National Institutes of Health

NIH 3D Printing Health and Safety Plan

2026

Authorized by the Division of Safety (DS)/ Industrial Hygiene and Campus Safety Branch (IHCSB)

Contents

Introduction

Three-dimensional (3D) printing refers to the manufacturing process where a three-dimensional solid object is generated from a computer-aided design (CAD) model by laying down many successive, thin layers of a material. The first step in the process is creating a digital file using 3D software or 3D scanning. Slicing software then slices the CAD into thousands of horizontal layers and prints each successively to create the final product. Since the creation of the 3D object is achieved through an additive process, 3D printing is also known as additive manufacturing.

3D printing is now widely used in a variety of industries like electronics, architecture, medicine, dentistry, arts, and various consumer products. Researchers and educators are using this technology as a very powerful tool to rapidly prototype complex experimental designs and test new materials to make scientific advancements in a variety of fields, such as medicine, engineering, and materials science. New technology can often bring new challenges in assessing health and environmental impact and developing best practices for managing safety and health concerns. Some of the more groundbreaking applications, such as bio printing, require even more time to comprehend the safety and health impact.

Purpose

The NIH 3D Printer Health and Safety Program establishes uniform procedures for the proper management and utilization of 3D printers, disposal of hazardous waste, and training requirements to operate 3D printers safely. The Division of Safety (DS) has established a 3D printer Safety and Health Program at the National Institutes of Health (NIH) to provide:

1. General guidelines for the safe use and handling of 3D printers and management of hazardous materials/waste.
2. Information and resources on occupational health and safety for 3D printers and printing processes.
3. Assessment of potential hazards of 3D printing and ways to reduce health and safety risks for NIH personnel.

Occupational health and safety regulations and/or guidelines on a specific 3D printer application may dictate additional, and specified, program elements as a part of this written program. Currently, this program is not specific to any 3D printer type or printing application.

Scope

This program applies to all NIH employees and contractors working with 3D printers at any NIH facility (owned or leased). Those Institutes/Centers (IC) having site-specific 3D Printer safety and health plans should adhere to the guidelines and recommendations of this written program. This program will be reviewed and updated annually, and as new and relevant information emerges.

Responsibilities

Institute/Center (IC)

- Contact the Division of Safety (DS) to request a risk assessment of locations that use and/or are planning to procure 3D printers.
    - Notify DS if significant changes in the number of 3D printers, work practices, and/or ventilation conditions occur in areas that have previously been surveyed.
- Ensure the safe use and operation of 3D printers within their spaces according to NIH guidelines.
- Display mandatory and recommended signage as applicable.
- Coordinate with DS to update the NIH 3D printing inventory records.

Division of Safety (DS) Industrial Hygiene and Campus Safety Branch (IHCSB)

- Develop guidelines and provide consultation on hazards associated with 3D printers and exposure control strategies.
- Assess ventilation (enclosure, local exhaust, ducted biosafety cabinet, chemical fume hood, etc.) requirements.
- Develop criteria for monitoring volatile organic compounds (VOCs) and ultrafine particles. (UFPs) or any other chemical-specific monitoring requirements.
- Establish an inventory program for the locations and types of printers used at NIH.
- Perform risk assessments for locations to ensure proper storage, use, and management.
- Provide consultation regarding the selection of appropriate printers and printing materials.
- Review and update of this guideline.

Division of Safety (DS) Research Safety Branch (RSB)

- Provide consultation/guidance to employees on hazards associated with 3D printers and exposure control strategies.
- Assist in hazard identification to determine the potential need for monitoring for VOCs/ultrafine. particles or any chemical-specific monitoring requirements.
- Inspect laboratory locations that operate 3D printers to ensure they are following regulatory guidelines and NIH policies.
- Report new 3D printers identified in interactions with the research community to the 3D Printing Safety Program Manager.

Principal Investigators/Supervisors

- Develop SOPs and ensure everyone under their supervision has completed all required training before working with 3D printers.
- Comply with the procedures outlined in NIH 3D Printer Health and Safety Program.
- Replace, repair, or dispose of defective or damaged 3D printers/associated equipment.
- Consult with DS when purchasing/acquiring new 3D printer(s).
- Notify DS if 3D printer operations or processes change.

