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ENVIRONMENT, SAFETY & HEALTH DIVISION

Laser Safety Systems Technical Basis Document

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This document, *Laser Safety Systems Technical Basis Document* (SLAC-I-730-0A05Z-001), has been reviewed and approved for implementation by

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Executive Summary

Operation of Class 3B and Class 4 lasers and laser systems require an engineered *laser safety system (LSS)* to help mitigate hazards for laser workers and affected personnel. The LSS is used to restrict access to *laser controlled areas (LCAs)* to authorized laser workers, to contain Class 3B and Class 4 laser radiation within LCAs or Class 1 enclosures, to control laser safety shutters, to set LCA or laser operation modes, and to help protect laser workers and other personnel from laser radiation.

This Laser Safety Systems Technical Basis Document provides guidance for implementing an engineered LSS for Class 3B and Class 4 laser facilities and laser systems. Criteria for specification, design, review and testing of a LSS are described. Administrative requirements are described for configuration control, training, and documentation. Roles and responsibilities for an LSS are also described.

The guidance in technical basis document applies to all Class 3B and Class 4 laser operations at SLAC and to all workers who design, build, implement, or test an LSS for these operations.

This guidance is based on requirements in ESH Manual Chapter 1, "General Policy and Responsibilities", Chapter 2, "Work Planning and Control", Chapter 10, "Laser Safety", and Chapter 51, "Control of Hazardous Energy", and the SLAC Conduct of Engineering Policy.

Contents

Figures

Tables

Acronyms

AEL	accessible emission limit
ALARP	as low as reasonably practicable
CCF	configuration control form
CDMS	Controlled Document Management System
CFR	*Code of Federal Regulations*
CoE	conduct of engineering
DOE	Department of Energy
ESH	environment, safety, and health
FMEA	failure modes and effects analysis
HMI	human machine interface
HPS	hutch protection system (for radiation safety)
ICD	interface control document
IAT	initial acceptance test
JSA	job safety analysis
LCA	laser controlled area
LCLS	Linac Coherent Light Source
LOTO	lockout/tagout
LSC	Laser Safety Committee
LSS	laser safety system
LST	Laser Safety Tool (database used for authorizing laser workers and for laser facility operation approval)
LSO	laser safety officer
MCP	main control panel (LSS)
MPE	maximum permissible exposure
NHZ	nominal hazard zone
OSHA	Occupational Safety and Health Administration
PLC	programmable logic controller
PPE	personal protective equipment
PPS	personnel protection system (for radiation safety)
QLO	qualified laser operator
RFID	radio frequency identification

SAT	safety assurance test
SIL	safety integrity level
SLSO	system laser safety officer
SOP	standard operating procedure
SSRL	Stanford Synchrotron Radiation Lightsource

Definitions

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

administrative control. Control measure that administratively mitigates the potential hazards associated with laser use. Examples include standard operating procedures, *laser safety system (LSS)* certification procedures, configuration control, reviews and approvals, and training

alternate control. Control measure that takes the place of explicitly specified control(s) in ESH Manual Chapter 10, "Laser Safety"

administrative lock. A non-red lock used to control an energy isolating device for operational or configuration control of equipment or systems *(Note: an administrative lock may not be relied on for lockout [LOTO])*

beam conduit. Conduit used to transport a laser beam between two locations

Class 1 enclosure. An *enclosure* that surrounds a laser or laser system and prevents access to laser radiation levels above the *maximum permissible exposure (MPE)* from the enclosed laser or laser system

credited control. An engineered, administrative, or personal protective equipment control that has been designated through hazard analysis to be essential for reducing risk to an acceptable level

control hierarchy. Engineering controls are first line of defense, followed by administrative controls, and finally personal protective equipment

defeatable interlock. A mechanism that allows for the bypassing of the interlock feature when a cover/panel is removed for special operations (for example, laser alignment or maintenance)

enclosure. A physical barrier that surrounds a laser or laser beam and prevents access to laser radiation inside it (for example, protective housings, Class 1 enclosures, beam conduits and fiber transport)

energy isolating device. Device that blocks the transmission of hazardous energy or that prevents the startup of a hazardous energy source. The device may be used as part of a *lockout (LOTO)* procedure or be used for configuration control with an administrative lock and tag.

engineering control. Control measure designed or incorporated into the laser or laser system (for example, interlocks, shutters, enclosures, key controls)

failsafe interlock. Interlock that does not permit an unsafe condition if there is a single component failure

failure mode effects analysis (FMEA). A method to determine possible failure modes in a design, device, operation or process; to determine the consequences of those failures; and to determine what controls are required

interface control document (ICD). A document that describes the interface, configuration control, and responsibilities when there is an interface between the *laser safety system (LSS)* and another safety or controls system

interlock. Engineering control that makes the state of two systems, or functions, mutually dependent. A laser safety interlock detects a fault condition that increases risk for exposure to hazardous laser radiation and takes action to mitigate that increased risk.

laser controlled area (LCA). An area within which potentially hazardous beam exposure from a Class 3B or Class 4 laser is possible. Access and/or occupancy of the area are controlled. This area may be defined by walls, barriers, or other means.

laser facility (laser lab). A work area where a Class 3B or Class 4 laser may operate. It may have one or more *laser controlled areas (LCAs)* but may also have no associated LCA if it is engineered and approved for fully enclosed Class 1 operation.

laser safety system (LSS). A combination of devices and logic systems that are used at *laser controlled areas (LCAs)* and for some Class 1 laser systems with embedded Class 3B or Class 4 lasers. The LSS provides engineering controls to restrict access to LCAs and to laser hazards within enclosures, to provide warning devices for indicating laser system status, and to provide permissives and/or control for safety shutters and laser power supplies.

LCA warning device. Electronic illuminated indicator that displays when laser radiation above the Class 3R *accessible emission limit (AEL)* may be present within the *laser controlled area (LCA)*

lockout (also *lockout/tagout, LOTO*). The placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be energized or operated until the lockout device is removed. Lockout is the primary means for controlling hazardous energy.

maintenance. Performance of adjustments or procedures, specified in a laser facility's standard operating procedure (SOP) or job safety analysis (JSA) document, to maintain the intended and optimal performance of the laser or laser system

maximum permissible exposure (MPE). The level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eye or skin

master key. A device (typically a mechanical key) that when removed prevents the associated laser(s) from emitting laser radiation above the *maximum permissible exposure (MPE)*

nominal hazard zone (NHZ). The space within which the level of the direct, reflected, or scattered radiation may exceed the applicable *maximum permissible exposure (MPE)*. Exposure levels beyond the boundary of the NHZ are below the applicable MPE.

non-credited control. A control that reduces risk from an already acceptable level to a level that is *as low as reasonably practicable (ALARP)*

normal operation. The performance of the laser or laser system over the full range of its intended functions. Removable covers for protective housings and Class 1 enclosures are in place. *(Note: alignment tasks can be performed during normal operation.)*

remote interlock connector. Part of a laser source that interfaces with the *laser safety system (LSS)*. When the connector contacts are open or faulted, the laser source is disabled from emitting laser radiation above the *maximum permissible exposure (MPE)*.

