LASER SAFETY Information Bulletin

Compliments of

Laser Institute of America

and

This brief bulletin has been prepared by the Laser Institute of America Laser Safety Committee to educate new laser users on the issues and concerns related to laser safety.

Laser Institute of America and its Corporate Members are dedicated to fostering lasers, laser applications and laser safety worldwide. LIA is the Secretariat and Publisher of the ANSI Z136 series of laser safety standards, the foundation of laser safety programs in industry, medicine, research and education.

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What is a Laser ?

LASER is an acronym which stands for Light Amplification by Stimulated Emission of Radiation. The energy generated by the laser is in or near the optical portion of the electromagnetic spectrum (see Figure 1). Energy is amplified to extremely high intensity by an atomic process called stimulated emission. The term "radiation" is often misinterpreted because the term is also used to describe radioactive materials or ionizing radiation. The use of the word in this context, however, refers to an energy transfer. Energy moves from one location to another by conduction, convection, and radiation. The color of laser light is normally expressed in terms of the laser's wavelength. The most common unit used in expressing a laser's wavelength is a nanometer (nm). There are one billion nanometers in one meter.

Laser Hazards

Laser Beam Hazards

The laser produces an intense, highly directional beam of light. If directed, reflected, or focused upon an object, laser light will be partially absorbed, raising the temperature of the surface and/or the interior of the object, potentially causing an alteration or deformation of the material. These properties which have been applied to laser surgery and materials processing can also cause tissue damage. In addition to these obvious thermal effects upon tissue, there can also be photochemical effects when the wavelength of the laser radiation is sufficiently short, i.e., in the ultraviolet or blue region of the spectrum. Today, most high-power lasers are designed to minimize access to laser radiation during normal operation. Lower-power lasers may emit levels of laser light that are not a hazard.

Lasers have the potential to damage both the eye and the skin

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

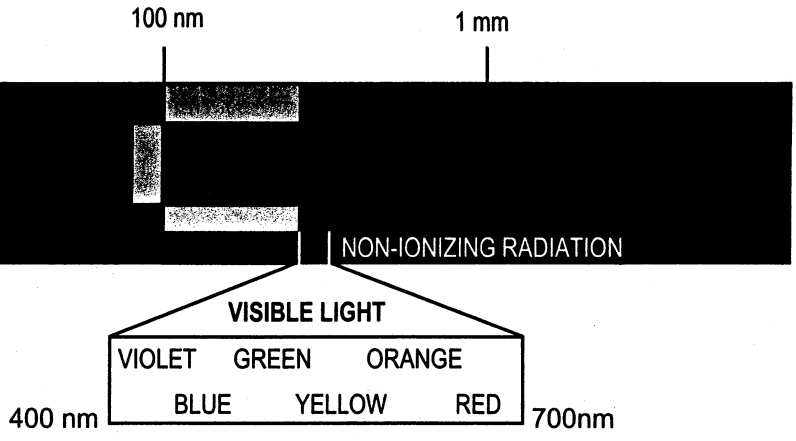


Figure 1. The optical spectrum. Laser light is nonionizing and ranges from the ultraviolet (100 - 400nm), visible (400-700nm), and infrared (700nm - 1mm).

than human skin. The cornea (the clear, outer front surface of the eye's optics), unlike the skin, does not have an external layer of dead cells to protect it from the environment. In the far-ultraviolet and far-infrared regions of the optical spectrum, the cornea absorbs the laser energy and may be damaged. Figure 2 illustrates the absorption characteristics of the eye for different laser wavelength regions. At certain wavelengths in the near-ultraviolet region and in the near-infrared region, the lens of the eye may be vulnerable to injury. Of greatest concern, however, is laser exposure in the retinal hazard region of the optical spectrum, approximately 400 nm (violet light) to 1400 nm (near-infrared) and including the entire visible portion of the optical spectrum. Within this spectral region collimated laser rays are brought to focus on a very tiny spot on the retina. This is illustrated in Figure 3.

