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).

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[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

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supplier of radioscopic examination services shall agree upon the system configuration to be used for each radioscopic examination application under consideration, and how its performance is to be evaluated; see Section 9.

6.1.1 The minimum radioscopic examination system configuration will include:

6.1.1.1 An appropriate source of penetrating radiation,

6.1.1.2 A radiation protective enclosure with appropriate safety interlocks and a radiation warning system or other appropriate radiation safety in accordance with local regulations,

6.1.1.3 A means for positioning the examination object within the radiation beam,

6.1.1.4 An image detection system (for example, fluorescent screen viewed by a video camera, a dynamic rate capable DDA, an LDA with linear motion of either the detector or component under examination, or a radiation detector with X-ray flying spot), and

6.1.1.5 An image display.

6.1.2 A more complex system might include the following additional components:

6.1.2.1 *Image Detector:*

*(1)* An Image Intensifier/Camera system to intensify the photon detection from a bare fluorescent screen image detector, or

*(2)* An X-ray Image Intensifier (XRII) tube and camera image detector.

6.1.2.2 *Radiation Source*—A micro- or mini-focus X-ray tube (can be used with magnification to facilitate higher-resolution projection imaging).

6.1.2.3 *Manipulation System*—A multiple axis examination part manipulation system to provide full volumetric examination part manipulation under operator manual control or automated program control.

6.1.2.4 *Information Processing System:*

*(1)* The function of the information processing system is to take the output of the detection system and present a useful image for display and operator interpretation, or for automatic evaluation. The information processing system may take many different forms, and may process analog or digital information, or a combination of the two.

*(2)* The information processing system includes all of the electronics and interfaces after the detection system including the image display and automatic evaluation system. Information system components include such devices as frame grabbers, image processors, and in general any device that processes radioscopic examination information after the detection system.

*(3)* A digital image processing system warrants special attention, since it is the means by which radioscopic examination information may be enhanced. Care shall be exercised in determining which image processing techniques are most beneficial for the particular application. Directional spatial filtering operations, for example, must be given special attention as certain feature orientations are emphasized while others are suppressed. While many digital image processing operations occur sufficiently fast to follow time-dependent radioscopic system variables, others do not. Some image processing operations require significant image acquisition and processing time, so as to limit the dynamic response of the radioscopic examination, in dynamic radioscopic systems. Image processing, if used, shall be included in the system qualification (see 9.5 and 9.6).

6.1.3 *Image Display:*

6.1.3.1 Image display monitors used for interpretation shall meet the following requirements as a minimum. Alternate image displays or requirements may be used with CEO approval.

6.1.3.2 The minimum brightness as measured off the image display monitor screen at maximum Digital Driving Level (DDL) shall be 250 cd/$m^2$.

6.1.3.3 The minimum contrast as determined by the ratio of the image display monitor screen brightness at the maximum DDL compared to the screen brightness at the minimum DDL shall be 250:1.

6.1.3.4 The image display monitor shall be capable of displaying linear patterns of alternating pixels at full contrast in both the horizontal and vertical directions without aliasing.

6.1.3.5 The image display monitor shall be free of discernable geometric distortion.

6.1.3.6 The image display monitor shall be free of screen flicker, characterized by high frequency fluctuation of high-contrast image details.

6.1.3.7 The image display monitor shall be capable of displaying a 5 % DDL block against a 0 % DDL background and simultaneously displaying a 95 % DDL block against a 100 % background in a manner clearly perceptible to the user.

6.1.3.8 The image display monitor shall be capable of discriminating horizontal and vertical low contrast (1 %) modulation patterns at the display center and each of the four corner locations.

6.1.3.9 The image display monitor shall be capable of displaying no less than 256 unique shades of gray.

6.1.4 *Image Display Monitor Test Pattern*—The test pattern for measuring the image display monitor requirements of 6.1.3 shall comply with SMPTE RP-133 and shall be configured to the image display monitor's resolution and aspect ratio. The test pattern shall be viewed at 1:1 digital zoom (One display pixel per image pixel). Alternate test patterns may be used when approved by the Cognizant Radiographic Level 3 provided they include the features described in SMPTE RP-133 required to perform the image display tests specified herein.

6.1.5 *Light Meters:*

6.1.5.1 *Luminance*—A calibrated light meter shall be used to measure image display monitors for brightness and contrast and shall measure luminance in candelas per square meter (cd/$m^2$) or foot-lamberts.

6.1.5.2 *Illuminance*—A calibrated light meter shall be used to measure ambient background lighting and shall measure illuminance in lux [lumens/$m^2$] or in foot candles (fc).

