

Safety Tips for Using Germicidal Lamps

What Are Germicidal Lamps?

Germicidal lamps emit radiation in the UV-C portion of the ultraviolet (UV) spectrum, which includes wavelengths between 100 and 280 nanometers (nm). The lamps are used in a variety of applications where disinfection is the primary concern, including air and water purification, food and beverage protection, and sterilization of sensitive tools such as medical instruments.

Germicidal light destroys the ability of bacteria, viruses, and other pathogens to multiply by deactivating their reproductive capabilities. The average bacteria may be killed in 10 seconds at a distance of 6 inches from the lamp. The wavelength with the greatest effectiveness is 253.7 nm, which defines the germicidal lamp category with optimized wavelength for maximum absorption by nucleic acids. Germicidal lamps that generate energy wavelengths shorter than 250 nm (particularly 185 nm) are very effective in producing ozone, which is required for certain applications to oxidize organic compounds.

Hazard and Risks from Germicidal Lamp UV Radiation

UV radiation (UVR) used in most germicidal bulbs is harmful to both skin and eyes, and germicidal bulbs should not be used in any fixture or application that was not designed specifically to prevent exposure to humans or animals.

UVR is not felt immediately; in fact, the user may not realize the danger until after the exposure has caused damage. Symptoms typically occur 4 to 24 hours after exposure.

The effects on skin are of two types: acute and chronic. Acute effects appear within a few hours of exposure, while chronic effects are long-lasting and cumulative and may not appear for years. An acute effect of UVR is redness of the skin called erythema (similar to sunburn). Chronic effects include accelerated skin aging and skin cancer.

UVR is absorbed in the outer layers of the eye – the cornea and conjunctiva. Acute overexposure leads to a painful temporary inflammation, mainly of the cornea, known as photokeratitis. Subsequent overexposure to the UV is unlikely because of the pain involved. Chronic exposure leads to an increased risk of certain types of ocular cataracts.

Working unprotected for even a few minutes can cause injury. It is possible to calculate the threshold for acute effects and to set exposure limits. It is not possible, however, to calculate threshold for chronic effects; therefore, because no exposure level is safe, exposure should be reduced as much as possible.



Example of biosafety cabinet with germicidal lamp

10 CFR 851 mandates the use of the threshold limit value (TLV) exposure limits established by the American Conference of Governmental Industrial Hygienists (ACGIH). The exposure limit for a germicidal lamp is 6 millijoules per square centimeter. At this level, detectable molecular damage appears to be fully repaired within 24 hours. For the case of continuous exposure for longer than 8 hours, such as is possible for a 10- to 12-hour extended shift or a double shift, special care needs to be taken.

Use of Germicidal Lamps

Biosafety cabinets

UV light has been used in the research laboratory as an effective germicide and virucide for most vegetative organisms and viruses. While it is used for disinfecting the interior surfaces of biosafety cabinets (BSCs) before and after use, UV does not penetrate well and will only disinfect the outer surface of any material stored in a BSC.

Laboratories

UV light installed at the ceiling level in some laboratories is used for air and surface disinfection. It is used secondarily to ventilation controls such as directional airflow, dedicated exhaust, and increased air exchanges.

Controls

Consult the manufacturer's manuals for specific information about the potential exposure level and frequency of radiation, as well as the suggested operating protocols.

An appropriate combination of engineering and administrative controls should be implemented, and appropriate personal protective equipment (PPE) should be worn, to ensure that the risk to health and safety from UV exposure is low. These must be documented in the Work Planning and Control system and Activity Manager.

Engineering Controls

Location

BSCs should be located in a separate room when possible, and access to the room must be controlled. Access to rooms with germicidal lamps mounted to the ceiling must be strictly controlled while the lamps are operating to prevent any possible exposures. Turn off UV lights before entering tissue culture rooms.

Interlocks

- Ensure that enclosures and doors have interlocks if there is the potential for exposure and if users do not need direct access to the UV. Some germicidal lamps have a switch that is interlocked to the room entry door; they are operational only when the door is closed.



Ceiling UV light used for air and surface disinfection

- Laboratories having germicidal lamps without an interlocking switch must strictly control access to that area by posting a warning sign on the door when the lamp is operating. The warning sign should include the following wording: “Caution: High Intensity Ultraviolet Energy. Protect Skin and Eyes.”
- The only significant leakage of UV from a BSC is from the front opening. Taking steps to eliminate that leakage is the key to eliminating exposure. Access to the interior of the BSC while the lamp is operating is controlled by closing the sash. Do not leave sashes open while the UV lights are on. UVR exposure at 18 inches from the front of the open sash can cause skin and eye burns in 15 minutes.
- Some cabinets are equipped with an interlocking switch that deactivates the UV lamp when the sash is opened. Some cabinetmakers manufacture retrofit kits to interlock the sash and UV bulb. Alternatively, a manufacturer can be asked to install such a switch if it has not been installed already. Regardless, personnel must ensure that the UV light is off before working at the cabinet.
- For those cabinets with fixed sashes, an opaque covering can be used to allow air flow while minimizing UV exposure.
- An additional precaution is to install a timer with the UV light. The timer ensures that adequate time is allowed for disinfection and that personnel are not in the room during that time.

Administrative Controls

If interlocks are not fitted, the equipment must be used in conjunction with strict administrative rules to avoid exposure. Typical administrative controls include limiting access, ensuring that personnel are aware of the potential hazards, and providing training and safe working instructions for users.

