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## Standard Reference Radiographs for Ductile Iron Castings<sup>1</sup>

This standard is issued under the fixed designation E689; 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.

<sup>ε1</sup>Note—Editorially changed “defect” to “discontinuity” in paragraph 7.6 in January 2004.

### 1. Scope

1.1 These reference radiographs extend the application of reference radiographs for steel castings to ductile iron castings.

1.2 In some instances, reference radiographs for steel castings may not be entirely applicable to ductile cast iron material dependent upon design or other usage criteria. Refer to 4.1 for guidance.

1.1 This standard extends the application of steel casting reference radiographs E446, E186, and E280 to ductile iron castings when determined appropriate for specific applications (see Section 4).

1.2 The reference radiograph films are an adjunct to E446, E186, or E280, and must be purchased separately from ASTM International, if needed (see 2.1). Categories and severity levels for each discontinuity type represented by these reference radiographs are described within each applicable standard above.

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, 5, and 6 of this standard.

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>

E94 Guide for Radiographic Examination

E186 Reference Radiographs for Heavy-Walled (2 to 412-in. [51 to 114-mm]) Steel Castings

E242 Reference Radiographs for Appearances of Radiographic Images as Certain Parameters Are Changed

E280 Reference Radiographs for Heavy-Walled (412 to 12-in. (114 to 305-mm)) Steel Castings

E446 Reference Radiographs for Steel Castings Up to 2 in. [51 mm] in Thickness

E1316 Terminology for Nondestructive Examinations

### 3. Terminology

3.1 Definitions of terms used in these reference radiographs may be found in Terminology

3.1 Definitions—For definitions of terms relating to radiographic examination, see Terminology E1316, Section D.

### 4. Significance and Use

4.1 These reference radiographs invoke Reference Radiographs E446, E186, and E280 for establishing categories and severity levels of internal discontinuities common to ductile iron castings subject to mutual agreement between purchaser and supplier in contractual specifications. The casting process has shown radiographic similarities between internal discontinuities for ductile cast iron and cast steel to the extent that the reference radiographs for steel castings are applicable. The exact application and usage of the above categories and severity levels must, however, give consideration to the differences in material properties between cast steel and ductile cast iron end usage applications.

4.2 Production radiographs are to be compared with the applicable set of reference radiographs for classification on the basis of section thickness, radiation energy level and type, and category and severity level of discontinuity specified.

<sup>1</sup> This reference radiograph 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.

- 4.3 The standard reference radiographs are published in three nominal section thickness ranges in separate documents as follows:
- 4.3.1 Castings up to 2 in. (51 mm): Reference Radiographs E446.
- 4.3.2 Heavy-walled castings 2 to 4½ in. (51 to 114 mm): Reference Radiographs E186.
- 4.3.3 Heavy-walled castings 4½ to 12 in. (114 to 305 mm): Reference Radiographs E280.

## 5.

### 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. For example, a severity level of “1” is more restrictive (requires a higher level of fabrication quality) than a severity level of “2”.

3.2.5 discontinuity class—an assigned 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 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 The casting process has demonstrated radiographic similarities between internal discontinuities for ductile cast iron and cast steel to the extent that the reference radiographs for steel castings are applicable. The exact application and usage of discontinuity classifications contained within steel casting reference radiographs must, however, give consideration to the differences in material properties between cast steel and ductile cast iron. In some applications, reference radiographs for steel castings may not be entirely applicable to ductile cast iron material dependent upon design or other usage criteria.

4.2 When employing steel casting reference radiographs to evaluate ductile iron castings, the applicable E446, E186, or E280 steel casting written standard shall also be used for specific guidance and evaluation procedures.

4.3 These reference radiographs are intended as a basis from which manufacturers and purchasers may, by mutual agreement, select particular discontinuity classes to serve as standards representing minimum levels of acceptability. Reference radiographs represented by these steel casting standards may be used, as agreed upon in a purchaser supplier agreement, for radiation energy levels, thicknesses or both outside the range of these standards when determined applicable for the casting service application

## 5. Determination of Radiographic Classification

5.1 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.

## 6.

5.1 For purposes of evaluation of castings, a determination must be made of the radiographic discontinuity classifications 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.

5.2 For each individual casting or specific area of a casting to be radiographed, the discontinuity class must be clearly specified. For example, severity level 2 might be specified for linear shrinkage, Category Ca, and severity level 3 for gas porosity, Category A, since the latter are generally much less deleterious to tensile properties (see Section 6).

5.3 When determining discontinuity severity levels for individual castings spanning multiple thickness ranges outside the range of this standard, consideration should be given to the potential for overlapping severity levels as described in the applicable written standard.