|  |  |
| --- | --- |
| Laser Safety: |  |
| Supersedes: |  |
| Vice President: |  |
| Revision: |  |
| Program Number: |  |
| Director: |  |

1.0 Purpose

* 1. The purpose of this document is to provide methods to protect (COMPANY) employees who must use lasers or do research or use lasers in the performance of their work at (COMPANY).
	2. Additionally, the purpose of this document is to provide (COMPANY) with a method of complying with regulatory mandates that govern the use of lasers in the workplace.

# Scope – The scope of this section includes the (COMPANY) laser safety applicability and use, requirements, the responsibilities, procedures and training requirements for the safe use of lasers.

# Requirements

* 1. General
		1. Lasers are used at (COMPANY) in research and development activities as well as in some production areas. As visible or invisible sources of intense energy, lasers can be hazardous to the eyes and skin. Additionally, laser applications require special attention to potential electrical, fire, and industrial hygiene (radiation) hazards.
		2. Lasers are classified by their degree of hazard. Each class has requirements of use to ensure safe operation. This program provides the framework for safe application of lasers and applies the American National Standards Institute (ANSI) "Standard for the Safe Use of Lasers" as the basis of engineering and administrative controls.
		3. The requirement to have an established policy and procedure for laser safety and control is driven by the possible severity of laser-associated incidents, illnesses or injuries, regulatory compliance, laser safety standards, and known best safety practices.
	2. Terms and Definitions
		1. ANSI Z136.1

American National Standards Institute consensus standard "For the Safe Use of Lasers." This standard contains the basis of the classification system for lasers and the control measures necessary for each class. Appendix 1 summarizes these control measures.

3.2.2 ANSI Classification System for Lasers

The laser classes are based on degree of biological hazard:

* + - 1. Class 1 – Considered to be incapable of producing damaging radiation levels.
			2. Class 2 and 2a – Emits in the visible portion of the spectrum and eye protection for the exposed individual is normally accomplished by the aversion response including the blink reflex.
			3. Class3a and 3b – May be hazardous to the eye under direct or specular reflection viewing conditions
			4. Class 4 – Is hazardous to the eyes and skin from the direct beam and sometimes from a diffuse reflection and also can be a fire hazard.

3.2.3 Laser – Laser stands for “Light Amplification by Stimulated Emission of Radiation”. A laser’s light beam is an intense coherent beam of light of a nearly single frequency in the ultraviolet, visible, or infrared portion of the spectrum.

3.2.4 Laser Safety Officer (LSO) – The individual designated to have authority to evaluate and establish the control of lasers and their associated hazards. The LSO is someone that has sufficient experience and education to understand the hazards, establish the programs and assist in the monitoring of laser use.

3.2.5 TPDG and R&D Laser Installation – Lasers used for research, development, and non‑routine testing. Non‑R&D lasers include all other uses.

3.2.6 Maximum Permissible Exposure (MPE) and Nominal Hazard Zone (NHZ)

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

* + - 1. When any class IIIb or IV laser is used at levels at or above IIIb in an open beam mode (unenclosed) the MPE will be assumed to be exceeded in that room or area and appropriate precautions must be taken.
			2. 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 IIIb levels. This is done to account for intentional or unintentional scattered or reflected beam. If (COMPANY)’s LSO believes the NHZ does not apply to the whole area he/she may justify a more limited NHZ in the Standard Operating Procedures by using information supplied by the laser manufacturer, by measurement, or by using the appropriate laser range equations or other equivalent assessments.
		1. Interlocks – An interlock is a device that automatically prevents human access above MPE limits.
		2. Pulsed Laser – A pulsed laser is one that must be fired to have the beam sent from the laser. It operates much like any other triggered device. The actual pulse is for a specific time duration.
	1. Classification and Registration

## 3.3.1 Classification of lasers will be done in accordance with US Food and Drug Administration (FDA) or American National Standards Institute specification ANSI Z136.1. Each Class IIIb or IV laser at (COMPANY) must be registered, and must have a Permit issued by the (COMPANY) LSO.

## 3.3.2 Several types of semiconductor lasers require a Permit if the cumulative power exceeds Class IIIa limits. Lasers which are classified as IIIa or lower, but which contain a IIIb or IV laser, must be controlled at the higher classification if the class IIIb or IV laser is accessed. Any class IIIb and IV laser will be referred to as "laser" unless otherwise noted. Each Permittee must be responsible for establishing and supporting laser safety for the Permitted laser.

