



LASER CUTTERS

Safety Guidance

Stanford | Environmental
Health & Safety
Research Safety

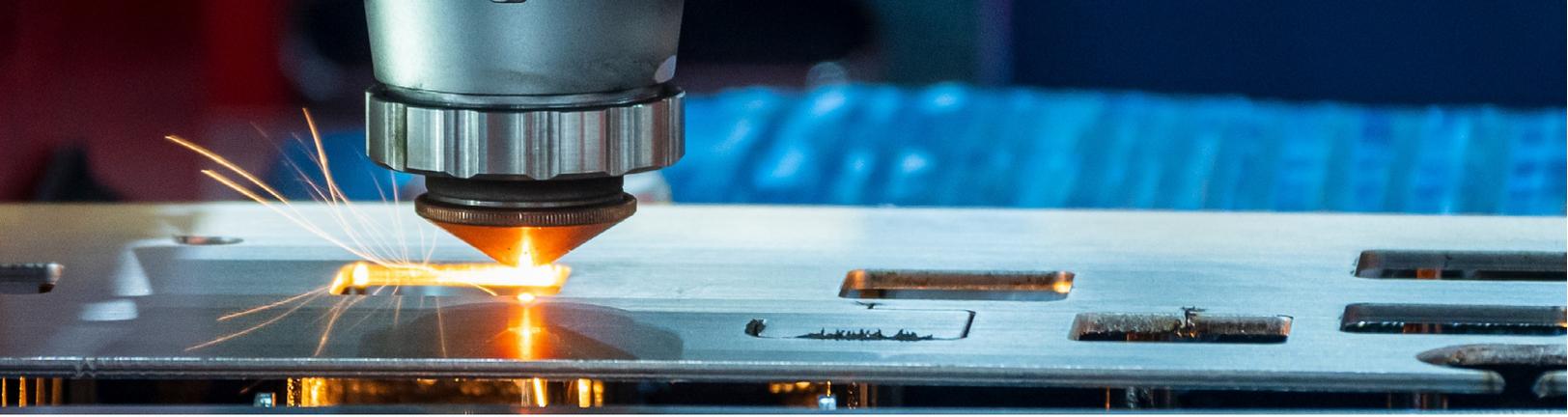


Table of Contents

1. Safety Guidance
2. Laser Cutter Setup and Use Checklist
3. Laser Cutter Warning Sign

Laser Cutters

Safety Guidance

Laser cutting devices are versatile tools that utilize a thermal process with a focused laser beam to engrave, drill, or cut a variety of substrate materials such as metals, wood, acrylics, and other plastics, with incredible accuracy and efficiency, from a 2D computer design. There are certain materials that should not be cut with a laser cutter (listed below) due to their chemical makeup – which if cut can generate dangerous vapors or particulates. This guidance document will cover substrate material compatibility, laser cutter hazards, and safety measures when using a laser cutter. This guidance applies to all Stanford faculty, staff, and students who operate laser cutters.

Laser Cutter Hazards

A) Fire Hazard: The high energy laser beam can produce extremely high temperatures and heat, as the substrate material is burned, melted, and vaporized during engraving, cutting, or drilling. Some substrate materials can catch fire while performing these operations, creating fumes and smoke inside the device. Some of the contributing factors to the fire hazard include but are not limited to:

- Use of unsuitable substrate material
- Insufficient exhaust ventilation
- Incorrect pulse and power settings
- Uncleaned optics and laser cutter
- **Not watching** the laser cutter while in operation

B) Respiratory Hazard: Laser cutters generate high heat as it melts, burns, vaporizes substrate material and will generate fumes, vapors, and particulates which can pose a health risk to those in the area.

C) Laser Hazard: Majority of laser cutters are inside enclosures, (i.e., protective housing and interlocks), which reduces the hazard of a Class 3B or Class 4 lasers to Class 1 lasers as per the *American National Standard Institute (ANSI) standard Z136.1 “Safe Use of Lasers”*.

D) Sharp Edges: Sharp or uneven edges can be created on substrate materials processed within the laser cutter. This can lead to skin injuries including cuts or abrasions.

Substrate Material

Spaces with laser cutters should develop a list of allowable and prohibited substrate materials based on the make, model, and type of the laser cutter used in their respective spaces.

Consider the following:

- Cutting certain materials can generate hazardous air contaminants including both hazardous gases and particulate matter that can pose a health risk to those in the area. The type of contaminant generated depends on the type of material (plastics, PVC, etc.) that is used under the laser.
 - Examples include airborne benzene, hydrochloric acid, isocyanates, toluene, and other hazardous by-products.

