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Standard Practice for Radiographic Examination[1]

This standard is issued under the fixed designation E1742/E1742M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice[2] establishes the minimum requirements for radiographic examination for metallic and nonmetallic materials.

1.2 *Applicability*—The criteria for the radiographic examination in this practice are applicable to all types of metallic and nonmetallic materials. The requirements expressed in this practice are intended to control the quality of the radiographic images and are not intended to establish acceptance criteria for parts and materials.

1.3 *Basis of Application*—There are areas in this practice that may require agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization. These items should be addressed in the purchase order or the contract.

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1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.5 *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 The following documents form a part of this practice to the extent specified herein:

2.2 *ASTM Standards:*[3]

E94 Guide for Radiographic Examination
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
E801 Practice for Controlling Quality of Radiological Examination of Electronic Devices
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

[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.

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[2] This practice replaced MIL-STD-453.

[3] 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.

***A Summary of Changes section appears at the end of this standard**

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
E1255 Practice for Radioscopy
E1316 Terminology for Nondestructive Examinations
E1390 Specification for Illuminators Used for Viewing Industrial Radiographs
E1411 Practice for Qualification of Radioscopic Systems
E1416 Test Method for Radioscopic Examination of Weldments
E1815 Test Method for Classification of Film Systems for Industrial Radiography
E2033 Practice for Computed Radiology (Photostimulable Luminescence Method)
E2698 Practice for Radiological Examination Using Digital Detector Arrays

2.3 *AWS Document:*
AWS A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Examination[4]

2.4 *Aerospace Industries Association Document:*
NAS 410 Certification & Qualification of Nondestructive Test Personnel[5]

2.5 *ASNT Documents:*[6]
SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
ANSI/ASNT-CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

2.6 *NCRP Documents:*[7]
NCRP 116 Limitation of Exposure to Ionizing Radiation
NCRP 144 Radiation Protection for Particle Accelerator Facilities
NCRP 147 Structural Shielding Design for Medical X-ray Imaging Facilities

2.7 *CEN Standards:*[8]
EN 444 Non-Destructive Testing- General Principles for Radiographic Examination of Metallic Materials by X-and Gamma-Rays

2.8 *ANSI/ISO Standards:*[9]
ANSI/NCSL Z540-3 Requirements for the Calibration of Measuring and Test Equipment
ISO 10012 Measurement Management Systems—Requirements for Measurement Processes and Measuring Equipment
ISO 5579 Non-Destructive Testing-Radiographic Examination of Metallic Materials by X-and Gamma-Rays-Basic Rules

2.9 *Military Standard:*
MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic and Ultrasonic)[10]

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

NOTE 2—*Order of Precedence:* In the event of conflict between the text of this practice and the references cited herein, the text of this practice takes precedence. Nothing in this practice, however, supersedes 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 system 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, NDT, or quality groups and others, as appropriate.

3.2.2 *component*—the part(s) or element of a system, assembled or processed to the extent specified by the drawing, purchase order, or contract.

3.2.3 *energy*—a property of radiation that determines its penetrating ability. In X-ray radiography, energy machine rating is determined by kilovolts (keV), million electronvolts (MeV). In gamma ray radiography, energy is a characteristic of the source used.

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 Practice E1025.

3.2.6 *NDT facility*—the NDT facility performing the radiographic examination.

3.2.7 *radiographic quality level*—The ability of a radiographic procedure to demonstrate a certain IQI sensitivity.

4. Significance and Use

4.1 This practice establishes the basic parameters for the application and control of the radiographic method. This practice is written so it can be specified on the engineering drawing, specification, or contract. It is not a detailed how-to procedure to be used by the NDT facility and, therefore, must be supplemented by a detailed procedure (see 6.1). Test

[4] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.
[5] Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, http://www.aia-aerospace.org.
[6] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.
[7] Available from National Council on Radiation Protection and Measurements, NCRP Publications, 7910 Woodmount Ave., Suite 800, Bethesda, MD 20814.
[8] Available from CEN-European Committee for Standardization, Rue De Stassart 36, Bruxelles, Belgium B-1050, http://www.cen.eu
[9] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[10] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

Methods E1030, E1032, and E1416 contain information to help develop detailed technique/procedure requirements.

5. General Practice

5.1 *Qualification:*

5.1.1 *Personnel Qualification*—Personnel performing examinations in accordance with this practice shall be qualified in accordance with MIL-STD-410, NAS 410, ANSI/ASNT-CP-189, or SNT-TC-1A and certified by the employer or certifying agency as applicable. Other equivalent qualification documents may be used when specified in the contract or purchase order.

5.1.2 *Agency Evaluation*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated in accordance with Practice E543. The applicable revision of Practice E543 shall be specified in the contractual agreement.

5.2 *Laboratory Installations:*

5.2.1 *Safety*—The premises and equipment shall present no hazards to the safety of personnel or property. NCRP 147, NCRP 116, and NCRP 144 may be used as guides to ensure that radiographic procedures are performed so that personnel shall not receive a radiation dosage exceeding the maximum permitted by city, state, or national codes.