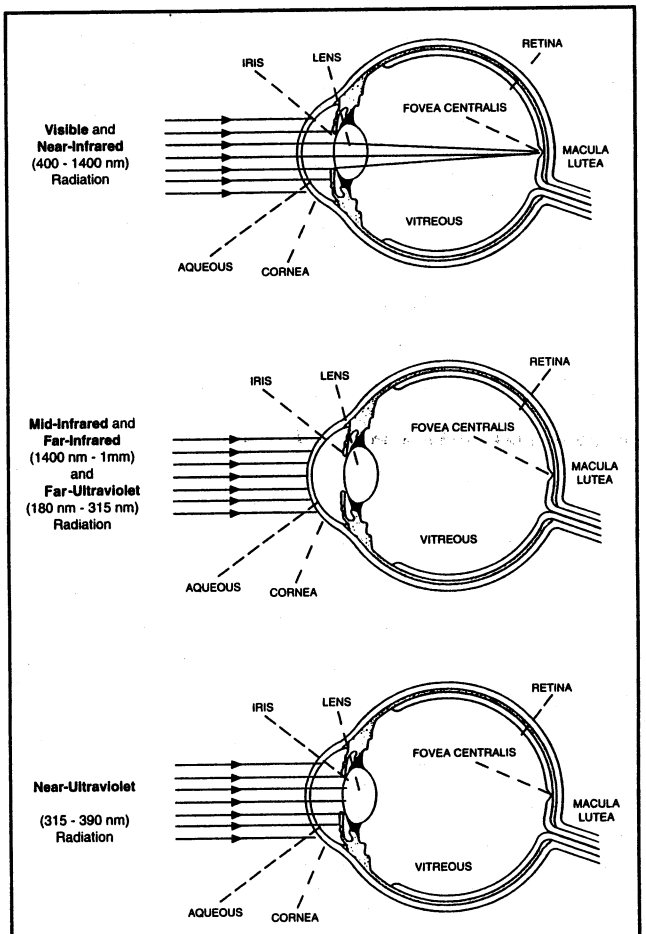


Figure 2. Absorption characteristics of the human eye. (From Sliney & Wolbarsht, Safety with Lasers and Other Optical Sources, Plenum Press, 1980)

In order for the worst case exposure to occur, an individual's eye must be focussed at a distance and a direct beam or specular (mirror-like) reflection must enter the eye. The light entering the eye from a collimated beam in the retinal hazard region is concentrated by a factor of 100,000 times when it strikes the retina. Therefore, a visible, 10 milliwatt/cm^2 laser beam would result in a 1000 watt/cm^2 exposure to the retina, which is more than enough power density (irradiance) to cause damage.

If the eye is not focussed at a distance or if the beam is reflected from a diffuse surface (not mirror-like), much higher levels of laser radiation would be necessary to cause injury. Likewise, since this ocular focussing effect does not apply to the skin, the skin is far less vulnerable to injury from these wavelengths.

Non-Beam Laser Hazards

In addition to the direct hazards to the eye

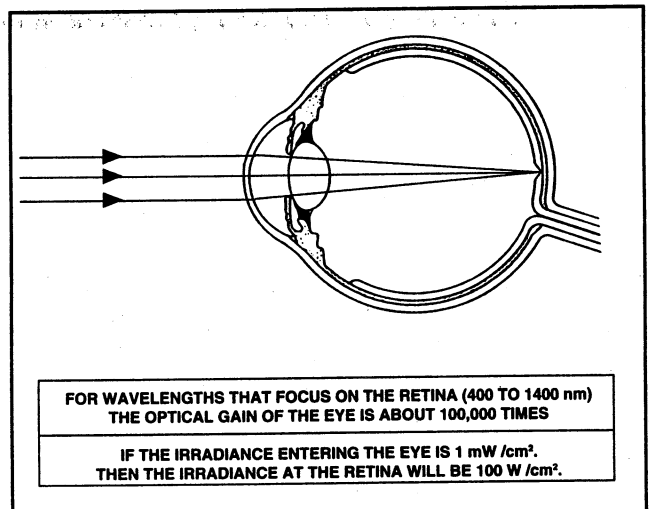


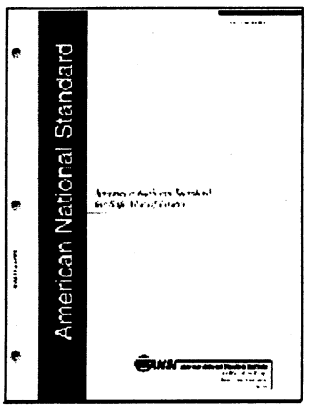
Figure 3. Focussing effects of the human eye. (From Sliney & Wolbarsht, Safety with Lasers and Other Optical Sources, Plenum Press, 1980)

and skin from the laser beam itself, it is also important to address other hazards associated with the use of lasers. These non-beam hazards, in some cases, can be life threatening, e.g. electrocution, fire, and asphyxiation. Table 1 indicates some of the potential non-beam hazards associated with laser usage. Because of the diversity of these hazards, the employment of safety and/or industrial hygiene personnel to effect the hazard evaluations may be necessary.

