भारतीय मानक

Indian Standard

IS 18687 : 2024

कीटाणुनाशक यूवी-सी किरण उपकरण — सुरक्षा अपेक्षाएँ

Germicidal UV-C Irradiation Devices — Safety Requirements

ICS 29.140.01

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Illumination Engineering and Luminaries Sectional Committee, ETD 49

FOREWORD

This Indian Standard was adopted by Bureau of Indian Standards, after the draft finalized by the Illumination Engineering and Luminaries Sectional Committee had been approved by Electrotechnical Division Council.

This standard specifies the safety requirements and tests for germicidal UV-C irradiation devices emitting wavelength in the range of 180 nm to 280 nm, their rated voltage being not more than 250 V a.c. for single phase appliances, 480 V a.c. for other appliances and not more than 250 V d.c.

This standard is applicable to UV-C devices for use in all kind of applications as mentioned in the standard. Wherever separate safety standards exist for specific products, the same shall take preference over this standard.

UV irradiation is a physical process of disinfection which leaves no chemical trace and is advantageous over chemical disinfection. UV-C radiation is a low-penetrating form of UV as compared to UV-A or UV-B radiation.

UV-C radiation is invisible to humans and exposure to UV-C radiation may have an ill-effect on health. Measurements of human tissue show that 4 percent to 7 percent of UV-C radiation, along with a wide range of wavelengths from 250 nm to 400 nm, is reflected and absorbed in the first 2 μm of the stratum corneum. Hence, the amount of UV-C transmitted through the epidermis is minimized.

Ocular damage due to exposure to UV-C radiation, generally begins with photokeratitis but can also result in photokerato conjunctivitis. Symptoms, which may not be evident until several hours after exposure, may include an abrupt sensation comparable to sand in eye such as tearing and eye pain of various degrees. Such symptoms may appear within 1 h to 12 h after exposure to UV-C radiation and may resolve fully within 24 h to 48 h. Acute overexposure to UV-C band radiation may cause vision incapacitance due to eye discomfort. Generally, this regresses after several days, leaving no permanent damage.

Cutaneous damage due to exposure to UV radiation consists of erythema (a reddening of the skin akin to sunburn but without tanning). The maximum effect of erythema occurs at a wavelength of 297 nm in the UV-B band. UV-C radiation at a wavelength of 254 nm is less effective in causin gerythema. Therefore, the areas subject to exposure should be marked and warning signs should be placed at suitable locations to protect personnel or passers-by from UV hazards.

Considerable assistance has been taken from IEC PAS 63313 : 2021 (position statement on germicidal UV-C irradiation-UV-C safety guidelines) in preparation of this standard.

A separate standard specifying the performance requirements for germicidal UV-C irradiation devices is under preparation.

The composition of Committee responsible for formulation of this standard is given in Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GERMICIDAL UV-C IRRADIATION DEVICES — SAFETY REQUIREMENTS

1 SCOPE

1.1 This standard specifies the safety requirements and tests for germicidal UV-C irradiation devices emitting in the wavelength range of 180 nm to 280 nm, their rated voltage being not more than 250 V a.c. for single phase appliances, 480 V a.c. for other appliances and not more than 250 V d.c.

NOTES

1 This standard specifies photo-biological and ozone safety requirements for limiting human exposure. For other general safety requirements (electrical, mechanical, thermal etc), please refer IS 302 (Part 1).

2 The term 'UV-C devices' is invariably used in the standard to denote 'Germicidal UV-C irradiation devices'.

3 Open/Partially-open portable UV-C devices shall be operated by skilled personnel

1.2 This standard also covers UV-C devices with in-built batteries.

1.3 This standard does not cover :

a) application environments of UV-C devices;

b) products combining UV-C irradiance disinfection with chemicals and additives;

c) UV devices that emit radiation other than UV-C radiation, such as UV-A, UV-B and near UV devices; and

d) Requirements to prevent material degradation and material damage.

NOTES

1 The safety requirements specified in this standard for risk group (RG) ≥ 1 products are limited to continuous exposure for not more than 8 h in a 24 h light/dark cycle. In case of continuous exposure for more than 8 h, special care shall be taken for products having risk group (RG) ≥ 1.

2 The standard assumes a normal 24-h light/dark cycle where cellular repair takes place, after the exposure from products with risk group ≥ 1 is discontinued , (source: ICNIRP)

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards:

IS No.	*Title*
IS 302 (Part 1) : 2008	Safety of household and similar electrical appliances: Part 1 General requirements (*sixth revision*)
IS 16108 : 2012	Photo-biological safety of lamps and lamp systems
IS/IEC 62368 - 1 : 2018	Audio/video, information and communication technology equipment: Part 1 Safety requirements (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the following terms and definitions shall apply:

3.1 Wavelength — Distance between repeating units of a wave pattern.

NOTE — It is, commonly, designated by the Greek letter, lambda (λ).

3.2 Waveband/Spectrum section/Spectrum band — Electromagnetic spectrum that is usually divided into a large spectral region, small spectral band and narrow spectral lines.

NOTE — Waveband is, commonly, expressed as a specific wavelength range of values. Sometimes, it uses numbers or letters as code.

3.3 Ultraviolet Radiation — Wavelength of the electromagnetic spectrum of radiation from 100 nm to 400 nm.

3.3.1 The range between 100 nm and 400 nm is commonly subdivided into following types as shown in Fig. 1:

a) UV-A: 315 nm to 400 nm;

b) UV-B: 280 nm to 315 nm;

c) UV-C: 200 nm to 280 nm; and

d) Vacuum UV: 100 nm to 200 nm.

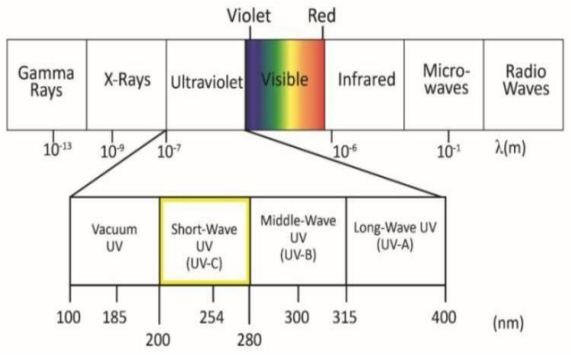


FIG. 1 TYPICAL BAND DIAGRAM OF ULTRAVIOLET RADIATION

UV radiation is classified in accordance to their wavelength and vary in their biological activity and penetration depth of human skin. Radiation of shorter wavelength cause more harm and are less able to penetrate skin.

3.3.1.1 *UV-A radiation*

The relatively long-wavelength UV-A radiation accounts for approximately 95 percent of the total UV radiation reaching the Earth's surface. It penetrates into deeper layers of skin and is responsible for the immediate tanning effect. Furthermore, it also contributes to skin ageing and wrinkling.

NOTE — It was perceived that UV-A do not cause any lasting damage. However, recent studies indicate that it may enhance the development of skin cancers.

3.3.1.2 *UV-B radiation*

Medium-wavelength UV-B radiation is biologically active and does not penetrate beyond the superficial skin layers. It is responsible for delayed tanning and burning. In addition to these short-term effects, it enhances skin ageing and significantly, promotes the development of skin cancer. Much of the solar UV-B radiation is filtered by the atmosphere.

