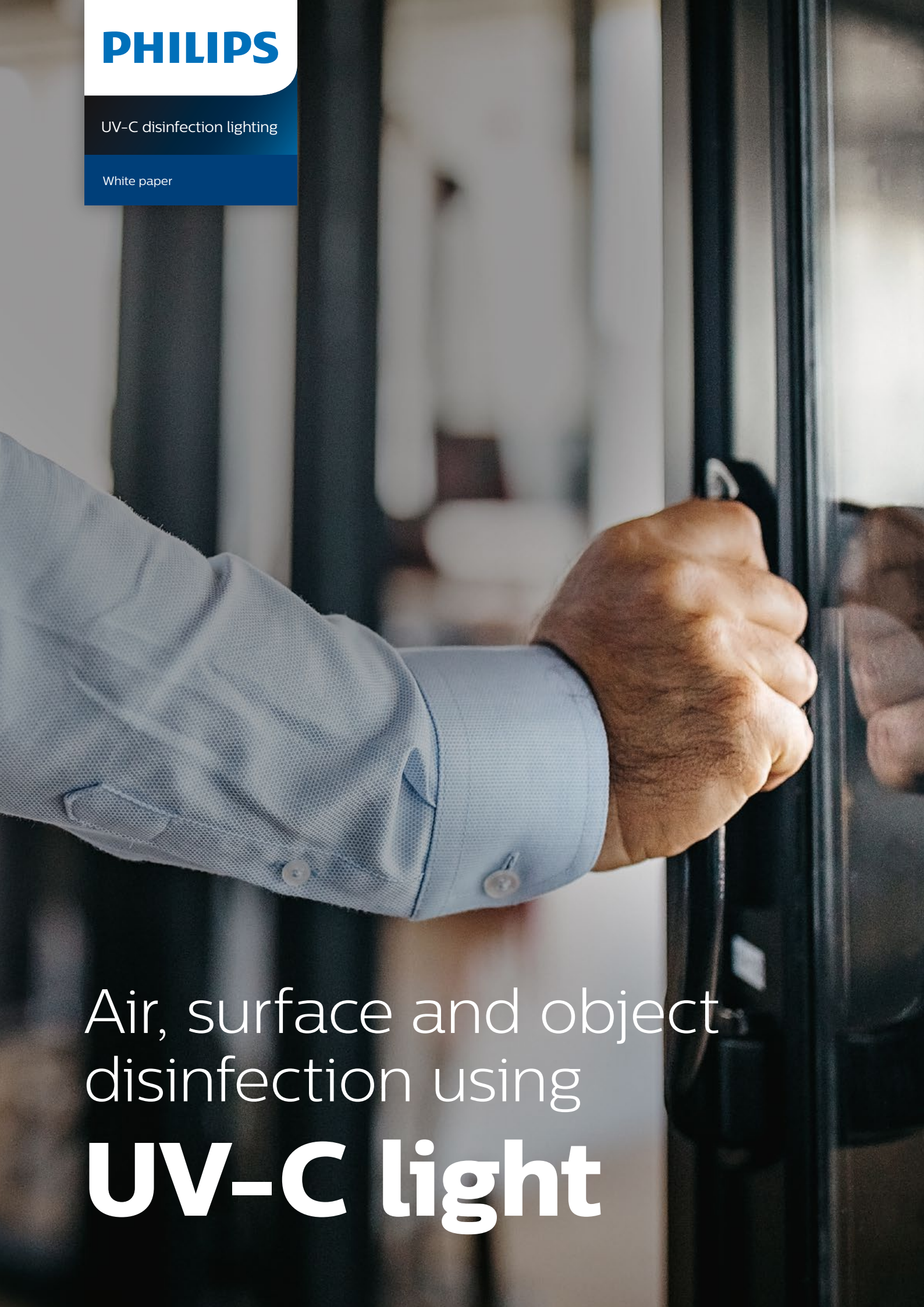
PHILIPS

UV-C disinfection lighting

White paper



Air, surface and object disinfection using **UV-C light**

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We are living in times of uncertainty. As the world continues to weather the global pandemic, there is an urgent demand for a proven, fast and effective way to help protect people from harmful bacteria and viruses.

