



Designation: E2023 – 99 (Reapproved 2004)

## Standard Practice for Fabrication of Neutron Radiographic Sensitivity Indicators<sup>1</sup>

This standard is issued under the fixed designation E2023; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This practice covers the fabrication of Sensitivity Indicators (SI), which can be used to determine the relative quality of radiographic images produced by direct, thermal neutron radiographic examination.

1.2 The values stated in inch-pound units are regarded to be standard. The SI equivalents given in brackets in the text are for information only.

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:*<sup>2</sup>

**E543** Specification for Agencies Performing Nondestructive Testing

**E545** Test Method for Determining Image Quality in Direct Thermal Neutron Radiographic Examination

**E748** Practices for Thermal Neutron Radiography of Materials

**E1316** Terminology for Nondestructive Examinations

### 3. Terminology

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

### 4. Summary of Practice

4.1 The Sensitivity Indicator (SI) is used for qualitative determination of the sensitivity of detail visible on the neutron radiograph. It consists of a step wedge containing gaps and

holes of known dimensions. Visual inspection of the image of this device provides subjective information regarding total radiographic sensitivity with respect to the step-block material, as well as optional subjective data, regarding detrimental levels of gamma exposure.

4.2 Neutron radiography practices are discussed in Practices **E748**. The neutron radiograph used to determine image quality using the SI shall meet the requirements of Method **E545**.

### 5. Significance and Use

5.1 The only truly valid image quality indicator is a material or component, equivalent to the part being neutron radiographed, with a known standard discontinuity, inclusion, omission or flaw (reference standard comparison part). The SI is designed to substitute for the reference standard, providing qualitative information on hole and gap sensitivity in a single unit. Fabrication in accordance with this practice is vital for accurate and consistent measurements.

5.2 This practice shall be followed for the fabrication of all SIs to be used with Method **E545** to determine image quality in direct thermal neutron radiography.

### 6. Basis of Application

6.1 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice **E543**. The applicable edition of Practice **E543** shall be specified in the contractual agreement.

6.2 *Procedures and Techniques*—The procedures and techniques to be utilized shall be as described in this practice unless otherwise specified. Specific techniques may be specified in the contractual agreement.

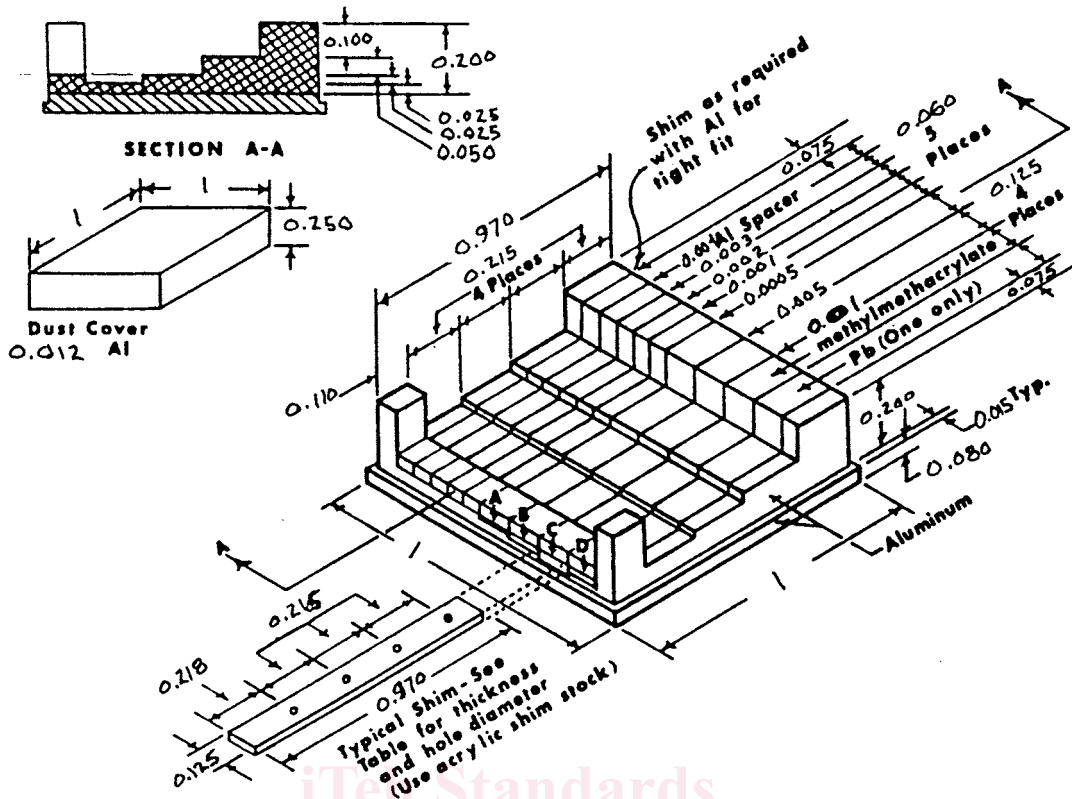
6.3 *Reporting Criteria/Acceptance Criteria*—Reporting criteria for the examination results shall be in accordance with Sections 9 and 10 unless otherwise specified. Acceptance criteria, for example, reference radiographs, shall be specified in the contractual agreement.