3.3.1.3 *UV-C radiation*

Short-wavelength UV-C radiation is most harmful of all types of UV radiations. It is completely filtered by the atmosphere and hence, does not reach the Earth's surface.

Since UV-C radiation has high photonic energy, it causes disruption of bacteria's DNA and destroy the germs/viruses. Hence, it is most effective radiation type to inactivate all microorganisms and viruses.

NOTES

1 The wavelength of UV-C radiation at lower band limit has been adjusted from 200 nm to 180 nm to include low-pressure mercury lamps of 185 nm. The product safety requirements for this wavelength extension are derived from ICNIRP guidelines, 2004.

2 UV-C radiation of wavelength less than 240 nm can generate ozone.

3.3.1.4 *Vacuum UV*

Vacuum UV is UV radiation of shortest wavelength and has energy to dislodge electrons from the atoms to create ions. The radiation ionises oxygen molecules and produces ozone (O_3). Ozone is powerful oxidant which can kill pathogens through oxidation.

3.4 UV-C Source — Surface or object emitting UV-C irradiance produced by a transformation of energy such as UV-C lamps and UV-C LEDs.

3.5 UV-C Device — Assembly of one or multiple UV-C source (s) and other elements intended to perform a required function. For example, UV-C luminaires, UV-C cabinets, UV-C chambers, UV-C carts/trolleys etc.

3.6 UV Dose and Dose Calculation — Product of UV irradiance and specific exposure time on a given microorganism or surface.

UV-C Dose = UV-C irradiance (μW/cm²) × exposure time (second)

NOTE — UV dose is expressed in millijoules per square centimetre ($1 mJ/cm^2 = 10 J/m^2$).

3.7 Fluence Rate — Fluence across a surface.

NOTE — Fluence rate is expressed in J/m^2, J/cm^2, or $W \cdot s/cm^2$.

3.8 Irradiance — Power of electromagnetic radiation incident on a surface per unit surface area.

NOTE — Irradiance is expressed in microwatts per square centimetre ($\mu W/cm^2$).

3.9 Disinfection — Process of inactivating microorganisms. Disinfection is less lethal as compared to sterilization.

3.10 Ultraviolet Germicidal Irradiation (UVGI) — Optical radiation able to kill or inactivate microbes such as viruses, bacteria, and fungal species.

3.11 UV-C Radiometer — Instrument for measuring electromagnetic energy intensity of UV-C radiation.

3.12 Exposure Time — The duration for which a surface is exposed to UV-C radiation. It is expressed in seconds.

3.13 UV-C Radiance — Density of radiant intensity with respect to projected area in a specified direction at a specified point on a real or imaginary surface:

$$L_e = \frac{dI_e}{dA}\frac{1}{\cos\alpha}$$

where I_e is radiant intensity, A is area, and α is the angle between the normal to the surface at the specified point and the specified direction.

NOTE — For further details, please refer IEV 845-21-049.

3.14 Spectral Irradiance — Quotient of the radiant power dΦ(λ) in a wavelength interval dλ, incident on an element of a surface divided by the area dA of that element and wavelength interval dλ. Its unit is W/m^2/nm.

$$E_\lambda = \frac{d\Phi(\lambda)}{dA \cdot d\lambda}$$

3.15 Closed Enclosure — Enclosures which completely enclose the hazardous UV-C irradiance. A closed enclosure openable by an ordinary person without tools, risking them to radiation exposure, shall be equipped with an automatic shut-down switch.

3.16 Containment Safeguard — Cabinets or controlled access locations which do not form physical part of UV-C device, block physical access to UV-C device while it is under operation or prevent the device from operation when accessed.

3.17 Controlled Access Location — An area where an engineering and/or administrative control measure is established to prevent access during UV-C device operation.

3.18 Equipment Safeguard — Closed enclosure, partially open enclosure and/or presence of detection system forming physical part of the equipment.

3.19 Instructional Safeguard — *See* 6.2.1.

3.20 Ordinary Person — A person who is not skilled.

3.21 Partially Open Enclosure — Enclosure which partially encloses hazardous UV-C irradiance. Partially open enclosures shall define its installation position and mounting properties based for effective UV-C irradiance distribution. In a particular area, properly installed partially open enclosures protect occupants during normal activity while irradiating unoccupied portions. For example, upper-room air disinfection.

3.22 Personal Safeguard — Personal protective equipment worn to reduce radiation exposure to the UV-C device. For example, shields, goggles, gloves, aprons, dose-meters, face masks and breathing apparatus etc.

NOTE — The UV-C personal safeguard complies with **7.4** of IS/IEC 62368-1.

3.23 Presence Detection System — A system of sensors and controls which detects the presence of people. A risk assessment shall be performed on the system of sensors and controls to determine if it qualifies as an equipment safeguard.

NOTES
1 A single motion detection sensor is not a presence detection system.
2 Presence detection system should alert the persons in vicinity through either audio or audio-visual alarm before.

3.24 Skilled person — A person with relevant education qualification and/or experience to identify hazards and take appropriate actions to reduce risk of injury to themselves and others.

3.25 Time Safeguard — A timer that switches off the UV-C power to stay below the human exposure energy of 30 J/m^2 within an 8 h time interval.

3.26 Closed UV-C Device — A device in which the UV-C irradiation source is fully enclosed inside the enclosure, thus, ensuring no risk of exposure of UV-C energy to humans and the environment.

3.27 Partially Open UV-C Device — A device in which UV-C irradiation source is partially enclosed, thus, partially preventing exposure of UV-C energy to humans and the environment.

3.28 Open Type UV-C Device — A device in which the UV-C irradiation source is fully exposed to the environment, thus can pose a health risk to living entities as well as to objects susceptible to damage.

3.29 HVAC Duct — Heating, ventilation and air conditioning duct for carrying cool air or heat air or air to be cooled or heated.

3.30 Air Handling Unit (AHU) — An air handler, or air handling unit is a device used to regulate and circulate air as part of a heating, ventilating, and air-conditioning (HVAC) system.

3.31 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove general qualities and design of a given type of UV-C device.

3.32 Routine Tests — Test carried out on each UV-C device to check the essential requirements which are likely to vary during production.

3.33 Acceptance Test — Tests carried out on samples selected from a lot for the purpose of verifying the acceptability of the lot.

4 CLASSIFICATION

UV-C devices can be broadly classified under three categories as under:

a) Closed enclosure device

A device in which the UV-C source is fully enclosed inside the enclosure, thus, ensuring no risk of exposure of UV-C energy to humans and the environment. For example, box/chamber type devices, devices for closed HVAC system etc.

b) Partially open enclosure device

A device in which UV-C source is partially enclosed, thus, partially preventing exposure of UV-C radiation to humans and the environment. For example, upper room UVGI devices, sanitizing tunnel/ conveyor, partially open hand held devices etc.

c) Open fixtures/devices

A device in which the UV-C source is fully exposed to the environment and can pose a health risk to living entities as well as to objects susceptible to damage. For example, UVGI tower/trolley, ceiling/suspended/wall fixtures, floor standing/table lamps etc.

5 SAFETY REQUIREMENTS

5.1 General Requirements

The UV-C device shall comply with IS 302 (Part 1).

5.2 Photo-biological Safety Requirements

The UV-C device shall comply with the requirements as per the risk group. The risk group shall be declared by manufacturer as per Table 1.

Effective irradiance (E_{eff}) shall be measured in accordance with Annex A.

