

Laser Safety



Elements of a Safety Program

Presented by

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LASER

- **L** = Light
- **A** = Amplification
- **S** = Stimulated
- **E** = Emission
- **R** = Radiation

Program Requirements

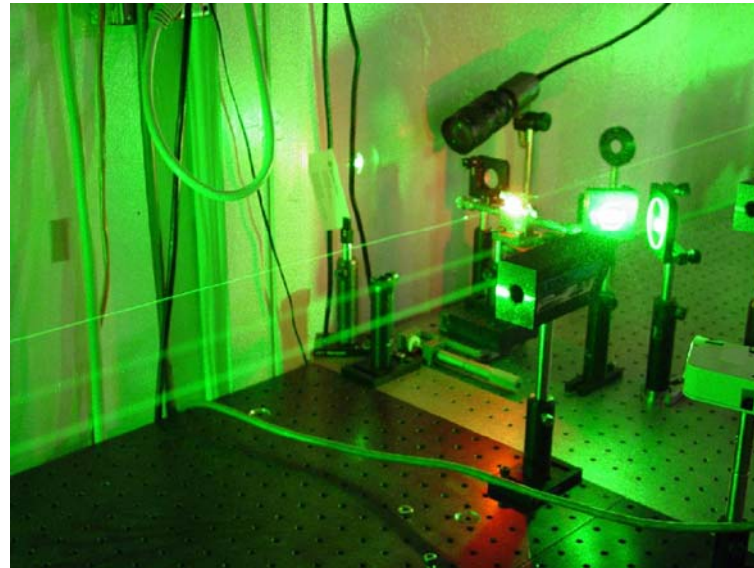
- Laser Safety Officer
- Inventory of Lasers
 - Identify types of lasers
 - Identify laser operators
- Standard Operating Procedures
- Inspections
- Personal Protective Equipment
- Laser Safety Training
- Documentation

Laser Safety Officer

- The LSO is an individual designated by management who has the responsibility and authority to:
 - manage the overall laser safety program.
 - ensure that all employees who operate maintain, or service laser products are properly trained.
 - is responsible for establishing, monitoring, and enforcing laser controls, as well as evaluating laser hazards.

Laser Classifications

- Class 1
- Class 2a
- Class 2
- Class 3a
- Class 3b
- Class 4



Laser Hazards

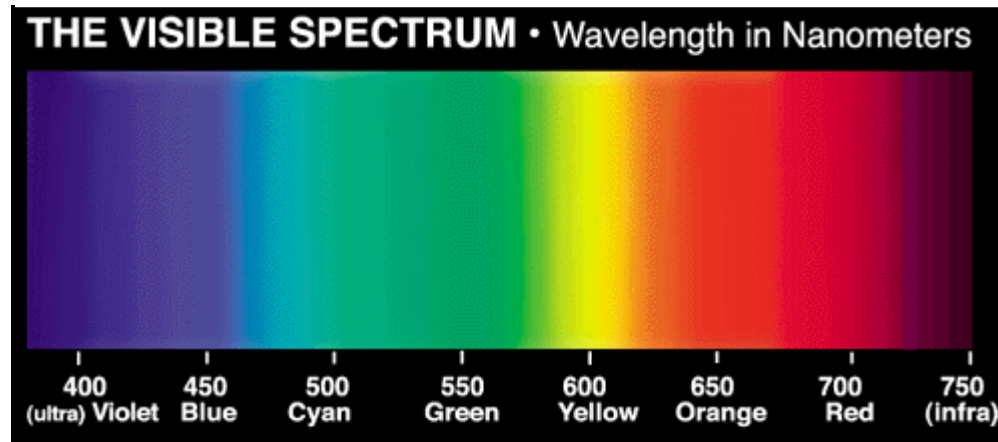
□ Laser Radiation

- Eye – acute injury corneal or retinal burns or chronic injury cataracts
- Skin – acute exposure to high levels of radiation result in burns, ultraviolet could lead to skin cancer
- Chemical – from laser materials (e.g.dye), or can result from particulate/gaseous byproducts
- Electiral – high power laser system
- Other/Secondary – cryogenic coolant, noise, fire, explosion, etc

Laser Radiation Hazards

Lasers emit beams of optical radiation

- Ultraviolet: 100 to 400 nm
- Visible: 400 to 780 nm (retinal)
- Infrared: 780 to 1400 nm (hazard region)



Class 1

- “Exempt” lasers or laser systems that do not, under normal operating conditions, pose a hazard even if all of the laser output were directed into the eye’s pupil (if it could get in) or focused into a 1 mm spot on the skin, thus, there are no safety requirements.

Class 2a

- ▣ Lasers not for continuous viewing longer than 1000 seconds. Visible light which can produce greater than class 1 power. The most common class 2a laser is the supermarket scanner.

