DOI: 10.11910/j.issn.2791-2043.2026.3.01

ICS 11.080
CCS C 59

WS

Health Industry Standard of the People's Republic of China

WS/T 10050—2026

Hygienic requirements for ultraviolet disinfection lamp

Issued on June 16, 2026 Effective on December 1, 2026

Issued by the National Disease Control and Prevention Administration

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Foreword

This document was drafted in accordance with the provisions of the Directives for Standardization - Part 1: Rules for the Structure and Drafting of Standardizing Documents (GB/T 1.1—2020).

Please note that certain contents of this document may involve patents. The issuing authority of this document does not assume responsibility for identifying patents.

This document was proposed by the Disinfection Standards Subcommittee of the National Disease Control and Prevention Standardization Committee, and is under the centralized management of the National Disease Control and Prevention Administration.

Drafting organizations of this document: National Institute of Environmental Health, China CDC; Beijing Center for Disease Prevention and Control; Chinese People's Liberation Army Center for Disease Control and Prevention; Air Force Medical Center; Renji Hospital Affiliated to Shanghai Jiao Tong University School of Medicine; Anhui Provincial Center for Disease Control and Prevention; Chinese Center for Disease Control and Prevention (Chinese Academy of Preventive Medicine); Affiliated Hospital of Xuzhou Medical University; Tsinghua University; Leshan Center for Disease Control and Prevention.

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Hygienic Requirements for Ultraviolet Disinfection Lamp

National Disease Control and Prevention Administration

1 Scope

This document specifies the raw materials, technical requirements, methods of use, scope of application, transportation and storage, instruction manual, and precautions for ultraviolet disinfection lamps.

This document is applicable to ultraviolet disinfection lamps that use C-band ultraviolet rays (with a wavelength range of 200 nm to 280 nm) as the germicidal factor.

2 Normative references

The contents of the following documents constitute essential provisions of this document through normative references in the text. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including all amendments) applies.

Standards for Drinking Water Quality (GB 5749)

Discharge Standard of Water Pollutants for Medical Organization (GB 18466)

Hygienic Requirements for Ultraviolet Appliance of Disinfection (GB 28235)

Hygienic Indicators and Limits for Public Places (GB 37488)

General Requirements for Label and Instruction Book of Disinfection Products (GB 38598)

Radiometric Measurement Methods of Ultraviolet Radiation Sources (GB/T 43817)

Test Methods of Disinfection Products (WS/T 10009—2023)

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 ultraviolet disinfection lamp

A special electric light source that directly utilizes ultraviolet rays with a wavelength of 200 nm to 280 nm to achieve disinfection purposes.

Note: It includes general ultraviolet disinfection lamps, electrodeless ultraviolet disinfection lamps, light-emitting diode ultraviolet disinfection lamps, pulsed ultraviolet disinfection lamps, and 222 nm ultraviolet disinfection lamps.

3.2 general ultraviolet disinfection lamp

An ultraviolet radiation source composed of a quartz glass or other ultraviolet-transparent glass envelope and built-in electrodes, which excites low-pressure mercury vapor when current passes through the lamp tube, producing ultraviolet rays with a wavelength of 253.7 nm as the primary germicidal factor.

Note: including single-ended lamps and double-ended lamps.

3.3 electrodeless ultraviolet disinfection lamp

An electrodeless ultraviolet radiation source composed of a quartz glass or other ultraviolet-transparent glass envelope and an induction power coupler, which generates a high-frequency electromagnetic field through electromagnetic induction coupling to excite low-pressure mercury vapor, producing ultraviolet rays with a wavelength of 253.7 nm as the primary germicidal factor.

3.4 light-emitting diode ultraviolet disinfection lamp

An ultraviolet lamp made of light-emitting diodes (LEDs) that emit ultraviolet rays with wavelengths ranging from 260 nm to 280 nm.

