ASHRAE®

STANDARD

ANSI/ASHRAE Standard 185.2-2014

Method of Testing Ultraviolet Lamps for Use in HVAC&R Units or Air Ducts to Inactivate Microorganisms on Irradiated Surfaces

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NOTE

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FOREWORD

Test standards form the foundation for air-cleaner selection in the ventilation industry. Recent EPA literature states that the most important need in the area of ultraviolet germicidal irradiation (UVGI) is industry standards to rate installed devices. Standards for testing and reporting on products under controlled conditions are essential for both users and specifiers to compare products, predict levels of performance under specified operating conditions with reasonable certainty, and determine appropriate UVGI efficiencies for specific situations. For these reasons, the development of standards has formed an important part of ASHRAE committee activity.

Historically, standards for testing air cleaners were developed in response to the needs of the times. Protection of machinery and coils came first, then reduction of soiling. Recent concerns about indoor air quality (IAQ) and respirable particles, protection of products during manufacture, and protection of HVAC equipment prompted development of test standards based on particle size. Current interest in controlling airborne infectious contaminants or viable species that produce chemical contaminants as metabolic byproducts has created the need to provide a test standard for UVGI equipment.

*Standards Project Committee (SPC) 185 was first organized in 2005 to develop a method of test to determine inactivation rates of airborne microorganisms in air-handling units and air ducts. In 2007 it was divided into SPC-185.1 (*Method of Testing UVC Lights for Use in Air Handling Units or Air Ducts to Inactivate Airborne Microorganism*) and SPC-185.2 (*Method of Testing Ultraviolet Lamps for Use in HVAC&R Units or Air Ducts to Inactivate Microorganisms on Irradiated Surfaces*).*

This is a test method standard, and its results are to be used to directly compare UVGI equipment on a standardized basis irrespective of their application. Results are also used to give the design engineer an easy-to-use basis for specifying UV devices or estimating the relative performance of UVGI for a given application. It is entirely possible that an industry organization may use this test method as the basis for an application standard in which they might require testing at conditions different than those required in this standard.

1. PURPOSE

This standard establishes a test method for measuring the intensity of ultraviolet lamps on irradiated surfaces under typical HVAC&R operating conditions.

2. SCOPE

2.1 This standard describes a method of laboratory testing to measure the ultraviolet C (UV-C) irradiance of ultraviolet lamps used in HVAC&R systems.

2.2 This standard also

a. defines methods of calculating and reporting results obtained from the test data, and
b. establishes a reporting system to be applied to ultraviolet lamps covered by this standard.

3. DEFINITIONS

Terms are defined below for the purposes of this standard. When definitions are not provided, common usage shall apply.

burn-in time: a period of time that UV lamps are powered on prior to putting the lamps into service.

irradiance: the power of electromagnetic radiation incident on a surface per unit surface area, typically reported in microwatts per square centimeter ($\mu W/cm^2$).

mercury vapor lamp: a lamp in which light is produced by an electric arc between two electrodes in an ionized mercury-vapor atmosphere; it gives off a bluish-green light rich in ultraviolet radiation

radiometer sensor grid: a nine-point cross-sectional grid with predetermined locations in which to mount the radiometer sensor head.

reflectivity: the fraction of incident UV-C radiation reflected by a surface.

ultraviolet (UV): ultraviolet electromagnetic radiation, which has a wavelength in the range of 100 to 400 nm. It can be subdivided into ultraviolet A (400 to 320 nm), ultraviolet B (320 to 280 nm), or ultraviolet C (280 to 100 nm) (see *ultraviolet C)*.

ultraviolet C (UV-C): electromagnetic wavelength between 280 and 100 nm, also called *short wave* or *germicidal*. The germicidal UV wavelength (commonly 253.7 nm when generated using a mercury vapor lamp) falls into this UV band.

UV-C device: a complete assembly consisting of lamp(s), ballast(s), and supporting fixture. Also called *UV-C light(s)* in the configurations, as specified by the equipment provider.

