Designation: E2033 – 17

Standard Practice for Radiographic Examination Using Computed Radiography (Photostimulable Luminescence Method)[1]

This standard is issued under the fixed designation E2033; 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 computed radiographic (CR) examination for metallic and nonmetallic materials using X-ray or gamma radiation.

1.2 *Applicability*—The requirements in this practice are intended to control the quality of computed radiographic examinations and are not intended to establish acceptance criteria for parts or materials.

1.3 *Basis of Application*—The requirements of this practice, Practice E2445 and E2446 shall be used together. The requirements of Practice E2445 will provide the baseline performance evaluation and long term stability test procedures for the CR system. Practice E2446 CR performance levels are recommended in Table 1. The user of the CR 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. The items that shall be determined and addressed in the written procedure are:

(a) Personnel qualification and certification.

(b) Minimum effective pixel coverage appropriate to the acceptance criteria and to meet the radiographic image quality level requirements of Table 1.

(c) Additional tests per Practice E2445 deemed appropriate.

(d) Organizations using a gamma source or radiation energy above 320 kV may need to modify the E2445 tests, gauges, or both.

(e) Maximum allowed unsharpness when other than Table 1.

(f) The method used to provide image traceability to the part and the examination facility.

1.3.1 This practice also requires the user to perform a system qualification suitable for its intended purpose and to issue a system qualification report (see subsection 7.1). Additionally, the user shall develop part specific inspection procedures (see subsections 5.5 and 7.5).

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. Where applicable, SI units are shown in brackets [xx].

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

1.6 *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.*

1.7 *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:*[2]

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

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

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

E1030 Practice for Radiographic Examination of Metallic Castings

[1] This test method 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 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.

TABLE 1 Total Image Unsharpness, Maximum

Material Thickness	Maximum Allowed Image Unsharpness ($U_T^{20\%}$ or U_{lm})	Recommended CR Performance Level per E2446
≤ 0.5 inch [≤ 12.7 mm]	0.010 inch [0.254 mm]	CR level I or Higher
> 0.5 through 1 inch [> 12.7 through 25.4 mm]	0.015 inch [0.381 mm]	CR level I or Higher
> 1 through 2 inches [> 25.4 through 50.8 mm]	0.020 inch [0.508 mm]	CR level II or Higher
> 2 through 4 inches [> 50.8 through 101.6 mm]	0.030 inch [0.762 mm]	CR level II or Higher
> 4 inches [> 101.6 mm]	0.040 inch [1.016 mm]	CR level II or Higher

E1032 Test Method for Radiographic Examination of Weldments
E1114 Test Method for Determining the Size of Iridium-192 Industrial Radiographic Sources
E1161 Practice for Radiologic Examination of Semiconductors and Electronic Components
E1165 Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging
E1316 Terminology for Nondestructive Examinations
E1647 Practice for Determining Contrast Sensitivity in Radiology
E1735 Test Method for Determining Relative Image Quality of Industrial Radiographic Film Exposed to X-Radiation from 4 to 25 MeV
E1742 Practice for Radiographic Examination
E1817 Practice for Controlling Quality of Radiological Examination by Using Representative Quality Indicators (RQIs)
E2002 Practice for Determining Total 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
E2446 Practice for Manufacturing Characterization of Computed Radiography Systems
E2736 Guide for Digital Detector Array Radiology
E2738 Practice for Digital Imaging and Communication Nondestructive Evaluation (DICONDE) for Computed Radiography (CR) Test Methods
E2903 Test Method for Measurement of the Effective Focal Spot Size of Mini and Micro Focus X-ray Tubes

2.2 *ASNT Standards:*[3]
ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel
SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

2.3 *Aerospace Industries Association of America Document:*[4]
NAS-410 Certification and Qualification of Nondestructive Testing Personnel

2.4 *Society of Motion Picture and Television Engineers (SMPTE):*[5]
RP133 Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard Copy Recording Cameras

2.5 *Government Documents:*[6]
NCRP 116 Limitation to Exposure to Ionizing Radiation
NCRP 147 Structural Shielding Design for Medical X-ray Imaging Facilities

2.6 *ISO Documents:*[7]
ISO 9712 Non-destructive Testing—Qualification and Certification of NDT Personnel
ISO 10012 Measurement Management Systems—Requirements for Measurement Processes and Measuring Equipment
ISO 17636-2 Non-destructive Testing of Welds—Radiographic Testing—Part 2: X- and Gamma-Ray Techniques with Digital Detectors
ISO 19232-1 Non-destructive Testing—Image Quality of Radiographs—Part 1: Determination of the Image Quality Value Using Wire-type Image Quality Indicators
ISO 19232-2 Non-destructive Testing—Image Quality of Radiographs—Part 2: Determination of the Image Quality Value Using Step/Hole-Type Image Quality Indicators

2.7 *EN Documents:*[8]
EN 4179 Aerospace Series—Qualification and Approval of Personnel for Non-destructive Testing
EN 12543-2 Non-destructive Testing—Characteristics of Focal Spots in Industrial X-ray Systems for Use in Non-destructive Testing—Part 2: Pinhole Camera Radiographic Method
EN 12543-5 Non-destructive Testing—Characteristics of Focal Spots in Industrial X-ray Systems for Use in Non-destructive Testing—Part 5: Measurement of the Effective Focal Spot Size of Mini and Micro Focus X-ray Tubes.

