Chapter 10: Laser Safety

Quick Start Summary

Who needs to know about these requirements

The requirements of Laser Safety apply to workers who use low-power lasers, operate high-power lasers, or access labs where such lasers operate; their line management, supervisors, points of contact, and ESH coordinators; laser lab program managers, system laser safety officers (SLSOs), the laser safety officer (LSO), and associate laboratory directors (ALDs); and Occupational Health and Purchasing.

Why

High-power lasers (Class 3B and Class 4) used at SLAC can damage the eye and burn skin and expose workers to electrical currents, explosions, and fires; toxic materials and laser-generated air contaminants; and collateral radiation, noise, and ultraviolet light. Low-power lasers can create a startle hazard and temporary flash-blindness, after images, and glare responses.

What do I need to know

- Lasers are classified (Class 1, Class 2, Class 3R, Class 3B, or Class 4) based on the level of accessible radiation and the associated ability to cause injury to the eye or skin. For example, a Class 4 laser is capable of causing greater injury than a Class 3B laser. Hazard controls are based on the class.
- Work involving Class 3B or Class 4 lasers requires qualified laser operators (QLOs) (or, for limited work, laser controlled area workers) under the supervision of approved system laser safety officers (SLSOs), in laser controlled areas (LCAs) with engineering and administrative controls developed by line management and the SLSO and approved by the SLAC laser safety officer (LSO).
- Use of other classes of lasers, including laser pointers, must meet basic safety requirements.

When

The requirements of this chapter take effect 26 August 2014.

Where do I find more information

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)
- Chapter 10, “Laser Safety”

Or contact the program manager.
Chapter 10

Laser Safety

1 Purpose

The purpose of this program is to mitigate the hazards posed by optical lasers, which operate at wavelengths between 180 nanometer and 1 millimeter. High-power lasers (Class 3B and Class 4) are used at SLAC in research and accelerator operations. The primary hazard associated with their operation is potential eye damage; other potential hazards include skin burns, electrical currents, explosions, fires, toxic material, laser-generated air contaminants, collateral radiation, noise, and ultraviolet light. Low-power lasers (Class 2 and Class 3R) include laser pointers and alignment lasers; they are safe when used as intended, but require some controls.

This program covers the setup and operation of high-power lasers, including the approval of laser controlled areas (LCAs) and of qualified laser operators (QLOs) and system laser safety officers (SLSOs). It also covers the operation of low-power lasers.

It applies to workers who use low-power lasers, operate high-power lasers, or may access labs where such lasers operate; their line management, supervisors, points of contact, and ESH coordinators; and laser lab program managers, SLSOs, the laser safety officer (LSO), associate laboratory directors (ALDs), and Occupational Health and Purchasing.

2 Roles and Responsibilities

Functional roles and general responsibilities for each are listed below. More detailed responsibilities and when they apply are provided in the procedures and requirements.

The roles may be performed by one or more individuals and one individual may play more than one role, depending on the structure of the organizations involved, and responsibilities may be delegated.

2.1 Worker

- Becomes acquainted with all potential laser hazards in his or her work area
- Learns and follows the laser safety policies, procedures, and hazard control methods appropriate for the class of laser being used
- Follows work planning and control requirements, including requesting or conducting pre-job briefings as appropriate
2.2 Qualified Laser Operator

Class 3B or 4 lasers may only be used in approved laser controlled areas (LCAs), by qualified laser operators (QLOs) (or laser controlled area workers, see Section 2.3).

- Is approved and authorized by the SLSO, the LSO, and his or her administrative supervisor. May only work in an LCA after being approved.
- Follows procedures and requirements in the standard operating procedure (SOP) and job safety analysis (JSA) for the work area, including wearing the appropriate personal protective equipment (PPE)
- Stops work and seeks instruction from the SLSO when encountering a circumstance that appears unsafe or is not clearly covered in an SOP or JSA document
- Notifies SLSO of new or increased laser hazards in the workplace
- Informs the SLSO if a laser safety control or procedure should be changed or improved
- In the event of a known or suspected accident involving a laser, disables the laser hazard, then follows SLAC’s incident response procedures, which include getting appropriate medical assistance and notifying supervisors, including the SLSO and the LSO

Generally, a QLO may only work in the lab for which he or she was approved. However, a QLO may enter a laser lab without becoming a QLO for that lab and perform short-term service work (including alignment), measurements, or experiments in Class 4 mode, subject to the following conditions:

- The visiting QLO, called a service QLO, must have approval from his or her administrative supervisor and the SLSO (or their designees) for the laser lab being visited.
- The visiting service QLO must be escorted by one of the lab’s QLOs/LCA workers.
- There must be a pre-job briefing between the service QLO and the escorting QLO/LCA workers for the work to be performed.

Unescorted work in Class 4 mode may only be done by the laser lab’s own QLOs.

2.3 Laser Controlled Area Worker

Laser controlled area (LCA) workers perform support work such as controls electronics, data acquisition, and accelerator operations. To do so they receive limited approval to be allowed access to laser labs. They have the same responsibilities as QLOs but are not authorized to perform laser alignment work, and, depending on the lab, may be restricted from changing operation mode or opening shutters.

LCA workers may enter and perform service work in laser labs not their own subject to the same conditions that apply to visiting QLOs (see Section 2.2).

2.4 Affected Worker

Affected workers are personnel other than QLOs, LCA workers, laser service subcontractors, or the LSO who may need to perform work in a facility that houses Class 3B or Class 4 lasers.
Must receive appropriate training information about laser hazard controls if relying on the transport shutters as a machine guard

Must work outside the envelope of the laser safety system components

May request to apply lockout/tagout (LOTO) for their work

2.5 System Laser Safety Officer

Each Class 3B or Class 4 laser lab will have a designated system laser safety officer (SLSO), to whom the line management and supervision responsibilities for laser safety are assigned.

- Is designated by the laser lab program manager and approved by the LSO
- Is knowledgeable of SLAC’s laser safety policies and implements the required controls
- Is a QLO for the laser lab to which he or she is assigned
- Ensures adequate work planning and control for safe laser operations
- Ensures adequate safety controls of laser hazards for all personnel, including visitors and the general public, before permitting the operation of a laser
- Suspends the operation of a laser when there is inadequate control of laser hazards

Together with administrative supervisors, approves QLOs, service QLOs, and LCA workers and holds them accountable for meeting laser safety requirements. SLSOs should minimize the number of QLOs approved for a specific laser lab by taking advantage of the service QLO and LCA worker designations.

For LCA workers, SLSOs should implement the following controls:

- Limit their number to only those that are essential and may need unescorted laser lab access
- Limit their scope of work, including limiting RFID authorization for the laser safety control panel
- Conduct periodic refresher OJT
- Conduct pre-job briefings prior to their laser lab work and determine if their work needs to be supervised by a regular QLO
- Determine if any additional LCA or NHZ controls are needed to accommodate their work
- Avoid scheduling their work during Class 4 laser operations as much as practical, in particular if laser alignment will be taking place

Designates an acting SLSO to perform SLSO functions when not available and qualifies at least one acting SLSO

Prepares and submits for LSO approval a standard operating procedure (SOP) before permitting Class 3B or Class 4 laser operations. The SLSO will also prepare and submit for LSO approval any additional job safety analyses (JSAs) that may be required for laser operations not adequately described in the SOP. The SLSO will ensure that these documents adequately describe the control of laser hazards in the laser lab and comply with SLAC policy.

Approves configuration control form (CCF) description and completion of work under the CCF and determines additional notifications.
Determine appropriate training requirements for laser workers and ensures that all are appropriately trained on the specific lasers they will operate, including appropriate site-specific and laser-specific on-the-job training (OJT). The SLSO must conduct refresher OJT annually.

In the event of a known or suspected accident involving a laser, disables the laser hazard, then follows SLAC’s incident response procedures, which include getting appropriate medical assistance and notifying line management and the LSO.

Maintains a current inventory of all lasers within his or her responsibility. The inventory will include the classification, wavelength, power, manufacturer, model designation, and serial number or SLAC property control number of the laser.

Maintains a laser safety binder at the laser lab that includes the SOP, JSAs, and CCFs and other laser safety documentation, such as QLO and LCA worker approval forms, OJT documentation, and eyewear records.

Shares with the laser lab program manager and the ESH coordinator responsibility for reviewing and addressing non-laser safety issues.

### 2.6 Acting System Laser Safety Officer

- Is designated by the SLSO to perform SLSO functions when the SLSO is not available.
- Meets all requirements for an SLSO, including being a QLO for the laser lab in question and completing all SLSO training.

### 2.7 ESH Coordinator

- Shares with the laser lab program manager and the SLSO responsibility for reviewing and addressing non-laser safety issues.

### 2.8 Administrative Supervisor / SLAC Point of Contact

**Note:** SLAC employees report directly to their administrative supervisor, and non-employees report to a SLAC point of contact, as described in Chapter 1, “General Policy and Responsibilities.” Administrative supervisors and SLAC points of contact have line management responsibility for their assigned workers. Line management for laser work of assigned workers is matrixed between the administrative supervisor and the SLSO.

- Assigns appropriate ESH laser safety training courses for assigned workers using the SLAC Training Assessment (STA).
- Discusses with the SLSO shared supervisory responsibilities, covering laser work to be performed by his or her assigned workers, required ESH laser safety training courses, and any required site-specific OJT.
- Conducts periodic discussions about laser work with his assigned workers and the SLSO.
- Has line management responsibility for the conduct of his assigned workers.
- Together with the SLSO, holds QLOs and LCA workers accountable for meeting laser safety requirements.
2.9 Purchasing Department

- Notifies the LSO before an order is placed for laser eyewear protection or for a Class 3B or Class 4 laser.

2.10 Occupational Health Center

- Conducts laser medical eye examinations, ESH Course 253ME, Laser Worker Baseline Medical Exam ([ESH Course 253ME](#)), for all employees, students, and users before they use Class 3B or 4 lasers at SLAC.
- For any injury or suspected injury, conducts a a laser medical eye exam and arranges for an ophthalmology exam if needed.
- For all reportable laser incidents, must meet with affected personnel even when there are no symptoms and inform them of the availability of laser eye exams.
- Conducts additional tests for SLAC employees if results of the baseline examination indicate an abnormality. For non-employees, SLAC requests that home institutions perform the required medical eye examination and send results to the SLAC Occupational Health Center for review.
- Follows SLAC’s incident response procedures and notifies the LSO immediately if an eye injury due to a laser accident is reported, suspected, or confirmed.

2.11 Laser Lab Program Manager

Each Class 3B or Class 4 laser lab must have a designated program manager, who has line management responsibility for the lab.
- Designates an SLSO for each Class 3B or Class 4 laser lab under his or her control.
- Assigns line management responsibility for laser safety in the lab to the SLSO.
- Periodically discusses the lab’s laser operations with the SLSO.
- Shares with the SLSO and ESH coordinator responsibility for reviewing and addressing non-laser safety issues.

2.12 Associate Laboratory Director

- Approves policy allowing use of alignment eyewear in laser labs in his or her directorate.

2.13 Laser Safety Committee

- Advises the LSO on laser safety matters and recommends improvements; also provides oversight and periodic review, as requested.
- Provides expertise in forming laser safety policy.
- Maintains an awareness of all applicable laser safety policies.
2.14 Program Manager / Laser Safety Officer

- Is assigned by the laboratory director
- Reports to the chief safety officer (CSO) and advises him or her on laser safety policies and requirements
- Establishes and maintains adequate policies for the control of laser hazards that comply with applicable federal regulations and accepted industry standards
- Approves
  - Operation of all Class 3B and Class 4 lasers
  - The laser safety contract, standard operating procedure (SOP), and job safety analysis (JSA) required for operation of a Class 3B or Class 4 laser
  - Configuration control forms (CCF) in instances where an LSO inspection is required
  - All non-service QLOs and LCA workers
- Determines when new laser labs or major changes to a laser lab should be reviewed by the Laser Safety Committee
- Has authorization to stop any operation for which he or she perceives the laser safety to be inadequate and can be overruled only by the CSO or the laboratory director
- Has authorization to inspect and monitor all laser operations and enforce laser safety control of hazards
- Classifies or verifies classification of all laser systems
- Consults on laser hazard evaluation and controls and assists SLSOs in developing SOPs and JSAs
- Reviews wording on laser area warning signs and equipment labels
- Ensures that the general laser safety training is adequate and available to all workers operating Class 3B and Class 4 lasers
- Performs an annual laser safety inspection of each Class 3B and Class 4 laser lab to review the lab’s laser systems, laser hazard controls, and compliance with the lab’s safety requirements given in the laser safety contract, SOP, and JSA. The LSO will document these inspections and submit the results to the SLSO, lab program manager, and ESH coordinator.
- Performs a hazard analysis for possibility of a hazardous exposure for all reportable incidents, and informs the Occupational Health Center of results
- Is an ex officio member of the Laser Safety Committee

3 Procedures, Processes, and Requirements

These documents state the core requirements for this program and describe how to implement them.