Table 1 Risk Group Categorization

(*Clauses* 5.2 and 6.4.1)

Sl No.	Risk Group (RG)	Categorization Criteria
(1)	(2)	(3)
i)	Exempt	E_{eff} at d_2 < 1 mW/m^2 t < 8 h
ii)	1	E_{eff} at d_2 < 3 mW/m^2 t < 10 000 s
iii)	2	E_{eff} at d_2 < 30 mW/m^2 t < 1 000 s
iv)	3	$t < \frac{30\ j/m^2}{E_{EFF}@d_2}$

5.3 Ozone Safety Requirements

The long-term ozone exposure shall be limited to 0.1 ppm per volume (≈ 200 µg/m^3) calculated as an eight hour time-weighted average concentration.

NOTE — The limits are derived from **7.3** in IS/IEC 62368-1.

Ozone concentration shall be measured in accordance with Annex A.

UV-C devices emitting ultraviolet radiation at wavelengths less than 240 nm shall comply with the Ozone concentration test.

NOTE — In case of irradiance of wavelength less than 240 mm is not more than 1 percent of the generated wavelength band of 240 mm to 400 nm, ozone concentration test need not be performed.

6 SAFETY SAFEGUARDS

6.1 Safeguards

6.1.1 *Radiation Exposure*

6.1.1.1 For accessible UV-C devices by ordinary persons involving risk group (RG) ≥ 1 shall be provided with the following:

a) Instructional safeguard; and
b) Time safeguard or equipment safeguard.

6.1.1.2 For accessible UV-C devices by skilled personnel only involving risk group (RG) ≥ 1 shall be provided with the following:

a) Instructional safeguards; and
b) Personal safeguard.

6.1.2 *Ozone Exposure*

UV-C devices exceeding the permissible ozone exposure limits as per **5.3** shall be provided with an instructional safeguard. In case of usage of such devices in enclosed spaces, arrangement for ozone concentration through appropriate measures shall also be provided.

6.2 Safeguard type description

6.2.1 *Instructional Safeguard*

All UV-C devices shall be provided with an instructional safeguard complying with the requirements mentioned in 7. The instructions marked on the device shall be legible and indelible.

NOTE — Distinct marking at prominent location on UV-C device for handling of portable devices by skilled personnel shall be made.

6.2.2 *Time Safeguard*

The UV-C devices intends to operate for a certain duration of time to provide effective radiation exposure to the pathogens for disinfection. The time depends upon the energy of radiation and dosage required for disinfection. To prevent direct exposure

of humans to radiation for a period more than permissible limits shall be controlled.

A time safeguard may be provided to automatically switch off UV-C device after a certain time limit. The safeguard ensures that effective dose emitted to disinfect is within the safe prescribed limits for human exposure (1 mW/m^2).

Partially open enclosure device and open fixtures/devices, except those installed in controlled access locations, may be provided with time safeguard in combination with other safeguards to limit irradiance exposure to human beings within safe prescribed limits.

6.2.3 *Equipment Safeguards*

6.2.3.1 *Closed enclosure device*

6.2.3.1.1 Closed enclosure devices for RG ≥ 1, provided with physically accessible access door, panel or any other such provision shall be provided with a switch safeguard. The safeguard automatically switches off the power supply to source and prevent the user from direct radiation exposure. Switch safeguard shall comply with the requirements given in **6.4.2**.

6.2.3.1.2 Closed enclosure devices for RG ≥ 1, provided with physically accessible access door, panel or any other such provision shall also be provided with an interlock safeguard. Interlock safeguard ensure proper and complete closure of the access door/panel to prevent leakage of UV-C radiation. Reliability of the interlock shall be verified by the test given in **6.4.3.**

6.2.3.2 *Partially open enclosure device*

6.2.3.2.1 Partially open enclosure device shall emit sound alert to advise/warn all occupants before start of operation.

6.2.3.2.2 Portable partially open enclosure devices such as portable handheld wands shall be equipped with a push-to-on switch such that the UV-C device operates only when the switch is in pressed state. Provision to automatically shut-down shall be provided whenever they are not in close proximity to any surface. It shall be ensured that the childproof switches are installed on such devices.

6.2.3.2.3 For partially open upper room UVGI fixtures, a blinking red light alarm shall be provided with a warning sign.

6.3 Open Fixtures/Devices (for *RG* ≥ 1)

6.3.1 Open fixture/devices shall be installed in an environment with containment safeguard as per **3.16**.

6.3.2 Automatic presence detectors shall be provided to shut off the device in case of human detection, except in case of controlled access locations.

6.3.3 Inbuilt automatic visual flashing and sound alarms shall activate during the operation of UV-C device.

6.4 Testing of Safeguards

6.4.1 *Time Safeguard Test*

Time safeguard shall be tested as per the following procedure:

a) Switch on the UV-C device with the maximum time limit setting for normal operation;
b) Note the time when the product automatically switches off; and
c) Note the duration for which the product had been in operation.

This time duration shall be less than the time of exposure as per the risk group classification of the device as per Annex A and Table 1.

6.4.2 *Switch Safeguard*

The adequacy of switch safeguard shall be verified as per the following procedure:

a) Switch on the UV-C device for normal operation until stable condition is achieved;
b) Open the accessible panel/door; and
c) Verify if the power supply is switched off and the UV source is no longer ignited.

6.4.3 *Reliability of Interlocks*

Connect the interlocks with suitable load to simulate normal operating conditions. Supply the rated voltage. Durability of interlocks is checked after 50 000 cycle of operation at a rate of 6 cycles/min.

After the test, interlocks shall not be damaged to such an extent impairing its further use.

For interlocks intended for operation only during user maintenance the number of cycles for the test, may be reduced to 5 000 cycles.

7 MARKING REQUIREMENTS

7.1 Marking Requirements

The following shall be marked on the UV-C device, its packaging and leaflet in accordance with Table 3:

a) Manufacturer's name or trademark;
b) Rated voltage (in V);
c) Rated wattage (in W);
d) Type of UV-C source;

e) Batch Number;
f) Date of manufacturing;
g) UV-C warning label with the following details:

1) UV-C warning symbol as shown in Fig. 2.

FIG. 2 UV-C WARNING SYMBOL

NOTE — In addition, other regional required or accepted warning symbols may be utilized.

2) UV-C risk group (RG) and caution text as per Table 2.

Table 2 Instructional Safeguards for Ultraviolet Hazard 180 nm to 280 nm

(*Clause* 7.1(g) (2))

Sl No.	Applicable Risk Group	Text Recommendation
(1)	(2)	(3)
i)	Exempt Risk Group	Not required
ii)	Risk Group 1	a) **NOTICE UV-C** emitted from this product; b) Minimize exposure to eyes or skin; c) Use appropriate shielding; and d) Follow the installation instruction and user manual.
iii)	Risk Group 2	a) **CAUTION UV-C** emitted from this product; b) Exposure may result in eye or skin irritation; c) Use appropriate shielding; and d) Follow the installation instruction and user manual.
iv)	Risk Group 3	a) **WARNING UV-C** emitted from this product; b) Avoid eye and skin exposure to unshielded product; c) Follow the installation instruction and user manual

NOTE — UV-C warning symbol (*see* Fig. 2) and text recommendation as per Table 2 shall be marked in black on a yellow background. Please (*see* Fig. 3).

h) Ozone warning label with the following details :

1) An ozone warning symbol as shown in Fig. 4.