4. TEST APPARATUS AND PROCEDURES

4.1 Mandatory and Discretionary Requirements. Critical dimensions and arrangements of the test apparatus are shown in the figures of this section. All dimensions shown are mandatory unless otherwise indicated, and either SI or I-P dimensions are acceptable for any element of the system. Units shown are in mm (in.) unless otherwise indicated. The design of equipment not specified, including, but not limited to blowers, valves, and external piping, is discretionary, but the equipment must have adequate capacity to meet the requirements of this standard.

4.2 Installation of UV-C Device. Installation of the ultraviolet C (UV-C) device, and configuration of the lamp assembly within the device, shall be as designated by the manufacturer or equipment provider. The burn-in time for lamps shall be 100 hours[1] and shall be performed by the test lab.

4.3 Test Duct. The test apparatus shown in Figure 4-1 is designed for test devices with nominal face dimensions of

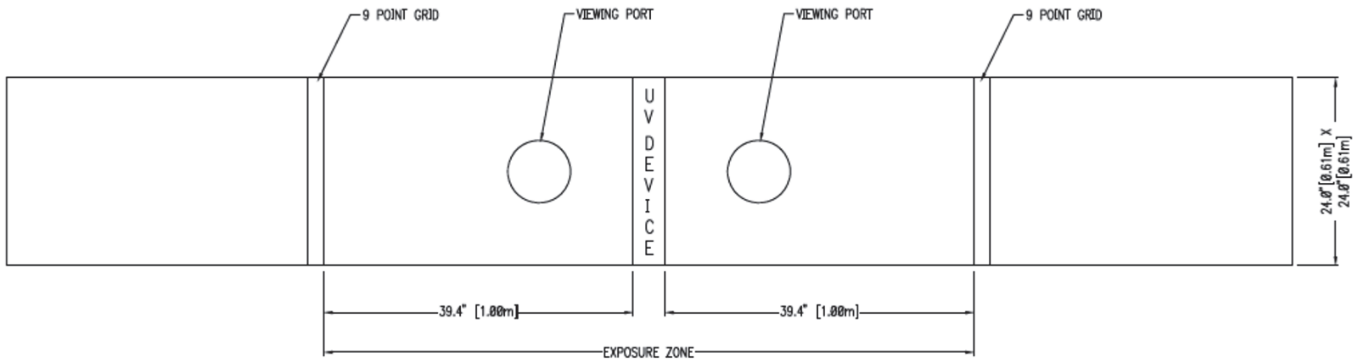

FIGURE 4-1 Test duct section (side-view detail).

610 × 610 mm (24 × 24 in.) and a length of 1 m (39.4 in.) before and 1 m (39.4 in.) after the test section. A radiometer sensor grid (Figure 4-2) shall be located 1 m (39.4 in.) on the upstream and downstream end of the duct section. This test duct section shall be completely lined with flat black felt material to limit reflectivity.

4.3.1 A means of viewing the lamps to verify operation shall be included and consist of UV-absorbing materials to ensure that exposure to radiation does not occur during viewing.

4.3.2 Test duct shall be capable of providing three test temperatures of 12.78°C, 23.89°C, and 48.89°C ± 2.2°C (55°F, 75°F, and 120°F ± 4°F). Relative humidity shall be 50% ± 5%, and air velocity shall be 2.39 ± 0.05 mps (470 ± 10 fpm).

4.3.3 The test duct shall be isolated from vibration caused by the blower or other sources of vibration.

4.3.4 System airflow is measured with an American Society of Mechanical Engineers (ASME) flow orifice[2] or equivalent.

4.4 UV Irradiance Measurement

4.4.1 Radiometer. The planar radiometer sensor shall be cosine corrected and fitted with correction filters to provide spectral response only to UV-C wavelengths between 220 and 280 nm, with a peak response at 254 nm. The radiometer and sensor shall be calibrated annually against a NIST-traceable 254 nm source, according to manufacturer procedures.

4.4.2 UV-C Irradiance Measurement. The general test method calls for measurement of UV irradiance at three different air temperatures at each of nine grid points. The general method describes measurements upstream and downstream of the test UV-C device.