3.1 General Requirements for All Laser Classifications

- [Laser Safety: General Requirements](SLAC-I-730-0A05S-008). Describes requirements that apply to all classes of lasers, including classification, control hierarchy, operation modes (normal, maintenance and service), exposure levels, protective housing, warning signs and labels, and WPC implementation.
3.2 Requirements for Class 2 and Class 3R Laser Operations

- **Laser Safety: Class 2 and Class 3R Laser Operation Requirements** (SLAC-I-730-0A05S-003). Describes requirements for using Class 2 and Class 3R lasers.

3.3 Requirements for Laser Pointer Use

- **Laser Safety: Laser Pointer Requirements** (SLAC-I-730-0A05S-010). Describes requirements for using laser pointers and warns about high-power laser pointers and defects observed with some green laser pointers.

3.4 Requirements and Procedures for Class 3B and Class 4 Laser Operations

- **Laser Safety: Qualified Laser Operator Approval Form** (SLAC-I-730-0A05J-007). Lists requirements for approving QLOs and must be completed before a QLO begins work with Class 3B and Class 4 lasers.
- **Laser Safety: Laser Controlled Area Worker Approval Form** (SLAC-I-730-0A05J-008). Lists requirements for approving laser controlled area (LCA) workers and must be completed before a LCA worker begins work with Class 3B and Class 4 lasers.
- **Laser Safety: System Laser Safety Officer Approval Form** (SLAC-I-730-0A05J-001). Documents approvals for SLSOs.
- **Laser Safety: Approval to Operate Form** (SLAC-I-730-0A05J-003). Lists requirements that must be met to permit Class 3B and Class 4 laser lab operation.
- **Laser Safety: Class 3B and Class 4 Laser Operation Requirements** (SLAC-I-730-0A05S-004). Describes requirements for identifying hazards, developing controls, and authorizing operations and personnel for Class 3B and Class 4 lasers.
- **Laser Safety: Class 3B and Class 4 UV Laser Operation Requirements** (SLAC-I-730-0A05S-012). Describes additional requirements for setup and use of facilities where Class 3B or Class 4 UV lasers may operate.
- **Laser Safety: Laser Controlled Area Requirements** (SLAC-I-730-0A05S-009). Describes requirements for setting up and working in a laser controlled area (LCA), which is a designation required when the maximum level of accessible laser radiation is Class 3B or Class 4.
- **Laser Safety: Class 3B and Class 4 Laser CoHE Requirements** (SLAC-I-730-0A05S-005). Describes requirements for control of hazardous energy (CoHE) for Class 3B and Class 4 lasers.
- **Laser Safety: Class 3B and Class 4 Laser Eyewear Protection Requirements** (SLAC-I-730-0A05S-007). Describes requirements for using protective eyewear when operating Class 3B and Class 4 lasers.
3.5 Other Laser Safety Forms, Tools, and Documents

Additional documents for implementing laser safety requirements are available from the Laser Safety SharePoint Site.

4 Training

4.1 Qualified Laser Operator / LCA Worker

Using the SLAC Training Assessment (STA), supervisors and SLAC points of contact assign training for laser workers and ensure that they are appropriately trained in laser hazards and controls before beginning work. General laser safety training courses are provided by the ESHQ Division. Site-specific on-the-job training (OJT) is provided by SLSOs (or their qualified designees), who also give the ESH Course 253PRA. SLSOs will maintain a record of training provided to laser workers, including on-the-job training.

4.1.1 General

- ESH Course 253, Laser Worker Safety Training (ESH Course 253)
- ESH Course 131, Laser Accidents and Lessons Learned (ESH Course 131)
- ESH Course 253PRA, Laser Alignment Safety Practical (ESH Course 253PRA) (only required for operators who perform laser alignment; not required for LCA workers)

4.1.2 Baseline Eye Examination

Baseline eye examinations (ESH Course 253ME) are required for all employees, students, and users before they may use Class 3B or 4 lasers at SLAC. They are also required following any suspected laser-induced injury. A voluntary 253ME exit examination is offered to SLAC employees upon employment termination.

The Occupational Health Department assists laser workers in obtaining a baseline eye examinations and issues a medical clearance for laser use if results are satisfactory. Such eye examinations establish a baseline against which suspected eye damage can be measured. If an abnormality is found, an additional fundusoscopic examination may be required. For non-employees, SLAC requests that home institutions perform the required medical eye examination and send results to the SLAC Occupational Health Department for review.

- ESH Course 253ME, Laser Worker Baseline Medical Exam (ESH Course 253ME)
4.1.3 Site-specific On-the-Job Training

SLSOs have line management responsibility for providing and documenting on-the-job training (OJT) to QLOs. (To assist this, templates for an OJT syllabus and an OJT completion form that indicate the expectations are available from the Laser Safety SharePoint Site.) SLSOs should have a one-page summary spreadsheet (QLO/LCA worker matrix) which is easily accessible at the laser lab (example template is available from the Laser Safety SharePoint Site.) The LSO will check that OJT is adequately implemented at the annual laser facility audit and during periodic inspections.

4.1.3.1 Refresher OJT

SLSOs must conduct annual refresher OJT with all authorized laser personnel for their laser lab. The training must cover

- Changing operation modes
- Zero energy verification
- Configuration control

The training should cover

- Laser operation modes and associated eyewear requirements
- Current configuration for lasers, safety shutters, and Class 1 enclosures
- Posted signs and procedures
- Recent SOP revision updates, and any JSA documents in use
- RFID permissions and approved operations

The training must be documented, including the date completed and a syllabus of subjects covered (templates are available from the Laser Safety SharePoint Site).

4.2 System Laser Safety Officer / Acting System Laser Safety Officer

SLSOs and acting SLSOs are required to complete all QLO requirements, and in addition must take the following courses:

- ESH Course 130, Laser Safety for Supervisors (ESH Course 130)
- ESH Course 157, Control of Hazardous Energy (ESH Course 157) or ESH Course 136, Control of Hazardous Energy – Affected Employee (ESH Course 136)

4.3 Affected Worker and Class 2 or Class 3R Laser Operator

This course is recommended for affected workers in areas where Class 3B or Class 4 lasers may operate and for workers who operate Class 2 or Class 3R lasers:

- ESH Course 132, Laser Safety Basics (ESH Course 132)
5 Definitions

Absorption, saturable. The property of laser eye protection where the absorption of light decreases (OD decreases) with increasing light intensity. This has been shown to occur with certain laser eye protection materials with high-energy sub-nanosecond pulses.

Analysis, job safety (JSA). Technique (and document) that identifies the tasks associated with a job and the related hazards and the controls to eliminate or reduce them to an acceptable risk level. The analysis focuses on the relationship between the worker, the task, the tools, and the work environment.

Area, laser controlled (LCA). An area with restricted access where Class 3B or Class 4 lasers may operate. An LCA will have controls to provide protection from laser hazards.

Coherent. A beam of light characterized by a fixed phase relationship in space (spatial coherence) or in time (temporal coherence) at a given wavelength.

Contract, laser safety. A contract between the SLSO, the LCA line management, and the LSO; it describes details of the laser facility and laser operations and the associated hazards and controls.

Control of hazardous energy (CoHE). Control measures used to protect workers from exposure to all forms of hazardous energy due to accidental equipment energization or startup, or from working on or near electrical conductors or circuit parts.

Density, optical. The logarithm, using base ten, of the reciprocal of the transmittance of a material, such as laser eyewear, at a particular wavelength (for example OD1 has a transmittance of 10 percent).

Device, energy isolating. A mechanical device that physically prevents the transmission or release of energy.

Enclosure. A physical barrier that completely encloses a laser beam, so that the associated laser beam is inaccessible. If an enclosure for a Class 3B or Class 4 laser beam is appropriately secured or interlocked and has appropriate safety labels, it may be approved by the LSO as a Class 1 enclosure.

Enclosure, Class 1. A complete enclosure that fully contains a laser beam to ensure there is no accessible laser hazard from the enclosed beam.

Exposure, maximum permissible (MPE). The maximum level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin.

Eyewear, alignment. Laser eyewear used in special procedures with visible lasers, which has reduced optical density from full protection eyewear.

Eyewear, full protection. Laser eyewear that has sufficient optical density that its transmission reduces exposure to a level below the maximum permissible exposure (MPE) for a direct laser beam and specular reflections.

Guard, machine. An engineered safety control used to prevent exposure to an energized (or partially energized or enabled) hazardous laser beam (examples include safety shutter, laser key, interlocked cover).
Hazard, non-beam. A hazard associated with laser equipment or laser operations that results from factors other than direct human exposure to a laser beam

Intensity. The radiant power per unit area, typically measured in W/cm². Also referred to as irradiance.

Laser. A device that produces a coherent, intense, highly directional beam of light of a single wavelength or tunable over a band of wavelengths

Laser, continuous wave (CW). A laser operated with a continuous output for a period greater than or equal to 0.25 seconds

Laser, pulsed. A laser that delivers its energy in a single pulse or a train of pulses, with duration of the pulses less than 0.25 seconds

Limit, accessible emission (AEL). The maximum accessible emission level permitted within a particular laser class

Manager, laser lab program. A manager of a Class 3B or Class 4 laser lab, or an area or building manager for an LCA

Mode, operation. Laser work will be in one of three operation mode categories: normal, maintenance, or service. Normal covers a laser operating over the full range of its intended functions. Maintenance covers adjustments or procedures being performed to maintain or re-establish optimal performance, usually when the configuration of a laser safety barrier is changed. Service covers repair to bring a laser back to normal operational status. A laser controlled area will also define a different type of operation mode that determines what the requirements are for entry, eyewear protection, and interlock functionality – for example Laser Off, Class 1, and Class 4 are three possible operation modes for a LCA.

Officer, laser safety (LSO). An individual designated by the laboratory director having the authority and responsibility to monitor and enforce the control of laser hazards and to effect the knowledgeable evaluation and control of laser hazards

Officer, system laser safety (SLSO). An individual designated by the laser lab program manager to have line management and supervision responsibilities for safe laser operations in a laser controlled area

Operator, qualified laser (QLO). A worker who has completed all the training requirements and has the necessary approvals to be authorized and released for performing laser work with Class 3B or Class 4 lasers in a specific laser lab (see also operator, service qualified laser and worker, laser controlled area)

Operator, service qualified laser (service QLO). A QLO authorized to perform limited service work in a laser lab other than the one for which he or she was approved

Procedure, standard operating (SOP). A pre-approved, job-specific procedure that describes the complete work scope; necessary work instructions, precautions, and prerequisites; hazards associated with the job; and the hazard controls to be implemented in order to prevent accidents, injuries, and property damage

Radiation, plasma. Black-body radiation generated by a heated material that can result from laser-target interactions. Hot electrons in a plasma may also generate hazardous x-rays under certain conditions at very high laser intensity.
Reflection, diffuse. Change of the spatial distribution of a beam of radiation when it is reflected in many directions by a surface or by a medium

Reflection, specular. A mirror-like reflection

Response, aversion. Blinking or looking away when exposed to a bright light. The aversion response time is assumed to be 0.25 seconds.

Shutter, laser safety. A remotely or manually controlled beam block that can be inserted to function as a machine guard (or sometimes as an energy isolating device in a LOTO procedure). It is often used to disable a laser hazard as part of an interlocked access control. It is also sometimes used in a laser controlled area (LCA) as part of a Class 1 enclosure if it is closed and disabled.

System, laser safety. Engineered controls used in an LCA for the following: interlocks, access control system, status display signs, control for setting operation modes, control for safety shutter operation

Transmission, visible light (VLT). The amount of visible light passing through a filter, weighted for the response of the human eye, expressed as a percentage

Visitor, laser lab. Personnel, not including service subcontractors or the laser safety officer (LSO), who have not been approved as a qualified laser operator (QLO) in a SLAC laser laboratory but are visiting one

Worker, laser controlled area (LCA worker). Workers who perform support work such as controls electronics, data acquisition, and accelerator operations, for which they receive limited approval to be allowed access to laser labs

Worker, service laser controlled area (service LCA worker). An LCA worker authorized to perform limited service work in a laser lab other than the one for which he or she was approved

Zone, nominal hazard (NHZ). An area where laser radiation may exceed the maximum permissible exposure (MPE)

6 References

6.1 External Requirements

The following are the external requirements that apply to this program:

6.2 Related Documents

**SLAC Environment, Safety, and Health Manual** (SLAC-I-720-0A29Z-001)
- Chapter 1, “General Policy and Responsibilities”
- Chapter 2, “Work Planning and Control”
- Chapter 28, “Incident Investigation”
- Chapter 51, “Control of Hazardous Energy”

Other SLAC Documents
- Laser Safety Committee
- SLAC Occupational Health Center
- SLAC Training Assessment
- On-The-Job (OJT) Training Requirements (200-2P-1)

Other Documents
  - Section 1040.10, “Laser Products” ([21 CFR 1040.10](#))
  - Section 1040.11, “Specific Purpose Laser Products” ([21 CFR 1040.11](#))
- Stanford University, *Department of Environmental Health and Safety, Research and Laboratory Safety: Laser Safety Program*
- *Food and Drug Administration (FDA), Illuminating Facts About Laser Pointers*
Chapter 10: Laser Safety

General Requirements

1 Purpose

The purpose of these requirements is to ensure applicable controls are in place for each class of laser. They cover classifying, labeling, and using all classes of lasers. They apply to workers using lasers, system laser safety officers (SLSOs), laser laboratory program managers, line management, and the laser safety officer (LSO).

