**Commonwealth of Massachusetts**

**Department of Labor Standards**

**OSHA Consultation Program**

[**mass.gov/dols/consult**](http://www.mass.gov/dols/consult)

**Sample Written Laser Safety Program (LSP)**

(OSH Act of 1970 General Duty Clause (5)(a)(1))

(Revised March 2024)

**Note: The following model written program is provided as a guideline only.**

**Employers must develop written programs that are specific to their company’s needs.**

**GENERAL INFORMATION**

This *Laser Safety Program* is being created in order to comply with the *OSH Act of 1970 General Duty Clause (5)(a)(1)* and the *American National Standards for Safe Use of Lasers (ANSI) Z136.1-2014*.

 *(Insert Company Name)*  is responsible for ensuring the safe use of lasers owned by and/or operated in its facility and will establish and maintain an adequate program for the control of laser hazards. This *Laser Safety Program* is being developed because the facility has Class 3B and/or Class 4 lasers and/or laser systems embedded Class 3B and/or Class 4 lasers where beam access by employees is required during maintenance and/or service.

A Class 3B Laser System may be hazardous under direct and specular reflection viewing conditions but is normally not a fire, diffuse reflection, nor a laser-generated air contaminant (LGAC) hazard.

A Class 4 Laser System is hazardous to the eyes or skin from the direct beam, may pose a fire hazard or diffuse reflection hazard, and may also produce LGAC and hazardous plasma radiation.

 *(Insert Company Name)*  has appointed *(employee name)*  as the Laser Safety Officer (LSO).

**Laser Safety Officer**

The LSO shall be provided with training on the potential hazards, control measures, applicable standards, medical examinations, and any other pertinent information.

The LSO is an individual with the authority and responsibility to affect the knowledge, evaluation, and control of laser hazards and the implementation of appropriate control measures. The LSO monitors and enforces compliance with required standards and regulations.

The LSO may also be the radiation safety officer, industrial hygienist, safety engineer, laser specialist, or laser operator. There must be a designated LSO for all circumstances of operation, maintenance, and service of Class 3B and Class 4 lasers or laser systems.

The specific duties and responsibilities of the LSO are as follows:

* Establish and maintain adequate policies and procedures for the control of laser hazards in accordance with federal, state, and local regulations
* Classify or verify the classification of lasers and laser systems used at the facility
* Evaluated the hazards associated with using the lasers
* Ensure that control measures are implemented and maintained
* Recommend or approve Personal Protective Equipment (PPE) such as eyewear, clothing, barriers, and screens that are required to ensure personnel safety
* Review and approve all warning signs and equipment labels concerning the lasers
* Review and approve all Class 3B and Class 4 laser installations, facilities, and equipment prior to use
* Ensure that adequate education and training are provided to laser personnel.
* Ensure employees receive medical evaluations when necessary
* Maintain all necessary records required by applicable government regulations such as medical evaluations, training records, audits, and SOP approvals
* Periodically audit or inspect the laser’s safety functions within the facility and ensure that corrective action is taken when required
* Develop a plan to respond to incidents of actual or suspected exposure to potentially harmful laser radiation, which include root-cause-analysis and report documentation
* Develop and approve *Standard Operating Procedures (SOPs)* for Class 3B and Class 4 laser or laser systems use, maintenance, and service operations which include adequate control measures

**Laser Safety Committee (optional)**

The Laser Safety Committee may establish and maintain adequate policies and procedures for the evaluation and control of laser hazards. *(Insert Company Name)*  has a Laser Safety Committee comprised of the following employees:

 *(Employee Name) (Job Title)*

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**Laser Safety Supervisor**

 *(Insert Company Name)*  shall designate *(Employee Name)*  as the laser safety supervisor. This employee should have the overall knowledge of laser safety requirements for lasers under his/her/they authority and have the following responsibilities:

* Training personnel who work with the lasers
* Permitting laser operations only if there are adequate controls for the hazards to the employees, visitors, and general public
* Submit the names of individuals scheduled to work with lasers to the LSO
* Implement accident response plans if an accident resulting from a laser occurs
* Ensure all employees involved in a laser accident obtain appropriate medical attention
* Permit the operation of a new or modified Class 3B or Class 4 laser only upon the approval of the LSO
* Be familiar with all SOPs involving the Class 3B and/or Class 4 laser

**Laser Operators**

*(Insert Company Name)* shall establish the following employees as laser operators:

 *(Employee Name)*  *(Name of Laser Operating)*

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Laser operators are responsible for the following:

* May only energize or operate a laser when authorized by the laser supervisor
* Will comply with safety rules and SOPs developed by the laser supervisor and LSO
* Inform the laser supervisor and LSO immediately if an accident occurs involving the laser

**Education and Training**

 *(Insert Company Name)*  will ensure that education and training shall be provided for operators, maintenance, and service personnel working on Class 3B or Class 4 lasers or lasers systems. Such lasers will only be operated or serviced by authorized personnel. The level of training shall be commensurate with the degree of potential laser hazards.

