LASERS
QUICK REFERENCE SHEET

This document was developed by the AIHA NIR Committee. The intent is to provide general information to practicing Industrial Hygienists on NIR topics and to determine next steps for assessing and controlling NIR hazards. For additional, detailed information please refer to the reference section.

Lasers can be found in virtually all work environments. Lasers are classified according to their hazard potential. Class 1 and 2 lasers require no specific controls for their intended use. Class 3a and 3R lasers are similarly relatively low risk and only pose a hazard when the beam is intentionally viewed and the eyes natural aversion response over-ridden. Class 3b lasers pose an eye hazard from direct ocular exposure to the beam. Class 4 lasers pose not only a hazard from direct exposure to the beam but can also pose a hazard from diffusely scattered light. They can also pose a risk of injury to the skin and ignite combustible materials. When purchasing lasers ensure that the lasers meet the performance criteria of the Federal Laser Product Performance Standard.

Characteristics - The three main characteristics of laser light are coherence, monochromaticity and directionality. Although the wavelength of a given laser is predictable and monochromatic it can be altered by various optical components. For instance, Nd:YAG lasers have a fundamental wavelength of 1064nm (Near-IR) but through the addition of various crystals the wavelength can be altered to 532nm (green), 355nm (UVA) and 266nm (UVC).

Exposure limits – The Maximum Permissible Exposure (MPE) limits are based upon a combination of the wavelength and exposure duration. Calculating the MPE can be difficult and in the case of repetitively pulsed lasers must be determined three different ways and the most restrictive limit used. Determining the MPE should be done following the processes in ANSI Z136.1. There are software tools available (some on-line ones will even do basic calculations for free) and most laser eyewear vendors will calculate it for you to aid in selecting eyewear.

Biological Effects – The wavelength determines where the beam will present the greatest hazard. For wavelengths between 1400nm and 10mm (MidIR and FarIR) the beam will interact with the surface of the exposed tissue with the damage being thermal in nature. For UVB and UVC the beam will interact with the cornea. UVA will interact with the lens in a photochemical manner and can cause cataracts with even very short duration exposures. Visible (400-700nm) and NearIR (700-1400nm) wavelength will interact with the retina. Retinal injuries may be thermal in nature for CW and long pulse lasers or photo acoustic (ablation with no thermal effect) for short pulse lasers. Retinal injuries are generally permanent and their severity is dependent upon their size and location on the retina.

Ancillary Hazards – Lasers may have numerous ancillary hazards associated with them which may actually present a more severe hazard than the laser light itself. High voltage sources are generally present and with lasers usually located on metal optical tables grounding is an important issue. Gas lasers may have pressure or toxic gas hazards present. If dye lasers are being used it is important to understand the toxicity of the dyes

being used as well as the solvents and determine if there are any synergistic effects when they are combined. Lasers used for material processing or medical procedures may present respiratory hazards from laser generated airborne contaminants.

Control Measures – Isolation / controlled access to Class 3b/4 lasers. Rooms with permanently installed open beam Class4 lasers should have door interlocks which are capable of disabling the laser. Beams should be confined to the table and steps taken to minimize strays reflections. Beams should be enclosed whenever possible. If lasers are to be used outdoors additional consideration should be given for the potential to interfere with aviation. Guidelines for the use of laser outdoors can be found in ANSI Z136.1 and FAA Advisory Circular 70-1.

Personal Protective Equipment – Laser protective eyewear is rated using Optical Density (OD), a logarithmic scale of the amount of attenuation the filter provides for a specific wavelength or wavelength range. It is important to remember to that all modes of operation and possible wavelengths be considered when choosing the eyewear. Another factor to take into account is the visible light transmission (VLT) of the eyewear e.g. will the eyewear interfere with the tasks or need to view the beam. Additional assistance in selection of eyewear can be obtained from the laser manufacturer and/or the laser eyewear manufacturer. Laser users should ALWAYS wear properly rated laser eyewear when hazardous open beams are present.

References and Additional Information

American National Standards Institute *Z136.1, Safe Use of Lasers*. Laser Institute of America.

American National Standards Institute *Z136.6, Safe Use of Lasers Outdoors*. Laser Institute of America.

Chapter 22, Nonionizing Radiation in *The Occupational Environment: Its Evaluation, Control, and Management*. Fairfax, VA: AIHA.

CLSO's Best Practices in Laser Safety. Laser Institute of America.

Ken Barat, *Laser Safety Management*. CRC Taylor and Francis Group.

Ken Barat, *Laser Safety: Tools and Training*. CRC Taylor and Francis Group.

21CFR1040 , *Federal Laser Product Performance Standard*, http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=1040.10

FAA Advisory Circular 70-1, Outdoor Laser Operations
http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/23080