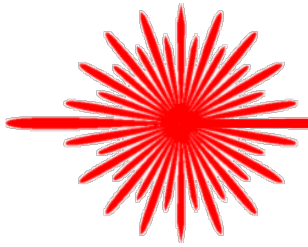
Safety & Environmental

"Your Compliance Pro"



Staying Safely on Target!

Laser Safety

Chuck Paulausky, CHMM, LSO

Laser Basics - Definition/Use

- **LASER stands for**

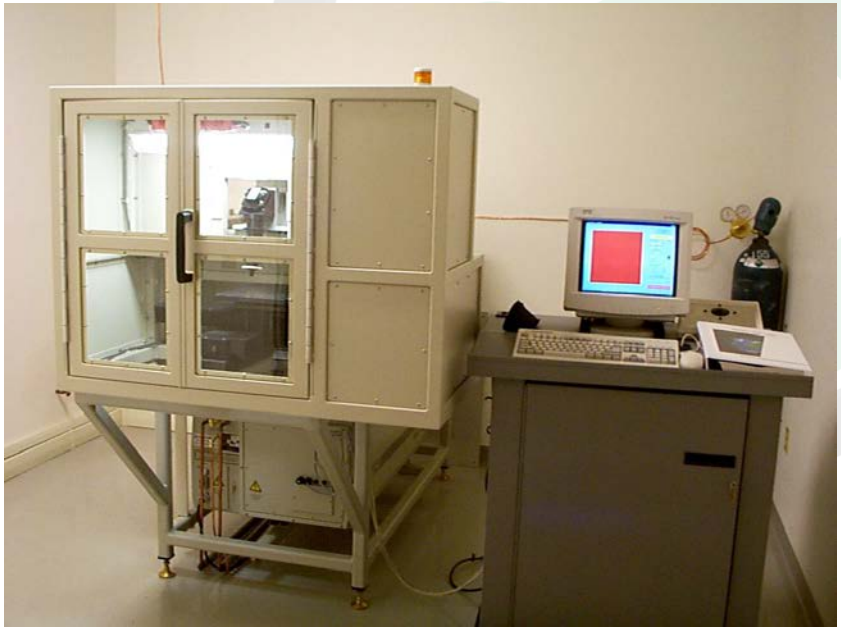
  Light

  Amplification by

  Stimulated

  Emission of

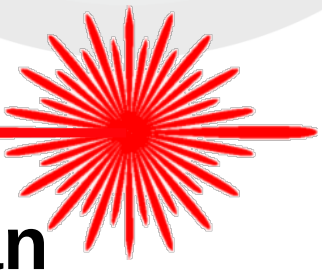
  Radiation



- **Common uses include:**
  - **Barcode scanners, Laser pointers**
  - **Military- Targeting, weapons**
  - **Research, Medical applications**
  - **Industrial applications**

Laser Basics - Laser Hazards

- **Laser light differs from ordinary light in 3 ways:**
  - **Monochromatic- One color or wavelength**
  - **Directional- Narrow beam, one direction**
  - **Coherent- Wavelengths in phase**

