



Designation: E186 – 20

## Standard Reference Radiographs for Heavy-Walled (2 to 4½ in. (50.8 to 114 mm)) Steel Castings<sup>1</sup>

This standard is issued under the fixed designation E186; 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.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope

1.1 These reference radiographs<sup>2</sup> illustrate various categories, types, and severity levels of discontinuities occurring in steel castings that have section thicknesses of 2 to less than 4½ in. (50.8 to 114 mm). The reference radiograph films are an adjunct to this document and must be purchased separately from ASTM International, if needed (see 2.2). Categories and severity levels for each discontinuity type represented by these reference radiographs are described in 1.2. Note that the basis of application for these reference radiographs requires a prior purchaser/supplier agreement of radiographic examination attributes and classification criterion as described in Sections 4, 6, and 7 of this standard. Reference radiographs for other steel casting thicknesses may be found in Reference Radiograph standards E446 and E280. Reference Radiograph standards E446 and E280 provide some overlap of severity levels for similar discontinuity categories within the same energy level range (see 4.2, 5.1, and 6.3)

1.2 These reference radiographs consist of three separate volumes as follows:

1.2.1 Volume I: 1-MV X-rays and Iridium-192 (called “1 to 2-Mev X-rays” in previous editions)-Set of 28 plates (*nominal* 5 by 8 in. (127 by 203 mm) in a 15 by 17 in. (381 by 432 mm) ring binder).

1.2.2 Volume II: 2 to 4-MV X-rays and Cobalt-60 (called “gamma rays” in previous editions). This includes cobalt-60 or equivalent isotope radiation and from 2-MV up to 4-MV X-rays- Set of 28 plates (*nominal* 5 by 8 in.) in a 15 by 17 in. ring binder.

1.2.3 Volume III: 4-MV to 30-MV X-rays (called “10 to 24 Mev X-rays” in previous editions)- Set of 28 plates (*nominal* 5 by 8 in.) in a 15 by 17 in. ring binder.

1.2.4 Unless otherwise specified in a purchaser supplier agreement (see 1.1), each volume is for comparison only with

production radiographs produced with radiation energy levels within the thickness range covered by this standard. Each volume consists of three categories of graded discontinuities in increasing severity levels, and three categories of ungraded discontinuities. Reference radiographs containing ungraded discontinuities are provided as a guide for recognition of a specific casting discontinuity type where severity levels are not needed. Following is a list of discontinuity categories, types, and severity levels for the adjunct reference radiographs of this standard:

1.2.4.1 *Category A*—Gas porosity; severity levels 1 through 5.

1.2.4.2 *Category B*—Sand and slag inclusions; severity levels 1 through 5.

1.2.4.3 *Category C*—Shrinkage; three types:

(1) *Ca*—linear shrinkage—severity levels 1 through 5. (Called Type 1 in previous revisions.)

(2) *Cb*—feathery shrinkage—Severity levels 1 through 5. (Called Type 2 in previous revisions.)

(3) *Cc*—sponge shrinkage—Severity levels 1 through 5. (Called Type 3 in previous revisions.)

1.2.4.4 *Category D*—Crack; one illustration (D3 in pre-1972 documents).

1.2.4.5 *Category E*—Hot tear; one illustration in pre-1972 documents.

1.2.4.6 *Category F*—Insert; one illustration (EB3 in pre-1972 documents).

1.3 From time to time, there may be minor changes to the process for manufacturing of the reference radiograph adjunct materials. These changes could include changes in the films or processing chemicals used, changes in the dies or printing for the cardboard mats, etc.; however, in all cases, these changes are reviewed by the Illustration Monitoring Subcommittee and all reference radiographs are reviewed against a fixed prototype image to ensure that there are no changes to the acceptance level represented by the reference radiographs. Therefore, the adjunct reference radiographs remain valid for use with this standard regardless of the date of production or the revision level of the text standard.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical

<sup>1</sup> These reference radiographs are under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and are the direct responsibility of Subcommittees E07.02 on Reference Radiological Images and E07.93 on Illustration Monitoring.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications, see related Reference Radiographs SE 186 in Section V of that Code.

conversions to SI units that are provided for information only and are not considered standard.

