

University of Kentucky 3-D Printing Safety Guidelines

1. Purpose

These guidelines have been developed to cover general procedures for the safe use and operation of 3D printers.

2. Scope

This guideline applies to all University of Kentucky faculty, staff and students that use and operate 3D Printers.

3. Introduction

3D printing, an additive manufacturing technology, has made rapid prototyping and small-scale manufacturing easier and more accessible. However, this advancement is not without risks.

4. Roles and Responsibilities

- a. UK Environmental Health and Safety (EHS) is responsible for:
 - i. Developing the written 3D Printing Guidelines and revising as necessary;
 - ii. Completing risk assessments and reviewing manufacturer's instructions and any applicable Safety Data Sheets (SDS) when new 3D printers are obtained;
 - iii. Conducting routine inspections to ensure the proper use and operation of 3D Printers.
- b. Departments will be responsible for:
 - i. Understanding and complying with the requirements of this guideline;
 - ii. Contacting EHS when a new 3D Printer is obtained, providing the manufacturer's instructions, SDSs and assisting in the hazard assessment review;
 - iii. Ensuring the safe use and operation of 3D Printers according to these Guidelines;
 - iv. Maintaining a clean and dust free work area in rooms where 3D Printers are housed; and
 - v. Contacting EHS if assistance is needed.
- c. Faculty, Staff and Students will be responsible for:
 - i. Completing training as necessary.
 - ii. Complying with the procedures outlined in these Guidelines; and
 - iii. Informing their supervisor/manager of the space (faculty or staff) of any problems, defective equipment or any other issues relating to 3D Printers and associated equipment.

5. Risks

The risks addressed by this guideline include, but are not limited to, the following:

a. Exposure to Nanoparticles

In some 3D printing processes, thermoplastics are heated, nozzle-extruded and then deposited onto a surface to build the object. As a by-product of the process, nanoparticles (ultrafine particles less than 1/10,000 of a millimeter) are emitted.

Nanoparticles are of concern because they are very small, have large surface areas and can interact with the body's systems, including the skin, lungs, nerves and the brain.

b. **Exposure to Volatile Organic Compounds**

3D printing can release several volatile organic compounds (VOCs) including, but not limited to, acrylonitrile; 1, 3-butadiene; styrene aldehydes, including formaldehyde, acetaldehyde and isovaleraldehyde; some phthalates such as DEP, DBP, and DEHP; and VOCs such as toluene and ethylbenzene^{[2][3]}.

c. **Flammable and Reactive Dusts**

Reactive and highly combustible powdered metals are used in the fabrication of 3D-printed metal alloy tools and parts. Finely divided metal powders, such as titanium and aluminum, can spontaneously combust causing fires (pyrophoric).

d. **Other Chemical Hazards**

The thermoplastics used for 3D printing can be flammable, cause irritation, skin sensitivity and may contain small amounts of toxic components. Further, caustics such as sodium hydroxide, are sometimes used for chemical dissolution of support material.

e. **Exposure to Hot Surfaces**

3D printers may contain hot surfaces which can lead to skin injury. These surfaces include the heat block and the UV lamp.

f. **Exposure to High Voltage**

3D printers are high voltage pieces of equipment and interaction with the UV lamp power supply or the printer power supply may result in exposure to high voltage.

g. **Exposure to UV Radiation**

Some 3D printers are equipped with UV light sources to harden resins, photopolymers and other materials. Exposure to this light source can damage eyes, lead to reddening of the skin and other effects.

h. **Exposure to Sharps**

To remove the support material, spatulas, razors, scalpels and other sharps are commonly used. This can lead to cuts, abrasions and other skin injuries.

6. Risk Controls

a. **Engineering controls**

- i. Areas where plastics, reactive metals and toxic support materials are used must be well ventilated (at least 6 air changers per hour) to reduce personnel exposures and the risk of fire or explosion.
- ii. 3D printers should only be used in work areas having a dedicated exhaust or appropriate air filtration system.
- iii. In the absence of enclosure/ventilation, the placement of 3D printers in any area should be reviewed by EHS before proceeding. EHS will review information including, but not be limited to, the printing method, type(s) of printing materials used, size of the area and operating parameters of the area ventilation system.
- iv. Areas where printing materials are handled or cured and/or where caustic support material is cleaned or removed should also be ventilated to control hazardous emissions.

b. **Administrative controls**

- i. Follow the manufacturer's documentation for safe use of 3D printers.
- ii. Consult Safety Data Sheet (SDS) for all materials being used in the 3D printing process.
- iii. Purchase and use the manufacturers supplied controls, such as an interlocked enclosure. (Enclosures appear to be more effective at controlling emissions than just a machine cover.)
- iv. Maintain a safe distance from the printer to minimize the inhalation of emitted particles.
- v. Maintain a clean and dust free working area in rooms where 3D printers are housed.
- vi. Turn off the printer if the printer nozzle jams and allow the printer to ventilate before removing the cover.

c. **Training for users** (faculty, staff and students)

