



Standard Guide for Use of UV-A and Visible Light Sources and Meters used in the Liquid Penetrant and Magnetic Particle Methods¹

This standard is issued under the fixed designation E2297; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This guide describes the use of UV-A/Visible light sources and meters used for the examination of materials by the liquid penetrant and magnetic particle processes. This guide may be used to help support the needs for appropriate light intensities and light measurement.

1.2 This guide also provides a reference:

1.2.1 To assist in the selection of light sources and meters that meet the applicable specifications or standards.

1.2.2 For use in the preparation of internal documentation dealing with liquid penetrant or magnetic particle examination of materials and parts.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

E165 Practice for Liquid Penetrant Examination for General Industry

E709 Guide for Magnetic Particle Testing

E1208 Practice for Fluorescent Liquid Penetrant Testing Using the Lipophilic Post-Emulsification Process

E1209 Practice for Fluorescent Liquid Penetrant Testing Using the Water-Washable Process

E1210 Practice for Fluorescent Liquid Penetrant Testing Using the Hydrophilic Post-Emulsification Process

E1219 Practice for Fluorescent Liquid Penetrant Testing Using the Solvent-Removable Process

E1220 Practice for Visible Penetrant Testing Using Solvent-Removable Process

E1316 Terminology for Nondestructive Examinations

E1417 Practice for Liquid Penetrant Testing

E1418 Practice for Visible Penetrant Testing Using the Water-Washable Process

E1444 Practice for Magnetic Particle Testing

E3022 Practice For Measurement of Emission Characteristics and Requirements for LED UV-A Lamps Used in Fluorescent Penetrant and Magnetic Particle Testing

3. Terminology

3.1 The definitions that appear in E1316, relating to UV-A radiation and visible light used in liquid penetrant and magnetic particle examinations, shall apply to the terms used in this guide.

3.2 *Definitions:*

3.2.1 *high-intensity UV-A source*—a light source that produces UV-A irradiance greater than 10 000 $\mu\text{W}/\text{cm}^2$ (100 W/m^2) at 38.1 cm (15 in.).

3.2.2 *illuminance*—the amount of visible light, weighted by the luminosity function to correlate with human perception, incident on a surface, per unit area. Typically reported in units of lux (lx), lumens per square metre (lm/m^2) or footcandle (fc).

3.2.3 *irradiance*—the power of electromagnetic radiation incident on a surface, per unit area. Typically reported in units of watts per square metre (W/m^2) or microwatts per square centimetre ($\mu\text{W}/\text{cm}^2$).

3.2.4 *radiometer*—an instrument incorporating a sensor and optical filters to measure the irradiance of light over a defined range of wavelengths.

4. Summary of Guide

4.1 This guide describes the properties of UV-A and visible light sources used for liquid penetrant and magnetic particle examination. This guide also describes the properties of radiometers and light meters used to determine if adequate

¹ This guide is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.03 on Liquid Penetrant and Magnetic Particle Methods.

Current edition approved July 15, 2015. Published September 2015. Originally approved 2004. Last previous edition approved in 2010 as E2297-04(2010). DOI: 10.1520/E2297-15.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

light levels (UV-A or visible, or both) are present while conducting a liquid penetrant or magnetic particle examination.

5. Significance and Use

5.1 UV-A and visible light sources are used to provide adequate light levels for liquid penetrant and magnetic particle examination. Radiometers and light meters are used to verify that specified light levels are available.

5.2 Fluorescence is produced by irradiating the fluorescent dyes/pigments with UV-A radiation. The fluorescent dyes/pigments absorb the energy from the UV-A radiation and re-emit light energy in the visible spectrum. This energy transfer allows fluorescence to be observed by the human eye.

5.3 UV-A light sources may emit visible light above 400 nm (400 Å), which may reduce the visibility of fluorescent indications. High intensity UV-A light sources may cause UV fade, causing fluorescent indications to disappear.

6. Equipment

6.1 Ultraviolet (UV)/Visible Light Spectrum

6.1.1 UV light sources emit radiation in the ultraviolet section of the electromagnetic spectrum, between 180 nm (1800 Å) to 400 nm (4000 Å). Ultraviolet radiation is a part of the electromagnetic radiation spectrum between the violet/blue color of the visible spectrum and the weak X-ray spectrum. (See Fig. 1.)

