Designation: E 1114 – 92 (Reapproved 1997)ε1

An American National Standard

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

This standard is issued under the fixed designation E 1114; 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.

ε1 NOTE—Section 10 was added editorially in February 1997.

1. Scope

1.1 This test method covers the determination of the focal 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 *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:*

E 999 Guide for Controlling the Quality of Industrial Radiographic Film Processing[2]

E 1316 Terminology for Nondestructive Testing[2]

3. Terminology

3.1 For definitions of terms relating to this test method, refer to Terminology E 1316.

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 focal 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. This test method allows the user to determine the focal size of the source and to use this result to establish source to object and object to film distances appropriate for maintaining the desired degree of geometric unsharpness.

5. Apparatus

5.1 *Subject Iridium-192 Source*, the focal 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*, industrial type fine grain, extra fine grain, or ultra fine grain as defined by the film manufacturer shall be used. Selection of film type should be determined by such factors as the required radiographic quality level, equipment capability, materials, and so forth. The films selected must be capable of demonstrating the required image quality. No intensifying screens should be used. The film should be processed in accordance with Guide E 999.

[1] This test method is under the jurisdictioin of ASTM Committee E-7 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.01 on Radiographic Practice and Penetrameters.

Current edition approved Sept. 15, 1992. Published November 1992. Originally published as E1114 – 86. Last previous edition E1114 – 86.

[2] *Annual Book of ASTM Standards*, Vol 03.03.

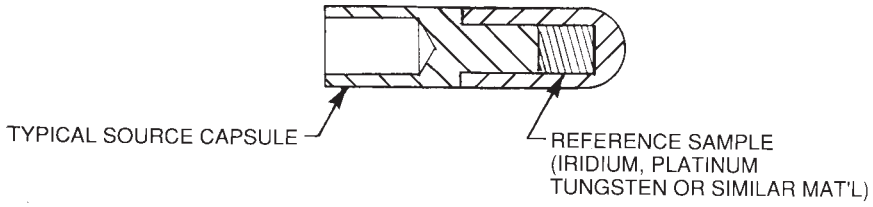
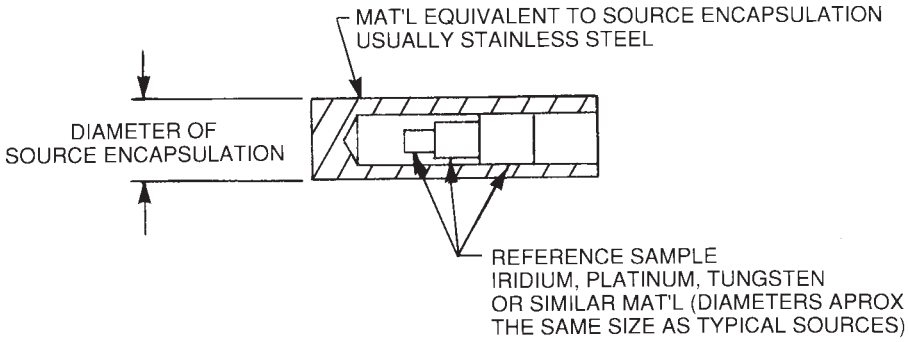


FIG. 1 Reference Sample in Standard Source Encapsulation



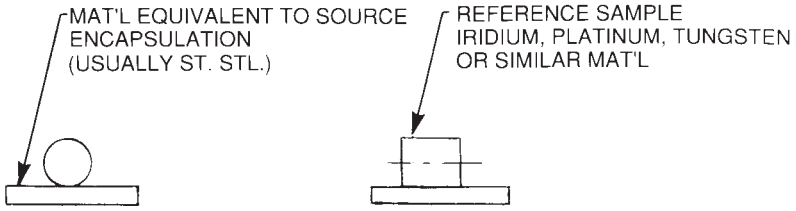


FIG. 2 Alternate Reference Sample Arrangement

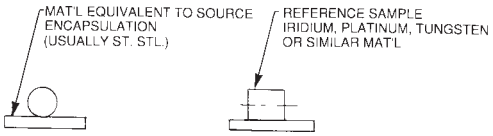


FIG. 3 Alternate Reference Sample Arrangement

5.5 *Image Measurement Apparatus*—This apparatus is used to measure the size of the image of the focal 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×.

