(B)

Each Class 3b and Class 4 laser shall have a laser safety Standard Operating Procedure (SOP) written for its operation. An SOP is the same as a laboratory/laser/research specific protocol that specifies safe use and procedures for the laser system. The SOP shall include at a minimum: operating instructions, appropriate personal protective equipment, eyewear parameters and instructions for proper use, interlock instructions, as well as safety procedures which will include the clearing of all non-essential personnel from the Nominal Hazard Zone. The SOP shall include emergency response actions and clear warnings to avoid possible exposure to laser and collateral radiation in excess of the MPE and 25 TAC §289.301(r)(1). The SOP shall be available for inspection by the LSO at any time.

6.2 Key control 25 TAC §289.301(r)(4)

Each Class 3b or 4 laser and IPL device shall incorporate a key actuated or computer-actuated master control. The key shall be removable and the Class 3b or Class 4 laser or IPL device shall not be operable when the key is removed. When not being prepared for operation or is unattended, the key will be removed from the device and stored in a location away from the machine and computers shall be secured or locked.

6.3 Safety Interlocks and Warning Systems (Reference) 25 TAC §289.301(r)(3)(B) and (D)

A safety interlock is a device that automatically prevents human access above MPE limits.

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 (r)(3)(E) of the referenced regulation, is established.

For pulsed lasers, interlocks shall be designed 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).

Each Class 3b or Class 4 laser system 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 (e.g., lights) shall be visible through protective eyewear for the wavelength of the laser so that eyewear need not be removed to see it.

6.4 Safety Interlocks-Alternatives 25 TAC§ 289.301(r)(3)(E)(iii)(II)

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

Where safety latches or interlocks are not feasible or are inappropriate, for example during surgical procedures, a **controlled area** shall be established. Designating an entire room as a control area is not acceptable. In a controlled area the following shall apply:

1. All authorized personnel shall be trained in laser safety and appropriate personal protective equipment shall be provided and worn upon entry.
2. An alcove with a door, constructed from appropriate materials such as: certified laser curtains, blocking barrier, screen, sheet rock, etc., (without gaps) shall be used to block, screen, or attenuate the laser radiation at the entryway. 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.
3. If a laser is energized and operating, at the entryway there shall be a visible or audible signal and signage indicating laser operations. This indicator may be interfaced with the laser itself, the power supply, or manually operated in accordance with the SOP requiring its use.
 - a. For indoor controlled areas, during tests requiring continuous operation, the individual in charge of the controlled area may momentarily override the safety interlock. The sole purpose is to allow access to other authorized persons if it is clearly evident that there is no optical hazard at the entry area and protective eyewear is worn by the entering person.
 - b. For outdoor controlled areas (such as atmospheric tests) the Permit Holder must contact the Federal Aviation Administration or other appropriate agencies as necessary and must notify the LSO 30 working days prior to operation of Class 4 lasers.
 - c. When removal of panels or protective covers and/or overriding interlocks becomes necessary, such as for servicing, testing or maintenance and laser radiation exceeds the MPE, a temporary controlled area must be established and posted.

6.5 Training 25 TAC §289.301(r)(3)(E)(iii)(II)(-a-)

Every person who operates or works with a laser shall complete the EHS general laser safety training. This training must be repeated every two years. Persons completing Laser Safety Training shall also complete specific laser safety training given by the Permit Holder. No person may work in a NHZ prior to completing both laser safety training classes.

6.6 Protective Eyewear 25 TAC §289.301(t)(1)

Each Permit Holder 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 during any operation where a Class 3b or Class 4 beam is not enclosed (including during the alignment of the laser). Training on identification, proper fit, location, and use of eyewear shall be included in the specific laser safety training by the Permit Holder or designee. Protective eyewear shall be inspected annually and records are to be retained for 5 years.

Protective eyewear shall meet the following requirements:

1. Provide a comfortable and appropriate fit all around the area of the eyes.
2. Be in good physical condition to ensure the lenses retain all protective properties during its use.
3. Be of Optical Density (OD) and Visible Light Transmission (VLT) adequate for the laser energy involved.
4. Have the optical density or densities and associated wavelengths permanently labeled on the filters or eyewear
5. Be examined at intervals not exceeding 12 months, to ensure the reliability of the protective filters and integrity of the holders. Unreliable eyewear shall be discarded and replaced. The performance and results of the examinations must be documented and kept as record by the Permit Holder.
6. The optical density of the protective eyewear shall be appropriate for the specific frequency and pulse length of the laser beam in use, 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

6.7 Miscellaneous Safety and Training Issues

1. Persons working in a laboratory with multiple lasers shall be made aware of the various wavelengths and other operating parameters by the laser operator/users
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 wavelength of the laser.