risk. The combination of the probability of an event and the consequence from that event that determines the potential impact. Risk is determined from analysis of probability and consequence, using a defined hazard analysis process.

safety beam block. A manually controlled beam block that can serve the same function as a *safety shutter*.

safety envelope. The set of engineered and administrative bounding conditions within which a system or process may be safely operated with acceptable risk. The safety envelope is comprised of control systems and operating parameters. The safety envelope is generally established through a hazard evaluation process.

safety shutter. A remotely 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.

search. A physical walkthrough of the *laser controlled area (LCA)* performed to ensure that no personnel, or only qualified personnel, are present before a certain *laser safety system (LSS)* operation mode is set. *(Note: in some LCAs, the search is enabled via the LSS.)*

service. The performance of procedures, typically defined as repair, to bring the laser or laser system or laser product back to full and normal operational status

transport safety shutter. A *safety shutter* that is used to prevent transport of a Class 3B or Class 4 laser beam outside of a *laser controlled area (LCA)*

1 Introduction

1.1 Purpose

This Laser Safety Systems Technical Basis Document specifies criteria for implementing an engineered *laser safety system (LSS)* for Class 3B and Class 4 laser facilities and laser systems. The LSS is a *credited control* needed for safe laser operations.

1.2 Scope

Criteria are given for

1. Hazard evaluation and risk assessment
2. Specification of LSS requirements
3. LSS design and implementation
4. Review, testing, and approval of the LSS

Administrative requirements are described for configuration control, training, and documentation. Roles and responsibilities for an LSS are also described.

1.3 Applicability

The guidance provided in this technical basis document applies to all Class 3B and Class 4 laser operations at SLAC and to all workers who design, build, or test an LSS for these operations.

1.4 Policies, Standards, and Other Guidance Documents

The LSS must be designed and implemented to meet the requirements of the following:

- ESH Manual Chapter 1, "General Policy and Responsibilities", including General Policy and Responsibilities: Hazard Control Selection and Management Requirements
- ESH Manual Chapter 2, "Work Planning and Control"
- ESH Manual Chapter 10, "Laser Safety"
- ESH Manual Chapter 51, "Control of Hazardous Energy"
- SLAC Conduct of Engineering Policy

Other documents used for guidance in developing the LSS Technical Basis Document include

- Radiation Safety Systems Technical Basis Document
- Conduct of Accelerator Facility Operations

- American National Standards Institute (ANSI) Z136.1, “Safe Use of Lasers” (ANSI Z136.1)
- American National Standards Institute (ANSI) Z136.8, “Safe Use of Lasers in Research, Development, or Testing” (ANSI Z136.8)

2 LSS Overview and Standalone Safety Controls

2.1 LSS Overview

The LSS is an engineering control system to protect personnel from exposure to Class 3B and Class 4 laser hazards. LSS functionality generally includes the following:

1. Restricting access to an LCA to its *qualified laser operators (QLOs)* and *LCA workers* (and personnel they may escort as described in a SOP or JSA document)
2. Restricting access to laser hazards within Class 1 laser *enclosures*
3. Establishing operation modes for an LCA or laser system
4. Providing permissive/enable outputs to laser power supplies and *safety shutters*
5. Monitoring *interlock* inputs (for example, position sensors for doors, laser curtains, enclosure covers, or safety shutters; and Emergency OFF or emergency entry devices)
6. Inserting safety shutters and/or disabling laser power supplies to put the LCA or laser system in a safe state when a fault condition exists
7. Providing electronic warning displays to indicate the current operation mode and laser eyewear requirements
8. Providing a control panel to
   - Set LCA or laser system operation modes
   - Open/close safety shutters
   - Reset interlocks
   - Provide status information for
     - Interlock inputs
     - Output permissives to safety shutters and laser power supplies
     - Current operation mode

The LSS is customized for each LCA in accordance with the LCA and laser system configuration, the personnel who operate or have access to the laser system, and other operational requirements.

The LSS must meet these requirements:

1. The LSS must be reliable, of high quality, and subject to configuration control and periodic certification and testing.
2. Before a new LSS is used for routine operation, its functional requirements must be documented (typically as part of a *laser facility's* SOP document) and approved by the laser safety officer (LSO).

3. LSS modifications must be documented, reviewed, and approved by the LSO.
4. Each LSS must be certified, operated, and maintained following established written procedures.
5. LSS certification procedure(s) must be linked from the laser facility's SharePoint site.

The LSS should

1. be easy to modify to accommodate changes in laser system configuration and operational requirements.

2.1.1 LSS Interfaces with Other Systems or Devices

When the LSS for a Class 3B or Class 4 laser system has an interface with another system or device that affects the LSS safety functions and that other system or device is the responsibility of a different group, an *interface control document (ICD)* must be prepared. Examples of systems and devices a LSS may interface with include a radiation safety system (PPS, HPS), a vacuum valve, and a shutter.

The ICD must specify

1. The information the LSS receives from and provides to the other system/device
2. The expected actions in relation to the information the LSS receives and provides
3. Who is responsible for all sides of the interface, including the hardware, documentation and testing
4. Configuration control requirements for the interface

2.2 Standalone Safety Controls

Laser manufacturers often provide cover interlocks and safety shutters that may be used independently as standalone controls to augment an LCA's LSS. Manufacturers are also required to provide a *master key* for Class 3B and Class 4 lasers, which is removable and renders the laser inoperable when the key is removed.

To enable laser system maintenance or service, manufacturer cover interlocks can be defeatable. SLAC groups may also build laser sub-systems, such as multi-pass amplifiers (MPAs), that have standalone cover interlocks to disable the sub-system hazard (typically by disabling an associated pump laser) when the cover interlocks are faulted.

When standalone safety controls are used for protecting personnel from exposure to Class 3B or Class 4 lasers, their functionality must be described in a laser facility's SOP or JSA or CCF document.

3 LSS Application Criteria and LSS Levels

An engineered LSS is required if a LCA is established for Class 3B or Class 4 laser operation. The controls required depend on the laser hazard evaluation. Table 3-1 provides a graded approach of minimum requirements (levels 1 to 4) for a LSS associated with a LCA.

Table 3-1 LSS Required Features for LCAs

Level	LCA Laser Classification	Laser Maximum Output	Minimum Requirements[1]
1	3B	<10 x Class 3R AEL	▪ Locked entryway ▪ Master key ▪ Administrative procedures (SOP, signs/labels, LSO review/approval)
2	3B	> Level 1, and < Class 3B AEL	Level 1 requirements, and ▪ Interlocked entryway ▪ Electronic LCA warning device at LCA entry ▪ Permissives for laser power supplies and safety shutters ▪ Audible warning prior to safety shutter opening
3	4	> Level 2, and Not high complexity*, and <100 W average power, and <10 J pulse energy	Level 2 requirements, and ▪ Emergency OFF buttons ▪ IN position sensors for safety shutters ▪ Interlocks for covers that may be removed during normal operations
4	4	> Level 3, or > Level 2 and high complexity*	Level 3 requirements, and ▪ 2 redundant transport shutters if laser can be transported to an uncontrolled area ▪ as determined by a risk assessment ▪ LSS logic review

* A determination of high complexity is done by the LSO, in consultation when with the LSC when needed. One example is if laser beam can be transported to an uncontrolled area or when there is a single LCA with multiple hazard zones.