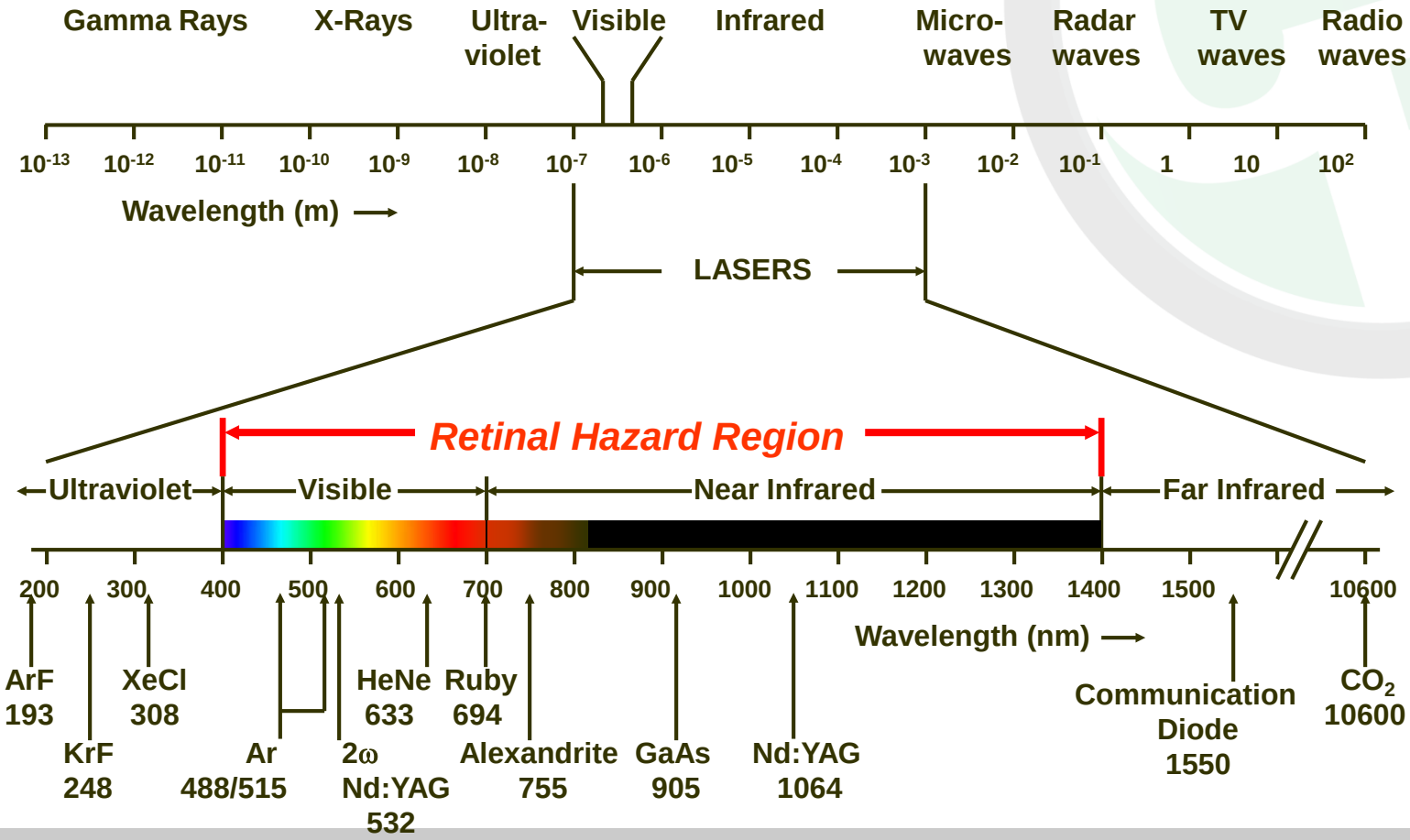


- **Lasers can pose more of a hazard than ordinary light because they can focus a lot of energy onto a small area**

Radiation

- **Types of Radiation**
  - **Ionizing**
    - **Radioactive atoms**
      - **Alpha/Beta, Neutron particles, Gamma/X-rays.**
    - **High energy of greater concern**
    - **Can interfere with normal cell processes**
  - **Non-ionizing**
    - **Ultraviolet, Visible light, Infrared, Microwaves, Radio waves, Heat**
    - **Lower energy**