2 Requirements

Laser safety requirements depend on three factors:

1. The laser classification: each laser is assigned a classification (Class 1, Class 2, Class 3R, Class 3B, or Class 4) based on the level of its accessible radiation and the associated ability of the laser beam to cause injury to the eye or skin. For example, a Class 4 laser is capable of causing greater injury than a Class 3B laser.

2. The environment in which the laser is used, including access to the beam path (considering such factors as enclosures and barriers).

3. The personnel who may use or be exposed to laser radiation.

2.1 Classification

Lasers are classified according to their accessible radiation during normal operation. A commercial laser purchased with a manufacturer-provided hazard classification that is in conformance with the Federal Laser Product Performance Standard (FLPPS, 21 CFR 1040.10 and 21 CFR 1040.11) fulfills all classification requirements.

Lasers fabricated for research and without manufacturer’s assurance of FLPPS compliance must be classified prior to operation.

The LSO will classify lasers and laser systems when the classification is not provided, the classification is not in accordance with the FLPPS, or the intended use is different from the use recommended by the manufacturer, or engineering control measures are added, deleted, or modified. Laser classes are given in Table 1.
### Table 1 Laser Classes and Hazards

<table>
<thead>
<tr>
<th>Class</th>
<th>Hazard</th>
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</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>▪ Incapable of producing damaging radiation levels</td>
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<td></td>
<td>▪ May have an accessible laser beam at very low intensity, or may be a fully enclosed laser with no accessible radiation</td>
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<td></td>
<td>▪ Exempt from any administrative or PPE control measure requirements</td>
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<td>Class 2</td>
<td>▪ Emits visible radiation at wavelengths between 400–700 nm</td>
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<td>▪ Eye aversion response (blinking or looking away) provides adequate protection, but eye injury is possible if there is an intentional prolonged exposure. The eye aversion response time is assumed to be 0.25 seconds.</td>
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<td></td>
<td>▪ Maximum average power for continuous wave (cw) lasers is 1 mW</td>
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<td></td>
<td>▪ Can present a startle hazard and may cause temporary flash-blindness, after images and glare responses; thus some controls are needed to prevent an accidental exposure</td>
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<tr>
<td>Class 3R</td>
<td>(previously called 3a)</td>
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<td></td>
<td>▪ Emitted radiation may be visible or invisible</td>
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<td></td>
<td>▪ Visible laser radiation is greater intensity than Class 2, but must be within a factor 5 of the Class 2 accessible emission limit (maximum average power for cw lasers is 5 mW). Invisible laser radiation is greater intensity than Class 1, but must be within a factor 5 of the Class 1 accessible emission limit.</td>
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<td></td>
<td>▪ Generally not considered a significant hazard for accidental viewing, but is a potential hazard for direct or specular reflection viewing</td>
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<tr>
<td></td>
<td>▪ Can present a startle hazard and may cause temporary flash-blindness, after images and glare responses; thus some controls are needed to prevent accidental exposure</td>
</tr>
<tr>
<td>Class 3B</td>
<td>(previously called 3b)</td>
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<tr>
<td></td>
<td>▪ Emitted radiation has intensity greater than Class 3R. Maximum average power is less than 500 mW (can be lower for pulsed lasers).</td>
</tr>
<tr>
<td></td>
<td>▪ Eye hazard for direct or specular reflection viewing; there are associated laser eyewear protection requirements.</td>
</tr>
<tr>
<td>Class 4</td>
<td>▪ Emitted radiation has intensity greater than Class 3B</td>
</tr>
<tr>
<td></td>
<td>▪ Hazard to eye or skin from direct beam; there are associated laser eyewear protection requirements</td>
</tr>
<tr>
<td></td>
<td>▪ Diffuse reflections may be hazardous</td>
</tr>
<tr>
<td></td>
<td>▪ Potential for fire hazard from laser intensity exceeding combustibility thresholds of some materials</td>
</tr>
<tr>
<td></td>
<td>▪ Laser-target interactions may produce laser-generated air contaminants, and hazardous plasma radiation at very high intensities</td>
</tr>
</tbody>
</table>
2.2 Control Hierarchy

Laser hazards are controlled with a combination of engineering and administrative controls and personal protective equipment (PPE). Engineering controls are given first priority. If possible, they are used to eliminate the laser hazard by fully enclosing the laser beam. Class 3B and Class 4 laser operation requires significant engineering, administrative, and PPE controls, in particular for use of laser eyewear protection. There must be sufficient redundancy of controls to ensure safe laser operations with minimal risk for injury.

2.3 Alternate Controls

Upon review and approval by the LSO, the engineering and administrative control measures specified in this chapter may be replaced by procedural, administrative, or other alternate engineering controls that provide equivalent protection. If alternate control measures are instituted, then those personnel directly affected by the measures must be provided the appropriate laser safety and operational training.

2.4 Operation Modes

Laser operation will be in one of three operation modes:

1. Normal. The laser is operating over the full range of its intended functions. This can include adjustments and alignment work, which are normal activities for qualified laser operators (QLOs). A laser controlled area (LCA) may define more than one normal operation mode to indicate which laser hazards are enabled and what the corresponding laser eyewear protection requirement is, for example Laser Off, Class 1, and Class 4.

2. Maintenance. Adjustments or procedures are performed to maintain or re-establish optimal performance of the laser system. Usually this operation mode means that the configuration of a laser safety barrier is changed, which may affect laser eyewear protection requirements or the functionality of interlock systems.

3. Service. The performance of procedures, typically defined as repair, to bring the laser or laser system or laser product back to normal operational status. For example, work by service subcontractors will be in service mode and an area NOTICE sign will be used to signify this.

2.5 Unattended Operation

Only Class 1 lasers or laser systems will be used for unattended operation in unsupervised areas without the implementation of additional control measure requirements.
2.6 Exposure Control

The following controls are recommended for all laser classes above Class 1 to minimize the risk from potential exposure to laser beams:

- Use the minimum laser radiation required for the application.
- Avoid eye and skin exposure and direct viewing of the laser beam; maintain the beam at a level other than the eye level of a person sitting or standing.
- Limit potential exposure levels to as far below the maximum permissible exposure (MPE) values as is practical (values for the MPE are below known hazardous levels and can be obtained from the LSO or ANSI Z136.1).

2.7 Protective Housing

A laser must be contained in its appropriate protective housing to reduce potential exposure. The aperture through which the useful beam is emitted is not part of the protective housing. Special safety procedures may be required when protective housings are removed.

The protective housing must

- Limit the maximum accessible laser radiation to a level that defines the classification
- Have classification labels affixed on a conspicuous part of the laser housing
- Limit access to other associated radiant energy emissions and to electrical hazards associated with components and terminals
- Have interlocks to disable the laser operation if the cover is removed (these interlocks may be defeatable for service work) or be secured and have an appropriate warning label, which states hazards and additional controls needed if cover is removed

2.8 Warning Signs and Labels

- All lasers must have labels on the protective housing that specify their classification.
- All lasers with an aperture output must have an associated aperture label.
- All lasers with defeatable interlocks must have an associated warning label.
- Long distance (>3 meters) beam conduits that contain beams operating above Class 1 levels must have labels at appropriate intervals (approximately 3 meters) to provide warning of the relative hazards of laser radiation contained within the conduit. \textit{Note: this requirement does not apply to fiber optics cables used in optical fiber communications systems.}

Templates for labels and signs are available on the Laser Safety SharePoint Site.
2.9 Work Planning and Control

Laser operations must comply with SLAC work planning and control (WPC) requirements (see Chapter 2, “Work Planning and Control”). WPC requirements for laser safety when working with Class 3B and Class 4 lasers include the following:

- Work by QLOs and laser controlled area workers is considered yellow work. Authorization and release for this work is done via Laser Safety: Qualified Laser Operator Approval Form or a Laser Safety: Laser Controlled Area Worker Approval Form, respectively. Such work performed by service subcontractors is considered red work and is authorized and released following Laser Safety: Laser Service Subcontractor Work Planning and Control Procedure.

- A laser safety contract, SOP, or JSA is used to describe hazards and controls associated with this laser work. Laser work may only begin after these documents and the laser laboratory itself have been approved.

- Pre-job briefings must be held as appropriate, and are recommended for new tasks, unfamiliar or infrequently performed tasks, significant configuration changes, or returning system to operation following a downtime or power outage.

- Additional requirements exist when laser work is performed by service subcontractors (see Laser Safety: Laser Service Subcontractor Work Planning and Control Procedure).

For details, see Laser Safety: Class 3B and Class 4 Laser Operation Requirements.

3 Forms

The following are forms required by these requirements:

- None

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- None

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)
Chapter 10, “Laser Safety”

- Laser Safety: Laser Pointer Requirements (SLAC-I-730-0A05S-010)
- Laser Safety: Class 2 and Class 3R Laser Operation Requirements (SLAC-I-730-0A05S-003)
- Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)
- Laser Safety: Class 3B and Class 4 UV Laser Operation Requirements (SLAC-I-730-0A05S-012)
- Laser Safety: Qualified Laser Operator Approval Form (SLAC-I-730-0A05J-007)
- Laser Safety: Laser Controlled Area Worker Approval Form (SLAC-I-730-0A05J-008)

Chapter 2, “Work Planning and Control”

Other SLAC Documents

- Laser Safety SharePoint Site

Other Documents

  - Section 1040.10, “Laser Products” (21 CFR 1040.10)
  - Section 1040.11, “Specific Purpose Laser Products” (21 CFR 1040.11)
1 Purpose

The purpose of these requirements is to protect workers from harmful exposure to low-power lasers, which can create a startle hazard and temporary flash-blindness, after images, and glare responses. They cover using Class 2 and 3R lasers and posting of hazards. They apply to workers whenever they are using lasers of this classification and their supervisors.

Note: Laser pointers are also classified as Class 2 and 3R but the requirements they are subject to are in Laser Safety: Laser Pointer Requirements. Class 3R lasers were formerly known as Class 3a lasers and may still bear a label with the former classification.

2 Requirements

<table>
<thead>
<tr>
<th>Type</th>
<th>Construction Project</th>
<th>Non-construction Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training</td>
<td>Documented training required</td>
<td>Basic laser safety training recommended (such as <a href="#">ESH Course 132</a>)</td>
</tr>
<tr>
<td>Operation</td>
<td>Unattended operation not permitted</td>
<td>Unattended operation should not be permitted unless additional controls such as appropriate barriers are used</td>
</tr>
<tr>
<td>Signage</td>
<td>An area hazard warning sign must be posted when a construction laser is in operation, and should be posted when a non-construction laser is in operation. This sign must indicate type of laser, wavelength, power, and classification. (Templates for labels and signs are available on the Laser Safety SharePoint Site.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Required signal word for Class 2 lasers: CAUTION</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Required signal word for Class 3R lasers: DANGER</td>
<td></td>
</tr>
</tbody>
</table>

3 Forms

The following are forms required by these requirements:

- None
4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- None

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, “Laser Safety”
  - Laser Safety: Laser Pointer Requirements

Other SLAC Documents

- Laser Safety SharePoint Site
- ESH Course 132, Laser Safety Basics (ESH Course 132)
Chapter 10: Laser Safety

Laser Pointer Requirements

1 Purpose

The purpose of these requirements is to prevent startle hazard, temporary flash-blindness, after images, glare responses, and permanent eye damage caused by unsafe use of laser pointers, which are hand-held battery-operated devices with a momentary on-off switch typically used as a pointing device during presentations. They cover classifying, selecting, labeling, and using laser pointers, both personal and SLAC owned. The requirements apply to anyone using a laser pointer at SLAC.

