

# Laser Safety Training

## CO<sub>2</sub> Laser Cutter

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# Laser Safety Training

## Properties of Lasers

- Monochromatic
- Directional
- Coherent light
  - Light waves stack and are in phase with one another
  - Gives laser light its power
- Low divergence
- High irradiance
  - High radiant power in a very small area is the single most important property of lasers that can lead to injuries.

# Laser Safety Training

| Laser type  | Wavelength<br>(nanometers) | Laser type                       | Wavelength<br>(nanometers) |
|---|----------------------------|----------------------------------|----------------------------|
| Argon fluoride (Excimer-UV)   | 193                        | Helium neon (yellow)             | 594                        |
| Krypton chloride (Excimer-UV)   | 222                        | Helium neon (orange)             | 610                        |
| Krypton fluoride (Excimer-UV)   | 248                        | Gold vapor (red)                 | 627                        |
| Xenon chloride (Excimer-UV)   | 308                        | Helium neon (red)                | 633                        |
| Xenon fluoride (Excimer-UV)   | 351                        | Krypton (red)                    | 647                        |
| Helium cadmium (UV)   | 325                        | Rhodamine 6G dye (tunable)       | 570 - 650                  |
| Nitrogen (UV)   | 337                        | Ruby (CrAlO <sub>3</sub> ) (red) | 694                        |
| Helium cadmium (violet)   | 441                        | Gallium arsenide (diode-NIR)     | 0840                       |
| Krypton (blue)  | 476                        | Nd:YAG (NIR)                     | 1,064                      |
| Argon (green)   | 488                        | Helium neon (NIR)                | 1,150                      |
| Copper vapor (green)  | 510                        | Erbium (NIR)                     | 1,504                      |
| Argon (green)   | 514                        | Helium neon (NIR)                | 3,390                      |
| Krypton (green)   | 528                        | Hydrogen fluoride (NIR)          | 2,700                      |
| Frequency doubled Nd YAG (green)  | 532                        | Carbon dioxide (FIR)             | 9,600                      |
| Helium neon (green)   | 543                        | <b>Carbon dioxide (FIR)</b>      | <b>10,600</b>              |
| Krypton (yellow)  | 568                        |                                  |                            |
| Copper vapor (yellow)   | 570                        |                                  |                            |
| <p><b>Key:</b> UV = ultraviolet (0.200-0.400 nm)<br/>           NIR = near infrared (700- 3400 nm)<br/>           FIR = far infrared (3400 nm or greater)</p> |                            |                                  |                            |

# Laser Safety Training

## Changes in Laser Classification System

### Old

#### Class 1

#### Class 2

#### Class 2A

- FDA only: max viewing 1000 sec.

#### Class 3A

- FDA only: for visible wavelengths only. No collecting optics.

#### Class 3B

#### Class 4

### New

#### Class 1

- Eye safe with optical aids.

#### Class 1M

- Eye safe without optical aids.

#### Class 2

- Eye safe for momentary viewing.

#### Class 2M

- Eye safe for momentary viewing w/o optical aids.

#### Class 3R

- Harmonizes ANSI & FDA hazard definitions with IEC. Potential hazard if eye appropriately focused and stable.