2) Caution text as under:

'**WARNING** harmful ozone may be created by this product. Follow installation and operating.

NOTE — Ozone warning symbol shall be marked in black on a yellow background. An example of ozone warning label is given in Fig. 5.

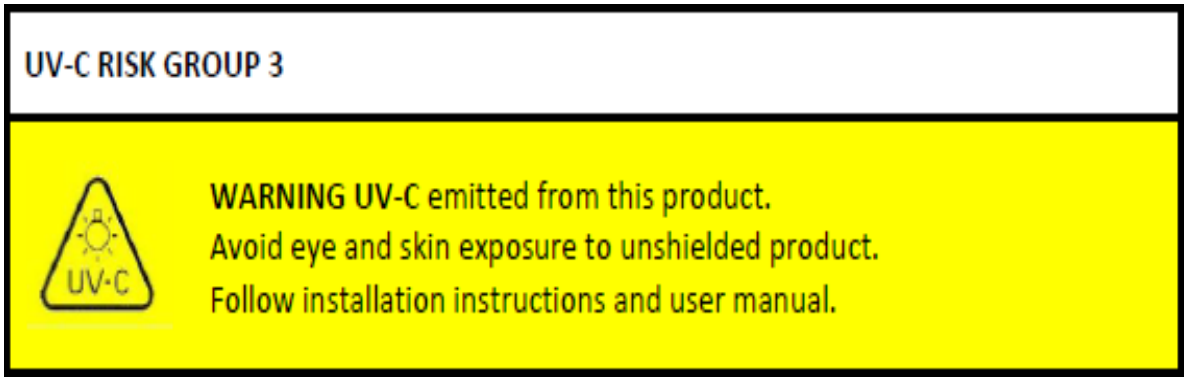


FIG. 3 EXAMPLE OF UV-C WARNING SYMBOL

FIG. 4 OZONE WARNING SYMBOL

NOTES
1 Additional warning symbols as per the requirement may be utilized.
2 The height of the graphical symbol shall be not less than 5 mm.
3 Ozone warning label is required only for the devices generating harmful ozone concentrations as per 6.1.2.

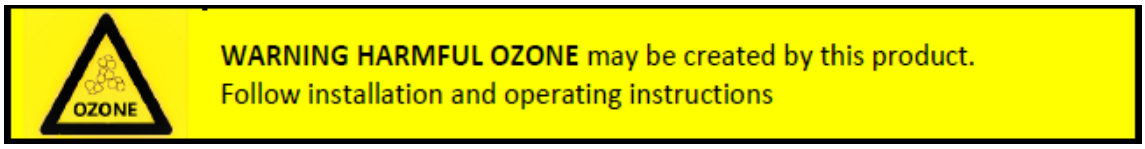


FIG. 5 EXAMPLE OF OZONE WARNING SYMBOL

1) Additional label requirement for environment expecting high ozone concentration depicting emergency overview, the safeguards, first aid procedures, fire procedures and spill procedures. An example of such a warning label is shown below in Fig. 6.

FIG. 6 ADDITIONAL LABEL REQUIREMENTS FOR HIGH OZONE CONCENTRATION EXPECTED ENVIRONMENT

NOTES
1 The height of the warning text shall be not less than 5 mm.
2 Due to size limitation of UV-C device, warning label of height less than 5 mm may be marked.

j) Additional applicable symbols as under shall be marked.

Sl No.	*Symbol*	*Function/Description*
a)	 FIG. 7 READ USER MANUAL BEFORE USE	To indicate that the user manual shall be read before use (*see* Fig. 7).

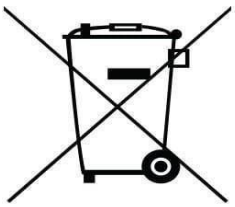
Sl No.	*Symbol*	*Function/Description*
b)	 FIG. 8 KEEP OUT OF REACH OF CHILDREN	To indicate that packages containing devices, devices and equipment that shall be kept out of reach of children (*see* Fig. 8).
c)	 FIG. 9 WEAR PROTECTIVE GEAR COVERING FULL BODY FOR SAFETY	To alert the killed personnel to wear the necessary personal protective equipment (PPE) for safe operation (*see* Fig. 9). NOTE — The symbol shall be marked on UV-C devices with risk group (RG) ≥ 1.
d)	 FIG. 10 MERCURY CONTAINING LAMP REQURING SAFE DISPOSAL	This symbol indicates that lamp source used in the UV-C device contains mercury. At end of life, the lamp classified as ‘e-waste’ shall be safely disposed. Consumer shall deposit such lamps sources at respective collection centres established by manufacturers/ producers/ dealers etc (*see* Fig. 10).
e)	 FIG. 11 TO BE USED BY TRAINED/SKILLED AND AUTHORIZED PERSONNEL ONLY	To indicate that the equipment shall only be operated by skilled/authorized personnel (*see* Fig. 11).

Table 3 Instructions for Marking

(*Clause* 7.1)

Sl No.	Marking clause	Product	Packaging	Leaflet	Website
(1)	(2)	(3)	(4)	(5)	(6)
i)	As per 7.1	a) to f), g(1), g(2), h)	a) to h)	a) to h)	a) to h)

7.5 User Manual

7.5.1 The following information shall be provided as part of user manual:

1) Warning labels (in English/Hindi or regional language) as per 7.1;
2) UV-C device operating wavelength or wavelength range (for broadband sources);
3) Effective irradiance of UV-C device at a distance d_2 = 200 mm as per Annex A;
4) Detailed description of the time, equipment, containment and/or personal safeguards incorporated in the UV-C device;
5) In case of an equipment safeguard in partially open enclosure, the effective UV-C irradiance distribution shall be defined;
6) Adequate instructions (such as audio-visuals) for proper assembly, installation, maintenance, and safe handling/use practices shall be provided;
7) Advice on safe operating procedures and warnings concerning reasonably foreseeable misuse, malfunctions and hazardous failure modes; and
8) Where servicing and maintenance procedures are detailed, explicit instructions on safe procedures to be followed shall be specified.

NOTE — Additional information on user manual is provided in Annex D.

8 TESTS

8.4 Classification of Tests

8.4.1 *Type Tests*

The following shall constitute the type tests to be carried out as per the following:

a) Marking (7.1);
b) Photo-biological safety test (5.2);
c) Ozone concentration test (5.3);
d) Testing of safeguards (6.4); and
e) Type tests as per IS 302 (Part 1) (6.1).

8.4.2 *Acceptance Test*

The following shall constitute as acceptance tests to be carried out as per the following:

a) Marking (7.1);
b) Photo biological safety test (5.2);
c) Ozone concentration test (5.3)
d) Testing of safeguards (6.4); and
e) Acceptance tests as per IS 302 (Part 1) (6.1).

8.4.3 *Routine Test*

The following shall constitute the routine tests and shall be carried out on each product:

a) Marking (7.1);
b) Testing of safeguards (6.2.1); and
c) Routine tests as per IS 302 (Part 1) (6.1).

8.5 Sample Size

Sample size for type and acceptance tests shall be as given below:

Sl No.	Test	No. of samples
(1)	(2)	(3)
i)	Marking	All
ii)	General safety requirements as per IS 302 (Part 1)	As per IS 302 (Part 1)
iii)	Photobiological safety test	01
iv)	Ozone concentration test	01
v)	Testing of safeguard	01

ANNEX A

(*Clauses* 5.2, 5.3 *and* 6.4.1)

METHOD OF MEASUREMENT — IRRADIANCE AND OZONE CONCENTRATION

A-1 GENERAL

The annexure specifies the method of measurement of irradiance and ozone concentration.