An engineered LSS is also required for a Class 1 laser system with an embedded Class 3B or Class 4 laser when the laser system's classification during normal operation is Class 1 and the LSS does not include a Class 3B or Class 4 operation mode. Table 3-2 lists the minimum requirements for this.

1 An overview of minimum requirements is given in this table. A complete description of LSS requirements is given in Section 4.

Table 3-2 LSS Required Features for a Class 1 Laser System with an Embedded Class 3B or Class 4 Laser

Level	Embedded Laser Classification	Embedded Laser Maximum Output	Minimum Requirements[2]
1	3B	<10x Class 3R AEL	▪ Locked or interlocked enclosure ▪ Master key ▪ Administrative procedures (SOP, signs/labels, LSO review/approval)
2	3B	> Level 1, and < Class 3B AEL	Level 1 requirements, and ▪ Interlocked enclosure ▪ Electronic warning device at laser ▪ Permissives for laser power supplies or safety shutters
3	4	> Level 2, and <100 W average power, and <10 J pulse energy	Level 2 requirements, and ▪ Emergency OFF button
4	4	> Level 3	Level 3 requirements, and ▪ as determined by a risk assessment ▪ LSS logic review

3.1 Laser Hazard Evaluation and Risk Assessment

Factors that influence the laser hazard evaluation or risk assessment include

1. The laser or laser system's capability to injure personnel or interfere with task performance
2. The environment in which the laser is used, including access to the beam path
3. The personnel who may use or be exposed to laser radiation

Specific factors must include

1. Laser beam characteristics for all lasers present in the lab, including wavelength, average power, classification and, if applicable, beam pulse parameters (pulse energy, pulse width, repetition rate)
2. Laser eyewear optical density requirements for all accessible wavelengths

Additional factors should include, as appropriate,

1. Configuration of the lasers and laser beam paths
2. Other equipment integrated with the lasers and laser systems (for example, power sources, vacuum chambers, pressure vessels)
3. Laser-target interactions, which can produce additional non-ionizing and ionizing radiation, as well as laser-generated air contaminants

2 An overview of minimum requirements is given in this table. A complete description of LSS requirements is given in Section 4.

4. Skin exposure (for example, additional consideration for beam containment and personal protective equipment [PPE] for ultraviolet [UV] or high-power laser operations)
5. LSS
    a. Software, devices, and cableplant
    b. Complexity
    c. *Human machine interface (HMI)* control panel interface

Hazard evaluations are performed as part of the normal review/approval process for all Class 3B and Class 4 lasers and laser systems. Controls requirements depend primarily on the laser system classification and the LSS level as determined in Tables 3-1 and 3-2. Some controls requirements, however, will depend on a hazard evaluation that uses the criteria factors noted above. For all laser operations, the LSS together with additional administrative and PPE controls must reduce the risk for a hazardous laser exposure to an acceptable level. When practical, the LSS and additional (non-credited) controls are used to further reduce the risk by employing the ALARP principle. A risk-based approach to hazard controls is described in ESH Manual Chapter 1, "General Policy and Responsibilities: Hazard Control Selection and Management Requirements.

For a Level 4 LSS

1. A more formal risk assessment should be used such as a *failure mode effects analysis (FMEA)*. LSS software must be included in the risk assessment.
2. The risk assessment should establish a safety envelope of credited controls, including documentation, that are required to achieve acceptable risk and are subject to configuration control
3. A safety programmable logic controller (PLC) should be considered. Compared to a regular PLC, safety PLCs have extra features such as
    – Redundancy
    – Hardware functionality adheres to a specific safety integrity level (SIL)
    – Locked logic or safety signatures to ensure that coding has not been changed
    – Ability to perform field device checking such as monitoring for broken wires, failed contacts, etc.

Safety PLCs introduce more complexity and cost however, including for writing and reviewing the code.

3.2 Alternate Controls

ESH Manual Chapter 10, "Laser Safety", specifies LSS control requirements but includes a provision for *alternate controls* that can be used if all the following requirements are met, which would be done as part of the laser system hazard evaluation:

- They provide equivalent protection as would be accomplished with the specific control(s) not used.
- They are reviewed and approved by the LSO.
- Training on them is provided to all affected laser workers.

Alternate controls may be needed when the LSS requirements specified in Section 4 are not feasible or not reasonably practicable.

4 LSS Requirements

Most SLAC LCAs require a Level 3 or Level 4 LSS and utilize a PLC for this. An example block diagram for a Level 3 LSS is given in Figure 4-1.

For LCAs requiring a Level 1 LSS, typically the only engineering controls are a locked entryway and master key(s) for the laser(s). Administrative control requirements for these LCAs are summarized in Table 3-1. Additional controls may be required depending on the hazard analysis and LSO review/approval.

LCAs requiring a Level 2 LSS will generally have engineering controls similar to a Level 3 LSS, but some Level 3 requirements may be relaxed depending on the hazard analysis and LSO review/approval.

LCAs requiring a Level 4 LSS will employ engineering controls similar to a Level 3 LSS, but there will be additional engineering and administrative controls requirements depending on the hazard analysis and LSO review/approval.

A laser system whose normal operation mode is Class 1 with an embedded Class 3B or Class 4 laser and whose LSS does not include a Class 3B or Class 4 operation mode, will generally have a simpler LSS than is used for a LCA and the LSS probably does not include a PLC. Its minimum LSS requirements are summarized in Table 3-2, and the specific LSS requirements are determined in the hazard analysis and LSO review/approval.

