Laser Safety Basics – Quick Tips



“LASER” is an acronym for Light Amplification by Stimulated Emissions of Radiation.

The laser was first developed in 1960 by Dr. Charles Maiman, a scientist working for Hughes Aircraft Company. Advances in laser technology have expanded the use of lasers in many areas including communications, research, the military and numerous medical applications. Eye safety is the number one concern when working with or near a laser. The pulse of a laser is so fast; it can cause severe damage to the eye in a flash of a second. Though the injuries are rare, they are permanent. Having a laser safety program is vital due to the high energy involved and damage it can cause to the body. Many accidents have involved untrained or unauthorized personnel, so it’s critical to define authorized laser users and train them appropriately.

Regulations

The Occupational Safety and Health Administration (OSHA) does not have a federal standard regulating the use of lasers. OSHA’s Safety and Health Topics – Laser Hazards Page does reference various internal resources such as a robotics safety directive and several interpretation letters as well as a variety of national consensus standards.

The primary consensus standard when it comes to development of a laser safety program is the American National Standards Institute (ANSI) Z136 series of laser safety standards developed by the Laser Institute of America (LIA):

- Z136.1, American National Standard for Safe Use of Lasers
- Z136.2, American National Standard for Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources
- Z136.3, American National Standard for Safe Use of Lasers in Health Care
- Z136.4, American National Standard Recommended Practice for Laser Safety Measurements for Hazard Evaluation
- Z136.5, American National Standard for Safe Use of Lasers in Educational Institutions
- Z136.6, American National Standard for Safe Use of Lasers Outdoors
- Z136.7, American National Standard for Testing and Labeling of Laser Protective Equipment
- Z136.8, American National Standard for Safe Use of Lasers in Research, Development, or Testing
- Z136.9, American National Standard for Safe Use of Lasers in Manufacturing Environments

Z136.1-2014 is a horizontal standard and starting point for development of a laser

safety program. All of the other Z136 series standards (Z136.2 – Z136.9) are vertical standards. If the scope of one of those standards applies that standard then takes precedence. All the standards provide guidance on the safe use of lasers and laser systems.

Resources

Section III, Chapter 6 of OSHA's Technical Manual (OTM) addresses laser hazards and is an excellent resource to use when developing a laser safety program. Contents of this chapter include:

- Nonbeam Laser Hazards
- Biological Effects of the Laser Beam
- Laser Hazard Classifications
- Investigational Guidelines
- Control Measures and Safety Programs

Appendix III:6-3 of the OTM references the ANSI Z136 series of standards.

LIA offers a Laser Safety Hazard Calculator Software. This software is based on Z136.1 and provides a reliable way to easily double-check laser safety calculations.

The hierarchy of hazard controls tells us eliminating the laser hazard is the first choice followed by engineering controls and then administrative controls and finally personal protective equipment… Protective eyewear is necessary only when all other controls are infeasible or not practical.

Laser Control Measures

Engineering controls, such as protective housings, remote controls, or enclosed laser-beam paths ensure protection for laser operators except when the operator is setting up, adjusting or maintaining the beam. Control measures are discussed in Section III, Chapter 6, paragraph VI of the OTM and section 4 of Z136.1-2014.

Laser Hazards The LIA laser safety information page states: "the human body is vulnerable to the output of certain lasers, and under certain circumstances, Exposure can result in damage to the eye and skin. Research relating to injury thresholds of the eye and skin has been carried out in order to understand the biological hazards of laser radiation. It is now widely accepted that the human eye is almost always more vulnerable to injury than human skin." The page highlights in detail laser and beam hazards.

Understanding the hazards of sunlight and conventional, man-made light sources along with research studies have permitted scientists to establish safe exposure limits for nearly all types of laser radiation. These limits are generally referred to as Maximum Permissible Exposures (MPE's) or Accessible Emission Limits (AEL) by laser safety professionals. This knowledge has led to the development of a system to classify lasers. Classes of lasers allow the use of standardized safety measures to reduce or eliminate incidents depending on the class of the laser. It is the responsibility of the manufacturer to provide the correct classification of a laser, and to equip the laser with appropriate warning labels and safety measures as prescribed by the regulations. The classifications of lasers are based on their ability to produce damage in exposed people, from class 1 (no hazard during normal use) to class 4 (severe hazard for eyes and skin). The LIA has identified four primary classes of lasers:

Class 1: Considered safe based upon current medical knowledge. This class includes all lasers or laser systems which cannot emit levels of optical radiation above the

exposure limits for the eye under any exposure conditions inherent in the design of the laser product. There may be a more hazardous laser embedded in the enclosure of a Class 1 product, but no harmful radiation can escape the enclosure.

Class 2: Must emit a visible laser beam. Because of its brightness, Class 2 laser light will be too dazzling to stare into for extended periods. Momentary viewing is not considered hazardous since the upper radiant power limit on this type of device is less than the MPE (Maximum Permissible Exposure) for momentary exposure of 0.25 second or less. Intentional extended viewing, however, is considered hazardous.

Class 3: Can emit any wavelength, but it cannot produce a diffuse (not mirror-like) reflection hazard unless focused or viewed for extended periods at close range. It is also not considered a fire hazard or serious skin hazard. Any continuous wave (CW) laser that is not Class 1 or Class 2 is a Class 3 device if its output power is 0.5 W or less. Since the output beam of such a laser is definitely hazardous for intrabeam viewing, control measures center on eliminating this possibility.

Class 4: Any laser that exceeds the output limits (Accessible Emission Limits, AEL's) of a Class 3 device. As would be expected, these lasers may be either a fire or skin hazard or a diffuse reflection hazard. Very stringent control measures are required for a Class 4 laser or laser system.

Protective Eyewear

How does laser eyewear protect your eyes? The lens of the eyewear is a filter/absorber designed to reduce light transmittance of a specific wavelength. The lens can filter out (or absorb) a specific wavelength while maintaining adequate light transmission for other wavelengths. The absorption capability of the filtering media is called the optical density (OD). The OD is always expressed as a factor of 10. An OD of 5 means the filter has reduced the power of the beam to 1/100,000 of its original power. The required OD is the minimum OD necessary to reduce the beam to a non-hazardous level. The OD of the eyewear has to be at least equal to or greater than the required OD. The LIA offers a free online OD Calculator which can be used to calculate the OD recommended for use with a given laser system and power.

When choosing appropriate eyewear, time is also a consideration. How long will the eyewear protect your eye before the beam goes through? How long will you have to react if you are hit with a direct beam? Per Z136.1, protective eyewear must exhibit a damage threshold for a specified exposure time and the eyewear must be used such that the damage threshold is not exceeded. Keys to selecting proper protective laser eyewear include:

- Knowing your laser type(s) and wavelength(s)
- Knowing the recommended OD
- Selecting eyewear with the highest visible light transmittance (VLT)
- Selecting a lens material and frame style that is right for you

Choosing the proper protective laser eyewear can be challenging. Consulting with your supplier is always suggested.

Sources

ANSI Z136.1-2014, American National Standard for Safe Use of Lasers

OSHA's Safety and Health Topics – Laser Hazards Page

Laser Institute of America (LIA)

OSHA Technical Manual Section III: Chapter 6-Laser Hazards

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