* 1. Laser Internal Registration Information
		1. Each laser which is possessed, purchased, manufactured, created, assembled or otherwise received by any person or group at (COMPANY) must have a (COMPANY) Permit issued by the LSO.
		2. Application for the Permit must be submitted to the (COMPANY) LSO by the receiving party as soon as possible, but in no case more than 10 days following receipt of the laser.
		3. See the appendicies of this section for Laser Permit Application forms.

## Removal from Registration or Permit Cancellation

## Each laser that is rendered permanently inoperative by disassembly or destruction, or which is removed from the (COMPANY)’s control, surplus designation, or transfer to a non-(COMPANY) entity must: provide information regarding the condition or destination to (COMPANY)’s LSO not later than 10 days from its inoperative state or removal. The Permittee must provide disposition information to (COMPANY)’s LSO prior to leaving (COMPANY).

## Protective Eyewear

* + 1. Each person working with a laser will be provided protective eyewear that meets the requirements of the applicable ANSI Standards (ANSI Z136.1, Z87.1, etc.).
		2. The eyewear must be located where person who operates the laser will have unrestricted access to the eyewear.
		3. The eyewear must be worn during any operation where a class IIIb or IV beam is not enclosed. This normally includes alignments.
		4. Training on identification, proper fit, location, and use of eyewear must be included in the specific laser safety training.
		5. Protective eyewear must meet the following requirements:

3.6.5.1. Provide a comfortable and appropriate fit all around the area of the eye,

* + - 1. Be in good physical condition to ensure the lenses retain all protective properties during its use,
			2. Be of optical density adequate for the laser energy involved,
			3. Have the optical density or densities (density necessary to stop or shield the direct contact of the laser beam) and associated wavelengths permanently labeled on the filters or eyewear,
			4. Be examined at intervals not less than 12 months, to ensure the reliability of the protective filters and integrity of the holders. Unreliable eyewear must be discarded and replaced.,
			5. The optical density of the protective eyewear must be appropriate for the specific frequency and pulse length of the laser beam in use, and must provide reduction of the incident energy to less than the MPE of the laser. The pulse length and frequency of pulse repetition of pulsed lasers must be included in selecting appropriate protective eyewear.

## Laser Safety Surveys

* + 1. Each area where lasers are used or each laser laboratory will have a survey performed by the (COMPANY) LSO.The survey must be performed using Laser Survey Form found in the appendicies part of this section.
		2. Laser Safety surveys must be performed at least annually, and must 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 will be retained for inspection by the (COMPANY) LSO. This survey will be conducted per the (COMPANY) Compliance Calendar.
	1. Laser Safety Standard Operating Procedures
		1. Each laser must 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.
		2. The SOP must be present at the operating console or control panel of the laser.
		3. The SOP must include at a minimum operating instructions, safety eyewear parameters and instructions for proper use, interlock instructions, and a checklist for operation. The SOP must also include clear warnings to avoid possible exposure to laser and collateral radiation in excess of the MPE.
		4. The SOP will be available for inspection or review by (COMPANY)’s LSO at any time.

## Safety Interlocks and Warning Systems

* + 1. Safety interlocks must 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.
		2. Adjustment during operation, service, testing, or maintenance of a laser containing interlocks must not cause the interlocks to become inoperative.
		3. For pulsed lasers, interlocks will be designed to prevent firing of the laser.
		4. Each class IIIb or IV laser system must provide visual or audible indication during the emission of accessible laser radiation. The indication must occur prior to emission of radiation with sufficient time to allow appropriate action to avoid exposure. Any visual indication (e.g., lights) must be visible through protective eyewear for the wavelength of the laser so that eyewear need not be removed to see it.
		5. Safety Interlock alternatives - The regulations recognize that in situations where an engineering control (automatic safety interlock) may be inappropriate, (COMPANY)’s LSO must specify alternate controls to obtain equivalent laser safety protection. Requests to use alternate controls may be submitted in writing to (COMPANY)’s LSO and, if accepted, will be documented in the SOP. Alternatives to interlocks must be established and the following will apply:
			1. All authorized personnel must be trained in laser safety and appropriate personal protective equipment must be provided and worn upon entry.
			2. A door blocking barrier, screen, or curtains must be used to block, screen, or attenuate the laser radiation at the entryway. The level at the exterior of these devices must not exceed the applicable MPE, nor must personnel experience any exposure above the MPE immediately upon entry.
			3. If a laser is energized and operating at class IV levels then at the entryway there must be a visible or audible signal and other appropriate 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.
			4. 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.
			5. For outdoor controlled areas (such as atmospheric tests) the (COMPANY) LSO must contact the Federal Aviation Administration or other appropriate agencies as necessary and must notify (COMPANY)’s LSO or Director of EHS three working days prior to operation of class IV levels of laser energy.
			6. 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. The controlled area is one that will prohibit unauthorized personnel from entering, provide adequate shielding from the beam and beam scatter and one that provides adequate warning to curtail entry.