Laser Radiation- Electromagnetic Spectrum

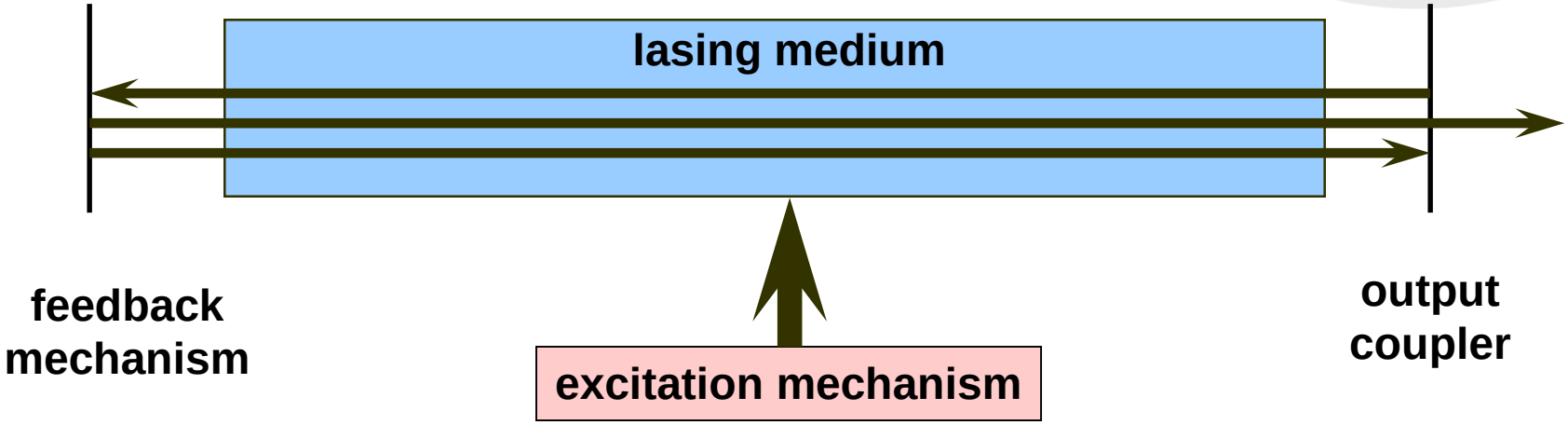


Laser Exposure Limits - Terms

- **MPE (Maximum Permissible Exposure)**
  - **the highest laser energy to which the eye or skin can be exposed for a given laser**
- **NHZ (Nominal Hazard Zone)**
  - **area within which the MPE is equaled or exceeded**
  - **no controls are required outside of the NHZ**
- **NOHD (Nominal Ocular Hazard Distance)**
  - **distance along the laser beam axis beyond which is acceptable for eye exposure**
- **OD (Optical Density)**
  - **measure of the attenuation of energy passing through a filter.**

Laser Basics - Design

- **Laser Design**
  - **Lasing Medium (gas, liquid, solid, semiconductor)**
  - **Excitation Mechanism (power supply, flashlamp, laser)**
  - **Feedback Mechanism (mirrors)**
  - **Output coupler (semi-transparent mirror)**



Laser Basics - Types of Lasers

- **Different lasing media**
  - **Gas, liquid, solid, semi-conductor, dye**
- **Continuous wave (CW), Pulsed, Q-switched**

CO2 Pulsed Laser system

Laser Hazard Classifications

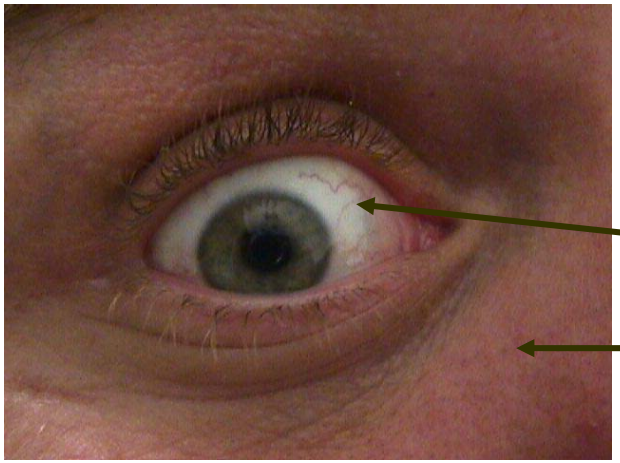
- **Class 1 - “Safe” if not disassembled; MPE not likely to be exceeded**
  - **CD-ROM players/drives**
- **Class 2/2a – Potential eye hazard if you stare into beam; Human blink reflex usually prevents damaging exposure**
  - **Supermarket scanners**
- **Class 3a - Eye hazard if collected or focused into eye; MPE can be exceeded, but risk of injury is low**
  - **Laser pointers**

