



Designation: **E592 – 15 E592 – 20**

## Standard Guide to Obtainable ASTM Equivalent Penetrameter Sensitivity for Film Radiography of Steel Plates ¼ to 2 in. (6 to 51 mm) Thick with X-Rays and 1 to 6 in. (25 to 152 mm) Thick with Cobalt-60<sup>1</sup>

This standard is issued under the fixed designation E592; 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

### 1. Scope\*

1.1 This guide to obtainable equivalent penetrameter sensitivity covers the minimum penetrameter thicknesses for which the image of the 1T and 2T holes is visible for a few practical radiographic ~~conditions~~ conditions using industrial X-ray film. The values represent near optimum sensitivity for flat steel plates. Radiographic conditions that give higher values of scatter buildup from the specimen or backscattered radiation at the image plane will give poorer sensitivity.

1.2 Eight radiographs that illustrate sensitivities obtainable with practical radiographic systems are included as adjuncts to this guide and ~~may~~ must be ~~obtained~~ purchased from ASTM.

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

1.4 ~~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 health environmental practices and determine the applicability of regulatory limitations prior to use.~~

1.5 ~~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:<sup>2</sup>

- 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
- E1316 Terminology for Nondestructive Examinations
- E1742 Practice for Radiographic Examination
- 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 ISO Standard:<sup>3</sup>

- ISO 7004 Photography—Industrial Radiographic Films—Determination of ISO Speed, ISO Average Gradient, and ISO Gradients G2 and G4 When Exposed to X- and Gamma-Radiation

#### 2.3 Military Standard:<sup>4</sup>

- NAVSEA Technical Publication T9074-AS-GIB-010/271 Requirements for Nondestructive Testing Methods

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.02 on Reference Radiological Images.

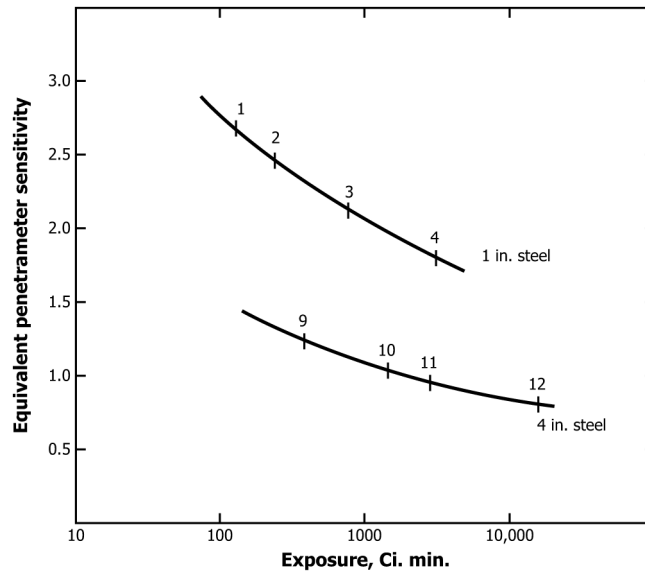
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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM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

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

<sup>4</sup> Available from Naval Sea Systems Command (NAVSEA), 1333 Isaac Hull Avenue, SE, Washington Navy Yard, DC 20376, <https://www.navsea.navy.mil>.

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



NOTE 1—The demonstration radiograph numbers on curves refer to exposure conditions given in Table 1.

FIG. 41 Obtainable Penetrameter Sensitivity for Cobalt-60 Radiography of 1 and 4-in. (25 and 102-mm) Thick Steel at 36-in. (914-mm) Distance

2.4 ASTM Adjuncts:<sup>5</sup>

Guide for Equivalent Penetrameter Sensitivity Between X-Rays and Cobalt-60

3. Terminology

3.1 Definitions—For definitions of terms used in this standard, refer to Terminology E1316, Section D.

3.2 Definitions: Definitions of Terms Specific to This Standard:

3.2.1 demonstration radiograph, n—radiographs from which data was gathered for Fig. 1 and Fig. 2.

3.2.2 reference radiograph, n—the adjunct materials illustrations. definitions of terms used in this standard, refer to Terminology E1316, Section D.

