THE UNIVERSITY OF ALABAMA® | Division of Finance and Operations
Environmental Health and Safety

Guidelines and Procedures for 3D Printers and Printing

Environmental Health and Safety
1500 Warrior Drive
Box 870178
Tuscaloosa, AL 35487
205-348-5905

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The following serve as guidance to assist UA campus members in the safe use of 3D printers and the 3D printing process. These guidelines are not intended to be all inclusive as each situation may present unique circumstances and require tailored guidelines. As such, use of 3D printers at UA must always be a collaborative effort between EHS and campus partners as well as the users. Refer to the 3D Printing Policy for UA policies governing safe use of 3D printers and the printing process.

Definitions

3D Printing:	The process of creating solid, three-dimensional objects by the deposition of material (by laying down successive layers of material), which is commonly a plastic, in accordance with specifications provided in an electronic form as a digital model. Also known as additive manufacturing.
ANSI:	American National Standards Institute
CAN:	Canada – refers to the Standards Council of Canada
Chemical vapors:	Vapor or gas-phase particles derived from a chemical that is normally in a liquid or solid state.
IFC:	International Fire Code
Nano-sized particle:	A nano-sized particle is a small particle that is undetectable by the human eye and measures between 1 and 100 nanometers.
NFPA:	National Fire Protection Association.
UL:	Underwriters Laboratories
Ultrafine particles:	Particulate matter of nanoscale size which is generally less than 0.1 micrometer (µm) or 100 nanometer (nm) in diameter.
User:	Any individual involved in installation, use, and operation of a 3D printer at UA.

General Information

3D printing, also commonly referred to as additive manufacturing, is the process of creating solid, three-dimensional objects by the deposition of material (by laying down successive layers of material), which is commonly a plastic, in accordance with specifications provided in an electronic form as a digital model. 3D printing has allowed for rapid prototyping and small-scale manufacturing to become easier and accessible. 3D printers are commonly found in research laboratories and libraries on campus. 3D printing is now being used in industries such as aerospace, automotive, electronic, and medical fields.

3D printing is becoming more accessible at the University of Alabama. Unfortunately, the 3D printing advancement has risks associated with its use. Research has indicated the presence of potentially harmful concentrations of ultrafine or nano-sized particles and chemical vapors when using 3D printers. In addition to exposure to nanoparticles and volatile organic compounds, other hazards exist in relation to the use of 3D printers, including, but not limited to, chemical hazards, flammable and reactive dusts,

exposure to hot surfaces, exposure to high voltage, exposure to UV radiation, exposure to lasers, exposures to chemical baths, or exposure to sharps, etc.

All 3D printing variations have the potential to create health and safety hazards depending on the media material utilized and the other processes involved in the printing. The amount of contaminant produced depends on the type of media used, the extruder nozzle temperature, and any additives present in the media.

Print Media

Most nonindustrial additive manufacturing operations are only permitted to use plastic filament production materials that are listed with the 3D printer and that are identified in the manufacturer's instructions.

Some of the most common printing processes include Fused Deposition Modeling (FDM)/Fused Filament Fabrication (FFF) and Stereolithography (SLA).

The most commonly used filaments in FDM/FFF include polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), and nylon. Although PLA produces a lower amount of emissions, early studies seem to suggest that PLA emissions are more toxic than those from other plastic printing media. On the other hand, while ABS is considered ideal due to its toughness and lightweight properties, ABS media produce a higher amount of emissions. For these reasons, always contact EHS for review prior to purchase of any 3D printing material.

In SLA, the finished product is usually placed in a chemical bath and cured in a UV oven. Users must ensure that they have successfully completed the appropriate training for handling hazardous materials such as chemicals.

General Guidelines

- All users shall comply with all requirements for use of 3D printers and printing as outlined in the UA 3D Printer Policy.
- Persons involved in 3D printing must comply with all mandatory training and PPE requirements.
- Locations with 3D printers using combustible media such as powdered metals or carbon nanotubes must be reviewed and in compliance with fire safety and other health and safety requirements BEFORE the printer begins operation.
- A location with a sprinkler system is highly recommended for installation of 3D printers due to fire safety concerns.
- Users must be familiar with the locations of fire extinguishers.
- All 3D printers must be installed according to:
    - Manufacturer's instructions and requirements
    - NFPA 70 National Electric Code
    - IFC Section 320 Additive Manufacturing
- 3D printers used in nonindustrial additive manufacturing shall be listed and labeled in accordance with UL 2011, UL 60950-1, UL 62368-1. The listing shall also verify:
    - The 3D printers are self-contained and utilize maximum 30-liter prepackaged production materials.

    - The operation of the 3D printer shall not create a hazardous (classified) electrical area or zone outside the unit.
    - If any hazardous (classified) electrical area or zone exists inside the unit's outer enclosure, the area shall be protected by intrinsically safe electrical construction or other acceptable protection methods.
    - The 3D printers shall utilize inert gas or an external combustible dust collection system.
- All safety interlocks and necessary switches must be enabled and working properly during printer operations.
- Necessary protection must be put in place to protect users from hot surfaces associated with printers.
- There should be a waiting period in place to allow cool down and contaminant dissipation before opening the printer to access the finished product regardless of the type of ventilation available.
- Safety data sheets (SDS) must be provided for all print feedstock and for any other chemical product used in the printing process. SDS must be readily accessible for review in the event of an emergency.
- 3D printing is not permitted in any housing or residential facilities.
- Required PPE and applicable shielding must be worn if UV light is used in the curing process.

Ventilation

Due to the increased safety concerns associated with use of any 3D printers, ventilation requirements must be discussed with EHS prior to installation of 3D printers.

- Special additional precautions may be required for 3D printers using certain types of media, including, but not limited to, thermoplastics, photopolymers, high impact polystyrene, high density polyethylene, thermoplastic polyurethane (TPU), metal filament, biological media, or other uncommon medias.
- 3D printers installed in office spaces or any other location without a designated exhaust system must meet general ventilation requirements and have self-contained exhaust systems to completely trap and vent exhaust materials.
- All 3D printers using ABS media or nylon must be fully enclosed and equipped with local exhaust ventilation or used within a fume hood.

EHS highly recommends discussing filtration and exhaust mediation accessories with vendor prior to purchase of the 3D printer units.

Enforcement

Failure to comply with the requirements specified in the 3D Printing Policy may violate various federal and state laws and regulations and expose the University to fines and violations. Additionally, failure to comply with the requirements specified in the 3D Printing Policy can result in disciplinary actions for the individual(s) involved, and such parties may have financial responsibilities for necessary repairs due to damages incurred.