4.4.2.1 Install UV-C device in test duct. The lamp shall be installed in the center of the duct, perpendicular to the flow of air. No part of the lamp shall be closer than 1 m (39.4 in.) away from the radiometer sensor grid.

4.4.2.2 Mount radiometer sensor on the first grid point (at Row A, Column 1). The UV-C irradiance sensor shall be mounted on the radiometer sensor grid within the duct such that the sensor is parallel to the grid and perpendicular to the airflow.

4.4.2.3 Close all accesses to test apparatus.

4.4.2.4 Start airflow through the duct and set the appropriate test conditions for the measurements. Air velocity shall be 2.39 ± 0.05 mps (470 ±10 fpm), and relative humidity shall be 50% ± 10%, for every test. Measurements are to be conducted at each of three air temperatures: 12.8°C (55°F), 23.9°C (75°F), and 48.9°C (120°F).

4.4.2.5 Turn on UV-C device. Allow airflow and device to run at stable conditions for 30 minutes before beginning irradiance measurements.

4.4.2.6 Record one minute average of irradiance from sensor.

4.4.2.7 Move radiometer sensor to next grid-point location. Repeat steps in Sections 4.4.2.4 through 4.4.2.7 until measurements have been taken at all grid points upstream and downstream for a minimum of three replications.

4.4.2.8 Change air temperature. Repeat steps in Sections 4.4.2.4 through 4.4.2.7 at each required air temperature.

5. APPARATUS QUALIFICATION TESTING

5.1 Apparatus Qualification Tests

5.2 Apparatus qualification tests shall verify quantitatively that the test rig and sampling procedures are capable of providing reliable measurements. The tests shall be performed in accordance with Table 5-1.

6. REPORTING RESULTS

6.1 Outline. The summary section of the performance report shall include the following information:

a. Name and location of the test laboratory
b. Date of the test.
c. Test operator's name(s)
d. UV-C device—Lamp manufacturer's name (or name of the marketing organization, if different from the manufacturer)
e. How the UV-C device/lamp was obtained—i.e., from open market, manufacturer, etc.
f. Description of the test UV-C device/lamp, including the following
    1. Brand and model number and any identifying marks