2 Requirements

2.1 Classification, Selection, and Labeling

Laser pointers have a maximum power output of 5 milliWatts (mW) and create a low-power visible laser beam, with wavelengths between 400 to 700 nanometer (nm). These lasers are either Class 2 (< 1 mW) or Class 3R (< 5 mW).

Note Class 3R lasers were formerly designated as Class 3a lasers and may be labeled this way.

- When choosing a laser pointer it is the best practice to pick a Class 2 laser. Most commercially available laser pointers, however, are Class 3R.

Warning Relatively inexpensive battery-operated hand-held laser “pointers” that are Class 3B (some Class 4) are now commercially available, which are well in excess of the 5 mW legal limit for laser pointers. These devices can be very dangerous. Use of all Class 3B and Class 4 lasers at SLAC must be approved by the laser safety officer (LSO); LSO approval for a Class 3B or Class 4 laser “pointer” would not be given.

Warning Some commercial green laser pointers have been observed to be missing the infrared (IR) filter, which results in dangerous emission of IR laser light that the user is unaware of. (The 532 nm laser pointers are not simple single wavelength diode lasers, but are a diode-pumped solid state laser. A doubling crystal is used to generate the 532 nm wavelength and then an IR filter must be used to block the 808 nm diode pump and the 1064 nm fundamental.)

- For a safety evaluation of a laser pointer or if you have questions on laser pointer safety, contact the LSO.
- Laser pointers must be labeled with either a CAUTION label for Class 2, or with a DANGER label for Class 3a or Class 3R.
2.2 Use

- Never point a laser pointer at a person. Permanent damage is possible if the beam is stared into, but there is also the possibility of startle hazard, temporary flash-blindness, after images, and glare response.
- Only point at inanimate objects.
- Laser pointers are not toys. Children should not be allowed to use them unless adequately supervised.

3 Forms

The following are forms required by these requirements:
- None

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:
- None

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)
- Chapter 10, “Laser Safety”
Chapter 10: Laser Safety
Qualified Laser Operator Approval Form

This form is to be completed by the qualified laser operator (QLO) to be approved with signatures indicated in Step 7. A copy must be on file in the laser safety binder at the laser laboratory (see Laser Safety: Class 3B and Class 4 Laser Operation Requirements).

Operator: _____________________________________________________________ (print and sign name and initials)

Laser laboratory name and location:  ________________________________________________

System laser safety officer (SLSO) ___________________________________________________ (print name)

1. If already a QLO for another SLAC laser laboratory and all training is current, then skip steps 2 through 4; print laboratory name and location if already a QLO: ______________________________________

2. Required training completed
   a. Reviewed STA with supervisor. Date and initial: __________
   b. ESH Course 253, Laser Worker Safety Training (ESH Course 253). Date and initial: __________
   c. ESH Course 253ME, Laser Worker Baseline Medical Exam (ESH Course 253ME). Date and initial: __________
   d. ESH Course 131, Laser Accidents and Lessons Learned (ESH Course 131). Date and initial: __________
   e. ESH Course 120, Work Planning and Control Overview (ESH Course 120). Date and initial: __________
   f. ESH safety orientation (ESH Course 219 for SLAC employees or ESH Course 396 for non-SLAC employees). Date and initial: __________
   g. For QLOs who perform laser optics work: ESH Course 253PRA, Laser Alignment Safety Practical (ESH Course 253PRA), Date and initial: __________

3. Has read ESH Manual Chapter 10, “Laser Safety”, and accepts roles and responsibilities described therein. Date and initial: __________

4. Students only: has read and agrees to comply with Laser Safety: Student Requirements. Date and initial: __________

5. Has read and understood the applicable standard operating procedure (SOP) and/or job safety analysis (JSA) (available from the Laser Safety SharePoint Site). Date and initial: __________

6. Has read building area hazard analysis (AHA) (see Area Hazard Analysis Library). Date: __________

7. Approvals
   a. Administrative supervisor approval signature: ________________________________ Date: __________
   b. SLSO approval signature: ________________________________ Date: __________
   c. SLAC LSO interview completed. SLAC LSO approval signature ________________________________ Date: __________

1 SLSO reviews SOP requirements with QLO and begins on-the-job training (OJT) without laser hazards present prior to approval. Following approval, additional OJT with laser hazards present is required prior to the laser operator being approved to work alone (see OJT syllabus example).

2 LSO interviews first-time QLOs to review responsibilities, laser classes, and expectations for site-specific OJT.
Chapter 10: Laser Safety

Laser Controlled Area Worker Approval Form

Product ID: 663 | Revision ID: 1671 | Date Published: 26 August 2014 | Date Effective: 26 August 2014
URL: http://www-group.slac.stanford.edu/esh/eshmanual/references/laserFormApprovalLCAWorker.pdf

This form is to be completed by the laser controlled area (LCA) worker and approved with required signatures indicated in Step 7. A copy must be on file in the laser safety binder at the laser laboratory (see Laser Safety: Class 3B and Class 4 Laser Operation Requirements).

LCA Worker: ____________________________________________________________ (Print and sign name and initial)

LCA Name and Location: ________________________________________________

System Laser Safety Officer (SLSO): _________________________________________ (print name)

1. If already a LCA worker for another SLAC laser laboratory and all training is current, then can skip Steps 2-4; print laboratory name and location if already a SLAC LCA worker: ______________________________

2. Required training completed
   a. Reviewed STA with supervisor. Date/Initial: _________
   b. ESH Course 253, Laser Worker Safety Training (ESH Course 253). Date/Initial: _________
   c. ESH Course 253ME, Laser Worker Baseline Medical Exam (ESH Course 253ME). Date/Initial: _________
   d. ESH Course 131, Laser Accidents and Lessons Learned (ESH Course 131). Date/Initial: _________
   e. ESH Course 120, Work Planning and Control Overview (ESH Course 120). Date/Initial: _________
   f. ESH Safety Orientation (ESH Course 219 for SLAC employees or ESH Course 396 for non-SLAC employees). Date/Initial: _________

3. Has read ESH Manual Chapter 10, “Laser Safety” and accepts roles and responsibilities described therein. Date/Initial: _________

4. Students only: has read and agrees to comply with Laser Safety: Student Requirements. Date/Initial: _________

5. Has read and understood the applicable laser laboratory SOP. Date/Initial: _________

6. Has read building AHA (see Area Hazard Analysis Library). Date/Initial: _________

7. Approvals
   a. Administrative supervisor approval signature: _________________________________ Date: __________
   b. SLSO approval signature: 1 ___________________________________________ Date: __________
   c. Interview with SLAC LSO completed. 2 SLAC LSO approval signature __________________________ Date: __________

1  SLSO reviews SOP requirements with LCA worker and begins on-the-job training (OJT) without laser hazards present prior to approval. Following approval, additional OJT with laser hazards present is required prior to the LCA worker being approved to work alone (see OJT syllabus example).

2  LSO interviews first-time LCA workers to review responsibilities, the four classes of lasers, and expectations for site-specific OJT.
Chapter 10: **Laser Safety**

System Laser Safety Officer Approval Form

Product ID: 99 | Revision ID: 1656 | Date Published: 26 August 2014 | Date Effective: 26 August 2014

URL: [http://www-group.slac.stanford.edu/esh/eshmanual/references/laserFormApprovalSLSO.pdf](http://www-group.slac.stanford.edu/esh/eshmanual/references/laserFormApprovalSLSO.pdf)

The person named below is being appointed the system laser safety officer (SLSO) for the laser laboratory named below, with SLSO responsibilities and authority as described in Chapter 10, “Laser Safety”. An SLSO is required for Class 3B or 4 laser laboratories (see Laser Safety: Class 3B and Class 4 Laser Operation Requirements).

The signatures below are required for assignment, acceptance, and approval.

Laser laboratory name and location: ________________________________

### Assignment

Laser Laboratory Program Manager

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

### Acceptance

System Laser Safety Officer (SLSO)

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

### Approval

SLAC Laser Safety Officer (LSO)

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>
Chapter 10: Laser Safety

Acting System Laser Safety Officer Approval Form

Product ID: 664 | Revision ID: 1672 | Date Published: 26 August 2014 | Date Effective: 26 August 2014
URL: http://www-group.slac.stanford.edu/esh/eshmanual/references/laserFormApprovalActingSLSO.pdf

The person named below is being appointed the acting system laser safety officer (SLSO) for the laser laboratory named below, with SLSO responsibilities and authority as described in Chapter 10, “Laser Safety”, when the SLSO is not available. An SLSO is required for Class 3B or 4 laser laboratories (see Laser Safety: Class 3B and Class 4 Laser Operation Requirements).

The signatures below are required for assignment, acceptance, and approval.

Laser laboratory name and location: ________________________________

Assignment

Laser Laboratory Program Manager

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

Laser Laboratory System Laser Safety Officer (SLSO)

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

Acceptance

Acting System Laser Safety Officer (SLSO)

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

Approval

SLAC Laser Safety Officer (LSO)

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>
# Approval to Operate Form

This form must be completed before operations begin using a Class 3B or 4 laser (see [Laser Safety: Class 3B and Class 4 Laser Operation Requirements](http://www-group.slac.stanford.edu/esh/eshmanual/references/laserFormApprovalFacility.pdf)).

<table>
<thead>
<tr>
<th>Laser laboratory name and location:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department and division:</td>
</tr>
<tr>
<td>System laser safety officer (SLSO) name:</td>
</tr>
<tr>
<td>Standard operating procedure (SOP) version and date:</td>
</tr>
<tr>
<td>Expiration date:</td>
</tr>
</tbody>
</table>

## Requirements

Authorization to operate this laser lab requires the following:

1. Approval that is current. (An approved, unexpired form must be on file and approval must be renewed upon or before expiration, in order to continue laser operations.)

2. Laser safety officer (LSO) approval of the SOP document  \( \text{Date: } \) 

3. Laser lab walkthrough and inspection checklist completed by LSO  \( \text{Date: } \) 

4. Laser safety system (LSS) configuration and interlock checks completed by SLSO  \( \text{Date: } \) 

## Approvals

By their approval signatures, the program manager for the laser lab, the SLSO, and the ESH coordinator indicate that they have adequately reviewed and addressed safety issues relevant to operation of the laser lab that are in addition to laser safety. The LSO is only approving the laser safety controls.

**Laser Lab Program Manager**

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

**System Laser Safety Officer (SLSO)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

**ESH Coordinator**

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

**SLAC Laser Safety Officer (LSO)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>
Chapter 10: Laser Safety

Class 3B and Class 4 Laser Operation Requirements

1 Purpose

The purpose of these requirements is to protect workers from harmful exposure to lasers. They cover identifying hazards, developing controls, and authorizing operations and personnel for Class 3B and Class 4 lasers. They apply to workers using lasers of this classification, visitors to laser laboratories, and system laser safety officers (SLSOs), laser lab program managers, line management, and the laser safety officer (LSO).

2 Requirements

Class 3B and Class 4 lasers have significant potential to cause injury and require specific control measures, described below.

2.1 Approvals

The following approvals need to be completed before Class 3B and Class 4 laser operations may begin:

- An Approval to Operate Form for the laser laboratory in which they are operating
- A System Laser Safety Officer Approval Form for the SLSO, who will have line management and supervision responsibilities for safe laser operations in the laser lab
- A Acting System Laser Safety Officer Approval Form for the acting SLSO, who performs SLSO functions when the SLSO is not available
- A Qualified Laser Operator Approval Form for the laser lab’s qualified laser operators (QLOs), who will operate these lasers
- A Laser Controlled Area Worker Approval Form for the laser lab’s LCA workers, who perform support work such as controls electronics, data acquisition, and accelerator operations

2.2 Engineering Controls

Engineering controls are given first priority over administrative procedures and PPE. They must include the following:

- Meeting Class 1 enclosure requirements if such enclosures are used. If these enclosures have covers that could be opened when an enclosed Class 3B or Class 4 beam is present, then such covers must
  - Be interlocked so that the enclosed laser beam will be disabled when the cover is open; or
– Have defeatable interlocks with an appropriate label indicating this, and be configured such that restoring the cover re-enables the interlocks; or
– Be secured (requiring a tool to remove) and have an appropriate label indicating the laser hazard accessible if the cover is open

Note Non-defeatable interlocked covers for Class 1 enclosures are required in uncontrolled areas if the covers may be removed to enable Class 4 work, though in some cases approval may be given to use an administrative configuration control lock.

• Having appropriate barriers and beam path control to block potential stray beams and prevent accidental placing of objects or parts of one’s body in a beam path:
  – Backstops behind turning mirrors are recommended; they are required behind the upper turning mirror in a periscope if there is an upward going beam.
  – Optics that can generate out-of-plane beams (ex periscopes, beam-splitting polarizers and diffraction gratings) require special attention to assure adequate beam barriers are in place for containing possible stray beams.
  – Table skirts are recommended at the perimeter of laser tables; these are barriers that extend 1 to 2 inches above the nominal height of laser beams on the table.

