29 CFR 1926.54(a) Construction Non-Ionizing Radiation

Laser Safety

Preparation

1. Read Applicable Background information and related Company Policy Chapter.

- 2. Make _____ Copies of this Lesson Plan for Personnel
- 3. Make Transparency, procure transparency pens, etc.
- 4. Coffee, tea, snacks

Material

1. Personal Protective Equipment

Objective

By the end of this session, personnel shall be able to describe Laser:

- 1. Eye and Skin Hazards
- 2. Associated Hazards to include:
 - a) Electrical hazards
 - b) Fire and Explosion Hazards
 - c) Other Associated Hazards
- 3. Classification
- 4. Safety Recommendations & Requirements
- 5. Personal Protective Equipment
- 6. Controlling Hazards
- 7. Accident Reporting & Medical Surveillance

Background

The use of lasers is becoming increasingly widespread in all walks of life. Lasers can present a variety of potentially serious hazards. Laser radiation can cause injury to the eyes and the skin. Lethal electrical and fire hazards can also be present with high-powered lasers. Hazardous chemicals may also be used in conjunction with lasers.

The purpose of this lesson is to insure the safe use of lasers by identifying hazards, providing recommendations for proper use, providing for medical surveillance and for laser safety training for individuals using lasers.

Notes

Lesson

Eye and Skin Hazards

Hazardous effects can occur to various parts of the eye depending on the wavelength of the laser radiation. The injuries can vary due to the variance in how tissues absorb energy. The following are some examples of hazards that can affect the eye:

- Radiation at the visible and near-infrared wavelengths is absorbed and can have hazardous effects on the retina.
- Radiation at the near-ultraviolet and middle infrared wavelengths is absorbed and can injure the lens.
- Corneal absorption and associated effects can occur with far-infrared and middle-ultraviolet wavelengths.
- Corneal lesions and retinal lesions can occur from the heat resulting from the energy absorption and from photochemical reactions.
- Some transitional wavelength zones can result in both corneal and retinal damages.

Associated Hazards

Although less frequent, the potential for injuries resulting from skin exposure to a laser beam should be treated just as strictly as the potential for eye injuries. In certain situations where eye protection is worn, skin exposure could represent a high level of danger.

Although eye and skin exposure to laser radiation represent the primary hazard associated with laser use, ancillary hazards associated with the use of lasers can be significant. Electrical shock, fire, injuries from cryogenics and chemicals are all potential hazards associated with laser use.

Electrical Hazards~

Next to skin and eye exposure, electrical shock represents the highest potential for injuries from laser use, especially with the newer, high-powered lasers. The potential for electrical hazards most commonly results from inappropriate electrical installation, grounding, or handling of the high voltage associated with many lasers. Any Company unit responsible for the operation of any laser shall ensure the necessary protective electrical circuit design. The laser resonator and electro-optical elements should also be designed so that no exposed metallic element is above ground potential. All electrical installations must comply with NEC.

Notes

Fire and Explosion Hazards~

High-pressure arc lamps, filament lamps, and associated optics can shatter or explode during laser operation. These components must be enclosed in housings that can withstand the maximum explosive pressures. The proper installation of the electrical power supply discussed in the above section is also important to reduce the potential for electrical fire. Any enclosures, barriers or baffles must comply with "Polymeric Materials for Use in Electrical Equipment," Underwriters Laboratories Standard, UL 746C.

Other Associated Hazards~

Consideration should be given to other hazards that may be associated with laser use, including the presence of compressed gases, cryogenic liquids, toxic fumes and gases, ionizing radiation, and toxic materials. Consideration should also be given to the proper disposal of any hazardous materials in accordance with the appropriate Company policies.

Laser Classification

Lasers are classified into four basic categories as indicated below:

- Class 1: Lowest power lasers that do not emit hazardous levels
- Class 2: Low-power lasers that pose a hazard only if viewed directly for extended periods
- **Class 3:** Medium-power lasers that pose moderate risk and can cause injury
- **Class 4:** High-energy, high-risk lasers that can cause injury to the eyes and skin from direct or diffused reflection

Personnel that need to work with a class 3 or 4 laser, must obtain a Laser Permit from the Safety and Health Manager. These laser devices require engineering controls to ensure safety. All Class 3 and 4 lasers require a combination of protective housing, area warning signs or remote firing capabilities.

Notes

The following information is required for obtaining a laser permit:

- Classification of the laser device
- Wavelength of the laser output
- Power output
- Appropriate eyewear

Personnel shall follow these guidelines when working with Class 3 and 4 lasers:

- Never aim a laser at a person.
- Use extreme caution when working with hand-held laser pointers.
- Do not allow children access to pointers.
- Wear protective clothing such as eyewear and skin protection as appropriate.
- Post warning signs at entrances where lasers are present.
- When working with power supplies, remove jewelry, stand on a dry surface, and work with only one hand at a time. Observe high voltage precautions (see Electrical Safety chapter).
- Control access to areas where lasers are used (i.e., no spectators).
- If possible, enclose the entire laser beam path on Class 4 lasers.

Safety Recommendations & Requirements

Eye Protection~

Principal Investigators or employees who operate or supervise the operation of a laser are responsible for determining the need for laser eye protection for a particular laser. If required, the supervisor will provide eye protection for employees.

The minimum laser radiant energy or laser power level required for the application should always be used.

Beam Control-

To minimize direct eye exposure, observe these precautions: 1. Do not intentionally look directly into the laser beam or at a

specular reflection, regardless of its power.

2. Terminate the beam at the end of its useful path.

3. Locate the beam path at a point other than eye level when standing or when sitting at a desk.

Notes

Beam Control~ (continued)

4. Orient the laser so that the beam is not directed toward entry doors or aisles.

5. Minimize specular reflections.

6. Securely mount the laser system on a stable platform to maintain the beam in a fixed position during operation and limit beam traverse during adjustments.