6.8 Surveys 25 TAC §289.301(w)

Each Permit Holder shall survey the laboratory containing the laser(s) for which the Permit Holder is responsible. The survey shall be performed according to the Laser Procedure Manual. The survey shall be performed biannually (included with the Permit Verification Report), 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 LSO and shall include:

1. A determination that all laser and intense-pulsed light (IPL) devices are labeled correctly and functioning within the design specifications;
2. A determination that protective devices are labeled correctly, functioning within the design specifications, and properly chosen for lasers and IPL devices in use;
3. A determination that all warning devices are functioning within their design specifications;
4. A determination that the controlled area is properly controlled and posted with accurate warning signs;
5. A re-evaluation of potential hazards from surfaces that may be associated with beam paths; and
6. Additional surveys that may be required to evaluate the primary and collateral radiation hazard incident to the use of lasers and IPL devices.

6.9 Fiber Optic Transmission 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 include at least one opaque sheath 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 Permit Holder must inform the LSO and include justification for lack of opaque cover in the SOP.

6.10 Skin protection 25 TAC §289.301(t)(2)

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

6.11 Magnification of Laser Beam 25 TAC §289.301 (r)(2)(C)(ii)

If at any time a laser beam is optically magnified or concentrated, special precautions such as interlocks, filters, or attenuators, shall be taken by the Permit Holder 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.

6.12 Viewing Optics and Windows 25 TAC §289.301 (r)(3)(C)

All viewing ports, viewing optics, display screens, or collecting optics, such as lenses, telescopes, microscopes, etc., included as an integral part of an enclosed laser or laser product shall incorporate suitable means such as interlocks, filters, or attenuators, to maintain the laser radiation transmitted through the collecting optics to levels at or below the appropriate MPE.

7.0 Records 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.

8.0 Non-Radiation Hazards

Each Permit Holder shall evaluate or have an evaluation made of non-radiation hazards. This evaluation shall include electrocution, chemical, cutting edge, compressed gases, noise, confined space, fire, and explosion, laser generated gases, vapors, or fumes, ventilation, and physical safety hazards. The evaluation shall be made part of the SOPs and be available for review.

9.0 Laser Security

Permit Holders are responsible for securing lasers against unauthorized removal or access at all times. While the laser is in operation, the doors shall be locked at all times to prevent unauthorized entry. The following are generally acceptable practices. If other security measures are employed, Permit Holders should consult with EHS.

1. If lasers are accessible (unsecured) in a laboratory, laboratory doors should be locked to prevent unauthorized access; or
2. During periods when the laboratory is not locked, security may be maintained by direct surveillance. The person watching the lab or area shall be instructed to question unauthorized and /or unrecognized persons who enter the laboratory.

10.0 Inspections of Permit Holder Operations

Permit Holders may be inspected at any time by either the TAMU EHS or the Texas Department of State Health Services (DSHS). The following information is intended to make the Permit Holder aware of the inspection program and to provide general information on what is expected of the Permit Holder.

10.1 Inspections by Environmental Health and Safety

EHS inspection of Permit Holders located on TAMU campus should be conducted at least once every two years. EHS reserves the right to inspect any Permit Holder with no advance notice. However, all routine inspections should be announced and scheduled at a time that is mutually acceptable with the Permit Holder. Inspection reports shall be generated by the EHS and a copy sent to the Permit Holder.

10.2 Inspections by the Texas Department of State Health Services

Inspections of EHS by the DSHS may include spot inspections of individual Permit Holders. Such inspections are generally unannounced. Permit Holders are requested to notify EHS when an inspection is in progress. Permit Holders should keep in mind that the EHS may have duplicates of any records found to be missing. By calling the EHS during the inspection and having those duplicates faxed, the Permit Holder may avoid being cited for violations.

11.0 Incident Reporting 25 TAC §289.301(z)-(bb)

Each Permit Holder shall immediately seek appropriate medical attention for the injured individual. The LSO shall be notified immediately of any exposure injury involving a laser or any non-injury incident (near miss) 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 five working days following the incident. Records of any incident shall be maintained by the Permit Holder. If a laser incident occurs, a Report of Injury form shall be completed.

12.0 Emergencies

The staff of the EHS is “on-call” for emergency response 24-hours per day, seven days per week. Any individual may contact the EHS to obtain assistance. Emergency telephone numbers should be posted in every laboratory in which lasers are used.

