Designation: E1735 – 19

Standard Practice for Determining Relative Image Quality Response of Industrial Radiographic Imaging Systems from 4 to 25 MeV[1]

This standard is issued under the fixed designation E1735; 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 standard provides a practice whereby industrial radiographic imaging systems or specific factors that affect image quality (that is, hardware, techniques, etc.) may be comparatively assessed using the concept of relative image quality response (RIQR) when exposed to X-radiation sources having photon energies from 4 to 25 MeV. The RIQR method presented within this practice is based upon the use of equivalent penetrameter sensitivity (EPS) described within Practice E1025 and Section 5 of this practice. For special applications, the user may design a non-standard RIQI-absorber configuration; however, the RIQI configuration shall be controlled by a drawing similar to Fig. 1. Use of a non-standard RIQI-absorber configuration shall be described in the user's written technique and approved by the RT Level III.

1.2 This practice is not intended to qualify the performance of a specific radiographic technique nor for assurance that a radiographic technique will detect specific discontinuities in a specimen undergoing radiographic examination.

1.3 This practice is not intended to be used to classify or derive performance classification categories for radiographic imaging systems. For example, performance classifications of radiographic film systems may be found within Test Method E1815, manufacturer characterization of computed radiography (CR) systems may be found in Practice E2446, and manufacturer characterization of digital Detector Array (DDA) systems may be found in Practice E2597.

1.4 This standard is not intended to be used with Cobalt 60 sources or X-ray sources below 4 MeV. For low energy X-ray applications (below 4 MeV), Test Method E746 provides a similar RIQR standard practice.

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

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

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

E1316 Terminology for Nondestructive Examinations

E1815 Test Method for Classification of Film Systems for Industrial Radiography

E2002 Practice for Determining Total Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy

E2033 Practice for Radiographic Examination Using Computed Radiography (Photostimulable Luminescence Method)

E2446 Practice for Manufacturing Characterization of Computed Radiography Systems