7. Confine primary beams and dangerous reflections to the optical table.

8. Clearly identify beam paths and ensure that they do not cross populated areas or traffic paths.

9. When the beam path is not totally enclosed, locate the laser system so that the beam will be outside the normal eye-level range, which is between 1.2 to 2 meters from the floor. A beam path that exits from a controlled area must be enclosed where ver the beam irradiance exceeds the MPE.

(Maximum Permissible Exposure (MPE): 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 criteria for MPE for the eye and skin are detailed in Section 8 of ANSI Z136.1-1993.)

Personal Protective Equipment

1. Laser protective eye wear shall be worn whenever MPE levels may be exceeded.

2. However, it is good practice to always wear eye protection when lasers are in use.

3. In general, eye wear provides protection over a narrow range of the laser spectrum. Eye wear designed for protection at one wavelength may afford little or no protection at another wavelength.

4. Consult eye wear manufacturers and THE SAFETY AND HEALTH MANAGER for proper selection of protective eye wear (see section 9.1).

5. Laser protective eye wear must be approved by the American National Standards Institute (ANSI) and clearly labeled with optical densities and wavelengths for which protection is afforded. Eye wear must be inspected periodically by the user for pitting and cracking of the attenuating material, and for mechanical integrity and light leaks in the frame.

6. Protection for the skin may be afforded through the use of clothing to cover normally exposed skin areas.

Notes
<u></u>
<u> </u>
<u> </u>

Controlling Hazards

Many chemical and physical hazards other than laser radiation can be found in the laser area that must also be adequately controlled.

Electrical Equipment and Systems~

 Always be aware of the high risk of injury and fire in laser operations because of the presence of electrical power sources.
The installation, operation, and maintenance of electrical equipment and systems must conform to the standards stated in the National Electric Code. Contact Physical Plant for assistance.

Lighting~

1. Adequate lighting is necessary in controlled areas.

2. If lights are extinguished during laser operation, provide control switches in convenient locations or install a radio controlled switch.

3. Luminescent strips should be used to identify table and equipment corners, switch locations, aisles, etc.

4. When natural light is not sufficient for safe egress from a laser area during an electrical power failure, install emergency lighting.

Ionizing and Non-ionizing Radiation~

1. A laser operation may involve ionizing radiation that originates from the presence of radioactive materials or the use of electrical power in excess of 15 kV.

2. Microwave and radio frequency (RF) fields may be generated by laser systems or support equipment.

3. Contact the Safety and Health Manager to obtain an evaluation of these hazards before starting an operation.

Hazardous Materials~

1. Bring into the laser area only those hazardous materials that are needed for the operation.

 All hazardous materials must be properly used, stored and controlled. Consult Materials Safety Data Sheets, the Chemical Hygiene Plan and the Safety and Health Manager for information.
Do not allow laser beams and strong reflections to impinge on combustible materials, explosives, highly flammable liquids or gases or substances that decompose into highly toxic products under elevated temperatures, without providing adequate controls.
Conduct or sponsor tests that establish the effects of beam interactions with hazardous materials. Test results can be used to determine safe parameters for laser operation. Notes

Dyes and Solutions~

1. Dye lasers normally use a lasing medium composed of a complex fluorescent organic dye dissolved in an organic solvent. These dyes vary greatly in toxicity, mutagenicity, and potential carcinogenicity.

2. All dyes must be treated as hazardous chemicals. Most solvents suitable for dye solutions are flammable and toxic by inhalation and/or skin absorption.

3. Obtain Material Safety Data Sheets from the Safety and Health Manager for all dyes and solvents.

4. Use and store all dyes and solvents in accordance with the University's Chemical Hygiene Plan.

5. Prepare/handle dye-solutions inside a chemical fume hood.

6. Wear a lab coat, eye protection and gloves. Call the Safety and Health Manager for assistance in glove selection.

7. Pressure-test all dye laser components before using dye solutions. Pay particular attention to tubing connections.

8. Install spill pans under pumps and reservoirs.

9. Be alert to contaminated parts.

10. Keep dye-mixing areas clean.

Accident Reporting and Medical Surveillance

Accident Reporting~

Any employee must report any suspected or known accident involving a laser or laser system to their direct supervisor who is responsible for transmitting the information to the Safety and Health Manager. In the absence of the supervisor, the employee will notify the Safety and Health Manager directly.

B. Medical Surveillance

The employee is required to report to the supervisor any medical conditions that could cause the laser user to be at an increased risk for chronic exposure. These conditions could include, but are not limited to, photosensitivity of the skin, use of photosensitizing medications, and dermatological abnormalities of the skin. When a known or suspected accident is reported to the Safety and Health Manager, any employee with a suspected injury will be referred to a physician, as appropriate. The employee must provide the Safety and Health Manager with a complete and accurate record of the medical examination and treatment, and the Safety and Health Manager is responsible for the confidential maintenance of these records. Individual medical records maintained by the Safety and Health Manager will be released **only** upon written request by the individual.

Notes

Closure

Most lasers are capable of causing eye injury to anyone who looks directly into the beam or specular reflections. In addition, diffuse reflection of a high-power laser beam can produce permanent eye damage. High-power laser beams can burn exposed skin, ignite flammable materials, and activate toxic chemicals that release hazardous fumes, gases, debris, and radiation.

The equipment and optical apparatus required to produce the lasing action and control and direct the laser beam also introduce additional hazards associated with high voltage, high pressure, cryogenics, noise, radiation, and toxic gases.

What questions do you have?

Notes