



## COVID-19

# Upper-Room Ultraviolet Germicidal Irradiation (UVGI)

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## Background

CDC recommends a layered strategy to reduce exposures to SARS-CoV-2, the virus that causes COVID-19. A layered strategy combines multiple prevention strategies such as [consistent and correct use of masks](#), [ventilation](#), [physical distancing](#), [cleaning and disinfection](#), and [hand hygiene](#).

Ventilation interventions can help reduce the number of infectious viral particles (e.g., SARS-CoV-2) in the air. Ventilation [interventions](#) include opening windows, using fans, adding high-efficiency particulate air (HEPA) fan/filter systems, and adding upper-room ultraviolet germicidal irradiation (UVGI). This factsheet presents information on upper-room UVGI, which can be effective at reducing exposures to SARS-CoV-2 in some group settings.

## General UVGI Facts

### What is UVGI?

Ultraviolet germicidal irradiation, or UVGI, is the use of ultraviolet (UV) energy to kill viral, bacterial, and fungal organisms. UVGI fixtures produce UV-C energy, which has shorter wavelengths than more penetrating UV-A and UV-B rays and pose less risk to human health. **Upper-room UVGI** refers to a disinfection zone of UV energy that is located above people in the rooms they occupy. This kills airborne pathogens in the room where they are released. Fixtures are installed to prevent direct UV exposures to people in the room.

### How does Upper-Room UVGI work?

1. Air passes through the disinfection zone from air flow through HVAC system, fans, and/or open windows.
2. The airborne pathogens are killed once they receive an appropriate amount of UV energy. The particles remain in the air, but they are no longer infectious.

*Note:* For airborne viral particles, upper-room UVGI systems provide air changes per hour that are similar to the introduction of clean air into the space.


## Considerations for Use of Upper-Room UVGI

- The most important locations for UVGI are high-risk indoor settings. These include:
  - Areas with an increased likelihood of sick people (for example, school nurse's office, hospital waiting room).
  - Crowded spaces, particularly when the health status of occupants is unknown (for example, courtrooms, lobbies, homeless shelter sleeping areas).
  - Spaces where people must take off masks to eat or drink (for example, school/institutional cafeterias, restaurants, break rooms).
  - Areas where it is difficult to stay at least 6 feet apart from others.
- UVGI is recommended in spaces with insufficient or no mechanical HVAC systems or where adequate natural ventilation cannot be maintained year-round. Spaces must be at least 8 feet tall, but a minimum ceiling height of 8.5 feet is

preferred, with some airflow to move air (for example, fans at low speed). Upper-room UVGI is not necessary in open-air environments, such as outdoor open-air seating areas.

- If the HVAC system allows for [efficient filtration](#) or provides outdoor air flow above minimum code requirements, it will remove most airborne virus particles and upper-room UVGI would not add as much benefit.

## How has UVGI been used in the past?

Upper-room UVGI has been used for over 70 years to eliminate airborne pathogens. Since 1950, the bulk of the research on upper-room UVGI systems focused on controlling the spread of tuberculosis (TB). [Current guidance](#)  [6 MB, 87 pages] from CDC and National Institute for Occupational Safety and Health (NIOSH) on the design, installation, testing, and safe operation of upper-room UVGI systems is based on science and practice-based evidence to control tuberculosis (TB).

## UVGI and SARS-CoV-2

- To date, UV research on SARS-CoV-2 indicates that the virus that causes COVID-19 is very similar to other coronaviruses (for example, SARS and MERS) regarding the UV dose necessary to inactivate it.<sup>1,2</sup>
- Upper-room UVGI systems can be used to control SARS-CoV-2 as a useful ventilation tool to consider in reducing the spread of infectious pathogens.
- UVGI does not replace the need for cleaning or disinfecting surfaces where infectious SARS-CoV-2 droplets may be present.

## Installation and Maintenance

- Upper-room UVGI systems are generally custom designed for the space in which they will be used. Systems should be designed, installed, and tested with the help of a qualified HVAC professional or a reputable UV-system manufacturer. These professionals have the tools and experience to provide an effective and safe system, including proper installation and positioning of the fixtures, code-compliant electrical connections, and training on proper use.
- A typical room with 500 square feet (ft<sup>2</sup>) of floor space will generally require two to three UV fixtures. The cost to install the system in a 500 ft<sup>2</sup> space is approximately \$1,500 to \$2,500.
- Once installed, the systems require little maintenance. The lamps will need to be replaced once per year, although some manufacturers offer lamps with 2-year replacement schedules. If the lamps become covered with dust, they can be cleaned when the unit is turned off by wiping with rubbing alcohol.
- Any time maintenance on the lamps is required or workers need to access areas near the ceiling (for example, maintaining lighting fixtures, testing smoke detectors), the UV fixtures should be powered off. Maintenance workers should receive special training before working on UVGI systems.