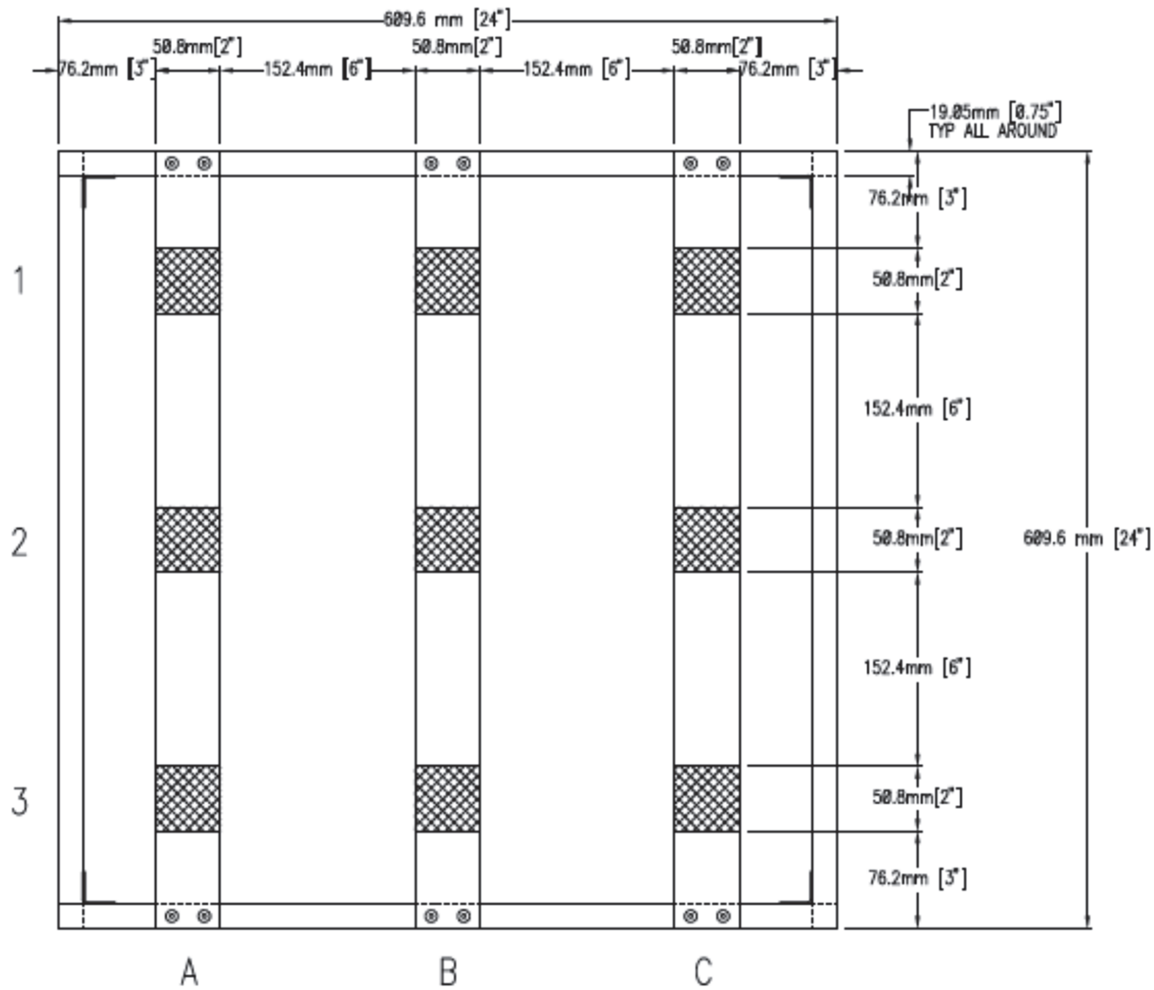

FIGURE 4-2 Radiometer sensor grid.

TABLE 5-1 System Qualification Measurement Requirements

Parameter	Control Limits
Air velocity uniformity is based on traverse measurements over a nine-point cross-sectional grid at the test flow rate. The velocity measurements shall be made with an instrument having an accuracy of 10% with 0.05 meter per second resolution.	CV* < 10%
Test velocity shall be	2.39 ± 0.05 mps (470 ± 10 fpm)
Duct leakage Ratio of leak rate to test flow rate. Determined by sealing the duct at inlet filter bank and at the ASME flow nozzle locations followed by metering in air to achieve a steady duct pressure. The flow rate of the metering air (equal to the leakage flow) is measured for a range of duct pressures.	Ratio < 1.0%

*CV = coefficient of variance

2. Full description of lamp(s) used, including rated power (watts input), rated amperage, arc length, lamp wattage and lamp pin configuration (Any marks on the lamp [i.e., date codes or serial numbers] shall also be noted.)
3. Full description of the ballast used to power the lamp for test, including manufacturer, identifying numbers/marks, rated input voltage, amperage and designed output amperage
4. Physical description of construction, including photo and outline drawing of device or lamp
5. Photos of device as positioned in the test rig and a plan view and elevation view drawing of exactly how the device/lamp is located in the test duct

g. Operating information as stated by the manufacturer
   1. Operating current
   2. Operating voltage

h. Test data
   1. Test air temperature and relative humidity
   2. Airflow rate
   3. Input volts and watts
   4. Pressure drop across the device
i. Complete data, including calibration dates for all measurement instruments used in the test
j. The UV-C radiometer and sensors (instrumentation)
   1. Specific radiometer information (brand, accuracy range, and last calibration record)
   2. Specific radiometer sensor information (brand, accuracy range, and the wavelength range)
k. Irradiance levels measured per the nine points on each of the Radiometer Sensor Grid locations indicating the specific columns and rows and for each of the three specified temperature conditions, as well as an average of all nine points at the three test temperature conditions

7. NORMATIVE LIMITATIONS

This standard only applies to low-pressure mercury vapor lamps.

