



Designation: E592 – 15

Standard Guide to Obtainable ASTM Equivalent Penetrator Sensitivity for 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-60¹

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 reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This guide to obtainable equivalent penetrator sensitivity covers the minimum penetrator thicknesses for which the image of the 1T and 2T holes is visible for a few practical radiographic conditions. 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 be obtained from ASTM.

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

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

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 Radiology](#)

[E1316 Terminology for Nondestructive Examinations](#)

[E1742 Practice for Radiographic Examination](#)

[E1735 Test Method for Determining Relative Image Quality of Industrial Radiographic Film Exposed to X-Radiation from 4 to 25 MeV](#)

[E1815 Test Method for Classification of Film Systems for Industrial Radiography](#)

2.2 ISO Standard:

[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-Radiation³](#)

2.3 Military Standard:

[NAVSEA Technical Publication T9074-AS-GIB-010/271 Requirements for Nondestructive Testing Methods](#)

2.4 ASTM Adjuncts:

[Guide for Equivalent Penetrator Sensitivity Between X-Rays and Cobalt-60⁴](#)

3. Terminology

3.1 *Definitions:* For 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 [E746](#) or [E1735](#) to provide a basis for developing data for evaluation of a user's

¹ 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.

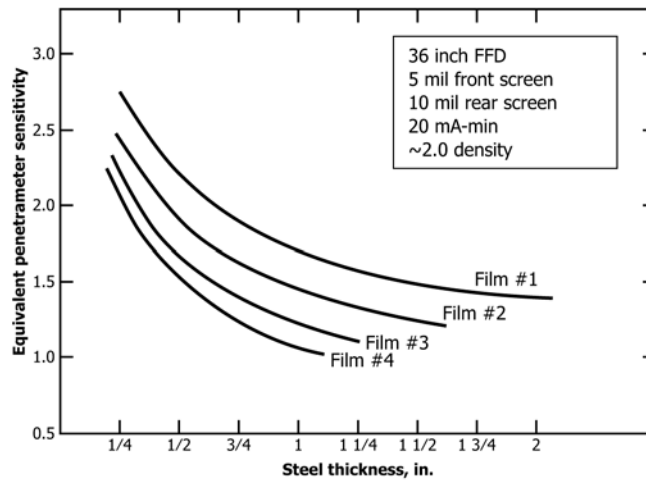
Current edition approved June 1, 2015. Published June 2015. Originally approved in 1977. Last previous edition approved in 2009 as E592 - 99(2009)^{e1}. DOI: 10.1520/E0592-99R15.

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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁴ Available from ASTM Headquarters. Order RRE0592.

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



NOTE 1—See 5.1.4 for exposure conditions.

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

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 penetrometer 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. 1-3 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 Penetrator Sensitivity (EPS) is defined in Eq 1. For a full discussion of EPS see Appendix X1 of Practice E1025.

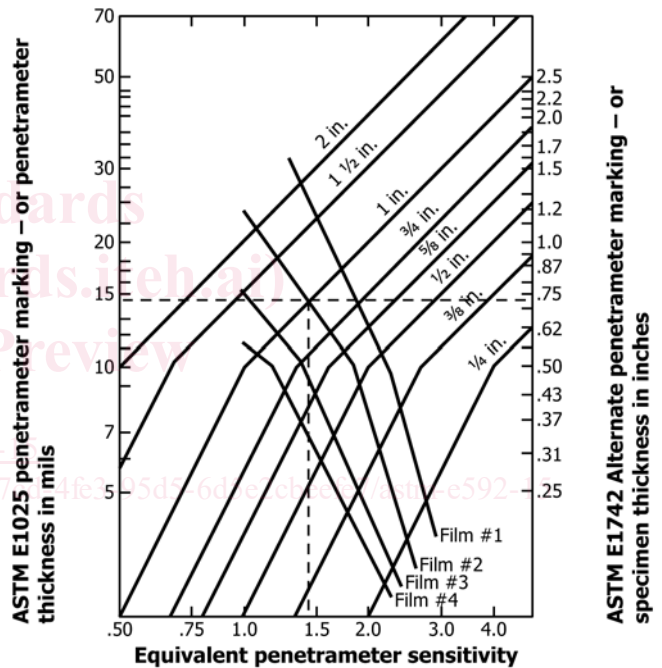
$$EPS, \% = 70.7 (dT)^{1/2}/t \tag{1}$$

where:

- d* = diameter of penetrometer hole,
- T* = thickness of penetrometer, and
- t* = specimen thickness.

A clear definition of equivalent penetrator sensitivity has not been established for penetrometers 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. 2 and Fig. 3 is a result of the established 10-mil minimum hole diameter in Practice E1025 and Practice E1742, Appendix A1.

5.1.3 Fig. 1 illustrates obtainable equivalent penetrator 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. 2 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.

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

5.1.4 The radiographic exposure conditions for reference radiographs 1, 2, 3, and 4 were: 36-in. (914-mm) focus-film distance, 5-mil (0.13-mm) front and 10-mil (0.25-mm) back lead screens, 20 mA·min exposure, and kilovoltage adjusted to give a density of near 2.0. The focal spot size was not recorded with the original data.