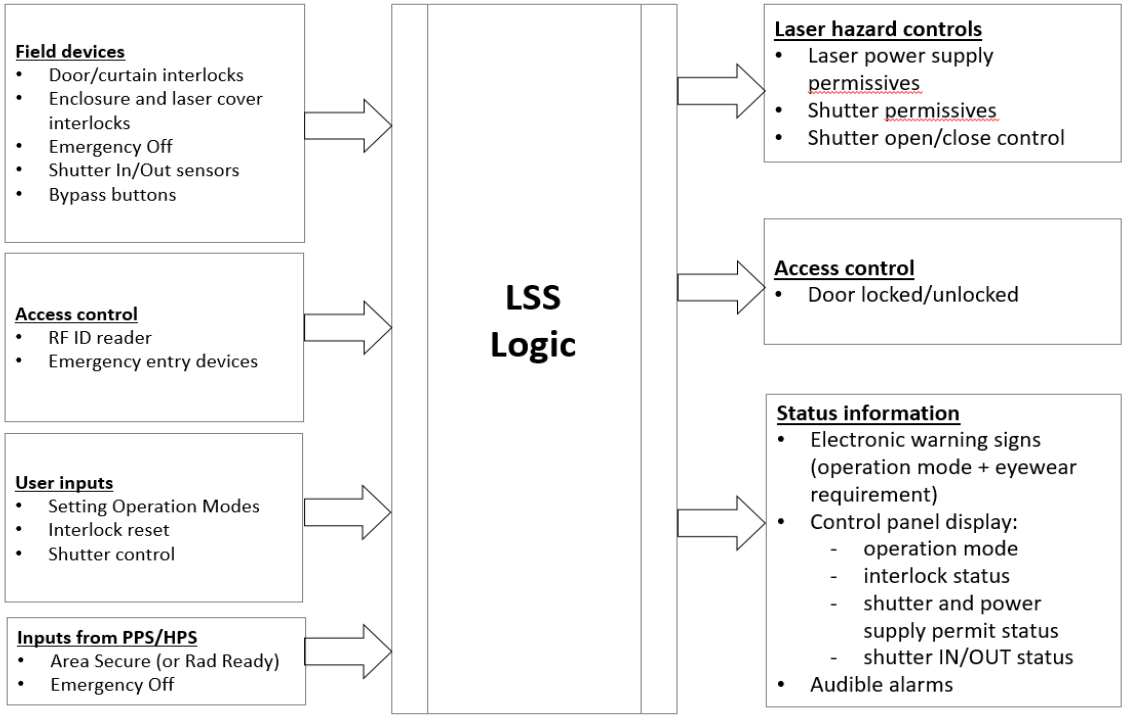

Figure 4-1 LSS Information Flow and Control Example

4.1 LSS Requirement Specifications

LSS requirements are summarized in logic tables in the laser facility's SOP document, with additional details given in a "LSS" section of the SOP and locations for LSS components shown in schematic(s) for the LCA and laser systems. For some applications, a separate requirement document may be written.

Three common logic tables used for the LSS specification are the following:

1. Operation mode summary (see example in Table 4-1). For each LSS operation mode, specifications are given for
   - Permissives for safety shutters and laser power supplies
   - Text for the electronic sign display; two messages alternate for the display (the two messages are separated by "…" in Table 4-1)
2. Mode NO SET logic (see example in Table 4-2). If certain interlock requirements are not met, then a mode change request at the LSS control panel may not be allowed. This is done to avoid challenging an interlock and for operational reasons to prevent tripping a laser source.
3. Interlock fault logic (see example in Table 4-3). Fault actions are specified when an interlock requirement is not met for a LSS operation mode.

Table 4-1 Summary of Laser Operation Modes, When Required Interlock Conditions Are Met (Example)

Operation Mode	Shutters	Laser Power Supplies	Sign Display
Laser OFF	Closed, Disabled	Disabled	LASER OFF … NO LASER HAZARD
Class 1	Closed, Disabled	Enabled	LASER ENCLOSED - CLASS 1 … NO GOGGLES REQUIRED
Class 4 Normal	Enabled	Enabled	LASER ON … GOGGLES REQUIRED
Class 4 Maintenance	Enabled	Enabled	LASER ON – MAINTENANCE GOGGLES REQUIRED
Class 4 JSA	Enabled	Enabled	LASER ON … JSA GOGGLES REQUIRED

Table 4-2 Mode NO SET Logic (Example)

Mode NO SET	Input Conditions	Action
All Mode NO SET	▪ Emergency OFF or Emergency Entry fault ▪ Shutter state inconsistent ▪ LSS master key removed	▪ Prevent any mode being set except Laser OFF ▪ Display error message on MCP
Class 1 NO SET	▪ Class 1 enclosure interlock requirement not met	▪ Prevent Class 1 Mode being set ▪ Display error message on MCP
Class 4 NO SET	▪ Door interlock requirement not met	▪ Prevent any Class 4 Mode being set ▪ Display error message on MCP

Table 4-3 Interlock Fault Logic (Example)

Interlock Fault Condition	Operation Mode	Action
Equipment door not closed	Any Class 4	▪ Close + disable all shutters ▪ Disable laser power supplies ▪ Change to Laser Off mode
Entry door open without timed bypass	Class 4	▪ Close + disable all shutters ▪ If in Maintenance or JSA mode, disable laser power supplies ▪ Sign display indicates “LSS Tripped”
Laser enclosure not closed	Class 1	▪ Close + disable all shutters ▪ Disable laser power supplies ▪ Change to Laser OFF mode
Emergency OFF or emergency entry fault	Any	▪ Close + disable all shutters ▪ Disable laser power supplies ▪ Change to Laser OFF mode ▪ Emergency entry fault unlocks laser entry door
Shutter state inconsistent	Any	▪ Close + disable all shutters ▪ Disable laser power supplies ▪ Change to Laser OFF mode ▪ Set audible and visual alarm at MCP
LSS/PLC power failure	Any	▪ Hazard display signs stop updating ▪ Close + disable all shutters ▪ Disable laser power supplies ▪ Change to Laser OFF mode
LSS master key removed	Any	▪ Close + disable all shutters ▪ Disable laser power supplies ▪ Change to Laser OFF mode
PLC stops cycling	Any	▪ Close all shutters ▪ Open all laser interlocks ▪ Sign displays stop updating

4.2 LSS Level 3 Engineering Requirements

Mandatory (must) and recommended (should) LSS requirements can be found in ESH Manual Chapter 10, "Laser Safety". A summary is provided here together with some additional LSS requirements.

4.2.1 LSS Master Key

1. The LSS must have a removable master key that when removed disables all Class 3B and Class 4 laser beams in the LCA (or *nominal hazard zone [NHZ]*). This must be done by closing/disabling all safety shutters, disabling laser power supplies and setting Laser OFF mode.
2. If there is more than one LCA or NHZ with separate LSS control panels, each of these control panels should have their own master key.
3. For Class 1 laser systems operating outside an LCA, their LSS must have a similar removable master key to disable the enclosed Class 3B and Class 4 laser hazards when the key is removed.