The results show only the UV-C intensity upon selected points on a surface at a specific lamp location.

8. NORMATIVE REFERENCES

1. IESNA. 2000. IESNA Lighting Handbook, 9th ed. M. Rea, ed. New York: Illuminating Engineering Society of North America.

2. ASME PTC (Performance Test Code) 19.5-72 *Application, Part II of Fluid Meters, Sixth Edition 1971—Interim Supplement on Instruments and Apparatus,* American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017, 1959.

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INFORMATIVE ANNEX A
LIMITATIONS

The results of the test do not predict performance over service life. The equipment provider is expected to give a potential user some estimate of the service life characteristics of the device for a specified set of expected operating conditions.

ASHRAE does not actually test ultraviolet (UV) systems or determine their performance but promulgates the test procedure used by manufacturers and independent testing laboratories.

UV-C device testing in a laboratory is intended to help the user compare the performance of different types of UV systems. Testing attempts to simulate the performance of UV-C devices in real-life operation but cannot duplicate field conditions. Field conditions vary from location to location. The reporting values obtained in accordance with this standard cannot be used by themselves to predict the cleanliness of a specific HVAC component or the service life of installed UV-C devices.

Users of the method will need to determine if their particular device requires specialized testing conditions; however, the general approach described here should be applicable to most technologies. If the performance of multiple technologies is to be compared, then the test lab needs to standardize all variables of the test plan.

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INFORMATIVE ANNEX B SAFETY

The primary safety issue associated with this test method is exposing test personnel to harmful levels of ultraviolet (UV) radiation.

Safety issues associated with this method may require safe transport (including lifting) and use of various heavy and awkward equipment at times. Institutional safety rules need to be followed.

Some UV devices may produce ozone, which could be hazardous to the test personnel, so a measure to mitigate ozone exposure should be in place.

No personnel should be subject to direct UV exposure, but if exposure is unavoidable, personnel should wear protective clothing (no exposed skin), protective eyewear, and gloves. Most eyewear, including prescription glasses, are sufficient to protect eyes from UV, but not all offer complete coverage; standard issue protective goggles may be the best alternative.

Lamp Breakage

If a lamp breaks, all laboratory workers should exit the test area. Panels or doors should be left open, and any additional lamp chamber access points should also be opened. Turn off all air-handling unit fans. After a period of 15 minutes, workers may reenter the test rig to begin bulb clean-up.

If a lamp breaks, clean-up, because of mercury drop proliferation, requires special care and should be performed by trained workers. At a minimum, workers should wear cut-resistant gloves, as well as safety glasses to protect eyes from glass fragments. Large lamp pieces should be carefully picked up and placed in an impervious bag. HEPA-vacuum the remaining particles, or use other means to avoid dust generation.

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INFORMATIVE ANNEX C ENVIRONMENTAL CONSIDERATIONS

C1. LAMP AND BALLAST DISPOSAL

Ultraviolet C (UV-C) lamps should be treated in the same manner as other mercury-containing devices, such as fluorescent lamps. Most lamps must be treated as hazardous waste and cannot be discarded with regular waste, although low-mercury lamps often can be discarded as regular waste; however, some state and local jurisdictions classify these lamps as hazardous waste. The U.S. Environmental Protection Agency's (U.S. EPA) universal waste regulations allow users to treat mercury lamps as regular waste for the purpose of transport to a recycling facility (EPA 2011). This simplified process was developed to promote recycling. The National Electrical Manufacturers Association maintains an online list of companies claiming to recycle or handle used mercury lamps (NEMA 2009). The most stringent of local, state, or federal regulations for disposal should be followed.

As electronic ballasts fail, they should be treated as electronic waste. Many lamp and ballast recyclers are expanding their businesses and becoming certified to accept electronic waste. Some recyclers now accept both lamps and electronic ballasts.

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INFORMATIVE ANNEX D
INFORMATIVE REFERENCES AND BIBLIOGRAPHY

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NEMA. 2009. ww.lamprecycle.org. National Electrical Manufacturers Association, Rosslyn, VA.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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