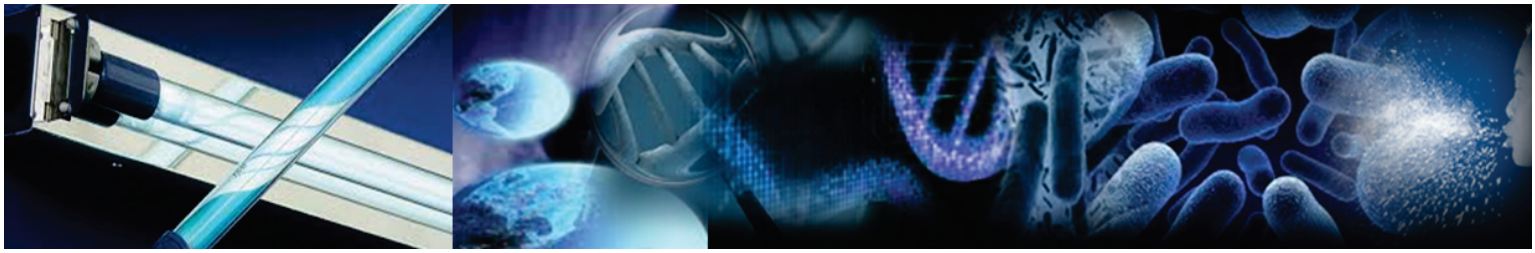


Ultraviolet Germicidal Irradiation - UVGI

Ultraviolet germicidal irradiation commonly known as UVGI or blue lights has been scientifically proven to be effective in controlling disease transmission by disinfecting contaminated air

How does UVGI work?

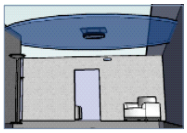
The UV-C light at 254 nm wavelength destroys infectious agents including tuberculosis (TB) by deactivating the DNA/RNA thus preventing the organism from multiplying and causing disease. The disinfection rate depends on the sensitivity of the microorganism, UV light intensity and exposure time. Some microorganisms require more energy due to different cell wall structures. The energy required is measured in microwatt seconds per square centimeter ($\mu Ws/cm^2$). Complete inactivation of infectious agents can occur through a cumulative effect of UVGI exposure over time. Too much mechanical ventilation (>6ACH) reduces the contact time of the infectious particles that are exposed to the UVGI.

Where is UVGI used?

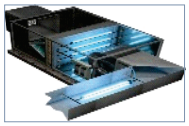
UVGI technology is used in areas with a high risk of infection where ventilation does not meet the regulatory requirements, particularly in crowded environments such as hospital waiting areas, prisons, shelters, communal areas etc. It is also used in areas at risk of contamination such as food production and pharmaceuticals. UVGI is considered a supplement to other infection prevention and control (IPC) measures (e.g. ventilation) and should not be used as a substitute to IPC measures. The installation of UVGI depends on room occupancy, air mixing or ratio of air volume, room size and reflective surfaces.

In every workplace where persons may be exposed to hazardous biological agents (HBA), the R1390 Government Gazette of 27 December 2001 No. 22956 is applicable. This legislation requires that the employer prevent transmission of biological exposure through well maintained engineering controls (e.g. UVGI), which are inspected by an approved inspection authority (AIA) or other competent verified delegate.

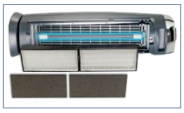
There are different UVGI applications used in various settings:



Upper room UVGI (ceiling or wall mounted): Air exchange between the lower and upper room reduces the levels of infectious agents through UVGI inactivation in the unoccupied upper room.



UV in the ductwork of a ventilation system: Contaminated air passing the irradiated zone inside the duct is disinfected by inactivation of the infectious agents.



Air cleaners: Room air cleaners with enclosed UVGI lamps circulate air to achieve a measure of clean air delivery to the room.

Whole room UVGI: Whole room UVGI sterilises room air and surfaces by exposing the entire room volume to high UV levels. It is, however, impracticable for reducing airborne transmission in occupied rooms.

How can the effectiveness of UVGI be assessed?

UVGI effectiveness can be assessed by a laboratory with competence and experience in testing UVGI performance in reducing the microbial load by at least 90% (D90). South African Bureau of Standards certification (SANS (IEC) 60 598-2-1) for the electronic components is important; however it is NOT certification for effectiveness of disinfection.

Factors influencing the effectiveness of UVGI

UVGI effectiveness is majorly influenced by system planning, space evaluation, design, room air mixing and regular maintenance. Relative humidity should be between 25-60% RH and temperature between 20-24°C for effective UV lamp performance.

