

## Laser Cutters SOP

### Summary

This SOP outlines the requirements and best practices for use of laser cutters on campus. All users of laser cutters must complete the EH&S laser cutter training in OWL prior to unattended work with laser cutters. Laser hazards are based on laser hazard classes. Laser hazards are typically minimal with laser cutters because the laser is enclosed during operation. Alignment can lead to beam exposure and should only be performed by appropriately trained and qualified individuals. Ventilation is important for safe operation of laser cutters. Connections to exhaust should be evaluated by EH&S and qualified engineers to ensure these meet manufacturer's requirements. Use of filter boxes are prohibited and fume extractors may only be used after evaluation and approval by EH&S. All acquisitions of laser cutters must be reported to EH&S.

### **What are laser cutters?**

A laser cutter is a cutting device which focuses a high energy laser beam onto a material resulting in a high quality and dimensionally accurate cut. These devices can be used to cut, etch, engrave, or drill a variety of materials. Laser cutters are normally fully enclosed systems that prevent laser operation unless the safety interlocked doors are fully closed.



Source: <https://all3dp.com/2/what-is-a-laser-cutter-simply-explained/>

## What are the hazards?

Laser hazards are based on laser hazard classes. The laser hazard classes are displayed in table 1.

Table 1. Laser Hazard Classes

Class FDA	Class IEC	Laser Product Hazard	Product Example
I	1, 1M	Considered non-hazardous. Hazard increases if viewed with optical aids, including magnifiers, binoculars, or telescopes.	<ul style="list-style-type: none"> <li>▪ laser printers</li> <li>▪ CD players</li> <li>▪ DVD players</li> </ul>
IIa, II	2, 2M	Hazard increases when viewed directly for long periods of time. Hazard increases if viewed with optical aids.	<ul style="list-style-type: none"> <li>▪ bar code scanners</li> </ul>
IIa, II	2, 2M	Hazard increases when viewed directly for long periods of time. Hazard increases if viewed with optical aids.	<ul style="list-style-type: none"> <li>▪ bar code scanners</li> </ul>
IIIa	3R	Depending on power and beam area, can be momentarily hazardous when directly viewed or when staring directly at the beam with an unaided eye. Risk of injury increases when viewed with optical aids.	<ul style="list-style-type: none"> <li>▪ laser pointers</li> </ul>
IIIb	3B	Immediate skin hazard from direct beam and immediate eye hazard when viewed directly.	<ul style="list-style-type: none"> <li>▪ laser light show projectors</li> <li>▪ industrial lasers</li> <li>▪ research lasers</li> </ul>
IV	4	Immediate skin hazard and eye hazard from exposure to either the direct or reflected beam; may also present a fire hazard.	<ul style="list-style-type: none"> <li>▪ laser light show projectors</li> <li>▪ industrial lasers</li> <li>▪ research lasers</li> <li>▪ medical device lasers for eye surgery or skin treatments</li> </ul>

Since they are fully enclosed and interlocked systems, laser cutters are normally a low risk, Class 1 laser in accordance with ANSI Z136.1 Safe Use of Lasers. These devices are safe when used as designed without manipulating the safety features. The lasers embedded inside the enclosed system are often Class 3B or Class 4 lasers. Safety interlocks should never be bypassed or manipulated since the high energy laser beams are capable of causing serious eye and skin injury if the beam is not contained or enclosed. If beam alignment is necessary, it should only be performed by technically qualified individuals who have received the appropriate training.

Laser cutters may generate fumes, vapors, particulates, and metal fumes from substrate that can be toxic (plastics and other combustible materials). These fumes or air contaminants can damage the machine and harm your health. As such, laser cutters typically require exhaust connections and should only be used in well ventilated areas.

## **Occupational Exposure Limits**

For laser exposure limits, please refer to FDA criteria for medical lasers or ANSI Z136.1, which can also be found in OSHA Technical Manual (OTM) Section III, Chapter 6, Laser Hazards ([https://www.osha.gov/dts/osta/otm/otm\\_iii/otm\\_iii\\_6.html](https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html)): Section V. Investigational Guidelines, Part B. Laser Exposure Limits. Please contact the UMass Laser Safety Officer for exposure evaluations.