- Ensure usage meets manufacturers' guidelines for safe operation.

Types of 3D Printing Processes

Below are common processes used in 3D printing/additive manufacturing:

- **Material Extrusion** –delivers filament (made of various types of plastic) or metal wire to a heated nozzle to deposit the melted material layer-by-layer on a build platform to create the 3D object. Filament materials often include acrylonitrile butadiene styrene (ABS) resin, or polylactic acid (PLA), along with various other materials. Can also use biological materials.
- **Powder Bed Fusion**- thin layers of plastic, metal, ceramic, or glass powders are deposited on a build platform. A laser selectively fuses the powder in cross-sectional layers to form the desired 3D object.

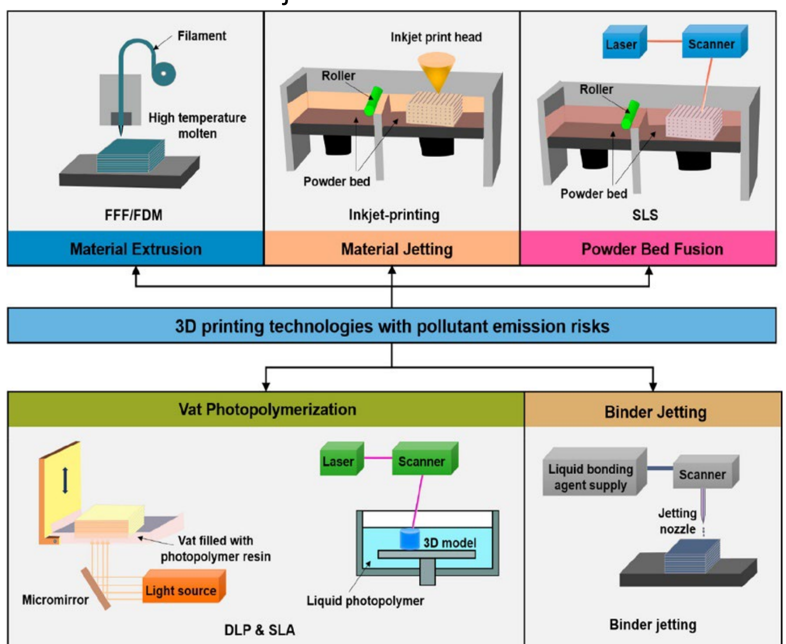

Figure 1. Overview of 3D printing technologies. Abbreviations: FFF, fused filament fabrication; FDM, fused deposition modeling; SLS, selective laser sintering; DLP, digital light processing; SLA, stereolithography. Source: Ke Min et al. via ACS Publications)

- **Binder Jetting** - a print head deposits powder material onto a build platform. A liquid bonding agent is applied to bond the particle layers together. The remaining powder can be removed and reused.
- **Material Jetting** - a print head deposits photopolymer resin on a build platform layer-by-layer to create an object, then hardens by cooling or curing by UV light.
- **Vat-Polymerization** –In vat polymerization, a vat of liquid photopolymer resin is selectively cured or hardened to create the 3D object layer- by- layer. UV light or a laser source can be used for curing/hardening.
- **Sheet Lamination** – In this process, sheet materials are added in layers and bound together with adhesives or welding. Metal sheets are welded by ultrasonic welding, and materials like paper sheets can be fused with adhesive layers and cut with precision blades.
- **Directed Energy Deposition** –a nozzle deposits metal powder or wire onto a build platform, subsequently melted by an energy source like electron beam, laser, etc., to form the 3D object.

Hazards Associated with 3D Printing

Exposure to Hazardous Vapors and Chemicals

3D printers have been shown to emit volatile organic compounds (VOCs) during the printing process. Exposure to VOCs poses several health risks, including irritation to the respiratory system, headaches, nausea, damage to the central nervous system, cardiovascular disease, cancer, etc. VOCs emitted from the printers depend on the type of filament used and the print temperature. Chemicals used during post-printing and cleaning operations can also create potentially hazardous conditions. Some of the resins used in SLA printers and metal powders used in powder printing are carcinogens/reproductive toxins.

