



Designation: E1411 – 23

## Standard Practice for Qualification of Radioscopic Systems<sup>1</sup>

This standard is issued under the fixed designation E1411; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope

1.1 This practice covers test and measurement details for measuring the performance of X-ray and gamma ray radioscopy systems. Radioscopy is a radiographic technique that can be used in (1) dynamic mode radioscopy to track motion or optimize radiographic parameters in real-time (25 to 30 frames per second), or both, 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<sup>2</sup> provides application details for radioscopy 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. 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 between the detector and component 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 object to build an image point by point.

#### 1.2 Basis of Application:

1.2.1 The requirements of this practice and Practice E1255 shall be used together. The requirements of Practice E1255 provide the minimum requirements for radioscopy examination of materials. This practice is intended as a means of initially qualifying and re-qualifying a radioscopy system for a specified application by determining its performance when operated in a static or dynamic mode. Re-qualification may require agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant

engineering organization and should be addressed in the purchase order or the contract.

1.2.2 System architecture including the means of radioscopy examination record archiving and the method for making the accept/reject decision are also unique system features and their effect upon system performance must be evaluated.

1.2.3 This qualification procedure is intended to benchmark radioscopy system performance under selected operating conditions to provide a measure of system performance. Qualification shall not restrict operation of the radioscopy system at other radioscopy examination parameter settings, which may provide improved performance on actual examination objects. This practice neither approves nor disapproves the use of the qualified radioscopy system for the specified application. It is intended only as a standardized means of evaluating system performance.

1.3 The general principles, as stated in this practice, apply broadly to transmitted-beam penetrating radiation radioscopy systems. Other radioscopy systems, such as those employing neutrons and Compton back-scattered X-ray imaging techniques, are not covered as they may involve equipment and application details unique to such systems.

1.4 The user of this practice shall note that energies higher than 320 keV may require different methods than those described within this practice.

1.5 This practice requires that a System Qualification Report be issued before using the system for production use.

1.6 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *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.*

1.8 *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.*

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Practice SE-1255 in Section II of that code.

## 2. Referenced Documents

### 2.1 *ASTM Standards:*<sup>3</sup>

- 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
  - E1025** Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiography
  - 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
  - E1647** Practice for Determining Contrast Sensitivity in Radiology
  - E1735** Practice for Determining Relative Image Quality Response of Industrial Radiographic Imaging Systems from 4 to 25 MeV
  - 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
  - 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 *ANSI Standard:*<sup>4</sup>
- ANSI/HPS N43.3** For General Radiation Safety – Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10 MeV
- ### 2.3 *ISO Standards:*<sup>5</sup>
- ISO 19232–2** Step Hole Image Quality Indicator
  - ISO 19232–5** Duplex Wire Image Quality Indicator
- ### 2.4 *Federal Standards:*<sup>6</sup>
- 21 CFR 1020.40** Safety Requirements of Cabinet X-Ray Systems
  - 29 CFR 1910.96** Ionizing Radiation
- ### 2.5 *National Council on Radiation Protection and Measurement (NCRP) Standards:*<sup>7</sup>
- 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

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

### 2.6 *Other Standard:*

**SMPTE RP-133** Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard-Copy Recording Cameras<sup>8</sup>

## 3. Terminology

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

## 4. Summary of Practice

**4.1** This practice provides a standardized procedure for the initial qualification and subsequent periodic requalification of a radioscopy system to establish radioscopy examination capabilities for a specified range of applications. Practice **E1255** also requires the user to perform a technique qualification suitable for its intended purpose and develop part specific inspection procedures before radioscopy examination of product.

**4.2** This practice specifies the procedures to be used in determining the performance of the radioscopy system. Unique system features, including component selection, system architecture, programmability, and image archiving capabilities are important factors and are taken into account in this practice. The overall system performance, as well as key system features, are to be recorded in a qualification document which shall qualify the performance of the total radioscopy system. An example of the Radioscopy System Qualification document form is included in the **Appendix X1**. This document may be tailored to suit the specific application and actual computer and storage technology.

## 5. Significance and Use

**5.1** As with conventional radiography, radioscopy examination is broadly applicable to the many materials and object configurations which may be penetrated with X-rays or gamma rays. The high degree of variation in architecture and performance among radioscopy systems due to component selection, physical arrangement, and object variables makes it necessary to establish the performance that the selected radioscopy system is capable of achieving in specific applications. The manufacturer or integrator of the radioscopy system, as well as the user, require a common basis for determining the performance level of the radioscopy system.

**5.2** This practice does not purport to provide a method to measure the performance of individual radioscopy system components that are manufactured according to a variety of industry standards. This practice covers measurement of the combined performance of the radioscopy system elements when operated together as a functional radioscopy system.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>5</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

<sup>6</sup> Available from U. S. Government Accountability Office (GAO), 441 G St., NW, Washington, DC 20548, <http://www.gao.gov>.

<sup>7</sup> Available from NCRP Publications, 7010 Woodmont Ave., Suite 1016, Bethesda, MD 20814.

<sup>8</sup> Available from the Society of Motion Picture and Television Engineers, White Plains Plaza, 445 Hamilton Ave, Ste 601, White Plains, NY 10601–1827, [www.smp-te.org](http://www.smp-te.org).