



Designation: E689 – 20

Standard Reference Radiographs for Ductile Iron Castings¹

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

1. Scope

1.1 This standard extends the application of steel casting Reference Radiographs [E446](#), [E186](#), and [E280](#) when performing film radiography and Digital Reference Images [E2868](#) and [E3030](#) when performing digital radiography to ductile iron castings when determined appropriate for specific applications (see Section 4).

1.2 The reference radiograph films are an adjunct to Reference Radiographs [E446](#), [E186](#), or [E280](#), and must be purchased separately from ASTM International, if needed. Likewise, when performing digital radiography, the digital reference images are an adjunct to Digital Reference Images [E2868](#) and [E3030](#) 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 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 *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 appro-*

priate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.5 *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:²

- [E94](#) Guide for Radiographic Examination Using Industrial Radiographic Film
- [E186](#) Reference Radiographs for Heavy-Walled (2 to 4½ in. (50.8 to 114 mm)) Steel Castings
- [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
- [E2868](#) Digital Reference Images for Steel Castings up to 2 in. (50.8 mm) in Thickness
- [E3030](#) Digital Reference Images for Heavy-Walled (2 to 4½ in. (50.8 to 114 mm)) Steel Castings

2.2 AIA Document:³

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

2.3 ASNT Documents:⁴

- [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

¹ These reference radiographs are under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and are the direct responsibility of Subcommittee E07.02 on Reference Radiological Images.

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

⁴ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

2.4 ANSI/ISO Standard:⁵

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 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 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*—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 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 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 for film radiography, the applicable E446, E186, or E280 steel casting written standard shall also be used for specific guidance and evaluation procedures. When employing digital radiographic methods, the digital reference images in Digital Reference Images E2868 and E3030 shall be used.

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.

4.4 Personnel utilizing reference radiographs to this standard shall be qualified and authorized to perform radiographic interpretation in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS 410, ISO 9712, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used and its applicable revision shall be identified in the contractual agreement between the using parties. A certified Level III shall be available to assist with interpreting specifications and product requirements as applied to the reference radiographs (if the Level III is the radiographic interpreter, this may be the same person).

5. Determination of Radiographic Classification

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 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>.