• Having appropriate beam termination for primary and stray beams

Engineering controls should include the following:

– Interlocked covers for SLAC-built lasers if similar commercial lasers would have them, because removing the cover exposes a different wavelength hazard
– Interlocks for Class 1 enclosure covers that are frequently removed or may be removed for an extended period, and may expose a different wavelength hazard when removed
– A engineered laser safety system configured so it is easy to add a new Class 1 cover interlock
– Dedicated beam blocks or safety shutters for enabling different wavelength hazards. Safety shutters controlled by the engineered laser safety system for the LCA are recommended for this purpose. When practical, the shutters should only be enabled when needed for a particular Class 4 operation mode.

For additional engineering controls see Laser Safety: Laser Controlled Area Requirements.

2.3 Procedures

2.3.1 Laser Safety Contract

The laser safety contract, between the SLSO, line management for the laser lab, and the LSO, describes details of the laser lab, laser operations, and the associated hazards and controls. Engineering, administrative, and personal protective equipment (PPE) controls associated with the laser equipment and laser operations are described. (For some laser labs, the safety contract and the standard operating procedure may be identical.)

See the Laser Safety Contract Template available on the Laser Safety SharePoint Site.
2.3.2 Standard Operating Procedure

The standard operating procedure (SOP) is a subset of the laser safety contract. Its purpose is to provide a more concise laser facility description to be used in QLO training and to be a useful reference for QLOs during laser operations. It must include the following:

- Schematic of the laser facility, which includes identifying the nominal hazard zone (NHZ). The NHZ is the area inside the laser controlled area (LCA) where there may be accessible laser radiation above the maximum permissible exposure (MPE) when lasers are enabled.
- Description of the laser operation modes
- Description of laser eyewear requirements for each operation mode
- Administrative procedures, including
  - How to set each operation mode (for example, Laser Off, Class 1, Class 4) and any operation mode requirements such as restrictions on unattended Class 1 operation
  - Reference to following core laser safety practices (see Laser Safety: Core Laser Safety Practices)
  - Special or non-routine alignment procedures that have requirements that go beyond what is described in core laser safety practices (for example, during OPA alignment)
  - Special requirements if more than one type of laser eyewear protection is used in Class 4 mode. Different eyewear requirements should have different Class 4 operation modes defined.
  - Special requirements for laser maintenance or service work
  - Requirements for satisfying control of hazard energy (CoHE) to prevent the unexpected startup or energization of a laser hazard (see Laser Safety: Class 3B and Class 4 Laser CoHE Requirements)
  - Entry and egress procedure during Class 4 operation
  - How to respond if there is a failure in a laser safety system component
  - Requirements for pre-job briefings
  - Requirements for safety configuration control, including for moving safety shutters or other key safety components

Example SOPs and an SOP template are available on the Laser Safety SharePoint Site.

2.3.3 Job Safety Analysis

A job safety analysis (JSA) is sometimes used to extend the description of laser hazards and controls given in a laser safety contract and SOP. For example, it may be used when a particular experiment is being done that is short-lived and it does not make sense to revise the contract and SOP, or it may be used for specialized procedures that only a few of the lab’s QLOs will perform.

Example JSAs are available on the Laser Safety SharePoint Site.

2.3.4 Configuration Control Form

Actions that modify the safety configuration or function of a Class 1 enclosure, a safety shutter, or a component of the engineered laser safety system require a configuration control change process to be followed, resulting in an approved configuration control form (CCF). Use of a CCF should be described in
an SOP or laser safety contract or JSA, but may also be used as a standalone procedure document if approval is given by the LSO.

Note Some simple actions that are adequately described in an SOP or JSA may be exempt from this requirement. Consult the LSO on such exemptions.

Example actions that would require a CCF are

- Changing a Class 1 enclosure in any manner that changes its safety function
- Relocating a safety shutter or interlocked laser power supply (except for very simple changes if LSO approval is given)
- Bypassing any required laser safety interlock (except for defeatable interlocks if used as described in the SOP)
- Re-starting laser operations for portable laser systems following a change in location or following a long period of non-use.
- Applying or removing a configuration control padlock

The CCF must include the following information fields:

- Description of action to be performed and its purpose
- Safety requirements and certification checks needed before starting the action
- Safety requirements and certification checks needed while laser system is in a modified state; when laser system is in a modified state, a copy of the CCF must be posted at the laser lab, preferably at the laser control panel and/or laser entry door
- Safety requirements and certification checks needed to restore normal laser operations
- Names and dates for persons performing the work and safety checks, together with their signatures or initials.

The person performing the work is responsible for completing the form. The SLSO approves the CCF description and completion of work under the CCF and determines additional notifications. LSO notification of CCF use is required; work under a CCF requiring an LSO inspection requires LSO approval.

A recommended CCF template is available on the Laser Safety SharePoint Site.

2.4 Training

SLSOs have line management responsibility for providing and documenting on-the-job training (OJT) to QLOs and LCA workers. This includes the SLSO maintaining an OJT syllabus for site-specific training for each worker. In addition, SLSOs are recommended to maintain a spreadsheet (QLO/LCA worker matrix), summarizing the training completed by the lab’s QLOs and LCA workers. The SLSO must conduct an annual refresher for this training.

Templates for an OJT syllabus, OJT completion form, and QLO/LCA worker matrix are available on the Laser Safety SharePoint Site.
2.5 Control of Hazardous Energy (CoHE)

CoHE requirements prevent the accidental startup or energization of energy sources. See

- [Laser Safety: Class 3B and Class 4 Laser CoHE Requirements](#)

2.6 Laser Eyewear Protection

When using Class 3B or Class 4 Lasers, follow these requirements:

- [Laser Safety: Class 3B and Class 4 Laser Eyewear Protection Requirements](#)

2.7 Safety Evaluation of Non-beam Hazards

Non-beam hazards result from factors other than direct human exposure to a laser beam but are associated with laser equipment or laser operations. Non-beam hazards include electrical (laser power supplies, high voltage connections); fire and explosion (flammable solvents in dye lasers, high pressure arc lamps, capacitor banks); chemicals; pressure vessels; compressed gases; cryogenics; mechanical (associated with robotics); collateral radiation (x-rays from electrical equipment operating above 15 kV, or UV radiation from flashlamp operation); and hazards from laser-target interactions (laser-generated air contaminants, combustion of flammable materials, plasma radiation, and, at very high irradiance, ionizing radiation).

- Evaluation and safety controls for non-beam hazards must be described in the laser safety contract, SOP, or JSA.
- The SLSO, laser lab program manager, and ESH coordinator are responsible for appropriate evaluation and safety controls for non-beam hazards and all non-laser safety issues.
- The LSO will assist in evaluating hazards and controls for non-beam hazards and consult with other subject matter experts as needed.

2.8 QLO and LCA Worker Service Work in Laser Labs

Generally, a QLO or LCA worker may only work in the lab for which he or she has been approved. However, a QLO or LCA worker may enter and work in a laser lab without becoming a QLO or LCA worker for that lab in order to perform short-term service work, measurements, or experiments, subject to the following conditions:

- The visiting QLO or LCA worker, called a service QLO or service LCA worker, must have approval from his or her administrative supervisor and the SLSO (or their designees) for the laser lab being visited.
- The visiting service QLO/LCA worker must be escorted by one of the lab’s QLOs or LCA workers.
- There must be a pre-job briefing between the service QLO/LCA worker and the escorting QLO/LCA worker for the work to be performed.

Unescorted work in Class 4 mode may only be done by the laser lab’s QLOs/LCA workers.
Note: SLSOs should minimize the number of QLOs approved for a specific laser lab by taking advantage of this service QLO (and LCA worker, described below) designation.

2.9 Laser Controlled Area Worker

Laser controlled area (LCA) workers perform support work such as controls electronics, data acquisition, and accelerator operations. To do so they receive limited approval to be allowed access to laser labs. They have the same responsibilities as QLOs but are not authorized to perform laser alignment work, and, depending on the lab, may be restricted from changing operation mode or opening shutters.

- SLSOs should implement the following controls for these workers:
  - Limit their number to only those that are essential and may need unescorted laser lab access
  - Limit their scope of work, including limiting RFID authorization for the laser safety control panel
  - Conduct periodic refresher OJT
  - Conduct pre-job briefings prior to their laser lab work and determine if their work needs to be supervised by a regular QLO
  - Determine if any additional LCA or NHZ controls are needed to accommodate their work
  - Avoid scheduling their work during Class 4 laser operations, in particular if laser alignment will be taking place

2.10 Laser Lab Visitor Policy

Laser lab visitors are personnel who have not been approved as a QLO/LCA worker in a SLAC laser lab. (This does not include service subcontractors or the LSO). Laser lab visitor access when Class 3B or Class 4 lasers may be in operation is strongly discouraged but may be allowed in some facilities if adequate controls are present. For requirements see Laser Safety: Laser Controlled Area Visitor Requirements.

3 Forms

The following are forms required by these requirements:

- Laser Safety: Approval to Operate Form (SLAC-I-730-0A05J-003)
- Laser Safety: Qualified Laser Operator Approval Form (SLAC-I-730-0A05J-007)
- Laser Safety: Laser Controlled Area Worker Approval Form (SLAC-I-730-0A05J-008)
- Laser Safety: System Laser Safety Officer Approval Form (SLAC-I-730-0A05J-001)
- Laser Safety: Acting System Laser Safety Officer Approval Form (SLAC-I-730-0A05J-009)
- Site-specific training documentation for QLOs and LCA workers. Example templates for OJT syllabus, OJT completion form, and QLO/LCA worker matrix are available on the Laser Safety SharePoint Site.
- Laser safety contract, SOP, JSA, and CCF documents: templates and examples for these are available on the Laser Safety SharePoint Site.
4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- The SLSO must maintain the following records at the laser lab to which he or she is assigned:
  - Laser safety contract (if used), SOP, JSA, and CCF
  - Current approval to operate form
  - SLSO/acting SLSO, QLO, and LCA worker approval forms
  - OJT documentation for the lab's QLOs and LCA workers
  - Inventory of lasers, laser keys, and keys issued to QLOs
  - Alignment eyewear approval forms and log forms, if alignment eyewear is used
  - Documentation for tests and certification of the laser safety system
  - Documentation for audits and facility reviews, such as the annual laser safety inspection conducted by the LSO

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, "Laser Safety"
  - Laser Safety: Class 3B and Class 4 UV Laser Operation Requirements (SLAC-I-730-0A05S-012)
  - Laser Safety: Class 3B and Class 4 Laser CoHE Requirements (SLAC-I-730-0A05S-005)
  - Laser Safety: Laser Controlled Area Requirements (SLAC-I-730-0A05S-009)
  - Laser Safety: Class 3B and Class 4 Laser Eyewear Protection Requirements (SLAC-I-730-0A05S-007)
  - Laser Safety: Laser Controlled Area Visitor Requirements (SLAC-I-730-0A05S-011)

Other SLAC Documents

- Laser Safety SharePoint Site
- On-The-Job (OJT) Training Requirements (200-2P-1)
1 Purpose

The purpose of these requirements is to minimize skin exposure to ultraviolet (UV) radiation. They cover setup and use of facilities where Class 3B or Class 4 UV lasers may operate. They apply to workers in these facilities, visitors to them, and system laser safety officers (SLSOs), laser lab program managers, line management, and the laser safety officer (LSO).

2 Requirements

2.1 Hazard Overview

Eye and skin maximum permissible exposures (MPEs) are the same in the UV and in the infrared IR outside of the retinal hazard region. In the retinal hazard region between 400–1400 nm, eye MPEs are less than skin MPEs; for example, for a 1000s exposure eye MPEs are ~×100–1000 less than skin MPEs.

- MPEs in the UV are the same for coherent (laser) and incoherent sources.
- MPEs in the UV depend on the cumulative exposure. For example the MPE is 3mJ/cm² between 180–300 nm for exposures from 10⁻⁹s to 1000s. The potential hazard from long exposures to diffuse reflections must be considered.
- Skin injuries are less serious than eye injuries:
  - Vision impairment has much higher consequences
  - Skin injuries are usually self-repairing
- Skin injuries are much more probable than eye injuries:
  - Large surface area
  - Hands close to laser beams
2.2 Controls

2.2.1 Engineering Controls (Enclosures and Barriers)

Skin protection can best be achieved with engineering controls: enclose UV laser beam paths as much as practical. When there are open beams, primary protection to accessible diffuse reflections is provided by personal protective equipment (PPE) for eye and skin protection.

- Enclose UV laser beam paths to the extent practical. If the beam paths cannot be enclosed, then implement adequate barriers to minimize potential skin exposure from chronic exposure to beam losses and other sources of diffuse reflections.
- Beam dumps. Design barriers or enclosures for beam dumps to minimize potential exposure to diffuse UV reflections from them.

