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.

Designation: E1255 – 23

Standard Practice for Radioscopy[1]

This standard is issued under the fixed designation E1255; 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[2] covers application details for radioscopic examination using penetrating radiation using an analog component such as an electro-optic device (for example, X-ray image intensifier (XRII) or analog camera, or both) or a Digital Detector Array (DDA) used in dynamic mode radioscopy. Radioscopy is a radiographic technique that can be used in (*1*) dynamic mode radioscopy to track motion or optimize radiographic parameters in real-time, or both (25 to 30 frames per second), near real-time (a few frames per second), or high speed (hundreds to thousands of frames per second) or (*2*) static mode radioscopy where there is no motion of the object during exposure as a filmless recording medium. This practice is not to be used for static mode radioscopy using DDAs. If static radioscopy using a DDA (that is, DDA radiography) is being performed, use Practice E2698.

1.1.1 This practice also may be used for Linear Detector Array (LDA) applications where an LDA uses relative perpendicular motion of either the detector or component under examination to build an image line by line.

1.1.2 This practice may also be used for "flying spot" applications where a pencil beam of X-rays rasters over an area to build an image point by point.

1.2 This practice establishes the minimum requirements for radioscopic examination of metallic and non-metallic materials using X-ray or gamma radiation. Since the techniques involved and the applications for radioscopic examination are diverse, this practice is not intended to be limiting or restrictive, but rather to address the general applications of the technology and thereby facilitate its use. Refer to Guides E94 and E1000, and Terminology E1316, provide additional information and guidance.

1.3 *Basis of Application:*

1.3.1 The requirements of this practice and Practice E1411 shall be used together. The requirements of Practice E1411 will provide the performance qualification and long-term stability test procedures for the radioscopic system. The user of the radioscopic system shall establish a written procedure that addresses the specific requirements and tests to be used in their application and shall be approved by the Cognizant Radiographic Level 3 before examination of production hardware. There are areas (listed below 1.3.1.1 – 1.3.1.14) in this practice that may require agreement between the cognizant engineering organization and the radioscopy supplier, or specific direction from the cognizant engineering organization. These items should be addressed in the purchase order or the contract.

1.3.1.1 Systems, equipment, and materials that do not comply with this Practice (1.5);

1.3.1.2 Modified tests and/or gauges when using a gamma source or radiation energy above 320 kV (1.6);

1.3.1.3 Personnel qualification and certification (5.8);

1.3.1.4 Qualification of the NDT supplier (5.9);

1.3.1.5 Alternate image displays (6.1.3.1);

1.3.1.6 Alternate image quality indicator (IQI) types (6.1.6.5);

1.3.1.7 Non-requirement for IQI (8.9.7);

1.3.1.8 Examination record archiving, hard copy, and recording (6.1.10);

1.3.1.9 Radioscopic quality levels (8.8.1.16);

1.3.1.10 Total image unsharpness (8.8.1.15);

1.3.1.11 Performance verification (9.3);

1.3.1.12 Interpreter duty and rest periods (10.2);

1.3.1.13 Examination report (11.1);

1.3.1.14 Retention and storage of radiographs (6.1.10, 8.16, and 11.1);

1.3.2 Appendix X1 may be used to fulfill existing contracts that use Appendix X1 or the former Annex A1. The former mandatory Annex A1 "DEPARTMENT OF DEFENSE CONTRACTS, SUPPLEMENTAL REQUIREMENTS" was deleted and the detailed requirements are appended now in the non-mandatory Appendix X1.

1.4 This practice also requires the user to perform a technique qualification suitable for its intended purpose and to issue a system qualification report (see 9.7). Additionally, the user shall develop part specific inspection procedures (see Section 8).

[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] For *ASME Boiler and Pressure Vessel Code* applications see related Practice SE-1255 in Section II of that code.

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1.5 *Compliance*—Systems, equipment, and materials that do not comply with this practice shall require approval from the Cognizant Engineering Organization (CEO).

1.6 The general principles discussed in this practice apply broadly to penetrating radiation radioscopic systems. However, this document is written specifically for use with X-ray and gamma-ray systems. Other radioscopic systems, such as those employing neutrons, will involve equipment and application details unique to such systems.

1.7 The user of this practice shall note that X-ray energies higher than 320 keV may require modified or different methods other than those described within this practice.

1.8 *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 non-conformance with the standard. Where applicable, SI units are shown in brackets [xx].

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.* For specific safety statements, see Section 7.

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:*[3]

E94 Guide for Radiographic Examination Using Industrial Radiographic Film

E543 Specification for Agencies Performing Nondestructive Testing

E746 Practice for Determining Relative Image Quality Response of Industrial Radiographic Imaging Systems below 4 MeV

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

E801 Practice for Controlling Quality of Radiographic Examination of Electronic Devices

E1000 Guide for Radioscopy

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

E1161 Practice for Radiographic Examination of Semiconductors and Electronic Components

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

E1255 Practice for Radioscopy

E1316 Terminology for Nondestructive Examinations

E1411 Practice for Qualification of Radioscopic Systems

E1416 Practice for Radioscopic Examination of Weldments

E1453 Guide for Storage of Magnetic Tape Media that Contains Analog or Digital Radioscopic Data

E1475 Guide for Data Fields for Computerized Transfer of Digital Radiological Examination Data

E1647 Practice for Determining Contrast Sensitivity in Radiology

E1734 Practice for Radioscopic Examination of Castings

E1742 Practice for Radiographic Examination

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

E2002 Practice for Determining Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy

E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)

E2445 Practice for Performance Evaluation and Long-Term Stability of Computed Radiography Systems

E2698 Practice for Radiographic Examination Using Digital Detector Arrays

E2903 Test Method for Measurement of the Effective Focal Spot Size of Mini and Micro Focus X-ray Tubes

