

## BASIC ASPECTS OF 3D PRINTERS SAFETY

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**Abstract.** The issue of safe work with 3D printers is considered. The need to carefully follow the instructions provided by the 3D printer manufacturer is substantiated. Safety rules and recommendations for operating specific printer models are given. The importance of updating the printer software to the latest version is justified in order to gain access to new functions and improvements.

**Keywords:** 3D printer, production, employer, safety rules, human safety, personal protection, certification, worker.

**Анотація.** Розглянуто питання безпечної роботи з 3D принтерами. Обґрунтовано необхідність ретельного дотримання інструкцій, наданих виробником 3D принтера. Наведено правила безпеки та рекомендації щодо експлуатації конкретних моделей принтерів. Обґрунтовано важливість оновлення програмного забезпечення принтера до останньої версії з метою отримання доступу до нових функцій та вдосконалення.

**Ключові слова:** 3D принтер, виробництво, роботодавець, правила безпеки, безпека людини, персональний захист, атестація, працівник.

**Introduction.** The work of employees using a 3D printer requires knowledge and skills from them. Although it is a printer, you should still not forget about safety rules when working with it, you need to know and follow the rules of behavior for a 3D printer, as well as safety measures during work. Because there is a risk of injury:

- getting dust into the eyes;
- ingress of powder particles;
- getting clothing particles into the moving parts of the 3D printer;
- electric shock;
- emission of toxic or harmful vapors;
- possibility of fire.

**Analysis of the state of the issue.** The situations described above can happen for various reasons. Therefore, you need to prepare in advance to reduce the risk of their occurrence.

**The purpose of the work:** to analyze dangerous factors when working with 3D printers, to provide recommendations on human safety measures when working with it and recommendations for the premises.

**Methods, materials and research results.** When working with a 3D printer, it is important to observe safety measures so as not to injure yourself. 3D printers are different, both small at home and quite large, in companies at enterprises, but the safety measures are similar for all of them.

You are responsible for your own safety at home and you must follow the safety rules. To begin with, you need to buy protective glasses and a respirator, because even

from printing with plastic, its small particles remain in the air, which then settle in the lungs. Also, the 3D printer should be placed away from flammable things, in no case should you touch it when it is working, and also take care of good ventilation of the room. If the 3D printer is of an open type, then it is impossible to allow anything to get into its mechanism.

If we are talking about enterprises and large-scale production, then the enterprise and the employer are primarily responsible for the safety of personnel.

The employer is obliged to ensure at his own expense the purchase, assembly, issuance and maintenance of personal protective equipment in accordance with the regulations on labor protection and the collective agreement.

In case of premature wear of these means through no fault of the employee, the employer is obliged to replace them at his own expense. In the event that an employee purchases overalls, other means of personal protection, detergents and disinfectants at his own expense, the employer is obliged to compensate all expenses under the conditions stipulated by the collective agreement. Also, the employer must conduct a medical examination at its own expense, upon hiring and periodically during employment. And do not forget that the employer must ensure safe working conditions at the workplace.

In our case, the use of personal protection: this is anti-static clothing (overalls, gloves, shoes), a respirator is also used, or a single-piece, or separately, a mask, a respirator and protective glasses for the eyes, which can protect you from dangers and injuries. At the expense of the workplace, the room should have an antistatic floor and good ventilation. All these things are necessary to protect the respiratory system and vision from the dust cloud from the materials, which has a negative effect on health, and also to prevent any discharges that could lead to a fire. In addition, the overalls will protect against particles of free-cut items entering the mechanisms of the 3D printer.

Enterprises are not allowed to employ minors in difficult jobs and in jobs with harmful or dangerous working conditions. Before starting work with a 3D printer, it is important to be trained and familiar with its proper use. Many manufacturers or specialized educational institutions offer educational materials, courses or workshops where you can get instructions on how to use a 3D printer safely and effectively. When a specialist is hired at the enterprise, he must be familiarized with safety measures and provide instructions for using the device. Use only original components: Use only original components, parts and accessories for your 3D printer. The use of counterfeit components can cause danger and damage to the printer. The state of the issue of safety rules when working with a 3D printer is very important, because the safety of users should be a priority when using any equipment.

