

LASER EFFECTS ON THE HUMAN EYE

FACT SHEET



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LASER EFFECTS ON VISUAL PERFORMANCE

Figure 1 shows a construction worker being exposed to a laser beam. Lasers may interfere with vision either temporarily or permanently in one or both eyes. At low-power levels, lasers may produce a temporary reduction in visual performance in critical tasks such as driving a vehicle. At high-power levels, greatly exceeding exposure limits, they may produce serious long-term visual loss or permanent blindness.

ANATOMY OF THE EYE

Figure 2 is a simple schematic of the eye. The following parts of the eye are important with regard to laser effects:

The Cornea, a transparent front part of the eye, transmits most laser wavelengths except for far-ultraviolet and far-infrared radiation.

The Iris, a pigmented diaphragm with an aperture (pupil) in its center, controls the amount of light entering the eye. During low-light conditions, such as in a dark room, visible and near-infrared lasers are slightly more dangerous since the pupil is larger than it would be in high-illumination conditions, such as in daylight.

The Lens, a transparent structure located behind the pupil, which focuses light on the retina, allows visible and near-infrared energy to pass through while absorbing near-ultraviolet radiation.

The Vitreous Humor, a jelly-like substance, which fills the volume of the eye between the lens and the retina, is transparent to both visible and near-infrared radiation.

The Retina, the back of the inside of the eye where images are formed, has a high concentration of photoreceptor cells. During laser exposure, no extended image is formed, and all the energy is simply focused to a pinpoint. A laser exposure occurring in the retinal periphery, (the area surrounding, but not including, the macula) will have a minimal effect on normal visual functions (unless large portions of the retinal periphery are involved). The retinal periphery is unable to detect small or distant objects or distinguish between fine shades of color. One of the primary functions of the retinal periphery is night vision. During bright conditions, the retinal periphery detects motion (peripheral vision).

The Macula, the central 1.5 mm of the retina, which covers about 5 degrees of the visual field, is the only part of the eye where precise vision takes place. The macula enables the location of small and distant targets and the detection of colors.

The Fovea, located in the center of the macula, is the central part of the macula with the highest visual acuity. The visual precision of the fovea is high enough in humans to allow them to read. If the fovea is damaged, the person experiences severe loss of vision. The degree of the impairment will depend upon both the location and the extent of the injury and the inflammatory response. In general, the closer the injury to the center of the fovea, the greater the chance of severe dysfunction.

The hazards of lasers depend on wavelength and on the structure of the eye as it relates to laser eye exposure and the potential for laser eye injury.



Figure 1.



Retinal Injury

Figure 2.

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LASER WAVELENGTH AND THE EYE'S RESPONSE

Figures 3-5 are diagrams of absorption of radiation in the eye.

Ultraviolet (Figures 4 & 5). Lasers operating in the ultraviolet spectrum (below 400nm) are absorbed in the anterior segments of the eye, primarily by the cornea, as well as by the lens.

Visible (Figure 3). Laser radiation in the visible region of the spectrum (400-700nm) is absorbed primarily within the retina. An ideal eye can focus a collimated visible beam by as much as 100,000 times.

Near Infrared (Figure 3). Laser radiation in the near-infrared region of the spectrum (700-1400nm) is absorbed primarily within the retina. An ideal eye can focus a collimated near-infrared beam by as much as 100,000 times. This portion of the spectrum is a very dangerous area. The eye will focus the energy, but it is not visible and thus creates a very dangerous situation.

Far Infrared (Figure 4). Laser radiation in the far-infrared region of the spectrum (1400+nm) primarily affects the cornea.

QUESTIONS?

Questions about lasers and laser safety can be referred to Laser Institute of America. Phone: 1.800.34.LASER

REFERENCES

Marshall, W. And D. Sliney (editors): Laser Safety Guide. Orlando, FL: Laser Institute of America, 2000.

Safety with Lasers and Other Optical Sources, A Comprehensive Handbook, Sliney and Wolbarsht. New York: Plenum Press, 1981.

Vision, Buser and Imbert. MIT Press, 1992.

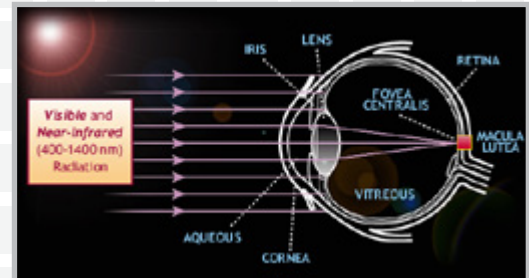


Figure 3.

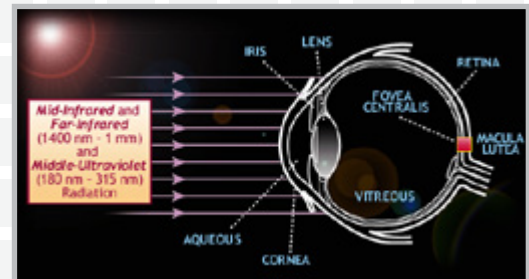


Figure 4.

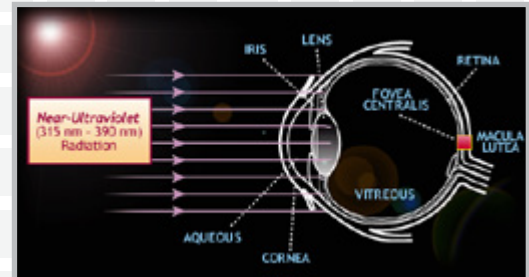


Figure 5.

www.laserinstitute.org/education

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