## Beam Control Precautions

* + 1. Individuals using lasers must not look directly into the beam or at a specular reflection, regardless of its power.
		2. The beam must be terminated at the end of its useful path. The termination is accomplished based upon the type and power of each laser. Some lasers can be stopped by something as simple as a sheet of paper, some need optically rated curtains and some may need a sand dump.
		3. The beam path must be at a point other than eye level when near personnel standing or sitting at a desk.
		4. The laser must be oriented so that the beam is not directed toward entry points to the controlled area or toward aisles.
		5. The possibility of specular and diffuse reflections must be minimized.
		6. The laser must be securely mounted on a stable platform.
		7. The laser beam traverse must be limited during adjustments.
		8. Beam paths must be clearly identified. The path must not cross into areas, where side activities are taking place, 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. The use of reflective objects must be limited or eliminated where lasers are being used if they are not part of the overall laser system/project.
		11. Cooling systems or any liquid condensate which can provide a specular reflective surface must be controled to eliminate exposure to the beam.
		12. Utilize appropriate eye protection during beam alignment and beam instrument manipulation
	1. Incident Reporting
		1. Anyone involved in a laser-related incident must immediately seek appropriate medical attention for the injured individual.
		2. They must then notify (COMPANY)’s LSO of any exposure injury involving a laser possessed by (COMPANY).
		3. The (COMPANY) LSO must be notified within 24 hours of any non-injury incident (near miss) which involves potential exposure to laser radiation exceeding the MPE.
		4. A written summary of an injury or non-injury incident must be forwarded to (COMPANY)’s LSO not later than one working day (24 hours) following the incident.
		5. Records of any incident must be maintained by (COMPANY)’s LSO and the supervisor of the area or department.

4.0 Responsibilities

*(COMPANY) Management and Supervision:*

* + 1. Ensure that lasers are purchased only with the approval of the LSO.
		2. Ensure that lasers are designed and used within the requirements of ANSI Z1 36.1 as well as all applicable (COMPANY) HSE Standards or guidelines. An outline of ANSI engineering and administrative/procedural controls is contained in Appendix of this section.
		3. Ensure that lasers are used within the requirements of all government regulations including those in the Reference Section below.
		4. Maintain a list in their departments of lasers with information necessary for state registration.
		5. Ensure that employees using Class 3 and 4 lasers receive training in laser safety.
		6. Ensure that employees undergo baseline eye exam prior to use of Class 3 or 4 lasers.
		7. Audit laser operations for compliance with this instruction.
		8. Use the checklists provided in the appendices to this section along with other specific (COMPANY) procedures to review all laser installations before start‑up. All non-­R&D Class 3b and 4 laser installations must be reviewed with the LSO.
		9. Ensure that laser permit applications are submitted to the LSO for approval and that laser use does not begin without appropriate permits being granted.
		10. Maintain and update the Laser Information Form as found in Appendices of this section.
		11. Provide a listing of employees to the appropriate Medical personnel for baseline eye exams prior to use of Class 3 and 4 lasers.
		12. Ensure that the LSO or trained delegate provides general training in laser safety to all users of Class 3 and 4 lasers.
		13. Require accountability for compliance with the Division’s laser safety program.
	1. Employees Will:
		1. Work with or around lasers only when they have a basic understanding of their operation and hazards.
		2. Follow all required safety procedures including the use of protective eyewear and skin protection where needed.Attend laser safety training sessions so that they better understand the magnitude and nature of laser related safety issues and concerns.Laser Safety Officer Will:Provide technical assistance in meeting ANSI Z136.1, other applicable ANSI standards and all applicable (COMPANY) Safety and Engineering Standards and government regulations with review of the application of all non‑R&D Class 3b and 4 lasers.
		3. Facilitate the (COMPANY) Laser Safety Permit program.
		4. Assist in risk analysis to establish the use of engineering and administrative controls in varying applications.
		5. Provide training for those who use Class 3 or 4 lasers.
		6. Ensure that lasers used at (COMPANY) are properly labeled regarding class and hazard.
		7. Maintain an inventory of lasers used in (COMPANY) with information necessary for state registration.
		8. Assist in the investigation of incidents and Injuries involving the use of lasers.
		9. Apply for any laser permits that are needed for regulatory compliance and to meet (COMPANY) internal requirements.
		10. Meet, communicate or plan with the Radiation Safety Officer to ensure that employees are not exposed to laser generated x-ray radiation.
		11. Provide training that includes information on biological effects of lasers, laser classif­ication, engineering and administrative controls, and use of personal protective equipment.
		12. Compile Laser Information Forms and submit to the appropriate regulatory authorities, as required.
		13. Conduct Laser Safety Surveys as dictated by the class of laser, use, enclosure, and changes in the environment or procedure using the laser.
		14. Determine the hazards of laser use without protective housing and ensure that controls are instituted to assure safe operation. These controls may include access restriction, eye protection, area controls, barriers, procedural controls and education and training.
		15. Facilitate the (COMPANY) Laser Permit program by reviewing all permit applications and granting permits where appropriate
	2. (COMPANY) Medical Provider Will:
		1. Provide baseline eye exam for those employees who use Class 3 and 4 lasers.
		2. Be prepared to address any adverse laser exposures eyes, shin or as a result of radiation.
		3. Assist the LSO in establishing procedures and response plans to address adverse laser beam exposures.
	3. Purchasing / User Group Departments Will:
		1. Purchase lasers only with the approval signature of the LSO.

