# LASER SAFETY

Lasers are divided into the following classes:

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|---|---|
| Class 1 | Low power / non-hazardous |
| Class 2/2a | Low power / minor controls necessary<br>Emit less than 1 mW visible CW radiation. Not considered hazardous for momentary (<0.25 sec) unintentional exposure. Class 2a lasers are those class 2 lasers not intended to be viewed, i.e. supermarket scanners. |
| Class 3a/3b | Medium power / direct viewing hazard / little diffuse reflection hazard.<br>Class 3a is visible lasers with 1-5 mW power output, invisible lasers, and those having 1-5 times the Accessible Emission Limit (AEL) of class 1 lasers. Class 3b is all other class 3 lasers at all wavelengths which have a power output less than 500 mW. |
| Class 4 | High power / eye and skin hazard / potential diffuse reflection hazard or fire hazard |

There are several pertinent instructions and guidelines regarding laser use. They are:

- SPAWARINST 5100.12B, Navy Laser Hazards Control Program
- MIL-HDBK-828, Laser Range Safety
- ANSI Z136.1-1993, American National Standard for the Safe Use of Lasers

Every Navy command which uses lasers must have a Laser System Safety Officer (LSSO). There are two categories of LSSOs, and each command should determine which type is appropriate considering their mission, types of lasers being used, and size of the laser safety program.

The CAT I LSSO must attend formal training at Naval Safety School. They are qualified to (a) Calculate and/or measure laser safety parameters, such as Nominal Ocular Hazard Distance (NOHD), and required optical densities for laser eye wear, (b) Train CAT II LSSO's, (c) Conduct hazard surveys, (d) Classify lasers and laser systems, and (e) Conduct laser incident investigations, and (f) Perform all the tasks of a CAT II LSSO.

The CAT II LSSO does not have the technical capability to calculate or measure laser safety parameters, and cannot serve as an instructor of other LSSO's. They are qualified to (a) Approve/disapprove the use of local lasers, (b) Instruct employees and supervisors on the safe use of lasers, (c) Supervise laser operations and maintenance, (d) Manage incidents investigations, (e) Conduct laser range safety compliance inspections, (f) Maintain a medical surveillance program, (g) Maintain an inventory of military exempt and class 3b and class 4 lasers, and (h) Post lasers warning signs, etc.

The hazard ranges of interest are the NOHD for direct viewing of a beam and the $r_{1(safe)}$ or $r_{2(safe)}$ for viewing a beam reflected off an object such as a wall. These are depicted in figure 1. The hazard range for a laser can be calculated using the information from enclosure (5) of SPAWARINST 5100.12B. The Maximum Permissible Exposure (MPE) values present laser safety levels as a function of exposure time, laser PRF, pulse duration, and wavelength. Different tables are used for eye safety while directly viewing a beam, for viewing a diffusely reflected beam, and for skin exposure.

For repeated pulses the following equation is used to calculate the maximum permissible exposure (MPE).

$$\text{MPE (repeated pulse)} = \frac{MPE(single\ pulse)}{(\ PRF\ x\ t_e\ )^{1/4}} \qquad \textbf{[1]}$$

Where PRF is the pulse repetition frequency of the laser and $t_e$ is the exposure duration.
For visible lasers $t_e$ is usually taken as 1/4 second and for non-visible lasers a value of 10 seconds is used.

Figure 1 depicts some of the laser hazard distances discussed in SPAWARINST 5100.12B.

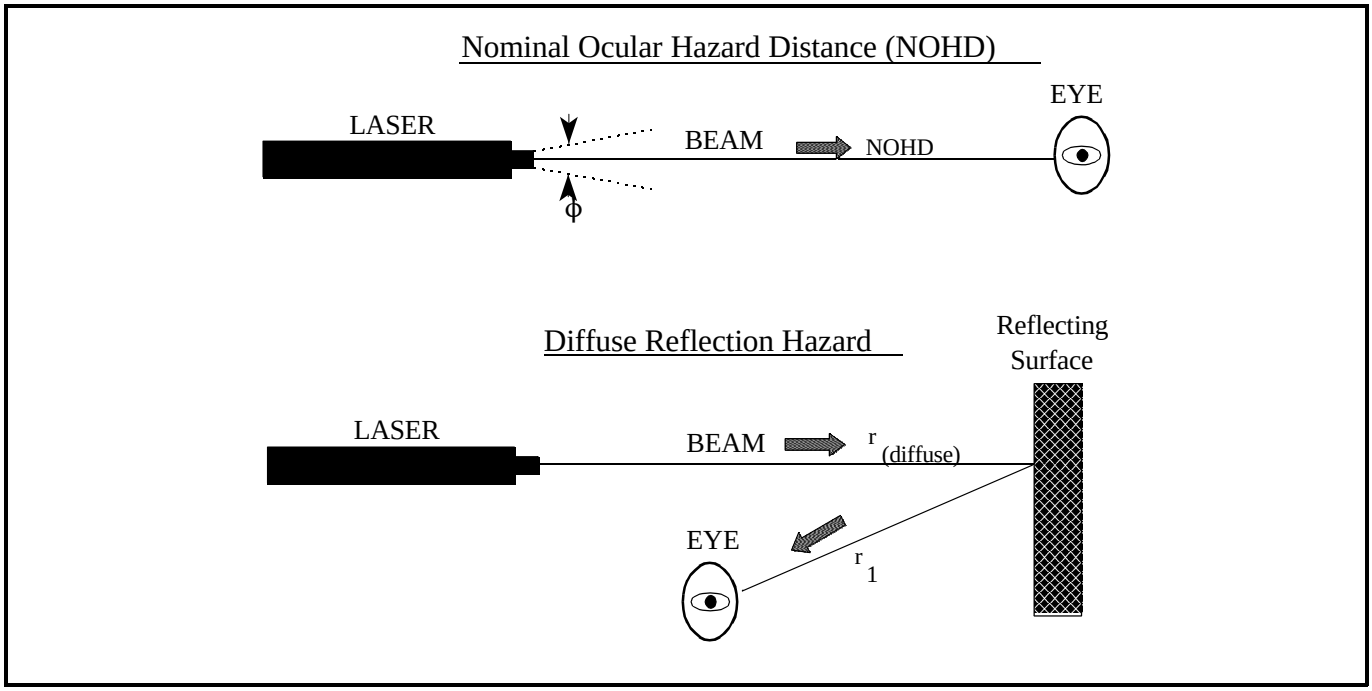


**Figure 1**. Laser Hazard Distances

Range laser safety officers shall be designated for external operations. Range test plans shall specify:

- Permissible aircraft flight paths, and ship or vehicle headings.
- Hazard areas to be cleared.
- Operational personnel locations.
- Types of surveillance to be used to ensure a clear range.
- Radio / communications procedures.

During laser operations no portion of the laser beam may extend beyond the controlled target area unless adequate surveillance can prevent radiation of unprotected areas. Class 3 and class 4 lasers shall not be directed above the horizon unless coordinated with those responsible for the given airspace (FAA, Navy, Air Force, etc).

In an industrial environment, warning and hazard signs and lights will be posted, a hazard zone shall be designated when lasers are in operation, and training shall be provided to operators in the proper eye and body (skin) protection required. Interlocks to laser operation shall be provided when there is the possibility of unauthorized personnel entering the hazard area.

Fiber optic cables usually have laser power sources so appropriate warnings or labels need to be applied to connections or possible breakage points.