3.5 pulsed ultraviolet disinfection lamp

A xenon lamp that excites and generates high-intensity ultraviolet rays with wavelengths ranging from 200 nm to 280 nm using instantaneous discharge pulse technology.

3.6 222 nm ultraviolet disinfection lamp

A krypton chloride excimer lamp that uses ultraviolet rays with a wavelength of 222 nm as the primary germicidal factor.

4 Raw materials

4.1 Ultraviolet disinfection lamps shall be made of quartz glass or other raw materials with the ultravi-

olet transmittance not lower than that of quartz glass.

4.2 222 nm ultraviolet disinfection lamps shall be equipped with filtering materials to ensure that the ultraviolet rays after filtration are predominantly at a wavelength of 222 nm.

5 Technical requirements

5.1 Ultraviolet intensity

5.1.1 General ultraviolet disinfection lamp

The intensity of general ultraviolet disinfection lamps shall comply with GB 28235, and the method for measuring the intensity shall follow GB 28235.

5.1.2 Electrodeless ultraviolet disinfection lamp

The initial ultraviolet intensity of electrodeless ultraviolet disinfection lamps shall not be less than 93% of the value specified in Table 1, and the method for measuring the intensity shall follow GB 28235.

5.1.3 Light-emitting diode ultraviolet disinfection lamp The initial ultraviolet intensity of light-emitting diode ultraviolet disinfection lamps shall not be less than the nominal value. For the method for measuring the intensity, refer to GB/T 43817.

5.1.4 Pulsed ultraviolet disinfection lamp

The initial ultraviolet intensity of pulsed ultraviolet disinfection lamps shall not be less than the nominal value. For the method for measuring the intensity, refer to GB/T 43817.

5.1.5 222 nm ultraviolet disinfection lamp

The initial ultraviolet intensity of 222 nm ultraviolet disinfection lamps shall not be less than the nominal value, and the method for measuring the intensity shall follow GB 28235.

For 222 nm ultraviolet disinfection lamps, the proportion of ultraviolet rays with a wavelength of 222 nm (±5 nm) shall be greater than 85%, and the proportion of ultraviolet rays with wavelengths ranging from 200 nm to 235 nm shall be greater than 97%.

5.2 Requirements for microbial killing

5.2.1 Air disinfection

5.2.1.1 Laboratory test

Disinfection shall be carried out in an aerosol chamber at a temperature of 20℃ to 25℃ and a relative humidity of 50% to 70%, according to parameters and procedures specified in the product instruction manual, such as the minimum effective disinfection dose, for the specified duration. The log reduction value for Staphylococcus albus (8 032) contaminated in the air shall be greater than or equal to 3.00. The test method shall follow 5.3 of WS/T 10009—2023.

5.2.1.2 Field test

Under natural field conditions, disinfection shall be carried out according to parameters and procedures specified in the product instruction manual, such as the minimum effective disinfection dose, for the specified duration. The elimination rate of natural bacteria in the air shall be greater than or equal to 90%. The test method shall follow 5.3 of WS/T 10009—2023.

5.2.2 Disinfection of object surfaces

5.2.2.1 Laboratory test

Under laboratory conditions, disinfection shall be carried out according to parameters and procedures specified in the product instruction manual, such as the minimum effective disinfection dose, for the specified duration. The microbial killing indicator shall comply with the requirements specified in Table 2. The test method at room temperature shall follow 5.5.1 of WS/T 10009—2023. For the test method at low temperature, refer to Annex A.