Laser Hazard Classifications

- **Class 3b – Serious eye hazard if direct or reflected beam is viewed; Diffuse exposure should not be hazardous**
  - **Research**
- **Class 4 - Eye hazard if direct, reflected or diffusely-reflected beam is viewed, resulting in devastating or permanent eye damage; potential for significant skin damage; May pose a fire risk and fume hazard**
  - **Research, manufacturing**

These Laser classes pose significant risk and fall under the OSHA/ANSI Laser Safety requirements

Laser Bioeffects - Damage

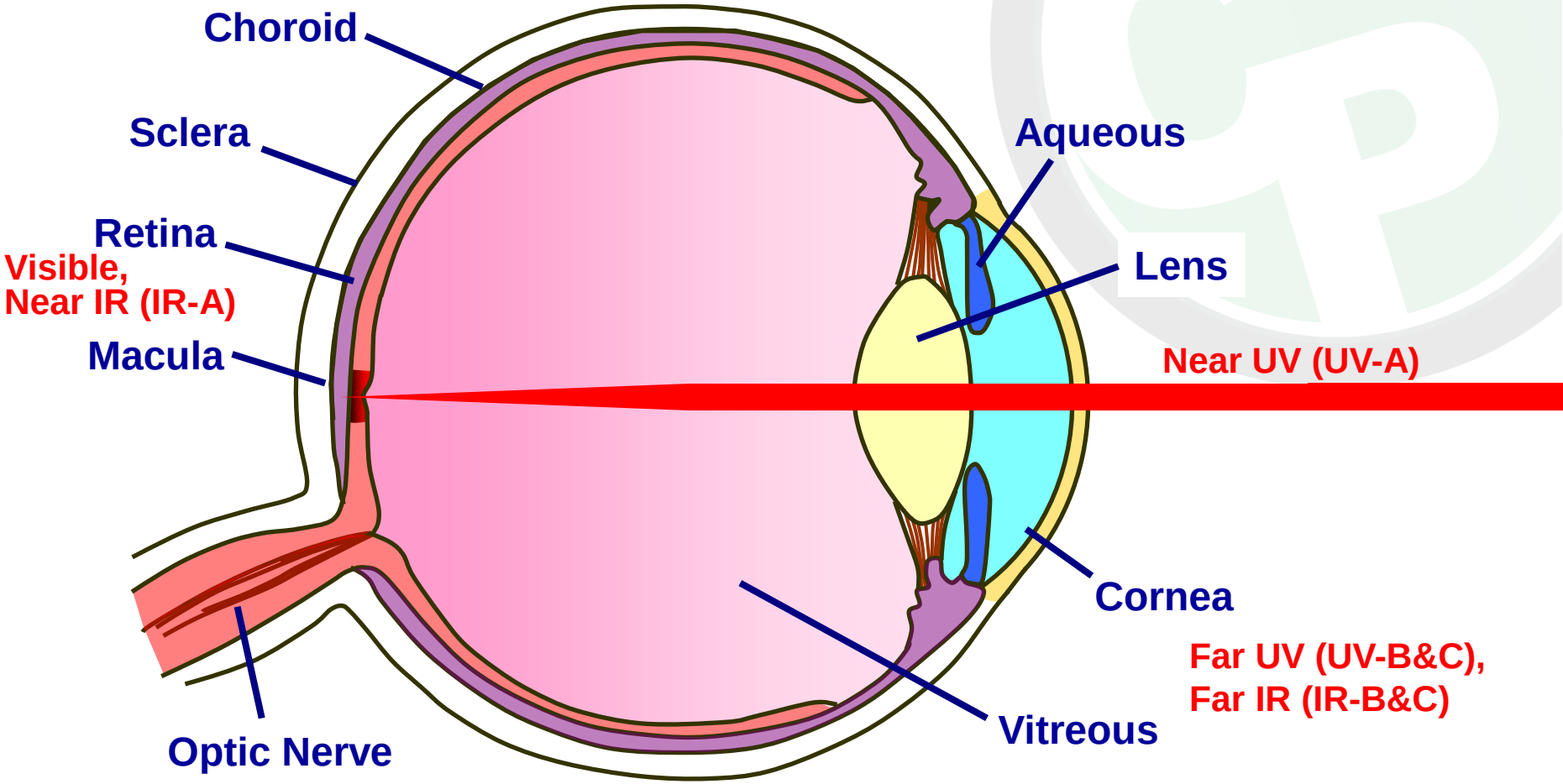


- **Primary sites of damage**
  - **eyes**
  - **skin**

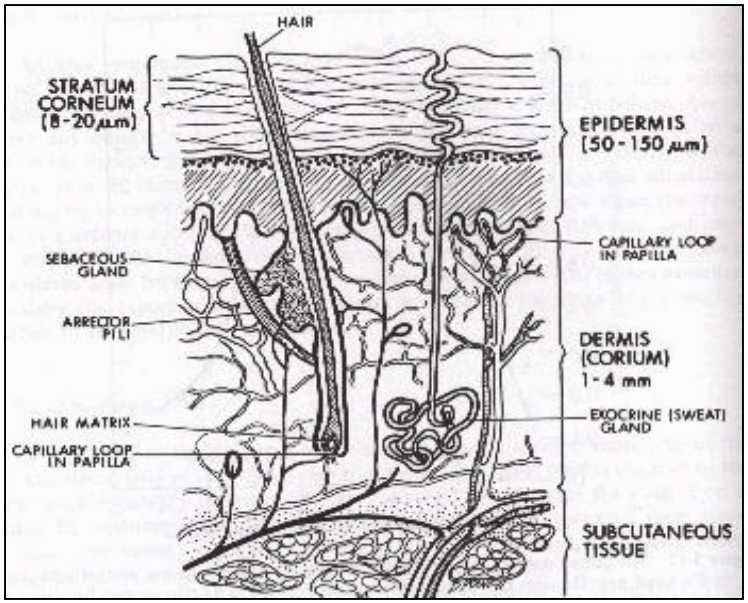
