Laser Safety 101
• What are lasers?
• What do they do?
• What makes them unique?
• How do they present injury hazards?

Hypothetical Situations: Your company has purchased a 2500 watt CO₂ laser for cutting, marking, welding, etc.
• What (if any) type of protective eyewear is required?
• The sales representative who sold your company the laser informed you that “…no safety eyewear is required…” Is this your company’s position?
• The same rep claims that standard clear polycarbonate safety glasses from the local hardware store are OK – are they?
• Are employees baseline eye exams required – should they be?
• Do the operators require any type of safety training and who decides?
• Is a protective barrier or enclosure required around this system and how is this determined, at what distance around the unit is it placed and what are the specifications?
• Is this a Class 1 or Class 4 system – what’s the difference?

Hypothetical Situations: You’re the Laser Safety Officer (LSO) for a large healthcare organization that owns several Class 4 medical lasers
• A nurse reports an ‘eye irritation’ that she is convinced is a result of an exposure to a KTP laser – what is your response to this?
• Your laser safety policy requires all personnel to wear laser protective eyewear during laser procedures, however, several doctors refuse saying the eyewear limits their ability to perform surgery or that the laser hazard is confined to within the delivery fiber optic – what is your response to this?
• A biomedical engineer claims to have seen a blinding flash of green light during alignment of an argon laser and risk management has been notified by his attorney that irreversible retinal injury has occurred – what is your response?
Hypothetical Situations: Your company is a military contractor and you develop laser target designators with the following operational parameters:

- Q-switched Nd:YAG laser at 1,060 nm
- Pulse width = 20 microseconds
- Pulse energy = 62.8 mJ
- Beam divergence = 0.5 mrad
- Emergent beam diameter (Ø) = 2 millimeters
- Pulse rep rate = 100 hertz
- Atmospheric absorption coefficient = 0 (assumed)

- What is the nominal ocular hazard distance (NOHD) for this system?
- What level of eye protection (optical density) should personnel wear within 2 km of this system?

Answers: As an employer it is your responsibility to know the answers to these and many other questions related to your lasers.

Laser is an acronym for

Light
Amplification by
Stimulated
Emission of
Radiation
Through the process of light amplification by the stimulated emission of radiation, laser light is:

- Collimated
- Coherent
- Monochromatic

ANSI Z136 (series) for Safe Use of Lasers

An American National Standard "…..implies a consensus of those substantially concerned with its scope and provisions…..is intended as a guide to aid the manufacturer, the consumer, and the general public…..is subject to periodic review….."
Class 3R lasers and laser systems include lasers and laser systems which have an accessible output between 1 and 5 times the Class 1 AEL for wavelengths shorter than 0.4 μm or longer than 0.7 μm, or less than 5 times the Class 2 AEL for wavelengths between 0.4 and 0.7 μm. Note: Products can be classified as Class 1M and Class 2M even if their output exceeds Class 3R.

Class 3B lasers and laser systems include:
1. Lasers and laser systems operating outside the retinal hazard region (i.e. < 0.4 μm or > 1.4 μm) which can emit accessible radiant power in excess of the Class 3R AEL during any emission duration but which (a) cannot emit an average radiant power in excess of 0.5 W for T ≥ 0.25 s or (b) cannot produce a radiant energy greater than 0.125 J within an exposure time T < 0.25 s. (2) Visible (0.4 to 0.7 μm) and near infrared (0.7 to 1.4 μm) lasers and laser systems which emit in excess of the AEL of Class 3R but which (a) cannot emit an average radiant power in excess of 0.5 W for T ≥ 0.25 s and (b) cannot emit a radiant energy greater than 0.03 CA J per pulse. For this limit, pulses separated by less than tmin are to be considered one pulse.

Class 4 lasers and laser systems are those that emit radiation that exceed the Class 3B AEL.

A Class 1 laser system (high-power):
• is a hazard to the eye by virtue of the direct beam, and
• may cause a diffuse reflection or fire hazard.
• May produce laser-generated air contaminants (LAC) and hazardous plasma radiation.