5.2.2.2 Simulated field test or field test

Under natural field conditions, the simulated field test or field test shall be carried out according to parameters and procedures specified in the product instruction manual, such as the minimum effective disinfection dose. In the simulated field test, the log reduction value for indicator microorganisms con-

Table 1 Specified Values of Initial Ultraviolet Intensity for Electrodeless Ultraviolet Disinfection Lamps

Nominal power/W	60	75	100	150	250	320	400	550	750
Ultraviolet intensity (μW/cm^2)	190	250	305	400	650	720	900	1 150	1 300

Table 2 Microbial Killing Indicator for Laboratory Test

Indicator microorganisms	Test method	Log reduction value
Bacillus subtilis var. niger spores (ATCC 9372) Mycobacterium chelonae subsp. abscessus (ATCC 19977 or CMCC 93326) Staphylococcus aureus (ATCC 6538) Escherichia coli (8099)	Carrier method	≥3. 00

Note: Bacillus subtilis var. niger spores are generally used as the indicator microorganism, or other indicator microorganisms may be selected as required in the product instruction manual.

taminated on the surface of the test object shall be greater than or equal to 3.00; in the field test, the killing rate for natural bacteria on the surface of the test object shall be greater than or equal to 90%. The test method shall follow 5.5.1 of WS/T 10009—2023.

For the evaluation of disinfection efficacy under low-temperature field conditions, the corresponding low-temperature field shall be selected in accordance with the product instruction manual, and the log reduction value for indicator microorganisms on the contaminated carriers shall be greater than or equal to 3.00. For the test method, refer to Annex A.

5.2.3 Water disinfection

5.2.3.1 Laboratory test

Disinfection shall be carried out under laboratory conditions at a temperature of 20℃ to 25℃, according to parameters and procedures specified in the product instruction manual, such as the minimum effective disinfection dose. The Escherichia coli (8099) count shall be reduced to 0 CFU/100 mL. The test method shall follow 5.4 of WS/T 10009—2023.

5.2.3.2 Simulated field test

Disinfection shall be carried out under natural field test conditions, according to parameters and procedures specified in the product instruction manual, such as the minimum effective disinfection dose. The Escherichia coli (8099) count shall be reduced to 0 CFU/100 mL. The test method shall follow 5.4 of WS/T 10009—2023.

5.2.3.3 Field test

Disinfection shall be carried out under natural field test conditions, according to parameters and procedures specified in the product instruction manual, such as the minimum effective disinfection dose. For the disinfection of medical institution wastewater, the number of fecal coliforms in the water after disinfection shall comply with the standard value specified in GB 18466; for the disinfection of drinking water, the microbiological indicator in the water after disinfection shall comply with the standard value specified in GB 5749; for the disinfection of swimming pool water, the microbiological indicator in the water after disinfection shall comply with the standard value specified in GB 37488; for the disinfection of reclaimed water, the microbiological indicator in the water after disinfection shall comply with the standard value specified in the relevant standard for urban wastewater reuse; for the disinfection of other types of water, the microbiological indicator after disinfection shall comply with the requirements of the relevant standard.

5.3 Service life

5.3.1 The effective service life of a general ultraviolet disinfection lamp shall not be less than 1,000 hours, and the retention rate of ultraviolet radiation intensity at the end of its service life shall not be less than 70% of the nominal value.

5.3.2 The effective service life of an electrodeless ultraviolet disinfection lamp shall not be less than 80,000 h, and the retention rate of ultraviolet radiation intensity at the end of its service life shall not be less than 70% of the nominal value.

5.3.3 The effective service life of a light-emitting diode ultraviolet disinfection lamp shall not be less than 10,000 h, and the retention rate of ultraviolet radiation intensity at the end of its service life shall not be less than 70% of the nominal value.

5.3.4 The effective service life of a pulsed ultraviolet disinfection lamp at a pulse frequency of 20 Hz shall not be less than 400 h, and the number of pulses shall not be less than 2.8×10^7. The retention rate of ultraviolet radiation intensity at the end of its service life shall not be less than 70% of the nominal value, and the irradiation dose per unit time shall not be less than 70% of the initial value.

5.3.5 The effective service life of a 222 nm ultravi-

olet disinfection lamp shall not be less than 3,000 h, and the retention rate of ultraviolet radiation intensity at the end of its service life shall not be less than 70% of the nominal value.