Exposure to Ultrafine Particles

3D printers generate particulates during the printing process, and some of them are ultrafine particles (UFPs) that fall within the nanoparticle range (smaller than 100 nanometers in size). Nanoparticles are of concern because of their very small size, and inhaled particles can travel deep into the lungs and potentially enter the bloodstream. Past studies have indicated that exposure to UFPs can produce inflammatory responses in the cardiovascular and respiratory systems. The composition and the toxicity of the UFPs depend on the chemistry of the source.

Fire and Electrical Hazard

Printing processes using fine metal powders or other flammable resins have the potential for creating an ignitable atmosphere. Some metal powders are spontaneously combustible due to the particle size. In addition to fires caused by the flammable print materials, electrical overheating, malfunctions, extruder jams, lasers, sparking electrical equipment, etc., can also create a fire risk during the printing process.

3D printers carry the additional risk of electrical shock during maintenance, malfunction, or improper use.

Biological Hazard

Printing with biological materials, such as cells and engineered tissues, can expose workers to aerosols containing biological materials and cause the release of bio-hazardous agents to the environment.

Thermal and Chemical Burn

Contact with heated surfaces like the print head/nozzle and/or UV lamp in systems using UV for curing/hardening poses the risk for thermal burns. Chemical baths used for the post-printing process in some 3D printers can cause serious chemical burns and injuries.

Asphyxiation

Potential risk of asphyxiation exists for printers using inert gases (e.g., nitrogen, argon, etc.) due to the displacement of oxygen if leaked to the surrounding areas.

Radiation Hazard

3D printers with UV lights and lasers emit non-ionizing radiation, which can cause irreversible damage to the skin and eyes. Ionizing radiation emitted by certain printing processes, such as electron beam melting (EBM), carries the risk of damage to living cells in exposed individuals. Appropriate shielding can reduce the risk of exposure.

Mechanical Hazards and Noise

3D printers contain many moving parts like pulleys, threaded rods, small fans, etc., and they can cause injury by trapping fingers, long hair, loose clothing, etc.
While a single 3D printer may not be a noise hazard, the combined noise from multiple printers can exceed the NIOSH recommended limit of 85 dB(A) averaged over an 8-hour workday. Post-printing operations like cutting, grinding, etc., with power tools also generate high noise levels.

Table 1 provides a summary of hazards associated with various types of printers when operated with different print materials.

Printing process	Printing types	Print material examples	Common Hazards
Material extrusion: delivers filament (plastic, metal wire, etc.) to a heated nozzle, which can deposit the melted material layer-by-layer on a build platform to create the 3D object.	• Fused Deposition Modeling (FDM)/Fused Filament Fabrication (FFF) • Bioprinting	• Thermoplastics • Biological materials • Metal wire • Fiberglass • Carbon fiber	• Inhalation exposure to VOCs and UTFs • Exposure to biological materials in bioprinting • Burns
Powder bed fusion: Thin layers of plastic, metal, ceramic, or glass powders are deposited on a build platform. A laser selectively fuses the powder in cross-sectional layers to get the desired 3D object.	• Selective Laser Sintering (SLS)	• Plastic, metal, ceramic, or glass powders	• Inhalation/dermal exposure to powder, fumes • Explosion • VOCs from post-printing operations • Laser/radiation exposure
Material jetting: A print head deposits photopolymer resin on	• Ink-jet printing	• Photopolymer	• Inhalation of VOCs/UTFs

a build platform layer-by-layer to create an object, then hardens by cooling or curing by UV light.			• Exposure to hazardous resins, solvents/chemicals • UV exposure
Vat Polymerization: a vat of liquid photopolymer resin is selectively cured or hardened to create the 3D object layer- by-layer. A UV light or laser source is used for the curing/hardening process.	• DLP- digital light processing and SLA-stereolithography	• Photopolymer	• Inhalation of VOCs • Exposure to hazardous resins, solvents/chemicals • UV exposure
Binder jetting: print head deposits powder material onto a build platform. A liquid bonding agent is applied to bond the particle layers together.	• Adhesive	• Plastic, metal, ceramic, or glass powders	• Inhalation/dermal exposure to powder • Explosion • Dermal exposure to binders
Sheet lamination: In this process, sheet materials are added in layers and bound together with an external force (adhesives or welding).	• Adhesive or ultrasonic welding	• Plastic, metal or ceramic	• Inhalation of chemical fumes • Electrical shock • Laser/radiation exposure

Table 1: Summary of various printing processes, print materials, and associated hazards

Control of Hazards

The hierarchy of controls used by safety professionals to prioritize control strategies can be applied to address the hazards associated with 3D printing, too. The recommendations provided in the following sections are some of the actions that the users can apply to mitigate hazards associated with 3D printing.