2.2.2 Administrative Procedures

- Attenuate laser beams to the minimum power required when there are open UV laser beams, in particular when alignment is done.
- Use remote steering controls and diagnostics as much as practical for aligning UV laser beams.
- Plan work to minimize time with potential skin exposure to hazardous UV laser beams.
- Keep exposed skin as far as practical from open beams.

2.2.3 PPE for Skin

- Wear long-sleeved shirts.
- Use gloves when working with hands near accessible laser beams (direct beam exposure hazard for primary or stray beams).
- Use gloves when diffuse reflection NHZ > 20 cm if hands may be within this distance of an open beam path when diffuse reflections may not be well shielded, for example, for beam powers above 10 mW at wavelengths less than 300 nm.
- Use a face shield when diffuse reflection NHZ > 1 m if working within this distance of an open beam path when diffuse reflections may not be well shielded: for example, for beam powers above 250 mW at wavelengths less than 300 nm.

2.2.4 Medical Exams

- Skin exams for laser personnel can be performed by the Occupational Health Center. Laser personnel should request a skin exam if they experience any symptoms from exposure to UV laser beams.
- Periodic skin exams are recommended for laser personnel who may have chronic exposures exceeding MPE values.

2.2.5 Site-specific Training and Procedures

- Lab-specific on-the-job training (OJT) and the standard operating procedure (SOP) or laser safety contract must describe the potential for skin injury and the controls to use. These need to emphasize barriers and enclosures for UV beams and when to use skin PPE.
3 Forms

The following are forms required by these requirements:

- None

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- None

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, “Laser Safety”
  - Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)

Other SLAC Documents

- Laser Safety SharePoint Site
  - PPE – Eye-Skin Protection
Chapter 10: Laser Safety

Laser Controlled Area Requirements

The purpose of these requirements is to prevent untrained and unprotected personnel from entering areas where Class 3B and Class 4 laser radiation is present and to warn qualified laser operators (QLOs) of the laser hazards present inside the laser controlled area prior to entry, what the current operation mode and entry requirements are, and ensure that they can enter and exit the area safely. They cover setting up and working in a laser controlled area (LCA), which is a designation required when the maximum level of accessible laser radiation is Class 3B or Class 4. They apply to the laser safety officer (LSO), system laser safety officer (SLSO), and persons with responsibility for approving projects that involve the setting up of areas in which Class 3B or Class 4 lasers are used.

2 Requirements

Class 3B and Class 4 laser operation may only take place inside an LCA. The LCA description will be given in the associated laser safety contract, standard operating procedure (SOP), or job safety analysis (JSA).

An LCA must

- Allow both emergency entry and rapid egress. The emergency entry procedure, including a description of how the laser hazard is disabled, must be posted at the LCA entry. An emergency entry must automatically disable laser hazards via interlocks unless additional controls are in place, such as no unattended operation.

- Have a master controller located inside the LCA that permits laser light in the LCA above the maximum permissible exposure (MPE) level when it is enabled and its input interlocks are satisfied.
  - For simple installations the master controller and associated master key may be the laser power supply (one or more) and associated key(s).

- Have a master key that enables the master controller operation. Removal of the master key will disable all Class 3B and Class 4 laser beams in the LCA and can be used for configuration control as part of an administrative lockout procedure. Access to the master key is restricted to qualified laser operators (QLOs). (See Laser Safety: Class 3B and Class 4 Laser CoHE Requirements.)

- Have an illuminated warning sign, interfaced to the LCA master controller or engineered laser safety system, to indicate when hazardous laser beams above the MPE may be present in the LCA. The warning sign must be located outside the entry door. (It is also recommended to locate additional signs inside the LCA.)

- Have a minimum of one interlocked and one locked door to gain entry. An unauthorized access must trip the door interlock, which then disables the laser hazards. Access entry to the LCA through the
locked door is restricted by key or coded access to QLOs. In some situations, though, the LCA entry may be unlocked if there is a guard posted at the entry. The means for restricted access must be specified in the laser safety contract or standard operating procedure (SOP) or job safety analysis (JSA).

- Be effectively light tight. If it is not light tight, an appropriate hazard analysis will be conducted by the LSO. Windows, doorways, and open portals will need curtains or covers to reduce laser radiation outside the LCA to levels below the MPE.

- Ensure no laser hazard exists at the entryway during entry or exit. The entryway must have one of the following:
  - A non-defeatable entry interlock that disables laser hazards in the LCA to be below the MPE during entry
  - A defeatable entry interlock that temporarily allows entry or exit without disabling laser hazards in the LCA, if barriers are in place to prevent a laser radiation hazard at the entry
  - Alternative controls such as a posted guard, if approved by the LSO, if interlocks are not feasible or are inappropriate. Entryway must be configured such that no laser hazard exists at the entry point during an entry or exit (for example, with the use of overlapping laser curtains).

- For LCAs where there is a work area (for example, computer work station or optics preparation area) outside the NHZ) an additional barrier must be implemented at the NHZ entryway to remind entering personnel to don laser eyewear protection during Class 3B or Class 4 laser operation. Engineered barriers are to be given priority over administrative barriers such as a sign. (An interlocked proximity sensor with an audible/visual alarm is one way to implement this NHZ entryway control.)

- Have a clearly marked and easily accessible EMERGENCY OFF button within the LCA that will reduce accessible laser light levels below the MPE

- Have an audible alarm during laser startup or activation (such as when a laser safety shutter is about to be opened) to notify personnel within the LCA. An emission delay (typically 10 to 15 seconds, during which the audible alarm sounds) following a request to start up the laser (for example, a request to open a laser safety shutter) is required before the laser beam energization occurs. If the LCA does not have such an audible alarm, then the laser safety contract or SOP or JSA must specify how verbal notification will be used instead. (See Laser Safety: Class 3B and Class 4 Laser CoHE Requirements.)

- Have all interlock faults be latching. Reactivating the laser will be done manually. It is recommended that reactivating the laser following an interlock fault require authorization (for example, by using an RFID key or coded access) from a QLO. (See Laser Safety: Class 3B and Class 4 Laser CoHE Requirements.)

- Have the following signs posted at the entryway location (templates for these available on the Laser Safety SharePoint Site):
  - Laser hazard warning sign, which gives the laser classification, laser parameters, and optical density (OD) requirements for laser eyewear
  - Contact information for responsible line management personnel and for phone within the LCA
  - Emergency entry procedure
  - Laser visitor policy, if visitors are permitted when Class 3B or Class 4 lasers are enabled (see Laser Safety: Laser Controlled Area Visitor Requirements)

- Have the following signs/procedures (or equivalent) posted at the laser control panel location for changing operation modes (templates for these available on the Laser Safety SharePoint Site):
All laser labs that have both Class 1 and Class 4 operation modes must post the Setting Class 1 (Laser Enclosed) Operation Mode procedure.

All laser labs that have a Class 4 operation mode must post the Setting or Changing Class 4 Operation Mode procedure.

All LCLS hutchs that have laser controlled areas (LCAs) must post the Hutch Search Procedure to Set Class 4 Laser Operation procedure.

Note SLSOs may modify these procedures, with the approval of the LSO. SLSOs must review these procedures as part of on-the-job training.

2.1 Recommendations

An LCA should

- Have a Class 1 operation mode, where beams are enabled but fully enclosed in an approved, engineered Class 1 enclosure. Laser eyewear protection would not be required in this mode. Unattended operation should not be permitted in this mode unless the associated removable panel covers are interlocked or secured by administrative configuration control locks.

- Use partitions or laser curtains to allow regions inside the LCA to be outside of the nominal hazard zone (NHZ). Outside the NHZ no accessible Class 3B or Class 4 laser beams are present and laser eyewear protection is not required. This can be useful to accommodate a computer workstation, an optics preparation area, and an entryway area where laser eyewear is stored and put on. (If such areas are set up, an additional barrier must be implemented at the NHZ entryway to remind entering personnel to don laser eyewear protection during Class 3B or Class 4 laser operation. See Section 2.)


3 Forms

The following are signs to be posted at the LCA that are described in these requirements (templates for these are available on the Laser Safety SharePoint Site):

- Laser hazard area warning sign
- Emergency entry procedure
- Visitor policy sign
- Core Laser Safety Practices poster

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- None
5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)
  - Chapter 10, “Laser Safety”
    - Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)
    - Laser Safety: Class 3B and Class 4 Laser CoHE Requirements (SLAC-I-730-0A05S-005)

Other SLAC Documents
  - Laser Safety SharePoint Site
Chapter 10: Laser Safety

Class 3B and Class 4 Laser CoHE Requirements

1 Purpose

The purpose of these requirements is to prevent unexpected energization or start-up of machines or equipment, or release of stored energy. They cover control of hazardous energy (CoHE) for Class 3B and Class 4 lasers. They apply to workers, system laser safety officers (SLSOs), and the laser safety officer (LSO).

2 Requirements

2.1 Overview

Class 3B and Class 4 laser radiation is considered hazardous energy because of the potential for serious eye injury, and therefore careful consideration of CoHE is needed to protect workers. Key CoHE practices are especially important to follow if laser eyewear protection is not being worn when working – workers need very good assurance that laser hazards have been adequately disabled and controlled.

There are three general approaches to meeting SLAC’s CoHE program requirements:

1. **Lockout/tagout (LOTO).** When service or maintenance is performed on equipment, de-energization of the equipment is the preferred method for achieving CoHE. When this is done, LOTO requirements apply (see Chapter 51, “Control of Hazardous Energy”).

2. **Alternative energy controls.** If service or maintenance on a laser is being done and LOTO is not applied, then alternative energy control methods must be used. Such methods must utilize appropriate machine guards (for example, laser master key and laser safety shutters). This is the method used to satisfy CoHE requirements for most laser service and maintenance. It is subject to the requirements noted in Section 2.3.

3. **Administrative lock and tag.** If a laser system needs to be shut down or secured (for example securing a barrier to ensure Class 1 operation) for purposes of configurational or operational control, not for the personal protection of the person applying the lock, then an administrative lock and tag procedure may be used (see Chapter 51, “Control of Hazardous Energy”).

Routine daily tasks by QLOs and laser controlled area (LCA) workers in laser labs are usually considered “normal, production operations” with energized or partially-energized laser equipment. Laser alignment and optics work by QLOs, including creating new beam paths and replacing damaged optics, are generally considered tasks that are “routine, repetitive and integral to normal operations” for laser workers.
Service and maintenance work by QLOs often require energized or partially energized (that is, enabled) laser beams, in which case laser eyewear protection is used in addition to other alternative energy controls to prevent an accidental exposure.

2.2 Energy Isolating Devices

SLAC’s CoHE program requires equipment to have energy isolating device(s) with appropriate LOTO capability. For laser systems this includes an easily verifiable closed position for a lockable beam block if a beam block is used. (Note it may not be necessary for a laser safety shutter to satisfy a LOTO capability requirement if cord-and-plug control can be used to disable the laser hazard or if an alternating current (a.c.) circuit breaker can be locked out.)

If a laser safety shutter or a laser beam block is used as an energy isolating device, rather than as a machine guard, then it must satisfy LOTO requirements. An equipment-specific lockout procedure (ELP) will need to be developed and approved (unless cord and plug control is applicable). The ELP will need to include a description of the location and operation of the energy isolating device. The ELP must also describe how zero energy verification is done. (See Chapter 51, “Control of Hazardous Energy”.)

2.3 Alternative Energy Controls

Alternative energy controls must use the necessary combination of engineering controls (machine guards such as safety shutters, interlocks, and key control), warning and alert systems, administrative procedures, training and personal protective equipment (laser eyewear) to achieve effective CoHE protection for workers. These controls must be documented in a laser safety contract, standard operation procedure (SOP) or job safety analysis (JSA), with review and approval by the LSO.

2.3.1 Master Keys

Each Class 3B and Class 4 laser requires an associated master key. The master key must be removable and the laser must not be operable when the key is removed.

2.3.2 Laser Safety Shutters

A laser safety shutter is a remotely or manually controlled beam block that can be inserted to function as a machine guard (or sometimes as an energy isolating device in a LOTO procedure). It is often used to disable a laser hazard as part of an interlocked access control. It is also sometimes used in a laser controlled area (LCA) as part of a Class 1 enclosure if it is closed and disabled; in Class 1 operation mode laser eyewear protection is not required. The following requirements apply to laser safety shutters:

- Each independent laser system should have an associated safety shutter. This shutter must be placed directly at the source laser output (or can be placed in the laser cavity or inside the laser’s protective housing) or as close as practical. Safety enclosures associated with safety shutters should be as small as practical to limit how often the shutter may be accessible.
- Shutters must have an IN readback sensor with an associated display signal available for monitoring by laser personnel.
- Shutters should have independent readback sensors (and associated displays) for the IN and OUT positions.
Shutters should have independent control and readback.

