

Laser Safety Program

The University of Texas at Austin

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Introduction

The University of Texas at Austin (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 Radiation Safety Committee (The Committee) by the President of The University. The Committee 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 Austin.

2.0 Laser Safety Officer

The Committee 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 Committee on a regular basis with material information about the operation of the Program as required by the Committee. 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.

6 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 Austin 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.

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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 UTLaser1) 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 UTLaser1):

- 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.

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6.6 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**6.6 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 post-doctoral 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.

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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 UTLaser3.

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.

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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.

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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), 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.

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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 UTLaser2 or equivalent that meets the requirements of UTLaser2. 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.

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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 UTLaser5).

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.

The University of Texas at Austin Laser Safety Program

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!

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Form UTLaser2

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? _____

4. HAZARDS & CONTROLS

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

COMMENTS:

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

COMMENTS:

¹ Required by 25TAC§.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		

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Form UTLaser4

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?	_____

ACRONYMS

ASAP As Soon As Possible

BRC Bureau of Radiation Control, Texas Department of Health

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