Elimination and Substitution

Eliminating or substituting hazardous processes or materials removes or reduces hazards and protects users more effectively than any other control approaches. Examples include eliminating unnecessary hazardous post-processing steps to remove associated hazards completely and substituting high ultrafine particle emitter filaments. An example would be replacing acrylonitrile butadiene styrene (ABS) with polylactic acid (PLA), which has lower particle emissions, to reduce exposure.

Engineering Controls

Engineering controls reduce exposures by removing the hazard from the process or isolating the user from the hazard with a protective barrier. The location, size, type, and number of printers will influence the selection and adequacy of the ventilation.

Operate all 3D printers in well-ventilated areas. NIOSH recommends a minimum of six air changes per hour (ACH) or using a portable HEPA (high efficiency particulate air) filter to lower ultrafine particle concentrations during printing operations. Any customized local exhaust system installed on 3D printers should not increase fire risk, void the manufacturer's warranty, or add any additional health and safety risks.

Compared to general ventilation, a more efficient approach is to place the 3D printers inside ventilated enclosures or install printers under a fume hood or next to a local exhaust to provide source control. For enclosed printers that are not inside a fume hood, an air filter recirculation system can eliminate the exhaust of VOC's and UFP's into the room. Some of the enclosed printers come with a HEPA filter to capture small particles and an activated carbon filter to absorb gaseous VOCs. These filters must be checked regularly for optimal performance and changed by following the manufacturer's recommendations. Even with a filtration system, proper ventilation in the room where the printer is located is still important.

Contact your IC Safety Specialist for a risk assessment of your area to identify appropriate control measures. If your printer uses inert gases, you may require oxygen monitoring in compliance with NIH guidelines (Oxygen Monitoring Guidelines).

Exposure to various emissions can be further controlled by:

- Placing the printer in a room with a negative air pressure differential relative to adjacent areas.
- Using a ventilated glove box, other ventilated enclosures, or a downdraft table for cleaning and post-printing activities like chemical cleaning, spray-painting, grinding, etc.

Administrative Control

Administrative controls refer to employer-established work practices and policies to reduce or prevent hazardous exposures. Below is a list of recommended administrative control strategies for 3D printing:

- Develop standard operating procedures (SOPs) for 3D printing covering all stages of printing operation (including pre/post-printing processes), cleaning, maintenance, and disposal of hazardous waste.
- Restrict access to 3D printing areas.
- Post appropriate signage at easily viewable locations.

    - UV light (UV Energy Sign).
    - Laser sign (Laser Safety Program).
    - Restricted access.
    - Oxygen monitoring devices (Download 'Oxygen Deficiency Danger' Signs Template).

- Never remove/tamper with manufacturer-installed controls (e.g., laser protection/interlocks, heat shields, machine guarding).
- Consider using printers with an interlock system that can pause printing when malfunctioning or when the enclosure access is opened. Never override the interlock system or use the printer if the interlock system is malfunctioning/damaged.
- Limit the time spent near the printers by remote monitoring using cameras or leaving the area when direct supervision is not required. Allow a waiting period of at least 30 minutes after print failures or the end of printing to allow the system to cool down and reduce exposure to VOCs/UFTs. Leaving 3D printers unattended is not recommended; provide remote monitoring using cameras if possible. Unattended overnight printing must be done in consultation with the Fire Marshal and the establishment of an emergency response process.
- Follow manufacturers' guidelines for printing, cleaning the printer, and using only the manufacturer's recommended printing materials.
- Set the nozzle and base plate temperatures at the lowest recommended settings.
- Use materials tested and verified to have low chemical and particle emissions if possible.
- Establish basic lab safety protocols and follow proper chemical safety practices for storage, labeling, and handling as specified in NIH Chemical Hygiene Plan (CHP).

