Designation: E2297 – 04

Standard Guide for Use of UV-A and Visible Light Sources and Meters used in the Liquid Penetrant and Magnetic Particle Methods[1]

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 *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

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.

4. Summary of Guide

4.1 This guide shows how the proper meter is correctly used to determine if adequate light levels (UV-A and/or visible) are available for use 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. 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 High Intensity UV-A light sources produce light intensity greater than 10,000 $\mu W/cm^2$ at 38.1 cm (15 in.).

6. Equipment

6.1 *Ultraviolet (UV)/Visible Light Spectrum*

6.1.1 The most common UV 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 (used for fluorescent liquid penetrant and fluorescent magnetic particle examinations) is considered to be between 320 nm (3200 Å) and 400 nm (4000 Å). The UV-B range (medium UV) is considered to be between 280 nm

[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 Method.

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[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.

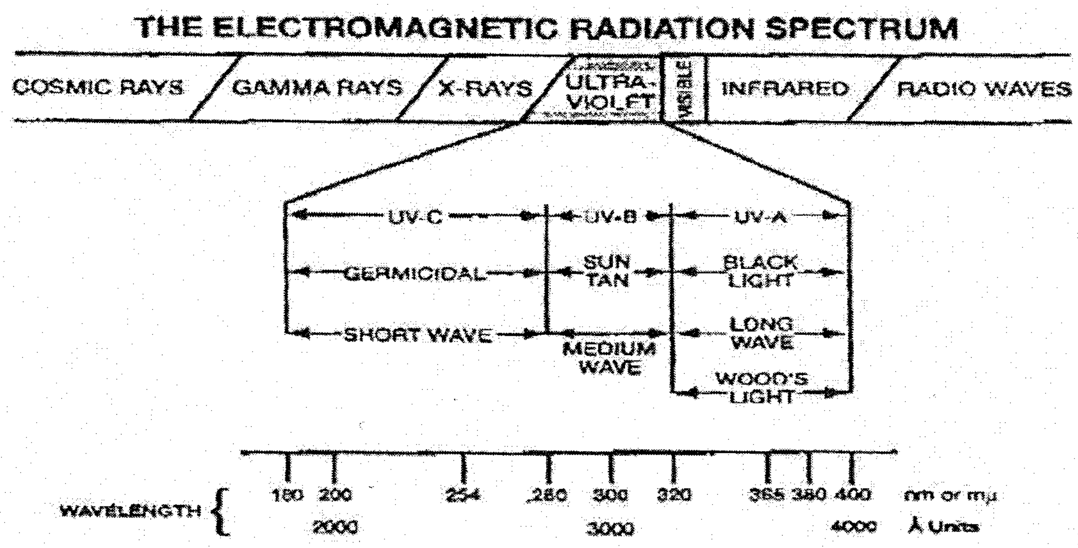

FIG. 1 The Electromagnetic Radiation Spectrum

(2800 Å) and 320 nm (3200 Å). The UV-C range (short UV) is considered to be between 180 nm (1800 Å) and 280 nm (2800 Å). 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 used in fluorescent NDT utilize a lamp containing a mercury-gas plasma that emits radiation specific to the mercury atomic transition spectrum. There are several discrete lines of the mercury spectrum in the ultraviolet section of the electromagnetic spectrum (between 180 nm (1800 Å) and 400 nm (4000 Å)). 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.

6.2.2 UV-A sources used for NDT, employ appropriate filters, either internal or external to the light source to minimize the visible light output (400 nm (4000 Å) to 760 nm (7600 Å)) that is detrimental to the fluorescent inspection process. These filters should also block harmful radiation below 320 nm (3200 Å).

6.2.3 UV-A sources are generally low or medium pressure vapor sources. Low pressure lamps are coated with a special phosphor in order to maximize the UV-A output. Medium pressure lamps do not have phosphor coatings but operate at higher electrical power levels, resulting in significantly higher UV-A output.

6.2.4 Typically, low pressure lamps (tubes) are used in wash stations or for general UV-A lighting in the inspection room. Medium pressure lamps are used in fluorescent inspection stations. A well designed medium pressure UV-A lamp should emit less that 0.25 % to 1 % of its total intensity under 320 nm (3200 Å) and above 400 nm (4000 Å). A UV-A bulb 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 using a Kopp 1041[3] UV filter. Other newer lamps using the same bulb but with the Kopp 1071[3] UV filter or bulbs based on the Philips HPW 125-watt bulb[4] will not differ greatly in UV-A output, but in general will produce more visible light in the blue/violet part of the spectrum. **Warning—**Certain high-intensity UV-A light sources may emit unacceptable amounts of visible light, which will cause fluorescent indications to disappear. Care should be taken to use only bulbs certified by the supplier to be suitable for such examination purposes.

NOTE 1—The Philips HPW 125-watt bulb has been restricted from use in the inspection station by many aerospace companies.

6.3 *UV-A Borescope, Fiberscope, Videoimagescope and Special UV-A Light Source Systems*

6.3.1 Borescopes, fiberscopes and videoimagescopes are thin rigid or flexible tubular optical telescopes. They are non destructive inspection quality control instruments for the visual detection of surface discontinuities in small bores, castings, pipe interiors, and on internal components of complex machinery.

6.3.2 The conventional optical glass fiber used as a light guide in borescopes, fiberscopes and videoimagescopes may be a poor transmitter of UV-A radiation. These fibers transmit white light in the 450 nm (4500 Å) to 760 nm (7600 Å) range, but do not effectively transmit light in the 350 nm (3500 Å) to 380 nm (3800 Å) range.

6.3.3 Three non traditional light guide materials for improved UV-A transmission in borescopes, fiberscopes or videoimagescopes, are liquid light guides, silica or quartz fibers, or special new glass fibers.

6.3.3.1 Silica or quartz fibers are good transmitters of UV-A energy, but are brittle and cannot be bent into a tight radius without breaking, nor can they accommodate the punishing stresses of repeated scope articulation.

[3] Kopp 1041 UV and Kopp 1071 UV are registered trademarks of Kopp Glass Inc., Pittsburgh, PA.

[4] Philips HPW 125 watt is a registered trademark of Philips Lighting Co., Somerset, NJ.