E2597 Practice for Manufacturing Characterization of Digital Detector Arrays

E2698 Practice for Radiographic Examination Using Digital Detector Arrays

[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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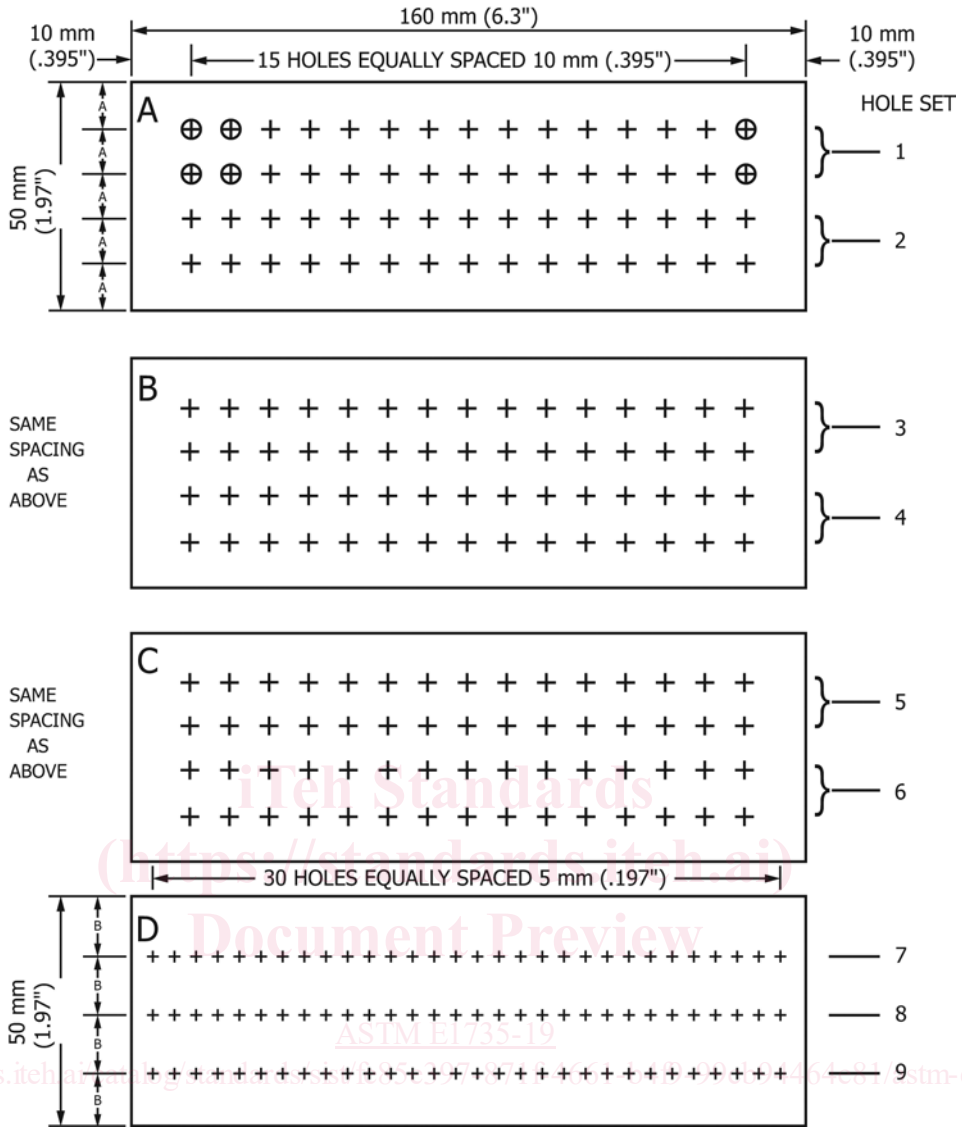
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1—All plaques identical except hole size and plaque thickness hole: row spacing tolerance ± 0.1 mm (± 0.004 in.), nonaccumulative Dimension A = 10 ± 0.1 mm (0.395 ± 0.004 in.) and Dimension B = 12.5 ± 0.1 mm (0.492 ± 0.004 in.); other dimensions in accordance with standard engineering practice.

Plaque Letter	Plaque Thickness		Hole Set	Hole Diameter	
	mm	(in.)		mm	(in.)
A	1.6 ± 0.025	(0.0625 ± 0.001)	1	3.0 ± 0.025	(0.118 ± 0.001)
B	1.3 ± 0.025	(0.050 ± 0.001)	2	1.8 ± 0.025	(0.072 ± 0.001)
C	0.97 ± 0.025	(0.038 ± 0.001)	3	1.8 ± 0.025	(0.072 ± 0.001)
D	0.64 ± 0.025	(0.025 ± 0.001)	4	1.5 ± 0.025	(0.060 ± 0.001)
			5	1.5 ± 0.025	(0.060 ± 0.001)
			6	1.22 ± 0.025	(0.048 ± 0.001)
			7	1.42 ± 0.025	(0.056 ± 0.001)
			8	1.17 ± 0.025	(0.046 ± 0.001)
			9	0.94 ± 0.025	(0.037 ± 0.001)

FIG. 1 Image Quality Indicator

2.2 *ISO Standards:*[3]

ISO 5-2 Photography Density Measurements-Part 2: Geometric Conditions for Transmission Density

ISO 17636 Non-destructive Testing of Welds—Radiographic Testing—Part 2: X- and Gamma-Ray Techniques With Digital Detectors

3. Terminology

3.1 *Definitions*—The definitions of terms relating to gamma and X-radiology in Terminology E1316 shall apply to terms used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *detector, n*—an imaging device used to store a radiographic latent image or directly convert ionizing radiation into electrical signals in proportion to the quantity of radiation absorbed (that is, film, imaging plate, or digital detector array).

3.2.2 *cassette, n*—a device that is either flexible or rigid used to hold or protect a detector.

