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Standard Reference Radiographs for Heavy-Walled (4½ to 12-in. [114(114 to 305-mm)]305-mm) Steel Castings¹

This standard is issued under the fixed designation E280; 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.

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

~~^{ε1}Note—Editorial changes were made throughout in January 2004.~~

1. Scope

1.1 These reference radiographs

1.1 These reference radiographs² for heavy-walled steel castings are applicable to nominal section thicknesses of 4½ to 12 in. [114 to 305 mm] and consists of two sets as follows:

1.1.12-MV X-rays and Cobalt-60—This includes cobalt-60 or equivalent isotope radiation and from 2 MV up to 4 MV X-rays. Set of 28 plates in 8½ by 11 in. [216 by 279 mm] ring binders:

1.1.24-MV to 30-MV X-rays:

1.1.3 Each set consists of three categories of graded discontinuities in increasing severity levels, and three categories of ungraded discontinuities furnished as examples only, as follows:

1.1.3.1 Illustrate various categories, types, and severity levels of discontinuities occurring in steel castings that have section thicknesses of 4½ to 12 in. (114 to 305 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 1—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 E186. Reference radiograph E186 provides 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 two separate volumes as follows

1.2.1 Volume I: 2-MV X-rays and Cobalt-60—This includes cobalt-60 or equivalent isotope radiation and from 2-MV up to 4-MV X-rays. Set of 28 plates in 8½ by 11 in. (216 by 279 mm) ring binders.

1.2.2 Volume II: 4-MV to 30-MV X-rays—Set of 28 plates in 8½ by 11 in. (216 by 279 mm) ring binders. ~~ε280-10~~

1.2.3 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:

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

1.2.3.2

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

1.2.3.3

1.2.3.3 Category C—Shrinkage; 3 types:—Shrinkage; three types:

(1) Type 1—Severity levels 1 through 5. Ca Linear Shrinkage—Severity levels 1 through 5 (called Type 1 in previous revisions).

¹ 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 Radiographs:

Current edition approved January 1, 2004. Published February 2004. Originally approved in 1965. Last previous edition approved in 1998 as E280-98. DOI: 10.1520/E0280-98R04E01 on Reference Radiological Images and E07.93 on Illustration Monitoring.

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² For ASME Boiler and Pressure Vessel Code applications see related Reference Radiographs SE 280 in Section V of that Code.

(2) *Type 2*—Severity levels 1 through 5. *Cb Feathery Shrinkage*—Severity levels 1 through 5 (called Type 2 in previous revisions).

(3) *Type 3*—Severity levels 1 through 5:

1.1.3.4 *Cc Sponge Shrinkage*—Severity levels 1 through 5 (called Type 3 in previous revisions).

1.2.3.4 *Category D*—Crack; one illustration D5 in pre-1972 documents.

1.1.3.5

1.2.3.5 *Category E*—Hot tear; one illustration D3 in pre-1972 documents.

1.1.3.6

1.2.3.6 *Category F*—Insert; one illustration EB2 in pre-1972 documents.

1.2

1.3 The values stated in inch-pound units are to be regarded as the standard. SI values are shown 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*:³

E94 [Guide for Radiographic Examination](#)

E186 [Reference Radiographs for Heavy-Walled \(2 to 412-in. \(50.8 to 114-mm\)\) Steel Castings](#)

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

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

E1316 [Terminology for Nondestructive Examinations](#)

2.2 *ASTM Adjuncts*:⁴

[Reference Radiographs for Heavy-Walled \(4 1/2 to 12-in. \[114 to 305-mm\]\) Steel Castings:](#)

[Volume I, 2-MV X Rays and Cobalt-60 to 12-in. \(114 to 305-mm\) Steel Castings:](#)

[Volume I, 2-MV to 4 MV X-rays and Cobalt-60](#)⁵

[Volume II, 4-MV to 30-MV X-Ray](#)⁶

3. Terminology

3.1 *Definitions*—for definitions of terms used in this document, see Terminology—For definitions of terms relating to radiographic examination, see Terminology E1316, section D.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *production radiograph*—a radiograph under review for compliance with this standard.

3.2.2 *discontinuity type*—a specific discontinuity characterized by its cause and appearance. For example: linear shrinkage is a specific discontinuity type.

3.2.3 *discontinuity category*—a nomenclature system used for grouping discontinuity types. For example: linear shrinkage is assigned category “Ca” where “C” represents the general shrinkage category and “a” represents the specific linear shrinkage discontinuity type.

3.2.4 *discontinuity severity level*—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. 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 class*—an assigned workmanship fabrication quality rating characterized by a discontinuity type, category and severity level. For example: “Ca 2” is a discontinuity class comprised of linear shrinkage with a severity level of “2”.