Personal Protective Equipment (PPE)

PIs/supervisors are responsible for identifying appropriate PPE required for various activities associated with the printing and ensuring that the workers are complying with the PPE recommendations. If you need assistance in selecting appropriate PPE, contact your IC Safety Specialist.

Examples of PPE include:

- Hand protection: Appropriate gloves compatible with the materials (print media, solvents, etc.) in use (e.g., nitrile, other chemical-resistant gloves. Refer to SDS for guidance).
- Use cut-resistant gloves when scraping/removing support materials with tools and thermal gloves to prevent burns from hot printer heads.
- Lab coat or coveralls.
- Eye protection is required (Safety glasses with side shields/goggles, face shields, etc.) during activities generating particulates, chemical mist/spray, etc. (e.g., pouring resins, using solvents, cutting, grinding, or sanding). Additional eye protection may be required for printers with lasers or UV lights.
- Respiratory protection when engineering and other controls cannot reduce exposures. DS approval is required for the use of respirators, including N95. Contact DS to conduct a risk assessment (Respiratory Protection Program (RPP).

- Ear protection if noise levels are equal to or exceed 85 decibels (an 8-hour time-weighted average-TWA). Contact DS if you suspect the noise levels are above the approved levels (Hearing Conservation Program).
- Never take PPE outside of the print area to prevent spreading contamination.
- Clean reusable PPE often and use an approved outside laundering service for reusable lab coats.
- Contaminated disposable PPE must be handled as hazardous waste (NIH Waste Disposal Guide).

Table-2 Summary of Hazard Controls for 3D Printing

Control Type	Summary of Recommendations
Elimination & Substitution	Eliminate hazardous chemicals and post-processing steps if possible. Substitute high-emission materials with lower-emission alternatives (e.g., use PLA instead of ABS) if available.
Engineering Controls	Operate printers in well-ventilated areas (minimum 6 air changes per hour or use a HEPA filter). Use enclosures, fume hoods, or local exhaust systems to capture emissions at the source. Use ventilated enclosures or downdraft tables for cleaning and post-processing tasks.
Administrative Controls	Develop Standard Operating Procedures (SOPs) for all printing stages. Restrict access to printing areas and post appropriate safety signage. Purchase enclosed printers with HEPA and activated carbon filters and regularly check and replace filters. Never tamper with or override manufacturer-installed safety features such as interlocks. Use the lowest effective temperature settings for the nozzle and base plate. Limit time spent near active printers; use remote monitoring and allow a 30-minute cool-down period after printing. Follow all manufacturer guidelines for operation, cleaning, and materials. Use oxygen monitoring if the process involves inert gases.
Personal Protective Equipment (PPE)	**Hand Protection**: gloves appropriate for the task (chemical-resistant for materials, cut-resistant for scraping, thermal for hot parts). **Eye Protection**: safety glasses with side shields, goggles, or face shields during activities that can generate particles or splashes. **Body Protection**: lab coat or coveralls. **Respiratory Protection**: Use only after a risk assessment and when other controls are insufficient. **Hearing Protection**: Required if noise levels are at or above an 85-decibel average. Follow proper procedures for selection, maintenance, and disposal of PPE.

Specific Safety Considerations

Fire/thermal Burn Safety

- 3D printers and related equipment should be connected directly to a certified electrical receptacle with verified grounding.
- Keep the printers away from flammable/combustible chemicals and other materials.
- Place printers in areas where fire extinguishers and suppression systems are available. Class D fire extinguishers are required in areas where metal powders are used.
- Use an intrinsically safe HEPA-filtered vacuum for areas that are using and creating fine powders.
- Use enclosures or guards for hot parts like the nozzle head and heated bed to reduce the risk of thermal burn.

