



Designation: E155 – 20

Standard Reference Radiographs for Inspection of Aluminum and Magnesium Castings¹

This standard is issued under the fixed designation E155; 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.

These Reference Radiographs have been developed in cooperation with the Quality Control Committee and Aerospace Research and Testing Committee of the Aerospace Industries Association.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 These reference radiographs illustrate the types and degrees of discontinuities that may be found in aluminum-alloy and magnesium-alloy castings. The castings illustrated are in thicknesses of $\frac{1}{4}$ in. (6.35 mm) and $\frac{3}{4}$ in. (19.1 mm). The reference radiograph films are an adjunct to this document and shall be purchased separately from ASTM International if needed.

1.2 These film reference radiographs are not intended to illustrate the types and degrees of discontinuities found in aluminum-alloy and magnesium-alloy castings when performing digital radiography. If performing digital radiography of aluminum-alloy castings, refer to Digital Reference Image Standard E2422. If performing digital radiography of magnesium-alloy castings, refer to Digital Reference Image Standard E2869.

1.3 This document may be used where no other applicable document exists, for other material thicknesses for which it has been found to be applicable and for which agreement has been reached between the purchaser and the manufacturer.

1.4 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 These reference radiographs are under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and are the direct responsibility of Subcommittee E07.02 on Reference Radiological Images.

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1.5 *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.

NOTE 1—Vol I: The set of reference radiographs consists of 13 plates covering discontinuities in aluminum-alloy castings and 10 plates covering discontinuities in magnesium-alloy castings. Each plate is held in an $8\frac{1}{2}$ by 11 in. (216 by 279 mm) cardboard frame and each plate illustrates eight grades of severity for the discontinuity in approximately a 2 by 2 in. (51 by 51 mm) area. The cardboard frames are contained in a $10\frac{1}{2}$ by $11\frac{1}{2}$ in. (267 by 292 mm) ring binder. The reference radiographs are not impacted by this revision. There have been no revisions to the adjunct reference radiographs since original issue. The adjunct reference radiographs of any issue remain valid and may be used to this standard.

Vol. II: The set of reference radiographs consists of four plates covering discontinuities in magnesium-alloy castings only. Each plate is held in an $8\frac{1}{2}$ by 11 in. (216 by 279 mm) cardboard frame and illustrates eight grades of severity for the discontinuity (with the exception of discrete discontinuities, where only one example of each discontinuity is given).

NOTE 2—Reference radiographs applicable to aluminum and magnesium die castings up to 1 in. (25 mm) in thickness are contained in Reference Radiographs E505.

1.6 *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.*

1.7 *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

E94 Guide for Radiographic Examination Using Industrial Radiographic Film

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.

*A Summary of Changes section appears at the end of this standard

E505 Reference Radiographs for Inspection of Aluminum and Magnesium Die Castings

E1316 Terminology for Nondestructive Examinations

E2422 Digital Reference Images for Inspection of Aluminum Castings

E2869 Digital Reference Images for Magnesium Castings

2.2 *ASTM Adjuncts:*

Reference Radiographs for Inspection of Aluminum and Magnesium Castings:

Volume I, Aluminum and Magnesium Castings³

Volume II, Magnesium Castings⁴

2.3 *AIA Document.*⁵

NAS 410 Certification & Qualification of Nondestructive Test Personnel

2.4 *ASNT Documents.*⁶

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

ANSI/ASNT-CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

2.5 *ANSI/ISO Standard.*⁷

ISO 9712 NDT—Qualification and Certification of NDT Personnel

3. Terminology

3.1 *Definitions*—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 The terms relating to discontinuities used in these reference radiographs are described based upon radiographic appearance.

3.2.2 *foreign materials, n*—appear as isolated, irregular, or elongated variations of film density, not corresponding to variations in thickness of material, nor to cavities.

3.2.2.1 *Discussion*—They may be due to the presence of sand, slag, oxide or dross, or metal of different density.

3.2.3 *gas holes, n*—appear as round or elongated, smooth-edged dark spots, occurring individually, in clusters, or distributed throughout the casting.

3.2.4 *gas porosity, n*—represented by round or elongated dark spots corresponding to minute voids usually distributed through the entire casting.

3.2.5 *microshrinkage (feathery type), n*—microshrinkage having an elongated appearance resembling feather-like streaks.

3.2.6 *microshrinkage (sponge type), n*—microshrinkage having a spongelike appearance, and more massive and equiaxed than the feathery type.

3.2.7 *reacted sand inclusions, n*—appear on radiograph as “spotty segregation,” that is, sharply defined round light areas, about 1 mm in diameter, and often with the rim lighter than the center.

3.2.7.1 *Discussion*—They are entrapped sand particles that underwent reaction with molten magnesium alloys containing zirconium (**Note 3**).

3.2.8 *segregations, n*—appear as variations in film density which can be explained by segregation of elements of atomic numbers different from that of the matrix.

3.2.8.1 *gravity segregation, n*—appears white on radiograph and may range from a mottling-type effect through white-diffused spots blending with the matrix, to a cloud-like appearance in more severe cases.

3.2.8.1 *Discussion*—They are agglomerations of particles precipitated at temperatures above liquidus (**Note 3**).

3.2.8.2 *eutectic segregation, n*—type of segregation generally represented when a defect or discontinuity develops during solidification and is fed with a near eutectic residual liquid rich with alloying elements that have a high X-ray attenuation. One exception to this enrichment as illustrated in Reference Radiographs E155 is flow line (or eutectic depletion), where there is a local impoverishment of the alloying elements that have a high X-ray attenuation (**Note 3**).

(1) *eutectic segregation—microshrinkage type, n*—type of segregation develops when a microshrinkage develops during solidification, and is fed with residual liquid rich in dense alloying elements such as thorium. The area will show light on a radiograph (**Note 3**).

(2) *eutectic segregation—pipe-shrink type, n*—type of segregation develops during solidification when a pipe shrink forms and is immediately filled with eutectic liquid rich in high X-ray attenuation alloying elements. The area shows light on a radiograph as a feathery or dendritic feature (**Note 3**).

(3) *eutectic segregation—hot-tear type, n*—type of segregation develops during solidification when the hot tear that takes place is immediately filled with liquid rich in alloying elements high in X-ray attenuation. The defect shows as white or light irregular defined lines (**Note 3**).

(4) *eutectic depletion—flow line, n*—type of segregation develops when a section of a mold is filled by liquid and solidifies at the front before liquid from another feed meets the solid front. A portion of the solid front then partially melts; otherwise, the discontinuity would be a cold shut. Solidification begins after this remelt and the initial crystals are of high purity and contain fewer high-density alloying elements than the melt average. Since the metal is still flowing across these crystals, the composition ahead of this solidifying front is depleted. This depletion of the eutectic shows on the radiograph as a dark diffused line (**Note 3**).

(5) *oxide inclusions in magnesium alloys containing zirconium, n*—show on a radiograph as well defined light area of irregular shape and size resembling a radiograph of a compacted fine steel wool. It is composed of complex magnesium oxide film with high zirconium content, and, if present, rare earths and thorium oxides also. It is often associated with zirconium-rich particles.

³ Available from ASTM International Headquarters. Order Reference Radiograph No. **RRE015501**.

⁴ Available from ASTM International Headquarters. Order Reference Radiograph No. **RRE015502**.

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

⁶ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

⁷ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.