- Consider including thickness parameters with substrate materials. For example Delrin should only be cut as thin sheets; polycarbonate cuts poorly and generates soot; foam core can cause fire, etc. Take care with combustible materials like polyethylene (PE) and high-density polyethylene (HDPE).
- Material libraries developed by manufacturers such as [ULS](#), [Epilog](#), [Trotec](#) can be referenced to evaluate if a material can be used for laser processing. (Note: Use these libraries with caution as they may not exclude materials that are flammable or provide thickness limits.)
- Contact EH&S at 650-723-0448 for questions about hazardous vapors and fumes from materials.

Substrate Material and Associated Air Contaminants Table

Material	Potential Air Contaminants
PVC, neoprene (Chlorine-containing polymers)	Chlorine gas, HCl (Toxic and Corrosive)
Teflon	Fluorine gas, HF (Toxic and Corrosive)
Acrylonitrile butadiene styrene (ABS)	Styrene (Skin/eye irritant, Inhalation toxicity, reproductive toxicity) Hydrogen cyanide (Highly acutely toxic)
Polystyrene	Styrene (Skin/eye irritant, Inhalation toxicity, reproductive toxicity)
Nylon, polyurethane, some acrylics	Hydrogen cyanide (Highly acutely toxic)
Fiberglass composites	Styrene (Skin/eye irritant, Inhalation toxicity, reproductive toxicity) Benzene (Carcinogen, germ cell mutagen, skin/eye irritant)
Carbon fibers	Fine particulate
Delrin	Formaldehyde
Plywood, MDF	Formaldehyde

Safety Measures

Engineering Controls:

- Laser cutters shall only be used in well-ventilated working areas that have a dedicated exhaust to the outside, which may be supplemented with an appropriate air filtration system. Follow the manufacturer's specifications. EHS is available to assess ventilation and air filtration selection.
- All ventilation controls must be functioning and operational prior to and for the duration of the project.
- Ensure safety interlocks are properly operating and never by-passed.
- Purchase and use the air assist feature, which is often sold as an optional add-on. Air assist reduces fire risk.
- Only manufacturer-trained personnel should perform maintenance on the device.

Administrative Controls:

- Adhere to all manufacturer's safety guidelines prior to and while operating the unit.
- Always keep the area/room and the inside of the laser cutter clean and free from debris. Use a HEPA-filtered vacuum to regularly clean the laser cutter bed.
- Keep the lid closed for a few minutes after each run before opening the lid, to allow airborne contaminants to purge.
- Always keep a fire extinguisher (e.g., ABC, carbon dioxide, or Halotron) close by while the unit is in operation.
- Ensure ventilation system filters are changed per the manufacturer's schedule by qualified personnel.
- Consult any safety data sheets (SDS) for all materials being processed in laser cutters.
- Always attend the laser cutter while it is operating.
- Post a list of acceptable and unacceptable materials next to the laser cutter. Include appropriate laser settings for each material.
- Ensure to post the signage for laser cutter.
- Use the Laser Cutter Setup and Use Checklist prior to using a laser cutter.
- Ensure all training is completed by users prior to using the unit and documented.
- Never engrave, cut, drill, or heat the following materials. Processing these materials can generate dangerous vapors or particulates:
 - Polyvinyl chloride (PVC)
 - Polyvinyl butyral (PVB)
 - Polytetrafluoroethylenes (PTFE/Teflon)
 - Beryllium Oxide
 - Any materials containing halogens, epoxy or phenolic resins
 - Carbon fibers

Personal Protective Equipment (PPE):

- Laser cutters shall only be used in well-ventilated working areas that have a dedicated exhaust to the outside, which may be supplemented with an appropriate air filtration system. Follow the

manufacturer's specifications. EHS is available to assess ventilation and air filtration selection.

- All ventilation controls must be functioning and operational prior to and for the duration of the project.
- Ensure safety interlocks are properly operating and never by-passed.
- Purchase and use the air assist feature, which is often sold as an optional add-on. Air assist reduces fire risk.
- Only manufacturer-trained personnel should perform maintenance on the device.

