



Designation: E3135 – 18

# Standard Practice for Determining Antimicrobial Efficacy of Ultraviolet Germicidal Irradiation Against Microorganisms on Carriers with Simulated Soil<sup>1</sup>

This standard is issued under the fixed designation E3135; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice will define test conditions to evaluate ultraviolet germicidal irradiation (UVGI) light devices (mercury vapor bulbs, light-emitting diodes, or xenon arc lamps) that are designed to kill/inactivate microorganisms deposited on inanimate carriers.

1.2 This practice defines the terminology and methodology associated with the ultraviolet (UV) spectrum and evaluating UVGI dose.

1.3 This practice defines the testing considerations that can reduce UVGI surface kill effectiveness, that is, presence of a soiling agent.

1.4 This practice does not address shadowing.

1.5 This practice should only be used by those trained in microbiology and in accordance with the guidance provided by Biosafety in Microbiological and Biomedical Laboratories (5th edition), 2009, HHS Publication No. (CDC) 21-1112.

1.6 This practice does not recommend either specific test microbes or growth media. Users of this practice shall select appropriate test microbes and growth media based on the specific objectives of their UV antimicrobial performance evaluation test plan.

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 **Warning**—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. Users should be aware

that selling mercury or mercury-containing products, or both, may be prohibited by local or national law.

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**E1053** Test Method to Assess Virucidal Activity of Chemicals Intended for Disinfection of Inanimate, Nonporous Environmental Surfaces

**E1153** Test Method for Efficacy of Sanitizers Recommended for Inanimate, Hard, Nonporous Non-Food Contact Surfaces

**E1316** Terminology for Nondestructive Examinations

**E2756** Terminology Relating to Antimicrobial and Antiviral Agents

**E2721** Practice for Evaluation of Effectiveness of Decontamination Procedures for Surfaces When Challenged with Droplets Containing Human Pathogenic Viruses

**G130** Test Method for Calibration of Narrow- and Broad-Band Ultraviolet Radiometers Using a Spectroradiometer

### 2.2 ISO Standards:<sup>3</sup>

**9370** Plastics -- Instrumental Determination of Radiant Exposure in Weathering Tests -- General Guidance and Basic Test Method

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E35 on Pesticides, Antimicrobials, and Alternative Control Agents and is the direct responsibility of Subcommittee E35.15 on Antimicrobial Agents.

Current edition approved May 1, 2018. Published July 2018. DOI: 10.1520/E3135-18

**21348 Space Environment (Natural and Artificial) – Process for Determining Solar Irradiances**

2.3 *AOAC Methods*:<sup>4</sup>

961.02 **Germicidal Spray Products as Disinfectants**

### 3. Terminology

3.1 *For Definitions of Terms used in this practice*, refer to Terminologies in **E1316**, **E2756**, and ISO 21348:

3.2 *Definitions*:

3.2.1 *carrier, n*—a surrogate surface or matrix that facilitates the interaction of test microorganisms and treatment(s).

3.2.2 *irradiance (E), n*—a radiometric term for the radiant flux that is incident upon a surface ( $W \cdot m^{-2}$ ).

3.2.3 *joule (J), n*—a unit of work or energy in the SI system of units.

3.2.3.1 *Discussion*—One Joule is one watt-second.

3.2.4 *light-emitting diode (LED), n*—a solid-state electronic device or transistor which emits light.

3.2.4.1 *Discussion*—An LED is a p-n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons.

3.2.5 *mercury vapor lamp, n*—a gas discharge lamp that uses electric arc through vaporized mercury to produce light.

3.2.6 *radiometer, n*—a device for measuring the radiant power that has an output proportional to the intensity of the input power.

3.2.7 *shadowing, v*—creating a dark area or shape by blocking light rays.

3.2.8 *soiling agent, n*—substance applied either along with or on top of the test microorganism that can reduce the effectiveness of the antimicrobial technology.

3.2.9 *ultraviolet germicidal irradiation (UVGI), n*—a method that uses short-wavelength ultraviolet (UV-C) light to kill or inactivate microorganisms primarily by forming pyrimidine dimers, leaving them unable to perform vital cellular functions.

3.2.10 *ultraviolet (UV) light, n*—radiation having wavelengths shorter than wavelengths of visible light (~400 nm) and longer than those of X-rays (~100 nm).

3.2.11 *UV-A, n*—radiation within the ultraviolet spectrum that extends from approximately 315 to 400 nm in wavelength.

3.2.12 *UV-B, n*—radiation within the ultraviolet spectrum that extends from approximately 280 to 315 nm in wavelength.

3.2.13 *UV-C, n*—radiation within the ultraviolet spectrum which extends from approximately 100 to 280 nm in wavelength.

3.2.14 *xenon arc lamp, n*—a specialized type of gas discharge lamp, an electric light that produces light by passing electricity through ionized xenon gas at high pressure.

### 4. Summary of Practice

4.1 This practice describes the steps required to deposit microorganisms onto carriers.

4.2 This practice defines the process for adding soiling agents on top of microorganisms, which can reduce the effectiveness of UV antimicrobial activity.

4.3 This practice defines a protocol for quantifying the dose a UVGI device delivers to a surface.

4.4 This practice defines the process for exposure of microorganisms to UVGI.

4.5 This practice defines protocols for extraction of viable microbes from carriers followed by enumeration.

### 5. Significance and Use

5.1 This practice determines the effectiveness of UVGI devices for reducing viable microorganisms deposited on carriers.

5.2 This practice evaluates the effect soiling agents have on UVGI antimicrobial effectiveness.

5.3 This practice determines the delivered UVGI dose.

### 6. Hazards

6.1 UV light becomes increasingly hazardous as the wavelength decreases, shifting from longer wavelengths (UV-A, UV-B) to shorter wavelengths (UV-C). UV-A and UV-B are part of the normal solar spectrum found in our atmosphere and are responsible for UV-related aging, sunburns, and mutagenic effects. UV-C radiation is filtered out by the Earth's atmosphere and is not part of the received solar spectrum. UV-C is highly mutagenic and is harmful to all life forms.

NOTE 1—This practice is not designed to evaluate safety concerns surrounding UV exposure.

6.2 Some UVGI bulbs produce ozone, which is harmful to all life forms. Consult the manufacturer of the UVGI bulbs or the device, or both, to determine if ozone is produced. If so, you must follow Occupational Safety and Health Administration (OSHA) regulations to ensure worker safety.

NOTE 2—This practice is not designed to evaluate safety concerns surrounding ozone production by UVGI devices.

6.3 Safety measures are required to ensure workers are not exposed to UV light during testing, especially UV-B and UV-C. Safety glasses with appropriate UV protection and appropriate lab attire shall be used at all times when working with UV devices.

6.4 Signage shall be posted on the laboratory when UV lights are in use to prevent accidental exposure to coworkers.

### 7. Reagents and Materials<sup>5</sup>

7.1 *Microorganisms*—selected by user based on the overall application.

<sup>5</sup> *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For Suggestions on the testing of reagents not listed by the American Chemical Society, see *Annual Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

<sup>4</sup> Available from AOAC International, 2275 Research Blvd., Suite 300, Rockville, MD 20850-3250, <http://www.aoac.org>.