Class 2

- “Low-Power” lasers are by definition incapable of causing eye injury within the duration of a blink (aversion response) and must be visible (400 to 700 nm) hazard can only exist if individual overcomes his natural aversion to bright light and stares directly into the laser beam. The majority of low power lasers are helium neon devices.

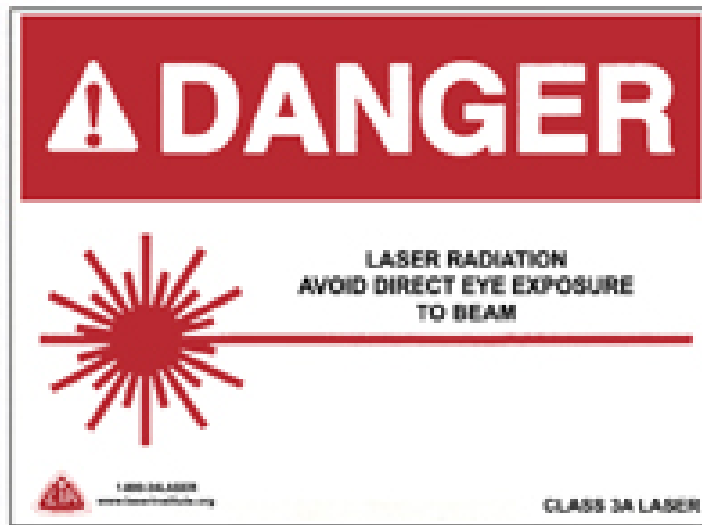
Class 2 Requirements/Safety Rule

- Product requirements for these lasers are two:
 - Have a Caution label and,
 - Have an indicator light to indicate laser operation
- Safety Rules
 - Do not permit a person to stare at the laser from within the beam
 - Do not point the laser at a persons eye

Class 3a

- Denotes some lasers or laser systems having a **CAUTION** label that normally would not injure the eye if viewed for only momentary periods (within the aversion response period) with the unaided eye, but may present a greater hazard if viewed using collecting optics. Another group of Class 3a lasers have **DANGER** labels and are capable of exceeding permissible exposure levels for the eye in 0.25s and still pose a low risk of injury. These can be invisible or visible.

Class 3a (Labels)



Class 3b

- “Medium-Power” lasers or laser systems that can produce a hazard if viewed directly. The hazard is acute to skin and eye from direct beam. The beam can be visible or invisible. Diffuse reflections may be a hazard if operation is at full power and viewing is close to the source of reflection.

Safety Rules for Class 3 Lasers

- ❑ Never aim a laser at a person's eye.
- ❑ Using proper safety eyewear if there is a chance that the beam or a hazardous specular reflection will the expose the eyes.
- ❑ Permitting only experienced personnel to operate the laser and not leaving an operable laser unattended if there is a chance that the unauthorized user may attempt to operate the laser.

Class 3 Safety Rules (cont.)

- ❑ A key switch should be used if untrained persons may gain access to the laser. A warning light or buzzer may be used to indicate when the laser is operating.
- ❑ Enclosing as much as the beam's path as practical.
- ❑ Avoid placement of the unprotected eye along or near the beam axis as attempted in some alignment procedures since the chance of hazardous specular reflections is greatest in this area.

Class 3 Safety Rules (cont.)

- ❑ Terminating the primary and secondary beams if possible at the end of their useful paths.
- ❑ Using beam shutters and laser output filters to reduce the beam power to less hazardous levels when the full output power is not required.
- ❑ Assuring that any spectators are not potentially exposed to hazardous conditions.

Class 3 Safety Rules (cont.)

- ❑ Attempting to keep laser beam paths above or below eye level for either sitting or standing position.
- ❑ Attempting to operate the laser only in a well-controlled area. For example, within a closed room with covered or filtered windows and controlled access.
- ❑ Labeling lasers with appropriate Class 3 danger statements and placarding hazardous areas with danger signs if personnel can be exposed.

Class 3 Safety Rules (cont.)

- ❑ Mounting the laser on a firm support to assure that the beam travels along the intended path.
- ❑ Assuring that individuals do not look directly into a laser beam with optical instruments unless an adequate protective filter is present within the optical train.
- ❑ Eliminating unnecessary specular (mirror-like) surfaces from the vicinity of the laser beam path, or avoid aiming at such surfaces.

Class 4

- “High-Power” lasers or laser systems that produce a hazard not only from direct or specular reflections, but may produce hazardous diffuse reflections. Such lasers may produce significant skin hazards as well as fire hazards. These lasers power levels exceed class 3 levels and also can create a fire hazard.