6.4 Reexamination of repaired/reworked items is not addressed in this practice and, if required, shall be specified in the contractual document.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee **E07** on Nondestructive Testing and is the direct responsibility of Subcommittee **E07.05** on Radiology (Neutron) Method.

Current edition approved May 1, 2004. Published June 2004. Originally approved in 1999. Last previous edition approved in 1999 as E2023 - 99. DOI: 10.1520/E2023-99R04.

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



Material — Methylmethacrylate

Shim	Thickness	Hole Diameter
A	0.005	0.005
B	0.010	0.010
C	0.020	0.020
D	0.010	0.010

NOTE 1—All dimensions are in inches.

NOTE 2—The lead step may be replaced with a methylmethacrylate strip with the D shim eliminated.

FIG. 1 Sensitivity Indicator

## 7. Sensitivity Indicator (SI)

7.1 The Sensitivity Indicator (SI) shall be constructed of cast acrylic resin, lead (optional), and aluminum. The construction and dimensions are shown in Fig. 1.

7.2 The optional lead step in the SI may be replaced with a blank, cast acrylic resin step. The lead provides a visual indication of beam gamma content; however, the lead image is not used for any of the SI calculations of Method E545.

7.3 The acrylic resin shall be methylmethacrylate.

7.4 All dimensional tolerances are as noted on the figures.

7.5 Aluminum shims and strips shall be 99.9 % pure elemental material.

7.6 The SI may be encased in a 6061 aluminum dust cover, 0.012-in. [0.305-mm] thick.

7.7 When used, the optional lead shim shall be at least 99.9 % pure elemental material.

## 8. Fabrication<sup>3</sup>

### 8.1 Components:

<sup>3</sup> The instructions in Section 8 assume the simultaneous fabrication of five units for practical reasons. Units may be fabricated singly, if desired.