#### Class 3B

#### Class 4

# Laser Safety Training

## Laser Warning Signs



Aversion response will protect your eyes  
- 0.25 sec

Class I, 2 and some 3R



Beam will cause eye damage

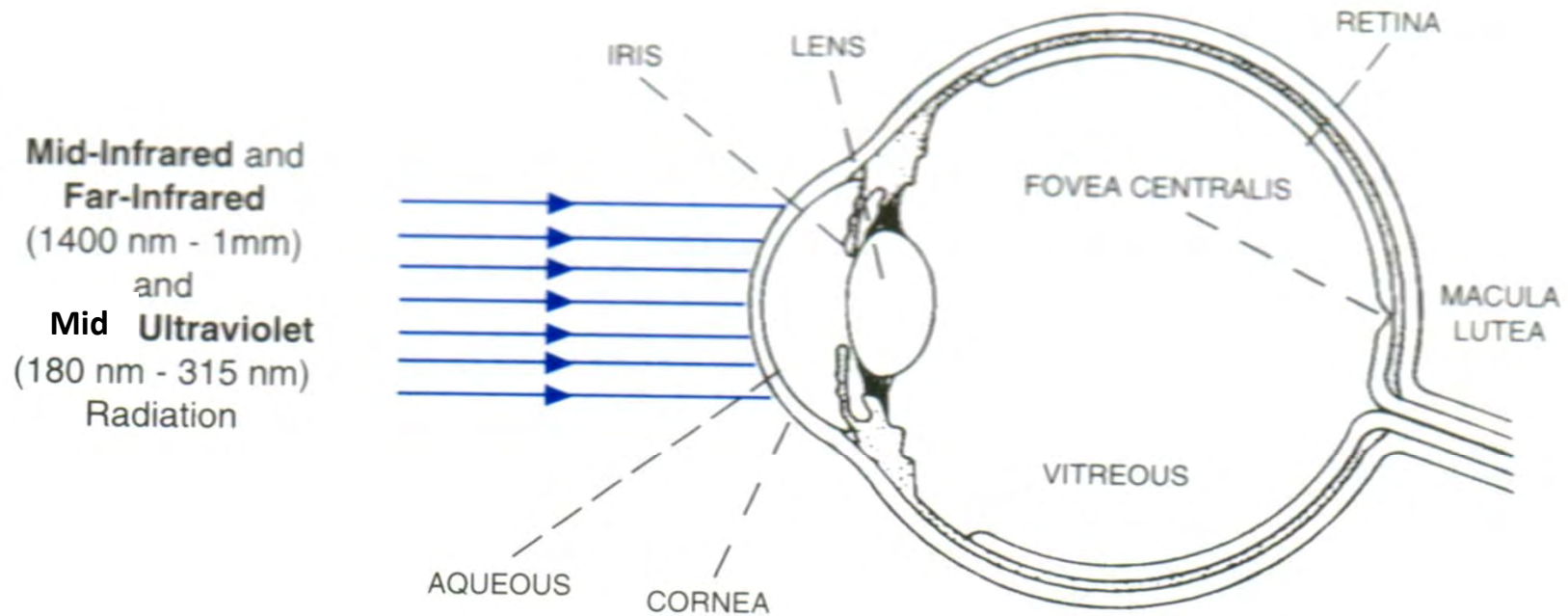
Some Class 3R  
- typically > 5mW

All Class 3B and 4

# Laser Safety Training

**Mid and Far Infrared - causes damage to the cornea by increased temperature in tears and tissue water.**

**Mid Ultraviolet – causes photokeratitis (welders flash)**



# Laser Safety Training



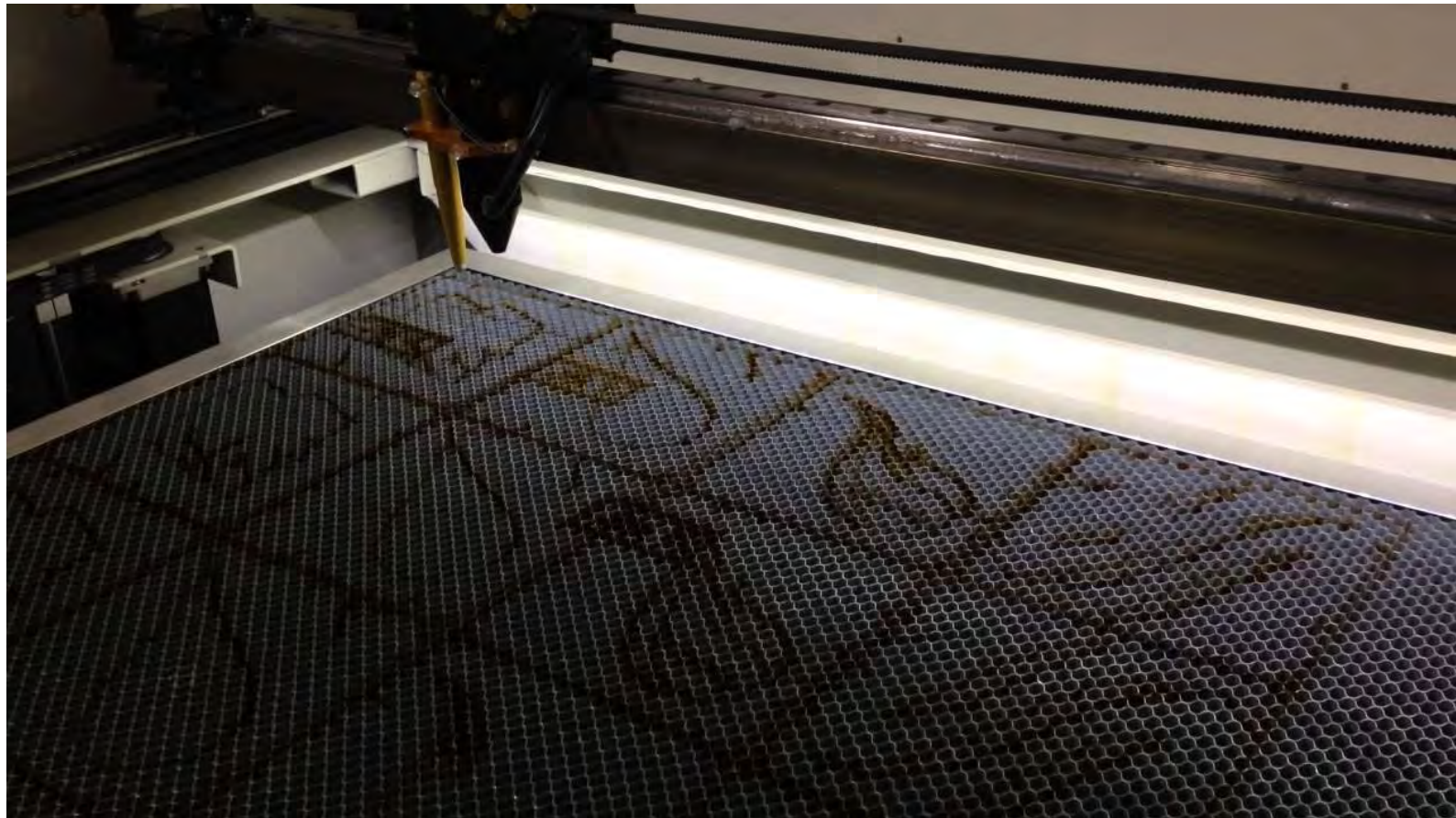
## Full Spectrum Laser P Series

- 90W CO<sub>2</sub> 10,600nm laser
- Water cooled
  - Distilled water
- Vented to house exhaust system
- Red laser for alignment
- Computer controlled



# Laser Safety Training

## Full Spectrum Laser P Series Work Surface





# Laser Safety Training

## Vision Impairments reported from overexposures to Class 2M or 3R (red) lasers

Symptoms reported to EH&S (vision recovered over time)

- Trouble focusing
- Watery eye
- Painful in bright light
- “Blank” spot in one eye when other eye is closed
- Gritty feeling when blinking
- Headache

Highly polished material can reflect the red aligning laser beam

# Laser Safety Training

Typical Thickness vs. Power  
Necessary to Cut Acrylic

| <u>Acrylic Thickness</u> | <u>Laser Power</u> |
|--------------------------|--------------------|
| 1/2 in.                  | 30 W               |
| 3/4 in.                  | 60 W               |
| 1 in.                    | 100 W              |

