

# Disinfection with UV-C radiation

- When people are exposed to UV-C radiation, it usually stems from artificial sources. UV-C radiation from the sun is filtered out by the ozone layer.
- UV-C radiation is generally able to kill bacteria and viruses. The dose that reaches the target organisms must be high enough to be effective.
- Common applications of UV-C radiation include surface disinfection and water treatment. To a lesser extent, it is used for the disinfection of foodstuffs.
- Disinfection by means of UV-C radiation is **not** a safe method for use on or in living organisms. **The BfS warns against use on the body, as there is a risk of damaging the eyes and skin.**



UV-C radiation is generally able to kill bacteria and viruses. The main areas of application for UV-C radiation include surface disinfection, indoor air disinfection or water treatment.

The effectiveness of disinfection measures using UV-C radiation depends on the dose: The irradiation intensity must be high enough and the irradiation duration long enough to be able to kill microorganisms and viruses to the intended extent.

Care must be taken when using UV-C radiation as there is a risk of damaging the eyes and skin.

UV disinfection lab  
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## Mechanism of action of UV-C radiation

High-energy UV-C radiation, like UV-B and UV-A, can have acute (immediate) and chronic (apparent only later in life) health consequences. Acute reactions to UV-C radiation include painful inflammation of the cornea or conjunctiva of the eye (photokeratitis, photoconjunctivitis) and of the skin (erythema). The genetic material, i.e., DNA, can be damaged over the long term, and cells damaged in this way can degenerate into cancer cells.

Because of this effect, the International Agency for Research on Cancer (IARC) has classified all wavelengths of UV radiation (UV-C 100-280 nm, UV-B 280 - 315 nm and UV-A 315 - 400 nm) as carcinogenic for humans, regardless of whether they are of natural or artificial origin.

UV-C radiation also damages the genetic material of microorganisms and viruses. This is the basis of their ability to kill bacteria and viruses. Most UV-C disinfection devices currently in use operate on wavelengths around 254 nm, which have been confirmed in several recent studies to have a mutagenic effect.

## Disinfection with UV-C radiation – various systems

Disinfection systems or processes in which people are safely protected from UV radiation are considered safe from a radiation protection standpoint. These include systems where the UV-C source is installed in a closed unit or where shielding of the source ensures that anyone present is not exposed to UV-C radiation. These may include systems for surface disinfection of conveyor belts in food production or in escalators, where the UV-C source is installed in the interior of the system. In the case of indoor air disinfection, these would be systems in which the indoor air is conducted past a shielded UV-C source.

In terms of radiation protection, applications that only carry out disinfection with UV-C radiation when there are no people present in the room are also considered safe.

### **Precautions when using UV-C disinfection systems where the possibility of people being exposed cannot be ruled out**

In principle, UV-C disinfection systems can still be used where exposure to people cannot be avoided. The BfS advises exercising caution in this case. Any acute effects on the eyes and the skin must be avoided, and any risk of long-term effects must be minimised, for example, by installing the radiation source on high ceilings to increase the distance between the radiation source and people in the room. There is no simple “off the shelf” solution in this regard.

The installation must be carried out by professionals and be adapted to the specific requirements and conditions on site.

### **Occupational health and safety requirements for workplace application**

At workplaces, the requirements of occupational health and safety and the exposure limits for UV radiation specified therein must be observed. The German Federal Institute for Occupational Safety and Health (BAuA) or the German Employer’s Liability Insurance Associations are the suitable contacts for questions regarding the safe use of UV irradiation equipment in occupational settings.

## **Can UV-C radiation be safe?**

Currently, UV-C disinfection systems are coming onto the international market which are advertised as “safe” or at least as lower-risk with the intention of being used in public areas in the presence of people (“occupied areas”). This application is being made possible by lamps that emit short-wave UV-C radiation in the range around 222 nm (“Far-UV-C”). It is claimed that the penetration depth of these wavelengths into the eye and skin is so low that virtually no DNA damage can occur.

Current studies – mainly animal studies on nude mice – have substantiated the differences to conventional 254 nm radiation. Nevertheless, the available research results do not currently permit a reliable assessment of health risks. For example, no robust evidence has been provided on the effects of regular or chronic exposure on injured or damaged skin or on sensitive groups of people such as children.

In addition, the spectrum emitted by the disinfection lamps plays a major role in the biological effects. In the current studies, UV-C sources were used in which the longer wavelength

components of the UV-C spectrum were filtered out. If this were not the case, it must be assumed that at least the longer-wave components of UV-C radiation can penetrate through the horny layer of the skin and cause damage to the living cells.

The BfS therefore also urges caution with devices that operate using “Far-UV-C” sources. It goes without saying that the requirements of occupational health and safety must also be complied with even for these “Far-UV-C” wavelengths.

## **Recommendations and advice from the BfS**

- Protect yourself and others from harmful UV radiation. Do not use UV-C radiation on the body. Do not irradiate the eyes or the skin.
- As a precaution, only use open devices for air disinfection, i.e., devices that emit UV-C radiation into the room, when there are no people present in the room.
- When disinfecting surfaces, only point portable UV-C devices at the surface to be disinfected.
- The manufacturer is responsible for the safety of its products. Follow the manufacturer’s instructions for safe handling.

UV-C irradiation equipment is not a toy. Keep them away from children’s hands.

### **The BfS does not inspect and assess the effectiveness of UV-C disinfection devices**

However, considering the variety of devices available on the market, general advice is given for the consumer, which should be considered before purchasing a device:

- Manufacturer’s information on a device should be provided as completely and precisely as possible. This includes information on the wavelengths used and the irradiation intensity.
- The manufacturer should specify the duration and distance from which surfaces or objects must be irradiated in order to reduce active microorganisms and viruses by a certain amount. Generally speaking, only microorganisms and viruses that can be reached by the radiation with the necessary dose can be killed.
- For the disinfection of textiles and masks, there should be evidence that the dose is sufficient to successfully inactivate even microorganisms and viruses that are located deeper in the fibrous material.
- For devices and systems for disinfecting indoor air, information on the air circulation volume and the room size for which the device/system is suitable is important. The air must pass by the UV-C source often enough and slowly enough so that the dose required to kill the microorganisms and viruses can be achieved in the airflow. The time it takes to reach a certain level of disinfection of the indoor air should also be discernible.

Users have to rely on the information provided by the manufacturer. Thus the manufacturer should provide clear evidence for claims, especially those regarding effectiveness.

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