Note *The master key can be used for configuration control as part of an administrative lock and tag.*

4.2.2 LCA Entryway Controls

The LSS must

1. Restrict access to the LCA through a locked door with a key, radio frequency identification (RFID) reader, or coded access to authorized QLOs and LCA workers.
2. Ensure no laser hazard exists at the entryway during entry or exit.
3. Have an interlocked entryway with one of the following options:
   - Entry interlock with a timed bypass capability (for example when a valid RFID is presented at the entry door) 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 entryway *(Note: this is the preferred option.)*
   - Is non-defeatable entry interlock that disables laser hazards in the LCA during entry or egress

The LSS should

1. Include a network-enabled RFID badge reader interfaced to the Laser Safety Tool database, so that only approved laser workers with up-to-date training can access the LCA

4.2.3 LCA Emergency Entry and Egress

The LSS must

1. Permit emergency entry and egress
2. Disable Class 3B and Class 4 laser hazards via interlocks when there is an emergency entry, by closing/disabling safety shutters and disabling laser power supplies

The LSS should

1. Set Laser OFF operation mode when there is an emergency entry

4.2.4 LCA Electronic Warning Devices (lights, signs, annunciators)

The LSS must

1. Have an illuminated electronic warning device to indicate when hazardous laser beams above the Class 3R *accessible emission limit (AEL)* may be present in the LCA. These LSS electronic displays must be located
    a. At the LCA entry so it is visible prior to entry, and
    b. Inside the LCA at one or more locations, where it should be easily viewable to persons within
2. Have its electronic device display the current LSS operation mode, which typically includes Laser OFF, Class 1 – Laser Enclosed, and Class 4 – Laser ON

The LSS electronic displays should

1. Indicate “tripped” if in a Class 4 mode and there is an interlock fault that disables accessible beams
2. Indicate eyewear requirement for different Class 4 modes when practical
3. Include a display located at the eyewear storage location

For LCAs with a work area outside the NHZ, the LSS should

1. Have an electronic warning device to remind personnel entering the NHZ to don laser protective eyewear. If an electronic device is not practical, then an administrative barrier such as a sign must be used. The device could be a proximity sensor or a light curtain.

4.2.5 Electronic Warning Devices for Class 1 Laser Systems

For Class 1 laser systems with embedded Class 3B or Class 4 lasers that operate outside an LCA, their LSS must

1. Provide a warning light or display to indicate when the enclosed laser hazard is operating

4.2.6 LSS Control Panel

The LSS must

1. Have a control panel located inside the LCA to set LSS operation modes, enable laser hazards and control safety shutters
2. For Class 1 laser systems operating outside of a LCA, have a control panel at the laser system location to set the laser’s operation mode, enable its laser hazards and control its safety shutters

The LSS should

1. Not permit remote control of laser hazards inside a LCA when laser workers are present in the LCA. If remote control is allowed, then additional controls (such as password protection and an engineering control or administrative procedure to communicate hazard changes) must be implemented to ensure workers present in the LCA are adequately protected.
2. Include a network-enabled RFID badge reader interfaced to the Laser Safety Tool database, so that only approved laser workers with up-to-date training can set operation modes, enable laser hazards or control safety shutters

4.2.7 Emergency OFF

The LSS must

1. Have a clearly marked and easily accessible EMERGENCY OFF button (at least one) within the LCA
2. Have an Emergency OFF fault close/disable all safety shutters and disable all laser power supplies, so that all accessible laser light levels will be below the Class 3R AEL

The LSS should

1. Have more than one EMERGENCY OFF button within the LCA, depending on the size and complexity of the LCA. Good locations for these are at the *main control panel (MCP)* and at the doors.
2. Have an Emergency OFF fault set Laser OFF mode

4.2.8 Safety Shutters and Safety Beam Blocks

Safety shutters and safety beam blocks must

1. Have an IN position sensor with an associated display signal available for monitoring by laser personnel
2. Close when control signals or power are deactivated or removed (safety shutters only)

Safety shutters and safety beam blocks should

1. Have independent position sensors (and associated displays) for the OUT positions
2. Be installed for each independent laser system (safety shutters are preferred)
3. Be installed at the input to devices that can generate other wavelength hazards (for example, harmonics crystals, OPAs, OPCPAs)
4. Have independent cables for control and readback (for example, to assist with a *lockout [LOTO]* or administrative lock and tag)
5. Not share common hardware, such as a controller interface chassis, with control shutters. Control shutters should not be controlled by the LSS. *(Note: control shutters are used to enable beam paths for operational needs or equipment protection rather than safety for laser exposure hazards.)*
6. When a safety shutter open request is given, there should be a delay (typically approximately 10 seconds) before the shutter opens during which an audible or visual warning is given
7. Give a warning and, if possible, inhibit the laser upstream of the safety shutter or safety beam block when there is an inconsistency between a requested IN state and the IN or OUT position sensors. Three inconsistent shutter states that are normally considered are when the safety shutter or safety beam block position sensors indicate
   - IN and OUT, or
   - NOT IN and NOT OUT, or
   - NOT IN when requested to be IN

4.2.9 Transport Safety Shutters

When safety shutters are used as a machine guard to prevent transport of a Class 3B or Class 4 laser beam to an area outside an LCA, then the LSS must

1. Have two redundant transport shutters
2. Have an illuminated display sign to communicate the laser hazard status (for example, Laser OFF or Laser Enclosed – Class 1) in the uncontrolled area outside the LCA.

4.2.10 Class 1 Enclosures

Class 1 enclosures must meet the following requirements:

1. Removable covers must have failsafe or redundant interlocks if they may be removed during normal operation or maintenance.
2. Covers that are only removed during infrequent service tasks must either
   - Be interlocked (failsafe or redundant interlocks not required), or
   - Be secured requiring a tool to remove
3. If *defeatable* cover interlocks are used, it must not be possible to replace the cover with the interlock defeated.
4. In uncontrolled areas, non-defeatable cover interlocks must be used for covers that may be removed to enable Class 3B or Class 4 work, except if LSO approval is given to use an administrative configuration control lock.
5. A cover interlock fault must disable Class 3B and Class 4 laser hazards within the enclosure.

4.2.11 Interlocks

The LSS must

1. Have all interlock faults latch so the laser hazard is not automatically re-enabled once the interlock fault is cleared, except for some faults when the LCA has been searched to be clear of personnel and laser operation is controlled remotely.
2. Put the laser system to a safe state if an interlock input connector is removed or there is a power failure to the interlock circuit.
3. Have interlock inputs for access doors, protective covers, service access panels, and enclosures be normally open (faulted). Doors and covers must be closed to satisfy (close) their interlock input to the LSS.

The LSS should

1. Require authorization, for example via RFID, to reset an interlock fault
2. Minimize when laser power supplies trip if laser hazards can be adequately disabled by closing/disabling safety shutters, except that Emergency OFF and Emergency Entry faults must disable laser power supplies. *(Note: some laser equipment is more sensitive to hard shutoffs when their remote interlock interface with the LSS is tripped.)*

3. Be implemented so normal laser operations, such as entering or exiting an LCA, do not challenge interlocks

4.2.12 LCA Operation Modes

The LSS must

1. Have a Laser OFF mode which disables laser power supplies and closes/disables safety shutters. This mode exists when the LSS master key is removed or when certain interlock faults occur. No Class 3B or Class 4 laser radiation is present in the LCA.
2. Have a Laser ON (Class 4) mode with laser power supplies and laser shutters enabled. Class 3B and Class 4 lasers may be on and hazardous beams accessible. There may be multiple Class 4 sub-modes in a given laboratory, with different interlock fault actions and different permissions for shutters and power supplies. Typical Class 4 modes include NORMAL, MAINTENANCE and JSA.