## Implementation Considerations

- Upper-room UVGI systems have been used safely and effectively for decades. However, UV energy directed or reflected into the occupied space has the potential to cause temporary eye or skin damage. Assistance from a qualified HVAC professional or a reputable UV system manufacturer will ensure the system is installed properly so UV energy is directed above occupied space and operates safely.
- The systems should be connected to designated electrical switches with limited access to the public and staff or volunteers not trained in managing the system. For example, consider using lockable switches or placing switches in a restricted area that only trained staff can access using a lock and key. This prevents the UV lamps from being turned on or off unintentionally and allows the fixtures to be safely powered off when necessary without fear of them being powered on during maintenance.
- Influenza viruses are more susceptible to UV energy than the bacteria that causes TB. Thus, any upper-room UVGI system installed to help during the COVID-19 pandemic will also be useful against seasonal flu, if it is properly maintained.<sup>1,2</sup>
- UV-C energy can damage plants placed in the disinfection zone (for example, on the top of tall bookcases or high shelves). The energy can also cause fading and cosmetic blemishes to wood surfaces and wallpapers (most wall and

shelves), the energy can also cause fading and cosmetic blemishes to wood surfaces and wallpapers (most wall and ceiling paints are not affected). Thus, care should be taken when installing upper-room UVGI systems in spaces with ornate architectural elements and plants.

## Selecting an Upper-Room UVGI System

- Care should be taken when using UVGI in areas where people could gain access to the UVGI unit's disinfection zone near the ceiling (for example, overhead storage, bunkbeds). This includes reviewing safety precautions, placing warning stickers where UVGI is located, and having trained staff familiar with the product.
- CDC does not provide recommendations for, or against, any manufacturer or product. Consult with a reputable UVGI professional (a UVGI fixture manufacturer or an experienced UVGI system designer) who is familiar with [NIOSH upper-room UVGI guidelines](#), to design and install the system. Consumers are encouraged to ask professionals for information on previous system installations, testing to ensure safety for room occupants, and training provided with the system. Do not hire a contractor who provides unsubstantiated claims or limited support throughout the design, installation, and operation phase. When hiring an expert:
  - Ask for proof of Environmental Protection Agency (EPA) registration and for a portfolio of UVGI installation projects. The facility that manufactures the UV device that is hung on the wall or suspended from the ceiling should be registered with EPA and the manufacturer should have a significant portfolio of UVGI installation projects, preferably some within medium and larger healthcare facilities.
  - Consider asking about any professional associations the UVGI manufacturer/system designer may be involved with (such as the [American Society of Heating, Refrigerating and Air-Conditioning Engineers](#) [↗](#), or ASHRAE) and if so, in what capacity are they involved.
  - Consider asking about performance guarantees that the manufacturer or professional may provide, and whether they offer ongoing maintenance or training programs for users of their products.

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### Additional Resources

[ASHRAE Epidemic Task Force Filtration and Disinfection Guidance](#)  [1 MB, 38 pages] [↗](#)

[ASHRAE 2020 Handbook—HVAC Systems and Equipment: Chapter 17, Ultraviolet Lamp Systems](#)  [252 KB, 10 pages] [↗](#)

[ASHRAE 2019 Handbook – HVAC Applications: Chapter 62, Ultraviolet Air and Surface Treatment](#)  [4 MB, 18 pages] [↗](#)

[ASHRAE Position Document on Infectious Aerosols](#)  [659 KB, 24 pages] [↗](#)

[CDC COVID-19 Ventilation in Buildings](#)

[CDC/NIOSH Environmental Control for Tuberculosis: Basic Upper-Room Ultraviolet Germicidal Irradiation Guidelines for Healthcare Settings](#)  [6 MB, 87 pages]

## References

1. Clerici M, et al. UV-C irradiation is highly effective in inactivating SARS-CoV-2 replication. *Sci Rep* 11, 6260 (2021). [↗](#)
2. Storm, N., McKay, L.G.A., Downs, S.N. et al. Rapid and complete inactivation of SARS-CoV-2 by ultraviolet-C irradiation. *Sci Rep* 10, 22421 (2020). [↗](#)

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