- i. Training on the safe use of 3-D printing must be documented by labs with them in use.
- ii. Chemical Hygiene and Hazardous Waste training must be completed by users in areas that are defined by the [Occupational Health and Safety Administration](#) as a laboratory.
- iii. Hazard Communication training must be completed by users in those areas not defined by the Occupational Health and Safety Administration as a laboratory.
- iv. Biological Safety training must be completed by users to print biological materials requiring BSL-2 containment.
- v. Fire extinguisher training should be completed by all laboratory personnel

d. **Personal Protective Equipment (PPE)**

- i. Eye Protection
 1. Face shields and/or chemical safety goggles must be worn when using caustic materials.
 2. Safety glasses must be worn when the potential for creation of projectiles exists.
- ii. Gloves
 1. Chemical-resistant gloves appropriate for the chemical in use must be worn when handling chemicals or irritants/sensitizers.
 2. Heat-resistant gloves must be worn when there is the potential to come into contact with the print head block or UV lamp.
 3. Abrasion-resistant gloves must be worn when using sharps and other jagged items to remove support media.
- iii. Laboratory coat or apron
 1. Lab coats or aprons must be used when using caustic materials.
- iv. Respiratory Protection
 1. Negative pressure air-purifying respirators must be worn when loading, leveling, changing filters, extracting or cleaning that involves pyrophoric and reactive materials.
 2. Respiratory protection may also be indicated based on a risk assessment.
 3. Personnel wearing respiratory protection must be enrolled in the University's Respiratory Protection Program, see <https://ohs.uky.edu/industrial-hygiene/respiratory-protection> for more information.
- v. Emergency Equipment
 1. Class D fire extinguishers must be present in all areas with powdered metals.
 2. Dry powder or CO2 fire extinguishers must be present in all other areas.
 3. Emergency eyewashes and showers should be present in all areas and must be present

in areas with caustics and powdered metals.

7. Waste Disposal

a. Chemical Waste

- i. All chemical waste, including caustic baths, must be disposed of through the University's Hazardous Waste Program (E-trax).
- ii. Please visit the [UK EQMD Hazardous Waste webpage](#) for additional information.

b. Powered Metals

- i. Powered metals used in 3D Printing are often considered hazardous because of their small mesh size. Usually classified as toxic, powered metals are also highly flammable and even potentially reactive.
- ii. Contact UK EQMD (859.323.6280) for guidance on collecting waste metal powders.
- iii. Additionally, the 3D Printing Machine filters are also considered hazardous. Follow the manufacturer's SOP for change-out and contact UK EQMD (859.323.6280) for assistance with disposal.

c. Sharps

All sharps must be disposed of in a sharps container appropriate for the type of contamination present on the sharp.

d. Biological Materials

All biological wastes must be disposed of through via chemical decontamination, autoclaving, or pick up by UK EQMD.

8. Emergency Procedures

a. Personal Injury or Contamination - [Follow established injury reporting procedures](#)

- i. For small burns, keep affected area clean and apply burn cream or antibiotic ointment if accessible.
- ii. For eye contamination, flush with an eyewash for 15 minutes
- iii. For localized skin contamination, wash the impacted area with soap and water
- iv. For widespread contamination, remove contaminated clothing and shoes and flush body with an emergency safety shower. Contact EQMD (859.323.6280) and/or University Police by dialing 911 from a campus phone.

b. Small Chemical Spills

- i. Alert people in the immediate area of the spill.
- ii. Avoid breathing vapors from the spill.
- iii. Wear protective clothing and gloves when addressing spills.
- iv. Confine spills to a small area.
- v. Use the appropriate spill kit.
- vi. Collect the residue, place in labeled container and contact UK EQMD (or use E-trax) disposal as hazardous waste.
- vii. Clean the spill area.

c. **Large Chemical Spills**

- i. Alert people in the immediate area of the spill.
- ii. Attend to your own needs first and then assist injured or contaminated people.
- iii. Control the spread of contamination if safe to do so.
- iv. Keep people away from the location.
- v. Stop work, turn off equipment, and close doors as you exit.
- vi. Evacuate to a safe location.
- vii. Contact UK EQMD at (859.323.6280) and/or University Police by dialing 911 from a campus phone.
- viii. If possible to remain safely, stay in a nearby unaffected area to inform emergency responders of:
 1. Number and extent of injured people;
 2. Name(s) of chemicals involved, and volume; and
 3. Hazards associated with the material(s).

d. **Powdered Metal Spills**

- i. Clean up powder with a spark-resistant vacuum equipped with High Efficiency Particulate Air (HEPA) filtration.

e. **Small Fires** (a fire the size of a typical household wastebasket)

- i. Keep the exit at your back.
- ii. Use the nearest fire extinguisher.
- iii. Pull the pin to break the seal.
- iv. Aim at the base of the fire.
- v. Squeeze handle grips or trigger.
- vi. Sweep the fire, spraying side-to-side at the base of the flames.
- vii. Ventilate the area after the fire is completely extinguished
- viii. Contact the UK Fire Marshal's office (859.257.6326) and report location, injuries and other hazards.

f. **Large Fires** (a fire larger than the size of a typical household wastebasket)

- i. Activate the nearest fire alarm pull station and alert others.
- ii. If safe to do so, assist others who may be in danger. However, do not put yourself at risk.
- iii. Evacuate the area, use stairs and close doors behind you.
- iv. Call 911 from a campus phone to initiate emergency response, then the UK Fire Marshal (859.257.6326) to report location, injuries and other hazards.
- v. Move away from the building exterior and assemble with floor marshal.
- vi. Inform emergency responders of any hazards, injuries, or locations of persons remaining inside.
- vii. Remain outside the building until cleared for re-entry.

For additional information, contact labsafety@uky.edu