6 Methods of use

6.1 Air disinfection

Ultraviolet disinfection lamps shall be installed in accordance with the volume of the space to be disinfected and the product instruction manual. During air disinfection, doors and windows shall be closed, and the ultraviolet disinfection lamps shall be turned on and operate for the specified duration.

6.2 Disinfection of environments and object surfaces

Ultraviolet disinfection lamps shall be installed according to the surface area of objects to be disinfected and the product instruction manual. The lamps shall be turned on, and the surface of items to be disinfected shall be exposed to ultraviolet irradiation for the specified duration. Items shall be placed in such a manner that overlapping and obstruction of surfaces to be disinfected are avoided.

6.3 Water disinfection

Ultraviolet disinfection lamps of appropriate specifications and quantities shall be selected for disinfection based on the quality, volume, and temperature of the water to be treated.

7 Scope of application

7.1 General ultraviolet disinfection lamps are suitable for the disinfection of indoor air, various smooth object surfaces, and water.

7.2 Electrodeless ultraviolet disinfection lamps feature high conversion efficiency and a long service life. They are suitable for the disinfection of various water bodies, such as sewage and drinking water in urban building water tanks; suitable for the disinfection of various smooth object surfaces; and suitable for indoor air disinfection, particularly for air disinfection in the ducts of central air-conditioning ventilation systems.

7.3 Light-emitting diode ultraviolet disinfection lamps feature small size and a long service life. They are suitable for the disinfection of indoor air, water, various smooth object surfaces, low-temperature object surfaces, and low-temperature environments, and are particularly suitable for air and surface disinfection in small spaces.

7.4 Pulsed ultraviolet disinfection lamps feature instantaneous activation and high radiation intensity. They are suitable for the disinfection of indoor air, general object surfaces, low-temperature object surfaces, and low-temperature environments.

7.5 222 nm ultraviolet disinfection lamps feature relatively low acute irritation to skin and ocular conjunctiva. They are suitable for the disinfection of indoor air and various smooth object surfaces.

8 Transportation and storage

8.1 Transportation

General means of transport may be used, and rain-proof and shock-proof measures shall be taken during transportation.

8.2 Storage

The product shall be stored indoors in a dry, well-ventilated place free from corrosive substances.

9 Instruction manual

The instruction manual shall comply with the relevant provisions of GB 38598.

10 Precautions

10.1 The product shall be installed and used in accordance with the product instruction manual and regularly maintained and serviced, and the power supply shall be cut off promptly after use and during maintenance and servicing. When the cumulative service time of an ultraviolet disinfection lamp exceeds its effective service life, the lamp tube shall be replaced.

10.2 Ultraviolet disinfection lamps shall, in principle, be used only in the absence of personnel and shall not be used as lighting. They are strictly prohibited from being used in places where flammable or explosive substances are stored.

10.3 The surface of ultraviolet disinfection lamps shall be cleaned regularly, and the cleaning frequency shall be determined according to the cleanliness level

of the service environment.

10.4 The ultraviolet radiation intensity shall be monitored regularly. When the ultraviolet disinfection lamp reaches 50% of its service life, the monitoring frequency shall be increased. Monitoring shall be carried out using an ultraviolet irradiance meter or ultraviolet lamp intensity chemical indicator cards. When the intensity falls below the specified range, the lamp shall be replaced promptly.

10.5 In addition to monitoring the ultraviolet radiation intensity, the ultraviolet effective dose may also be directly monitored using ultraviolet dose indicator cards. The effective dose shall be measured under the conditions specified in the instruction manual of the ultraviolet disinfection lamp. When it falls below the minimum effective dose specified in the product instruction manual, the lamp shall be replaced promptly.

10.6 When general ultraviolet disinfection lamps, electrodeless ultraviolet disinfection lamps, or 222 nm ultraviolet disinfection lamps are used, and the ambient temperature is not within the optimal range, the irradiation time shall be appropriately extended to ensure effective disinfection.

