Lasertechnics™

The Safe Use of Marking Lasers

General

Lasers are safely used every day in many different applications and in many different environments around the world. Lasers do, however, present certain hazards, some even life threatening. A proper understanding of these hazards and the often-simple means of protecting against them is essential to ensure a safe environment for users of this equipment.

Lasers used in the United States are subject to the controls of the Center for Devices and Radiological Health (C.D.R.H.), a division of the FDA. The C.D.R.H. categorizes lasers in classes from Class I to Class IV, according to the risks they present. Most lasers used for marking applications are Class IV. Class IV lasers are defined as high power lasers which are hazardous to view (either specular or diffuse reflections), and are a potential fire and skin hazard.

While not strictly adopted by OSHA, the ANSI Standard, Z136.1-2000, "Safe Use of Lasers", is considered an appropriate guideline for ensuring a safe environment where lasers are present. The ANSI standard requires that companies using Class IV lasers have a designated Laser Safety Officer (LSO). The LSO is one who has authority to monitor and enforce the control of laser hazards. Typically the Industrial Hygiene department or the company Safety Specialist oversees the implementation of laser safety. Lasertechnics offers additional training programs to assure all our customers' safety needs are supported.

OSHA information concerning laser hazards can be accessed through the following link:
http://www.osha-slc.gov/dts/osta/otm/otm_iii/otm_iii_6.html

Common Laser Hazards

Other than the light that is emitted, lasers generate the same hazards as many other types of equipment. Common hazards are high voltage, compressed gases and intense radio frequency energy. The presence of these hazards depends upon the specific laser technology employed. For example, pulsed CO_2 lasers can generate internal voltages in excess of 25,000 volts and often contain large capacitors capable of delivering over 200 Joules of energy. These lasers have interlocked enclosures, which should not be defeated. When opening the enclosures of these lasers, capacitive discharge procedures should be understood and strictly followed.

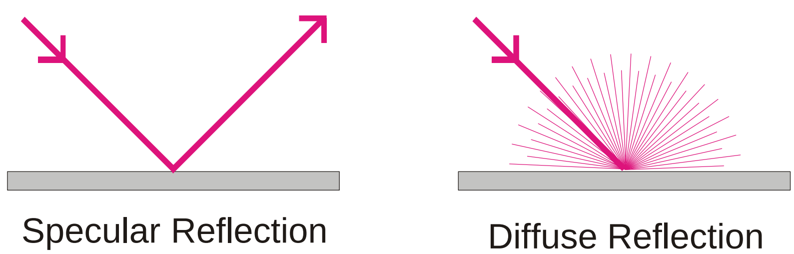
Pulsed lasers also typically use a flowing gas design, requiring connection to a cylinder of compressed gas. While most laser gases are very safe, pressurized cylinders can be hazardous and must be properly restrained during use and transportation.

Radio frequency energy can cause severe burns. Only trained personnel should service laser equipment employing RF generators (like sealed CO_2 lasers). Connections carrying RF energy should never be touched during operation.
Often materials being marked give off fumes and gases. Sometimes these gases are noxious or even toxic. Fumes from laser marking should be controlled with an adequate vapor extraction system. When in doubt, a chemical analysis of the fumes is suggested to determine if any fume hazards exist.

Light Hazards

Laser systems are typically designed to prevent a beam from directly contacting a person. Risks, therefore, are more a result of unintentional reflected light. Reflected light falls into two categories, diffuse and specular. Diffuse reflections result when reflective surface irregularities scatter light in all directions. Diffuse reflections are typically much safer as the energy is split up into many directions.

Specular reflections are mirror-like reflections and can reflect close to 100% of the incident light. Because such a large percentage of the energy can be redirected, specular reflections are more hazardous. Note that as the diameter of the laser beam increases, the ability to cause damage decreases. Laser intensity is measured in power or energy over a measured area (W/cm^2). While focused laser beams produce a very small spot size (and very intense energy) at the mark point, they are typically safer than unfocused beams because the laser beam size spreads out much more rapidly as the distance from the mark point increases.



While specular reflections are more hazardous, they are much less common. Most laser marking systems can be designed to eliminate specular reflective surfaces in the beam path.

Laser Radiation Effects on Skin

Skin effects are generally considered of secondary importance with lasers used for most marking applications. High power infrared lasers, like those used in cutting and welding applications, pose a larger skin effect hazard. Lasers emitting radiation in the visible and infrared regions produce effects that vary from mild reddening to blisters and charring. These conditions are usually repairable or reversible. However depigmentation, ulceration, and scarring of the skin, and damage to underlying organs may occur from extremely high-powered lasers.