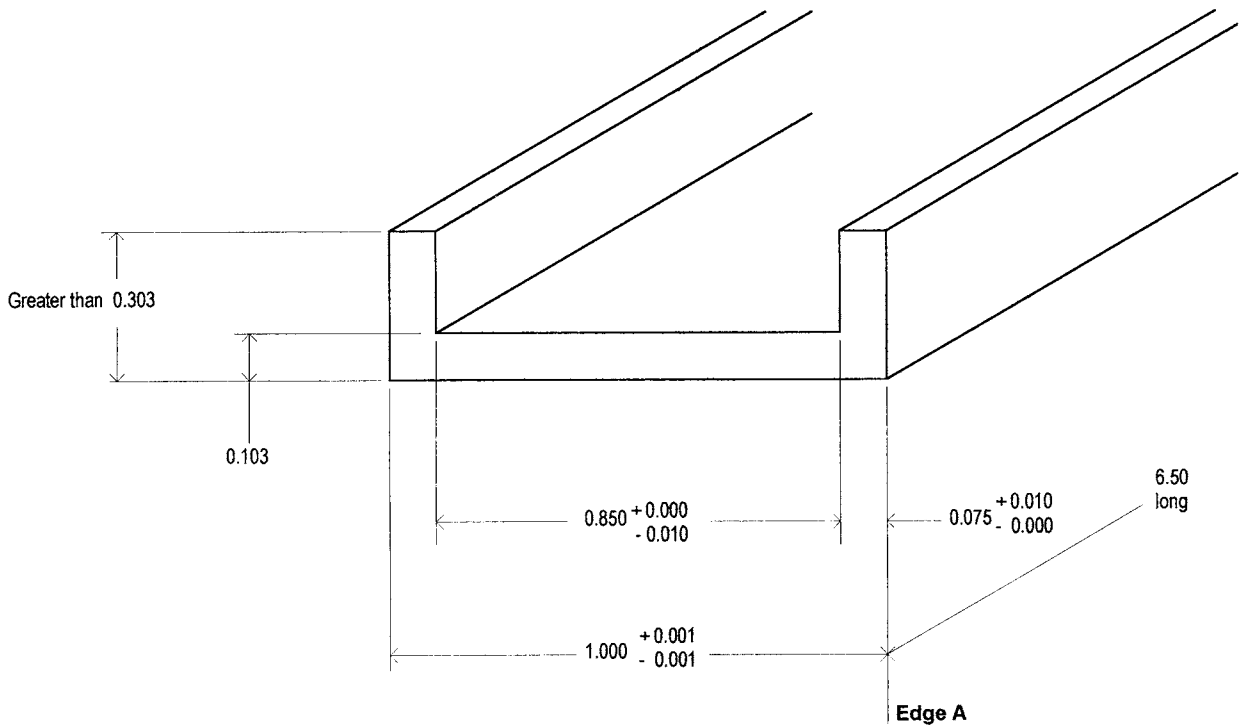
8.1.1 *Mill a Channel*, 0.850-in. (21.6-mm) wide by 6.5-in. [165-mm] long from an aluminum block, 1-in. [25.4-mm] wide by at least 0.303-in. [7.70-mm] high by 6.5-in. [165-mm] long. The channel should begin 0.075-in. [1.90-mm] from edge A and leave 0.103-in. [2.62-cm] aluminum in the bottom of the channel (see Fig. 2).

8.1.2 *Mill the A Channel* (see Fig. 1), within this channel, 0.125-in. [3.18-mm] wide by 0.005-in. [0.127-mm] deep by 6.5-in. [165-mm] long. The near edge of channel A should be 0.450-in. [11.4-mm] from edge A (see Fig. 3).

8.1.3 *Mill the B Channel*, adjacent to the A channel, 0.125-in. [3.18-mm] wide by 0.010-in. [0.254-mm] deep by 6.5-in. [165-mm] long. The near edge of channel B should be 0.325-in. [8.26-mm] from edge A (see Fig. 3).