Below are a few things to consider when working with a 3D printer. Place the 3D printer in a well-ventilated area or use a special exhaust system to remove the fumes, if this is not enough, then consider using additional ventilation systems or exhaust fans to avoid the accumulation of harmful fumes that can be generated when printing with plastic material, one of the reasons for their formation is the heating of the material above its temperature limit. This will help prevent inhalation of harmful substances.

Electrical safety. Follow the instructions regarding the connection of the printer to the power source and other equipment. Avoid using damaged electrical cables or outlets. To prevent fire, do not leave the printer unattended during operation. It is important to connect the 3D printer to a grounded power source to prevent electrical hazards and equipment damage. First of all, it is necessary to inform that the use of personal protection when working with a 3D printer is mandatory. Many 3D printers have heating elements such as heating platforms or hot extruders. Be careful not to touch these hot surfaces when handling the printer. Always wear gloves or other protective equipment when handling heating elements. Before touching, you need to wait for the material and the printer to cool down.

Fire Safety. Always have a fire extinguisher handy in case of fire. 3D printers work with heating elements and materials that can become a source of ignition. Keep enough distance between the printer and flammable materials or things that can catch fire. Just as some materials from which products are made are flammable and explosive, in particular powder materials such as titanium powder.

Control over the process. Before starting to print, make sure that all the printing parameters are set correctly. Monitor the printing process, especially in the initial stages, to detect potential problems such as material hardening or broken parts in time.

Materials storage. Store 3D printing materials in appropriate containers and out of the reach of children. Some materials may be toxic or flammable, so care should be taken when storing and using them.

Regular maintenance. Keep your 3D printer in good condition by performing regular maintenance. This includes cleaning the printer of dirt and material residue, inspecting and replacing worn parts and components, and following other manufacturer recommendations.

Documentation and Logging. It is important to keep documentation of your 3D printer, including materials used, settings, print results, and other information. This will help you troubleshoot potential issues and serve as a guide for future projects and setups.

Avoid long-term exposure. Do not leave the 3D printer unattended for long periods of time, especially while printing. If problems occur or abnormal operation of the printer is noted, it is necessary to disconnect it from the power source and contact a specialist. And finally, do not forget to inform that in the event of a malfunction of the 3D printer, it is forbidden to work on it. Be prepared for emergencies such as fire or printer damage. Always have a power switch or other means of shutting down the printer close by if necessary. In the event of serious problems or unknown malfunctions, contact a specialist or technical support. Workplaces must be certified at such enterprises, because the technological process can use materials or raw materials that are potential sources of harmful and dangerous production factors, which in turn can negatively affect the health of employees. Such attestation must be carried out by the attestation commission for compliance with occupational health and safety regulations in accordance with the procedure and time limits determined by legislation, and based on their results, take measures to eliminate dangerous and harmful to health production factors. In general, the state of security when working with a 3D printer is

quite good, but there are certain risks that must be taken into account. Following the correct procedures and using the appropriate equipment and materials can greatly reduce the risks and ensure safety when working with a 3D printer. However, it is important to remember that safety rules may vary depending on the specific 3D printer model and manufacturer. Therefore, it is recommended to always read the instructions and recommendations of the manufacturer, as well as receive training and support from professionals in this field. Remember that safety should always be your top priority when working with a 3D printer. Invest time in training, take the necessary safety precautions, and always be alert and cautious.

Conclusions. To safely use a 3D printer, you need:

- acquire appropriate skills in using a 3D printer for safe work;
- familiarize yourself with the provided instructions for using the device and its processes;
- observe the rules for wearing personal protective clothing;
- do not touch the device during its operation;
- monitor the temperature of the 3D printer and the ventilation in the room;
- before using the 3D printer, make sure of its integrity.

In the article, we analyzed the dangerous factors when working with 3D printers, provided recommendations on human safety measures when working with it, and recommendations for the premises.

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