Bacteria and viruses can cause a wide range of infections, including COVID-19. Any contamination left behind on the everyday things we come into contact with and the air that we breathe can have a profound effect on our health.

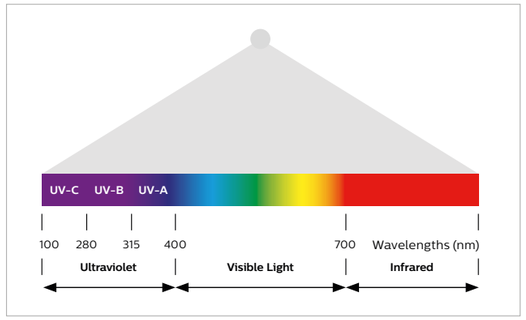
Naturally, the constant need for permanent disinfection poses many challenges to business owners and their staff. Managing costs, availability of cleaning equipment and chemicals, training staff, as well as simply finding sufficient time in busy schedules to prepare and maintain the cleanliness of spaces, all need to be considered.

Ultraviolet (UV) irradiation is an extensively tested, widely used and effective no-contact method for inactivating viral pathogens.[1–3] Today, in the face of a global pandemic, the advantages of UV technology are applicable to a far wider range of settings, where the risk of contracting and spreading diseases from bacteria and viruses is ever present.

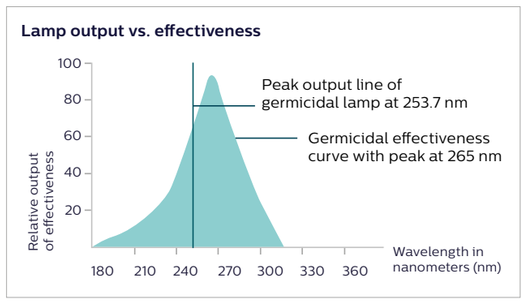
What is UV lighting?

Ultraviolet (UV) is that part of electromagnetic light bounded by the lower wavelength extreme of the visible spectrum and the X-ray radiation band.The spectral range of UV light is, by definition between 100 and 400 nm (1 nm=10-9m) and is invisible to human eyes. Using the CIE classification the UV spectrum is subdivided into three bands:

UVA (long-wave) from 315 to 400 nm
UVB (medium-wave) from 280 to 315 nm
UVC (short-wave) from 100 to 280 nm



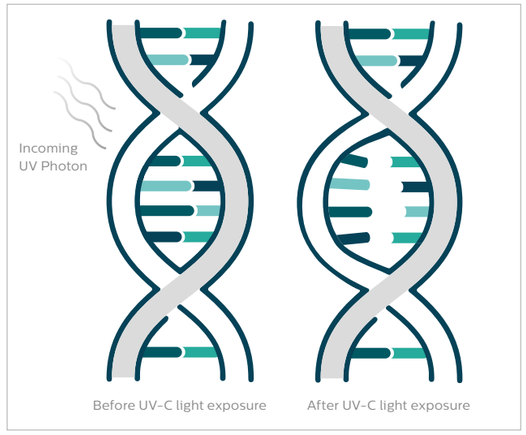
Wavelengths in the photobiological ultraviolet spectral band known as UV-C have been shown to inactivate bacteria, spores and viruses. The peak output of Philips germicidal lamps (253.7nm) is close (80-85%) to the maximum effectiveness of UV-C (265 nm).



How does UV-C work?

