



Designation: E310-99 (Reapproved 2004)^{ε1} 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.

^ε1 Note— Editorial changes were made throughout in May 2004.

1. Scope

1.1 These reference radiographs are reproductions of original radiographs and illustrate various types and degrees of discontinuities occurring in tin bronze and related types of alloys. The reference radiograph films are an adjunct to this document and must be purchased separately from ASTM International if needed. They are intended to provide the following:

1.1.1 A guide to the recognition of common discontinuities and their differentiation both as to type and severity level.

1.1.2 A standard nomenclature for reference in acceptance standards, specifications and drawings.

1.1.3 A source of reference radiographs from which manufacturers and purchasers may, by mutual agreement, select particular radiographs to serve as standards representing minimum acceptability. The standards so established are identified by an alphabetic defect type and severity level (or class) designation.

1.2 The original radiographs are of discontinuities in sand cast 88:8:4 Cu-Sn-Zn, “G” type, bronze alloy plates. These discontinuities are representative of those found in wide solidification range copper-tin base alloys. 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	B61B61 ^A
Composition bronze or ounce metal castings	B62B62 ^B
Tin bronze sand castings	B584B584
Leaded red brass sand castings	B584B584
Copper-base alloy centrifugal castings (as applicable)	B271B271

^ASimilar to MIL-B-16541.

^BSimilar to MIL-B-16444.

1.3 The discontinuity types and severity levels represented by the reference radiographs are shown in Table 1, which also indicates the code designation for each discontinuity type.

1.4 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 and not restrictive. The document may be used, where there is no other applicable document, for other energy levels or thicknesses, or both, for which it is found to be applicable and for which agreement has been reached between purchaser and manufacturer.

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 reference radiographs consist of twenty-two 2½-in. [63.5 mm] radiograph reproductions of low voltage X rays. Fifteen of these were made with newly developed 1-in. [25.4 mm] plate castings and seven were made with ¾-in. plate castings used originally for documents NAVSHIPS 250-537-1 and -2. The new plate castings cover Gas Porosity, Linear Shrinkage, and Feathery Shrinkage discontinuity types.

1.2 These reference radiographs consists of twenty-two 2½ by 5½-in. [63.5 by 139.7 mm] radiograph reproductions of low voltage X rays. Fifteen of these were made with newly developed 1-in. [25.4 mm] plate castings and seven were made with ¾-in. plate castings used originally for documents NAVSHIPS 250-537-1 and -2. The new plate castings cover Gas Porosity, Linear Shrinkage, and Feathery Shrinkage discontinuity types.

1.5 The values stated in inch-pound units are to be regarded as the standard.

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

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1.6-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 3/4-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](#)

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 used in this document, see Terminology

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

4. Significance and Use

4.1 These reference radiographs were produced by the use of 88:8:4, Cu-Sn-Zn, “G” plate castings. Table 2 lists the chemical composition and mechanical property limits for the alloy type. The references illustrate the appearance of the various radiographic severity levels when the original radiographs are produced to an optical density of 2.0 ± 0.2 on high contrast, fine grain film with a sensitivity (quality level), as determined by standard penetrameters, of 2% (2-2T). In selecting these reference radiographs, the aim was to obtain a progressively graduated series for each type of discontinuity (Note 2). It was not intended that alike numbered levels or classes be considered of equal severity (as far as deterioration of mechanical properties is concerned) for the various categories.

NOTE 2—For a description of sensitivity or quality levels, see Guide E94.

4.2 The reproductions have been prepared to an *H* and *D* density of 2.0 ± 0.2 and have retained substantially the contrast of the original radiographs. Details of the technique used in the original radiography are listed in Table 3. These data are presented as a matter of record and are not to be construed as the only recommended techniques to be used for the radiography of castings to be evaluated by these references.

4.3 *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.

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 Available from ASTM International Headquarters. Order RRE0310.

TABLE 2_1 Alloy Type Used to Produce Plate Castings for Original Radiographs

Chemical Composition, %		
	min	max
Copper	86.00	89.00
Tin	7.50	9.00
Zinc	3.00	5.00
Nickel	...	1.00
Lead	...	0.30
Iron	...	0.15
Phosphorus	...	0.05
Mechanical Properties		
Tensile strength, min, psi [MPa]	40 000 [275]	
Tensile strength, min, psi (MPa)	40 000 (275)	
Elongation in 2 in. or 51 mm, min,	20	