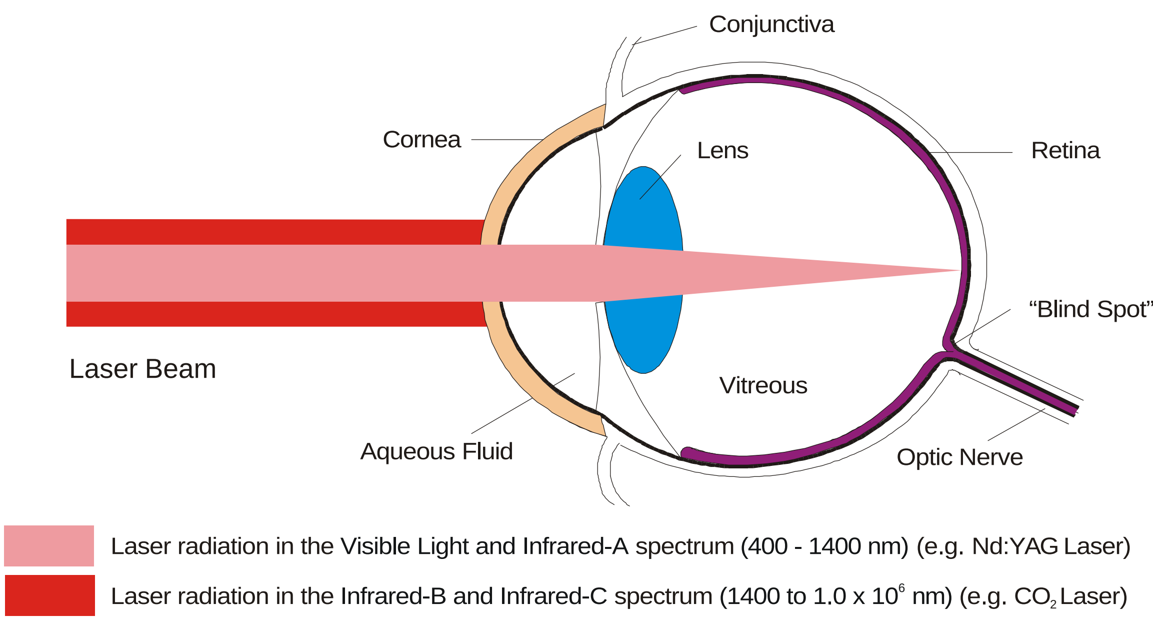
Laser Radiation Effects on the Eye

Infrared-B and Infrared-C (1400 to 1.0 x 10^6 nm)

The most common marking laser in this category is the CO_2 laser, which operates at various wavelengths from 9.3 to 10.6 µm (9,300 – 10,600 nm). Corneal tissue will absorb light with a wavelength longer than 1,400 nanometers (nm). Damage to the cornea results from the absorption of energy by tears and tissue water causing a temperature rise and subsequent denaturation of protein in the corneal surface. Since the cornea absorbs the laser energy, the beam is not transmitted to the retina. While cornea burns can be severe, many quickly heal.

Visible Light and Infrared-A (400 - 1400 nm)

The marking laser most commonly used in this category is the Q-switched Nd:YAG laser, which operates at a typical wavelength of 1,064 nm. Eye exposure to this laser beam is more hazardous, since at this wavelength the laser beam is transmitted through the eye and focused onto the retina. Exposure may initially go undetected because the beam is invisible and the retina lacks pain sensory nerves. Visual disorientation due to retinal damage may not be apparent to the operator until considerable thermal damage has occurred. Since the energy is concentrated by the eye's lens, the strength of the laser beam that is required to damage the eye is significantly less.



Maximum Permissible Exposure (MPE)

The MPE is defined in ANSI Z-136.1-1993 as "The level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin." The MPE is not a distinct line between safe and hazardous exposures. Instead they are general maximum levels, to which various experts agree should be occupationally safe for repeated exposures. The biological effects of laser radiation are dependent on the wavelength of the laser and exposure duration. The goal of any control measures is to ensure that any laser radiation contacting a person is below the MPE.

Nominal Hazard Zone (NHZ)

In many marking applications, and most packaging applications, it is not practical to fully enclose the area where the laser beam is delivered onto the product. In these instances, it is necessary to define an area of potentially hazardous laser radiation. This area is called the nominal hazard zone (NHZ). The NHZ is the space within which the level of direct, scattered or reflected laser radiation exceeds the MPE. The purpose of a NHZ is to define an area in which control measures are required. The Laser Safety Officer should determine the NHZ and the control measures to protect the laser worker from exposure to radiation above the MPE.

To quote the OSHA Technical Manual, Section III, Chapter 3: **"This (NHZ), is an important factor since, as the scope of laser uses has expanded, controlling lasers by total enclosure in a protective housing or interlocked room is limiting and in many instances an expensive overreaction to the real hazards."**

Carefully designed guarding can eliminate any real light hazards associated with laser radiation during equipment operation. This guarding can often be of very simple design. For example, the infrared emissions from a CO_2 laser can be blocked by clear polycarbonate (lexan) sheet. Often a simple tunnel through which the product passes while being marked provides reliable, adequate protection, preventing unsafe exposure from the direct beam or any diffuse reflections. Lasertechnics products are engineered for safety, with ample consideration to the Nominal Hazard Zone, beam shielding, beam attenuation and customer training.

Control Measures

Certain control measures need to be in place wherever there are lasers in use. The extent of the control measures is a function of the type of equipment installed, the nature of any shielding, and any maintenance procedures that may be undertaken. These control measures include:

Engineering Controls

Engineering controls include proper shield interlock designs (when required), and safe system operation controls, as in situations where the laser will be integrated into another control system.

Personal Protective Equipment

In the case of virtually all laser marking installations, personal protective equipment is limited to the use of proper eyewear. Protective eyewear must be chosen with regard to the wavelength of the laser light and, where appropriate, the wavelength of any light emitted from the material surface during the marking process.

Administrative and Procedural Controls

These controls largely involve access to the laser-controlled area, where required, controls put in place during abnormal conditions (such as equipment repair and maintenance) and general safety rules (such as insisting that the equipment not be operated with shielding removed).

Conclusion

Laser marking systems can be operated safely and in compliance with national and regional safety requirements, often with very simple shielding and controls.

Many laser suppliers will assist their customers to insure the equipment is installed and operated safely. Lasertechnics evaluates our customer's unique production areas and requirements and has safely installed thousands of lasers. In twenty years of supplying lasers equipment to customers worldwide, no work related injuries have ever been reported when following our operating recommendations.