- **Laser beam damage can be**
  - **thermal (heat)**
  - **acoustic**
  - **photochemical**

Nd:YAG 1064-nm retinal injury

Laser Bioeffects - Eye Anatomy & Exposures



Laser Bioeffects - Skin

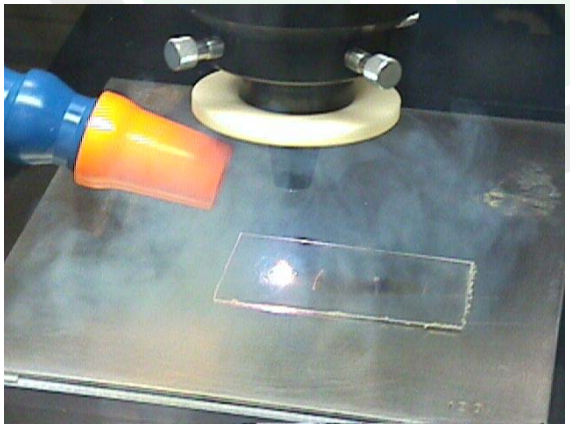


- **Skin Damage**
  - **Epidermis (UV-B, UV-C)**
  - **Dermis (IR-A)**

Accidental exposure to partial reflection of 2000 W CO_2 laser beam from metal surface during cutting

Non-Beam Hazards

- **Electrical-**
  - **High-voltage power, Capacitor banks**
- **Chemical-**
  - **Organic dyes**
  - **Process fumes**
- **Optical-**
  - **UV/IRA exposures- discharge tubes, process welding, pumping systems**
- **Explosion, Fire-**