During normal business hours:
979-845-1361 (EHS Main Office)

After normal business hours, weekends, and holidays:
979-862-1111

Glossary of Terms:

ANSI - American National Standards Institute; provides the American National Standard for Safe Use of Lasers

Beam - A collection of rays characterized by direction, diameter (or dimensions), and divergence (or convergence).

Blink reflex - The closure of the eyelid or movement of the head to avoid an exposure to a noxious stimulant or bright light. Also known as Aversion Response.

Coherent - A light beam is said to be coherent when the electric vector at any point in it is related to that at any other point by a definite, continuous function.

Collateral radiation - Any electromagnetic radiation, except laser radiation, emitted by a laser that is physically necessary for its operation. The applicable, accessible emission limits for collateral radiation may be found in Title 21, CFR, Part 1040.10.

Continuous wave - The output of a laser that is operated in a continuous rather than a pulsed mode. In this manual, a laser operating with a continuous output for a period of ≥ 0.25 seconds is regarded as a continuous wave laser.

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.

Diffuse reflection - Change of the spatial distribution of a beam of radiation when it is reflected in many directions by a surface or by a medium.

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.

Erythema - Reddening of the skin, a.k.a. “sunburn”

Immediate notification - Notification of the proper authorities at the first opportunity available but in no case shall the time period between incident and notification exceed one hour.

Infrared radiation - Electromagnetic radiation with wavelengths, which lie within the range of $0.7 \mu\text{m}$ to 1 mm .

Intense-pulsed light (IPL) device - A device that emits radiation to energy density levels that could reasonably cause bodily harm and that is used for photothermolysis. This device is a Class 2 or Class 3 surgical device certified as complying with the design, labeling, and manufacturing standards of the United States Food and Drug Administration (FDA).

Intrabeam viewing - When the eye views or is exposed to a laser beam directly. This includes most collimated beams and point sources

Inoperable - Incapable of operation by reason of damage, disassembly, removal, or inactivation of key components that cannot be restored without significant repair or renovation.

Joule (J) - A unit of energy. One joule is equal to one watt · second.

Laser - An electronic device that emits stimulated radiation to energy density levels that could reasonably cause bodily harm. A laser may also produce an intense, coherent, directional beam of light by stimulating electronic or molecular transitions to lower energy levels. The term "laser" also includes the assembly of electrical, mechanical, and optical components associated with the laser. A laser can be a component of a product or system. An acronym for Light Amplification by Stimulated Emission of Radiation.

Laser Safety Officer (LSO) - An individual who has 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.

Laser System - An assembly of electrical, mechanical, and optical components, which includes a laser.

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. For the purposes of this section, maximum permissible exposures for laser radiation may be found in ANSI Z136.1-2000, Safe Use of Lasers.

Nominal Hazard Zone (NHZ) - The space within which the level of direct, reflected, or scattered radiation during operation exceeds the applicable MPE. Exposure levels beyond the boundary of the NHZ are below the applicable MPE level.

Optical density (D_λ) - The logarithm to the base ten of the reciprocal of the transmittance. $D_\lambda = -\log_{10} \tau_\lambda$, where τ_λ is transmittance.

Power - The rate at which energy is emitted, transferred, or received.

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 work station and shall limit access to other associated radiant energy emissions and to electrical hazards associated with components and terminals.

Pulse duration - The duration of a laser pulse. This is usually measured as the time interval between the half-power points on the leading and trailing edges of the laser pulse.

Pulsed laser - A laser that delivers its energy in the form of a single pulse or a train of pulses. In this manual, the duration of a pulse is <0.25 seconds.

Reflection - The deviation of radiation following incidence on a surface.

Source - A laser or a laser-illuminated reflecting surface.

Specular Reflection - A mirror like reflection.

Transmission - Passage of radiation through a medium.

Ultraviolet Radiation - Electromagnetic radiation with wavelengths smaller than those of visible radiation; for the purposes of this manual 0.18 to 0.4 μm .

Viewing Portal - An opening in an experimental system, allowing the user to observe the experimental chamber. All viewing portals and display screens included as an integral part of a laser system must incorporate a suitable means to maintain the laser radiation at the viewing positions at or below the applicable MPE for all conditions of operation and maintenance.

Visible radiation (light) - Electromagnetic radiation which can be detected by the human eye.

Watt - The unit of power or radiation flux. 1 watt = 1 joule per second

Wavelength (λ) - The distance between two successive points on a periodic wave that have the same phase.