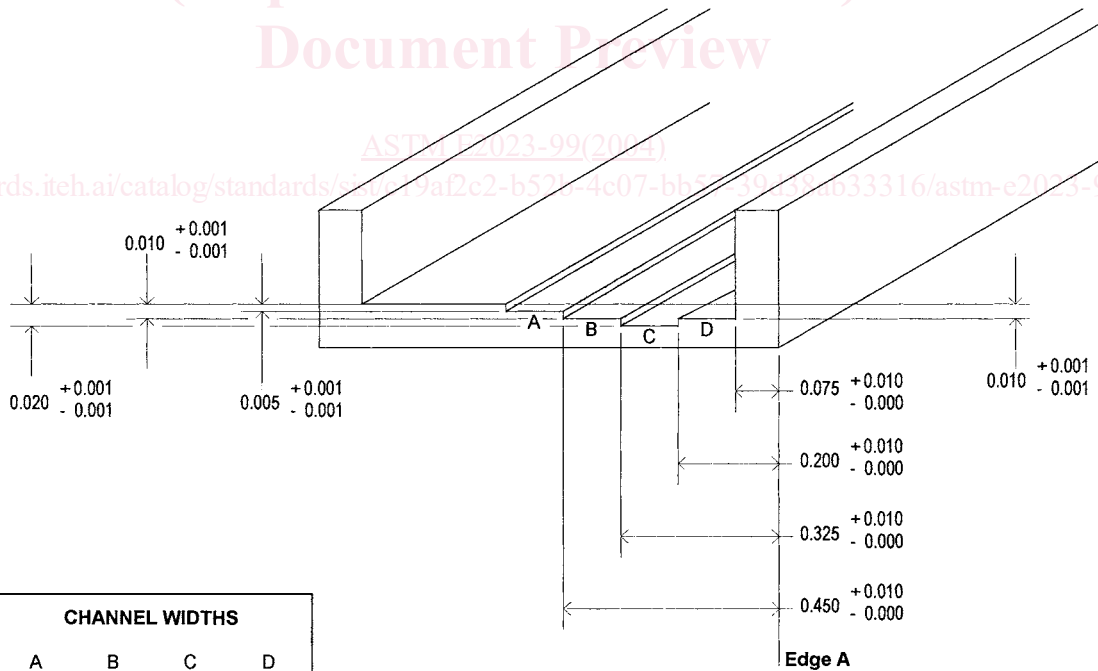
8.1.4 *Mill the C Channel*, adjacent to the B channel, 0.125-in. [3.18-mm] wide by 0.020-in. [0.508-mm] deep by 6.5-in. [165-mm] long. The near edge of channel C should be 0.200 in. [5.08 mm] from edge A (see Fig. 3).

8.1.5 *Optional*—Mill the D channel adjacent to the C channel, 0.125-in. [3.18-mm] wide by 0.010-in. [0.254-mm] deep by 6.5-in. [165-mm] long. The near edge of channel D should be 0.075-in. [1.90-mm] from edge A.



NOTE 1—Unless otherwise specified, use the following:  
 Dimensions are in inches.  
 Tolerances on machined dimensions: .XX = ± .01 .XXX = ± .002.

FIG. 2 Main Channel in Aluminum Block



CHANNEL WIDTHS			
A	B	C	D
0.125	0.125	0.125	0.125

NOTE 1—Unless otherwise specified, use the following:  
 Dimensions are in inches.  
 Tolerances on machined dimensions: .XX = ± .01 .XXX = ± .002.

FIG. 3 Channels A Through D in Main Channel

NOTE 1—The D channel is not required and shall not be milled if the lead shim is not to be used.

8.1.6 Prepare five methacrylate strips, 0.060-in. [1.52-mm] thick by at least 0.200-in. [5.08-mm] wide by 6.5-in. [165-mm] long. These strips will be used in 8.2.11.

8.1.7 Prepare four methacrylate strips, 0.125-in. [3.18-mm] thick by at least 0.200-in. [5.08-mm] wide by 6.5-in. [165-mm] long. One of the methacrylate strips may be replaced with an optional lead strip of the same dimensions. These strips will be used in 8.2.5.

8.1.8 Prepare one each strip from aluminum shim stock, at least 0.200-in. [5.08-mm] wide by 6.5-in. [165-mm] long, with the following thickness:

- 0.0005 in. [0.0127 mm]
- 0.0010 in. [0.0254 mm]
- 0.0020 in. [0.0508 mm]
- 0.0030 in. [0.0762 mm]
- 0.0040 in. [0.102 mm]
- 0.0050 in. [0.127 mm]
- 0.0100 in. [0.254 mm]

8.1.9 Prepare one each methacrylate strip to fit snugly in the 0.125-in. [3.18-mm] wide by 6.5-in. [165-mm] long with the following thickness:

- 0.0050 in. [0.127 mm] (Shim A)
- 0.0100 in. [0.254 mm] (Shim B)
- 0.0200 in. [0.508 mm] (Shim C)
- 0.0100 in. [0.254 mm] (Shim D) (If used, this strip is to be fabricated from lead stock (see Fig. 4). These strips will become Shim A through Shim D in 8.1.10.)

8.1.10 Drill four holes in the shims from 8.1.9, starting 0.218 in. [5.54 mm] from one end and centering the other three holes 0.215 in. [5.46 mm] from the first hole. Repeat the process along the rest of the 6.5-in. [165-mm] length (see Fig. 4).