For laser generated air contaminants, compressed gases, and laser dyes, please refer to OSHA 1910.1000 Table Z-1 (<https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1000TABLEZ1>), NIOSH Pocket Guide to Chemical Hazards (<https://www.cdc.gov/niosh/npg/npgd0473.html>) and ACGIH® 2021 Threshold Limit Values for more information. You can also reach out to EH&S with any questions.

## **What Activities Could Pose a Risk?**

- Cutting materials that are highly flammable, explosive or produce toxic byproducts, such as PVC, Corrugated Plastic, ABS, PLA, HDPE, PET, PETG, Delrin, etc. can cause fire, explosion or exposure to toxic plumes.
- Operating laser cutters without appropriate training.
- Leaving the laser cutter operating unattended.
- Placing laser cutter on a wooden surface.
- Looking directly into the laser beam.
- Inadequate cleaning or vacuuming of the work area or the internal cavity of the laser cutter.
- Defeating, modifying or disabling the safety features of the laser cutter.
- Removing material from the cutting bed before it has cooled.
- Using a laser cutter with a malfunctioning exhaust system or clogged air filter.
- Operating laser cutters without pre-inspections.
- Wearing reflective jewelry such as watches, rings, necklaces, and keeping reflective objects around laser cutters such as high gloss paints, metal containers and objects with a highly reflective finish.
- Using filter boxes or fume extractors to replace hazardous exhaust ventilation.
- Operating the laser cutter without the cover in place.

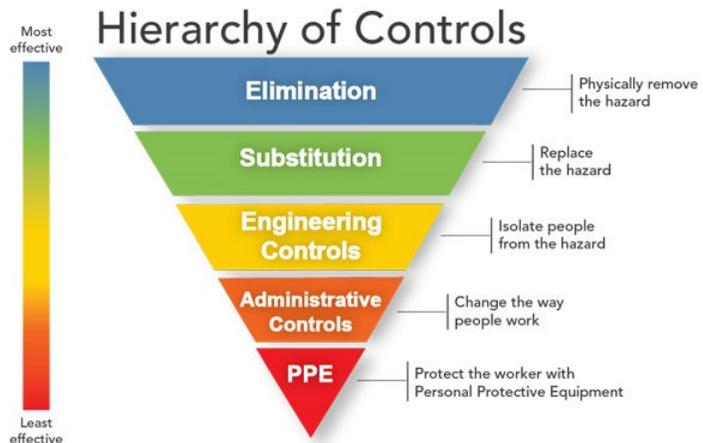
## **How Can Exposures Be Minimized?**

When working with laser cutters, or any other hazardous material, always conduct a thorough risk assessment and employ the hierarchy of controls to minimize risk. Some specific applications of the hierarchy of controls to the hazards of laser cutters are listed below. Always apply the controls in the

order of most effective to least effective (see graphic), and apply as many controls as possible to reduce the risk to the lowest achievable level.

### Elimination/Substitution

- Whenever possible, using lower class lasers instead of class 3B and class 4 lasers.
- The use of dimethylsulfoxide (DMSO) as a solvent for cyanide dyes in dye lasers should be discontinued, if possible. DMSO has the ability to penetrate the skin barrier and provide direct exposure to any solutes. DMSO also readily permeates many different types of glove material.
- Do not use materials that are highly flammable, explosive or produce toxic byproducts. Only use materials can be safely cut, such as natural wood, marble, glass, plywood, etc. Some materials such as PVC produce hydrogen chloride gas which is extremely dangerous. Please contact EH&S if you are unsure if the material is safe to cut.



### Engineering Controls

- **Filter boxes are not allowed to be used to replace hazardous exhaust ventilation. Fume extractors can only be used with evaluation and approval from EH&S.**
- Do not use a laser cutter with malfunctioning ventilation system. Always check the ventilation system is on before turning on the laser cutter. Preparation of dye solutions should be conducted in a fume hood when solvents are used.
- All covers should be in place when operating laser cutters.