Safety Standards

There are a variety of laser safety standards including Federal and state regulations, and non-regulatory standards. The most important and most often quoted is the American National Standards Institute's Z136 series of laser safety standards. These standards are the foundation of laser safety programs in industry, medicine, research, and government. The ANSI Z136 series of laser safety standards are referenced by the Occupational Safety and Health Administration (OSHA) and many U.S. states as the basis of evaluating laser-related occupational safety issues.

ANSI Z136.1 Safe Use of Lasers, the parent document in the Z136 series, provides



information on how to classify lasers for safety, laser safety calculations and measurements, laser hazard control measures, and recommendations for Laser Safety Officers and Laser Safety Committees in all types of laser facilities. It is designed to provide the laser user with the information needed to properly develop a comprehensive laser safety program.

For manufacturers of laser products, the standard of principal importance is the regulation of the Center for Devices and Radiological Health (CDRH), Food and Drug Administration (FDA) which regulates product performance. All laser products sold in the USA since August 1976

There are Federal and state regulations and non-regulatory standards

must be certified by the manufacturer as meeting certain product performance (safety) standards, and each laser must bear a label indicating compliance with the standard and denoting the laser hazard classification.

Laser Hazard Classification

Research studies, along with an understanding of the hazards of sunlight and conventional, man-made light sources have permitted scientists to establish safe exposure limits for nearly all types of laser radiation. These limits are generally referred

Table 1 - Non-Beam Hazards Associated with Laser Use

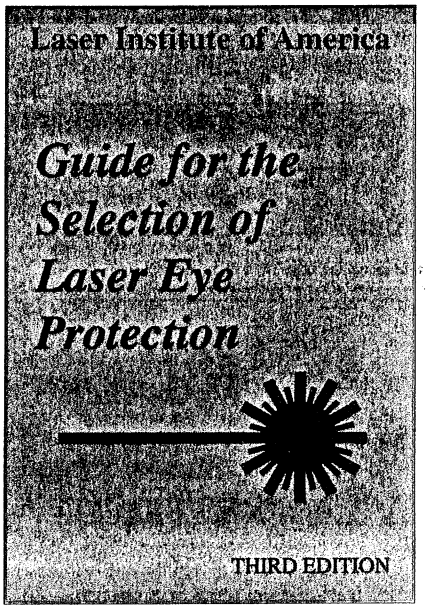
Noise
X-Radiation
Fire
Explosion
Electrical
Cryogenics
Compressed Gas
Airborne Contaminants

Specially reduced prices on LIA laser safety information

Laser Institute of America is the professional society dedicated to fostering lasers, laser applications and laser safety worldwide. To ensure your organization has the proper resources to safely apply laser technology, we would like to offer you the opportunity to receive important information regarding laser safety at a special low price. LIA and our Corporate Members are making this special offer as part of a national effort to expand the application of laser technology and safety awareness.

As an added bonus, if you act now you will receive a complimentary one-year subscription to LIA's official newsletter, *LIA TODAY*. This newsletter contains information regarding laser safety, laser applications, and the laser industry.

Complete the enclosed information card and return it to Laser Institute of America and receive your specially priced laser safety information. As an added bonus you will receive a complimentary subscription to LIA TODAY.



Guide for the Selection of Laser Eye Protection
Price: $15 LIA Members: $10
This guide provides the reader a comprehensive review of the general guidelines and factors to consider when considering laser eye protection. Further, the guide includes a simplified 5-step process for determining the correct protection required for your specific laser. Also included is an index of laser eye protection providers and their products.

Laser Safety Guide
Price: $15 LIA Members: $10
One of the most recognized guides in the industry, this publication provides the reader an easy to read and understand description of laser hazards and guidelines. The Laser Safety Guide is the perfect introduction needed to understand the various safety issues related to laser applications. The information in this publication corresponds with the ANSI Z136.1 laser safety standard.

Order one of these guides for the reduced price of $8, or receive both for $15

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Your Name _____

Position/Dept. _____

Company _____

Address _____

City _____ State _____ Zip _____

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Type of Laser(s) used (CO_2, Nd:YAG, Argon...) _____

Primary Application (Cutting, Measurement...) _____

Laser Safety Officer Name _____

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