Designation: ~~E2104 – 09~~ E2104 – 15

Standard Practice for Radiographic Examination of Advanced Aero and Turbine Materials and Components[1]

This standard is issued under the fixed designation E2104; 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 practice establishes the minimum requirements for radiographic examination of metallic and nonmetallic materials and components used in designated applications such as gas turbine engines and flight structures.

1.2 The requirements in this practice are intended to control the radiographic process to ensure the quality of radiographic images produced for use in designated applications such as gas turbine engines and flight structures; this practice is not intended to establish acceptance criteria for material or components. When examination is performed in accordance with this practice, engineering drawings, specifications or other applicable documents shall indicate the acceptance criteria.

1.3 All areas of this practice may be open to agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization.

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]

E543 Specification for Agencies Performing Nondestructive Testing

E747 Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology

E999 Guide for Controlling the Quality of Industrial Radiographic Film Processing

E1025 Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiology

E1030 Test Method for Radiographic Examination of Metallic Castings

E1032 Test Method for Radiographic Examination of Weldments

E1079 Practice for Calibration of Transmission Densitometers

E1165 Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging

E1254 Guide for Storage of Radiographs and Unexposed Industrial Radiographic Films

E1390 Specification for Illuminators Used for Viewing Industrial Radiographs

E1316 Terminology for Nondestructive Examinations

E1815 Test Method for Classification of Film Systems for Industrial Radiography

E1817 Practice for Controlling Quality of Radiological Examination by Using Representative Quality Indicators (RQIs)

E2033 Practice for Computed Radiology (Photostimulable Luminescence Method)

E2698 Practice for Radiological Examination Using Digital Detector Arrays

2.2 *AWS Documents:*[3]

ANSI/AWS A2.4 Symbols for Welding and Nondestructive Testing

---

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.01 on Radiology (X and Gamma) Method.

Current edition approved ~~Jan. 1, 2009~~June 1, 2015. Published ~~January 2009~~June 2015. Originally approved in 2001. Last previous edition approved in ~~2001~~2009 as ~~E2104 - 01.~~E2104 - 09. DOI: ~~10.1520/E2104-09.~~10.1520/E2104-15.

[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.

[3] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

TABLE 1 Lead Screen Thickness[A]

Energy Range/ Isotopes	Lead Thickness, in. (mm)	
	Front Screen (Maximum)	Back Screen[B,C] (Minimum)
0 – 100 keV	0.001 (0.025)	0.005 (0.127)
101 – 200 keV	0.005 (0.127)	0.005 (0.127)
201 – 320 keV	0.010 (0.254)	0.005 (0.127)
Se-75	0.010 (0.254)	0.005 (0.127)
321 – 450 keV	0.015 (0.381)	0.010 (0.254)
Ir-192	0.015 (0.381)	0.010 (0.254)
451 keV – 2 MeV	0.020 (0.508)	0.010 (0.254)
Co-60	0.020 (0.508)	0.010 (0.254)
>2 MeV	0.125 (3.175)	0.010 (0.254)

[A] Pre-packed film, with or without lead screens, may be used provided radiographic quality level, contrast, density and back scatter requirements are met.
[B] Back scatter radiation shall still be monitored per the requirements of 7.11.
[C] A back screen is not required provided the back scatter requirements of 7.11 are met through the use of alternate measures.

2.3 *AIA Documents:*[4]

NAS-410 Certification and Qualification of Nondestructive Test Personnel

2.4 *NCRP Documents:*[5]

NCRP 51 Radiation Protection Design Guidelines for 0.1-100 MeV Particle Accelerator Facilities

NCRP 91 Recommendations on Limits for Exposures to Ionizing Radiation

2.5 *Other Government Documents:*

NIST Handbook 114 General Safety Standard for Installations Using Non-Medical X-ray and Sealed Gamma-ray Sources, Energies up to 10 MeV[6]

NOTE 1—*DoD Contracts:* Unless otherwise specified, the issues of the documents that are DoD adopted are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) cited in the solicitation.

NOTE 2—*Order of Precedence:* Contractual requirements and specific direction from the cognizant engineering organization shall take precedence over the requirements in this practice. In the event of conflict between the text of this practice and the references cited herein, the text of this practice shall take precedence. However, nothing in this practice shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. Terminology

3.1 *Definitions*—Definitions relating to radiographic examination which appear in Terminology E1316 shall apply to the terms used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cognizant engineering organization*—the company, government agency or other authority responsible for the design, or end use, of the material or component for which radiographic examination is required. This, in addition to design personnel, may include personnel from engineering, material and process engineering, stress analysis, NDE, quality assurance and others, as appropriate.

3.2.2 *component*—the part(s) or element of the system assembled or processed to the extent specified by the drawing, purchase order or contract for which radiographic examination is required.

3.2.3 *film system*—the combination of a film and a processing system. A processing system is defined by the chemistry used and the specified developer immersion time and temperature.

3.2.4 *like section*—a separate section of material that is similar in shape and cross section to the component or part being radiographed, and is made of the same or radiographically similar material.

3.2.5 *material group*—materials that have the same predominant alloying elements and which can be examined using the same IQI. A listing of common material groups is given in Practices E747 and E1025.

3.2.6 *NDE facility*—the NDE agency performing the radiographic examination.

3.2.7 *radiographic quality level*—the ability of a radiographic procedure to demonstrate a specified IQI sensitivity (see Table 3).

3.2.8 *radiographic technique*—a procedure which details the exact radiographic setup to be used for each exposure to be made (see 7.1).

[4] Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, http://www.aia-aerospace.org.
[5] Available from National Council on Radiation Protection and Measurements (NCRP), NCRP Publications, 7910 Woodmount Ave., Suite 800, Bethesda, MD 20814.
[6] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.