Bioprinters

For work involving biological printers:

- ALL work with biological materials, pathogens, toxins, and recombinant DNA must be registered using the Electronic Registration System ERS) https://ers.ors.nih.gov/.
- Consult with NIH Biosafety Officer (BSO) for a risk assessment and safety recommendations.
  - NIH Exposure Control Program for Non-Hospital Personnel. (https://ors.od.nih.gov/sr/dohs/Documents/exposure-control-plan.pdf).
  - https://policymanual.nih.gov/3035.
- Develop SOPs consistent with the hazards, including spill response and decontamination procedures.

Printing with metal powder

Metal powders can be highly flammable/combustible and pose a significant risk if mishandled. In addition to the flammability hazard, some of the metal powders used in 3D printing, such as stainless steel, cobalt chrome, etc., are highly toxic due to the presence of heavy metals like Cr, Co, Ni, etc. To ensure the safety of personnel and prevent incidents, it is very important to establish appropriate control methods, starting with powder storage to the disposal of hazardous waste. One of the key safety components in metal printing is minimizing aerosolization of the powder and controlling the surface contamination. Appropriate storage, use of proper PPE, engineering/ventilation controls, and implementation of proper cleaning procedures can reduce contamination. Purchase and use of 3D printers using metal powders requires prior approval from the Division of Safety. Consult with the assigned IC Safety Specialist before purchasing the equipment. By adhering to strict safety precautions, the 3D printing process involving metal powders can be carried out in a safe and controlled manner.

Pre-Printing, Post-Printing, and Maintenance Activities

It is not just the printing, pre-printing, post-printing, and maintenance activities that have potential for exposure to chemicals and nanoparticles. These activities include pre-printing tasks, such as cleaning nozzles and loading filaments, and post-printing tasks, like removing support structures with chemicals, spray-painting, and grinding. Exposure can be reduced by performing these activities under containment systems (e.g., CFH, glove box, downdraft table, etc.) and wearing appropriate PPE. Maintenance and cleaning are other activities that can cause exposures based on the type of printing being done.

Always make sure to turn off, unplug, and cool down the printer before any cleaning, maintenance, or repair work to avoid electrical shock. Always apply a wait time before opening the printer post-printing (follow manufacturer's recommendations for "wait time" if one exists).

Chemical-Based Support Material Removal Process

Chemical-based post-processing dissolves or breaks down temporary support structures using chemicals instead of mechanical removal. In most processes, printed parts are placed in a chemical bath that selectively dissolves the support material while leaving the "build" material intact.

Use of Corrosive/Flammable Baths

Safety precautions for corrosive/flammable baths:

- Perform risk assessment to select appropriate controls.
- Use corrosive/flammable baths only in designated areas with proper ventilation.
- Wear appropriate PPE such as a lab coat, chemical-resistant gloves, and safety goggles. Additional PPE, such as a face shield, may be required if the potential for splashes exists.
- Label the tank with the chemical name and hazards. Chemical labels are available at the NIH Self Service Store https://nihsccatalog.od.nih.gov/pc/products.do.
- Areas working with corrosive material must have access to an emergency eyewash station and facilities for quick drenching of the body. It is the responsibility of the user to inspect the eyewash weekly and maintain an inspection log (Weekly Eyewash Equipment Inspection Sheet).
- Never pour the used chemicals down the drain; dispose of them as hazardous waste by following the NIH Waste Disposal Guide.

Chemical Storage

Chemicals should be stored in designated chemical storage areas in compliance with the NIH Chemical Hygiene Plan (CHP). Store flammable substances (e.g., resin polymers, solvents, etc.), in approved flammable storage cabinets. If multiple types of chemicals are stored in the same storage area, segregate them according to hazard class (Chemical Segregation and Storage Table) and provide secondary containment. Refer to chemical segregation and storage, compatible chemical storage, and storage cabinets for additional information on chemical storage.

Exposure assessment

The emissions from 3D printers (VOCs and UFPs) can be assessed using various industrial hygiene sampling techniques. DS IHCSB has the capabilities to perform personal and area sampling to evaluate exposure. Some areas, such as working with metal powders, may require additional chemical-specific monitoring. All 3D printing areas can request an exposure assessment by contacting IC Safety Specialists.

Purchasing 3D printers

When evaluating the purchase of 3D printers, prioritize safety along with your needs, budget, and other requirements.