3.2.6 *classification specification*—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).

3.2.7 *graded illustration*—a category of discontinuity that is assigned a severity level.

3.2.8 *ungraded illustration*—a category of discontinuity without an assigned severity level.

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

4. Significance and Use

4.1 These reference radiographs are reproductions of original radiographs and are supplied as a means for establishing the categories and severity levels of discontinuities in steel castings that may be revealed by radiographic examination. They may be

³ 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.

⁴ Available from ASTM Headquarters.

⁵ Order [RRE028001](#).

⁶ Order [RRE028002](#).

used in accordance with contractual specifications.

4.2 Radiographs for evaluation are to be compared with these reference radiographs for classification on the basis of the category and severity level of the discontinuity.

4.3 The use of this document is not intended to be restricted to the specific energy level or to the absolute thickness limits that are contained in the document title. The title is intended to be descriptive, not restrictive. The document may be used where there is no other applicable document, for other energy levels or thicknesses, or both, for which agreement has been reached between purchaser and manufacture.

5. 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 during typical fabrication processes. Reference radiographs containing ungraded discontinuities are provided as a guide for recognition of a specific casting discontinuity type where severity levels may not be needed. These reference radiographs are intended as a basis from which manufacturers and purchasers may, by mutual agreement, select particular workmanship classes to serve as standards representing minimum levels of acceptability (see Sections 6 and 7).

4.2 Reference radiographs represented by this standard may be used, as agreed upon in a purchaser supplier agreement, for energy levels, thicknesses or both outside the range of this standard when determined applicable for the casting service application. Overlapping severity levels of similar discontinuity categories and energy level range of E186 reference radiographs may alternatively be used, as determined appropriate for the casting service application, if so agreed upon in a purchaser supplier agreement (see 5.1).

4.3 Procedures for evaluation of production radiographs using applicable reference radiographs of this standard are prescribed in Section 8; however, there may be manufacturing-purchaser issues involving specific casting service applications where it may be appropriate to modify or alter such requirements. Where such modifications may be appropriate for the casting application, all such changes shall be specifically called-out in the purchaser supplier agreement or contractual document. Section 9 addresses purchaser supplier requisites where weld repairs may be required.

5. Method of Preparation

5.1 The original radiographs used to prepare the accompanying reference radiographs were produced on high contrast, fine grain film by the respective use of radiation energies stated in 1.1.1.

5.1 The original radiographs used to prepare the adjunct reference radiographs were produced on ASTM Class I or II film systems by the respective use of radiation energies stated in 1.2.1 and 1.1.2.2. The original radiographs were made with a penetrometer sensitivity as determined by ASTM penetrameters (see Guide E94) of 2-2T. The reproductions have been prepared to an optical density of 2.00 to 2.25 and they have retained substantially the contrast of the original radiographs. The adjunct reference radiographs are reproductions prepared to an optical density of 2.00 to 2.25 and they have substantially retained the contrast of the original radiographs. In preparing these reference radiographs, the objective was to obtain progressively graduated severity levels for each graded discontinuity category over the thickness range of this standard. Additionally, some overlap of severity levels may occur for similar discontinuity categories of Reference Radiograph standard E186 with the same energy level range. For example, aggregate gas porosity severity level 1 of this standard is less severe than aggregate porosity severity level 5 of E186 (see 6.3).

5.2 *Film Deterioration*—Radiographic films are subject to wear and tear from handling and use. The extent to which the image deteriorates over time is a function of storage conditions, care in handling and amount of use. Reference radiograph films are no exception and may exhibit a loss in image quality over time. The radiographs should therefore be periodically examined for signs of wear and tear, including scratches, abrasions, stains, and so forth. Any reference radiographs which show signs of excessive wear and tear which could influence the interpretation and use of the radiographs should be replaced.

6. Determination of Radiographic Classification

6.1 For purposes of evaluation of castings, a determination must be made of the radiographic classification to be assigned to individual castings or specific areas of castings. The determination of the applicable radiographic severity classification shall be based on an evaluation of the casting applications, design, and service requirements. In these evaluations, consideration shall be given to such factors as pressure, temperature, section thickness, applicable design safety factor, vibration, shock, resistance to corrosion, involvement of penetrating radiations or radiation products, and involvement of dangerous gases or liquids.

7.

6.1 For purposes of evaluation of castings, a determination must be made of the radiographic discontinuity classification to be assigned to individual castings or specific areas of castings. The determination of the applicable radiographic discontinuity classification shall be based on an evaluation of the casting applications, design, and service requirements. In these evaluations, consideration shall be given to such factors as pressure, temperature, section thickness, applicable design safety factor, vibration, shock, resistance to corrosion, involvement of penetrating radiations or radiation products, and involvement of dangerous gases or liquids.