SAVER TechNote

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LASER PROTECTIVE EYEWEAR

Laser protective eyewear is used to protect wearers against eye damage from commercial or industrial lasers. The lenses are designed to block specific wavelengths of laser light. They can be used as safety glasses in workplaces where lasers are operated and by pilots and first responders as protection from laser pointer attacks. Laser protective eyewear falls under AEL reference number 01ZA-03-LASR titled, "Protection, Laser Eye, Personal."

Overview

Laser pointers, often used to enhance a visual presentation in educational or business settings, or as signaling devices for hikers and campers, have become commonplace. Laser pointers are also increasingly being used illegally or with ill intent, such as to distract law enforcement officers during demonstrations and civil unrest. High power laser pointers can also cause temporary or permanent eyesight damage if aimed directly at someone's eyes. Law enforcement agencies are starting to issue laser protective eyewear in order to protect personnel from these emerging threats.

Figure 1: Protesters direct laser pointers at a newspaper during an anti-government rally in Hong Kong, China
Image credit: Studio Incendo. CC BY 2.0

Laser protective eyewear is available in a variety of form factors. Protective lenses can be incorporated into glasses and goggles or provided as inserts for tactical eyewear. Face shields can also be constructed with special materials to provide laser protection. Some manufacturers offer laser protective films that they apply to safety glasses or face shields.

The level of protection a lens provides is specified in terms of optical density (OD), which is a logarithmic measure of the attenuation of light that passes through an optical filter. The higher the OD value, the greater the attenuation. An OD of one indicates an attenuation by a factor of ten or 10x; an OD of two is equivalent to 100x, and so on. OD varies as a function of wavelength, so lenses rated for a specific wavelength of light may provide little to no protection for other wavelengths.

Manufacturers also specify the visual light transmittance (VLT) – the percentage of visible light that passes through a protective lens. In general, lenses that block multiple visible light spectrums and/or have higher OD values will have lower VLT ratings. Lenses with VLT ratings below 20% may not be suitable for use at night or in low-light conditions. First responders must consider this tradeoff when choosing their protective eyewear.

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The SAVER program gathers and reports information about equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

SAVER publications focus on answering two main questions: "What equipment is available?" and "How does it perform?"

SAVER knowledge products are created for the nation's first responders and made available to help them make operational and procurement decisions.

To explore the full reports library and to learn more, visit SAVER online at www.dhs.gov/science-and-technology/SAVER.

For additional information on the SAVER program, email NUSTL at NUSTL@hq.dhs.gov.

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Protective Lens Materials

Laser protective lenses are fabricated from glass or polycarbonate and designed to filter laser light of specific wavelengths. Polycarbonate lenses are manufactured by mixing clear polycarbonate with dyes or other light absorbing materials that provide laser filtering. The material is then formed into eyewear lenses through a thermal injection-molding process. Several dyes can be combined to provide protection from multiple laser wavelengths. Polycarbonate lenses are generally lighter weight and less costly than glass lenses but tend to have slightly lower VLT values.

Glass lenses are created by infusing the glass with metal ions or other similar materials as it is formulated. This process provides differing levels of OD at varying wavelengths depending on the density and type of material used. The glass sheets are cut into smaller squares and heated in kilns where they are molded to the desired curvature. The lenses are then polished to a specified thickness and cut to the required shape for use in various frames and goggle styles. Unlike polycarbonate lenses, glass lenses can be fabricated as prescription eyewear.

Figure 2: Laser Protective Glasses and Goggles

Image credit: Cascade Laser Corp.

Protective Films and Laminates

Laser protection can also be provided by applying films or laminates to tactical face shields or safety glasses. Laser protective films are produced by applying dielectric materials to the glass or polycarbonate surface using a physical vapor deposition process. Additionally, some manufacturers offer protective laminate strips that can be applied to existing helmets and face shields.

Laser protective films and laminates are lightweight and generally have similar OD and VLT values as compared to protective lenses. They are often applied as a strip at the top of a face shield so that if a laser threat is encountered, the wearer can lower their head and look through the protective strip.

Figure 3: Face Shield with Laser Protective Strip

Image credit: Pro-Tech Sales

Specifications and Standards

The American National Standards Institute (ANSI) publishes two relevant specifications for laser protective eyewear. ANSI Z136.1 [1] is the U.S. standard that provides recommended guidelines for the safe use of laser systems, as well as requirements for laser safety equipment. It also defines the duties of the laser safety officer and provides education and training requirements. ANSI Z87.1 [2] is the standard for personal eye and face protection devices. This standard provides criteria for the selection, use and maintenance of various eye and face protectors. It includes requirements for protection from impacts, non-ionizing radiation, and liquid splash exposures.

Some laser safety glasses conform to MIL-PRF-32432A [3], which establishes the performance specifications for military combat eye protection products to safeguard against dust, flying debris and ballistic hazards.

References

[1] "Safe Use of Lasers, ANSI Z136.1," 2014. https://blog.ansi.org/2021/01/ansi-z136-1-2014-safe-use-of-lasers/

[2] "Occupational and Educational Personal Eye and Face Protection Devices, ANSI Z87.1," 2020. https://blog.ansi.org/2020/04/ansi-isea-z87-1-2020-safety-glasses-eye-face/

[3] "Performance Specification: Military Combat Eye Protection System, MIL-PRF-32432A," 2018. http://everyspec.com/MIL-PRF/MIL-PRF-030000-79999/MIL-PRF-32432A_55832/