 *(Insert Company Name)* will provide the appropriate level of laser safety proficiency through periodic training. Refresher training may be an abbreviated version of the original training with the end result being that the users have the necessary laser safety awareness and knowledge to work safely with their lasers.

 *(Employee Trained) (Job Title) (Date)*

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**Control Measures**

No employee shall be exposed to laser radiation levels exceeding the applicable maximum permissible exposure levels (MPEs) under any reasonably foreseeable conditions of operation. Control measures for the levels of laser radiation hazards, shall be devised to reduce the possibility of exposure to the eyes or skin and to mitigate indirect hazards due to visual interference effects.

Control measures are divided into three groups: engineering, administrative, and personal protective equipment (PPE). Engineering controls are more reliable than administrative controls and should be given priority. Enclosure of the laser equipment will isolate and minimize the hazard. Administrative controls include training and the development and posting of Standard Operating Procedures (SOPs) and policies. PPE shall be used when hazard mitigation cannot adequately be endured using engineering and/or administrative control measures.

Engineering control measures for Class 3B lasers shall include:

* Protective housing
* Interlocks on removable protective housing
* Service-access panels
* Collecting optics

Engineering-control measures for Class 4 lasers shall include all the above for Class 3B lasers and the following:

* Area warning device
* Laser radiation emissions warning
* Entryway controls
* Class 4-controlled area

Administrative control measures for Class 3B and Class 4 lasers include:

* SOPs for Class 4 lasers
* Education and training
* Authorized personnel
* Indoor laser-controlled area
* Outdoor laser-control measures
* Alignment procedures
* Warning signs
* Nominal Hazard Zone (NHZ) analysis for fully or limited open-beam path

**Operating a Class 3B or Class 4 laser without a protective housing**

If a laser is operated without a protective housing, the LSO shall affect a hazard analysis and ensure that adequate engineering control measures are implemented appropriately. The additional engineering controls may include barriers, shrouds, beam conduits, and beam stops.

**Walk-in Protective Housing**

Embedded Class 3B or Class 4 lasers or laser systems with protective housing of sufficient size to allow personnel within the workspace (walk-in protective housing) shall be provided with an area warning system (floor mat, IR sensor) that is activated upon entry by personnel and interlocked with the laser power.

**Service Access Panels**

Service access panels are portions of the protective housing that are only intended to be removed from any laser or laser system by service personnel, which then permit direct access to laser radiation associated with Class 3B or Class 4 lasers. These panels shall be:

* Interlocked
* Require a tool for removal with an appropriate warning label on the panel

All energy services associated with Class 3B, or Class 4 lasers or laser systems shall be designed to permit lockout/tagout procedures required under OSHA.

**Windows**

Facility windows that are located within the NHZ of a Class 3B or Class 4 laser or laser system shall be provided with an appropriate absorbing filter, scattering filter, blocking barrier, or screen that reduces any transmitted laser radiation to levels below the MPE.

**Area Warning Devices**

A Class 3B laser-controlled area should have, and a Class 4 laser-controlled area shall have, an area warning device that is visible prior to entering the area. The warning device is to ensure that persons who are about to enter the laser-controlled area are aware that a laser is emitting accessible radiation within the area.

 *(Insert Company Name)*  has a Class 4 laser-controlled area will have a visible warning device which is mechanical or electrical that indicates when the laser is operating. Examples include an illuminated single lamp or a laser warning sign that is lit or flashes when the laser is operating. The light or lighted-sign can be electronically-interfaced and controlled by the laser power supply so that the light is on (or flashing) only when the laser is operating.

Within the laser-controlled area, an audible or visible laser radiation emission warning device (or emission indicator) should be used with Class 3B lasers and shall be used with Class 4 lasers or laser systems during activation or start-up. The most common laser radiation emission warning device is a single red light located on the laser or its control panel.