LSS should

1. Have Laser OFF be the default mode when the LSS master key is first turned on.
2. Have a Class 1 operation mode, where laser hazards are enabled but fully enclosed in an approved, engineered Class 1 enclosure.
3. Have a Laser ON (Class 4) Normal mode, when LSS safety shutters can be inserted to disable/block all laser hazards.
4. Have a Laser ON (Class 4) Maintenance mode, when a laser cover has been removed which limits the effectiveness of the safety shutters. Such covers will have labels indicating to switch to Maintenance mode when removed.
5. Have a Laser ON (Class 4) JSA. QLOs and LCA workers are referred to a specific job safety analysis (JSA) document in effect.
6. Have additional Laser ON Class 4 modes, when practical, if more than two types of laser eyewear are specified in the laser facility’s SOP document. Such modes may include Class 4 OPA and/or Class 4 Harmonics.

5 LSS Design and Implementation

The LSS should be designed according to the principles and criteria listed in this section. Examples of specific LSS devices and components can be found on the LCLS LSS Confluence website. For SSRL laser facilities, information on LSS devices and components can be found in LSS documentation linked from the facility SharePoint sites.

5.1 LSS Logic

The LSS logic should meet the following requirements:

1. PLC code should be organized in modules according to different functions. Example modules include
   - Startup configuration in Laser OFF mode with all safety shutters and power supplies disabled
   - Shutter open/close control
   - Interlock reset
   - Entry door interlock bypass
   - Latching interlock faults
   - Interlock fault actions
   - Setting LSS operation modes, with associated permissives for safety shutters and laser power supplies
   - Electronic sign display messages
   - Indicator lights and audible warnings
   - User inputs from LSS control panel
   - Error messages to display at LSS control panel
2. Permissives for safety shutters and power supplies. The LSS should
   - Define a “shutter enabled” variable that is true when the LSS logic permits the shutter to be open
   - Define a “power supply enabled” variable that is true when the LSS logic outputs an enable permit for a laser power supply, which is typically the “remote interlock” input for the power supply
3. When one PLC is used for multiple NHZs or LCAs, the logic should be organized with separate modules for each NHZ/LCA and dependencies of code logic between modules should be minimized.
4. The logic should be simplified when practical and avoid unnecessary duplicative logic. This helps make the code more robust and easier to review.
5. Normal laser operations, such as entering or exiting an LCA, should not challenge interlocks. For example: most LCAs have a locked entry door with RFID reader. Presenting a valid RFID at the entry door unlocks the door and gives a timed bypass (typically less than 20 seconds) during which the entry door interlock sensor is ignored.

6. User-requested mode changes should not be allowed if an interlock requirement for the new mode is not met. This helps prevent challenging interlocks and is also done for operational reasons, for example to avoid tripping a laser which may then require a long time to recover stable operation or risk damaging the laser.
7. Fault actions that change the operation mode. The LSS should
   - Set Laser OFF mode if the fault actions closes/disables all safety shutters and disables all laser power supplies
   - Avoid changing operation mode when there is an interlock fault unless the change is to Laser OFF mode. Other mode changes due to fault conditions can make the LSS code more complex.
8. If the PLC stops cycling or loses power, output permissives to devices should be disabled and there should be a means for a laser operator to determine this fault condition. *(Note: one way to indicate the fault condition is for the LSS electronic warning sign to display two alternating messages when the LSS is operating normally. If the PLC stops cycling or loses power, only one message would then be displayed.)*
9. LSS master key. When the LSS master key is removed or in the OFF position:
   - The LSS must close/disable all safety shutters and disable all laser power supplies.
   - The LSS should set Laser OFF mode.
10. Emergency OFF. When the LSS EMERGENCY OFF button is activated:
    - The LSS must close/disable all safety shutters and disable all laser power supplies.
    - The LSS should set Laser OFF mode.
11. Emergency Entry. When the Emergency Entry device is activated:
    - The LSS must close/disable all safety shutters and disable all laser power supplies and unlock the entry door.
    - The LSS should set Laser OFF mode.

5.2 LSS Control Panels/Modules

5.2.1 LSS Main Control Panel (MCP) for LCAs

The LSS MCP should

1. Use an HMI touch screen for its user interface
2. Restrict control functions to authorized laser workers by use of RFID badge reader, key control or coded access
3. Have a two-position key switch for the LSS master key

HMI touchscreens must have the capabilities to

1. Set LSS operation modes
2. Control safety shutters
3. Reset interlocks

4. View LSS status information (current operation mode, permissives for shutters and power supplies, interlock status, and safety shutter open/closed status)

HMI touchscreens should

1. Have a main screen to view summary LSS status information and to set LSS operation modes
2. Have an interlock summary screen
3. Have a shutter controls screen

LSS control panels that do not employ a touchscreen must

1. Have buttons or switches to set operation modes, control safety shutters, and reset interlocks
2. Have indicator lights to provide LSS status information for current operation mode, permissives for shutters and power supplies, interlock status and safety shutter open/closed status

5.2.2 Entry Control Panel for LCAs

The LCA's entry door should have a control panel with the following features:

1. RFID badge reader. Presenting a valid badge unlocks the door for approximately 20 seconds. During this time the door interlock is ignored if the LCA is configured so the entry door is outside the NHZ.
2. Emergency entry device. When activated, this unlocks the door and should trip all Class 3B and Class 4 laser hazards in the LCA.
3. Indicator light for when the door is locked
4. Indicator light for laser curtain closed sensor, if an interlocked laser curtain is used at the entry door

5.2.3 Interlock Bypass Module for LCA Entryway

To enter or exit an LCA without interrupting laser operations during a Class 4 (or Class 3B) operation mode, the entry interlock needs to have a timed bypass capability. That is acceptable only for a LCA with an entry that is outside the NHZ. Entry is done by presenting a valid RFID badge at the LCA's entry control panel (see 5.2.2).

For exit, an interlock bypass module can be used which has the following features:

1. Push button, that when pressed unlocks the door for approximately 20 seconds; during this time the door interlock is ignored. The push button should have an associated indicator light that is illuminated when the bypass request is active.
2. Indicator light for when the LSS is in an operation mode where the door interlock is active (should be illuminated red when in these modes)
3. Indicator light for when it is OK to exit (should be illuminated green when door interlock is not active, such as when the LSS is in a Laser OFF or Class 1 operation mode or when a timed bypass is in effect in a Class 4 mode).

A different type of door interlock bypass for egress can be implemented using a door egress device with a sensor reporting the state of the device to the LSS. Once the egress device (for example, push bar or door handle) is activated for exit, the signal received by the LSS triggers a timed door interlock bypass.

5.3 RFID badge readers

RFID readers can be used to enable entry of authorized personnel into a LCA and their access to control functions at the LSS MCP.

When used, LSS badge readers should

1. Read SLAC badges
2. Be interfaced to the Laser Safety Tool database, so that only approved laser workers with up-to-date training can access the LCA and perform control functions at the MCP

5.4 Electronic Warning Signs and alarms

5.4.1 Text LED sign display

These devices can communicate LSS information using a scrolling text capability.