1.5 These film reference radiographs are not intended to illustrate the types and degrees of discontinuities in steel castings when performing digital X-ray imaging. When performing digital X-ray imaging of these castings, refer to Digital Reference Images [E3030](#).

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

1.7 *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>3</sup>

[E94](#) Guide for Radiographic Examination Using Industrial Radiographic Film

[E242](#) Reference Radiographs for Appearances of Radiographic Images as Certain Parameters are Changed

[E280](#) Reference Radiographs for Heavy-Walled (4½ to 12 in. (114 to 305 mm)) Steel Castings

[E446](#) Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness

[E1316](#) Terminology for Nondestructive Examinations

[E3030](#) Digital Reference Images for Heavy-Walled (2 to 4½ in. (50.8 to 114 mm)) Steel Castings

### 2.2 ASTM Adjuncts:<sup>4</sup>

Reference Radiographs for Heavy-Walled (2 to 4½-in. (50.8 to 114-mm)) Steel Castings:

Volume I, 1-MV X-rays and Iridium-192<sup>5</sup>

Volume II, 2 to 4-MV X-rays and Cobalt-60<sup>6</sup>

Volume III, 4-MV to 30-MV X-rays<sup>7</sup>

### 2.3 AIA Document:<sup>8</sup>

[NAS 410](#) Certification & Qualification of Nondestructive Test Personnel

### 2.4 ASNT Documents:<sup>9</sup>

[SNT-TC-1A](#) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

[ANSI/ASNT-CP-189](#) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

<sup>3</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.

<sup>4</sup> Available from ASTM Headquarters.

<sup>5</sup> Order [RRE018601](#).

<sup>6</sup> Order [RRE018602](#).

<sup>7</sup> Order [RRE018603](#).

<sup>8</sup> Available from Aerospace Industries Association (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209, <http://www.aia-aerospace.org>.

<sup>9</sup> Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

### 2.5 ANSI/ISO Standard:<sup>10</sup>

[ISO 9712](#) NDT—Qualification and Certification of NDT Personnel

## 3. Terminology

3.1 *Definitions*—For definitions of terms relating to radiographic examination, see Terminology [E1316](#).

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *classification specification, n*—a set of user defined acceptance criterion that prescribes the radiographic workmanship discontinuity class requirements for a specified user casting service application (see Sections [6](#) and [7](#)).

3.2.2 *discontinuity category, n*—a nomenclature system used for grouping discontinuity types.

3.2.2.1 *Discussion*—For example: linear shrinkage is assigned category “Ca,” where “C” represents the general shrinkage category and “a” represents the specific linear shrinkage discontinuity type.

3.2.3 *discontinuity class, n*—an assigned workmanship fabrication quality rating characterized by a discontinuity type, category, and severity level.

3.2.3.1 *Discussion*—For example: “Ca 2” is a discontinuity class comprised of linear shrinkage with a severity level of “2.”

3.2.4 *discontinuity severity level, n*—a relative rank in terms of “quantity, size and distribution” of a collection of discontinuities where “1” is the least and “5” is the greatest “quantity, size and distribution” present on the reference radiograph.

3.2.4.1 *Discussion*—Example: a severity level of “1” is more restrictive (requires a higher level of workmanship fabrication quality) than a severity level of “2.”

3.2.5 *discontinuity type, n*—a specific discontinuity characterized by its cause and appearance.

3.2.5.1 *Discussion*—For example: linear shrinkage is a specific discontinuity type.

3.2.6 *graded illustration, n*—a category of discontinuity that is assigned a severity level.

3.2.7 *production radiograph, n*—a radiograph under review for compliance with this standard.

3.2.8 *prorating, n*—assignment of quantity, size, and distribution on a production radiograph in proportion to a similar size area of a reference radiograph.

3.2.8.1 *Discussion*—For example: a production radiograph covers an area that is smaller than the unit area of a reference radiograph and the extent of discontinuity on the applicable reference radiograph is reduced proportionately.

3.2.9 *ungraded illustration, n*—a category of discontinuity without an assigned severity level.

## 4. Significance and Use

4.1 Graded reference radiographs are intended to provide a guide enabling recognition of specific casting discontinuity types and relative severity levels that may be encountered

<sup>10</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.