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. The film plane must be normal to the central ray of the X-ray beam. The X-ray focal spot should be 0.90 m (36 in.) from the film. 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. The plane of the source stop and reference sample must be parallel to the film 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. 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 during source transit.

6.2 Place identification markers to be imaged on the film to identify, as a minimum, the identification (serial number) of the

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

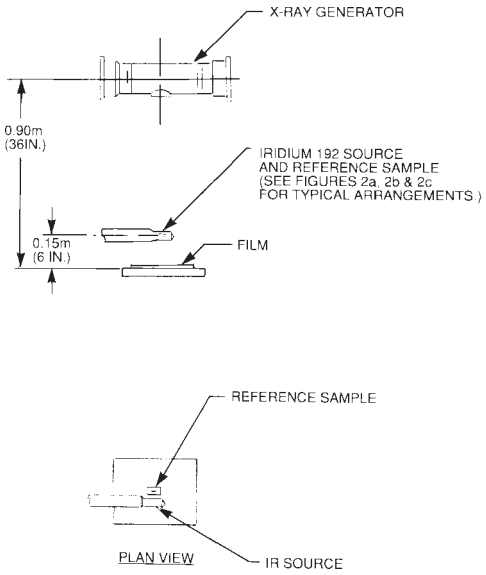


FIG. 4 Typical Exposure Arrangement

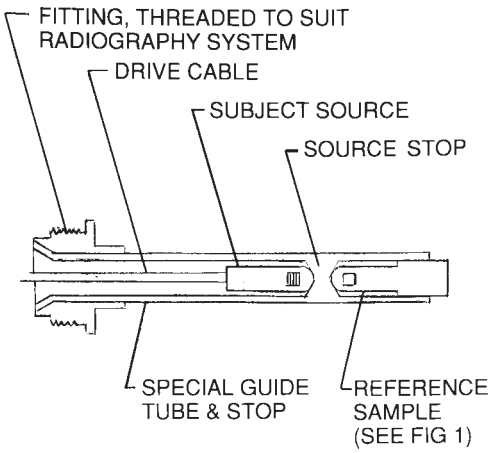


FIG. 5 Typical Arrangement Using a Specially Designed Guide Tube

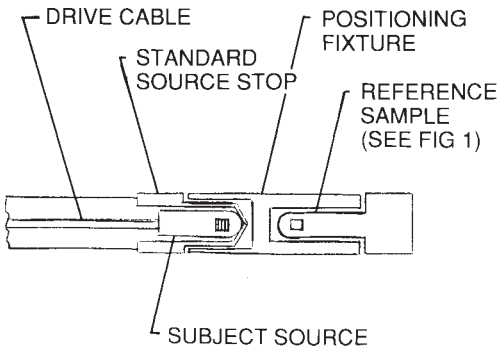


FIG. 6 Typical Arrangement Using a Standard Guide Tube and Special Positioning Fixture

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.

NOTE 1—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.

6.3.2 At the conclusion of the exposure time, deenergize the X-ray generator and, at the same time, return the subject source to the proper shielded storage position.

6.3.3 Process the film.

7. Measurement of Focal Dimensions

7.1 View the radiograph with sufficient light intensity for adequate viewing. Using an optical comparator with built-in graticule as described in 5.5, measure the linear dimensions of the image of the focal spot of the subject source and the reference sample. Take measurements from the perceptible edges of the image. When performing the physical measurements with the optical comparator, the actual measured values shall be to the nearest graduation on the graticule scale being used.

7.2 The focal size for a given technique is the maximum projected dimension of the source in the plane perpendicular to a line drawn from the source to the object being radiographed. Therefore, sufficient measurements of the image of the iridium must be made to determine the focal size of the source in any orientation. Sections 7.2.1-7.2.4 serve as examples.

7.2.1 *Uniform Right Circular Cylinder* (see Fig. 8)—Determine the focal size of a uniform right circular cylindrical source by measuring the diameter, *d*, the height, *h*, and the diagonal, *m*, as illustrated in Fig. 8 and computing the actual dimensions as described in 8.1.

7.2.2 *Sphere* (see Fig. 9)—Determine the focal size of a spherical source by measuring the diameter, *d*, as illustrated in Fig. 9 and computing the actual dimension as described in 8.1.

7.2.3 *Nonuniform Stack of Right Circular Cylinders* (see Fig. 10)—Determine the focal size of a nonuniform stack of right circular cylindrical components of a source by measuring the intrinsic diameter, *d*, the height, *h*, and the effective maximum dimension, *m*, as illustrated in Fig. 10 and computing the actual dimensions as described in 8.1.