Shutters must close when control signals or power are deactivated or removed.

When there is an inconsistency between the requested state and the IN and OUT sensors, the laser safety system should give an alarm warning and if possible inhibit the laser upstream of the shutter.

Shutters’ manufacturing information must be described in the laser safety contract, SOP, or JSA, including an evaluation of their ability to withstand the maximum laser irradiance.

Shutters must be labeled LASER SAFETY DEVICES. Safety labels should be placed over the securing bolts for the shutter and indicate that SLSO approval is required to move or modify. SLSOs should also consider use of a special tool, administrative lock, or interlock to address safety configuration control.

Correct shutter operation and interlock functionality must be tested at least once per year as part of a laser safety certification procedure.

2.3.3 Activation Warning System Requirements

An audible or visual emission indicator is required to indicate the possible presence of an accessible Class 3B or Class 4 laser beam. An appropriate audible or visual indicator is also required just prior to laser emission to allow actions to avoid exposure. Laser safety shutters usually require an audible warning 10 to 15 seconds prior to opening; this will be described in the laser safety contract, SOP, or JSA.

2.3.4 Requirements for Laser Safety System Interlocks

- Interlocks for access doors, protective covers, service access panels, and enclosures must be normally open. Doors and covers must be closed to satisfy (close) the interlocks.
- Power failure to an interlock circuit or removing an interlock connector must cause the laser system to go into, or remain in, a safe state by closing shutters or disabling power.
- All interlock faults must be latching.

2.3.5 LCA Search Required Prior to Enabling Laser Hazards

Before turning on the beam and making it accessible, the responsible QLO must

- Search the LCA to ensure that only qualified laser personnel are present and that all wear appropriate protective eyewear
- Give warning of the laser hazard being enabled to personnel present

This procedure must be described in the SOP or JSA.

2.4 Laser Transport Safety Shutters

When a laser safety shutter is used as a machine guard (ex. as part of a Class 1 enclosure or as a beam block) to prevent transport of a Class 3B or Class 4 laser beam to an area that has unrestricted access to affected workers (personnel other than QLOs, LCA workers, laser service subcontractors, and the LSO), the following requirements apply:

- Two redundant transport shutters must be installed to act as an effective machine guard.
A shutter acceptance test must be done to verify the mechanical integrity of the shutter system to be an effective machine guard, and the LSO must review and approve the test (a template for this test is available on the Laser Safety SharePoint Site).

An illuminated display sign must be used to communicate the laser hazard status (for example, Laser Off mode or Class 1 mode).

Affected workers who rely on the transport shutters as a machine guard must receive appropriate training information about the laser hazard controls (in some cases the area hazard analysis document may be used for this).

Work by affected workers must be outside the envelope of the laser safety system components.

If affected workers request to apply LOTO for their work then such requests need to be respected and accommodated.

2.5 Zero Energy Verification

If the laser safety system is being used as a machine guard to disable the laser hazard so that laser eyewear protection can be removed, a zero energy verification must be done prior to removal of the eyewear. This may be done by verifying the IN status of a laser safety shutter or by using an appropriate laser beam power meter or diagnostic. Zero energy verification procedures should be described in the SOP or JSA.

2.6 Service and Maintenance Procedures

The laser safety contract, SOP, or JSA must define service and maintenance work. Examples include work done by service subcontractors and work done when interlocked protective covers or service access panels are removed.

A NOTICE sign must be placed at the LCA entry when service work is in progress, and may be required during maintenance work; it must indicate any change in protective eyewear requirements.

When an interlocked cover or service access panel is removed, the laser safety system must be evaluated for any changes in its normal functions (for example to prevent laser hazards by inserting shutters and to provide an activation warning system with emission delay). If some of the normal laser safety system functions are absent, additional controls may be needed to provide equivalent protection as during normal operation.

The SLSO is responsible for determining if any work activity requires LOTO.

2.7 Equipment Custodian Requirements

The laser safety contract, SOP, or JSA must describe who is responsible for the laser equipment.

2.8 Training

Workers who rely on alternative energy controls to provide effective CoHE protection against an accidental laser exposure must receive appropriate training from the SLSO or designee. For QLOs and LCA workers this must be done as part of their OJT and site-specific training.
In addition, the SLSO is required to take ESH Course 157, Control of Hazardous Energy (ESH Course 157), or ESH Course 136, Control of Hazardous Energy – Affected Employee (ESH Course 136).

2.9 Fiber Optics Connectors

- Connectors must be secured, requiring a tool for removal, and must have a label stating DANGER – DISCONNECTED OPTICAL CONNECTORS MAY EMIT HAZARDOUS OPTICAL RADIATION. Connector label templates are available on the Laser Safety SharePoint Site.
- If connecting/disconnecting is done without disabling the laser hazard, a laser control area (LCA) must be established and protective eyewear worn. It is strongly recommended, however, that the laser hazard be disabled prior to connecting or disconnecting fibers.
- If the fiber terminations are to be directly inspected, then the laser hazard must be disabled – protective eyewear may never be relied on to permit direct intrabeam viewing. The QLO performing this task may disable the laser hazard by removing the laser enabling key (master key) if he or she is in control of this key; if this cannot be done, then LOTO must be used unless cord and plug control can be used. Whatever method is used to disable the laser hazard, a zero energy verification must also be done.

2.10 Affected Worker

Affected workers are personnel other than QLOs, LCA workers, laser service subcontractors, or the LSO who may need to perform work in a facility that houses Class 3B or Class 4 lasers.

- Work should be done in Laser Off mode with the master key removed to disable laser hazards as part of an administrative configuration control or administrative lock and tag control. Such work can be done without requiring LOTO if the workers are not doing service or maintenance on laser equipment and are adequately informed of how the lasers are disabled.
- Work may be done in Laser On mode (may be Class 1 or Class 4), if all the following requirements are satisfied:
  - Workers are not doing service or maintenance on equipment associated with the laser safety system.
  - Work should be done in Class 1 mode rather than Class 4 mode.
  - Laser visitor requirements are satisfied as described in Laser Safety: Laser Controlled Area Visitor Requirements.
  - While LOTO is not generally required, if affected workers request to apply LOTO for their work to satisfy CoHE, then such requests need to be respected and accommodated.

3 Forms

The following are forms required by these requirements:
4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- Transport shutter acceptance test documents will be maintained by the SLSO.

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, “Laser Safety”
  - Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)
  - Laser Safety: Class 3B and Class 4 Laser Eyewear Protection Requirements (SLAC-I-730-0A05S-007)
  - Laser Safety: Laser Controlled Area Visitor Requirements (SLAC-I-730-0A05S-011)

- Chapter 51, “Control of Hazardous Energy”

Other SLAC Documents

- Laser Safety SharePoint Site
- ESH Course 157, Control of Hazardous Energy (ESH Course 157)
- ESH Course 136, Control of Hazardous Energy – Affected Employee (ESH Course 136)
Chapter 10: Laser Safety

Core Laser Safety Practices

1 Purpose

The purpose of these requirements is to avoid harmful exposure to lasers. They cover using Class 3B or Class 4 lasers. They apply to qualified laser operators (QLOs) and laser controlled area (LCA) workers.

2 Requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement</th>
</tr>
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| 1    | ▪ Select proper eyewear; check condition before each use  
      | ▪ Ensure all personnel are wearing appropriate eyewear |
| 2    | ▪ Be knowledgeable of all safety controls and equipment safety features |
| 3    | ▪ Remove or cover jewelry, watches, et cetera if the objects may be near the beam path |
| 4    | ▪ Communicate: alert others prior to turning on laser, opening shutters, or creating new beam paths |
| 5    | ▪ Exclude unnecessary personnel during alignment |
| 6    | ▪ Have good diagnostics available for indirect viewing of the laser beam such as fluorescent cards, CCD cameras, or infrared (IR) viewers |
| 7    | ▪ Keep primary and stray beams in horizontal plane below eye level when possible  
      | ▪ Avoid bringing eyes near plane in which the laser propagates |
| 8    | ▪ Check for and block stray beams: when placing a new optical component in the beam, locate and block all stray reflections before proceeding to next step |
| 9    | ▪ Use beam blocks: block the beam upstream until beam is needed; place a block downbeam of optic path being aligned |
| 10   | ▪ Use special caution when using periscopes, beam-splitting polarizers, and other optics that may generate out-of-plane beams: secure appropriate beam blocks to contain possible stray beams |
| 11   | ▪ Use Class 1 enclosures to eliminate laser hazards when possible  
      | ▪ Use barriers, beam tubes, and table enclosures or side shields when possible |
| 12   | ▪ Use irises to aid in alignment |
| 13   | ▪ Use minimum intensity needed, and use low-power alignment lasers when possible |
| 14   | ▪ Secure all optics to table  
      | ▪ Practice good housekeeping |
| 15   | ▪ Perform zero energy verification when disabling a laser hazard such that laser eyewear can be removed, in accordance with the standard operating procedure (SOP) |
3 Forms

The following are forms required by these requirements:

- None

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- None

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, “Laser Safety”
  - Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)
  - Laser Safety: Class 3B and Class 4 Laser Eyewear Protection Requirements (SLAC-I-730-0A05S-007)
  - Laser Safety: Class 3B and Class 4 UV Laser Operation Requirements (SLAC-I-730-0A05S-012)
Chapter 10: Laser Safety

Class 3B and Class 4 Laser Eyewear Protection Requirements

1 Purpose

The purpose of these requirements is to protect workers from harmful exposure to lasers. They cover use of protective eyewear when operating Class 3B and Class 4 lasers. They apply to workers whenever they are using lasers of this classification and associate laboratory directors (ALDs), laser lab program managers, system laser safety officers (SLSOs), line management, and the laser safety officer (LSO).

2 Requirements

2.1 General

Laser eyewear protection must

- Be required in the nominal hazard zone (NHZ), unless an LSO-approved exception exists (see below). Class 3B and Class 4 laser operation requires a master key and a NHZ to be defined for the laser system. When the master key enables the laser hazards, full protection eyewear is normally required within the NHZ.
- In work areas that are outside the NHZ, but within the LCA, QLOs and LCA workers should carry eyewear protection (by use of a lanyard, for example)
- Provide full protection, that is, have sufficient optical density (OD) to reduce exposure from an enabled laser beam (either direct beam or specular reflection) to a level below the maximum permissible exposure (MPE). (The MPE and OD requirement must be evaluated for each enabled laser beam.)
- Be labeled with wavelength-dependent OD information
- Have sufficient visible light transmission (VLT) for tasks to be performed. From a practical standpoint, when the VLT is less than 20 percent additional lab lighting may be required to perform the intended tasks.
- Have an evaluation done for saturable absorption and for material damage due to potential power density from a direct hit
- Have a proper fit when used, to provide adequate protection
- Be approved by the LSO as part of the approval process for a standard operating procedure (SOP) or job safety analysis (JSA) document. The LSO will also perform periodic inspections of the eyewear in use.
Be adequately maintained and cleaned
- Be adequately labeled, stored, and organized to avoid confusing different types of eyewear that may be used
- Be inspected before each use to verify correct selection for the hazards enabled and to check for possible damage. Damaged eyewear must be discarded if the damage could compromise the required protection.

2.1.1 Exceptions to Full Protection Eyewear Requirement

Exceptions to the full protection eyewear requirement within the NHZ may exist as described in a SOP or JSA if one of the following five conditions exists:

1. Laser beams are fully enclosed in an approved, engineered Class 1 enclosure.
2. A limited open beam path exists with no credible possibility of a beam exposure.
3. A visible, open laser beam is present during an approved alignment eyewear procedure.
4. An approved administrative procedure is used to disable the laser hazard, which includes verification that the hazard has been disabled.
5. The LSO gives approval for the exception, with documented justification.

2.2 Alignment Eyewear Requirements

For all routine laser operations and for most laser alignment procedures, full protection eyewear must be used. Alignment eyewear is defined as protective eyewear with a reduced OD from full protection. Alignment eyewear may only be used for specific alignment procedures that have been appropriately evaluated, documented, and authorized. Alignment eyewear use is therefore a highly regulated and authorized activity.

Laser safety training emphasizes the critical importance of wearing appropriate laser eyewear.

Caution:
1. The most common scenario for laser accidents in a research and development environment involves not wearing adequate protective eyewear during alignment procedures.
2. While alignment eyewear and the associated procedures may be adequate for the diffuse reflection hazard, adequate consideration also needs to be given to possible unintended stray beams, which can be a greater hazard. The diffuse reflection irradiance hazard at 0.5 meter viewing distance is typically a factor of 10,000 less hazardous than the direct beam hazard, but stray beams may be present at more hazardous levels (for example, partial transmission through dielectric mirrors or partial reflection from an uncoated optic).

