UNIVERSITY OF KANSAS -LAWRENCE CAMPUS LABORATORY SAFETY MANUAL PART V - LASER SAFETY PLAN

Appendix 8.8 - Brief Overview of Biological Effects

1) Effects in Skin

Skin damage from laser radiation is not as great a concern as eye damage; such skin injury can be treated similarly to treatment for a thermal burn or wound. Also, for those beams which the power or energy density is high enough to cause skin damage, the beam is usually enclosed, or some type of physical control is provided for laboratory users/occupants.

2) Effects in Eyes

2.1) Introduction (summary of ANSI Z136.1-1993 Appendix G)

There is no evidence that exposure at levels equal to or below applicable Maximum Permissible Exposures (MPE) cause any damage. MPE's are generally set a factor of 10 below exposure levels known to cause damage of the types described. However, users must remember that exposures inside any Nominal Hazard Zones are above the MPE's. In such zones, even reflected beams from structures in the beam may produce exposures above the MPE's.

The brightness of a laser can exceed all known natural and man-made light sources. The focusing effect of the cornea and lens of the eye can concentrate parallel rays from laser light by a factor of 100,000. Therefore, it is not surprising to discover that the eyes are the most susceptible organ to laser light. Wavelengths in the infrared (IR) and ultraviolet (uv) range can cause corneal damage. Extremely low densities of pulsed lasers can cause retinal damage.

2.2) Corneal damage

A minimal corneal lesion is a small white area involving the epithelium. It appears within 10 minutes after the exposure. Such a lesion will heal within 48 hours without visible scarring.

2.3) Minimal damage from infrared lasers (1.4 - 1000 m)

Excessive infrared exposure causes a loss of transparency or produces a surface irregularity in the cornea based upon experience with CO2 lasers. Extrapolation to other wavelengths should be made with care.

Damage results from absorption of the energy by tears and tissue water in the cornea. The critical temperature for this effect is not much above normal body temperature and appears to be a function of exposure duration.

2.4) Minimal damage from UV lasers (0.18 - 0.4 m)

Excessive exposure in this region "produces photophobia accompanied by surface redness, tearing, conjunctival discharge, and corneal exfoliation and stromal haze" (quoted from ANSI Z136.1-1993). The action is photochemical rather than thermal.

2.5) Minimal retinal damage (0.4 - 1.4 m)

The minimal retinal lesion has been defined as the smallest ophtalmoscopically visible change in the retina which is a small white patch which occurs within 24 hours of the time of exposure. Most serious effects will occur for damage in the central portion of the retina, the macula. (There are no data for long exposures and small spot sizes but such exposures are not likely.)

For wavelengths that are transitional, both types of damage may occur.

Note on continuous wave (cw) vs. pulsed lasers:

A cw laser causes eye damage by thermal processes that overheat the absorbing tissue. The steady stream of photons is absorbed by tissue until the temperature rises above that of the eye's cooling method. Eye surgeons use this thermal effect (under controlled conditions) when they "spot weld" detached retinas using argon or ruby lasers.

Pulsed lasers are more hazardous to the eye than cw, especially when the wavelength is in the ocular focus region. Pulsed lasers cause "blast (mechanical) damage" if the pulse duration is low. The pulse durations are so short that little or no thermal conduction occurs during the length of the pulse.