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3D PRINTER GUIDELINE

1. PURPOSE

This guideline supports the *Health and Safety Policy* and the *Plant Risk Assessment Guidelines* to provide assistance with the safe operation of 3D printers at the University. This guideline is to be applied to the use of all types of 3D printers.

2. ABBREVIATIONS

3D	Three Dimensional
AM	Additive Manufacturing
ABS	Acrylonitrile butadiene styrene
PPE	Personal Protective Equipment
SDS	Safety Data Sheet
SOP's	Safe Operating Procedures
UV	Ultraviolet

3. What is 3D printing?

3D Printing is an additive manufacturing (AM) process of making three dimensional objects from digital files. The AM process involves laying down successive layers of a material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the object.
Each 3D printer has been designed to print with certain types of materials which have their own hazards and may become more hazardous when subjected to the printing process. Printers range from 'hobbyist' machines with few inbuilt safety features (exposed moving parts and hot components for example) to high quality commercial machines with interlocks and fume filtration.
In addition to printing, a 3D print job may include pre - and post-processing work which can consist of chemical baths or high pressure cleaners to remove support structures or harden the printed object.

3.1. Printing materials

Thermoplastics & Photopolymers. Thermoplastics can be flammable, cause irritation and skin sensitivity. Some may contain small amounts of toxic components. Photopolymers utilise exposure to UV light to harden during the printing process. These often contain hazardous monomers, such as acrylates. Additionally, UV light is a radiation hazard, which can cause damage to eyesight and skin

Support Materials. The 3D printing process often utilises a support material to allow for creation of the empty spaces in the fabrication design. Support materials often contain harmful chemicals, such as phenyl phosphates, that are incorporated into the thermoplastic acrylic polymer, and thus are hazardous during use and disposal

Metal Materials. Reactive and highly combustible powder metals are used in the fabrication of 3D-printed metal alloy tools and parts. Finely divided metal powders, such as titanium and aluminium, can spontaneously combust causing fires (pyrophoric). It's recommended that potential ignition sources

are eliminated and avoid storing the powder materials near explosion hazards. 'Class D' metal fire extinguishers are required.
It is essential that the manufacturer's information/instruction is adhered to and that electrical equipment and wiring is suited for the work. This process uses very high heat which may expose users to thermal injury, as well as potential inhalation of the powders.

3.2. Possible harmful effects of 3D printing

New research from the Finnish Institute of Occupational Health, Aalto University and the University of Helsinki has showed 'that nanoparticles and gases are released from 3D printers used in office-type workplaces.' The concentrations depend on the printing technique, the material used and the printing temperature. The potential harmful effects of these nanoparticles are not yet fully known, which is why caution is recommended for their use in unventilated environments.

3D printing may also release gaseous compounds into the air. The temperature and printing material used affect the release of gaseous compounds. Studies show that the printing of ABS plastic release styrene and formaldehyde, but the concentrations remain typically low in small scale printing.

Assessing the risk of exposure would need to take into account other activities taking place in the work environment and the number of printers running simultaneously as part of the risk assessment. Ensure that you read the manufacturers guide and refer to the Safety Data Sheet (SDS) of the feed material prior to use.

4. Risk Management

The Plant Risk Assessment Guidelines and or the Plant Pre-Purchase checklist will assist workers at Curtin in conducting a thorough risk assessment. The following should be taken into consideration during the process:

a) Purchase fully encased printers.
b) Are pinch points and hot surfaces enclosed?
c) Power supply needed for printing and associated processes.
d) Does the printer require a wet area for the chemical dissolution process?
e) Does the chemical dissolution process require the use of corrosive materials – is a safety shower and eyewash available?
f) Assessment for the selection, use and storage of Personal Protective Equipment (PPE).
g) Does the printer include extraction, filter or ventilation accessories, or are these an additional cost?
h) Who can install and maintain the printer?
i) Labs or offices where these printers are located should contain smoke alarms (not thermal detectors) which will provide early warning in the event of a fire.

The main principle of the risk management process is to identify and assess the risk of introducing a new process and equipment into the workplace. The risk assessment should include the hazards associated with chemicals used at any stage of the print process, waste management and post processing cleaning and removal of support structures.

5. RECOMMENDATIONS

The following recommendations must be applied when considering 3D printers:

a) Purchase fully enclosed printers where extraction is available.
b) Substitute harmful chemicals for safer alternatives.
c) Develop guidelines which clearly outline what can be printed due to copyright laws, the model of printer and filament capabilities.
d) Provide operators with training on the safe operation and use of 3D printers.
e) Provide access to Australian compliant SDS for the filaments and or chemicals used in printing and for the removal of support material.
f) Refer to the SDS for the correct storage of all chemicals in the printing process.
g) Review SDS to ensure the appropriate PPE is provided.
h) Review SDS and the installation/user guide for the correct print temperature for the print material used.
i) Complete chemical risk assessments for the removal of support material by chemical dissolution.
j) Ensure that the printer is installed, used and maintained as per the manufacturer's specifications.
k) Ensure that the room has adequate ventilation and extraction – HEPA filtration to the outdoor environment is recommended.
l) Do not store items next to printers (for example paper and cleaning chemicals) as this can interfere with an inbuilt ventilation system and pose a fire risk.
m) Protect staff and students from the generation of dust during cleaning and maintenance by vacuuming and wiping surfaces with a damp cloth.
n) All waste is disposed of as per local guidelines and budgeted for.
o) No eating or drinking is allowed in areas where 3D printers are used.
p) Safe Work Procedures (SWPs) are required for operation of all types of 3D Printer.

6. EXEMPTIONS

These procedures apply to all areas of the University where 3D printers and associated equipment and processes are intended to be used.

7. RELEVANT DOCUMENTS/LINKS

Health and Safety Policy
Plant Pre-Purchase checklist
Plant Risk Assessment Guidelines
FIOH - Instructions for Safe 3D printing
Chemical safety of 3D printing at workplaces

8. REFERENCES

www.cmu.edu/ehs/fact-sheets/3D-Printing-Safety.pdf.
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