



Designation: E3184 – 24

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

This standard is issued under the fixed designation E3184; 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 These digital reference images illustrate various categories, types and severity levels of discontinuities occurring in high-strength copper-base, nickel-copper, and related alloy castings. The digital reference images are an adjunct to this document and must be purchased separately from ASTM International if needed (see 2.4). Categories and severity levels for each discontinuity type represented by these digital reference images are described in 1.2.

NOTE 1—The basis of application for these reference images requires a prior purchaser supplier agreement of radiographic examination attributes and classification criterion described in Sections 4, 6, and 7 of this standard.

1.2 These reference images consist of forty-five 5 in. by 7 in. (127 mm 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 digital images produced with radiation energy levels within the thickness range addressed by the category. These digital reference images 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. The categories, types and severity levels for the adjunct digital reference images of this standard are shown in 1.2.1 – 1.2.3 (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 in. (50.8 mm) in thickness.

1.2.1.2 A_G —Greater than 2 in. (50.8 mm) up to and including 6 in. (152.4 mm) in thickness.

¹ This test method is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.02 on Reference Radiological Images.

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1.2.2 *Category B*—Inclusions; 2 types:

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

(1) B_{aX} —Up to and including 2 in. (50.8 mm) in thickness.

(2) B_{aG} —Greater than 2 in. (50.8 mm) up to and including 6 in. (152.4 mm) in thickness.

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

(1) B_{bX} —Up to and including 2 in. (50.8 mm) in thickness.

(2) B_{bG} —Greater than 2 in. (50.8 mm) up to and including 6 in. (152.4 mm) in thickness.

1.2.3 *Category C*—Shrinkage; 3 types:

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

1.2.3.2 C_b —Feathery shrinkage, severity levels 1 through 5 for section thicknesses up to and including 2 in. (50.8 mm) in thickness.

1.2.3.3 C_c —Spongy shrinkage, severity levels 1 through 5 for greater than 2 in. (50.8 mm) up to and including 6 in. (152.4 mm) in thickness.

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 or 2 MV X rays, or both. Section 4 details the significance and use of these digital reference images.

1.3 All areas of this standard may be subject to agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization. These items should be addressed in the purchase order or the contract.

1.4 These digital reference images are not intended to illustrate the types and degrees of discontinuities found in high-strength copper-base, nickel-copper, and related alloy castings when performing film radiography. If performing film radiography of high-strength copper-base, nickel-copper, and related alloy castings, refer to Reference Radiographs E272.

1.5 Only licensed copies of the software and images shall be utilized for production examination. A copy of the ASTM/User license agreement shall be kept on file for audit purposes (see Note 3).

NOTE 3—The digital reference images consist of 28 digital files, software to load the desired format and specific instructions on the loading process. The 45 reference images illustrate three categories of graded discontinuities (1.2.1 (Gas porosity), 1.2.2 (Inclusions), and 1.2.3 (Shrinkage)) and contain an image of a step wedge. Available from ASTM International Headquarters, Order No: RRE3184.

1.6 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.

1.7 *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.*

1.8 *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

- B148 Specification for Aluminum-Bronze Sand Castings
- B369 Specification for Copper-Nickel Alloy Castings
- B584 Specification for Copper Alloy Sand Castings for General Applications
- E272 Reference Radiographs for High-Strength Copper-Base and Nickel-Copper Alloy Castings
- E1316 Terminology for Nondestructive Examinations
- E2002 Practice for Determining Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy

2.2 SMPTE Practice:³

- RP133 Recommended Practice Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard-Copy Recording Cameras

2.3 Military Specification:⁴

- MIL-B-21230A Bronze, Nickel Aluminum and Manganese-Nickel Aluminum, Casting, Ship Propeller Application

2.4 ASTM Adjuncts:

- Digital Reference Images for High-Strength Copper-Base and Nickel-Copper Alloy Castings⁵

3. Terminology

3.1 Definitions:

3.1.1 Definitions of terms used in this standard may be found in Terminology E1316.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *aliasing, n*—artifacts that appear in an image when the spatial frequency of the input is higher than the output is capable of reproducing; this will often appear as jagged or stepped sections in a line or as moiré patterns.

3.2.2 *classification specification, n*—a set of user defined acceptance criteria that prescribes the radiographic workmanship discontinuity class requirements for a specified user casting service application (see Sections 6 and 7).

3.2.3 *contrast normalization, n*—the adjustment of contrast between the production image and the reference image that makes the change in digital driving level versus change in thickness equal for both images.

3.2.4 *DDL, n*—Digital Driving Level, also known as monitor pixel value.

3.2.5 *discontinuity category, n*—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.

3.2.6 *discontinuity class, n*—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”.

3.2.7 *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 image; for example, a severity level of “1” is more restrictive (requires a higher level of fabrication quality) than a severity level of “2.”

3.2.8 *discontinuity type, n*—a specific discontinuity characterized by its cause and appearance; for example, linear shrinkage is a specific discontinuity type.

3.2.9 *graded illustrations, n*—a category of discontinuity that is assigned a severity level.

3.2.10 *measured resolution, n*—the characteristic resolution of a digital radiographic system as measured in accordance with 9.5.

3.2.11 *production image, n*—an image under review for compliance with this standard.

3.2.12 *prorating, n*—assignment of quantity, size and distribution on a production image in proportion to a similar size area of a reference image. For example, a production image covers an area that is smaller than the unit area of a reference image and the extent of discontinuity on the applicable reference image is reduced proportionately.

3.2.13 *ungraded illustrations, n*—a category of discontinuity without an assigned severity level and is for descriptive purposes only.

4. Significance and Use

4.1 Reference images 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 in the reference

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from the Society of Motion Picture and Television Engineers, 3 Barker Avenue, White Plain, NY 10601, http://www.smpete.org/smpete_store.

⁴ Available from Standardization Documents Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

⁵ Available from ASTM Headquarters. Order RRE3184.