4. Significance and Use

4.1 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, film system class, type and thickness of intensifying screens, exposure (density), etc. This guide permits the user to estimate the degree of sensitivity that may be obtained with X-rays and cobalt-60 gamma rays when using a prescribed set of radiographic parameters. This guide may also be used in conjunction with Test Methods Practices E746 or 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. An alternate to this approach is the use of those adjunct radiographic illustrations detailed in Section 6.

5. Procedure

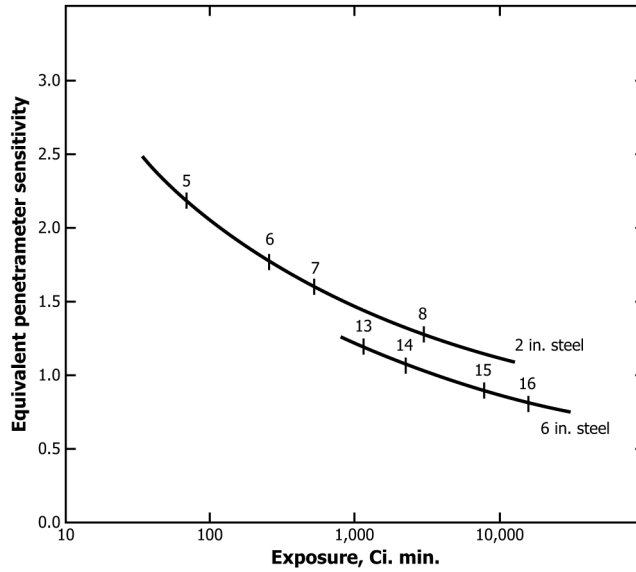
5.1 Sensitivity for 1/4 to 2-in. (6 to 51-mm) Thick Steel Using X-Rays:

5.1.1 The values of sensitivity were determined from a statistical study of visibility of images of penetrameter holes. Near 100 % certainty of seeing the image of a hole on any radiograph was taken as the criterion for determining sensitivity. Most radiographs will show slightly better sensitivity than indicated in Figs. 1-35 because of the statistical nature of recording information from a beam of X-rays, but occasionally, one will not show quite as good sensitivity.

5.1.2 Equivalent Penetrameter Sensitivity (EPS) is defined in Eq 1. For a full discussion of EPS see Appendix X1 of Practice E1025.

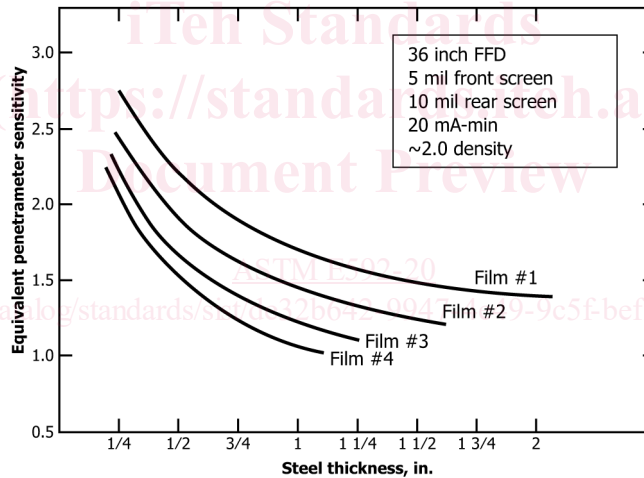
$$EPS, \% = 70.7 (dT)^{1/2} \tag{1}$$

<sup>5</sup> Available from ASTM Headquarters. Order RRE0592.



NOTE 1—The demonstration radiograph numbers on curves refer to exposure conditions given in Table 1.

FIG. 52 Obtainable Penetrameter Sensitivity for Cobalt-60 Radiography of 2 and 6-in. (51 and 152-mm) Steel at 36-in. (914-mm) Distance



NOTE 1—See 5.1.4 for exposure conditions.