When used, the LSS should

1. Provide the text message to display, rather than a text address where the text message is determined by a manual programming device *(Note: having the LSS provide the text message is more robust.)*
2. Refresh the text display, rather than continuously display a static message, to convey to laser workers that the information is current (and that the PLC for the LSS is cycling, if a PLC is used)

5.4.2 Bi-lights and Tri-lights

Bi-light and tri-light devices are high brightness LED tower lights where two (usually red and green) or three (usually red, amber, and green) colors are emitted in a continuous or pulsating pattern. These devices are interfaced with the LSS to indicate the operation mode in an LCA or NHZ. They can also be used to indicate status for a Class 1 laser system operating outside an LCA, or for a transport shutter open/closed status.

5.4.3 Shutter Warning

The LSS should

1. Activate a visual and audible warning to signal that a laser shutter is about to open following a request to open. The warning devices should be located at the LSS control panel or at the safety shutter.
2. Activate a visual and audible warning when there is an inconsistent shutter state interlock fault (see 4.2.8). This warning should use the same device as for the shutter opening warning but have a different pattern to distinguish between the two warnings.

5.4.4 Proximity and Light Curtain Warning Sensors

To help prevent entering an NHZ without proper laser eyewear or to prevent an entry interlock fault and disruption to laser operation, a proximity or light curtain sensor may be installed near the entry to a NHZ (see also 4.2.4). The sensor actuates an alarm or an audio recording to remind workers about requirements for entering the NHZ, for example, to don proper laser eyewear.

5.5 Emergency Entry device for LCAs

The LSS must

1. Provide an emergency entry device to at least one entry door for an LCA. When activated, the LSS must unlock the door, close/disable all safety shutters, and disable all laser power supplies.

The LSS should

1. Locate the emergency entry device on the LSS entry door control panel
2. Set Laser OFF mode when the device is activated

5.6 Door Locks

The LSS should

1. Use electric strike (E-strike) locks so they can be controlled, when desired, by an entry door badge reader or according to the LSS operation mode. These are electromechanical access devices that have additional functionality compared to a mechanical lock. They are used in combination with another form of locking device, such as a lock set or a panic bar.
2. Configure the lock so the door can always be opened from inside the LCA for egress from the secure side.

6 LSS Administrative Requirements

6.1 LSS Certification

The LSS must be initially and periodically thereafter tested and certified to be operating properly. Laser facility operation approval requires a certified LSS, with the LSS functioning according to the specification requirements for it in the laser facility's SOP document. An approved SOP that correctly describes the LSS specification is another requirement for laser facility operation approval.

The procedures for initial acceptance testing (initial acceptance test, IAT) and periodic verification (safety assurance test, SAT) that ensure correct functionality of the LSS are subject to the review and approval of the laser facility system laser safety officer (SLSO) and the SLAC LSO, or their designees. If an SAT is not prepared for a laser facility, the IAT must be used for periodic verification tests. When significant modifications are made to the LSS, the revised IAT must be executed for recertifying the LSS and restoring normal operations.

The LSS must be certified annually, but extensions up to six months are allowed if LSO approval is given.

6.1.1 Initial Acceptance Test (IAT)

The IAT contains tests to verify and certify the LSS performance in all its operation modes. The IAT is used for a new LSS and may be executed annually when the LCA receives its annual approval to operate, but often a simplified SAT is used for the annual LSS certification. The IAT may also need to be executed following significant modifications of the LSS.

The IAT procedure must include

- Section for approving the IAT document to indicate that it accurately describes the LSS and provides adequate verification checks for the LSS specification requirements
- List of components used
- Names, signatures, and initials of all individuals who took part in the certification
- Set of tests to establish correct operation per the LSS specification in the SOP. These should be organized in sections, according to each LSS operation mode or to a global LSS fault condition that is independent of LSS operation mode
- LSS engineer (or SLSO) sign-off, following the certification checks, stating that no jumpers or other devices used during the procedure to bypass an input signal to the LSS have been left installed
- Figures for the HMI for the LSS control panel(s)
- Section to describe any hardware or procedural issues discovered during the certification
- Section for SLSO (or designee) signoff certifying that the checkout has been completed, except for the noted hardware and procedural issues
- Section for approval signatures by LSO and SLSO indicating their acceptance that any outstanding hardware or procedural issues do not affect safe operation of the facility

For accelerator, LCLS, and SSRL laser facilities, the IAT should be published in the CDMS.

6.1.2 Safety Assurance Test (SAT)

Executing the IAT for an annual recertification of the LSS may be replaced by completing a shorter SAT procedure if there have been no significant changes to the LSS since the last certification. The SAT typically uses the LSS logic tables in the SOP document.

The SAT procedure must include

- Names, signatures, and initials of all individuals who took part in the certification
- Verifying the permissives for safety shutters and laser power supplies, when required interlocks are satisfied, for each LSS operation mode
- Verifying hazard display signs for each LSS operation mode
- Verifying the actions for each interlock logic fault
- Section to describe any hardware or procedural issues discovered during the certification
- Section for SLSO (or designee) signoff certifying that the checkout has been completed, except for the noted hardware and procedural issues
- Section for approval signatures by LSO and SLSO indicating their acceptance that any outstanding hardware or procedural issues do not affect safe operation of the facility

The SAT should also include tests to verify that

- All LSS status indicator lights (such as those on LSS control panels/modules) are functional
- All doors latch properly and electrical locks work properly
- Safety shutters are correctly configured and their mechanical integrity is good

6.2 Configuration Control

6.2.1 LSS Design, Fabrication, and Installation

The SLAC Conduct of Engineering Policy, and directorate conduct of engineering (CoE) implementation plans describe the policy and implementation of engineering-related work. SLAC laser facilities must follow the requirements of CoE for the design, fabrication, and installation of engineered systems for laser safety, including the LSS.

6.2.2 LSS Modifications

A configuration control form (CCF) must be completed when the LSS is modified, including when there is a change in the safety configuration or function of a Class 1 enclosure, safety shutter, other LSS component or LSS logic. Requirements for CCFs are given in the ESH Manual Chapter 10, “Laser Safety”. The CCF must describe any LSS certification or verification checks that must be completed prior to restoring normal operations. CCF templates and examples are available on the Laser Safety SharePoint site.

When LSS modifications require updates to the LSS code, control panel HMI or LSS certification procedure the documentation for these must be revised as appropriate.

No removal, modification, bypass, or any other changes of the LSS, including work on its software, must take place without appropriate work planning and control.

6.3 Reviews, Approvals, and Documentation

6.3.1 LSS Specification

The LSS specification is documented in a laser facility's SOP document. The SOP requires review and approval from the facility SLSO and program manager, the ESH coordinator and the LSO. The SOP is linked from a laser facility's SharePoint site. For accelerator, LCLS, and SSRL laser facilities the SOP should be published in CDMS.

The Laser Safety Committee (LSC) must review the LSS specification when requested by the LSO. The LSC should review the LSS for new laser facilities and for major LSS modifications, depending on the complexity for the LSS.