Summary General Safe Work Practices

1. When purchasing laser cutters, only use reputable commercial manufacturers that have interlocked enclosure, emergency power off, air assist*, and other safety features.
2. A good quality assurance is purchasing equipment that has been listed or labeled by UL or [Nationally Recognized Testing Laboratory \(NRTL\)](#).
3. Before using a laser cutter, ensure that the researchers/users are trained by a qualified individual.
4. Develop a written SOP for each laser cutter model incorporating use parameters, control measures, Personal Protective Equipment (PPE), training, maintenance, user log, allowed substrate material, hours of use, work alone policy etc.
5. Develop a list of allowable and prohibited materials. Have a process in place to vet new materials prior to use.
6. Avoid placing the laser cutter on wood and other combustible surfaces.
7. Keep the area around the laser cutter free of flammable or combustible materials.
8. Do not obscure the viewing window.
9. **Never** leave an operating laser cutter unattended.
10. A fire extinguisher (e.g., ABC, carbon dioxide, or Halotron) should be mounted on the wall near the laser cutter.
11. Regular vacuuming of the cutting deck and the internal cavity of the laser cutter for preventing fires.
12. Know how setting the pulse rate of the laser affects the chance of a fire.
13. Do not tamper with laser interlocks built into the cutter. This could allow the beam to escape.
14. Leave material on the cutting bed until it is cool to the touch.

**Air assist: This safety feature provides compressed air to remove debris and heat at the laser cut point which can be helpful in preventing flare-ups and charring especially for more combustible materials.*

References

- Bates-Green, K., & Howie, T. (n.d.). Materials for Laser Cutter Machines. MatEdu National Resource Center. https://www.materialseducation.org/educators/matedu-modules/docs/Laser_Cutter_Materials.pdf
- Environmental Health and Safety. University of Florida. Laser cutter/Engraver Guide. <https://www.ehs.ufl.edu/wp-content/uploads/2021/06/Laser-Cutter-Guide.pdf>
- Massachusetts Institute of Technology. Laser Cutter Safety. EHS. (n.d.). <https://ehs.mit.edu/workplace-safety-program/laser-cutter-safety/>
- Stanford University. Laser Cutters. Making @ Stanford. (n.d.). <https://making.stanford.edu/resources/process-guides/laser-cutting>

University of Massachusetts Amherst. Laser Cutters SOP. EHS. (2022). <https://ehs.umass.edu/laser-cutters-sop>

University of Washington. Laser Cutter Safety. EHS. (3/3/2023). <https://www.ehs.washington.edu/resource/laser-cutter-safety-focus-sheet-1357>

Yale Environmental Health and Safety. Shop Safety Procedure for laser cutters. (n.d.). <https://ehs.yale.edu/sites/default/files/files/laser-cutter.pdf>

Laser Cutter Setup and Use Checklist

Laser Cutter Setup

- Verify the material is safe to use on the laser cutter and has appropriate thickness and geometry.
- Prepare the 2D computer design file.
- Identify the appropriate laser settings for the material.
- Remove any protective coatings from the workpiece, which can cause flare-ups.
- Secure loose clothing and hair.
- Put on ANSI approved safety glasses.
- Confirm the location of the nearest exit and fire extinguisher.
- Confirm completion of SU fire extinguisher training.

At the Laser Cutter

- Clean the laser cutter bed with vacuum equipped with HEPA filter prior to use.
- Turn on the local exhaust and/or filter.
- Follow shop procedures to place the workpiece and operate the laser cutter.
- Close the lid and ensure that all interlocks are satisfied (no flashing lights).
- Turn on the Air Assist.
- Observe the laser cutting operations without staring at the beam.
- Do not leave the laser cutter unattended while in operation.
- Ensure there are no flare-ups and all flames self-extinguish. If flames persist, press the Emergency Stop button.
- After the cut is completed, wait several minutes prior to opening the lid to allow the workpiece to cool and fumes to purge.
- Ensure that the workpiece has cooled before removing it. If the workpiece has sharp edges use cut resistant gloves.

After Cutting

- Allow the exhaust fan to run for several minutes.
- Clean the laser cutter bed of scraps and vacuum with a HEPA-filtered vacuum.
- Record laser cutter use on a local logbook.
- Report any issues or unexpected observations to the PI or local shop supervisor.

WARNING

LASER CUTTER IN USE



General Safe Operation Practices for Laser Cutters:

- Before using a laser cutter, ensure you are trained by a qualified individual.
- Always follow the manufacturer's instructions while using a laser cutter.
- Avoid placing the laser cutter on wood and other combustible surfaces.
- Keep the area around the laser cutter free of flammable or combustible materials.
- Know how setting the pulse rate of the laser affects the chances of a fire.
- Do not obscure the viewing window.
- Never leave an operating laser cutter unattended.
- Know what materials can be safely used for your laser cutter.
- A fire extinguisher should be mounted on the wall near the laser cutter.
- Regular vacuuming of the cutting deck and the internal cavity of the laser cutter for fire prevention.
- Do not tamper with laser interlocks built into the cutter. This could allow the beam to escape.

For additional laser cutter safety information, scan this QR code:



Lab Contact Name, Phone Number: _____

Laser Safety Officer: Arzu Ozkan, (650) 498-9904