Training

Personnel should be trained in using the UV equipment safely. The manufacturer’s manuals provide specific safety-related information (type of eye/skin protection needed, ventilation requirements, etc.) that must be completely understood before using the equipment. If any uncertainty or concern exists regarding the safe use of UV-generating equipment, contact the manufacturer for clarification.

Personnel should carefully study the manufacturer’s manuals of the UV-generating equipment and be familiar with its use. It is important never to deviate from the instructions for safe operation without first contacting the manufacturer.

At a minimum, lab personnel should be familiar with the following when working with or around UV light:

- Proper use of the UV light-producing equipment
- Warning signs and labels
- Proper use of protective equipment provided by the manufacturer (e.g., UV shields or enclosures), as well as PPE
- Symptoms of UV exposure

Minimizing exposure

- Never view the UV lamp directly. Although the inverse square law applies to non-laser-beam UVR, it is not advisable to look directly at any UV source (e.g., a germicidal lamp) – at any distance.
- Keep exposure time to a minimum and keep as far away from the source as practicable.
- Turn off UV lights before working in the BSC.
- Restrict access to those personnel who are directly involved with the operation of the UV source. Do not loiter near the cabinets.

Hazard warning signs

Warning signs are necessary to inform about the risk of exposure during use and maintenance. Warning signs should be used where applicable to indicate the presence of potential UVR hazards, to restrict access, and to specify PPE. The warning sign should read “Caution: High Intensity Ultraviolet Light. Wear Proper Eye & Skin Protection.”

BSCs should have the following hazard label located above the sash: “Caution: High Intensity Ultraviolet Light. Turn Off UV Light Before Using Unit.”

Warning signs and labels can be downloaded from the non-ionizing radiation safety web page:

<http://www2.lbl.gov/ehs/safety/nir/index.shtml>.

Personal Protective Equipment

The PPE for BSC use must protect the eyes and skin, and includes gloves, lab coat with no gap between the cuff and the glove, and a UV-protective face shield.

Face shield

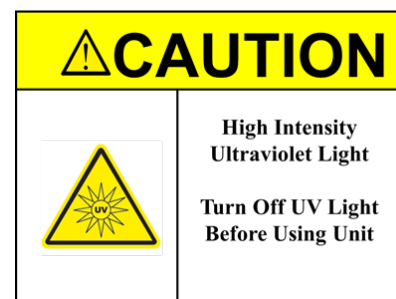
UV-absorbing full-face shields should be worn (goggles may **not** provide sufficient face protection). Severe skin burns can happen in a very short time, especially under the chin (which is often left exposed).

Gloves

At a minimum, nitrile, latex, or tightly woven fabric gloves are recommended. The transmission of UV-A and UV-B through these materials is low compared to vinyl gloves. Gloves should protect personnel from UV light, as well as from the hazard of the activity being performed.

Lab coat

Personnel should wear a fabric lab coat that fastens securely at the wrists and up the neck so that no skin is exposed. Note that burns to uncovered wrists and the neck are not uncommon. Tyvek® protective wear, such as arm shields, coveralls, and lab coats, is not appropriate as a shield from UVR, as it may allow significant leakage of UV through it.



UV-Protective Face Shields

PPE must be either readily available and cleaned between users or personally allocated to each user. Eye and face protection must be inspected either regularly or before each use for damage or defects such as cracks, crazing, or bleaching, and replaced when necessary. Note that PPE may need to serve multiple purposes, such as protecting against chemical splashes and UV.

Environment, Health & Safety Division personnel can provide assistance in measuring UV emissions and selecting the appropriate PPE to wear.

Limitations for Use of Germicidal Lamps

Listed below are limitations that should be considered when using the germicidal lamps:

- In a BSC, UV light is not penetrating. Microorganisms beneath dust particles or beneath the work surface are not affected by the UV irradiation.
- UV intensity is significantly reduced by dust-covered lamps and the interior of BSC cluttered with equipment.
- Bulbs should be wiped on a monthly basis with a soft cloth and dampened with ethanol after the bulb cools down.
- UV lamps should be checked periodically with a UV meter (approximately every six months) to ensure that the appropriate intensity of UV light is being emitted for germicidal activity. The amount of germicidal wavelength light emitted from these bulbs decreases with age, and bulb ratings may vary by manufacturer.
- 254 nm radiation can directly interact with plastics and cause crazing and potential weakening. This can be eliminated using good BSC practices, specifically, by minimizing the amount of material left in a cabinet.
- Humidity adversely affects the effectiveness of UV. Above 70% relative humidity, the germicidal effects drop off extremely.
- Optimum temperature for output is 77°F–80°F. Temperatures below this optimum temperature range will result in reduced output of the germicidal wavelength. Moving air tends to cool the lamp below its optimum operating temperature, which results in reduced output.

Cleaning Up a Broken Lamp

- If lamps are broken, ventilate the area where the breakage occurred. Take the usual precautions for collecting broken glass. Clean up with a mercury vacuum cleaner or with other suitable means that avoids generating dust and mercury vapor. **Do not use a standard vacuum cleaner.** Place collected materials in a closed container.
- After handling broken lamps, remove protective clothing and thoroughly wash hands before eating, smoking, or using toilet facilities.
- Contact your waste generator assistant for assistance with the disposal of spent and broken lamps.

Take-Away Safety Tips

- Units containing germicidal lamps should be interlocked to prevent access while the lamp is on. All open-source UV lights must be risk assessed.
- NEVER tamper with or bypass the interlocks.
- Close the hood sash completely if using UV lights in a BSC. Do not leave sashes open while the UV lights are on.
- Turn off UV lights before working in BSC.
- ALWAYS use appropriate PPE for the hazard, namely, UV face shield, gloves, and buttoned-up lab coat.

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