



Designation: E1734 – 23

Standard Practice for Radioscopic Examination of Castings¹

This standard is issued under the fixed designation E1734; 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 covers a uniform procedure for radioscopic examination of castings. Radioscopic examination of weldments can be found in [E1416](#).

1.2 This practice applies only to radioscopic examination in which an image is finally presented on a display screen (monitor) for evaluation. Test part acceptance may be based on a static or dynamic image. The examination results may be recorded for later review. This practice does not apply to fully automated systems in which evaluation is performed automatically by a computer.

1.3 Due to the many complex geometries and part configurations inherent with castings, it is necessary to recognize the potential limitations associated with obtaining complete radioscopic coverage. Consideration shall be given to areas where geometry or part configuration does not allow for complete radioscopic coverage.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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.*

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.

Current edition approved June 1, 2023. Published June 2023. Originally approved in 1995. Last previous edition approved in 2016 as E1734 – 16a. DOI: 10.1520/E1734-23.

2. Referenced Documents

2.1 ASTM Standards:²

- [E94 Guide for Radiographic Examination Using Industrial Radiographic Film](#)
- [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](#)
- [E1000 Guide for Radioscopy](#)
- [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](#)
- [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](#)
- [E1742 Practice for Radiographic Examination](#)
- [E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation \(DICONDE\)](#)
- [E2903 Test Method for Measurement of the Effective Focal Spot Size of Mini and Micro Focus X-ray Tubes](#)

3. Terminology

3.1 *Definitions*—Definitions of terms applicable to this practice may be found in Terminology [E1316](#).

4. Significance and Use

4.1 The requirements in this practice are intended to control the quality of the radioscopic images to produce satisfactory

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.

and consistent results. This practice is not intended for controlling the acceptability of the casting. The radioscopic method may be used for detecting volumetric discontinuities and density variations that are within the sensitivity range of this practice. The dynamic aspects of radioscopy are useful for maximizing defect response.

5. Basis of Application

5.1 The following items shall be agreed upon between the purchaser and the supplier:

5.1.1 *Nondestructive Testing Agency Evaluation*—If specified in the contractual agreement, nondestructive testing (NDT) agencies shall be qualified and evaluated as described in Practice E543. The applicable edition of Practice E543 shall be specified in the contractual agreement.

5.1.2 *Personnel Qualification*—If specified in the contractual agreement, personnel performing examinations to this standard 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. The practice or standard used, and its applicable revision, shall be identified in the contractual agreement between the using parties.

5.1.3 *Recording Media*—If required, the recording media to be used shall be specified in accordance with the requirements of Section 6.

5.1.4 *Performance Measurements*—Performance measurement shall be specified in accordance with the requirements of Section 7.

5.1.5 *Procedure*—Procedural requirements shall be specified in the contractual agreement.

5.1.6 *Records*—Records shall be specified in the contractual agreement.

6. Apparatus

6.1 Success of the radioscopic process depends on the overall system configuration and the selection of appropriate subsystem components. Guidance on the selection of subsystem components and the overall system configuration is provided in Guide E1000 and Practice E1255. Initial qualification and periodic re-qualification of the radioscopic system is required (see Section 7). The suitability of the radioscopic system shall be demonstrated by attainment of the required image quality and compliance with all other requirements stipulated herein.

6.2 Equipment:

6.2.1 *Radiation Source (X-Ray or Gamma-Ray)*—Selection of the appropriate source is dependent on variables regarding the casting being examined, such as material composition and thickness. Guidance on selection of the radiation source may be found in Practice E1255 or Guides E94 and E1000.

6.2.2 *Manipulation Subsystem*—Selection of the appropriate manipulation system (where applicable) is dependent on variables such as the size and orientation of the object being examined and the range of motions, speed of travel, and smoothness of motion. Guidance on selection of the manipulation subsystem may be found in Practice E1255.

6.2.3 *Detector Subsystem*—Selection of the appropriate detection system is dependent on variables such as the material and size of the object being examined and the energy and intensity of the radiation used for the examination. Guidance on selection of the detector subsystem may be found in Guide E1000 or Practice E1255.