### Administrative Controls

- Pl's must inform the laser safety officer when they purchase a new laser cutter. Please send information on the laser cutter including manufacturer and model number to EH&S at [askehs@umass.edu](mailto:askehs@umass.edu).
- Risk assessments must be performed by the laser safety officer in line with ANSI standards before setting up the laser cutter. EH&S must also evaluate and approve exhaust connections prior to installation.
- Do not wear reflective jewelry or keep reflective objects around laser cutters.
- Please follow the compressed gases SOP (<https://ehs.umass.edu/compressed-gases>) while using compressed gases.
- Written standard procedures for operation, service, and maintenance of the laser cutter shall be developed by the Principal Investigator and observed.
- All individuals who will operate or service the laser cutter shall be provided with training which includes information on the potential hazards and the appropriate controls to be utilized in minimizing these hazard before using laser cutters. EH&S training on laser cutters must be completed through OWL.

- ANSI Z136.1 requires that lasers and laser systems have appropriate warning labels and that the areas in which they operate be posted with appropriate warning signs.
- Always follow the manufacturer's instructions when operating a laser cutter.
- A fire extinguisher should be available near the laser cutter. Typically, carbon dioxide (CO<sub>2</sub>) fire extinguishers should be used.
- Always keep the area around the cutter free of debris, clutter and flammable materials before and after each use. Regular vacuuming of the cutting deck and the internal cavity of the laser cutter can help to prevent fires.
- Never leave an operating laser cutter unattended.
- Avoid placing laser cutters on wooden surfaces.
- Never defeat laser interlocks built into the cutter or modify or disable any safety features, which could allow the beam to escape from the laser cutter.
- Before operating the laser cutter, inspect the covers and interlocks first. Do not operate the laser cutter unless all covers are in place and interlocks are working properly.
- Do not remove material from the cutting bed before it has cooled.

### Personal Protective Equipment

- Personal protective equipment, such as appropriate gloves, and eye protection (safety glasses) are necessary when preparing solutions.
- If you need help with selecting hearing protection, please contact the hearing conservation program (<https://ehs.umass.edu/hearing-conservation-program>) for more information.

### Waste Handling

All lab waste containing metal powders or solvents should be handled as hazardous waste. This includes contaminated debris (e.g. PPE, plastic, bench covers). Contaminated waste should be placed in an appropriate container and labeled. The label should indicate relative amounts (by percentage) of all constituents within the waste container. Complete a Hazardous Materials Pickup Request Form in CEMS to have the waste collected by EH&S staff.

### Exposure and Spill Procedure

In the event exhaust ventilation stops and/or there is smoke in the room:

- Kill power to the laser
  - Use the switch on the laser or emergency switch
- Evacuate the room, closing the door behind you.
- Activate the building fire alarm and proceed to the nearest exit.
- Call EH&S at (413)-545-2682 to report the nature of the incident.

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

Notify EH&S (413-545-2682) as soon as possible in the event of any exposure or injury and complete the lab incident form (<https://ehs.umass.edu/lab-incidents-and-lab-incident-report-form>).

### **References and Additional Resources**

1. UMass Amherst Laser Safety Manual. <https://ehs.umass.edu/laser-safety-manual>
2. FDA, Laser Products and Instruments. <https://www.fda.gov/radiation-emitting-products/home-business-and-entertainment-products/laser-products-and-instruments>
3. American National Standards Institute (ANSI), American National Standard for Safe Use of Lasers, ANSI Z136.1-2014.
4. OSHA Technical Manual (OTM), Section III, Chapter 6: Laser Hazards. [https://www.osha.gov/dts/osta/otm/otm\\_iii/otm\\_iii\\_6.html](https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html)
5. MRCP Regulation 105CMR120.000, Laser System. <https://www.mass.gov/regulations/105-CMR-12100-to-control-the-radiation-hazards-of-lasers-laser-systems-and-optical>
6. MIT Laser Cutter Safety: <https://ehs.mit.edu/workplace-safety-program/laser-cutter-safety/>
7. University of Washington Laser Cutter Safety: <https://www.ehs.washington.edu/system/files/resources/laser-cutter-safety.pdf>