



Designation: E310 – 21

Standard Reference Radiographs for Tin Bronze Castings¹

This standard is issued under the fixed designation E310; 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 U.S. Department of Defense.

1. Scope

1.1 These reference radiographs illustrate various categories, types, and severity levels of discontinuities occurring in tin bronze and related alloy castings. 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 described in Sections 4, 7, 8, 9, and 10 of this standard.

1.2 These reference radiographs consists of twenty-two 2½ by 5½-in. (63.5 by 139.7-mm) nominal size reproductions originally exposed with low voltage X-rays. Fifteen of these were produced with 1 in. (25.4 mm) plate castings and seven (sand inclusions, inserts, chaplets) were produced with ¾-in. plate castings originally derived for NAVSHIPS 250-537-1 and -2. The 1-in. plate castings cover gas porosity, linear shrinkage, and feathery shrinkage discontinuity types. The original radiographs illustrate discontinuities in sand cast 88:8:4 Cu-Sn-Zn, “G” type, bronze alloy plates and are representative of those found in wide solidification range copper-tin base alloys. Following is a list of discontinuity categories, types, and severity levels for the adjunct reference radiographs of this standard:

1.2.1 *Category A*—Gas porosity; severity levels 1 through 5 for up to and including 2 in. (50.8 mm). (Called “Code A discontinuity type” in previous revisions.)

1.2.2 *Category B*—Sand inclusions; severity levels 1 through 5 for up to and including 2 in. (50.8 mm). (Called “Code B discontinuity type” in previous revisions.)

1.2.3 *Category C*—Shrinkage; two types (Called “Code C discontinuity type in previous revisions).

1.2.3.1 *Ca*—Linear shrinkage; severity levels 1 through 5 for up to and including 2 in. (50.8 mm). (Called “Code Ca discontinuity type” in previous revisions.)

1.2.3.2 *Cd*—Feathery and spongy shrinkage (see Note 2); severity levels 1 through 5 for up to and including 2 in. (50.8 mm). (Called “Code Cd discontinuity type” in previous revisions.)

NOTE 2—The feathery shrinkage discontinuity type is used to illustrate aggregate severity levels for either feathery or spongy shrinkage discontinuity types (see 6.1).

1.2.4 *Category D*—Hot tear; one illustration (Called “Code Da discontinuity type” in previous revisions).

1.2.5 *Category E*—Inserts, chaplets; one illustration (Called “Code Eb discontinuity type” in previous revisions).

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 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *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.*

1.6 *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.*

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 Radiological Images and E07.93 on Illustration Monitoring.

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2. Referenced Documents

2.1 ASTM Standards:²

- B61 Specification for Steam or Valve Bronze Castings
 - B62 Specification for Composition Bronze or Ounce Metal Castings
 - B271 Specification for Copper-Base Alloy Centrifugal Castings
 - B584 Specification for Copper Alloy Sand Castings for General Applications
 - E94 Guide for Radiographic Examination Using Industrial Radiographic Film
 - E242 Reference Radiographs for Appearances of Radiographic Images as Certain Parameters are Changed
 - E1316 Terminology for Nondestructive Examinations
- ### 2.2 ASTM Adjuncts:
- Reference Radiographs for Tin Bronze Castings³
- ### 2.3 ASNT Documents:⁴
- ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel
 - SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing
- ### 2.4 AIA Document:⁵
- NAS 410 Nondestructive Test Personnel Certification
- ### 2.5 ISO Standard:⁶
- ISO 9712 Non-destructive Testing — Qualification and Certification of NDT Personnel

3. Terminology

3.1 *Definitions*—For definitions of terms related 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 7 and 8).

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.”

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 ASTM International Headquarters. Order RRE0310.

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

⁵ Available from Aerospace Industries Association (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209, <http://www.aia-aerospace.org>.

⁶ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

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 Personnel utilizing reference radiographs to this standard shall be qualified 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. Personnel shall be authorized to perform radiographic interpretation by the employer. 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).

4.2 Reference radiographs for tin bronze and related alloy castings are intended to be used as a guide to the recognition of common discontinuities and their differentiation both as to type and severity level. Discontinuity types most common to these alloys are illustrated. For reference, descriptions of typical casting defects and corresponding radiographic indication types are contained in Section 5. Purchasers and suppliers may, by mutual agreement, select particular discontinuity categories (see 1.2) to serve as standards representing minimum levels of acceptability (see Sections 7 and 8).

4.3 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. Section 10 addresses purchaser supplier requisites where weld repairs may be required.