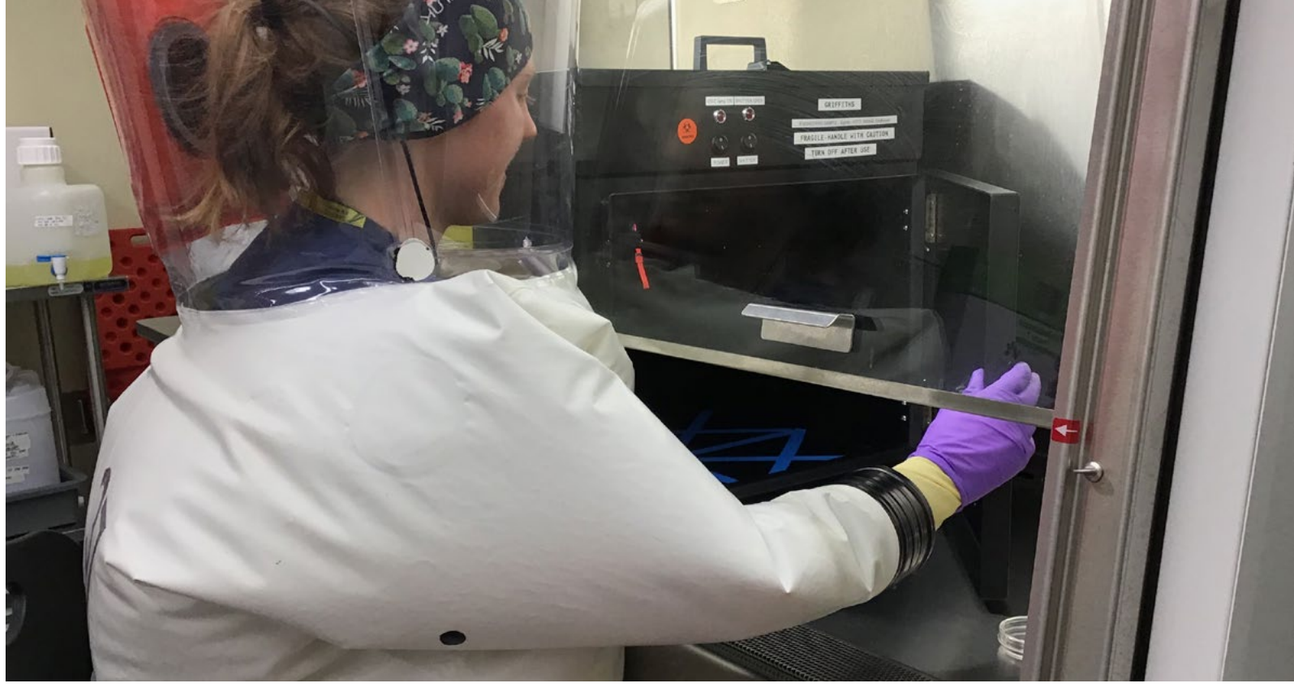
Micro-organisms such as bacteria, moulds, yeasts and protozoa can be destroyed or removed by physical, biological and chemical methods. UV-C works using a photolytic effect whereby the radiation inactivates the micro-organism so that it can no longer multiply.

For DNA it does this by causing adjacent thymine bases to form a chemical bond thus creating a dimmer and if sufficient of these are created, DNA cannot replicate.



All bacteria and viruses tested to date (many hundreds over the years, including various coronaviruses) respond to UV-C disinfection.[4] A clear indication that UV-C light should play a valuable part in the protection strategy agianst COVID-19.

[1] Darnell, M.E.R. *et al.* Inactivation of the coronavirus that induces severe acute respiratory syndrome, SARS-CoV. *J Virol Methods* **121**, 85–91, https://doi.org/10.1016/j.jviromet.2004.06.00 (2004).
[2] McDevitt, J.J. *et al.* Aerosol susceptibility of influenza virus to UV-C light. *Appl Environ Microbiol* **78**, 1666–1669, https://doi.org/10.1128/AEM.06960-11 (2012).
[3] Buonanno, M., *et al.* Far-UVC light (222 nm) efficiently and safely inactivates airborne human coronaviruses. *Sci Rep* **10**, 10285, https://doi.org/10.1038/s41598-020-67211-2 (2020).
[4] Fluence (UV Dose) Required to Achieve Incremental Log Inactivation of Bacteria, Protozoa, Viruses and Algae Revised, updated and expanded by Adel Haji Malayeri, Madjid Mohseni, Bill Cairns and James R. Bolton. With earlier contributions by Gabriel Chevrefils (2006) and Eric Caron (2006) With peer review by Benoit Barbeau, Harold Wright (1999) and Karl G. Linden



