Designation: E2869 – 17

Standard Digital Reference Images for Magnesium Castings[1]

This standard is issued under the fixed designation E2869; 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 the types and degrees of discontinuities that may be found in magnesium-alloy castings. The castings illustrated are in thicknesses of ¼ in. (6 mm) and ¾ in. (19.1 mm).

1.2 All areas of this standard may be open 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.

1.3 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.

1.4 These digital reference images are not intended to illustrate the types and degrees of discontinuities found in magnesium-alloy castings when performing film radiography. If performing film radiography of magnesium-alloy castings, refer to Reference Radiographs E155.

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.

NOTE 1—The set of digital reference images consists of 14 digital files, software to load the desired format and specific instructions on the loading process. The 14 reference images illustrate eight grades of severity and contain an image of a step wedge and two duplex wire gauges.

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]

E155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings

E1316 Terminology for Nondestructive Examinations

E2002 Practice for Determining Total Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy

2.2 *SMPTE Practice*[3]

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

2.3 *ASTM Adjuncts*[4]

Digital Reference Images for Magnesium Castings

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 digital reference images are described based upon radiological appearance. (See Note 2.)

3.2.2 *aliasing*—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.

3.2.3 *contrast normalization*—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*—digital driving level also known as monitor pixel value.

[1] This standard 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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[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 Society of Motion Picture and Television Engineers, 3 Barker Avenue White Plains, NY 10601; or http://www.smpte.org/smpte_store/

[4] Available from ASTM International Headquarters. Order Adjunct No. RRE2869. Original adjunct produced in 2013.

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

3.2.5 *foreign materials*—appear as isolated, irregular, or elongated variations in brightness, not corresponding to variations in thickness of material, nor to cavities. They may be due to the presence of sand, slag, oxide or dross, or metal of different density.

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

3.2.7 *gas porosity*—represented by round or elongated dark spots in a negative image corresponding to minute voids usually distributed through the entire casting.

3.2.8 *measured resolution*—the characteristic resolution of a digital radiographic system as measured in accordance with 8.5.

3.2.9 *micro shrinkage (feathery type)*—micro shrinkage having an elongated appearance resembling feather-like streaks.

3.2.10 *micro shrinkage (sponge type)*—micro shrinkage having a sponge-like appearance, and more massive and equiaxed than the feathery type.

3.2.11 *reacted sand inclusions*—appear as "spotty segregation," which is, sharply defined round light areas (in a negative image) about 1 mm in diameter, and often with the rim lighter than the center. They are entrapped sand particles that underwent reaction with molten magnesium alloys containing zirconium (see Note 3).

3.2.12 *segregations*—appear as variations in image darkness, which can be explained by segregation of elements of atomic numbers different from that of the matrix.

3.2.12.1 *gravity segregation*—appears lighter in a negative image 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. They are agglomerations of particles precipitated at temperatures above liquidus (see Note 3).

3.2.12.2 *eutectic segregation*—type of segregation is 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 density. One exception to this enrichment as illustrated in the reference images is flow line (or eutectic depletion), where there is a local impoverishment of the alloying elements that have a high X-ray density (see Note 3).

a) eutectic segregation—micro shrinkage type—type of segregation develops when a micro shrinkage develops during solidification, and is fed with residual liquid rich in dense alloying elements such as thorium. The area will show light on a radiographic image (see Note 3).

b) eutectic segregation—pipe shrink type—type of segregation develops during solidification when a pipe shrink forms and is immediately filled with eutectic liquid rich in high X-ray density alloying elements. The area shows light in a negative image as a feathery or dendritic feature (see Note 3).

c) eutectic segregation—hot tear type—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 density. The defect shows as white or light irregular defined lines in a negative image (see Note 3).

d) eutectic depletion—flow line—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 in a negative image as a dark diffused line (see Note 3).

e) oxide inclusions in magnesium alloys containing zirconium—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.

3.2.13 *shrinkage cavity*—appears as a dendritic, filamentary, or jagged darkened area in a negative image.

3.2.14 *shrinkage porosity or sponge (nonferrous alloys)*—a localized lacy or honeycombed darkened area in a negative image.

3.2.15 *system resolution*—the detector-measured resolution divided by the geometric magnification.

NOTE 2—In the descriptions of terms above, references to darkness of the image refer to cases where the images are being reviewed in negative format such that the images appear similar to the way the images would appear on film (that is, air or lower density materials show dark while higher density materials show as a lighter shade of gray). Where images are reviewed in positive format, the terms light or dark or lighter or darker will need to be reversed.

NOTE 3—More detailed descriptions of these discontinuities can be found in the article referenced below[5].

4. Significance and Use

4.1 These digital reference images are intended for reference only, but are so designed that acceptance standards, which may be developed for particular requirements, can be specified in terms of these digital reference images. The illustrations are digital images prepared from castings that were produced under conditions designed to develop the discontinuities. The images of the ¼ in. (6.4 mm) castings are intended to be used in the thickness range up to and including ½ in. (12.7 mm). The images of the ¾ in. (19.1 mm) castings are intended to be used in the thickness range of over ½ in. (12.7 mm), up to and including 2 in. (50.8 mm).

4.2 *Image Deterioration*—Many conditions can affect the appearance and functionality of digital reference images. For example, electrical interference, hardware incompatibilities, and corrupted files or drivers may affect their appearance. The ASTM E2002 line pair gauges located in the lower right hand corner of each digital reference can be used as an aid to detect

[5] Lagowski, B.,"New Reference Radiographs for Magnesium Alloy Castings," *Journal of Testing and Evaluation,* Vol 2, No. 4, July 1974.