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Standard Test Method for Determining the Size of Iridium-192 Industrial Radiographic Sources[1]

This standard is issued under the fixed designation E1114; 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.

ϵ[1] NOTE—Editorially corrected 2.2 and Figure 4 in June 2011.

1. Scope

1.1 This test method covers the determination of the size of an Iridium-192 radiographic source. The determination is based upon measurement of the image of the Iridium metal source in a projection radiograph of the source assembly and comparison to the measurement of the image of a reference sample in the same radiograph.

1.2 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.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E999 Guide for Controlling the Quality of Industrial Radiographic Film Processing
E1316 Terminology for Nondestructive Examinations
E1815 Test Method for Classification of Film Systems for Industrial Radiography
E2445 Practice for Qualification and Long-Term Stability of Computed Radiology Systems
E2597 Practice for Manufacturing Characterization of Digital Detector Arrays

[1] This test method is under the jurisdictioin 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. ~~DOI: 10.1520/E1114-09.~~

2.2 *Other International Standards:*

~~EN12579~~EN 12679:2000 Industrial Radiography—Radiographic Method for the Determination of the Source Size for Radioisotopes[3]

3. Terminology

3.1 For definitions of terms relating to this test method, refer to Terminology E1316.

4. Significance and Use

4.1 One of the factors affecting the quality of a radiographic image is geometric unsharpness. The degree of geometric unsharpness is dependent upon the size of the source, the distance between the source and the object to be radiographed, and the distance between the object to be radiographed and the film or digital detector. This test method allows the user to determine the size of the source and to use this result to establish source to object and object to film or detector distances appropriate for maintaining the desired degree of geometric unsharpness.

NOTE 1—The European standard CEN EN 12579 describes a simplified procedure for measurement of source sizes of Ir-192, Co-60 and Se-75. The resulting source size of Ir-192 is comparable to the results obtained by this test method.

5. Apparatus

5.1 *Subject Iridium-192 Source*, the source size of which is to be determined. The appropriate apparatus and equipment for the safe storage, handling, and manipulation of the subject source, such as a radiographic exposure device (also referred to as a gamma ray projector or camera), remote control, source guide tube, and source stop are also required.

5.2 *Reference Sample (see* Figs. 1-3*)*—The reference sample shall be of material which is not radioactive. The recommended material is Iridium. However, substitutes such as platinum, tungsten or other material of similar radiopacity may be used. The sample should be of the same geometric shape as the subject source, should be approximately the same size as the subject source, and should be positioned on or within a shim or envelope to simulate the source capsule wall. The resulting radiographic contrast, with reference to adjacent background density of the image of the reference sample, should be approximately the same as that of the subject source. The actual dimensions of the reference sample should be determined to the nearest 0.025 mm (0.001 in.).

5.3 *X-ray Generator*, capable of producing a radiation intensity (roentgen per hour at one metre) at least ten times greater than that produced by the subject source. Examples of typical X-ray generator output requirements that satisfy this criterion are presented in Table 1.

5.4 *Film systems*—Only film systems having cognizant engineering organization approval or meeting the system class requirements of Test Method E1815, for system classes I, II or Special, shall be used. Selection of film systems should be determined by such factors as the required radiographic quality level, equipment capability, materials and so forth. The film system selected shall be capable of demonstrating the required image quality. No intensifying screens shall be used. Radiographic films shall be processed in accordance with Guide E999.

5.5 *Image Measurement Apparatus*—This apparatus is used to measure the size of the image of the spot. The apparatus shall be an optical comparator with built-in graticule with 0.1 mm divisions or 0.001 in. divisions and magnification of 5× to 10×.

5.6 *Digital Detectors*—Digital detectors, which are either imaging plates or digital detector arrays, may be used as film replacement. The digital detector shall possess a pixel pitch which is at least 40 times smaller than the nominal source size to measure and a basic spatial resolution smaller than 1/20 of the nominal source size. The basic spatial resolution shall be measured in accordance with the procedure of Practice E2597 for DDAs or Practice E2445 for the imaging plate scanner system or taken from manufacturer statements. In the area of free beam a detector $SNR_D > 100$ shall be achieved. The measurement procedure of the SNR shall be in accordance with the procedure of Practice E2597 for DDAs or Practice E2445 for the imaging plate scanner system.

5.7 *Evaluation of Digital Images*—Digital images shall be evaluated by an image processing software with contrast, brightness, profile and zoom function. The digital images shall be magnified at the monitor to a degree that allows the image viewing with at least one pixel of the image at one pixel of the monitor.