The LSO shall consider alternative-control measures for hearing- or visually-impaired employees.

For emergency conditions, there shall be a clearly marked “Emergency Stop” or other appropriately marked device suitable for the intended purpose of deactivating the laser or reducing the output to levels at or below the applicable MPE.

**Entry Controls**

All Class 4-controlled areas shall incorporate one of the following alternatives:

* Non-defeatable (non-override) area or entryway safety control. Non-defeatable safety latches, entryway, or area interlocks (ex. electrical switches, pressure-sensitive floor mats, infrared or sonic detectors) shall be used to deactivate the laser or reduce the output to levels at or below the applicable MPE in the event of an unexpected entry into the laser-controlled area.
* Defeatable area or entryway safety controls such as defeatable safety latches, entryway, or area interlocks
* Procedural Area. Where safety latches or interlocks are not feasible or are inappropriate (during medical procedures), the following shall apply:
	+ All authorized personnel shall be adequately trained and have PPE upon entry
	+ A door, blocking barrier, screen, curtains, etc., shall be used to block, screen, or attenuate the laser radiation at the entryway
	+ At the entryway, there shall be an area warning device indicating that the laser is energized and operating at a Class 4 level

**Standard Operating Procedures**

All laser related SOPs for operating, maintenance, and service procedures should be required for Class 3B lasers and shall be required for Class 4 lasers as well as be approved by the LSO. All SOPs must be kept with the laser equipment for reference.

**Laser-Controlled Area**

 *(Insert Company Name)* will ensure that a Laser-Controlled Area shall be established with adequate control measures when using Class 3B or Class 4 lasers.

Indoor laser-controlled areas have the following minimum requirements for Class 3B and Class 4 lasers:

* Must be controlled by authorized personnel
* Must be posted with appropriate warning signs at entryway and possibly within the laser-controlled area
* Must have a well-defined beam path
* Must require that the appropriate eye protection always be worn

Indoor laser-controlled areas have the following additional minimum requirement for Class 4 lasers:

* Must be under the direct supervision of an individual with knowledge in laser safety
* Must have potentially hazardous beam terminated in a beam stop
* Must use only diffusely reflective materials in or near the beam path
* Must have windows, doorways, and/or open portals covered or restricted to reduce the transmitted laser radiation
* Must store or disable the laser or laser system when not in use

**Alignment Procedures**

An ocular hazard may exist during beam alignment procedures. The LSO will ensure that the alignment of Class 3B or Class 4 laser optical systems (mirrors, lenses, beam deflectors) shall be performed in such a manner that the primary, specular, or diffuse reflection beam does not expose the eye to a level of laser radiation above the applicable MPE.

**Laser Warning Signs**

Laser equipment labels must have the following information:

* Class of the laser or laser system
* Emitted wavelength, pulse duration
* Class 3R and 3B lasers must have the words “Laser Radiation – Avoid Direct Eye Exposure to Beam”
* Class 4 lasers must have the words “Laser Radiation – Avoid Eye Exposure to Direct or Scattered Radiation; Avoid Skin Exposure to Direct Radiation”

 *(Insert Company Name)* and the LSO will ensure that all its Class 3B and Class 4 lasers have adequate control measures.

 *(Name of Laser) (Classification) (Control Measures)*

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**Personal Protective Equipment (PPE)**

Class 3B and Class 4 PPE control measures both include Laser Eye Protection (LEP). Optical Density (OD) and wavelength markings are required on the protective eyewear. Clothing and gloves specifically selected for suitable protection against laser radiation should also be considered. The LEP may include goggles, face shield, spectacles, or prescribed eyewear with special absorbing filter materials or reflective coatings to reduce the potential ocular exposure to or below the appropriate MPE.

When selecting the proper LEP, the following factors need to be considered:

* Laser power and/or pulse energy
* Wavelength of the laser output
* Potential for multi-wavelength operation
* Worst-case scenarios that would require LEP
* Exposure time
* MPE
* Optimal density requirement
* Angular dependence
* Visible luminous (light) transmission (VLT) requirements and assessment of the effect of the eyewear
* Need for side-shield protection
* Radiant exposure or irradiance and the corresponding time factors at which laser safety filters degrade
* Need for prescription glasses
* Comfort and fit
* Strength of materials
* Potential specular reflection
* Anti-fogging designs or coatings

The LEP should be periodically cleaned and inspected with a safety inspection conducted annually. Eyewear in suspicious condition should be tested or discarded. The LEP have limitations because the filters used in constructing the PPE all have damage thresholds that may be exceeded under certain conditions.