Our test results show that above a specific dose of UV-C radiation, viruses were completely inactivated: in a matter of seconds we could no longer detect any virus."

Dr. Anthony Griffiths
Associate Professor of Microbiology at
Boston University School of Medicine

Validating the effectiveness of UV-C light sources on inactivating the virus that causes COVID-19.

Together with the National Emerging Infectious Diseases Laboratories (NEIDL)[5] at Boston University in the US, we have conducted research that validates the effectiveness of Signify's UV-C light sources on the inactivation of SARS-CoV-2, the virus that causes COVID-19.

Since the start of the SARS CoV-2 pandemic, Dr. Anthony Griffiths, Associate Professor of Microbiology at Boston University School of Medicine and his team have been working on developing tools to support scientific advancement in this field. In a study conducted by the National Emerging Infectious Diseases Laboratories (NEIDL) at Boston University in a laboratory setting, Signify's UV-C light sources irradiating the surface of a material inoculated with SARS-CoV-2 (the virus that causes the COVID-19 disease) with a UV-C irradiance of 0.849 mW/cm^2 reduced SARS-CoV-2 virus infectivity to below detectable levels in as few as 9 seconds for dried virus and 4 seconds for wet virus.[6]

The test results suggest that UV-C is an affordable and effective tool for inactivating SARS-CoV-2 in inoculated surfaces that can easily be deployed to help combat the current COVID-19 pandemic.

[5] The NEIDL is a state-of-the-art research facility that encompasses significant containment laboratories at Biosafety Level -2, -3, and -4
[6] Nadia Storm et al., Rapid and complete inactivation of SARS-CoV-2 by ultraviolet-C irradiation, 2020. Subject to peer review and available only as a pre-print at https://www.researchsquare.com/article/rs-65742/v2

Ultimate protection for **air, surfaces and objects**

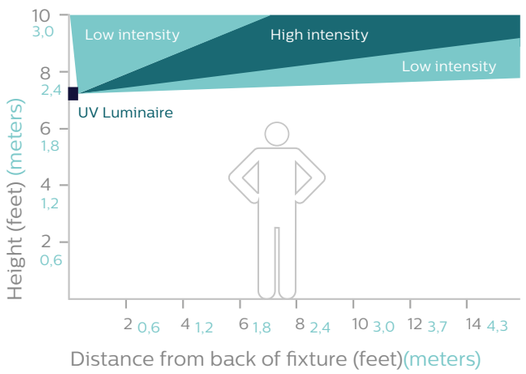
The official position of the World Health Organization (WHO) is that the COVID-19 virus is spread by contact with large respiratory droplets, directly or indirectly by touching contaminated surfaces and then touching the eyes, nose, or mouth.[7] Research is underway to determine the degree of airborne spread – meaning virus in particles so small that they remain suspended in air.

The Philips range of UV-C lamps, luminaires, devices, control systems and services can be used in a variety of air, surface and object disinfection applications.

Air disinfection

Upper air luminaires

In rooms where people are present, upper air UV-C disinfection luminaires can be installed to help to continuously disinfect air. These systems are usually installed at a height of above 2,4 m. By making use of parabolic reflectors, and non-reflective lamellas, the ultraviolet germicidal irradiation (UVGI) can be concentrated in a zone, namely the upper area of a room. Through the mechanism of natural convection of air or with the help of mechanical ventilation in the room, air flows from the lower areas of a room where people are present to the upper areas of a room and gets disinfected as it passes through the UV-C irradiated zone.[8]



[7] IES Committee Report CR-2-20-V1a (IES Photobiology Committee, 2020)
[8] Natural convection of air is a pre-requisite of any UV-C upper air disinfection luminaire solution. Signify usually recommends a design of its UV-C upper air disinfection luminaire solutions taking into account 2 ACH (air changes per hour) as a minimum requirement.