A-2 IRRADIANCE MEASUREMENT

For carrying out irradiance measurement, the procedure and conditions shall be as per IS 16108. The effective irradiance of UV-C devices shall be determined as per **A-2** and **A-3.**

A-3 EFFECTIVE IRRADIANCE (Eeff)

The effective irradiance for ensuring photo-biological safety shall be determined as per the following:

A-3.1 Closed Enclosure

The effective UV-C irradiance (E_{eff}) leakage shall be determined as per **A-4** at a distance of 200 mm from the surface of the enclosed device. The highest irradiance shall be noted:

a) In case of no leakage, the same shall be reported; and

b) In case of leakage, risk group shall be determined.

A-3.2 Partially Open Enclosure

The measurement of effective irradiance (E_{eff}) shall be conducted at locations accessible for UV-V radiation exposure.

a) The effective irradiance (E_{eff}) shall be determined as per section **A-4** at a distance of 200 mm from the UV-C source/device and risk group shall be determined;

b) The effective irradiance (E_{eff}) distribution of the partially open devices shall be determined (calculated/measured) as per **A-4** in all relevant directions, intended to radiation exposure, during far-field or near-field operations; and

c) The effective irradiance (E_{eff}) for partially open devices (such as Upper Room UVGI disinfectant etc) shall be determined as per **A-4** at specified level.

Since the recommended height of mounting the 'upper room UVGI disinfectant products' is not less than 2.1 m from the floor level, the measurement of exposed radiation for human exposure shall be carried out at height not be more than 1.8 m from the floor level.

A-3.3 Open Fixtures

Such devices are not recommended for general applications susceptible to direct human exposure. The manufacturer shall specify the distance at which effective irradiance (E_{eff}) limit of the product is less than the safe limit ($0.1\mu W/cm^2$/8 h) and shall be determined as per **A-4**.

A-4 CALCULATION OF EFFECTIVE UV-C IRRADIANCE

To determine the effective irradiance of broadband UV-C devices, its irradiance shall be weighed against the peak of the spectral effectiveness curve (270 nm) according to equation (1).

$$E_{eff} = \sum_{180nm}^{280nm} E\lambda \cdot S(\lambda) \cdot \Delta(\lambda) \quad (1)$$

NOTE — The modification in existing lower and upper wavelengths limits as per IS 16108 has been made to include safety considerations for 185 nm UV-C source.

For monochromatic UV-C devices, equation (1) can be simplified to equation (2).

$$E_{eff} = E\lambda \cdot S(\lambda). \Delta(\lambda) \quad (2)$$

where

E_{eff} = Effective irradiance at a distance d1 from the UV-C device in $\mu W/cm^2$ or W/m^2 and weighted against a 270 nm source;

$E\lambda$ = Spectral device irradiance in $\mu W/cm^2/nm$ or $W/m^2/nm$ measured at a distance d1 from the UV-C device;

$S(\lambda)$ = Relative spectral effectiveness as specified in Table 4; and

$\Delta\lambda$ = Bandwidth of the calculation or measurement intervals (in nm).

Table 4 Spectral Weighting S(λ)

(*Clause* A-4)

Sl No.	UV-range	λ (nm)	S (λ)
(1)	(2)	(3)	(4)
i)		180	0.012
ii)		185	0.015
iii)		200	0.03
iv)		220	0.12
v)	UV-C	222	0.13
vi)		240	0.30
vii)		254	0.50
viii)		260	0.65
ix)		270	1.00
x)		280	0.88

NOTES

1 185 nm and 254 nm are characterstic wavelengths of mercury pressure vapur lamps.

2 Wavelengths indicated are representative in nature. S(λ) at intermediate wavelength shall be derived by logarithmic interpolation.

3 CIE 239 : 2020 TR 'Goniospectroradiometry of optical radiation sources' gives guidance on spectral distribution measurements in the range of 200 nm to 2 500 nm. For effective UV-C spectral irradiance distribution, spectroradiometers or detectors shall be sensitive in the range of interest (180 nm to 280 nm). Below 200 nm, difficulties in measuring irradiance distributions are observed in typical ambient conditions. Nitrogen environment may be required due to ozone blocking of the UV radiations.

4 Broadband UV-C devices that emit in the 280 nm to 400 nm range shall be evaluated as per IS 16108 as such devices have additional product safety requirements.

A-4.1 Effective Irradiance at a Distance *d2*

The effective irradiance from a UV-C device can be determined at any distance d2 by the inverse square law as given in equation (3).

$$E_{eff} \text{ at } d_2 = (d_1/d_2)^2 \cdot E_{eff} \qquad (3)$$

where

E_{eff} = effective irradiance at a distance d1 from the UV-C device in μW/cm² or W/m² and weighted against a 270 nm source; and

E_{eff} at d_2 = effective irradiance at a distance d2 from the UV-C device in μW/cm² or W/m² and weighted against a 270 nm source.

For devices unable to be modelled by the inverse square law (such as collimated sources), the effective irradiance should be measured at all relevant distances.

A.4.2 Effective irradiance at a distance d_2 = 200 mm

The effective irradiance from UV-C devices should be determined in the direction where the highest irradiance occurs and at a fixed distance d_2 of 200 mm.

NOTE — The distance d_2 = 200 mm is derived from IS 16108 and shall be used for all UV-C devices on order to compare characteristics values and to categorize for the respective UV-C risk group.

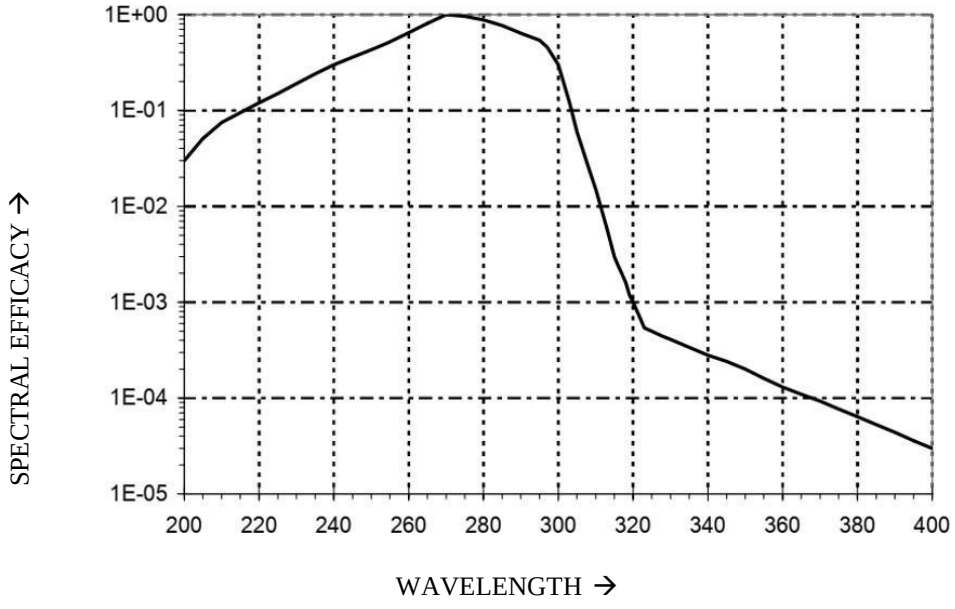


FIG. 12 SPECTRAL WEIGHTING FUNCTION, SUV(Λ), FOR ACTINIC UV HAZARD FOR SKIN AND EYE

A-4.3 UV-C Risk Groups

The UV-C risk group shall be determined on the basis of Eeff at 200 mm and the exposure time (t) as per the Fig. 13.