References:

- 1) *Title 25 of the Texas Administrative Code (TAC), §289.301; Registration and Radiation Safety Requirements for Lasers and Intense-Pulsed Light Devices.*
https://dshs.texas.gov/radiation/pdffiles/Rules/301fn_10_08.pdf
- 2) *ANSI Z136.1-2007: American National Standard for Safe Use of Lasers.* Laser Institute of America, 2007.
- 3) *American National Standard for Safe Use of Lasers in Health Care Facilities.* American National Standards Institute, 2005.
- 4) *American National Standard for the Safe Use of Lasers in Educational Institutions.* Laser Institute of America, 2000.

Appendix A

Laser Application Form

MEMORANDUM

TO: Applicant

FROM: Radiological Safety Staff
Environmental Health and Safety

SUBJECT: Laser Permit Application

Attached is an application for a permit to possess and use laser(s) at Texas A&M University. The Adobe Acrobat PDF file must be completed, printed, and then signed. The Radiological Safety Committee requires this information before a permit can be approved.

All applicants are required to demonstrate training and experience in laser device operation. In addition, the Radiological Safety Committee require that an applicant and authorized user complete an online General Laser Safety Training course offered by the Environmental Health and Safety. Please complete this training course by clicking here: <https://ehsdtraining.tamu.edu/>. A laser application is considered complete when the following items are received by EHS:

1. Complete and signed laser application form
2. Schematic or drawing of proposed use location for all laser(s)
3. Standard Operating Procedures (SOP's) for the laser lab.
4. Please include a copy of the specification sheet that accompanies this laser.

By signing the laser application, you are attesting that you have read the University Laser Program Manual. The manual (29 pages) can be found by clicking here: [Laser Safety Program Manual](#). You may also find the manual located on the EHS web page at <https://ehs.tamu.edu>.

You may contact us at (979) 845-1361 or by e-mail at radiological-safety@tamu.edu if you have any questions.

Thank You.

Radiological Safety Staff

Laser Permit Application

All class IIIb and IV lasers used at Texas A&M University are required to have a permit from Environmental Health and Safety (EHS) [Refer to Section 3.1 of the Laser Safety Program Manual]. Safe laser use and procedural compliance is the responsibility of the laser permit holder. **To apply for a permit, complete this application and submit it along with any necessary attachments to [radiological-safety@tamu.edu](mailto:safety@tamu.edu) or TAMU Environmental Health and Safety via MS. 4472. Contact (979) 845-1361 for any questions.**

PERSONAL INFORMATION

NAME AND TITLE:		EMAIL:
OFFICE PHONE:	INSTITUTION/ CAMPUS ADDRESS: (include Campus, department, mail stop, building and room no.)	
ALTERNATE:		ALTERNATE EMAIL:

LASER DEVICE INFORMATION

SERIAL #:	MANUFACTURER:	MODEL:
CLASS: IIIb or IV	DESCRIPTION (Dye, Argon, Diode, Excimer, etc.):	
LOCATION (BUILDING/ROOM):		INVENTORY # (If Applicable):
BEAM DIAMETER (mm):	BEAM DIVERGENCE (milliradian):	WAVELENGTH (nm):
EXCITATION MECHANISM (Optical, electrical, chemical, etc.):		LENS or FIBER OPTIC SPECIFICATIONS (If Applicable):

OPERATION MODE (select one)

PULSED OR Q-SWITCHED

CONTINUOUS WAVE

PULSE DURATION (s):	AVG. POWER (W):
PULSE FREQUENCY (Hz):	MAX. POWER (W):
AVG. JOULES/PULSE (J):	
MAX. JOULES/PULSE (J):	
MAX. POWER (W):	

USE CATEGORY (*Check all that Apply*)

- | | |
|---|---|
| <input type="checkbox"/> Human (<i>Healing Arts</i>) | <input type="checkbox"/> Academic/Educational (<i>Classroom & Demonstration lasers</i>) |
| <input type="checkbox"/> Veterinary | <input type="checkbox"/> Mobile (<i>Fixed on vehicles, or used at temporary job sites</i>) |
| <input type="checkbox"/> Industrial (<i>Engravers, 3D Printers, etc.</i>) | |
| <input type="checkbox"/> Research | |

Please attach a schematic of the proposed use location showing the location of laser device(s), a picture of the laser device to be added, and a copy of the manufacturer's specification sheet if available.

List the name and title of each individual who will use or directly supervise the use of the laser device. Include names of technicians and students (please designate one of the users as an alternate/lab contact and include his/her office phone #).

Statement of training/experience of applicant: Include training courses completed, laser device operation experience, and the type of work performed. Certificates of completion may be attached if possible.

Statement of use: Describe the purpose for which the laser device(s) will be used. Use additional sheets, if necessary.

