



Designation: E1032 – 19

Standard Practice for Radiographic Examination of Weldments Using Industrial X-Ray Film¹

This standard is issued under the fixed designation E1032; 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 provides a uniform procedure for radiographic examination of weldments using industrial radiographic film. Requirements expressed in this practice are intended to control the quality of the radiographic images and are not intended for controlling acceptability or quality of welds.

1.2 The radiographic extent, the quality level, and the acceptance criteria to be applied shall be specified in the contract, purchase order, product specification, or drawings.

1.3 The radiographic techniques stated herein provide adequate assurance for defect detectability; however, it is recognized that, for special applications, specific techniques using more or less stringent requirements may be required than those specified. In these cases, the use of alternative radiographic techniques shall be as agreed upon between purchaser and supplier (also see Section 4).

1.4 The values stated in inch-pound units are to be regarded as standard.

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.* (For more specific safety precautionary information, see Section 9.)

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 Feb. 1, 2019. Published March 2019. Originally approved in 1985. Last previous edition approved in 2012 as E1032 – 12. DOI: 10.1520/E1032-19.

2. Referenced Documents

2.1 ASTM Standards:²

E94 Guide for Radiographic Examination Using Industrial Radiographic Film

E242 Reference Radiographs for Appearances of Radiographic Images as Certain Parameters are Changed

E390 Reference Radiographs for Steel Fusion Welds

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

E999 Guide for Controlling the Quality of Industrial Radiographic Film Processing

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

E1079 Practice for Calibration of Transmission Densitometers

E1254 Guide for Storage of Radiographs and Unexposed Industrial Radiographic Films

E1316 Terminology for Nondestructive Examinations

E1742 Practice for Radiographic Examination

E1815 Test Method for Classification of Film Systems for Industrial Radiography

2.2 ASNT Documents:³

Recommended Practice No. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel

2.3 Other Standards:

NAS 410 Certification and Qualification of Nondestructive Test Personnel⁴

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.

³ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlington Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

⁴ Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, <http://www.aia-aerospace.org>.

*A Summary of Changes section appears at the end of this standard

ISO 5579 Nondestructive Testing—Radiographic Examination of Metallic Materials by X and Gamma Rays—Basic Rules⁵

ISO 9712 Non-Destructive Testing—Qualification and Certification of NDT Personnel—General Principles⁵

ISO 17636 Non-Destructive Testing of Welds—Radiographic Testing⁵

3. Terminology

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

3.2 With issuance of this practice, the terms *film density* and *radiographic density* have been replaced with the term *optical density*.

4. Basis of Application

4.1 *Personnel Qualification*—Nondestructive testing (NDT) personnel shall be qualified in accordance with a nationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS 410, or a similar document. The practice or standard used and its applicable revision shall be specified in the contractual agreement between the using parties.

4.2 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated in accordance with Specification **E543**. The applicable edition of Specification **E543** shall be specified in the contractual agreement.

4.3 *Time of Examination*—The time of examination shall be in accordance with **8.1** unless otherwise specified.

4.4 *Procedures*—The procedures to be utilized shall be as described in **7.1**.

4.5 *Extent of Examination*—The extent of the examination shall be in accordance with **7.2**.

4.6 *Reporting Criteria/Acceptance Criteria*—Reporting criteria of the examination results shall be in accordance with Section **11**.

4.7 *Reexamination of Repaired or Reworked Items*—Reexamination of repaired or reworked items is not addressed in this practice and if required shall be specified in the contractual agreement.

4.8 *Radiographic Quality Level*—The radiographic quality level shall be in accordance with **7.4**.

5. Materials

5.1 *Film Systems*—Only film systems having cognizant engineering organization (CEO) approval or meeting the requirements of Test Method **E1815** shall be used to meet the requirements of this standard.

6. Apparatus

6.1 *Radiation Source (X-Ray or Gamma-Ray)*—Selection of the appropriate source is dependent upon variables regarding

the weld being examined (material composition and thickness). The suitability of the source shall be demonstrated by attainment of the required IQI sensitivity and compliance with all other requirements stipulated herein (optical density and area of interest density tolerances, etc.).

