



Designation: E310 – 10

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 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 inches (50.8 mm). (Called “Code Ca discontinuity type” in previous revisions).

1.2.3.2 *Cd*—Feathery and spongy shrinkage (see note 1); 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 The values stated in inch-pound units are to be regarded as the 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 appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

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
- E242 Reference Radiographs for Appearances of Radiographic Images as Certain Parameters are Changed
- E1316 Terminology for Nondestructive Examinations

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

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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.

2.2 ASTM Adjuncts:

Reference Radiographs for Tin Bronze Castings³

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 *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 7 and 8).

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 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).

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

4.3 Procedures for evaluation of production radiographs using applicable reference radiographs of this standard are prescribed in Section 9; 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 called-out in the purchaser supplier agreement or contractual document.

4.4 The following ASTM specifications illustrate alloys covered by these standards; however, it is intended that these reference radiographs also apply to related government and commercial material specifications:

Valve bronze castings	B61 ^A
Composition bronze or ounce metal castings	B62 ^B
Tin bronze sand castings	B584
Leaded red brass sand castings	B584
Copper-base alloy centrifugal castings (as applicable)	B271

^A Similar to MIL-B-16541.

^B Similar to MIL-B-16444.

5. Descriptions of Discontinuities

5.1 The following paragraphs are provided to aid in the identification and classification of discontinuities (see Note 3). They briefly describe the radiographic appearance of common types of discontinuities and indicate their probable cause.

5.1.1 *Gas Holes*—Round or elongated, smooth-edged dark spots which may occur either individually, in clusters, or distributed throughout the casting section. They are generally caused by trapped air or mold gases.

NOTE 3—Discontinuities caused by evolved gases may occur as more or less spherical voids, but may also occur as elongated “worm holes” or cavities somewhat resembling certain types of shrinkage. It is recommended that the “worm hole” cavities be evaluated by the use of the feathery or sponge shrinkage category reference radiographs.

5.1.2 *Shrinkage*—Shrinkage is generally associated with improper feeding and manifests itself in the following different indication forms:

5.1.2.1 *Linear Shrinkage*—Usually a continuous structure of connected lines, branches or network of variable length, width, and density.

5.1.2.2 *Feathery Shrinkage*—Appears on the radiographs as sponge but with a more feathery outline.

5.1.2.3 *Sponge Shrinkage*—Appears on the radiographs as a dark area or areas, lacy in texture, usually with a diffuse outline.

5.1.3 *Hot Tears*—The similarly, appearing “hot tear” and “linear shrinkage” have distinctive characteristics. The following information is presented as guide to interpreters to minimize confusion in distinguishing hot tears from linear shrinkage:

5.1.3.1 Hot tears usually occur singly; shrinkage will generally be multiple.

³ Available from ASTM International Headquarters. Order **ADJE0310**.