Safety protocols: Describe procedures or engineered safety features which will be used to minimize hazards during operation of the laser device.

I have read and understand the University Laser Safety Program Manual regarding laser safety and accept responsibility, as the permitted user, for all lasers used under my permit as stated in section 4.1 (Permit Holder).

PERMIT HOLDER:

Signature

Date

Please print or type name

DEPARTMENT HEAD (or Designee):

Signature

Date

Please print or type name

State law requires that you be informed of the following: (1) you are entitled to request the information collected through this form about yourself (with a few exceptions as provided by law); (2) you are entitled to receive and review that information; and (3) you are entitled to have the information corrected at no charge to you.

Contact: radiological-safety@tamu.edu or (979) 845-1361.

Appendix B

Laser Amendment Form

Texas A&M University Laser Safety Program

Laser Amendment Form

Please complete all applicable items on the amendment including the required signature. For further questions, contact the Radiological Safety Office at (979) 845-1361

TAMU Radiological Safety, EHS, Mail Stop 4472

PERMIT INFORMATION:

PERMIT HOLDER:	PERMIT NUMBER:	DEPT:
OFFICE PHONE:	MAIL STOP:	EMAIL:

TYPE OF ACTION:

- | | |
|--|---|
| <input type="checkbox"/> Additional Use Location | <input type="checkbox"/> Add Equipment |
| <input type="checkbox"/> Remove a Use Location | <input type="checkbox"/> Delete Equipment |

For the addition or removal of a use location, please complete **section A**. For the addition or deletion of new laser equipment, please complete **BOTH sections A and B**.

SECTION A:

LASER SERIAL #:	MANUFACTURER:	MODEL:
PROPOSED USE LOCATION (BUILDING/ROOM):		TAMU ASSET#:

USE CATEGORY (*Check all that apply*)

- | | |
|--|---|
| <input type="checkbox"/> Human (<i>Healing Arts</i>) | <input type="checkbox"/> Academic/Educational (<i>Classroom & Demonstration lasers</i>) |
| <input type="checkbox"/> Veterinary | <input type="checkbox"/> Mobile (<i>Fixed on vehicles, or used at temporary job sites</i>) |
| <input type="checkbox"/> Industrial (Engravers, 3D Printers, etc.) | |
| <input type="checkbox"/> Research | |

SECTION B:

CLASS: IIIb or IV	DESCRIPTION (Dye, Argon, Diode, Excimer, etc.):
BEAM DIAMETER (mm):	BEAM DIVERGENCE (milliradian):
EXCITATION MECHANISM (Optical, electrical, chemical, etc.):	WAVELENGTH (nm):
LENS or FIBER OPTIC SPECIFICATIONS (If Applicable):	

OPERATION MODE (select one)

<u>PULSED OR Q-SWITCHED</u>	<u>CONTINUOUS WAVE</u>
PULSE DURATION (s):	AVG. POWER (W):
PULSE FREQUENCY (Hz):	MAX. POWER (W):
AVG. JOULES/PULSE (J):	
MAX. JOULES/PULSE (J):	
MAX. POWER (W):	

Statement of use: Describe the purpose for which the laser device(s) will be used. Use additional sheets, if necessary. **Please attach a schematic of the proposed use location showing the location of laser device(s), a picture of the laser device to be added, and a copy of the manufacturer's specification sheet if available.**

List the name and title of each individual who will use or directly supervise the use of the laser device. Include names of technicians, students and the date of their respective laser safety training.

Safety protocols: Describe procedures or engineered safety features which will be used to minimize hazards during operation of the laser device(s):

PERMIT HOLDER:

Signature

Date

Please print or type name

DEPARTMENT HEAD (or Designee): *Required for new use locations only.

Signature

Date

Please print or type name

State law requires that you be informed of the following: (1) you are entitled to request the information collected through this form about yourself (with a few exceptions as provided by law); (2) you are entitled to receive and review that information; and (3) you are entitled to have that information corrected at no charge to you.

Contact: radiological-safety@tamu.edu or (979) 845-1361

Appendix C

Laser Transfer Form

Laser Transfer Form

LASER TRANSFERRED FROM:

Permit Holder Name: _____ Permit Number: _____

Date of Transfer: _____

Serial Number/s & Model/s:

Manufacturer/s:

Total amount of Lasers being transferred: _____

Approved By (*Permit Holder "From" signature*): _____

LASER TRANSFERRED TO:

Permit Holder Name: _____ Permit Number: _____

Registration Number/s: _____ (*office use only*)

Approved By (*Permit Holder "To" signature*): _____