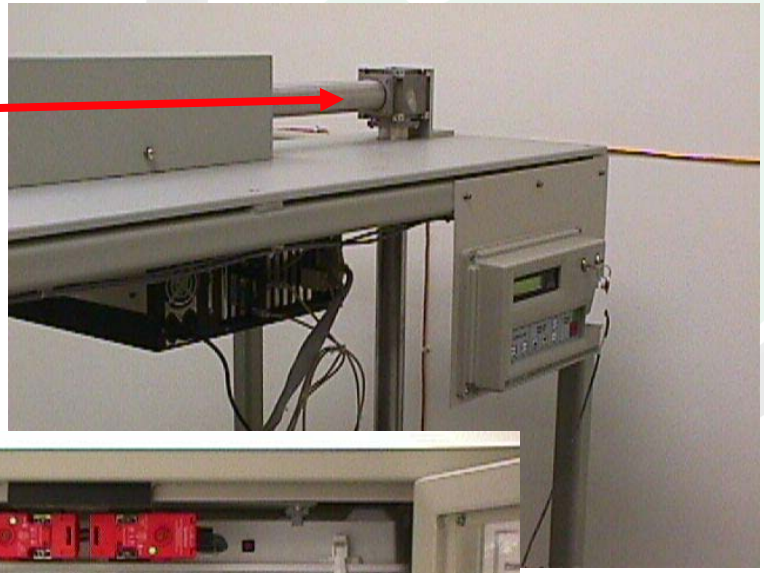


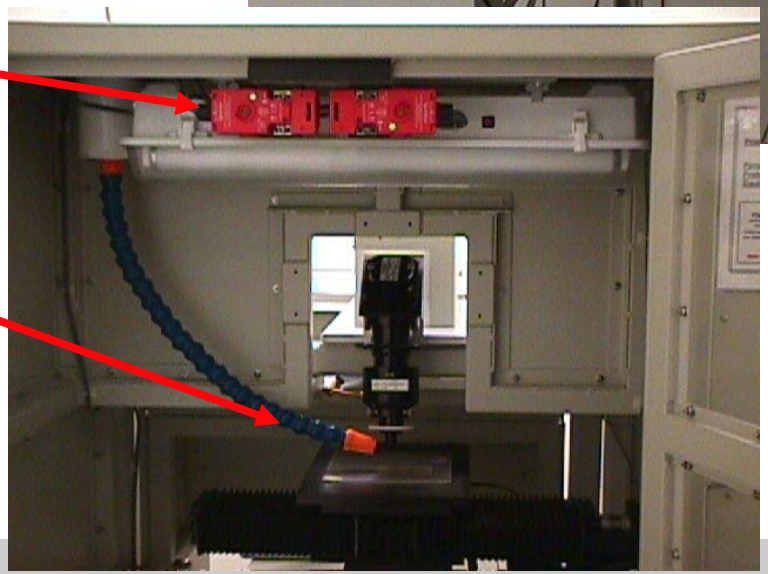
Common Causes of Accidents

- **Bypassing interlocks. This is always a bad idea.**
- **Inserting reflective objects into the beam path.**
- **Accidental firing of the Laser.**
- **Altering the beam path, or adding additional optical components.**
- **Changing the Laser settings without recalculating the MPE, and OD requirements.**

