

Chapter 10: [Laser Safety](#)

# Class 3B and Class 4 Laser Eyewear Protection Requirements

Product ID: [549](#) | Revision ID: 2600 | Date published: 5 May 2023 | Date effective: 5 May 2023

URL: <https://www-group.slac.stanford.edu/esh/eshmanual/references/laserReqClass3Band4Eyewear.pdf>

## 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, *laser facility program managers, system laser safety officers (SLSOs), line management, and the laser safety officer (LSO).*

## 2 Requirements

### 2.1 General

Laser eyewear protection must meet all the following requirements:

- Must be worn within the *nominal hazard zone (NHZ)* when the *master key* enables the laser hazards and the *laser controlled area (LCA)* is in a Class 3B or Class 4 laser operation mode
  - In work areas that are outside the NHZ, but within the LCA, *qualified laser operators (QLOs)* and *LCA workers* should carry eyewear protection (by use of a lanyard, for example)
- Must provide full protection unless an LSO-approved exception exists (see Section 2.1.1). Full protection eyewear has 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.)
- Must be labeled with wavelength-dependent OD information
- Must 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.
- Must be evaluated for *saturable absorption* and for material damage due to potential power density from a direct hit
- Must fit properly when used, to provide adequate protection. **Peeking over or under laser eyewear is not allowed.**
- Must be approved by the LSO as part of the approval process for a *lab-specific standard operating procedure (SOP)* or *job safety analysis (JSA)* document. The LSO will also perform periodic inspections of the eyewear in use.

- Must be adequately maintained and cleaned
- Must be adequately labeled, stored, and organized to avoid confusing different types of eyewear that may be used
- Must 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. (*Note if reflective eyewear with dielectric coatings is used, even small scratches to the filter may cause damage and compromise the required protection.*)

### 2.1.1 Exceptions to Full Protection Eyewear Requirement

Exceptions to the full protection eyewear requirement within the NHZ are allowed if at least one of these 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.

Exceptions must be documented in the lab-specific SOP or JSA.

## 2.2 Alignment Eyewear Requirements

For all routine laser operations and for most laser alignment procedures, *full protection eyewear* must be used. *Alignment eyewear*, defined as protective eyewear with reduced OD from full protection, may only be used for specific alignment procedures that have been appropriately evaluated, documented, and authorized. **Use of alignment eyewear 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 m 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).

All the following alignment eyewear requirements must be met:

- 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 charged-couple device (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 m. 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, defined as 400 to 700 nm. (More careful evaluation and justification will be needed for alignment eyewear at 750 to 800 nm than at 530 nm, 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 Program Site](#).)
  - QLOs must use an alignment eyewear log to document each time an alignment procedure is carried out using alignment eyewear and which QLO performs the task. (A template for this is available on the [Laser Safety Program 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 are recommendations that 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 forms and systems are required by these requirements:

- Qualifier Laser Operator Approval for Alignment Eyewear Form (available on the [Laser Safety Program Site](#) [SharePoint])
- Alignment Eyewear Usage Log (available on the [Laser Safety Program Site](#) [SharePoint])

## 4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- The SLSO must maintain completed alignment eyewear forms and use logs in the laser facility's safety binder or [SharePoint site](#).

## 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)
  - [Laser Safety Program Site](#) (SharePoint)

Other Documents

- American National Standards Institute (ANSI) Z136.1, "Safe Use of Lasers" ([ANSI Z136.1](#))