The following alignment eyewear requirements must all be met:

- Associate laboratory directors (ALDs) must approve policy allowing use of alignment eyewear in laser laboratories operated by their directorate.
  - This approval is not needed for each use of alignment eyewear, but the ALD must approve exercising this policy by personnel in their directorate and accept responsibility for this hazardous
A technical note or JSA describing the alignment procedure must be approved by the LSO. It must include

- Justification for why full protection eyewear cannot be utilized for completing the alignment task. Appropriate consideration must be given to using remote viewing with CCD cameras (or other electronic devices), to operate the laser at lower power and to use low power alignment lasers.
- A schematic
- Calculations specifying the required OD for the alignment eyewear. The minimum OD allowed will be determined by a calculation for diffuse viewing at 0.5 meters. The laser operator should use the highest OD (up to the full protection OD) that will permit successful completion of the alignment task. For most alignment eyewear procedures, a reduction of OD1 or OD2 from full protection should be adequate.
- A step-by-step procedure for the alignment that also details the hazard controls. Measures must be taken to ensure that no stray hazardous diffuse or specular reflections are present before the lower-OD alignment eyewear is worn. The procedure should avoid creation of new beam paths and insertion of material in or near the beam path when this eyewear is worn with the laser beam present. Appropriate beam blocks must be used. Appropriate consideration for satisfying control of hazardous energy (CoHE) requirements must also be given (see Laser Safety: Class 3B and Class 4 Laser CoHE Requirements).
- Description of a NOTICE sign that must be placed at the LCA entry when this alignment procedure is in progress

- Special alignment eyewear must be conspicuously labeled and stored separately from the other eyewear in the lab.
- QLOs wearing full protection eyewear are not allowed to perform laser/optics work when alignment eyewear is being worn by other laser personnel. Such QLOs may only observe or supervise work. Laser personnel not needed for the alignment eyewear procedures should not be present.
- Alignment eyewear may be permitted only for “visible” wavelengths; such wavelengths may be outside the ANSI Z136.1 visible range that is defined to be 400 to 700nm. (More careful evaluation and justification will be needed for alignment eyewear at 750 to 800nm than at 530nm, however.)
- QLOs must receive special approval and receive appropriate on-the-job training (OJT) to use alignment eyewear. (An approval form template for this is available on the Laser Safety SharePoint Site.)
- An alignment eyewear log must be used to document each time an alignment procedure was carried out using alignment eyewear and which QLO performed the task. (A template for this is available on the Laser Safety SharePoint Site).
- For laser service subcontractor work, the relevant JSA must identify if alignment eyewear will be worn during the service work. Service subcontractors must satisfy the same alignment eyewear requirements as QLOs. (See Laser Safety: Laser Service Subcontractor Work Planning and Control Procedure.)

The following recommendations should be implemented:

- A checklist should be used for performing alignment eyewear procedures.
The procedure should allow only one QLO at a time to wear alignment eyewear. If the procedure may require more than one QLO to wear alignment eyewear, this must be stated and justified. Other QLOs present during the alignment procedure must wear full protection eyewear.

Alignment eyewear should be worn for the minimum amount of time possible to safely complete the procedure. Full protection eyewear should be worn to the extent possible. Alignment work and optimization should be attempted with full protection eyewear first and alignment eyewear worn only if needed.

When alignment eyewear is worn, the beam power density should be reduced to the minimum needed to perform the task.

3 Forms

The following are forms required by these requirements:

- ALD approval form for alignment eyewear (available on the Laser Safety SharePoint Site)
- QLO approval form to use alignment eyewear (available on the Laser Safety SharePoint Site)
- Alignment eyewear use log (available on the Laser Safety SharePoint Site)

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- The system laser safety officer (SLSO) must maintain completed alignment eyewear forms and use logs in the lab’s laser safety binder.

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, “Laser Safety”
  - Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)
  - Laser Safety: Class 3B and Class 4 Laser CoHE Requirements (SLAC-I-730-0A05S-005)
  - Laser Safety: Laser Service Subcontractor Work Planning and Control Procedure (SLAC-I-730-0A05C-001)

Other SLAC Documents

- Laser Safety SharePoint Site

1 Purpose

The purpose of these requirements is to ensure that visitors are aware of conditions under which they can enter a laser controlled area (LCA), and that the LCA will be in a state of minimal hazard during the visit. They cover entering laser controlled areas. They apply to qualified laser operators (QLOs), laser controlled area workers (LCA workers), visitors, system laser safety officers (SLSOs), and the laser safety officer (LSO).

2 Requirements

Visitors, defined as personnel, not including service subcontractors or the laser safety officer (LSO), who have not been approved as a qualified laser operator (QLO) or LCA worker in a SLAC laser laboratory, may only be permitted access to an LCA if the following requirements are met, unless an exception is approved by the LSO. These conditions must be posted at the laser entry if a laser visitor is permitted in an LCA in Class 1 or Class 4 operation mode.

<table>
<thead>
<tr>
<th>Operation Mode</th>
<th>Requirements</th>
</tr>
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</table>
| Laser OFF      | • The SLSO or designee is responsible for ensuring that the LCA's lasers are not operating.  
- Unescorted access is permitted. Laser eyewear protection is not required. |
| Class 1        | • Visitors must be escorted by one of the lab's QLOs or LCA workers.  
- Lasers may be operating but the laser beams are fully enclosed in approved Class 1 enclosures and there are no open beams. The escorting QLO or LCA worker is responsible for ensuring Class 1 laser conditions during the visit.  
- Laser eyewear protection is not required. |
| Class 4        | • Visitor access is strongly discouraged because high-power laser beams may be accessible. Access may, however, be permitted subject to the following conditions:  
- Visitors must be 18 years of age or older.  
- A QLO/LCA worker must escort the visitor at all times in the laser lab. (Approval from the SLSO is required for LCA workers to escort visitors.)  
- Prior to entry, the visitor and QLO/LCA worker must discuss the visit's purpose, scope, and plan for a safe method of completing the task. WPC requirements must be followed. The QLO/LCA worker will explain relevant aspects of laser hazards and controls for the lab. This generally includes a restriction that no laser alignment takes place during the time the visitor is in the LCA.  
- Prior to entry by the visitor, the QLO/LCA worker will check the laser lab to ensure the...
Chapter 10 | Laser Controlled Area Visitor Requirements

### Operation Mode Requirements

- The laser system is in and will stay in a state of minimal hazard during the visit.
  - Prior to and during entry, the QLO/LCA worker ensures the visitor wears appropriate laser eyewear protection.
  - Visitors are not allowed to operate or manipulate the laser beams or perform work on equipment associated with the laser safety system.

### 3 Forms

The following are forms required by these requirements:
- None

### 4 Recordkeeping

The following recordkeeping requirements apply for these requirements:
- None

### 5 References

**SLAC Environment, Safety, and Health Manual** (SLAC-I-720-0A29Z-001)
- Chapter 10, “Laser Safety”
  - Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)
Chapter 10: Laser Safety

Student Requirements

Purpose

The purpose of these requirements is to ensure the safety of students, secondary, undergraduate, and graduate, working with lasers at SLAC. They cover operating Class 3B and Class 4 lasers in SLAC laser laboratories. They apply to students, the persons who supervise them, and system laser safety officers (SLSOs).

Requirements

Recognizing that

1. Students are not SLAC employees
2. Students may be working at SLAC for a short period (for example, summer students)
3. Students require significant supervision and mentoring

SLAC requires that

1. Secondary school students and students under 18 will not be allowed to work with Class 3B or Class 4 lasers and cannot become qualified laser operators (QLOs) or laser controlled area (LCA) workers
2. Undergraduate students (for example, university and community college students) working at SLAC for less than 10 weeks may work with Class 3B and Class 4 lasers as QLOs only under direct supervision of an experienced QLO who is present in the laser lab. After 10 weeks of work at SLAC, such students may be evaluated and approved by the SLSO to work unsupervised in a lab with Class 3B and Class 4 lasers present. Undergraduate students may be approved as LCA workers following completion of on-the-job training.
3. Graduate students may be evaluated and approved by the SLSO after four weeks of supervised QLO work (rather than 10 weeks as described above) with Class 3B and Class 4 lasers to work unsupervised in a lab with these lasers present. Graduate students may be approved as LCA workers following completion of on-the-job training.

Forms

The following are forms required by these requirements:

- None
4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- None

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, “Laser Safety”
  - Laser Safety: Class 3B and Class 4 Laser Operation Requirements (SLAC-I-730-0A05S-004)
  - Laser Safety: Laser Controlled Area Visitor Requirements (SLAC-I-730-0A05S-011)
Chapter 10: Laser Safety

Laser Service Subcontractor Work Planning and Control Procedure

The purpose of this procedure is to ensure an equivalent level of safety requirements as called for by Chapter 2, “Work Planning and Control”, while accommodating the unique requirements of laser service subcontractor work. It covers work planning and control (WPC) for laser service subcontractor work on Class 3B and Class 4 laser systems. It applies to the SLAC project manager, system laser safety officer (SLSO), buyer, and SLAC laser safety officer (LSO), and the subcontractor.

2 Procedures

The LSO will review the work plans, provide safety oversight, and give the final work release following a pre-job briefing. WPC for laser service subcontractor work will have some differences compared to other high-hazard service work and will not utilize a service manager (SM), but it will utilize many of the same procedures and safety documents and forms.

<table>
<thead>
<tr>
<th>Step</th>
<th>Person</th>
<th>Action</th>
</tr>
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</table>
| 1.   | Project manager | Submits purchase requisition for laser installation (may be part of a laser purchase) or laser maintenance/service, sends notification of purchase requisition to the SLAC LSO. The requisition will indicate sole source if applicable, give scope/statement of work and note that on-site work will be done that requires:  
  - Site-specific safety plan (SSSP) and job safety analysis (JSA) documents
  - A description of laser safety training for subcontractor personnel
  - Approval by the LSO
  The project manager will be the SLAC point-of-contact (POC). |
| 2.   | Buyer           | Conducts procurement process, which will utilize terms and conditions appropriate for on-site service work |
| 3.   | Buyer           | Awards contract to the selected service subcontractor |
| 4.   | Project manager | Executes WPC  
  Obtains a red folder from the LSO and starts to put together the required safety documentation. |
At this stage
- Completes the Hazard Evaluation and Planning eTool, and prepares the site-specific safety plan (SSSP) and an associated job safety analysis (JSA). (The SSSP and JSA will generally include reference to the laser facility's standard operating procedure [SOP] document and area hazard analysis; subcontractor personnel follow the same safety requirements as SLAC's qualified laser operators.)
- Sends the SSSP and JSA to the subcontractor for review and for subcontractor to make any needed updates or changes; sends copies to the LSO

5. Subcontractor  
   Signs the SSSP and sends it to the buyer and/or the project manager

6. Project manager  
   Obtains the necessary signatures for the SSSP, including from the LSO and the SLSO, then submits signed SSSP to the buyer and requests a notice-to-proceed (NTP)

7. Buyer  
   Issues NTP to subcontractor

8. Project manager  
   Completes the work integration plan (WIP) document

9. Laser facility manager  
   Signs initial release for the work on the WIP

10. Project manager, SLSO, LSO, and subcontractor  
    Pre-job briefing held
    JSA is updated as needed and then signed by all personnel
    Pre-job review document is completed and signed by all personnel
    SLSO signs JSA indicating authorization for the work and final release is given by the LSO as indicated on the pre-job review document

11. Subcontractor  
    Performs work under supervision of project manager
    Red folder with all the safety documentation is available at the job site.

12. LSO  
    Performs periodic inspections of the work

13. Project manager  
    Provides update status to LSO at the end of each day until the work is completed
    PM notifies LSO when any changes may be needed to the JSA; if changes are needed, these require signature approvals, re-authorization by SLSO, and re-release by LSO

14. Project manager  
    Notifies LSO when work is complete

15. SLSO  
    Retains appropriate documentation for laser service work in the Laser System Safety Binder

16. LSO  
    Updates the spreadsheet summary of laser service work

3 Forms

The following forms are required by this procedure:
- Laser site-specific safety plan (SSSP) and job safety analysis (JSA) templates (available from Laser Safety SharePoint Site)
- Hazard Evaluation and Planning eTool
4 Recordkeeping

The following recordkeeping requirements apply for this procedure:

- The SLSO retains appropriate documentation for laser service work in the Laser System Safety Binder
- The LSO updates the spreadsheet summary of laser service work when the work is complete

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 10, “Laser Safety”
- Chapter 2, “Work Planning and Control”
  - Work Planning and Control (includes forms and online tools)