Before Ordering 3D printers:

- Contact DS (IC Safety Specialist) for a risk assessment of the space to ensure the planned use locations have appropriate ventilation and meet other safety requirements to prevent injuries/exposures.
- Consider printers that meet ANSI/CAN/UL 2904: Standard Testing/Assessment of 3D printing and meet established electrical safety and fire code standards.
- Consider printers with integrated enclosures, direct exhaust lines, or local active filtration systems equipped with HEPA and interlock systems. Ensure these features have been verified to be effective.
- Review the Safety Data Sheet and other reference materials available for understanding the physical, health, and environmental hazards associated with the filaments/other chemicals involved in printing.
- If you require printers with lasers or UV lights, ensure they have an interlock system.
- Use the type of filament recommended by the printer manufacturer with the lowest VOC and particle emissions.
- Train the laboratory staff on the hazards, pressure systems, regulators, etc.

Identifying a location for installing the printer:

- Locate 3D printers away from heavy traffic areas and isolate them in a room with an operable door.
- Ensure that the planned use locations have appropriate ventilation.
- Ensure location has fire extinguishers/sprinkler system to address fire safety concerns.

Standard Operating Procedures (SOP)

Working with 3D printers requires developing Standard Operating Procedures (SOPs). DS developed SOP templates for various types of 3D printers that are available (3D Printing SOP for fdm, 3D Printing SOP for Metal Powders and 3D Printing- SOP For sla) for the users.

Training

Anyone working with 3D printers must have appropriate training. PIs/supervisors are responsible for ensuring that the users are in compliance with the training requirements. IC Safety Specialist is available to assist you with developing and reviewing training. Below is a list of the minimum training required for 3D printer users:

- Lab Safety/Studio Safety.
- Chemical safety/HAZCOM.
- 3D printer operation and training on SOP.
- Biological Safety training and NIH Bloodborne Pathogen (only if biological materials are involved).
- Laser safety training for printers with lasers.
- Lab-specific training courses, if any.

Emergency Response & Spill Cleanup

- Develop an emergency response/spill response plan as part of the SOP and have access to an appropriate chemical spill kit if solvents and other chemicals are used.
- Areas using biological materials must develop specific plans in consultation with the Biosafety Officer.
- Access to an eyewash station is required if hazardous chemicals are used or stored. Weekly inspection of the eyewash station is the responsibility of the laboratory (Weekly Eyewash Equipment Inspection Sheet).

The table (Table 3) has information on how to respond to specific emergencies and phone numbers for getting emergency help/medical assistance.

Emergency medical help and high-level hazard spills	Contact Emergency Services/Fire Department. **Bethesda, MD -** call 911 on-campus, 9-911 off-campus**;** 301-496-9911 (cell phone) **Baltimore, MD -** 911 **Frederick, MD -** 911 **Hamilton, MT -** 911 **Research Triangle Park, NC -** 911 (landline), 919-541-2800 (cell phone)

For eye & dermal exposure, wash immediately under eyewash or safety shower for at least 15 minutes.	Seek **emergency medical help** if needed as described above. The injury/exposure should be immediately reported to your supervisor and local OMS clinic: **Bethesda, MD**: Building 10, Room 6C306; (301) 496-4411 **Baltimore, MD**: 251 Bayview Blvd., BRC 01B210; (667) 312-5843 **Frederick, MD:** 8200 Research Plaza, Room 1B116; (301) 631-7233 **Hamilton, MT:** 903 South 4th Street, Room 5202; (406) 375-9755 **Research Triangle Park, NC:** 111 T W Alexander Drive, Building 101, Room E111; (984) 287-4178

Table 3: How to respond to emergencies

Laboratory personnel can clean up low-level hazard spills by following the spill response plan for laboratories and NIH CHP Appendix H. Areas using/creating powders/fine dust should be cleaned frequently by wet wiping techniques to avoid aerosolization of dust particles. Using a HEPA-filtered vacuum to clean floor/furniture etc., is recommended. Never use compressed air for cleaning 3D printer areas.

Waste management

Handle and dispose of all waste materials (including contaminated cleaning materials and disposable PPE) as hazardous waste in compliance with the NIH Waste Disposal Guide.

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