6.2 *Film Holders and Cassettes*—Film holders and cassettes shall be light tight and shall be handled properly to reduce the likelihood that they may be damaged. They may be flexible vinyl, plastic, or other durable material, or they may be made from metallic materials. In the event that light leaks into the film holder and produces images on the radiograph, the radiograph need not be rejected unless the images encroach on the radiographic area of interest. If the film holder exhibits light leaks, it shall be repaired before reuse or discarded. Film holders and cassettes should be routinely examined to minimize the likelihood of light leaks.

6.3 *Intensifying Screens:*

6.3.1 *Lead-Foil Screens:*

6.3.1.1 Intensifying screens of the lead-foil type are generally used for production radiography. Lead-foil screens shall be of the same approximate dimensions as the film being used and shall be in direct contact with the film during exposure.

6.3.1.2 Unless otherwise specified in the purchaser-supplier agreement, the lead-foil screens shown in **Table 1** shall be used, except as provided within the tabular notes below it.

6.3.2 *Fluorescent, Fluorometallic, or Other Metallic Screens*—Such screens may be used with CEO approval as described under **5.1**; however, they must be capable of demonstrating the required IQI sensitivity. Fluorescent or fluorometallic screens may cause limitations in image quality (see Guide **E94**, Appendix X1).

6.3.3 *Screen Care:*

6.3.3.1 All screens should be handled carefully to avoid dents, scratches, grease, or dirt on active surfaces. Screens that render nonrelevant indications on radiographs shall be visually examined and discarded if physical damage is observed.

6.3.3.2 Screens, with or without backing, shall be free of dust, dirt, oxidation, or any other foreign material that render undesirable nonrelevant images on the film.

6.3.3.3 *Other Screens*—ISO 5579 contains similar provisions for intensifying screens as in this practice. International users of these type screens should specify such alternative provisions within separate contractual arrangements from this practice.

6.4 *Filters*—Filters shall be used whenever the contrast reductions caused by low energy, scattered radiation, or the extent of undercut (edge burn-off) occurring on production radiographs is of significant magnitude to cause difficulty in meeting the quality level or radiographic coverage requirements stipulated by the job order or contract (see Guide **E94**).

6.5 *Masking*—Masking material may improve radiographic quality (see Guide **E94**).

6.6 *IQI's (Penetrameters)*—Unless otherwise specified by the applicable job order or contract, only those IQI's that comply with the design and identification requirements specified in Practice **E1025** or Practice **E747** shall be used.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

TABLE 1 Lead-Foil Screens

keV Range	Front Screen ^A	Back Screen Minimum
0 to 150 keV ^B	0.000 to 0.001 in. [0 to 0.025 mm]	0.005 in. [0.127 mm] ^C
151 to 200 keV	0.001 to 0.005 in. [0.025 to 0.127 mm]	0.005 in. [0.127 mm]
201 to 320 keV	0.001 to 0.010 in. [0.025 to 0.254 mm]	0.005 in. [0.127 mm]
Se-75	0.001 to 0.010 in. [0.025 to 0.254 mm]	0.005 in. [0.127 mm]
321 to 450 keV	0.005 to 0.015 in. [0.127 to 0.381 mm]	0.010 in. [0.254 mm]
Ir-192	0.005 to 0.015 in. [0.127 to 0.381 mm]	0.010 in. [0.254 mm]
451 keV to 2 MeV	0.005 to 0.020 in. [0.127 to 0.508 mm]	0.010 in. [0.254 mm]
Co-60	0.005 to 0.020 in. [0.127 to 0.508 mm]	0.010 in. [0.254 mm]
Over 2 MeV to 4 MeV	0.010 to 0.020 in. [0.254 to 0.508 mm]	0.010 in. [0.254 mm]
Over 4 MeV to 10 MeV	0.010 to 0.030 in. [0.254 to 0.762 mm]	0.010 in. [0.254 mm]
Over 10 MeV to 25 MeV	0.010 to 0.050 in. [0.254 to 1.27 mm]	0.010 in. [0.254 mm]

^A The lead screen thickness listed for the various voltage ranges are recommended thicknesses and not required thicknesses. Other thicknesses and materials may be used provided the required radiographic quality level, contrast, and density are achieved.

