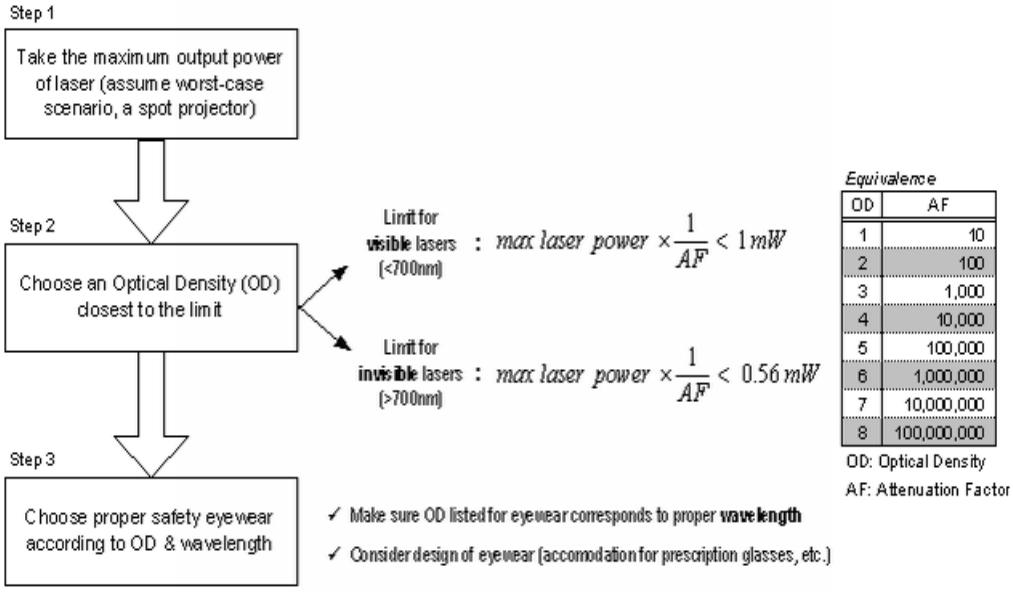
Selecting Laser Safety Eyewear

Application Note

Introduction

The unprotected human eye is extremely sensitive to laser radiation and can be permanently damaged from direct or reflected beams. Protective eyewear in the form of goggles, glasses, or shields provides the principal means to ensure against ocular injury, and must be worn at all times during laser operation of Class IIIb (CDRH), 3B (IEC) or higher lasers. Selecting the right type of eyewear is critical in reducing the amount of incident light to safe levels, while transmitting sufficient light for good vision. The following flowchart summarizes the decision-making plan for selecting the right protective eyewear for your laser and application (see page 2 and 3 for details).

Guidelines



Equivalence

OD	AF
1	10
2	100
3	1,000
4	10,000
5	100,000
6	1,000,000
7	10,000,000
8	100,000,000

OD: Optical Density
AF: Attenuation Factor

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Choosing an optical density value

Optical density (OD) is a measure of the radiation permitted to pass through the lens, and is determined by the filter of the safety eyewear.

Example: OD of 2.0 allows 1/100 of the laser light energy to be transmitted (see chart on page 1). If the user is wearing Laser Safety Eyewear (LSE) with an OD of 2.0 and the laser has an output power of 20 mW, this means his/her eye will perceive:

$$laser\ power\ with\ LSE = \frac{laser\ power}{attenuation\ factor\ of\ LSE} = \frac{20\ mW}{100} = 0.2\ mW$$

Is 0.2 mW sufficiently safe for a user? Is any eyewear with an OD value of 2.0 safe for this laser?

There are three important factors to take into account when choosing the OD value:

1 – Limits of Laser Power with Laser Safety Eyewear

Upper Limit Visible <1 mW

Users of visible lasers (400-700nm) should select eyewear that offers a protection similar to a Class II laser, i.e., up to 1 mW. Our previous example had a laser power with LSE of 0.2 mW, which is less than 1 mW (satisfies Class II = good OD).

Upper Limit Invisible <0.56 mW

Users of invisible lasers (>700nm) should select eyewear that offer a protection similar to a Class I invisible laser, i.e., up to 0.56 mW (this value is the worst-case scenario for invisible lasers, i.e., for the 710-780 nm region). Our previous example had a laser power with LSE of 0.2 mW (satisfies Class I invisible = good OD).

Lower Limit

Working with protective eyewear that completely blocks the light would render manipulation quite difficult. As such, it is important to select eyewear with an OD value close to its upper limit OD such that the laser beam is still safely visible.

2 - Wavelength

The OD value varies with wavelength. For example, eyewear can have the following specifications:

1-2 @ 633nm
4-5 @ 670-680nm

This means a 633 nm - 20 mW laser would obtain 1/10 or 0.1 mW of laser power with LSE, and a 670 nm - 20 mW laser would obtain 1/10,000 or 0.0001 mW of laser power with LSE.

3 - Design of Eyewear

Eyewear chosen should also take into consideration the following points:

- **Comfort**: lightness, model type for prescription eyeglass users (some models are worn over eye glasses)
- **Field of view**
- **Effect on color vision**: the colored filter material may reduce color vision and contrast, creating additional hazards. For example, certain laser safety eyewear may interfere with visualizing monitoring equipment

Training

Proper protective eyewear can filter a laser down to a Class II rating. A CDRH Class II laser is deemed "eye safe", however this does not mean the laser poses no risk of injury. This type of laser assumes that radiation exposure is only 0.25 seconds in length; because the human eye blinks as soon as radiation is detected, the governing bodies assume the user will blink after 0.25 seconds.

Employees dealing with lasers on a daily basis may become insensitive to the risk hazard, and tolerate an exposure without blinking. For this reason, all employees possibly exposed to radiation must be sensitized to the dangers of a laser beam and fully trained, in addition to wearing laser safety eyewear at all times.

Please visit the Laser Safety section of our website for more details: www.stockeryale.com/lasers

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