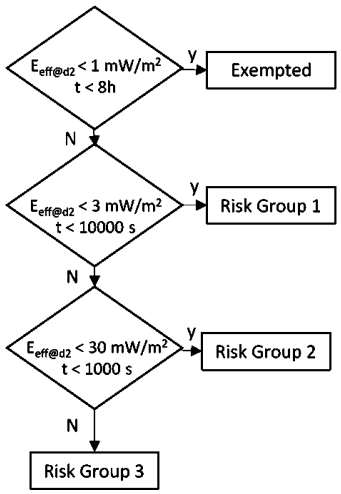


FIG.13 FLOW CHART TO DETERMINE UV-C RISK GROUPS

A-5 MEASUREMENT OF OZONE CONCENTRATION

The measurement shall be carried out in a closed chamber of dimensions 2.5 m × 3.5 m × 3.0 m. The walls shall be covered with polyethylene sheet.

NOTE — The dimensions of the test chamber shall be increased in accordance with the coverage volume declared by manufacturer.

The device is positioned in accordance with the instruction manual. For table positioned devices, it shall be placed in the centre of test chamber at 750 mm above the floor level. The test chamber is maintained at 25 °C and 50 percent RH. The device is supplied at rated voltage for 24 h.

The ozone sampling tube is located at 50 mm from the device where maximum radiation exposure is possible. The ozone concentration is calculated as the difference between the maximum concentration measured during the test and the background ozone concentration measured prior to the test.

ANNEX B

(*Informative*)

GERMICIDAL UV-C IRRADIATION DEVICES — SOURCES, APPLICATIONS AND POTENTIAL HAZARDS

B-1 GENERAL

Disinfection through ultraviolet germicidal irradiation (UVGI) uses the UV-C radiation to kill or inactivate microorganisms by destroying their nucleic acids and disrupting their DNA structure, thereby, leaving them unable to perform vital cellular functions.

This informative annexure provides information on the available sources of UV-C radiation for disinfection, prevalent applications of UV-C devices and potential hazards associated with exposure to UV-C radiation.

B-2 SOURCES OF UV-C RADIATION

The following available sources of UV-C radiation for disinfection are as under:

a) Low-pressure mercury vapour lamps

A gas discharge lamp that uses electric arc through vaporized mercury to produce light, and other electromagnetic radiation.

The principle difference with respect to ordinary fluorescent lamp is that of non-phosphor coating for conversion of UV radiation to visible light and usage of special glass for UV transmission.

The resonant wavelengths emitted from the low-pressure discharge lamp are 254 nm (most widely utilized dominant wavelength for the purpose of disinfection) and 185 nm (ozone producing wavelength absorbed by the special glass of the lamp).

Regular and high output (HO) lamps are commonly used for air, surface and water disinfection, while amalgam UV-C lamps are used mainly for water disinfection.

NOTE — The variation in UV-C radiation output of low pressure mercury vapour lamps is dependent on temperature. The variations are more prominent in soft glass lamps than for quartz lamps.

b) Medium-pressure and high-pressure mercury vapour lamps

The radiation from Medium-pressure mercury lamp contains considerable amount of UV-A, UV-B and light in the visible spectrum.

However, UV-C radiation (250 nm to 280 nm) in medium-pressure mercury lamps is capable of germicidal applications, primarily, for flowing water disinfection requiring high capacity such as city water supply etc.

c) Pulsed-driven xenon lamps

A specialized type of gas discharge lamp that produces light in the visible spectrum and other electromagnetic radiations, by passing electricity through ionized xenon gas at high pressure.

Pulsed-driven xenon lamps are high intensity discharge sources with transient power of more than 50 000 W, generating very high intensity radiation in single pulse. Xenon lamps emit radiation of wavelength around 275 nm, which can be utilized for germicidal applications.

NOTE – Intensive pulsed light (IPL) has been proven effective for disinfection of air, surface, and food providing advantage of rapid and effective treatment. However, high energy consumption and critical heat dissipation requirements limits the application of IPL.

d) Excimer lamps

The lamps belong to mercury free class of disinfecting lamps which emit narrow band radiation of wavelength around 222 nm. The emitted radiation can efficiently inactivate bacteria and viruses without causing harm to exposed skin and eyes.

NOTE — The potential use of excimer lamps is in open luminaires for air and surface disinfection. However, the study of inactivation effect as well as the physiological innocuousness of UV-C radiation at wavelength around 222 nm is under research.

e) UV-LEDs

LEDs emit irradiation in UV-A, UV-B and UV-C range. However, the efficacy of UV LEDs reduces from UV-A to UV-C range. Since UV-C LEDs are directional sources and thereby, direct the radiation energy towards the target more efficiently.

B-3 APPLICATIONS OF UV-C DEVICES

The prevalent application of germicidal UV-C irradiation devices for disinfection purposes is stated as under.

B-3.1 Air Disinfection

Trapped or recirculated indoor air may contain bacteria, moulds and viruses. The contaminants spread throughout the building can cause infection, resulting in illness to occupants.

The contaminants and the associated airborne infections can be considerably reduced by applying UV-C germicidal irradiation in open controlled access locations, partially open upper-air purification luminaires or in closed heating, ventilation, air conditioning and cooling (HVAC) systems. In commercial and medical installations, air disinfection units are installed and operated by trained personnel for prevention of exposure hazards.

B-3.1.1 *Open Controlled Access Locations*

This method of air disinfection is used where the interior is unoccupied or where it is possible for the occupants to take protective measures against the UV-C radiation (*see* Fig. 14).

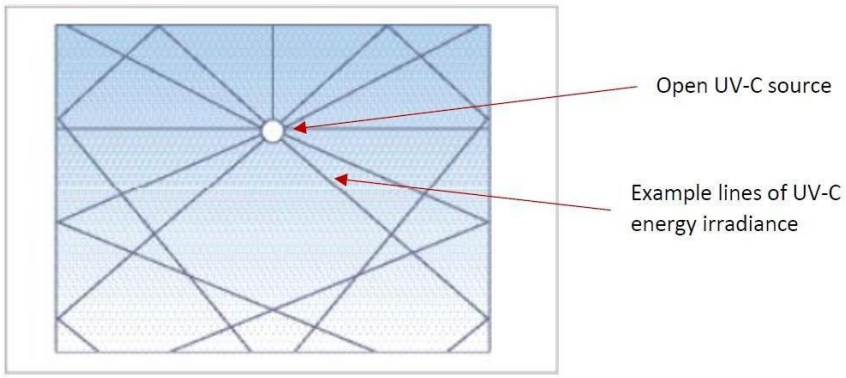


FIG. 14 TYPICAL EXAMPLE OF OPEN TYPE UV-C SOURCE

B-3.1.2 *Partially Open Upper-Air Disinfection Luminaires* (*see Fig. 15*)

This method of air disinfection can be used in occupied indoor areas. The UV-C radiation source (lamps) (*see* Fig. 17) are mounted in suitable reflectors to emit no radiation below a certain horizontal level (2.10 m above the floor). This renders the occupied area entirely free of any direct UV-C radiation and protects occupants from radiation exposure risks. The air above specified horizontal level is subject to direct exposure to UV-C radiation and therefore, leading to a lower microbial count.

