



Designation: E272 – 10

Standard Reference Radiographs for High-Strength Copper-Base and Nickel-Copper Alloy Castings¹

This standard is issued under the fixed designation E272; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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 high-strength copper-base, nickel-copper, 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 2.3). 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 consist of forty-five 5 by 7-in. (127 by 178-mm) nominal size reproductions (twenty made from 1-in. (25.4-mm) plate castings exposed with low voltage X-rays for thicknesses up to and including 2 in.) and twenty-five made from 3-in. (76-mm) plate castings exposed with 2 MV X-rays or Cobalt 60 isotope for thicknesses greater than 2 in. up to and including 6 in. Unless otherwise specified in a purchaser supplier agreement (see 1.1), each discontinuity category is for comparison only with production radiographs produced with radiation energy levels within the thickness range covered by the category. These reference radiographs illustrate discontinuities in sand-cast manganese-nickel-aluminum bronze-alloy plates and are representative of those found in narrow freezing range (formerly “high shrinkage”), high-strength copper and nickel-copper alloys. Following is a list of discontinuity categories, types and severity levels for the adjunct reference radiographs of this standard (see Note 2):

1.2.1 *Category A*—Gas porosity; severity levels 1 through 5 for two thickness ranges.

1.2.1.1 A_x —Up to and including 2 inches (50.8 mm) (called “Code A Discontinuity type” in previous revisions).

1.2.1.2 A_G —Greater than 2 in. (50.8 mm) up to and including 6 in. (152.4 mm) (called “Code A Discontinuity type” in previous revisions).

1.2.2 *Category B*—Inclusions

1.2.2.1 B_a —Sand inclusions, severity levels 1 through 5 for two thickness ranges.

(1) B_{a_x} —Up to and including 2 in. (50.8 mm) (called “Code B_a Discontinuity type” in previous revisions).

(2) B_{a_G} —Greater than 2 in. (50.8 mm) up to and including 6 in. (152.4 mm) (called “Code B_a Discontinuity type” in previous revisions).

1.2.2.2 B_b —Dross inclusions, severity levels 1 through 5 for two thickness ranges.

(1) B_{b_x} —Up to and including 2 in. (50.8 mm) (called “Code B_b Discontinuity type” in previous revisions).

(2) B_{b_G} —greater than 2 in. (50.8 mm) up to and including 6 in. (152.4 mm) (called “Code B_b Discontinuity type” in previous revisions).

1.2.3 *Category C*—Shrinkage; three types

1.2.3.1 C_a —linear shrinkage, severity levels 1 through 5 for 2 inches to and including 6 in. (50.8 to 152.4 mm) in thickness

1.2.3.2 C_b —feathery shrinkage, severity levels 1 through 5 for thicknesses up to and including 2 in. (50.8 mm). (Called “ C_d feathery shrinkage” in previous revisions).

1.2.3.3 C_c —spongy shrinkage, severity levels 1 through 5 for 2 in. to and including 6 in. (50.8 to 152.4 mm) in thickness (called “ C_d spongy shrinkage” in previous revisions).

NOTE 2—Discontinuity classes designated with a subscript “X” were produced with low energy X-ray radiation; discontinuity classes designated with subscript “G” were produced with Cobalt 60 and/or 2 MV X-rays and are the same reference radiographs and thickness ranges used in previous editions of this standard. Section 4 details the significance and use of these reference radiographs.

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.*

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

- [B148 Specification for Aluminum-Bronze Sand Castings](#)
- [B369 Specification for Copper-Nickel Alloy Castings](#)
- [B584 Specification for Copper Alloy Sand Castings for General Applications](#)
- [E94 Guide for Radiographic Examination](#)
- [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](#)
- [E192 Reference Radiographs of Investment Steel Castings for Aerospace Applications](#)
- [E446 Reference Radiographs for Steel Castings Up to 2 in. \(50.8 mm\) in Thickness](#)
- [E1316 Terminology for Nondestructive Examinations](#)

2.2 Military Specification:

- [MIL-B-21230A Bronze, Nickel Aluminum and Manganese-Nickel Aluminum, Casting, Ship Propeller Application³](#)

2.3 ASTM Adjuncts:

- Reference Radiographs for High-Strength Copper-Base and Nickel-Copper Alloy Castings⁴

3. Terminology

3.1 *Definitions*—For definitions of terms used in this document, 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. Example: a severity level of “1” is more restrictive (requires a higher level of workmanship fabrication quality) than a severity level of “2”.

3.2.5 *discontinuity class*—an assigned workmanship 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 workmanship 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 high-strength copper-base and nickel-copper 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. Other discontinuity types such as hot tears, cracks and unfused chaplets are illustrated in applicable Reference Radiographs [E186](#), [E192](#), and [E446](#). 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 classes (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.

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

4.4 The following ASTM specifications illustrate alloys that may be used with these standards. It is intended that these reference radiographs also apply to related government and commercial material specifications.

Alloys	ASTM Specifications ^A
Aluminum Bronze	B148
Nickel-Aluminum Bronze	B148
Copper-Nickel	B369
Manganese Bronze	B584
Alloys	Government Specification ^A
Manganese-Nickel-Aluminum Bronze	MIL-B-21230A—Alloy No. 2.
Nickel-Copper	MIL-B-21230A—Alloy No. 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 Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098

⁴ Available from ASTM Headquarters. Order [ADJE0272](#).