3.2.3 *relative image quality indicator (RIQI), n*—an image quality measuring device that is capable of determining meaningful differences between two or more radiographic imaging systems or changes of individual components of radiographic imaging systems.

4. Significance and Use

4.1 This standard provides a practice for determining the relative image quality response of a radiographic detector (film, CR imaging plate, or DDA) when exposed to 4 to 25 MeV X-rays as any single component of the total X-ray system (for example, screens) is varied.

4.2 The practice is not intended to be used to compare two different systems or imaging types.

4.3 The approach uses RIQR evaluations of film and non-film imaging systems when exposed through an absorber material. Three alternate data evaluation methods are provided in Section 8. Determining RIQR requires the comparison of at least two radiographs or radiographic processes whereby the relative degree of image quality difference may be determined using the EPS plaque arrangement of Fig. 1 as a relative image quality indicator (RIQI). In conjunction with the RIQI, a specified radiographic technique or method must be established and carefully controlled for each radiographic process. This practice is designed to allow the determination of subtle changes in EPS that may arise to radiographic imaging system performance levels resultant from process improvements/changes, technique changes, or change of equipment attributes. This practice does not address relative unsharpness of a radiographic imaging system as provided in Practice E2002. The common element with any relative comparison is the use of the same RIQI arrangement for both processes under evaluation.

4.4 In addition to the standard evaluation method described in Section 8, there may be other techniques/methods in which the basic RIQR arrangement of Fig. 1 might be utilized to perform specialized assessments of relative image quality performance. For example, other radiographic variables can be altered to facilitate evaluations provided these differences are known and documented for both processes. Where multiple radiographic process variables are evaluated, it is incumbent upon the user of this practice to control those normal process attributes to the degree suitable for the application. RIQR may also be useful in evaluating imaging systems with alternate materials (RIQI and base plate). When using any of these specialized applications, the specific method or techniques used shall be as specified and approved by the RT Level III.

5. Relative Image Quality Indicator

5.1 Fig. 1 illustrates a relative image quality indicator (RIQI) that has four different plaque thicknesses (1.6, 1.3, 0.97, and 0.64 mm (0.063, 0.050, 0.038, and 0.025 in.)) sequentially positioned (from top to bottom) on an absorber plate of carbon steel or Type 300 stainless steel with a thickness of 15 cm (6 in.). The four plaques contain a total of 9 different arrays of penetrameter-type hole sizes designed to render varied conditions of threshold visibility when exposed to the appropriate radiation. Each "EPS" array consists of 30 identical holes, thus providing the user with a quantity of threshold sensitivity levels suitable for relative image qualitative response comparisons.

5.2 The materials for the RIQI and absorber should be the same. For metals, use the same alloy and heat treat family. When situations arise which preclude the use of same or "like" materials (that is, excessive material grain variation affecting test results), alternate absorber materials may be used, provided the alternate material and thickness produces the same optical density (film) or pixel value (PV) (for CR/DDA) as the like material of the thickness used to calculate the EPS.

5.3 The RIQI steps, identified as plaques A-D, may be fabricated as a single multi-step unit or separately and taped together to form the penetrameter type hole arrays shown in Fig. 1. If tape is used, the tape shall not cover or interfere with any of the holes in the RIQI. All dimensions of the RIQI shall conform to Fig. 1. The surface finish of the IQI top and bottom surfaces shall be a maximum of 6.3 µm (250 µin.) R_a ground finish.

5.4 The RIQI shown in Fig. 1 consists of 9 groups of 30 holes where all hole diameters are the same for each array. Hole diameters are based upon a "multiple" of each respective step thickness; therefore, each group of 30 holes has a unique "equivalent" penetrameter sensitivity (EPS) as defined by the following relationship (Practice E1025):

$$EPS,\ \% - \frac{100}{X} \times \sqrt{\frac{Th}{2}} \tag{1}$$

where:

h = hole diameter, mm,
T = step thickness of IQI, mm, and
X = thickness of test object, mm.

[3] 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.