Two hospital controlled studies[9,10] have shown upper air UV-C disinfection to be about 80 % effective against tuberculosis (TB) spread. Even when the radiation is confined to the upper room, good air mixing (ideally with low-velocity ceiling fans, but easily accomplished by other types of forced-air ventilation) results in very high equivalent air changes per hour (ACH) in the lower, occupied space – estimated to be an additional 24 ACH in a South African study.[9]

Air conditioning systems

In air conditioning systems, high output (HO) UV lamps will keep the cooling coil free from biofilm. Combined with photocatalytic oxidation they can also remove VCOs such as odors. Depending on the size of the system, this will require up to 150W of power in commercial applications, or up to 25W in residential applications.[11]

Surface disinfection

Surface disinfection generally requires high-intensity short-wave UV light. In high contact areas such as schools, retail outlets, industry, offices and public transportation, UV-C can be used for a deep disinfection of surfaces (e.g., floors, walls).

Open UV luminaires

Fixed installation on the ceiling, radiating UV-C directly without shielding, therefore no people can be present in the room. A control system and appropriate safeguards are required to be installed together with open UV luminaires to ensure correct and safe usage of the system.

UV-C trolleys

These can be positioned centrally in a standard-sized room to inactivate viruses and bacteria on surfaces.
To support the operator in set up and usage, additional safeguard controls as a timer to plan disinfection for a pre-defined period, remote control, voice alarm and key locks are included. Additional containment safeguards (such as the user manual and mounting instruction) should be deployed together with the UV-C trolley in order to ensure that no people or animals are exposed to the UV-C rays.

[9] Mphaphlele M, Dharmadhikari AS, Jensen PA, Rudnick SN, van Reenen TH, Pagano MA, Leuschner W, Sears TA, Milonova SP, van der Walt M, et al. Institutional tuberculosis transmission. Controlled trial of upper room ultraviolet air disinfection: A basis for new dosing guidelines. Amer J Respir Crit Care Med. 2015;192(4):477-84.
[10] Miller SL. Upper room germicidal ultraviolet systems for air disinfection are ready for wide implementation (editorial). Am J Respir Crit Care Med. 2015;192(4):407-9.
[11] Ultraviolet air and surface treatment (American Society of Heating, Refrigerating and Air-Conditioning Engineers), available at https://www.ashrae.org

Object disinfection

Viruses can live on surfaces for up to 5 days[12], so devices which come into regular contact or are shared between people can provide a higher risk.

UV-C disinfection chambers are designed for the disinfection of objects. Typical usage includes disinfection of shared objects such as headsets, handheld scanners and devices, and even returned clothing in retail stores.

Our UV-C surface disinfection products, fitted with our UV-C light sources, can inactivate SARS-CoV-2 (the virus that causes COVID-19 disease) on surfaces by more than 99% to below detectable levels.[13]

No toxic chemicals

As UV-C disinfection is based on radiation it's a physical, rather than a chemical process thus eliminating the need to make, handle, transport or store toxic, hazardous or corrosive chemicals. It's a simple, sustainable and safety conscious solution. The disinfection effect is directly related to the UV-C dose and leaves no chemical residue, unlike liquid cleaning processes.

However, it is strongly recommended to use UV-C disinfection as part of a disinfection strategy that also includes sanitizing hands, surfaces and objects with liquid disinfectants.