Ultra-violet germicidal irradiation (UVGI) monitoring sensors with alarms shall be installed in the area at strategic eye levels to ensure that the UVGI level does not exceed the permissible 8 h dose due to change in environment parameter such as improper fixing after maintenance, increase in ceiling reflectance, modification of existing set-up etc.

B–3.1.3 *Closed Heating, Ventilating and Air Conditioning* (*HVAC*) *Systems* (*see Fig.* 16)

Closed HVAC systems completely enclose the UV-C radiation source (lamps). This provide sincreased advantage of not limiting radiation dose to the permissible levels as living beings are not subjected to UV-C radiation exposure.

UV-C sources (lamps) are installed at the sides of cooling coils to check the growth of germs and fungus. The increased air disinfection requirements are met by increasing the intensity of UV-C source irradiation.

NOTE — Condensation of water on cooling coils results in deposition of fungal molds and accumulation of dust resulting in increased air resistance in HVAC system. Thus, installation of UV-C sources to irradiate cooling coils prevent growth of germs and fungus and results in substantial power saving while maintaining efficiency.

This provision allows for centralised disinfection. However, it does not cater to localised in-room transmission of infection. For handling such situations, localised in-room air disinfection systems shall be installed. Further, air sterilization can be attained through installation of UV-C radiation sources (lamps) in the air passage ducts.

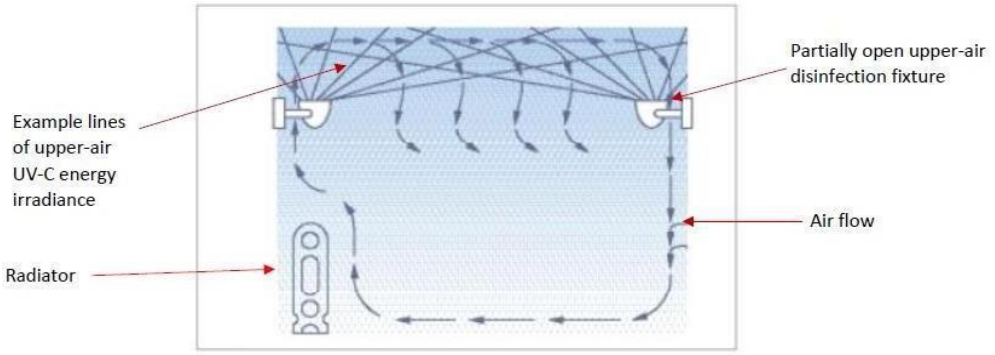


FIG. 15 TYPICAL EXAMPLE OF PARTIALLY OPEN TYPE UV-C SOURCE

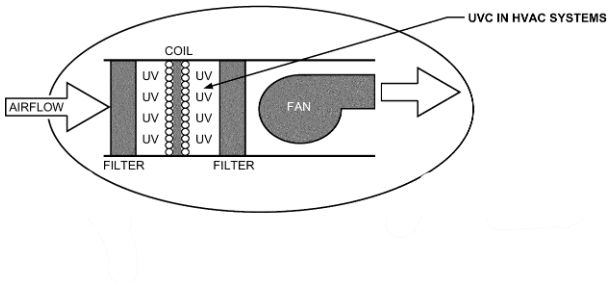


FIG. 16 TYPICAL EXAMPLE OF CLOSED HEATING, VENTILATING AND AIR CONDITIONING (HVAC) SOURCE

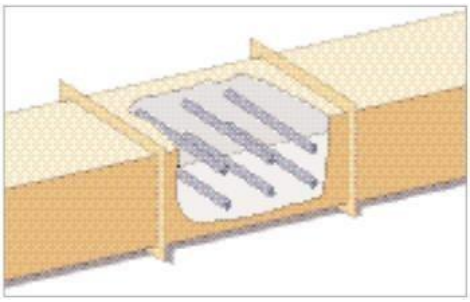


FIG. 17 TYPICAL EXAMPLE OF UV-C RADIATION SOURCE (LAMPS) IN-DUCT APPLICATIONS

B-3.2 Water Disinfection

UV-C devices are intensively used for city water supply and waste-water disinfection. UV-C irradiation provides water disinfection without the addition of chemicals which can result in harmful by-products along with unpleasant tasting water.

UV-C water disinfection systems are mainly closed systems where direct contact between the UV-C source (lamp) and the water is prevented through transparent quartz glass.

Other water disinfection applications include:

a) Drinking water (including water coolers, dispensers, coffee machines);
b) Process water;
c) Swimming pools, and
d) Fishponds and aquarium.

Care shall be taken as water quality parameters such as iron, water hardness, total concentration of suspended solids and the UV transmittance may affect the performance of UV-C devices.

B-3.3 Surface Disinfection

B-3.3.1 *General*

Surface disinfection can be achieved by using UV-C devices such as wands, conveyors, chambers etc.

UV-C surface disinfection is successful when the entire surface is exposed to UV-C irradiance. Bacteria, mold, and viruses may not deactivate due to micro-shadowing of the surface.

Rough surfaces can be treated with short wavelength UV-C radiation (wavelength < 200 nm). The radiation produces ozone (toxic in nature) which penetrates the indentations and tissue of the material leading to deactivation of the bacteria, moulds and viruses. Due to production of ozone, such disinfection shall be used in closed cabinets/chambers.

Solid surfaces, granular materials and packaging (plastic, glass, metal, cardboard, foil etc) are disinfected by means of intensive direct irradiation.

Mass surface disinfection systems such as enclosed conveyors or large chambers are prevalent in industrial and public establishments. Smaller cabinets/based disinfection systems may also be used for surface disinfection in residential set-ups.

NOTE — Disinfection through UV-C radiation occurs at the exposed surface. Surfaces shadowed due to reasons such as physical features of objects, placement of nearby objects etc, are not subjected to disinfection.

B–3.3.2 *Chambers*

These are enclosures containing one or multiple UV-C radiation source(s) for the purpose of disinfection. Suitably designed UV-C chambers may be used for disinfecting a range of objects. Such devices carry no risk of unwanted exposure to living beings. The devices can be of varied shapes and sizes ensuring that UV-C radiation falls from all six surfaces on the object under disinfection.

B–3.3.3 *Wands*

For localised area disinfection, handheld UV-C devices in the shape of wands can be used. Care shall be taken to prevent inadvertent exposure of human body to UV-C radiation through use of personal protective equipment (PPEs). Such devices shall have protection features to prevent direct exposure of operator to UV-C radiation while disinfecting the surfaces. The supplied product user manual shall provide clear instructions on usage and safety aspects.

B–4 POTENTIAL HAZARDS OF UV-C RADIATION

B–4.1 Irradiance Hazard for Human Beings – Eye and Skin

UV-C devices produce a monochromatic or broadband UV-C irradiance from 200 nm to 280 nm wavelength range. For effective disinfection purposes, the UV-C irradiance energy of these UV-C devices is much higher than that of normal sunlight which poses risk to humans and materials on exposure without adequate safety measures.