Control Measures - Engineering

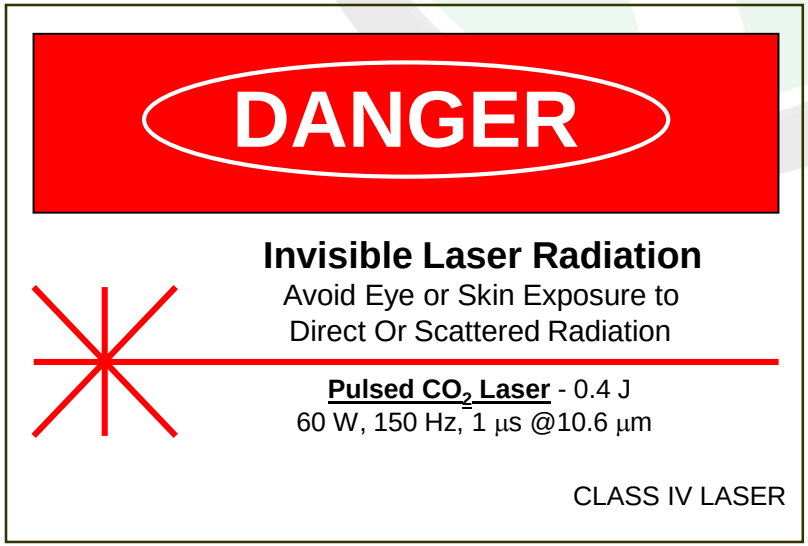
- **Beam housings**
- **Shutters**
- **Remote firing controls**
- **Interlocks**
- **Attenuators**
- **Fume exhaust**
- **Barrier curtains**
- **OD windows**





Control Measures - Administrative

- **Written Laser Safety Plans**
- **SOPs**
- **Training**
- **ANSI Warning signs & labels**



Administrative Safety Practices

- **Supervisor responsibility**
- **Authorized personnel only**
- **Designate NHZ for Class 3b and 4 Lasers**
- **Use minimum power/energy required for project**
- **Use diffuse reflective screens, remote viewing systems, etc., during alignments, if possible**
- **Remove unnecessary objects from vicinity of laser**
- **Keep beam path away from eye level (sitting or standing)**

Never put body parts into the beam!

Control Measures – Personal Protective Equipment

- **Gloves**
- **Special clothing**
- ***Appropriate* eyewear**
  - **Eyewear must be for the appropriate laser wavelength, attenuate the beam to safe levels, yet be comfortable enough to wear**

OSHA Regulations & Requirements

- **No OSHA regulations specific to Lasers, but…**
  - **PPE Requirements**
  - **Standard interpretations, directives, guidance documents**
  - **General Duty Clause**
  - **National Consensus**
    - **ANSI Z136.1-2007 Safe Use of Lasers, etal**
  - **Additional requirements for:**
    - **Medical Applications**
    - **FDA- 21CFR 1040.10 & .11**
    - **Construction- 29CFR1926.54**

State Requirements

- **State requirements- Usually based on ANSI Z136.1 these may include:**
  - **Registration (fees)**
  - **Laser Safety Officer (Requirements vary by State)**
  - **Written Plans**
  - **Medical evaluations**
  - **Periodic inspections, evaluation of safety functions**
  - **Reporting of Laser-related incidents**
  - **Generally, these requirements apply to Class 3B & Class 4 Lasers only**

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For assistance with your OSHA or EPA compliance programs, contact:

Chuck Paulausky
480-694-1975
cpaulausky@cpsafety.net
www.cpsafety.net

Protecting your employees, your company, and your community

CHUCK PAULAUSKY, CHMM
Principal Consultant & President
CP Safety & Environmental, LLC
1900 W. Chandler Blvd., Suite 15-128
Chandler, AZ 85224

Mobile: 480.694.1795
cpaulausky@cpsafety.net

- Chuck Paulausky is the Principle Consultant and President of CP Safety & Environmental. He is a Certified Hazardous Materials Manager (CHMM) and OSHA/Environmental Compliance trainer.
- Chuck has provided EHS management services since 1989 for facilities across the US and in Europe and Asia. He has also published articles in trade and business magazines, as well as webinars, podcasts and seminars on various EHS topics.
- He is a past member of the Board of Directors of the AHMP Thunderbird Chapter, is an AHMP Champion of Excellence Award winner, and current member of EPAZ and ASSE. Chuck has been a member of the Gatekeeper Regulatory Roundup Planning Committee and annual presenter since its inception in 2005. Chuck is active in several other professional and business organizations, including past Chairman of the Chandler Chamber of Commerce Safety Committee.
- CP Safety & Environmental, LLC is a full-service Environmental, Health, and Safety consulting firm providing EPA & OSHA compliance support, expert witness, and worker's compensation loss control/risk assessment services.