6.1.5.3 Calibration frequency for light meters is listed in Table 1.

6.1.6 *Image Quality Indicators (IQIs)*—A Certificate of Compliance (COC) is required to verify material type and dimensional accuracy. A means to trace COCs to individual

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**TABLE 1 Calibration and Process Control**

| Check | Method | Frequency | Subsection |
|---|---|---|---|
| Focal spot size | E1165 or E2903 | See E1411[A] | 8.1 |
| Detector basic spatial resolution ($SR_b^{detector}$) | E2002 | See E1411[B] | 8.1 |
| Contrast Sensitivity | E1647 | See E1411[B] | 8.1 |
| Image Quality | IQI and/or RQI | See E1411[B] | 8.1 |
| Image Display Monitor: | | | |
| Brightness | Light Meter | Monthly | 6.1.3.2 |
| Contrast | Light Meter | Monthly | 6.1.3.3 |
| High Contrast Resolution | Visual | Daily[C] | 6.1.3.4 |
| Low Contrast Resolution | Visual | Daily[C] | 6.1.3.8 |
| Flicker | Visual | Daily[C] | 6.1.3.6 |
| Distortion | Visual | Daily[C] | 6.1.3.5 |
| Small Contrast Change | Visual | Daily[C] | 6.1.3.7 |
| Light Meter(s) | Calibration | 6 months | 6.1.5 |
| Image Quality Indicators | Certified | When Procured | 6.1.6 |
| | Visual | Prior to Use[C] | 6.1.6 |
| Representative Quality Indicators | Visual | Prior to Use[C] | 6.1.7 |
| Dimensional Reference Standard | Calibration | [D] | 6.1.8 |
| Measurement Tools | Calibration | [D] | 6.1.9 |
| Background Ambient Light | Light Meter | [E] | 10.3.1 |

[A] In case of a fixed focus tube the value from the manufacturer may be used.
[B] Unless otherwise specified, frequency not to exceed 10 days for these performance checks.
[C] Documentation of this check is not required.
[D] Calibrated and recorded in accordance with ANSI Z540-3 or ISO 10012, as applicable.
[E] Initially and when conditions change. Fixed viewing locations with acceptable and controlled ambient lighting conditions need not be re-verified as long as those conditions are maintained.

IQIs shall be provided. Users shall visually inspect IQIs for damage and cleanliness in accordance with Table 1.

6.1.6.1 *Hole-Type IQIs*—Hole-type IQIs shall comply with Practice E1025, Practice E1742 Annex A1, or ISO 19232-2, however, the minimum thickness may be 0.005 in. [0.127 mm] and the minimum hole sizes, 1T, 2T, and 4T, may be 0.010 in. [0.254 mm], 0.020 in. [0.508 mm] and 0.040 in. [1.016 mm].

6.1.6.2 *Wire-Type IQIs*—Wire-type IQIs shall comply with Practice E747 or ISO 19232-1 and shall be correlated to hole-type radiographic quality levels.

6.1.6.3 *IQI and Shim Material*—IQIs and shims shall be of the same material group as the specimen being examined. When IQIs and shims of the same material group are not available, radiographically similar IQIs and shims as defined in Practice E1025 may be used. IQIs and shims of radiographically less dense material than the subject shall be allowed.

6.1.6.4 *IQI Shims*—Shims used with IQIs shall exceed the IQI dimensions such that the pertinent features of the IQI are visible in the image.

6.1.6.5 *Alternate IQI Types*—The use of other types of IQIs, or modifications to types specified, is permitted upon approval of the cognizant engineering organization. Details of the design, materials designation, and thickness identification of the IQIs shall be in the written procedure, or documented on a drawing that shall be referenced in the written procedure.

6.1.7 *Representative Quality Indicators (RQIs)*—When used, RQIs shall comply with the requirements of Practice E1817. Users shall visually inspect RQIs for damage and cleanliness in accordance with Table 1.

6.1.8 *Dimensional Reference Standard*—When image features are measured for accept/reject evaluations, a calibrated physical standard shall be used when calibrating the software measurement tool. Users shall visually inspect the reference standard to ensure the calibration is current and for damage and cleanliness in accordance with Table 1.

6.1.9 *Measurement Tools*—As an alternative to the dimensional reference standard, a feature or item included in the image, such as the IQI, may be measured with a calibrated measurement tool (for example, calibrated dial caliper) to establish software calibration. Users shall ensure the calibration is current in accordance with Table 1. A dimensional calibration of the measuring function based upon a verifiable scanned pixel size may also be used.

6.1.10 *Radioscopic Examination Record Archiving System:*

6.1.10.1 The examination record archiving system shall be as agreed upon by the CEO and NDT supplier of radioscopic examination services. The reproduction quality of the archival method shall be sufficient to demonstrate the same image quality as was used to qualify the radioscopic examination system. To reduce storage capacity image compression may be used (if lossy compression like JPEG or MPEG is used, ensure that the resulting quality is equivalent to the original image). Lifetime of the image storage media shall meet CEO requirements. Guide E1475 or Practice E2339 shall be consulted if stored radioscopic data is to be shared with dissimilar radioscopic storage, retrieval, display, and hard copy systems.

6.1.10.2 Video hard copy device used to create an image from the video signal shall meet CEO requirements.

6.1.10.3 Laser print hard copy device used to create a film image shall meet CEO requirements.

6.1.10.4 Analog video tape recording and playback shall meet CEO requirements (Guide E1453 shall be consulted for radioscopic data media storage precautions).