Full Spectrum Laser website states  
P-Series can cut up to 1/2 inch of  
plastic or wood with 90W laser

| Material        | Jameison 70W |           | GCC LaserPro GLS 80W |
|-----------------|--------------|-----------|----------------------|
|                 | Cutting      | Engraving |                      |
| Acrylic         | X            | X         | X                    |
| Anodized Al     |              | X         | X                    |
| Bare Metal*     |              | X         | X                    |
| Bamboo          |              |           | X                    |
| Brass*          |              | X         |                      |
| Brick           |              | X         |                      |
| Cardboard       | X            | X         | X                    |
| Ceramic         |              | X         | X                    |
| Coated Metals   |              | X         |                      |
| Composites      |              |           | X                    |
| Corian          |              | X         |                      |
| Cork            | X            | X         | X                    |
| Crystal         |              | X         |                      |
| Delrin          | X            | X         |                      |
| Fabric          | X            | X         | X                    |
| Fiberglass      |              |           | X                    |
| Glass           |              | X         | X                    |
| Leather         | X            | X         | X                    |
| Marble          |              | X         | X                    |
| MDF             | X            | X         |                      |
| Melamine        | X            | X         | X                    |
| Mirror          |              | X         |                      |
| Mylar           | X            | X         | X                    |
| Nylon           |              |           | X                    |
| Painted Metals  |              | X         | X                    |
| Paper           | X            | X         | X                    |
| Plastic         |              |           | X                    |
| Polyester       |              |           | X                    |
| Polyester Film  |              |           | X                    |
| Plywood         | X            | X         |                      |
| Polycarbonate   |              | X         |                      |
| Pressboard      | X            | X         | X                    |
| Rubber          | X            | X         | X                    |
| Silicon         |              |           | X                    |
| Slate           |              | X         |                      |
| Stainless Steel |              | X         |                      |
| Stone           |              |           | X                    |
| Styrene         |              |           | X                    |
| Titanium*       |              | X         |                      |
| Twill           | X            | X         |                      |
| Veneer          | X            | X         |                      |
| Vinyl           |              |           | X                    |
| Wood            | X            | X         | X                    |

*\*Can be marked using  
Cermark*

From Jameison  
website

**Please Note:**

**Lasering PVC , Vinyl  
or Teflon with any  
CO<sub>2</sub> laser will release  
corrosive and toxic  
fumes and will VOID  
the warrantee!**

CO<sub>2</sub> laser cutting resource:

[www.photomachining.com](http://www.photomachining.com)

Go to "News" then "Video"

# Laser Safety Training

## Eyewear and Shielding

Make sure you choose the **proper safety eyewear**.

For the CO<sub>2</sub> (10,200 – 10,800 nm) laser that is used for P-Series cutting machine, clear plastic safety glasses will stop the SCATTERED laser beam from hitting the eye

- must be plastic eyewear (polycarbonate)
  - glass eyewear will transmit light
- shatterproof (Z-87.1 rated)

Clear plastic strips of a 1/4 inch in thickness surrounding a CO<sub>2</sub> is an effective shield for stray (diffuse) beams when cutting large items

- in laser machine shops, clear, plastic strips or sheets hanging from the ceiling are used to shield diffuse beams
- not unlike the clear, plastic strips at a car wash entrance
- beware of reflectivity of surface you are cutting!

# Laser Safety Training



## Full Spectrum Laser P Series

- Red buttons do not kill cabinet power
- Ensure water level is not LOW
- Vented to dedicated exhaust system
  - No debris on spark arrestors
  - Exhaust fan is ON before cutting
- If there is smoke in the room, ventilation may be compromised
  - check lens for damage
  - check for scorch marks on belts
  - check for other scorch marks



# Laser Safety Training

## Before using the P-Series

- Ventilation must be ON
- Ensure the fire extinguisher is fully charged
- Ensure the cooling system does not need to be recharged with distilled water
- Ensure you see the location of the laser circuit breaker for emergency power-down
  - This is NOT on the laser itself but the separate power cut-off switch near the extinguisher
- Power the laser