6.3.2 LSS Logic

The LSS logic for a Level 4 LSS must be independently reviewed by the LSO or a competent person approved by the LSO for this task. The LSS logic for a Level 3 LSS should be reviewed by the LSO or a competent person approved by the LSO for this task. Documentation for the LSS Logic must be linked, sometimes through a LSS Confluence website, from a laser facility's SharePoint site.

6.3.3 Human Machine Interface for the LSS Main Control Panel

The HMI for the LSS MCP must

1. Be documented (via figures or schematics) in the IAT procedure
2. Be reviewed by the SLSO and LSO and approved by them as part of the IAT approval

6.3.4 LSS Certification Procedures

The IAT procedure is developed by the LSS engineer. It must be reviewed and approved by the SLSO and LSO.

The SAT procedure, if used, is typically developed by the SLSO. It must be reviewed and approved by the LSO.

The IAT and SAT documents must be linked from a laser facility's SharePoint site. For accelerator, LCLS, and SSRL laser facilities the IAT should be published in CDMS.

6.3.5 LSS Certification Documentation

LSS certification using an IAT or SAT procedure must be reviewed and approved by the SLSO and LSO.

The certification documentation must be linked from the laser facility's SharePoint site.

6.3.6 Configuration Control Forms

CCFs are developed by the SLSO. They must be reviewed and approved by the LSO, should be sent to the LSS engineer as notification and must meet requirements for them in the ESH Manual Chapter 10, "Laser Safety". The LSO may then require additional review or approvals, such as approval by the LSS engineer or LSO before restoring normal operation.

CCFs must be linked from a laser facility's SharePoint site when they are in effect.

6.3.7 Interface Control Documents

The ICD must be reviewed by the LSS engineer and by the technical system owner for the other side of the interface and should be reviewed by the LSO. The ICD must be approved by the owner of the technical system having its hazards controlled, which is typically the laser facility program manager.

The ICD should be published in CDMS and must be linked from the laser facility's SharePoint site.

6.3.8 Additional LSS Documentation (Schematics, Diagrams, Cableplant)

The LSS engineer is responsible for any additional LSS documentation. For a laser facility using a LSS developed by LCLS LSS engineering, this documentation may be stored on their LSS Confluence website.

6.4 Training

Laser workers (QLOs and LCA workers) receive on-the-job training (OJT) from the SLSO for each laser facility they are approved for. The OJT must include an overview of the LSS, including its operation modes and eyewear requirements. QLOs must receive more detailed instruction as appropriate, commensurate with their work activities. The training is described in an OJT syllabus linked from the laser facility's SharePoint site and is documented in the Laser Safety Tool database. Annual refresher OJT is required.

7 Roles and Responsibilities

7.1 LSS Engineering

- Implements the LSS according to the LSS specification requirements in the laser facility SOP document
- Documents the LSS, including its logic and HMI for LSS control panels
- Develops the IAT certification procedure
- Performs LSS validation tests *(Note: LSS validation tests are performed to verify or test the required LSS functionality. For example, they are often done prior to certification when the LSS is installed or updated and may be done during troubleshooting or service.)*
- Updates LSS documentation when any modification is made

7.2 System Laser Safety Officer (SLSO)

- Develops and approves the LSS specification requirements in the laser facility SOP document
- Reviews and approves the IAT certification procedure
- Develops the SAT certification procedure, if one is used
- Performs LSS certification tests and documents the results using an IAT or SAT
- Completes a CCF when a modification is made to the LSS, in coordination with the LSS engineer, and work with the LSO for their review and approval
- Requests laser facility operation approval, which requires a certified LSS and an approved SOP document

7.3 SLAC Laser Safety Officer (LSO)

- Reviews and approves the LSS specification requirements in the laser facility SOP document
- Reviews the LSS logic for a Level 4 LSS or approves a competent person to perform this review
- Reviews the HMI for LSS control panels
- Reviews and approves the IAT and SAT LSS certification procedures
- Reviews and approves the LSS certification documentation, which uses an IAT or SAT procedure
- Reviews and approves LSS modifications
- Approves laser facility operation, which requires a certified LSS and an approved SOP document

7.4 ESH Coordinator

- Reviews laser facility inspection reports from the LSO, which include status information for the LSS certification and the lab's SOP document that gives the LSS specification
- Approves laser facility operation, which requires a certified LSS and an approved SOP document

7.5 Laser Facility Program Manager

- Reviews laser facility inspection reports from the LSO, which include status information for the LSS certification and the lab's SOP document that gives the LSS specification
- Approves laser facility operation, which requires a certified LSS and an approved SOP document

7.6 Laser Safety Committee

- Reviews specifications for laser facilities and their LSS when requested by the LSO
- Provides expertise and advises on laser safety policy and laser safety requirements

8 References

Title	Document Number	Originating Unit	URL
ESH Chapters / Programs			
Chapter 1, “General Policy and Responsibilities”	SLAC-I-720-0A29Z-001	ESH	https://www-group.slac.stanford.edu/esh/general/general_policy/
General Policy and Responsibilities: Hazard Control Selection and Management Requirements	SLAC-I-720-0A24S-001	ESH	https://www-group.slac.stanford.edu/esh/eshmanual/references/eshReqControls.pdf
Chapter 2, “Work Planning and Control”	SLAC-I-720-0A29Z-001	Contractor Assurance	https://www-group.slac.stanford.edu/esh/general/wpc/
Chapter 10, “Laser Safety”	SLAC-I-720-0A29Z-001	RP	https://www-group.slac.stanford.edu/esh/hazardous_activities/laser/
Chapter 51, “Control of Hazardous Energy”	SLAC-I-720-0A29Z-001	CCS	https://www-group.slac.stanford.edu/esh/hazardous_activities/cohe/
Other SLAC			
Radiation Safety Systems Technical Basis Document	SLAC-I-720-0A05Z-002	RP	https://www-group.slac.stanford.edu/esh/documents/techbas/rss.pdf
SLAC Conduct of Engineering Policy	ENG-2018-018		https://policies.slac.stanford.edu/policy/conduct-engineering
Conduct of Accelerator Facility Operations	CACM-2019-059	Contractor Assurance	https://policies.slac.stanford.edu/policy/conduct-accelerator-facility-operations
Laser Safety Program Site (SharePoint)		RP	https://slac.sharepoint.com/sites/ESH/laser/
Laser Safety Tool	LST	RP	https://www-bis2.slac.stanford.edu/LST/Default.aspx
LCLS LSS Confluence		LCLS	https://confluence.slac.stanford.edu/pages/viewpage.action?pageId=16744606
Controlled Document Management System	CDMS		https://slac.sharepoint.com/sites/pub/default.aspx

Title	Document Number	Originating Unit	URL
Other			
American National Standards Institute (ANSI) Z136.1, “Safe Use of Lasers”	ANSI Z136.1	American National Standards Institute	https://slacprod.servicenowservices.com/kb_view.do?sysparm_article=KB0011928
American National Standards Institute (ANSI) Z136.8, “Safe Use of Lasers in Research, Development, or Testing”	ANSI Z136.8	American National Standards Institute	https://slacprod.servicenowservices.com/kb_view.do?sysparm_article=KB0011928