Class 4 Safety Rules

- ❑ Enclose the entire laser beam path if all possible. If done correctly, the laser's status could revert to a less hazardous classification.
- ❑ Confine open beam indoor laser operations to a light-tight room. Interlock entrances to assure that the laser cannot emit when the door is open, if the Nominal Hazard Zone (NHZ extends to the entrances).

Class 4 Safety Rules (cont.)

- ❑ Insure that all personnel wear adequate eye protection, and if the laser beam irradiance represents a serious skin or fire hazard that a suitable shield is present between the laser beam(s) and personnel.
- ❑ Use remote firing and video monitoring or remote viewing through a laser safety shield where feasible.

Class 4 Safety Rules (cont.)

- ❑ Install appropriate signs and labels as needed.
- ❑ Use dark, absorbing, diffuse, fire resistant target and backstops where feasible.
- ❑ Design safety into laser-welding and cutting equipment and laser devices used in miniature work. If feasible, such work should be accomplished in a light-tight or baffled interlocked enclosure to eliminate the requirements for eye protection.

Class 4 Safety Rules (cont.)

- ❑ Use beam shutter and laser output filters to reduce the laser beam irradiance to less hazardous levels whenever the full beam power is not required.
- ❑ Assure that the laser device has a key-switch master control to permit only authorized personnel to operate the laser.

Electrical Hazards

- ❑ There have been reported electrocutions of individuals from laser-related accidents.
- ❑ Examples:
 - in 1986, a graduate student working with a CO₂ laser was wiping condensate from the laser tube when he received a 17 kV electrical shock. He suffered cardiac arrest and 2nd. degree burns.
 - In 1988, a laser repair technician was fatally electrocuted while working alone on a CO₂ laser. He had reportedly defeated the interlock system.

Sample SOP

□ Alignment:

- Appropriate security measures to restrict access to the laboratory should be effected to protect personnel not wearing protective equipment from exposure.
- Assemble all needed items or tools to perform the alignment. Remember to keep objects off the table, which may cause specular reflections.
- The laser should be set to the lowest practical power while performing alignments.

Sample SOP (cont.)

- Avoid working with the room lights off. Reducing the illumination in the room causes the pupils to dilate and increases the possibility of eye injury. The potential for electrical shock or other hazard also increases when vision is hampered.
- Persons performing alignments and persons present in an area where a direct or reflected source of laser light could come into contact with their eye must wear appropriate eye protection.

Sample SOP (cont.)

- Beam stops should be in place at locations where the beam may leave the table or stray off its intended path. If beam stops, enclosures or other safety devices were moved to perform an alignment, they must be replaced prior to operation.
- Never look directly into the beam. If intra-beam viewing is required to align the beam, use a remote viewing camera.
- In the case of invisible laser emissions, a visible low power laser should be used for the purposes of alignment wherever possible.

Inspections

- The Laser Safety Officer conducts the inspection of the laser facilities in the presence of the department supervisor. Inspection findings are recorded denoting areas of noncompliance and the corrective action taken.

Personal Protective Equipment (PPE)

- Flame Resistant Materials - Class 4 beams
- Eyewear is characterized by Optical Density (OD)
 - Example: OD of 6 represents a reduction of the incident radiation by a factor of 1 million
- Eyewear must be marked with OD & Wavelength for proper selection

PPE (cont.)

- ❑ Eyewear should be used as directed
- ❑ Stored Properly
- ❑ Inspected for pitting, crazing, or solarization of the lenses
- ❑ Goggle straps or spectacle sideshields



Training

- Recommended for Class 1 and 2 lasers
- Required for Class 3 and 4 lasers
- Training contents:
 - Contents of OSHA guidelines
 - Location and availability of the Laser Safety Plan
 - Maximum Permissible Exposure Limits for ANSI standards and any recommended exposure limits from OSHA
 - Methods and observations used to detect the presence or release of laser light

Training (cont.)

- Physical and Health hazards of lasers in the work area
- Measures employees can take to protect themselves from laser light including specific procedures (SOP's) to be used
- Signs and symptoms associated with exposures to hazardous laser light used in the work area
- The location of known reference material on the hazards, safe handling, storage and disposal of lasers found in the workplace

Recordkeeping

- Each department as well as the Laser Safety Officer will keep records:
 - Inventory
 - Training
 - Inspections

Standards/Regulations

- Applicable standard
 - ANSI Z136.1 – 2000 Safe Use of Lasers
- Applicable regulations
 - OSHA Pub. 8-1.7-OSHA Laser Safety Policies & Standards (Instructional Publication)
 - 29 CFR Part 100 – Federal Laser Product Performance Standard. Center for Devices and Radiological Health (CDRH)
 - 29 CFR 1910.132 – Eye and Face Protection
 - 29 CFR 1910.269 – Electric Power Generation