6.2.4 *Image Processing Subsystem*—Where agreed upon between the purchaser and the supplier, image processing systems may be used for noise reduction through image integration or averaging, contrast enhancement, and other image processing operations. Users of digital image processing are cautioned to test image processing parameters thoroughly before use. For example, some spatial filter functions produce directional results and may suppress desired image information. Other spatial filters can introduce artifacts into the image.

6.2.5 *Image Display Subsystem*—Selection of the appropriate image display is critical to the transfer of image information from the radioscopic system to the person making the accept-reject decision. The image display should be suitably sized and placed in a controlled environment with subdued lighting to maximize the transfer of image information to the radioscopic system operator.

6.2.6 *Collimation*—Selection of appropriate collimation is dependent on the geometry of the object being examined. It is generally useful to select collimation to limit the primary radiation beam to the detector area or region of interest, whichever is smaller, thereby limiting scatter radiation in order to improve radioscopic image quality.

6.2.7 *Filters and Masking*—Filters and masking may be used to improve image quality by alleviating contrast reductions caused by low-energy scattered radiation. Guidance on the use of filters and masking is provided in Guide E94.

6.3 *Location and Identification Markers*—Lead numbers and letters may be used to designate the part number and location number, as needed, provided they do not mask regions of interest on the casting. On-part identification is not required where the manipulator is programmable or manipulator coordinates are provided as a means of ensuring that all regions of interest are covered. A video typewriter or similar device may be used to display location and identification information electronically. When identification is not provided on the part, the method of identification shall be documented in the records in accordance with Section 11.

6.4 Areas that are considered impractical or very difficult to view (see 9.2), shall be marked in the Radioscopic Shooting Sketch.

6.5 *Recording Media*—Recording media for storage of analog or digital images shall be agreed upon between the purchaser and the supplier. Guidance on selection and usage of recording media may be found in Practice E1255.

7. System- and Product-Specific Qualification

7.1 *System Performance Measurement*—The Radioscopic system shall be qualified according to Practice E1411.

7.1.1 Performance Measurement Intervals shall be according to Practice E1411 unless otherwise specified.

8. Safety

8.1 Radioscopic procedures shall comply with applicable local, state, and federal safety regulations.

9. Requirements

9.1 *Procedure Requirement*—Unless otherwise specified by the applicable job order or contract, radioscopic examination shall be performed in accordance with a written procedure. Specific requirements regarding the preparation and approval of the written procedures shall be as agreed by purchaser and supplier. The production procedure shall address all applicable portions of this test method and shall be available for review during interpretation of the images. The written procedure shall include the following:

9.1.1 Material and thickness range to be examined,

9.1.2 Equipment to be used, including specifications of source parameters (such as tube voltage, current, focal spot size) and imaging equipment parameters (such as detector size, field of view, electronic magnification, camera black level, gain, look-up table (LUT)),

9.1.3 Examination geometry, including source-to-object distance, object-to-detector distance and orientation,

9.1.4 Image quality indicator designation and placement,

9.1.5 Test-object scan plan, indicating the range of motions and manipulation speeds through which the test object shall be manipulated in order to ensure satisfactory results,

9.1.6 Image-processing parameters,

9.1.7 Image-display parameters,

9.1.8 Image storage, and

9.1.9 Plan for system qualification and periodic requalification as described in Practices E1255 and E1411.

9.2 *Radioscopic Coverage*—Unless otherwise specified by purchaser and supplier agreement, the extent of radioscopic coverage shall include 100 % of the volume of the casting (see paragraph 6.4). In this case a radioscopic shooting sketch (RSS) in accordance with Appendix X1 shall be required.

9.3 *Examination Speed*—For dynamic examination, the speed of object motion relative to the radiation source and detector shall be controlled to ensure that the required radioscopic quality level is achieved.