NATIONAL INSTITUTE FOR OCCUPATIONAL HEALTH
Division of the National Health Laboratory Service

How to determine UVGI performance?

Device performance should be verified independently in accordance with SATS 1706:2016, and must correspond with the initial specification stipulated in the procurement bid. The performance includes measurement of the UV irradiance (light intensity) as UV lamp output deteriorates with time; lamp replacement at least annually; and periodic inspection and cleaning of dust on the lamp. The selected device's minimum equivalent clean air delivery rate (CADRe, l/s) illustrates device performance. The UV dose should inactivate airborne infectious agents by at least 90% (D90) or a percentage equivalent of the ventilation rate of 80 l/s/per person as recommended by the World Health Organization (WHO).

Key points to consider before implementing UVGI:

1. The need for implementing UVGI as a supplemental measure should be informed by a risk assessment conducted by competent personnel.
2. Risk prioritization and adopting more conventional infection control strategies is essential.
3. Consult with available local standards (e.g. SATS 1706:2016) and guidelines (see reference below) on the design, installation, maintenance and decommissioning of UVGI.
4. Ensure that design planning is conducted prior to developing the procurement specification. Planning involves a multidisciplinary team (infection control & occupational health specialists, ventilation, electrical & building design specialists etc.).
5. If ventilation meets regulatory requirements then UVGI is not necessary.
6. Interrogate efficacy & irradiance testing data of UVGI fixtures from manufactures to ensure performance criteria are met.
7. Maintenance and monitoring should be conducted by trained and competent personnel (in-house or outsourced).

What is the cost of UVGI installation?

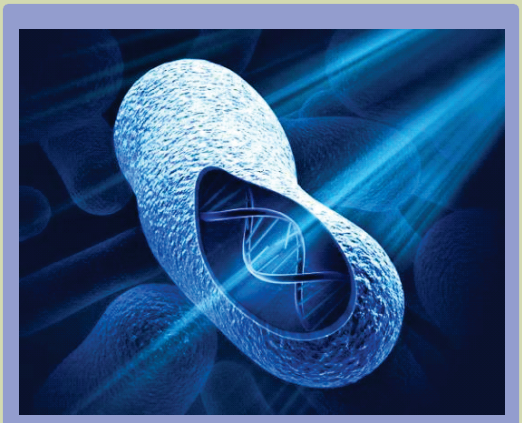
The cost of UVGI installation can be considered as:

i) the cost to purchase and install the fixtures and lamps
ii) the cost to operate the fixtures which include electricity and repairs
iii) the cost of lamp replacement at least annually

References:
Singh, T., P. de Jager, M. Poluta, et al., UVGI disinfection of room air: an evidence based guideline for design, implementation and maintenance. 2015. http://www.iussonline.co.za
Kowalski, W. Ultraviolet germicidal irradiation handbook: UVGI for air and surface disinfection. 2009, Springer Heidelberg.

Services offered by the NIOH Bioaerosol Laboratory

- Risk assessments
- UVGI efficacy testing
- Training on biorisk management
- Consultation on occupational exposures
- Research focusing on infection prevention and control



Is UVGI harmful to your health?

UV-C has a lower skin penetration depth, thus does not easily cause skin irritation or cancers when compared to UV-A and UV-B found in sunlight. Health effects have been associated with high exposure levels to UV-C due to poorly designed or installed UVGI fixtures. The symptoms include:

- eye irritation or conjunctivitis (pink eyes)
- sensitivity to light
- keratitis (inflammation of the cornea of the eye)
- skin erythema (redness of the skin)
- skin carcinogenesis (development of skin cancer)

To prevent health effects, occupant exposure should not exceed 0.4 W/cm^2 for a period of time equivalent to 4 hours per day. It is also important that personal protective equipment (PPE) be worn during lamp inspections and maintenance.

Who may be at risk of exposure?

- Employees in rooms with poorly installed UVGI fixtures
- Patients, contractors, visitors etc. in rooms with high UVGI irradiance levels in the occupied zone
- Maintenance personnel performing repairs and services in the irradiated zone
- Technicians doing inspections and cleaning

This pamphlet was produced by NIOH. For more information or assistance contact the Immunology & Microbiology Section at **www.nioh.ac.za** or contact us at **011 712 6400**
The NIOH is administered from 25 Hospital Street, Constitution Hill, Johannesburg, South Africa