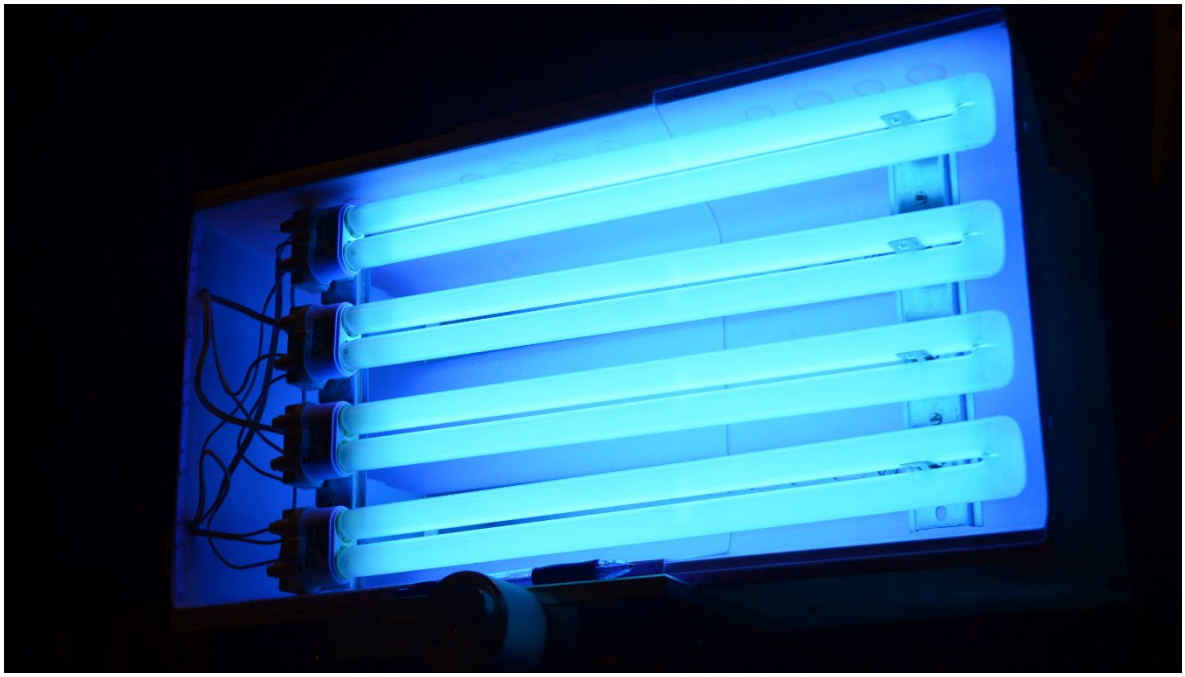
DSA Bulletin

Norwegian Radiation and Nuclear Safety Authority

2020 Number 4

Use of UVC to Inactivate Coronavirus

Short-wave ultraviolet radiation (UVC, 100-280 nm) can be used to disinfect surfaces and air in rooms, such as operating rooms and laboratories. Direct radiation can kill or inactivate organisms such as bacteria or viruses. UVC systems are well suited as a supplement to other disinfection methods.



UVC tubes for sterilizing air and surfaces. Photo: Bjorn Johnsen, DSA.

Although studies so far have not been conducted on the coronavirus SARS-CoV-2, it has some similarities with other known viruses. It can be assumed that UVC radiation also inactivates this virus after a few minutes of direct radiation. UVC radiation causes acute damage to the skin and eye. No person should be exposed to the radiation without protection.

UVC is ultraviolet radiation with wavelengths from 100-280 nm (nanometers, billionths of a meter). UVC radiation is energy rich and very effective in killing or inactivating bacteria, viruses and other microorganisms. Other types of UV radiation are UVA (315-400 nm) and UVB (280-315 nm).

UVC radiation from the sun does not reach the earth's surface, but we can get UVC from special UV lamps. Fluorescent tubes made of quartz glass and filled with mercury vapor are most prevalent. Ninety-five percent of the energy emitted by these tubes is at 254 nm, in addition to some faint, bluish light. Recent technological advances have produced UVC-emitting LED lamps, as well as lamps that can emit shorter UVC wavelengths. UVC sources emit intense radiation that can cause acute skin and eye damage such as sunburn (erythema) and corneal or conjunctival inflammation (snow blindness). Acute eye damage can be very painful. Chronic skin damage may occur. Such sources should never be used on the skin or the eyes (1,2).

DSA

Contact Terje Christensen
Phone 67 16 25 00
Email Terje.christensen@dsa.no

ISSN 2535-7352
Date 28.05.20

Justified Use for Disinfection

The general use of UVC to kill microorganisms in water, in air or on surface is supported. There are studies on the use of UVC sterilization of rooms and surfaces in health institutions as summarized by the National Institute of Public Health (3), but there is no analysis of the benefit or risk of using UVC compared to other disinfection methods against SARS-CoV-2. Many experts who work with disinfection or sterilization using UVC radiation prefer it as an addition to other disinfection. It is impossible to achieve 100% eradication of microorganism using UVC. Just like light rays, the radiation cannot reach the backs of objects or where surface irregularities can shade. Research, including preliminary information on new coronavirus, suggests that coronavirus can survive on surfaces from a few hours to several days. This will vary under different conditions such as type of surface, temperature, sun exposure and humidity (4,5). The new Coronavirus SARS-CoV-2 has certain genetic similarities to the SARS virus (Severe Acute Respiratory Syndrome) which belongs to the coronavirus family (4-6). The coronavirus genetic makeup may confer particular sensitivity to UVC. The corona virus consists of a single-stranded RNA genome, which may be more sensitive to UVC radiation than viruses consisting of double-stranded DNA or double-stranded RNA (7). Therefore, UVC is believed to be able to effectively disinfect surfaces contaminated with SARS-CoV-2 virus (7).