Laser Safety in the Workplace

Laser Safety Officer is "... an individual designated by the employer with the authority and responsibility to effect the knowledgeable evaluation and control of laser hazards, and to monitor and enforce the control of such hazards..." may be designated from among such personnel as the radiation safety officer, industrial hygienist, safety engineer, laser specialist, laser operator or user, etc. In any case, there shall be a designated LSO for all circumstances of operation, maintenance, and service of a Class 3B or Class 4 laser or laser system..."
Laser Safety Officer Duties and Responsibilities
• Safety Program
• Classification
• Hazard Evaluation
• Control Measures
• Procedure Approvals
• Protective Equipment
• Signs and Labels
• Facility and Equipment
• Employee Training Programs
• Medical Surveillance
• Records
• Audits, Surveys and Inspections
• Accidents
• Approval of Laser Systems Operations

Select regulatory compliance agencies & standards for review:
• Federal Laser Product Performance Standards (FLPPS) 1040.10 & 1040.11
• International Electrotechnical Commission (IEC 60825-1)
• American National Standard ANSI Z136.1 for Safe Use of Lasers (series)
• Laser Institute of America (LIA)
• Occupational Safety & Health Administration (OSHA)
• State & local regulations may also apply


Applicability
...provisions of this section and 1040.11, as amended, are applicable as specified to all laser products manufactured or assembled after August 1, 1976, except when...
SUBCHAPTER J-RADIOLOGICAL HEALTH
PART 1010 PERFORMANCE STANDARDS
FOR ELECTRONIC PRODUCTS: GENERAL
21 CFR Part 1010.2 Certification
21 CFR Part 1010.3 Identification
21 CFR Part 1040.10 Laser Products
• Classification of Laser Products
• Accessible Emission Limits
• Tests for Determination Of Compliance
• Performance Requirements
• Labeling Requirements
• Informational Requirements
• Modification of A Certified Product
21 CFR Part 1040.11 Specific Purpose Laser Products
(A) Medical Laser Products

Food and Drug Administration, Center for Devices and Radiological Health (CDRH):

...intends to amend its standard for laser products (Federal Laser Product Performance Standards [FLPPS] CFR 1040.10 & 1040.11) to harmonize with those of IEC 60825-1 and 60601-2-22*... 

* Per Laser Notice No. 50, Document issued on July 26, 2001

Laser Institute of America (LIA) is the secretariat and publisher of the ANSI Z136 series:
• Z136.1 Safe Use of Lasers (parent document)
• Z136.2 Safe Use of Lasers and LED’s in Telecommunications Applications
• Z136.3 Safe Use of Lasers in Health Care Facilities
• Z136.4 Measurements and Instrumentation
• Z136.5 Safe Use of Lasers in Educational Institutions
• Z136.6 Safe Use of Lasers Outdoors
• Z136.7 Eyewear and Protective Barriers
• Z136.8 Safe Use of Lasers in Research, Development and Testing
• Z136.9 Safe Use of Lasers in Manufacturing Environments
• Z136.10 Safe Use of Lasers in Entertainment, Displays and Exhibitions
U.S. Department of Labor Occupational Safety & Health Administration

What standards apply?

Occupational Safety & Health Administration

Section 5(a)(1) of the OSH Act, often referred to as the General Duty Clause, requires:

“…..employers to furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees…”

Regulations (Standards - 29 CFR) Nonionizing radiation. - 1926.54

“…..Only qualified & trained employees shall be assigned to install, adjust, and operate laser equipment…. Proof of qualification of the laser equipment operator shall be available and in possession of the operator at all times…..”

Note: While the ANSI Z136 standards for Safe Use of Lasers (series) are not OSHA regulations they provide guidance from their originating organizations related to worker protection, and may be referenced by OSHA inspectors for informational purposes:

U.S. Department of Labor  Occupational Safety & Health Administration

OSHA News Release

2005 - 08/09/2005 - OSHA Aligns with Laser Institute of America

WASHINGTON – The Occupational Safety and Health Administration (OSHA) and the Laser Institute of America have formed an Alliance that focuses on providing access to training resources to help protect worker safety and health particularly by reducing and preventing exposure to laser beam and non-beam hazards in industrial and medical workplaces……
Appendix D
Guide for Organization and Implementation of Employee Laser Safety Training Programs

Laser safety training must be provided to users of class 3B or class 4 lasers...may be developed by the employer...courses and other training programs on laser safety are also commercially available...

Safety Training Program Topics
- Fundamentals of laser operation (physical principles, construction, etc.)
- Bioeffects of laser radiation on the eye and skin
- Significance of specular and diffuse reflections
- Non-beam hazards of lasers (see Section 7)
- Laser and laser system classifications
- Control measures
- Overall responsibilities of management and employee
- Medical surveillance practices (if applicable)
- CPR for personnel servicing or working on lasers with exposed high voltages and/or the capability of producing potentially lethal electrical currents

Check with radiation organizations as state & local regulatory oversight may apply.

Wisconsin Radiation Protection Section
Division of Public Health
P.O. Box 309
Madison, WI 53701-0309

Regulations: courtesy written notification

...it's all fun and games until someone loses an eye...

- Mom