# Fire Safety Review

In the event of a fire:

- Inform others of fire
- Kill power to the laser (not the “Emergency” switch on the laser)
- Leave the area
  - Follow lighted signs towards the exits
- Pull fire alarm
  - Fire alarms are typically located near exits
- Have a rally area so fire fighters can account for lost persons
  - DO NOT go home or leave the rally area

Use the CO<sub>2</sub> fire extinguisher **ONLY**. Remember **P - A - S - S**

- PULL the pin
- AIM the nozzle at the base of the fire
- SQUEEZE the handle
- SWEEP the nozzle from side to side

# Laser Safety Training

## Barriers and Shielding





# Laser Safety Training

- **If the LENS FAILS, leave the area immediately.**
  - ZnSe will most likely be vaporized
- **Call 545-2121 or 911 (UMPD).**
  - **Tell the operator that a potentially toxic substance has been released.**
  - **Tell the operator potential ZnSe release.**
- Laser lens (window) shattered, Orange, MA, December 4, 2012
  - Company manufactures metal valves and gates
- Elicited a Hazardous Materials Response
- Several workers in area tested for exposure to hazardous substance

# Laser Safety Training

## Laser generated aerosols

Care must be taken to prevent the inhalation of aerosols when using a laser to heat or burn any biological sample, metal, wood, plastic or other material.

- nanoparticle formation

Example: Particle board and medium density fiberboard (MDF) are created in the same way, though with different types of wood trimmings. Particle board is also made from ground-down wood particles such as sawdust. MDF is made from steam-separated fibers, which are dried and then mixed with a binder --- a resin that holds the wood debris together. This waxy resin is usually a synthetic compound called urea formaldehyde.

Proper ventilation (snorkel, vented enclosure) must be used when using a laser cutter to avoid excessive inhalation of smoke or aerosols produced during the cutting procedure.

# Laser Safety Training

## Laser generated aerosols

### **Viral Disease Transmitted by Laser-Generated Plume (Aerosol)**

Jerome M. Garden, MD; M. Kerry O'Banion, MD, PhD; Abnoeal D. Bakus, PhD; Carl Olson, DVM, PhD, Copyright **2002** American Medical Association. All Rights Reserved.

**Objective** To evaluate the possibility of disease transmission through liberated plume from virally infected tissue that is exposed to the carbon dioxide laser.

**Design** Bovine papillomavirus–induced cutaneous fibropapillomas were exposed to the carbon dioxide laser. Laser settings were within the range of clinically used settings. The laser plume (aerosol) was suctioned and collected and then reinoculated onto the skin of calves.

**Setting** University laboratory research center.

**Main Outcome Measures** Laser plume viral content and postinoculation tumor growth were analyzed and documented.

**Results** Collected laser plume contained papillomavirus DNA in all tested laser settings. The viral DNA was most likely encapsulated. Tumors developed at laser plume–inoculated sites for all laser parameter settings. Histological and biochemical analyses revealed that these tumors were infected with the same virus type as present in the laser plume.

**Conclusions :** **Laser plume has been shown, for the first time to our knowledge, to actually transmit disease.** Strict care must be maintained by the laser practitioner to minimize potential health risks, especially when treating viral-induced lesions or patients with viral disease.

# Laser Safety Training

## Any Laser Injury

If you have or suspect a laser eye injury:

- Call 5-2121 or 911 immediately
- Tell the operator that you need to be transported to the hospital
- Tell the operator to inform the ambulance crew that you have a laser eye injury.

If you feel ill and suspect an inhalation of a laser generated aerosol:

- Go to UHS and specify that the cause may be a laser generated aerosol
- Have information on the material that was burned or being cut by the laser

If you have or suspect a laser burn to the skin:

- Go to UHS if the burn is minor
- Call 5-2121 or 911 if the burn is major or if there is bleeding