10.7 When electrodeless ultraviolet disinfection lamps are installed, the amalgam end of the lamp tube shall face downward; if they are installed in a disinfection unit, the operating temperature inside the lamp chamber shall be between 10℃ and 50℃, and severe vibration and impact are strictly prohibited.

10.8 Pulsed ultraviolet disinfection lamps shall be placed in well-ventilated locations, and shall not be placed in damp environments or in direct sunlight.

Annex A

（Informative）

Method for Evaluating the Disinfection Efficacy of Ultraviolet Disinfection Lamps on Low-Temperature Object Surfaces

A. 1 Scope of application

Evaluation of the low-temperature disinfection efficacy of ultraviolet disinfection lamps when they are used for disinfection of low-temperature object surfaces or low-temperature environments.

A. 2 Test equipment and materials

A.2.1 Test microorganisms

Staphylococcus aureus (ATCC 6538), Escherichia coli (8099), and Bacillus subtilis var. niger spores (ATCC 9372). Generally, Bacillus subtilis var. niger spores shall be used as the indicator microorganism. Other indicator microorganisms may also be selected as required in the product instruction manual.

A.2.2 Inoculated carrier

The inoculated carrier shall be selected according to the object to be disinfected. Typically, 10 mm× 10 mm glass slides or circular stainless steel discs of 12 mm diameter (0.5 mm thick) shall be used.

A.2.3 Culture medium

Tryptone soya agar (TSA) culture medium.

A.2.4 Diluent

Phosphate-buffered saline (PBS).

A. 3 Laboratory tests

A.3.1 Inoculated carriers shall be placed in the corresponding low-temperature environment for at least 30 minutes to ensure that indicator microorganisms reach the required low temperature before the test, and the inoculated carriers shall be maintained at the corresponding low temperature throughout the test.

A.3.2 The irradiation position of the inoculated carriers shall be determined. Unless otherwise specified, the irradiation position shall be at the center point vertically below the lamp tube, at a distance of 1 000 mm±1 mm.

A. 3.3 The inoculated carriers shall be arranged in groups of two, without overlapping, and placed flat in sterile Petri dishes.

A. 3.4 The low-temperature environment shall be determined according to the product instruction manual. The ultraviolet disinfection lamp shall be switched on, and the carriers shall be irradiated for the specified duration. The inoculated carriers shall be subjected to viable microbial culture and enumeration.

A. 3.5 The inoculated carriers of the same batch shall be placed in the corresponding low-temperature

environment. Immediately after the disinfection of the test group is completed, two carriers from this batch shall be individually placed into test tubes containing 5.0 mL of PBS, and then vortexed on an electric mixer for 20 seconds or subjected to 80 vigorous shakes. The eluate shall be taken for viable microbial culture and enumeration, and used as the positive control group.

A.3.6 The culture medium used in the same test or PBS-inoculated medium shall be used as the negative control group.

A.3.7 The test shall be repeated three times.

A. 4 Field test

A.4.1 The corresponding low-temperature field shall be selected according to the product instruction manual.

A.4.2 The inoculated carriers shall be placed in the corresponding low-temperature environment for at least 30 minutes to ensure that indicator microorganisms reach the required low temperature before the test.

A. 4.3 Points shall be arranged according to the product instruction manual, and the inoculated carriers shall be placed in the field, with a sample size of not less than 30.

A. 4.4 The ultraviolet disinfection lamp shall be switched on, and the carriers shall be irradiated for the specified duration. The inoculated carriers shall be subjected to viable microbial culture and enumeration.

A.4.5 The inoculated carriers of the same batch shall be placed in the corresponding low-temperature environment. Immediately after the disinfection of the test group is completed, the carriers from this batch shall be placed into test tubes containing 5.0 mL of PBS, and then vortexed on an electric mixer for 20 seconds or subjected to 80 vigorous shakes. The eluate shall be taken for viable microbial culture and enumeration, and used as the positive control group.

A.4.6 The culture medium used in the same test or PBS-inoculated medium shall be used as the negative control group.

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