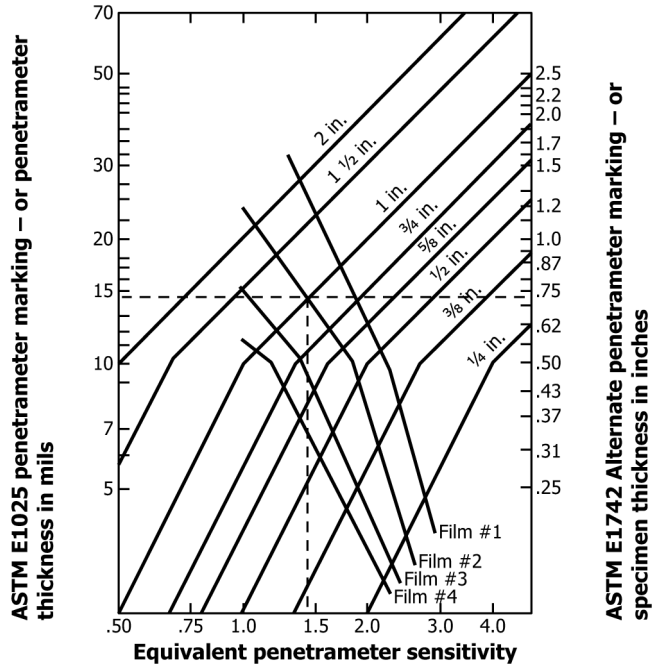
FIG. 43 Obtainable Penetrameter Sensitivity for 1/4 to 2-in. (6 to 51-mm) Thick Steel When Radiographing with X-Rays

where:

- $d$  = diameter of penetrameter hole,
- $T$  = thickness of penetrameter, and
- $t$  = specimen thickness.

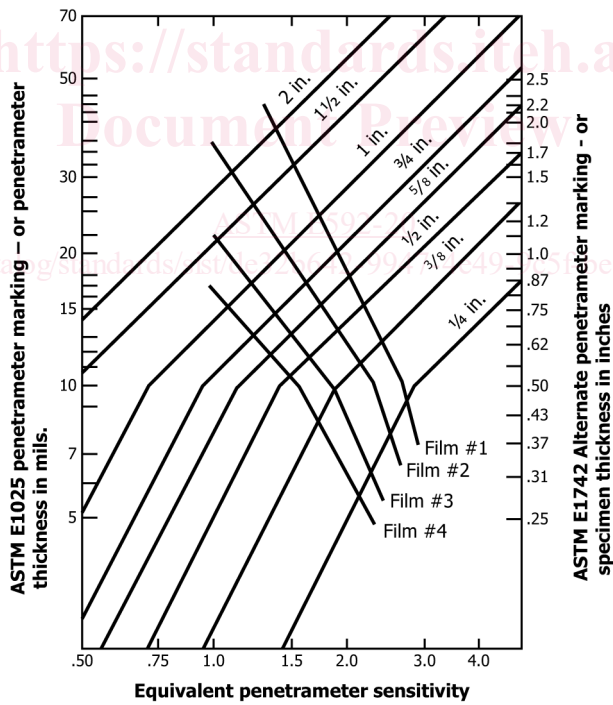
A clear definition of equivalent penetrameter sensitivity has not been established for penetrameters less than 10 mils (0.25 mm) thick. For this work, it was calculated as in Eq 1. The change in slope of the steel thickness curves on Fig. 24 and Fig. 35 is a result of the established 10-mil minimum hole diameter in Practice E1025 and Practice E1742, Appendix A1.

5.1.3 Fig. 43 illustrates obtainable equivalent penetrameter sensitivity for four X-ray films. The films are identified by reciprocal speed (see Test Method E1815) when exposed in accordance with ISO 7004 in a 200-kV range, and processed in accordance with the manufacturer's recommendations (see Guide E999).



NOTE 1—See 5.1.4 for exposure conditions.

FIG. 24 Penetrator Sensitivity and Minimum Penetrator Markings for Showing the 2T Hole When Radiographing 1/4 to 2-in. (6 to 51-mm) Thick Steel with X-Rays.



NOTE 1—See 5.1.4 for exposure conditions.

FIG. 35 Penetrator Sensitivity and Minimum Penetrator Markings for Showing the 1T Hole When Radiographing 1/4 to 2-in. (6 to 51-mm) Thick Steel with X-Rays.

Film Type	Roentgen Speed	ISO Speed	ASTM Class
1	17	1700	none
2	4.0	400	III
3	1.2	120	I
4	0.35	35	Special