6.1.2 The UV-A range is considered to be between 320 nm (3200 Å) and 400 nm (4000 Å).

6.1.3 The UV-B range (medium UV) is considered to be between 280 nm (2800 Å) and 320 nm (3200 Å).

6.1.4 The UV-C range (short UV) is considered to be between 180 nm (1800 Å) and 280 nm (2800 Å).

6.1.5 The visible spectrum is considered to be between 400 nm (4000 Å) and 760 nm (7600 Å).

6.2 Mercury Vapor UV-A Sources

6.2.1 Most UV-A sources utilize a lamp containing a mercury-gas plasma that emits radiation specific to the mercury atomic transition spectrum. There are several discrete element emission lines of the mercury spectrum in the ultraviolet section of the electromagnetic spectrum. The irradiance output is dependent on the gas pressure and the amount of mercury content. Higher values of gas pressure and mercury content result in significant increase in its UV emission. Irradiance output is also dependent on the input voltage and the age of the lamp bulb. As the bulb ages, mercury diffuses into the enclosing glass, causing the emission to decrease.

6.2.2 Mercury vapor UV-A sources used for NDT must have appropriate filters, either internal or external to the light source, to pass UV-A (6.1.2) and minimize visible light (6.1.5) output that is detrimental to the fluorescent inspection process. These UV-A pass filters should also block harmful UV-B (6.1.3) and UV-C (6.1.4) radiation.

6.2.3 Mercury vapor bulbs used for fluorescent NDT are generally low- or medium-pressure vapor sources.

6.2.3.1 Low-pressure bulbs (luminescent tubes) are coated with a special phosphor in order to maximize the UV-A output. Typically, low-pressure lamps are used in wash stations or for general UV-A lighting in the inspection room.

6.2.3.2 Medium-pressure bulbs do not have phosphor coatings but operate at higher electrical power levels, resulting in significantly higher UV-A output.

6.2.4 Medium-pressure lamps are typically used for fluorescent examination. A well designed medium pressure UV-A lamp with a suitable UV-A pass filter should emit less than 0.25 % to 1 % of its total intensity outside of the UV-A range. A typical lamp is based on the American National Standards Institute's Specification H 44 GS-R100, is a 100 watt mercury-vapor bulb in the Par 38 configuration, and normally uses a

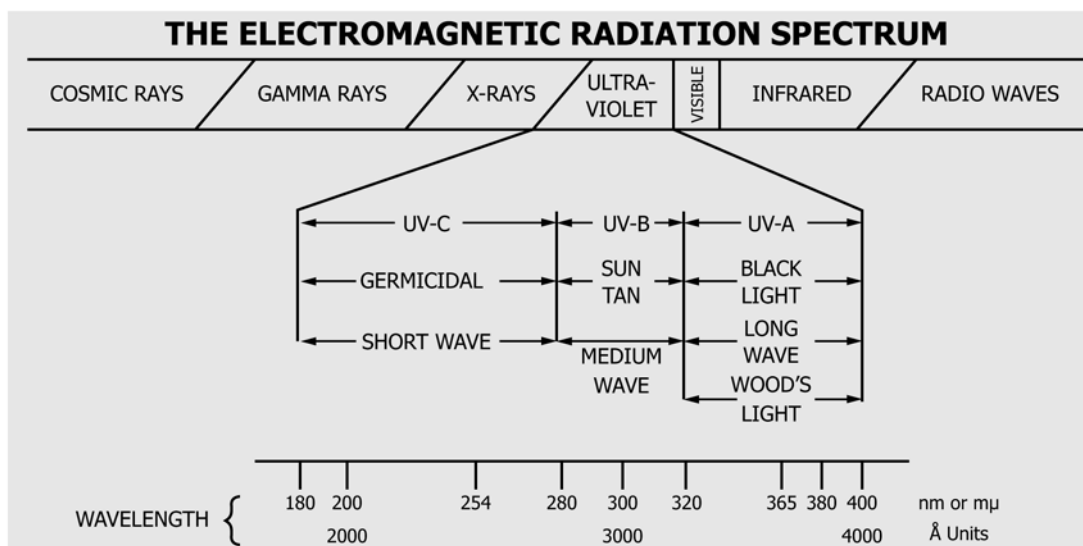


FIG. 1 The Electromagnetic Radiation Spectrum