



Designation: E3421 – 24

Standard Digital Reference Images for Appearances of Radiographic Images as Certain Parameters are Changed¹

This standard is issued under the fixed designation E3421; 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 document describes the appearance of a radiographic image where fundamental components of image quality are changed, that is, variables such as whether an X-ray or gamma ray source was used, the characteristics of the radiographic detector, and specimen thickness (the geometrical configuration of the radiographic set-up and focal spot size both affect image quality but are not considered in the reference images).

1.2 The X-ray film systems used in obtaining the original illustrative data were as follows: Very Fine Grain (comparable to class I of Test Method E1815) and Fine Grain (comparable to class II of Test Method E1815).

1.3 These digital reference images consist of four composite illustrations and show how such factors as radiation energy, specimen thickness, and detector properties affect the radiographic image. The digital reference images are an adjunct to this document and must be purchased separately from ASTM if needed.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 Only licensed copies of the software and images shall be utilized for production inspection. A copy of the ASTM/User license agreement shall be kept on file for audit purposes. (See Note 1.)

NOTE 1—The set of digital reference images consists of four digital data files, and software to load the desired format and specific instructions on the loading process. The four reference images illustrate the effects of radiographic parameters in material from one inch to six inches thick. Available from ASTM International Headquarters, Order No: RRE3421.

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

E94 Guide for Radiographic Examination Using Industrial Radiographic Film

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

E746 Practice for Determining Relative Image Quality Response of Industrial Radiographic Imaging Systems below 4 MeV

E1316 Terminology for Nondestructive Examinations

E1735 Practice for Determining Relative Image Quality Response of Industrial Radiographic Imaging Systems from 4 to 25 MeV

E1815 Test Method for Classification of Film Systems for Industrial Radiography

2.2 *ASTM Adjuncts:*

Digital Reference Images for Appearances of Radiographic Images as Certain Parameters Are Changed³

2.3 *SMPTE Practice:*⁴

RP133 Recommended Practice Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and HardCopy Recording Cameras

3. Terminology

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

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

³ Available from ASTM Headquarters. Order RRE3421.

⁴ Available from the Society of Motion Picture and Television Engineers, 3 Barker Avenue, White Plain, NY 10601, http://www.smpte.org/smpte_store.

¹ These reference radiographs are under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.02 on Reference Radiological Images.

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4. Significance and Use

4.1 These reference images are intended as examples of how radiographic parameters affect the radiographic image. The use of these images in determining acceptance of production components is not intended or recommended.

4.2 A key consideration with any radiographic system is its contrast resolution and spatial resolution capability (that is, sensitivity). The degree of obtainable sensitivity with a given system is dependent upon several radiographic parameters such as source energy level, detector type, and material thickness radiographed. These reference images permit the user to estimate the degree of sensitivity change that may be obtained when these parameters are varied from a specific technique. This standard may also be used in conjunction with Test Method E1815 or with Practice E746 or Practice E1735 to provide a basis for developing data for evaluation of a user's specific system. This data may assist a user in determining appropriate parameters for obtaining desired degrees of radiographic system sensitivity.

5. Factors Affecting Radiographic Appearance

5.1 The final interpretation of the radiograph is greatly affected by the appearance of a discontinuity. A poor technique can minimize the radiographic appearance of a discontinuity and conversely the optimum technique can emphasize this appearance. The appearance of a radiographic image is affected mainly by:

- 5.1.1 X-ray or gamma ray energy,
- 5.1.2 Section thickness,
- 5.1.3 Unsharpness,
- 5.1.4 Detector type and parameters, and
- 5.1.5 Exposure geometry.

5.2 These reference radiographs do not consider the effects of unsharpness other than due to specimen thickness.

6. Radiographic Illustrations

6.1 A series of 36 radiographs, each on 10 in. by 12 in. (254 mm by 305 mm) film, were taken of a 12 in. by 12 in. (305 mm by 305 mm) welded steel plate which contained discontinuities in the weld. These were taken to illustrate the differences in appearance of the radiographic image when techniques for taking radiographs are varied by changing the factors listed in Section 5. Technique data for each radiograph is in Table 1. A 2 in. by 2 in. (51 mm by 51 mm) area, which includes the identical image of the discontinuities in the weld, was selected and cut out from each 10 in. by 12 in. (254 mm by 305 mm) radiograph and arranged so as to make four composite illustrations identified as Figures 1 through 4. These composite illustrations are an abridged version of the original 36 radiographs and serve as the reference radiographs for this document. Following are brief descriptions of these figures. The 2 in. by 2 in. images were subsequently digitized to establish the digital images for this standard.

6.1.1 *Figure 1—Composite Illustration A* consists of cut outs from the 10 radiographs taken of the 1 in. (25 mm) thick welded steel plate.

6.1.2 *Figure 2—Composite Illustration B* consists of cut outs from the 10 radiographs taken of the welded steel plate, built up to 2 in. (51 mm) in thickness.

6.1.3 *Figure 3—Composite Illustration C* consists of cut outs from the 10 radiographs taken of the welded steel plate, built up to 4 in. (102 mm) in thickness.

6.1.4 *Figure 4—Composite Illustration D* consists of cut outs from the 6 radiographs taken of the welded steel plate, built up to 6 in. (152 mm) in thickness.

TABLE 1 Technique Data

NOTE 1—No radiographic geometry or focal spot size information is available.

Source	Lead Screens		Composite Illustration				Film	Notes
			A	B	C	D		
	Steel Thickness							
	Front, in.	Back, in.	1 in. (25 mm)	2 in. (51 mm)	4 in. (102 mm)	6 in. (152 mm)		
150 kVp	0.005	0.005	x	...	...	...	Fine Grain	¼ in. lead mask
250 kVp	0.005	0.005	...	x	...	...	Fine Grain	¼ in. lead mask
1 MeV	{	0.010	x	x	x	...	Very Fine Grain	...
		0.010	...	...	...	x	Fine Grain	...
		0.030	x	x	x	...	Fine Grain	...
		0.005	...	...	...	...	Fine Grain	...
2 MeV	{	0.010	x	x	x	x	Very Fine Grain	...
		0.005	x	x	x	x	Fine Grain	...
10 MeV	0.040	0.010	x	x	x	x	Fine Grain	...
15 MeV	0.030	0.010	x	x	x	x	Very Fine Grain	...
Iridium 192	{	0.010	x	...	...	...	Fine Grain	...
		0.010	...	x	x	...	Fine Grain	...
Cobalt-60 (2½ Ci)	{	0.010	x	...	...	...	Fine Grain	...
		0.010	...	x	x	...	Fine Grain	...
Cobalt-60 (1000 Ci)	0.010	0.010	...	...	x	x	Fine Grain	0.080 in. lead filter
Radium-226 (250 mg)	0.010	0.010	x	x	x	...	Fine Grain	...