^B Prepacked film with lead screens may be used from 80 to 150 keV. No lead screens are recommended below 80 keV. Prepacked film may be used at higher energy levels provided the contrast, density, radiographic quality level, and backscatter requirements are achieved. Additional intermediate lead screens may be used for reduction of scattered radiation at higher energies.

^C No back screen is required provided the backscatter requirements of 8.5 are met.

6.7 Shims, Separate Blocks, or Like Sections—Shims, separate blocks, or like sections made of the same or radiographically similar materials (as defined in Practice E1025) may be used to facilitate IQI positioning. There is no restriction on shim or separate block maximum thickness, provided the IQI and area-of-interest density variation requirements of 8.8.2 are met. The like section should be geometrically similar to the object being radiographed.

6.8 Radiographic Location and Identification Markers—Lead numbers and letters are used to designate the part number and location number. The size and thickness of the markers shall depend on the ability of the radiographic technique to discern the markers on the radiograph. As a general rule, markers 1/16 in. [1.58 mm] thick will suffice for most low energy (less than 1 MeV) X-ray and Iridium 192 radiography; for higher energy radiography it may be necessary to use markers that are thicker (1/8 in. [3.18 mm] thick or more).

6.9 Optical Density Measurement Apparatus—Either a transmission densitometer or a step-wedge comparison film shall be used for judging optical density requirements. Step-wedge comparison films or densitometers calibration, or both, shall be verified by comparison with a calibrated step-wedge film traceable to the National Institute of Standards and Technology. Where applicable, a film digitization and analysis system may be substituted for a transmission densitometer provided the film digitization and analysis system has been calibrated and verified by comparison with a calibrated step-wedge film traceable to the National Institute of Standards and Technology. Densitometers shall be calibrated in accordance with Practice E1079.

7. Requirements

7.1 Procedure Requirement—Unless otherwise specified by the applicable job order or contract, radiographic examination shall be performed in accordance with a written procedure. Specific requirements regarding the preparation and approval of the written procedures shall be dictated by purchaser and supplier agreement. The production procedure shall address all applicable portions of this document and shall be available for review during interpretation of the radiographs.

7.2 Radiographic Coverage—Unless otherwise specified by purchaser and supplier agreement, the extent of radiographic coverage shall include 100 % of the volume of the weld.

7.3 Radiographic Film Quality—All radiographs shall be free of mechanical, chemical, handling-related, or other blemishes of a severity which could mask or be confused with the image of a rejectable discontinuity in the area of interest on the radiograph. If any doubt exists as to the true nature of an indication exhibited by the radiograph, the radiograph shall be rejected and the view retaken.

NOTE 1—Digital image enhancement techniques applied to scanned radiographic images have, in some cases, shown the ability to resolve doubts regarding the true nature of indications shown in the original radiograph. Where applicable, these techniques may be used in an effort to resolve questions regarding the nature of the indication.

7.4 Radiographic Quality Level—Radiographic quality level shall be determined upon agreement between the purchaser and supplier and shall be specified in the applicable job order or contract. See Guide E94 for a discussion of Radiographic Quality Level.

7.5 Acceptance Criteria—Accept and reject criteria shall be stipulated by the applicable contract, job order, drawing, or other purchaser and supplier agreement.

7.6 Optical Density Limitations:

7.6.1 Hole-Type IQIs—The optical density through the body of the IQI and area of interest shall be 1.5 to 4.0 for single film viewing and 2.0 to 4.0 for composite viewing. Optical densities above 4.0 are permitted when agreed upon between the cognizant engineering organization and the NDT facility and when 7.7.3 film viewing facilities are sufficient. In no case shall the maximum optical density exceed 4.5.

7.6.2 Wire IQIs—The optical density adjacent to the required wire and the area of interest shall be 1.5 to 4.0 for single film viewing and 2.0 to 4.0 for composite viewing. Optical densities above 4.0 are permitted when agreed upon between the cognizant engineering organization and the NDT facility and when 7.7.3 film viewing facilities are sufficient. In no case shall the maximum optical density exceed 4.5.