4.4.3 Attend laser safety training sessions so that they better understand the magnitude and nature of laser related safety issues and concerns.

* 1. Engineering Department or Staff Will:

## Design and install lasers following the engineering requirements of ANSI Z136.1 as outlined in the appendices of this section.

## Attend laser safety training sessions so that they better understand the magnitude and nature of laser related safety issues and concerns.

## TPDG or Research and Development

## Consult with the LSO on all applications of lasers involved in the R&D process.

## Ensure that laser permit applications are submitted to the LSO for approval and that laser use does not begin without appropriate permits being granted.

## Ensure all lasers are included on facilities laser inventory.

## Ensure the lasers used in the R&D process are properly maintained.

## Assist in the Laser Safety Survey process.

## Attend laser safety training sessions so that they better understand the magnitude and nature of laser related safety issues and concerns.

## Standards / Regulations

## Occupational Safety and Health Act (Administration) Title 29 CFR 1910 Subpart G .97(a)(3)

## Occupational Safety and Health Act (Administration) Title 29 CFR 1926 Subpart D .54

## ANSI Z136.1 ‑ American National Standard for the Safe Use of Lasers

## 105, Code of (State) Regulations - Rules and Regulations Relative to the Use of Laser Systems, Devices or Equipment to Control the Hazards of Laser Rays or Beams.

## 21, Code of Federal Regulations 1040.10 and 1040.11 ‑ Performance Standard for Laser Products.

## (State OSHA agency)

## Training

## Training will be conducted for all employees that work with or may become involved with lasers in the course of their work at (COMPANY).

## Retraining will be done every two years or whenever it is apparent that such training is needed.

## Training will include the following:

## An overview of the (COMPANY) laser safety program, policy and procedures,

## An overview of regulations and standards governing the use of lasers in the workplace,

## How lasers are classified,

## How lasers actually work,

## Laser labeling systems used at (COMPANY),

## Where lasers are used and what they are used for,

## The hazards associated with use of lasers in the workplace,

## Protective measures to be used with lasers,

6.3.8.1. Eye protection

6.3.8.2. Skin protection,

6.3.8.3. Alternative interlock procedures,

6.3.8.4. Warning lights,

* + - * 1. Alarms,
				2. Beam control and stops,
				3. Laser curtains,
		1. The scope and purpose of the Laser Safety Survey
		2. Laser incident reporting

# Documentation

## Laser Reviews – Laser safety reviews will be kept by the LSO as for a period of 5 years after use of the selected laser has been terminated.

## 7.2 Laser Safety Surveys – Laser safety survey reports generated by the LSO must be kept for a period of 5 years after the operation using the laser has been terminated.

## 7.3 Laser Information Forms – Completed laser information forms must be kept by the LSO for a period of 5 years after the laser use has been terminated.