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

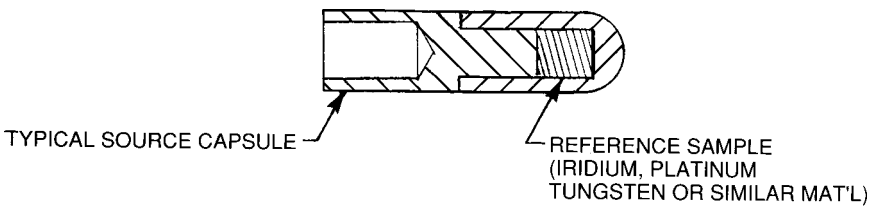

FIG. 1 Reference Sample in Standard Source Encapsulation

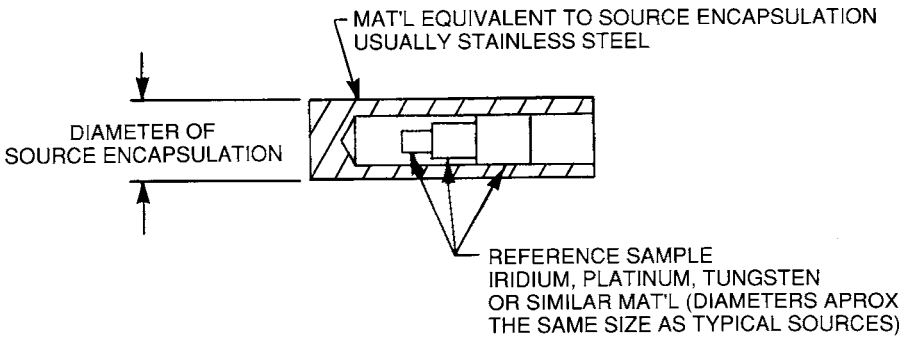

FIG. 2 Alternate Reference Sample Arrangement

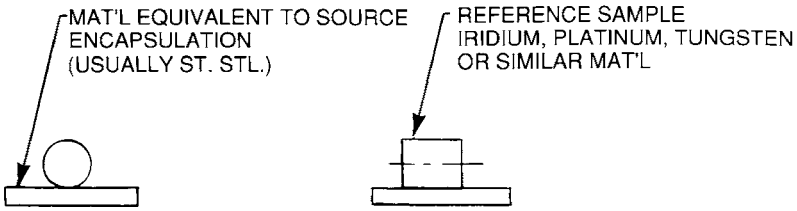

FIG. 3 Alternate Reference Sample Arrangement

TABLE 1 Examples of Typical X-ray Generator Output Requirements for Related Iridium[192] Source Activities

Subject Iridium[192] Source Radiation				Typical X-ray Generator Output Requirements	
Activity (Curie)	Output (R/h at 1 m)	Potential	Current		
30	14.4		160 kV	5 mA	
			or	200 kV	3 mA
	100	48.0		160 kV	10 mA
			or	250 kV	4 mA
	200	96.0		160 kV	20 mA
			or	250 kV	8 mA
			or	300 kV	6 mA

6. Procedure

6.1 Set up the exposure arrangement as shown in Figs. 4-7. Position the X-ray tube directly over the center of the film or digital detector. The film or detector plane must be normal to the central ray of the X-ray beam. The X-ray spot should be 0.90 m (36 in.) from the film or detector. Position the reference sample and apparatus used to locate the subject source (source stop) as close together as possible and directly over the center of the film or detector. The plane of the source stop and reference sample must be parallel to the film or detector and normal to the central ray of the X-ray beam. The source stop and reference sample should be 0.15 m (6 in.) from the film or detector. The source stop should be connected to the radiographic exposure device by the shortest source guide tube practicable in order to minimize fogging of the film or detector during source transit.

6.2 Place identification markers to be imaged on the film or detector to identify, as a minimum, the identification (serial number) of the subject source, the size of the reference sample, the identification of the organization performing the determination, and the date of the determination. Care should be taken to ensure that the images of the subject source and reference sample will not be superimposed on the image of the identification markers.

6.3 *Exposure*—Select the X-ray tube potential (kV), X-ray tube current (mA) and exposure time such that the density in the image of the envelope surrounding the reference sample does not exceed 3.0 and that the density difference between the image of the reference sample and the image of the envelope surrounding the reference sample is at least 0.10. In digital images the linear grey value difference between the image of the reference sample and the image of the envelope surrounding the reference sample shall be five times larger than the image noise σ(σ = standard deviation of the grey value fluctuations in an area of homogeneous exposure, measured in a window of at least 20 by 55 pixels) in a homogeneous neighbor area.

NOTE 2—The actual parameters that will produce acceptable results may vary between X-ray units, and trial exposures may be necessary.

6.3.1 Energize the X-ray generator and, at the same time, manipulate the subject source into the exposure position in the source stop. It is important that this be performed as quickly as possible to minimize fogging of the film or detector.