Laser safety

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LASER CLASSIFICATION SUMMARY

Class 1	Incapable of causing injury during normal operation
Class 1M	Incapable of causing injury during normal operation unless collecting optics are used
Class 2	Visible lasers incapable of causing injury in 0.25 s.
Class 2M	Visible lasers incapable of causing injury in 0.25 s unless collecting optics are used
Class 3R	Marginally unsafe for intrabeam viewing; up to 5 times the class 2 limit for visible lasers or 5 times the class 1 limit for invisible lasers
Class 3B	Eye hazard for intrabeam viewing, usually not an eye hazard for diffuse viewing
Class 4	Eye and skin hazard for both direct and scattered exposure

LASER SAFETY STANDARDS

- The Federal Laser Product Performance Standard (FLPPS) of the Center for Devices and Radiological Health (CDRH)
  This is federal law and applies to the manufacture of lasers.

- The American National Standard for Safe Use of Lasers (ANSI Z136.1)
  It is "recognized by" : (OSHA)The Occupational Safety and Health Administration
  This is a VOLUNTARY Standard that applies to the use of lasers.

- IEC 60825 International Standard

FEDERAL SAFETY REQUIREMENTS FOR CLASS 1 LASER SYSTEMS WITH ENCLOSED CLASS 3b AND 4 LASERS

Protective Housing
prevents access to laser radiation above safe level.

Safety Interlocks
terminate laser beam if protective housing in opened.

Only personnel with written authorization from the owner of the laser, may operate laser with interlocks defeated.

Warning Labels
alert personnel if opening the housing might expose a laser hazard.

Viewing Windows and Optics
limit laser and collateral radiation to safe levels.

CDRH CLASS WARNING LABELS

INTERNATIONAL LASER WARNING LABELS

Symbol and Border: Black
Background: Yellow

Legend and Border: Black
Background: Yellow

LASER HAZARD EVALUATION

FACTORS IN HAZARD EVALUATION

- The laser or laser system's capability of injuring personnel (Hazard Analysis Calculations)
- The environment in which the laser is used
- The personnel who may use or be exposed to laser radiation

DEFINITION OF MPE

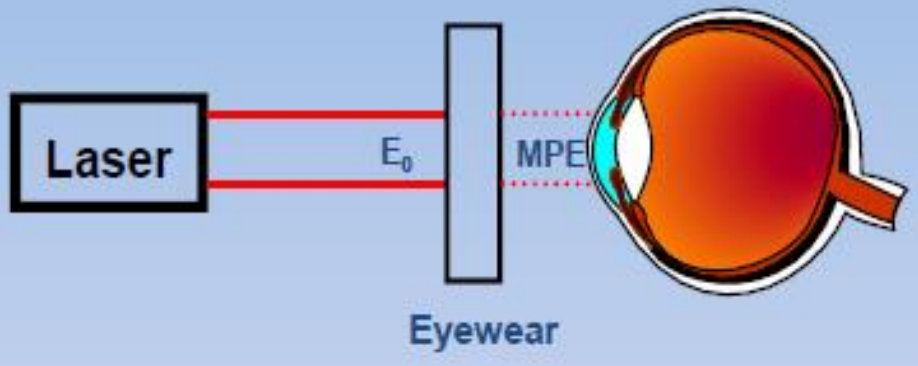
Maximum

Permissible

Exposure

The level of laser light to which a person may be exposed without risk of injury.

OPTICAL DENSITY OF LASER SAFETY EYEWEAR



OD	% Transmission
0	100%
1	10%
2	1%
3	0.1%
4	0.01%
5	0.001%
6	0.0001%

$$OD = \log \frac{E_0}{MPE}$$

Given: $\lambda = .488\ \mu m$

$\Phi = 5\ W$

$d = 7\ mm$

$A = 0.4\ cm^2$

Area of Limiting Aperture (Table 8)

$E_0 = (5W)/(0.4\ cm^2) = 12.5\ W/cm^2$

$MPE = 2.5 \times 10^{-3}\ W/cm^2$ (for 0.25 sec.)

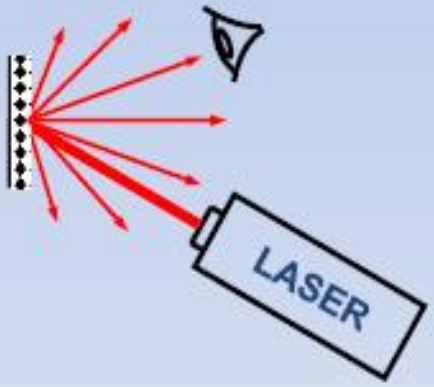
$$OD = \log_{10} \left(\frac{12.5\ W/cm^2}{2.5 \times 10^{-3}\ W/cm^2} \right)$$

$OD = 3.7$

NOMINAL HAZARD ZONE

The space within which the potential exposure exceeds the MPE.

Intrabeam Nominal Hazard Zone



Diffuse Reflection Nominal Hazard Zone

HAZARD EVALUATION BY LASER USERS

All users of lasers with exposed beams should:

- Understand the hazards associated with the laser they use
- Evaluate the control of hazards every time they operate the lasers
- Use their best judgment in controlling all laser hazards (be conservative; don't take chances)
- Consult their Laser Safety Officer whenever they have safety concerns or questions