9.4 *Radioscopic Image Artifacts*—All images shall be free of marks or other blemishes that could mask or be confused with the image of any discontinuity in the area of interest. It may be possible to prevent blemishes from masking discontinuities or being confused with discontinuities by moving the object being examined relative to the imaging device. If any doubt exists as to the true nature of an indication exhibited in the image, the image shall be rejected and a new image of the area shall be made.

9.5 *Radioscopic Quality Level*—Radioscopic quality level shall be determined upon agreement between the purchaser and supplier and shall be specified in the applicable job order or contract. If no quality level is defined, an equivalent penetrameter sensitivity (EPS) of 2% or 2-2T shall be the standard. Radioscopic spatial resolution shall be determined upon agreement between the purchaser and supplier and shall be specified in the applicable job order or contract.

9.6 *Acceptance Level*—Accept and reject levels shall be stipulated by the applicable contract, job order, drawing, or other purchaser and supplier agreement.

9.7 *Image-Viewing Facilities*—Viewing facilities shall provide subdued background lighting of an intensity that will not cause troublesome reflection, shadows, or glare on the image. The image display performance, size, and placement are important radioscopic system considerations. A test pattern similar to SMPTE RP133 shall be used to qualify the display.

9.8 *Storage of Images*—When storage is required by the applicable job order or contract, the images should be stored in a format stipulated by the applicable contract, job order, drawing, or other purchaser and supplier agreement. The image-storage duration and location shall be as agreed between purchaser and supplier (see Guides E1453 and E1475 and Practice E2339).

9.9 *Initial Qualification*—An initial qualification of the radioscopic system shall be performed in accordance with paragraph 7.1. The periodic re-qualification shall be performed in accordance with paragraph 7.1.1. The suitability of the radioscopic system shall be demonstrated by attainment of the required image quality and compliance with all other requirements stipulated herein.

10. Procedure Considerations

10.1 *Time of Examination*—Radioscopy may be performed in the as-cast, intermediate, or final machined condition, as may be specified by the applicable job order or contract.

10.2 Material and thickness range to be examined.

10.3 *Surface Preparation*—While no surface preparation is required for radioscopy, the removal of flash, surface blemishes, and debris that could adversely affect the radioscopic image is recommended.

10.4 *Examination Speed*—For dynamic examination, the speed of the test object relative to the radiation source and detector shall be subject to agreement between the purchaser and the supplier. Base this determination on the achievement of the required radioscopic quality level at that examination speed.

10.5 *Direction of Radiation*—The direction of radiation shall be governed by the geometry of the casting, coverage, and quality requirements stipulated by the applicable job order or contract. Practically, place the central beam of the radiation perpendicular to and centered on the surface of the detector.

10.6 *Scattered Radiation*—Scattered radiation (radiation scattered from the test object and surrounding structures) reduces radioscopic contrast and may reduce radioscopic quality. Precautions such as collimation of the source, collimation of the detector, and additional shielding should be used, as appropriate.

10.7 *IQI Selection*—Where specified, IQI selection shall be based on the following: if the thickness to be inspected exceeds the design thickness of the finished piece, the IQI size shall be based on the thickness that does not exceed the design thickness of the finished piece by more than 20 % or ¼ in.

(6.35 mm), whichever is greater. The IQIs should be of the same or similar material to that being examined. In no case shall the IQI size be based on a thickness greater than the thickness to be examined.

10.8 *Number of Image Quality Indicators:*

10.8.1 Where an IQI is required, at least one IQI (Practice E747, Practice E1025, or Practice E1742) shall be placed in the area of interest in which the brightness or signal level is relatively uniform.

10.8.2 When a series of radioscopic images is made under similar conditions of unsharpness, it is permissible for the IQIs to be used only on the first and last images in an inspection series subject to agreement between the purchaser and the supplier. Where the irregular shape or size of a casting makes meaningful IQI placement difficult, the qualifying images may be of the IQIs on mounting blocks, simulating the thinnest and thickest sections of the casting that must be imaged.

10.8.3 Qualifying images shall be retained as part of the radioscopic examination record in order to validate the required IQI sensitivity and placement.