Following are the identified hazards associated with exposure to UV-C irradiance:

a) The exposure to UV-C irradiance can cause photo kerato conjunctivitis, which is the

inflammatory response of the cornea and conjunctiva. UV-C radiation of wavelengths shorter than 320 nm are most effective in causing this condition. The peak of the action spectrum is approximately at 270 nm.

b) The UV-C irradiance can also cause (actinic) erythema which is reddening of the skin, with or without inflammation, caused by the actinic effect of solar radiation or artificial optical radiation. The symptom is more evident in light-skinned people compared to dark skinned, however, the damage is comparable. Repeated exposure to UV-C radiation can cause skin cancer and is also considered to reduce immunity of the human body.

c) Since UV-C radiation is not detected by the human body through skin sensation or visual effect. As there is no pain sensation, tendency of over-exposure to such UV-C radiation is very high. Hence, great care should be taken to protect humans from UV-C exposure while using such devices.

B–4.2 Hazard Exposure Limits

Actinic UV-C radiation hazard exposure limit for the skin and eye:

The limits for exposure to ultraviolet radiation incident upon the unprotected skin or eye apply to exposure within 8 h period. Continuous exposure for duration greater than 8 h in any day need not be considered. The exposure limit for effective radiant exposure is 30 Jm^{-2}.

Note — The limits are derived from **4.3.1** of IS 16108.

B-4.2 Irradiance Hazard on Materials (Located in the Application Area)

Plastics and some organic materials are susceptible to damage on prolonged exposure to UV-C radiation. Hence, overexposure of such products to UV-C shall be avoided.

NOTE — The effects of UV-C irradiance on materials have not been specified in detail due to limited information available on the subject.

B-4.3 Ozone Generation and Associated Hazards

High ozone concentrations are generated by UV-C devices with emission wavelengths below 240 nm. Ozone is a highly toxic gas which is extremely irritating to the eyes, mucous membranes and respiratory tract. The characteristic odour of ozone can be detected below the permissible exposure limits, therefore, regarded to have adequate warning properties. However, at higher concentrations the ability to smell ozone may decrease.

ANNEX C

(*Informative*)

APPLICATION GUIDELINES FOR USE OF GERMICIDAL UV— C IRRADIATION DEVICES

C-1 Disinfection through UV-C radiation is effective on the surface at line of sight. Surfaces obstructed by the objects block the fall of UV-C radiation on the surface and therefore, do not result in disinfection in the shadowed area. Hence, it shall be ensured that all unnecessary obstructions are removed before initiating the disinfection procedure.

C-2 In general, UV-C radiation do not penetrate through solid substance and are significantly attenuated by most materials. However, quartz glass, soda barium glass, and polytetrafluoroethylene (PTFE) plastic permit higher transmission of UV-C radiation.

C-3 UV-C radiation reflects from polished metal surfaces and various types of painted and non- painted surfaces. However, it may be noted that a surface's ability to reflect visible light does not indicate ultraviolet light reflectance. Observance of blue glowing light on the metal surface from operation of low-pressure UV lamp may indicate the presence of UV-C radiation and therefore, it shall be ensured that there is no exposure risk through its measurement.

C-4 UV-C trolleys devices emit high-power UV-C radiation such that exposure for few seconds can cause severe damage to the eyes and the skin. Therefore, the operator (skilled personnel) must wear personal protective equipment (PPE) and shall ensure the restriction of entry of unauthorized personnel in the area under disinfection through suitable means such as door locking, placement of sign boards etc, It is recommended that the device may have sound/buzzer warning system and red flash lighting system. For portable devices with the provision of automatic operation or remote handling (for switching and movement), automatic presence detection system shall be provided to shut down the device in human presence within the dangerous vicinity.

C-5 For UV-C chambers, the devices shall be equipped with in-built mechanism to shut down the device if the door, inadvertently, opens during the operation.

C-6 Handheld devices shall have adequate protection features so as not to expose the operator to direct exposure to UV-C radiation while operating such devices for disinfecting surfaces. The product user manual shall be supplied with clear instructions on safety aspects and usage.

ANNEX D

(*Clause* 7.5.1)

GUIDANCE ON USER MANUAL FOR OEMS

D-1 GENERAL

The informative annex provides the details on user manual for OEMs. The recommended items are indicative in nature.

a) Installation related instructions;

b) Repair, maintenance and service related instructions; and

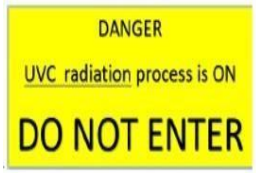
c) Safe handling and safe operation instructions as per Table 5.

Table 5 Recommended Instructions of Safe Handling and Safe Operation

(*Clause* D-1)

Type	Example
(1)	(2)
WARNING/CAUTION STATEMENTS	a) Germicidal ultraviolet sources in this products are shortwave, produce ultraviolet wavelengths lethal to microorganisms in the air, on surfaces and in water; b) Most equipment is intended for indoor use only; c) Do not alter the construction or design. Do not remove safety labels on devices; d) Do not use equipment for other than its intended purpose, as described in the user manual; e) On devices with blowers keep inlet and outlet vents, clean and clear of objects; f) Do not operate equipment if the power cord and/or plug are damaged, or if any other damage to the unit is visible or suspected; g) Protect Equipment from elements and from temperatures below freezing; and h) Do not exceed equipment's maximum flow capacity and/or operating pressure.

UTILITY OF UV-C DEVICE BASED ON OCCUPATION	This Product has been designed for **Occupied** spaces . And/Or This Product has been designed for **UNOCCUPIED** spaces. **DANGER** **MUST** avoid exposure to direct or reflected germicidal ultraviolet rays, since they cause painful eye irritation and reddening of the skin. In order to use the direct germicidal UV-C products, you **MUST** wear personal protection equipment—gloves, Clothing that covers all exposed parts of the body , gloves, neck graters and an ultraviolet-blocking eyeware and face shield to protect eyes and exposed skin. Under no circumstances should any direct germicidal UV-C unit be permitted to operate with humans, plants, or animals present in the operation area.
WARNING/CAUTION AGAINST HEALTH HAZARD	**WARNING** **Avoid exposure to direct or reflected germicidal ultraviolet rays. Germicidal ultraviolet rays are harmful to the eyes and skin.**
WARNING/CAUTION AGAINST ELECTRIZAL HAZARDS	**WARNING** **ARC FLASH AND SHOCK HAZARD** DISCONNECT MAIN POWER SUPPLY BEFORE SERVICING EQUIPMENT **WARNING** **Always disconnect power to the equipment and unplug before performing any service or maintenance.** **CAUTION** **Do not operate without proper electrical ground.**

	 To prevent the risk of severe or fatal electrical shock, special precautions must be taken. Equipment should be plugged into an approved Ground Fault Circuit Interrupt (GFCI) receptacle.
WARNING/CAUTION AGAINST MATERIAL DAMAGE	**CAUTION** Germicidal ultraviolet rays may break down plastic, rubber, or other non-metallic materials, can fade colors, and can be damaging to plant life. Shield all plastic, rubber, or other non-metallic parts, plant life, etc. which may be exposed to direct or reflected germicidal ultraviolet rays.
WARNING/CAUTION DURING OPERATION	 UVC process is on  Use Location Avoidance signages when
READ USER MANUAL BEFORE USE	
KEEP OUT OF REACH OF CHILDREN	

ANNEX E

(*Foreword*)

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Amendments Issued Since Publication

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