5.2.2 *Radiographic Exposure Areas*—Radiographic exposure areas shall be clean and equipped so that acceptable radiographs may be produced in accordance with the requirements of this practice.

5.2.3 *Darkroom*—Darkroom facilities, including equipment and materials, shall be capable of producing uniform radiographs free of blemishes or artifacts, which might interfere with interpretation in the area of interest.

5.2.4 *Film Viewing Area*—The film viewing room or enclosure shall be an area with subdued lighting to preclude objectionable reflective glare from the surface of the film under examination, (see 6.27.6).

5.3 *Materials:*

5.3.1 *Film*—Film selection for production radiographs should be based on radiation source energy level, part thickness/configuration, and image quality. Only film systems having cognizant engineering organization approval or meeting the class requirements of Test Method E1815 shall be used.

5.3.1.1 *Non-film Recording Media*—Other recording media, such as paper and analog tape, may be used when approved by the cognizant engineering organization.

5.3.2 *Film Processing Solutions*—Production radiographs shall be processed in solutions capable of consistently producing radiographs that meet the requirements of this practice. Solution control shall be in accordance with Annex A4. Guide E999 should be consulted for guidance on film processing.

5.4 *Equipment:*

5.4.1 *Radiation Sources.*

5.4.1.1 *X-Radiation Sources*—Selection of appropriate X-ray voltage and current levels is dependent upon variables regarding the specimen being examined (material type and thickness) and exposure time. The suitability of these exposure parameters shall be demonstrated by attainment of the required radiographic quality level and compliance with all other requirements stipulated herein.

5.4.1.2 *Gamma Radiation Sources*—Isotope sources that are used shall be capable of demonstrating the required radiographic quality level.

5.4.2 *Film Holders and Cassettes*—Film holders and cassettes shall be light tight, constructed of materials that do not interfere with the quality or sensitivity of radiographs, and shall be handled properly to reduce damage. In the event that light leaks into the film holder and produces images on the radiograph, the radiograph need not be rejected unless the images obscure, or interfere with, the area of interest. If the film holder exhibits light leaks it shall be further repaired before use, or discarded. Film holders and cassettes should be routinely examined for cracks or other defects to minimize the likelihood of light leaks.

5.4.3 *Intensifying Screens:*

5.4.3.1 *Lead Foil Screens*—When using a source greater than 150 keV, intensifying screens of the lead foil type are recommended. Screens shall have the same area dimensions as the film being used and shall be in intimate contact with the film during exposure. Recommended screen thicknesses are listed in Table 1 for the applicable voltage range being used. Screens shall be free from any cracks, creases, scratches, or foreign material that could render undesirable nonrelevant images on the film.

5.4.3.2 *Fluorescent, Fluorometallic, or Other Metallic Screens*—Fluorescent, fluorometallic, or other metallic screens may be used. However, they must be capable of demonstrating the required penetrameter (IQI) sensitivity. Fluorescent or fluorometallic screens may cause limitations in image quality (see Guide E94, Appendix X1).

5.4.4 *Film Viewers*—Viewers used for final interpretation shall meet the following requirements:

TABLE 1 Lead Screen Thickness[A]

Energy Range/ Isotopes	Front Screen	Back Screen Minimum	Front and Back Screens[B]
	in.	in.	mm
0 – 150 keV[C]	0.000 to 0.001	0.005[D]	0-0.15
151 – 200 keV	0.000 to 0.005	0.005[D]	0.02-0.15
201 – 320 keV	0.001 to 0.010	0.005	0.02-0.2
Se-75	0.001 to 0.010	0.005	0.1-0.2
321 – 450 keV	0.005 to 0.015	0.01	0.1-0.2
Ir-192	0.005 to 0.015	0.01	0.02-0.2
451 keV – 2 MeV	0.005 to 0.020	0.01	0.1-0.5
Co-60	0.005 to 0.020	0.01	0.1-0.5
2 – 4 MeV	0.010 to 0.020	0.01	0.1-0.5
4 – 10 MeV	0.010 to 0.030	0.01	0.5-1.0
10 – 25 MeV	0.010 to 0.050	0.01	1.0-2.0

[A] The lead screen thickness listed for the various energy ranges are recommended thicknesses and not required thicknesses. Other thicknesses and materials may be used provided the required radiographic quality level, contrast, and density are achieved.

[B] Lead screen thicknesses in accordance with EN 444 and ISO 5579 in SI units. For energy ranges of Co-60 and 451 keV to 4 MeV, steel or copper screens of 0.1 to 0.5 mm may be used. For energy ranges above 4 MeV to 10 MeV, 0.5-1.0 mm steel or copper or up to 0.5 mm tantalum screens are recommended. Additional back scatter shielding may be achieved by additional lead screens behind the cassettes.

[C] Prepackaged film with lead screens may be used from 80 to 150 keV. No lead screens are recommended below 80 keV. Prepackaged film may be used at higher energy levels provided the contrast, density, radiographic quality level, and backscatter requirements are achieved. Additional intermediate lead screens may be used for reduction of scattered radiation at higher energies.

[D] No back screen is required provided the backscatter requirements of 6.22 are met.