10.9 *IQI Placement:*

10.9.1 Wherever possible, placement of the IQI shall be on the source side of the casting or mounting block.

10.9.2 *Detector Side IQIs*—In those cases in which the physical placement of the image quality indicators on the source side is not possible, the IQIs may be placed on the detector side of the casting, along with a lead letter “D.” The applicable job order or contract shall specify the applicable detector-side quality level. The accompanying documents shall indicate clearly that the IQIs were located on the detector side.

10.9.3 When Practice E1025 IQIs are used on mounting blocks, the mounting block length and width dimensions shall exceed the IQI length and width dimensions by at least 0.12 in. (3 mm) on at least three sides. At least three edges of the IQI shall be visible in the radioscopic image.

10.9.4 *Image Identification*—A system of positive identification of the radioscopic image shall be provided. As a minimum, the following shall appear along with the radioscopic image: the name or symbol of the company performing radioscopy, date, and casting identification number traceable to part and contract. Reshots and different views of the same test part area shall be identified uniquely. Subsequent images made of a repaired area shall be identified using “R-1,” “R-2,” and so forth. For digitally stored images, the identification of the image shall be in the filename or tags associated with the file (see Guide E1475).

10.10 *Radioscopic Techniques:*

10.10.1 *Single-Wall Technique*—A technique in which the radiation passes through only one casting wall to form the radioscopic image.

10.10.2 *Double-Wall Technique*—A technique in which the radiation passes through both casting walls to form the radioscopic image.

10.11 *Examination Speed*—For dynamic examination, the speed of test object motion relative to the radiation source and detector shall be controlled to ensure that the required radioscopic quality level is achieved and maintained.

10.12 *Radioscopic Image Quality*—All images shall be free of artifacts that could mask or be confused with the image of any discontinuity in the area of interest. It may be possible to prevent artifacts from masking discontinuities or being confused with discontinuities by moving the object being examined relative to the direction of radiation. If any doubt exists concerning the true nature of an indication exhibited in the image, the image shall be rejected and a new image of the area shall be made.

10.13 *Image Viewing Facilities*—Viewing facilities shall provide subdued background lighting with an intensity that will not cause troublesome reflection, shadows, or glare on the image. The image-viewing environment should be conducive to operator concentration, thereby improving the quality of the accept-reject decision.

10.14 *Storage of Images*—When storage is required by the applicable job order or contract, the images shall be stored in a format stipulated by the applicable contract, job order, drawing, or other purchaser and supplier agreement. Guide E1453 should be consulted for radioscopic data media storage precautions. Guide E1475 should be consulted if stored radioscopic data is to be shared with dissimilar radioscopic storage, retrieval, display, and hard copy systems. Image-storage duration and location shall be subject to agreement between the purchaser and the supplier.

11. Records

11.1 Records shall be maintained for a specified period of time. As a minimum, the following records shall be maintained as subject to agreement between the purchaser and the supplier:

11.1.1 Radioscopic shooting sketch (RSS), including examination geometry, source-to-object distance, object-to-detector distance, and orientation;

11.1.2 Material and thickness range examined;

11.1.3 Radioscopic system qualification details, as specified in Practice E1411;

11.1.4 Qualifying images;

11.1.5 Test-object scan plan;

11.1.6 Image processing parameters;

11.1.7 Image-storage data;

11.1.8 Casting repair documentation; and

11.1.9 Image-interpretation record, containing the following information as a minimum:

11.1.9.1 Disposition of each casting (acceptable or rejectable);

11.1.9.2 If rejectable, part identification number, view number, and cause for rejection (shrink, crack, porosity, and so forth);

11.1.9.3 Surface indications that have been verified by visual examination; and

11.1.9.4 Signature of the interpreter, including level of certification.

11.2 Guide E1453 should be consulted for radioscopic data media storage precautions.

11.3 Guide E1475 or Practice E2339 should be consulted if stored radioscopic data is to be shared with dissimilar radioscopic storage, retrieval, display, and hard-copy systems.