[12] Source: World Health Organization
[13] In laboratory testing, Signify's UV-C light sources reduced SARS-CoV-2 virus infectivity on a surface to below detectable levels in as few as 9 seconds (Nadia Storm et al., 2020, accessible at https://www.researchsquare.com/article/rs-65742/v2). In this study, an exposure to an UV-C irradiance of 0.849 mW/cm² for the duration of 9 seconds was applied, resulting in an UV-C dose of 7.64 mJ/cm². Our UV-C surface disinfection products (fitted with our UV-C light sources) will achieve the same level of virus infectivity reduction as long as the same UV-C dose is achieved on each area of surface that is irradiated.

Benefits of Philips UV-C disinfection luminaires

Reliable
In laboratory testing, Signify's UV-C light sources reduced SARS-CoV-2 virus infectivity on a surface to below detectable levels in as few as 9 seconds.[14]

Effective
All bacteria and viruses tested to date respond to UV-C disinfection.[15]

Efficient
Disinfects air, surfaces and objects in numerous applications as part of a multi-barrier strategy, saving cleaning time and sanitizer cost.

Safety in mind
Philips UV-C products come with physically integrated equipment or time safeguards, or are otherwise to be installed with containment safeguards, to enable safe operation. In addition, we provide training materials to help educate on the correct installation, usage and maintenance of our UV-C products.

Environmentally friendly
All our UV-C solutions emit no ozone gases during or after use.

Versatile
Innovative, high-quality solutions that are suitable for a wide range of applications.

[14] Nadia Storm et al, Rapid and complete inactivation of SARS-CoV-2 by ultraviolet-C irradiation, 2020. Subject to peer review and available only as a pre-print at https://www.researchsquare.com/article/rs-65742/v2. The UV-C irradiance used in this study was 0.849 mW/cm².
[15] Fluence (UV Dose) Required to Achieve Incremental Log Inactivation of Bacteria, Protozoa, Viruses and Algae Revised, updated and expanded by Adel Haji Malayeri, Madjid Mohseni, Bill Cairns and James R. Bolton. With earlier contributions by Gabriel Chevrefils (2006) and Eric Caron (2006) With peer review by Benoit Barbeau, Harold Wright (1999) and Karl G. Linden

Safety first. And second. And third.

All disinfection solutions emit UV-C light in varying amounts, which can be harmful in some circumstances. That's why our products are designed with safety in mind and have very clear installation and usage instructions to avoid exposure to UV-C light, which can damage the eyes or skin.

When used by professionals and people with UV experience, Philips UV lamps and devices present minimal risk. Philips UV-C products are delivered with a range of safeguards and instructions. They come with physically integrated equipment or time safeguards, such as presence or motion detection sensors or timers, or otherwise they are to be installed with containment safeguards to enable correct operation. The safe usage of our products is additionally supported by:

- ✓ A user manual on correct operation, usage and maintenance.
- ✓ Training materials on safety installation standards and compliance – including integration with an alarm system, BMS or control system.
- ✓ Disinfection recipes that specify reach, distance and time of dosage for specific microorganisms.
- ✓ Experienced experts for end-to-end support from design-in and specification to installation, usage and maintenance.

In addition to these safety measures, we strongly recommend that all warnings are clearly communicated on third-party websites, information and instruction materials, as well as in face-to-face meeting and safety briefings.

UV-C light should always be used by professionals in accordance with the safety requirements and instructions to avoid humans and animals from being exposed to it since it can damage their skin and eyes.

Helping to protect people wherever they are

Retail
Keep shelves and counters free from contamination.

Schools
Disinfect classroom walls, floors, desks and surfaces.

Offices
Neutralize work rooms, restrooms, meeting spaces and corridors.

Transportation
Disinfect carriages,compartments, seats and armrests.

Food outlets
Eliminate pathogens on preparation surfaces and equipment.

Hospitality
Disinfect guest rooms, health clubs and reception areas.

We're well prepared so you can be:
with the Philips UV-C disinfection portfolio.

Get more information and find the right product for you now at **philips.com/uv.c**

www.philips.com/uv-c