[3] Available from American Society for Nondestructive Testing, 1711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228-0518.
[4] Available from Aerospace Industries Association of America, Inc., 1250 Eye St. NW, Washington, D.C. 20005.
[5] Available from Society of Motion Picture and Television Engineers, 3 Barker Ave, White Plains, NY 10601.
[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
[7] 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.
[8] Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsigroup.com.

2.8 *ANSI Documents:*[9]
Z540–3 Requirements for the Calibration of Measuring and Test Equipment

3. Terminology

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

3.1.1 *1:1*—an image display scenario where a single pixel of the image is mapped to a single pixel on the image display monitor.

3.1.2 *Cognizant Radiographic Level 3*—the certified level 3 radiographer holding final technical responsibility for the radiographic facility and staff.

3.1.3 *Effective Pixel Size*—effective pixel size is equal to the basic spatial resolution of the detector ($SR_b^{detector}$).

3.1.4 *Fast Scan Direction*—the fast scan direction refers to the laser scan direction along an image line of the IP. This may also be referred to as "laser scan direction."

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

3.1.6 *Pixel Coverage*—for the purpose of this practice, the term "pixel coverage" refers to the minimum number of effective pixels required to cover a feature such as a critical flaw size or the IQI designated hole or essential wire size, whichever is smallest. Geometric magnification may be required to achieve adequate pixel coverage. Additional information on pixel coverage and geometric magnification can be found in Guide E2736.

3.1.7 *Slow Scan Direction*—Slow scan direction refers to the mechanical transport direction of the IP through the scanner. This may also be referred to as "IP transport direction."

4. Summary of Practice

4.1 *Apparatus*—This practice covers application details for computed radiography using a system that consists of a radiation source, a storage phosphor imaging plate (IP) and cassette, an IP scanner/digitizer, scan parameter settings, a workstation with software, an image display monitor, and a digital image archiving system.

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

5. Significance and Use

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

5.2 *Weld Examination*—Additional information on weld examination may be found in Practice E1032, ISO 17636-2, or both.

5.3 *Casting Examination*—Additional information on casting examination may be found in Practice E1030.

5.4 *Electronic Components*—Radiographic examination of electronic components shall comply with Practice E1161.

5.5 *Part-Specific Examination Technique*—A detailed written procedure in the form of a part-specific examination technique (7.5) shall be documented for each part, or group of parts, and shall be approved by the Cognizant Radiographic Level 3.

5.6 *Personnel Qualification*—Personnel performing examinations to this practice shall be qualified in accordance with ISO 9712, NAS 410, EN 4179, 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 on the contract or purchase order. The applicable revision shall be the latest unless otherwise specified in the contractual agreement between parties.

5.7 *System Qualification*—All CR systems shall be qualified for their intended use. System qualification requirements are specified in subsection 7.1.

5.8 *Process Control*—All CR systems shall be monitored for long term stability (process control) as specified in subsection 7.1.4.

5.9 *Preventative Maintenance*—All CR systems and X-ray machines require periodic maintenance to ensure proper functionality. Preventative maintenance requirements are specified in subsection 6.2.

5.10 *Environmental Conditions*—CR systems should be operated within environmental conditions that are in compliance with manufacturer's stated acceptable environmental conditions, e.g., temperature and humidity. When CR systems are operated outside the specified manufacturer's environmental ranges, the system shall be qualified (7.1) for such conditions.

6. Equipment and Facilities

6.1 *Equipment:*

6.1.1 *X-Radiation Sources*—Selection of appropriate X-ray machine parameters (e.g., voltage, current, focal spot) is dependent upon the examination requirements for the specimen being examined (e.g., material type, geometry, acceptance criteria). The suitability of any X-ray machine and the examination technique parameters shall be demonstrated by attainment of the required radiographic quality level and compliance with all other requirements specified herein.

6.1.2 *Gamma Radiation Sources*—Selection of an appropriate isotope source (e.g., energy, source size) is dependent upon the examination requirements for the specimen being examined (e.g., material type, geometry, acceptance criteria). The suitability of any gamma ray source and the examination technique

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