Designation: E186 – 98 (Reapproved 2004)ε1

Standard Reference Radiographs for Heavy-Walled (2 to 4½-in. [51 to 114-mm]) Steel Castings[1]

This standard is issued under the fixed designation E186; 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.

ε[1] NOTE—Editorial changes made throughout in January 2004.

1. Scope

1.1 These reference radiographs[2] for heavy-walled steel castings are applicable to nominal section thicknesses of 2 to 4½ in. [51 to 114 mm] and consists of three separate sets as follows:

1.1.1 Volume 1: 1–MV X Rays and Iridium 192 (called "1 to 2–Mev X rays" in previous editions)-Set of 28 plates (5 by 8 in. [127 by 203 mm] in a 15 by 17 in. [381 by 432 mm] ring binder).

1.1.2 Volume 2: 2–MV X Rays and Cobalt-60 (called "gamma rays" in previous editions). This includes cobalt-60 or equivalent isotope radiation and from 2–MV up to 4–MV X rays- Set of 28 plates (5 by 8 in.) in a 15 by 17 in. ring binder.

1.1.3 Volume 3: 4–MV to 30–MV X rays (called "10 to 24 Mev X rays" in previous editions)- Set of 28 plates (5 by 8 in.) in a 15 by 17 in. ring binder.

1.1.4 Each set consists of three categories of graded discontinuities in increasing severity levels, and three categories of ungraded discontinuities furnished as examples only, as follows:

1.1.4.1 *Category A*—Gas porosity; severity levels 1 through 5.

1.1.4.2 *Category B*—Sand and slag inclusions; severity levels 1 through 5.

1.1.4.3 *Category C*—Shrinkage; three types:

(1) Type 1— Severity levels 1 through 5.

(2) Type 2— Severity levels 1 through 5.

(3) Type 3— Severity levels 1 through 5.

1.1.4.4 *Category D*—Crack; one illustration D3 in pre-1972 documents.

1.1.4.5 *Category E*—Hot tear; one illustration in pre-1972 documents.

1.1.4.6 *Category F*—Insert; one illustration EB3 in pre-1972 documents.

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

1.3 *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:*[3]

E94 Guide for Radiographic Examination

E1316 Terminology for Nondestructive Examinations

2.2 *ASTM Adjuncts:*[4]

Reference Radiographs for Heavy-Walled (2 to 4½-in. [51 to 114-mm]) Steel Castings:

Volume I, 1-MV X Rays and Iridium-192[5]

Volume II, 2-MV X Rays and Cobalt-60[6]

Volume III, 4-MV to 30-MV X Rays[7]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this document, see Terminology E1316, Section D.

4. Significance and Use

4.1 These reference radiographs are reproductions of original radiographs and are supplied as a means for establishing the

[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.

Current edition approved January 1, 2004. Published February 2004. Originally approved in 1962. Last previous edition approved in 1998 as E186 - 98. DOI: 10.1520/E0186-98R04E01.

[2] For ASME Boiler and Pressure Vessel Code applications see related Reference Radiographs SE 186 in Section V of that Code.

[3] 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.

[4] Available from ASTM Headquarters.

[5] Order RRE018601.

[6] Order RRE018602.

[7] Order RRE018603.

categories and severity levels of discontinuities in steel castings that may be revealed by radiographic examination. They may be used in accordance with contractual specifications.

4.2 Radiographs for evaluation are to be compared with these reference radiographs for classification on the basis of the category and severity level of the discontinuity.

4.3 The use of this document is not intended to 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.

5. Method of Preparation

5.1 The original radiographs used to prepare the accompanying reference radiographs were produced on high contrast, fine grain film by the respective use of radiation energies stated in 1.1.1 to 1.1.3. The radiographs were made with a penetrameter sensitivity as determined by ASTM penetrameters (see Guide E94) of 2-2T. The reproductions have been prepared to an optical density of 2.00 to 2.25 and they have retained substantially the contrast of the original radiographs.

5.2 *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.

6. Determination of Radiographic Classification

6.1 For purposes of evaluation of castings, a determination must be made of the radiographic classification to be assigned to individual castings or specific areas of castings. The determination of the applicable radiographic classification shall be based on an evaluation of the casting applications, design, and service requirements. In these evaluations, consideration shall be given to such factors as pressure, temperature, section thickness, applicable design safety factor, vibration, shock, resistance to corrosion, involvement of penetrating radiations or radiation products, and involvement of dangerous gases or liquids.

7. Classification Specifications

7.1 The applicable radiographic severity classification should be designated by the contracting agency in formal specifications or drawings and in the specific contract or order. The specifications, drawings, contract, or order should also designate the sampling plan for the castings to be radiographed and the extent of radiographic coverage, as well as the classification or level of acceptable discontinuity.

8. Procedure for Evaluation

8.1 Compare the production radiographs of the casting submitted for evaluation with the reference radiographs of similar thickness that were exposed at an equivalent energy range.

8.2 When the severity level of discontinuities in the production radiograph being evaluated is equal to or better than the severity level in the specified reference radiograph, that part of the casting represented by the production radiograph shall be acceptable. If the production radiograph shows discontinuities of greater severity than the reference radiograph, that part of the casting shall be rejected.

8.3 An area of like size to the reference radiograph shall be the unit area by which the production radiograph is evaluated, and any such area or any area that shares a discontinuity with an adjacent film area shall meet the requirements as defined for acceptability. When the area of interest of a production radiograph is less than the unit area, such area of interest shall be prorated to the reference radiographic area.

8.4 When two or more categories of discontinuity are present in the same production radiograph, the predominating discontinuities, if unacceptable, shall govern without regard to the other categories of discontinuities, and the casting rejected until satisfactorily repaired.

8.5 When two or more categories of discontinuity are present to an extent equal to the maximum permissible level as shown in the pertinent standards for each category, then that part of the casting shall be judged unacceptable until satisfactorily repaired.

8.6 Reference radiographs are provided showing a variety of forms of shrinkage cavities. Production radiographs showing shrinkage shall be judged by the most representative reference radiograph.

8.7 Production radiographs showing porosity, gas, or inclusions shall be evaluated by the overall condition with regard to size, number, and distribution. The aggregate size of discontinuities shall not exceed the total accumulation in area of the discontinuities of the reference radiograph. It is not the intent that the maximum size of the illustrated discontinuity shall be the limiting size for a single production radiographic discontinuity, or that the number of discontinuities shown on the reference radiograph shall be the limiting number of production radiographs. Also, caution should be exercised in judging a large discontinuity against a collection of small discontinuities on the basis of size alone. Each of the factors of size, number, and distribution must be considered in balance.

8.8 Reference radiographs in this standard do not illustrate elongated or "worm hole" type of gas discontinuities. When this condition occurs in a production radiograph, it shall be evaluated by comparison with the most representative reference radiograph.

8.8.1 When the source has been placed perpendicular to the length of the gas hole, evaluate the production radiograph with a shrinkage reference radiograph.

8.8.2 When the source has been placed diametrically or" into" the diameter of the gas hole, evaluate the production radiograph with a gas reference radiograph.