Tightly-woven flame-retardant fabrics provide the best skin protection from Class 4 lasers. Opaque flame-retardant gloves (welders’ gloves) provide the best protection from Class 4 lasers.

Particular care shall be taken when using UV lasers or laser systems (295 nm to 400 nm). If the potential for damaging skin exists, then “sunscreen” creams are recommended. UV radiation can also lead to hazardous bi-products such as skin-sensitizing agents, ozone, and Laser-Generated Air Contaminants (LGACs).

 *(Insert Company Name)*  and the LSO will ensure that all its Class 3B and Class 4 lasers operators have adequate PPE.

 *(Name of Laser) (Classification) (PPE Provided)*

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**Accident Investigation**

 *(Insert Company Name)*  and the LSO will ensure that any laser accident is reported, investigated, and a future prevention plan developed.

Any employee with an actual or suspected laser-induced injury should be evaluated by a medical professional as soon as possible after an exposure but usually within 48 hours. The medical examination shall be consistent with the medical symptoms and the anticipated biological effect based upon the laser system used during the incident.

**Hazard Evaluation and Classification**

Only personnel trained in laser safety, optical engineering, physics, or a related field are suited to perform the detailed hazard evaluation computations or the classification determination of a laser or laser system. If the LSO doesn’t possess these qualifications, he/she/they may choose to delegate the responsibility. Such evaluations are to be performed only by individuals who, as a result of training or experience, can provide knowledgeable technical assistance.

Laser classification will be based on the maximum output power or radiant energy available for the intended use.

Laser classification for multi-wavelength lasers which are capable of emitting energy at numerous wavelengths shall be based on the most hazardous possible operation.

A multi-wavelength laser that can operate only as a single-wavelength laser shall be classified as a single-wavelength laser.

For repetitive-pulse lasers that can be operated at any time T, the accessible emission limit (AEL) for multiple pulses or temporal variations shall not exceed the AEL for a single exposure of duration T.

**Environmental Factors**

Environmental factors are important when determining total laser hazards. If exposure of unprotected personnel to the primary or a reflected beam is possible, the LSO shall determine the irradiance or radiant exposure for the primary or reflected beam or the radiance of an extended source of the locations of possible exposures.

Where applicable, the LSO may need to specify the Nominal Hazard Zone (NHZ). The NHZ is the space within which the level of the direct, reflected, or scattered radiation may exceed the applicable maximum permissible exposure (MPE). Exposure levels beyond the boundary of the NHZ are below the applicable MPE.

The MPE is the level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eyes or skin.

The LSO must also ensure that consideration is given to direct, reflected, and scattered radiation in the establishment of boundaries for the Laser-Controlled Area (LCA). The LCA is a laser use area where the occupancy and activity of those within are controlled and supervised. This area may be defined by walls, barriers, or other means. Within this area, potentially hazardous beam exposure is possible.

The LSO may declare the LCA as the NHZ in lieu of calculating all possible NHZ distances such as in the case of a designated laser use room.

**Non-Beam Hazards (NBH)**

NBH are hazards arising from the presence of a laser or laser system, excluding direct exposure of the eyes or skin to a laser beam. NBH includes physical, chemical, and biological agents. All SOPs shall address NBH as well as beam hazards.

NBH can occur due to the interaction of the laser beams with the target material. Other NBH can be:

* Electrical hazards
* Electric Shock
* Thermal burns due to resistive heating
* Electrical fires due to sparks igniting flammable materials
* Arc flash
* Laser-induced damage threshold (LIDT)
* Ionizing radiation
* Optical radiation – UV and Blue light
* Microwave, radiofrequency, extremely low frequency, and static electromagnetic fields
* Fire hazards from Class 4 lasers
* Explosion hazards
* Robotic mechanical hazards
* Noise
* Nanoparticles
* Laser-Generated Air Contaminants (LGAC)
* Compressed Gases
* Laser dyes and solvents
* Biological agents

In order to deal with NBH, *(Insert Company Name)* will use exhaust ventilation, isolation at the process and/or respiratory protection to control the exposures. Respiratory protection must be used in accordance with regulation *29 CFR 1910.134*.

 (Signature of Company Representative)\_\_\_

 (Date)\_\_\_\_