## 7.4 Laser Inventories – Laser inventories must be kept by the LSO for a period of at least 5 years after the use of the lasers has been terminated.

## 7.5 Laser Safety Training – All laser safety training documentation must be kept for a minimum of 4 years after the training is completed.

## 7.6 Laser PPE Documentation – All laser PPE documentation regarding selection, provision, use, vendors, etc. must be kept by the LSO for a minimum of at least 5 years after the use of the laser has been terminated.

# Review – This laser safety program, policies and procedures must be reviewed at least every 3 years or whenever applicable standards change. The review must consider a combination of compliance and best practices involved in the use of lasers.

 **Laser Control Measures Table** – Each laser, to meet Federal Regulations, must be labeled with its classification. The control measures necessary for each classification are listed in the table below:

|  **Control Measures** | **Laser Classification** |
| --- | --- |
|  **Engineering** | **1** | **2a** | **2** | **3a** | **3b** | **4** |
|  Engineering Controls | X | X | X | X | X | X |
|  Protective Housing | X | X | X | X | X | X |
|  Without Protective Housing | LSO Shall Establish Alternate Controls |
|  Interlocks on Protective Housing |  |  |  | X | X | X |
|  Service Access Panel | O | O | O | O | O | X |
|  Key Switch Master | — | — | — | — |  | X |
|  Viewing Portals | — | — |  |  |  |  |
|  Collecting Optics | — | — |  |  |  |  |
|  Totally Open Beam Path | — | — | — | — | X | X |
|  Limited Open Beam Path | — | — | — | — | X | X |
|  Remote Interlock Connector | — | — | — | — |  | X |
|  Beam Stop or Attenuator | — | — | — |  |  | X |
|  Activation Warning Systems | — | — | — | — |  | X |
|  Emission Delay | — | — | — | — | — | X |
|  Class 3b Laser Controlled Area | — | — | — | — | X | — |
|  Class 4 Laser Controlled Area | — | — | — | — | — | X |
|  Laser Outdoor Controls | — | — | — | — | X  | X |
|  Temporary Laser Controlled Area | O | O | O | O | — | — |
|  Remote Firing & Monitoring | — | — | — | — | 1 |  |
|  Labels | — | X  | X  | X  | X  | X  |
|  Area Posting | — | — |  |  | X  | X  |
|  **Administrative and Procedural**  |
|  Administrative & Procedural Controls | — | X | X | X | X | X |
|  Standard Operating Procedures  | — | — | — | — |  | X |
|  Output Emission Limitations  | — | — | — | LSO Determination |
|  Education and Training  | — | — |  | X | X | X |
|  Authorized Personnel  | — | — | — | — | X  | X |
|  Alignment Procedures | — | — | X  | X  | X  | X  |
|  Eye Protection | — | — | — | — |  | X |
|  Spectator Control  | — | — | — | — |  | X |
|  Service Personnel  | O | O | O | O | X | X |
|  Laser Demonstration  | — | — | X  | X  | X  | X  |
|  Laser Fiber Optics  | — | — | X  | X  | X  | X  |

|  |
| --- |
| **Legend** |
| X = Shall |  — = No Requirement  | ! = Shall if MPE is exceeded | \* = During Service Only |
| 1 = Should | O = Shall if Embedded Class 3b or 4 | : = Shall if Embedded Class 3a, 3b or 4 |

***Laser Information Form:***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Laser No.** |  |  |  |  |  |
| **Department:** |  |  |  |  |  |
| **User:** |  |  |  |  |  |
| **Building:** |  |  |  |  |  |
| **Area:** |  |  |  |  |  |
| **Make:** |  |  |  |  |  |
| **Type:** |  |  |  |  |  |
| **Model No.:** |  |  |  |  |  |
| **Serial No.:** |  |  |  |  |  |
| **Wavelength:** |  |  |  |  |  |
| **Power:** |  |  |  |  |  |
| **Class:** |  |  |  |  |  |
| **Mode:** |  |  |  |  |  |
| **Current Application:** |  |  |  |  |  |
| **Comments:** |
|  |
|  |
|  |

Type = lasing medium, e.g. He‑Ne.

Power = output power in watts or output energy in joules per pulse.

Class = Classification of 1, 2a, 2, 3a, 3b, or 4.

Mode = continuous wave (CW), Q‑switched, Pulsed, etc.

Current Application = R&D, Production, etc.