The diameter of the holes are as follows:

- Shim A 0.005-in. [0.127-mm] diameter
- Shim B 0.010-in. [0.254-mm] diameter
- Shim C 0.020-in. [0.508-mm] diameter
- Shim D 0.010-in. [0.254-mm] diameter, if optional Shim D is to be used.

To verify that the various shims have the proper holes drilled into them, a certified hole measurement report is required.

8.1.11 To keep the SI intact during use, it is highly recommended that a dust cover be kept on the unit. One dust cover for each SI may be prepared from aluminum shim stock, 0.012-in. [0.305-mm] thick by 1.50-in.<sup>2</sup> [38.1-mm<sup>2</sup>] by cutting out a 0.250-in.<sup>2</sup> [6.35-mm<sup>2</sup>] from each corner and folding the aluminum to form a cover, 1-in.<sup>2</sup> [25.4-mm<sup>2</sup>] by 0.250-in. [6.35-mm] high (see Fig. 1).

8.2 Assembly:

8.2.1 Insert Shim C into the C channel milled in 8.1.4 (see Fig. 5).

8.2.2 Insert Shim B into the adjacent B channel milled in 8.1.3 (see Fig. 5).

8.2.3 Insert Shim A into the adjacent A channel milled in 8.1.2 (see Fig. 5).

8.2.4 If the D channel was milled in 8.1.5, insert the lead shim (see Fig. 5).

8.2.5 Insert a 0.125-in. [3.18-mm] methacrylate strip (previously prepared in 8.1.7) into the channel so that the second strip is positioned over Shim C. Over Channel D, insert either the optional lead strip or a 0.125-in. [3.18-mm] methacrylate strip (see Fig. 6).

8.2.6 Insert the 0.010-in. [0.254-mm] thick aluminum strip next to the methacrylate strip between the B and C channels (see Fig. 6).

8.2.7 Insert another 0.125-in. [3.18-mm] methacrylate strip next to the aluminum strip (see Fig. 6).

8.2.8 Insert the 0.005-in. [0.127-mm] thick aluminum strip (see Fig. 6).

8.2.9 Insert the last 0.125-in. [3.18-mm] methacrylate strip next to the previously inserted aluminum strip (see Fig. 6).

8.2.10 Insert the 0.0005-in. [0.0127-mm] thick aluminum strip next to the previously inserted methacrylate strip (see Fig. 6).

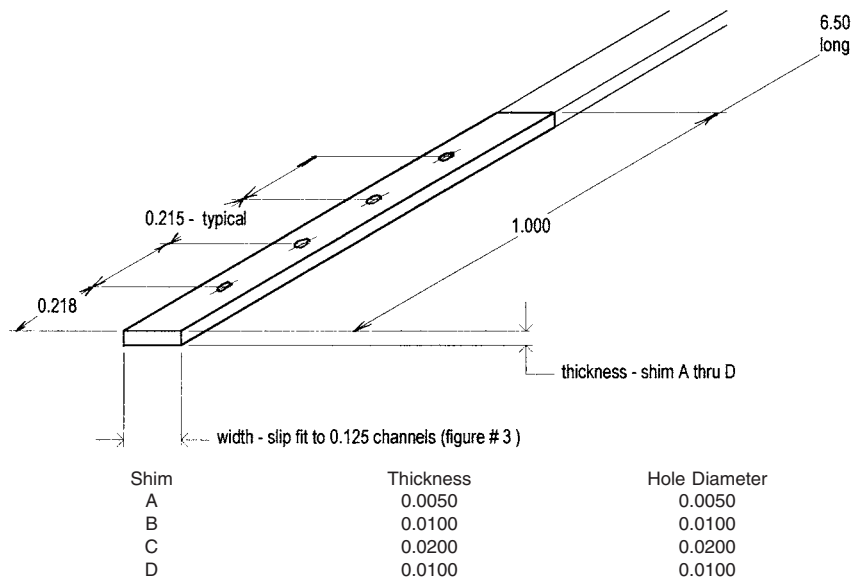


FIG. 4 Shims