6.1.10.5 Digital recording on magnetic tape shall meet CEO requirements.

6.1.10.6 Digital recording on optical disk shall meet CEO requirements.

6.1.10.7 Digital records shall have backup storage.

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## 7. Hazards

7.1 The premises and equipment shall present no hazards to the safety of personnel or property. Radioscopic examination procedures shall be conducted under protective conditions so that personnel will not receive ionizing radiation dose levels exceeding that permitted by company, city, state, or national regulations. NCRP 49, NCRP 61, NCRP 116, NCRP 147, ANSI/HPS N43.3, 21 CFR 1020.40, and 29 CFR 1910.96 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.

## 8. Procedure

8.1 A written procedure must be approved by the Radiographic Level 3 of the NDT facility. Where required, the written procedure shall be approved by the contracting agency prior to use. The written procedure shall include the following general requirements.

8.2 *Examination and Coverage*—The number of parts examined and the examination coverage of each part shall be as specified by the engineering drawing or other authorizing documentation. When the number of parts to be examined or the amount of coverage is not specified, then all parts shall be examined and shall receive 100 % coverage.

8.3 *Examination Sequence*—The sequence for radiographic examination shall be as specified by the engineering drawing or other authorizing documentation. When not specified, radiographic examination shall be performed at a stage in the manufacturing process or assembly where pertinent discontinuities can be detected.

8.4 *Surface Preparation*—Components may be examined without surface preparation or conditioning except as required to remove surface conditions that may interfere with proper interpretation and evaluation of the radiographic images.

8.5 *Acceptance Requirements*—Indicate the criteria by which the components are judged acceptable. Complex components may be divided into zones and separate criteria assigned to each zone in accordance with its design requirements.

8.6 *Examination Object Scan Plan*—A listing of object orientations, ranges of motions, and manipulation speeds through which the object shall be manipulated to ensure satisfactory examination.

8.7 *Dynamic Imaging*—Dynamic or in-motion imaging may be used to gain useful information about the object. However, unless dynamic imaging is specified and qualified, the final assessment of image formation for mandatory radioscopic examinations shall be made in the static mode.

8.8 *Radioscopic Parameters*—A radioscopic examination technique shall be established and documented for each part examined. When the technique is similar for multiple parts, a master examination technique may be used that covers the details common to a variety of parts. The technique shall be capable of consistently producing the detail requirements of this practice and shall be approved by the Cognizant Radiographic Level 3.

8.8.1 The following detail information, as applicable, shall be documented on the radiographic examination technique:

8.8.1.1 Name and address of the examination facility.

8.8.1.2 Customer name.

8.8.1.3 Revision level and date of the technique.

8.8.1.4 Part name and part number.

8.8.1.5 Part material and alloy.

8.8.1.6 Part thickness or thickness range (which the IQI is based on).

8.8.1.7 IQIs/RQIs used.

8.8.1.8 Source energies or gamma isotope.

8.8.1.9 Source intensities.

8.8.1.10 Focal spot sizes.

8.8.1.11 Filter in the X-ray beam (as applicable).

8.8.1.12 Collimator positions and settings (as applicable).

8.8.1.13 Range of source-to-object distances object-to-image plane distances, and source-to-image plane distances.

8.8.1.14 Frame rate and averaging.

8.8.1.15 *Total Image Unsharpness*—Maximum total image unsharpness shall be in accordance with the requirements of Table 3 unless otherwise approved by the CEO and Cognizant Radiographic Level 3.

8.8.1.16 *Radioscopic Quality Level*—Table 2 lists the radioscopic quality levels. Unless otherwise specified on the engineering drawing or other authorizing documentation, the default radiographic quality level shall be 2-2T. The radioscopic image shall render a clearly defined image of the required IQI features.

8.9 *Image Quality Indicator Use:*

8.9.1 When placed directly on the component, one IQI shall represent an area with a pixel value or brightness equal to or less than the least radiographically dense area of the represented area of the image.

8.9.1.1 Additional IQIs may be used, as necessary, to cover the entire thickness range of the object. For components such as castings and forgings, where there are changes in wall thickness and wall alignment and the use of multiple IQIs is not

**TABLE 2 Radioscopic Quality Levels**

| Radioscopic Quality Level | Maximum IQI Thickness, %[A] | Minimum Perceptible Hole Diameter[B,D] | Equivalent IQI Sensitivity, %[C,E] |
|---|---|---|---|
| 1–1T | 1 | 1T | 0.7 |
| 1–2T | 1 | 2T | 1.0 |
| 2–1T | 2 | 1T | 1.4 |
| 2–2T | 2 | 2T | 2.0 |
| 2–4T | 2 | 4T | 2.8 |

[A] Expressed as a percentage of material thickness.
[B] Expressed as multiple thickness of IQI.
[C] Equivalent IQI sensitivity is that thickness of the IQI expressed as a percentage of the specimen thickness in which a 2T hole would be clearly visible under the same radiographic conditions.
[D] When using Wire Type IQIs, Table 4 of Practice E747 shall be used to determine equivalent wire size to corresponding 1T, 2T or 4T hole size.
[E] EPS values shown above are not applicable for material thicknesses below 0.500 in. [12.7 mm] when using standard Hole Type IQIs with minimum thickness and hole size (Notes A and B).

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