We do not know exactly what dose is needed to kill the SARS-CoV-2. Data for similar viruses indicate that UVC doses of less than 70 J/m^2 significantly reduced the number of single-stranded RNA viruses (7,8). Conventional UV sources (wavelength 254 nm), deliver sufficient doses in a few minutes provided the items to be disinfected are at arm's length and in clear line of sight from the radiation source.

Effectiveness of UVC disinfection may be markedly reduced if SARS-CoV-2 is present in droplets or media containing biological substances that absorb UVC (proteins, pigments). UVC may confer additional patient care benefits. It has been pointed out that the high mortality of Covid-19 in Italy is due to superimposed bacterial nosocomial infections, cf Chronicle in the Aftenposten on 26.3.2020. UVC may confer additional patient care benefits and is effective regardless of bacterial antibiotic resistance. UVC sterilization can simultaneously help reduce hospital bacterial and viral loads if the radiation dosage is appropriately adjusted.

UVC sources emit intense radiation that can cause skin and eye damage, and UVC sources used for disinfection should always be considered "strong non-ionizing sources" as defined in the Radiation protection regulations (9).

The Radiation protection regulations have provisions that apply to work near UVC sources. This is described in more detail in a guide (1). The Working Environment Act has regulations for the physical working environments. The EU directive for artificial optical radiation in the workplace is also applicable (Directive 2006,25/EC) (10).

These laws limit how much UVC radiation a worker should be exposed to, based on the limits of the International Commission for Non-Ionizing Radiation Protection, ICNIRP. These limits are reached after a short time near the source, i.e. about one minute at a meter distance from a normal UVC source. Protective measure must be implemented. It is not necessary to have individual measurements performed to demonstrate such a need.

First and foremost, we recommend making arrangements so that no people are close to the source, thus eliminated exposure completely. This can be done by evacuating rooms, using door switches or shielding around the source. If someone must be near the source, they must use personal protective equipment. The skin can be protected using solid clothing. The eye can be protected by solid protective goggles or visors made of plastic material. International eyewear standards specify types of eye protection.

In addition to radiation protection measure, it must be understood that some UVC sources also produce ozone, which is a toxic gas (2). More information on precautions against ozone can be

found at the Norwegian Labour Inspection Authority.

Myths about disinfecting people

There has been unfounded advice about irradiating people with UVC or intense sunlight to prevent Covid-19. In this regard, the World Health Organization has issued warning and information to dispute these myths. UVB radiation which is part of solar radiation can quite properly destroy DNA and RNA, but its efficiency is many times lower than that of UVC radiation. Any disinfection effect, on human or other surface, can only occur after long periods (hours) of sunlight, under good weather conditions. Both types of radiation can damage the skin and eyes.

References

1. Veileder for bruk av kortbølget ultrafiolett stråling (UVC). Veileder til forskrift om strålevern og bruk av stråling. Veileder 7. Østerås: Statens strålevern, 2005. https://www.dsa.no/publikasjon/veileder-7-veileder-for-bruk-av-kortboelget-ultrafiolett-straaling-uvc.pdf [01.04.2020]
2. SCHEER (Scientific Committee on Health, Environmental and Emerging Risks). Preliminary Opinion on Biological effects of UVC radiation relevant to health with particular reference to UVC lamps, 6 July 2016. https://ec.europa.eu/health/scientific_committees/scheer/docs/scheer_o_002.pdf [02.04.2020]
3. Kirkehei I. Automatisert desinfeksjon av rom og overflater: systematisk litteratursøk med sortering. [Automatic disinfection of rooms and surfaces: systematic reference list]. Oslo: Folkehelseinstituttet, 2017. https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2017/automatisert-desinfeksjon-av-rom-og-overflater-rapport-2017.pdf [02.04.2020]
4. van Doremalen N, Bushmaker T, Morris DH, Holbrook MG et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. N Engl J Med. 2020 Mar 17. doi: 10.1056/NEJMc2004973. [Epub ahead of print]
5. Folkehelseinstituttet. Fakta om viruset og sjukdomen (covid-19). https://www.fhi.no/nettpub/coronavirus/fakta-og-kunnskap-om-covid-19/fakta-om-koronavirus-coronavirus-2019-ncov/?term=&h=1 [02.04.2020]
6. International Ultraviolet Association, IUVA. IUVA Fact sheet on UV disinfection for COVID-19. http://iuva.org/COVID-19 [02.04.2020]
7. Kowalski, Wladyslaw & Walsh, Thomas & Petraitis, Vidmantas. (2020). 2020 COVID-19 Coronavirus Ultraviolet Susceptibility. 10.13140/RG.2.2.22803.22566.
8. Tseng CC, Li CS. Inactivation of viruses on surfaces by ultraviolet germicidal irradiation. J Occup Environ Hyg. 2007 Jun; 4(6):400-5.
9. Forskrift 16. desember 2016 nr. 1659 om strålevern og bruk av stråling (strålevernforskriften). https://lovdata.no/dokument/SF/forskrift/2016-12-16-1659 [01.04.2020]
10. Lov 17. juni 2005 nr. 62 om arbeidsmiljø, arbeidstid og stillingsvern mv. (arbeidsmiljøloven). https://lovdata.no/dokument/NL/lov/2005-06-17-62 [02.04.2020]