7.2.4 *Separated Stack of Right Circular Cylinders* (see Fig. 11)—Determine the focal size of a separated stack of right circular cylindrical components of a source by measuring the intrinsic diameter, *d*, the effective height, *h*, and the effective maximum dimension, *m*, as illustrated in Fig. 11 and computing the actual dimensions as described in 8.1.

8. Calculation and Evaluation

8.1 Measure the linear dimension of interest in the subject source image and measure the same linear dimension in the

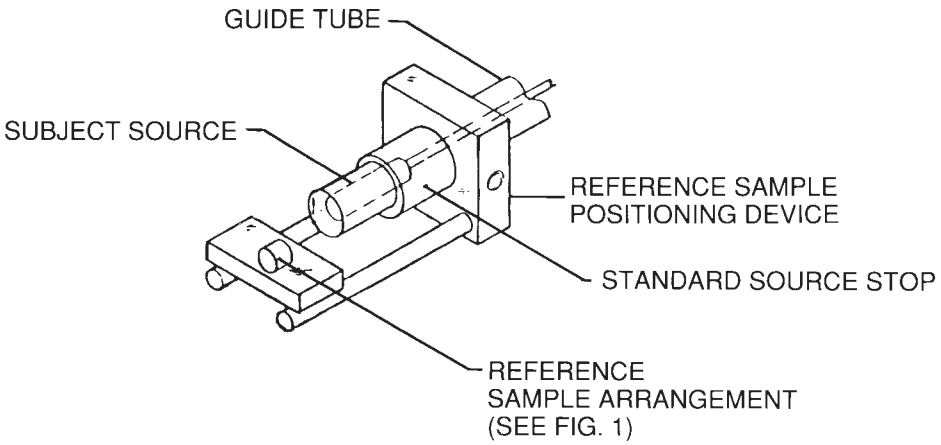


FIG. 7 Typical Arrangement Using Reference Sample Positioning Device

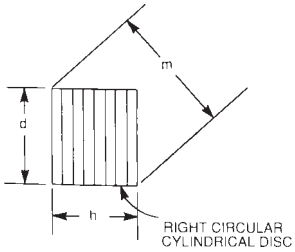


FIG. 8 Uniform Right Circular Cylinder

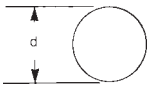


FIG. 9 Sphere

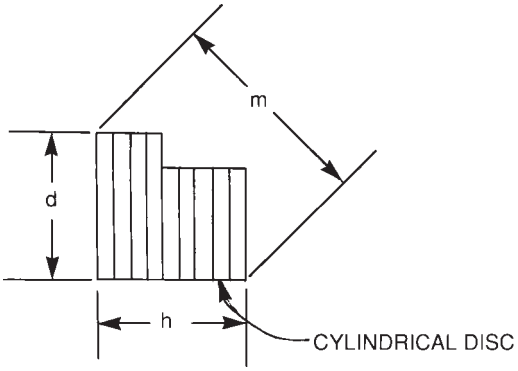


FIG. 10 Nonuniform Cylindrical Stack

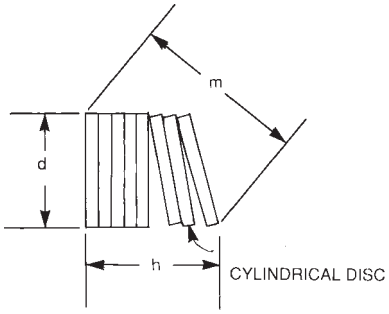


FIG. 11 Separated Cylindrical Stack

reference sample image (that is, the diameter of each). The actual dimension of the subject source is computed from the following:

$$a = bc/d$$

where:
a = actual dimension of the subject source,
b = actual dimension of the reference sample,
c = measured dimension of the subject source image, and
d = measured dimension of the reference sample image.

9. Report

9.1 A report of the focal size of an iridium-192 source should indicate the model number and serial number of the source, the name of the organization making the determination, the date the determination was made, a description of the shape of the source (or an appropriate sketch), and the calculated actual dimensions. The actual radiograph should accompany the report.

10. Keywords

10.1 cylinder(s); focal size; iridium 192; radiographic source; reference sample; sphere