2.2 *Department of Defense Standard:*[4]

DOD-STD-2167 Defense Systems Software Development

2.3 *Federal Standards:*[5]

21 CFR 1020.40 Safety Requirements of Cabinet X-Ray Systems

29 CFR 1910.96 Ionizing Radiation

2.4 *Health Physics Society Standard:*[6]

ANSI/HPS N43.3 Radiation Safety for Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV

2.5 *National Conference of Standards Laboratories (NCSL) Standard:*[7]

ANSI Z540-3 Requirements for the Calibration of Measuring and Test Equipment

2.6 *National Council on Radiation Protection and Measurement (NCRP) Standards:*[8]

NCRP 49 Structural Shielding Design and Evaluation for Medical Use of X Rays and Gamma Rays of Energies Up to 10 MeV

NCRP 61 Radiation Safety Training Criteria for Industrial Radiography

NCRP 116 Limitation of Exposure to Ionizing Radiation

[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.

[4] Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401, http://www.gpo.gov.

[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil or https://www.ecfr.gov/

[6] Available from HIS Markit, 15 Inverness Way East, Englewood, CO 80112

[7] Available from National Conference of Standards Laboratories (NSCL) International, 5766 Central Ave, Boulder, CO 80301, https://ncsli.org/.

[8] Available from NCRP Publications, 7010 Woodmont Ave., Suite 1016, Bethesda, MD 20814.

NCRP 147 Structural Shielding Design for Medical X-ray Imaging Facilities

2.7 *ISO Standards:*[9]

ISO 10012 Requirements for measurement processes and measuring equipment

ISO 19232-1 Part 1: Determination of the image quality value using wire-type image quality indicators

ISO 19232-2 Part 2: Determination of the image quality value using step/hole-type image quality indicators

2.8 *Other Standards:*[10]

SMPTE RP 133 Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard-Copy Recording Cameras

3. Terminology

3.1 *Definitions:* For definitions of terms used in this practice, see Terminology E1316.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *camera spatial resolution, n*—an expression for the resolution of a camera inside an image intensifier or viewing a fluorescent screen.

4. Summary of Practice

4.1 Visual evaluation as well as computer-aided automated radioscopic examination systems are used in a wide variety of penetrating radiation examination applications. A simple visual evaluation radioscopic examination system might consist of a radiation source, a fluorescent screen viewed with an analog camera, suitably enclosed in a radiation protective enclosure, and a video display. At the other extreme, a complex automated radioscopic examination system might consist of an X-ray source, a robotic examination part manipulator, a radiation protective enclosure, an electronic image detection system with a camera, a frame grabber, a digital image processor, an image display, and a digital image archiving system. All system components are supervised by the host computer, which incorporates the software necessary to not only operate the system components, but to make accept/reject decisions as well. Systems having a wide range of capabilities between these extremes can be assembled using available components. Guide E1000 lists many different system configurations.

4.2 This practice provides details for applying radioscopic examination. Supplemental requirements are necessary to address areas that are application and performance specific.

5. Significance and Use

5.1 As with conventional radiography, radioscopic examination is broadly applicable to any material or examination object through which a beam of penetrating radiation may be passed and detected including metals, plastics, ceramics, composites, and other nonmetallic materials. In addition to the benefits normally associated with radiography, radioscopic examination may be either a dynamic, filmless technique allowing the examination part to be manipulated and imaging parameters optimized while the object is undergoing examination, or a static, filmless technique wherein the examination part is stationary with respect to the X-ray beam. Systems with digital detector arrays (DDAs) or an analog component such as an electro-optic device or an analog camera may be used in dynamic mode. If achievable video rates are not adequate to examine features of interest in dynamic mode then averaging techniques with no movement of the test object shall be used – in this case, if using a DDA, Practice E2698 shall be used. If used with a high speed camera system, the user must be aware of the various image conversion materials decay time such that the converter signal can change as fast or faster than the frame rate. Linear Detector Arrays (LDAs) and flying spot systems may be considered radioscopic configurations as they are included in as shown in Guide E1000.

5.2 This practice establishes the basic parameters for the application and control of the radioscopic examination method. This practice is written so it can be specified on the engineering drawing, specification, or contract.

5.3 *Weld Examination*—Additional information on radioscopic weld examination may be found in Practice E1416.

5.4 *Casting Examination*—Additional information on radioscopic casting examination may be found in Practice E1734.

5.5 *Electronic Components*—Radioscopic examination of electronic components shall comply with Practice E1161.

5.6 *Explosives and Propellants*—Radioscopic examination of explosives/propellant components shall comply with Practice E1742 Annex A3.

5.7 *Part-Specific Examination Technique*—A detailed written procedure including a part-specific examination technique shall be prepared for each part, or group of parts, and shall be approved by the Cognizant Radiographic Level 3.

5.8 *Personnel Qualification*—Personnel performing radioscopic examinations and interpretations to this practice shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard and certified by the employer or certifying agency as applicable. Other equivalent qualification documents may be used when specified on the contract or purchase order. The applicable revision shall be the latest unless otherwise specified in the contractual agreement between parties.

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

6. Apparatus

6.1 *System Configuration*—Many different radioscopic examination systems configurations are possible, and it is important to understand the advantages and limitations of each. It is important that the radioscopic examination system be selected for each examination requirement through an analysis of the benefits and limitations of the available system components and the chosen system configuration. The CEO and NDT

[9] Available from International Organization for Standardization, Chemin de Blandonnet 8 CP 401-1214 Vernier, Geneva, Switzerland, https://www.iso.org/home.html.

[10] Available from SMPTE, White Plains Plaza, 445 Hamilton Ave, Suite 601, White Plains, NY 10601