12. Keywords

12.1 castings; digital image processing; gamma ray; in-motion; nondestructive testing; radiation; radioisotope; radioscopic examination; radioscopy; X-ray

APPENDIX

(Nonmandatory Information)

X1. RADIOSCOPIC SHOOTING SKETCH (RSS)

X1.1 The RSS provides the operator and radioscopic interpreter with pertinent information regarding the examination of a casting. The RSS is designed to standardize radioscopic methodologies associated with casting examination; it may also provide a means for purchaser and supplier agreement, prior to initiation of the examination on a production basis. The use of a RSS is advantageous due to the many configurations associated with castings and the corresponding variations in techniques for inspection of any particular casting. The RSS provides a map of location marker placement, directions for source and detector arrangement, and instructions for all other parameters associated with radioscopy of a casting. This information serves to provide the most efficient method of controlling the quality and consistency of the resultant radioscopic representations. The RSS usually consists of an instruction sheet and one or more sketches of the casting. The instruction sheet specifies the radioscopic equipment, materials, techniques, and acceptance parameters for each location; the sketches illustrate the location, orientation, and source and conversion device arrangement for each radioscopic location. The RSS should provide the following information, unless marked not applicable (NA).

X1.1.1 The instruction sheet should provide the following:

- X1.1.1.1 Purchaser of radioscopic services;
- X1.1.1.2 Supplier of radioscopic services;
- X1.1.1.3 Company and individual preparing the RSS and date;
- X1.1.1.4 Entity performing radioscopy;
- X1.1.1.5 Casting information, including the following:
 - (1) Drawing number,
 - (2) Casting identification number,
 - (3) Descriptive name (for example, pump casting, valve body, and so forth),
 - (4) Material type and material specification,
 - (5) Heat number, and
 - (6) Pattern number;
- X1.1.1.6 Casting condition at time of radioscopy (as-cast, rough-machined, or finished-machined);
- X1.1.1.7 Method for determining image quality;
- X1.1.1.8 Performance monitoring intervals;
- X1.1.1.9 The following radioscopy technique parameters for each radioscopic location:

- (1) Single-wall thickness for radioscopy,
 - (2) Single-wall finished thickness,
 - (3) Double-wall thickness for radioscopy,
 - (4) Double-wall finished thickness,
 - (5) Radioscopic sensitivity measuring device—IQI, calibration block, or actual test part,
 - (6) Required sensitivity,
 - (7) X-ray kilovolt range and pre-filter or radioisotope source type,
 - (8) X-ray milliamperage range or radioisotope source strength,
 - (9) Focal spot size, measured by Test Method E1165 or E2903—or in case of a fixed focus tube—value from supplier of tube,
 - (10) Magnification mode,
 - (11) Source-detector-distance (SDD),
 - (12) Object-detector-distance, measured from source side of object to detector (ODD),
 - (13) Radioscopy accept-reject standard, and
 - (14) Applicable radioscopic acceptance criteria; and
- X1.1.1.10 Spaces for approval, as applicable.

X1.1.2 The RSS's should provide the following information:

- X1.1.2.1 Location marker placement;
- X1.1.2.2 Location of foundry's identification pad or symbol on the casting;
- X1.1.2.3 Designation of areas that require inspection, as applicable;
- X1.1.2.4 Designation of areas that are considered impractical or very difficult to view (see paragraph 1.3 and paragraph 6.4); and
- X1.1.2.5 Radiation source, masks, collimators, and filters used and radiation beam direction for each location.
- X1.1.2.6 Detector type, internal magnification mode, camera, camera modes, frame integration, and image processing (if applied).

NOTE X1.1—The RSS should designate the involved locations and stipulate that the technique for those locations is typical for sections of the casting on which a continuing series of locations are to be imaged with the same basic source and detector arrangement for each location. This appendix provides a sample RSS that includes an instruction sheet (Fig. X1.1) and shooting sketch (Fig. X1.2) that have been developed for a typical casting application.