



Designation: E390-01 (Reapproved 2006)^{ε1} Designation: E390 – 11

Standard Reference Radiographs for Steel Fusion Welds¹

This standard is issued under the fixed designation E390; 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.

^{ε1}Note—A sentence about reference radiograph films was editorially added to 1.1 in February 2006.

1. Scope

1.1 This standard provides reference radiographs for steel fusion welds that contain typical discontinuities with varying severity levels in different thicknesses of material. The reference radiograph films are an adjunct to this standard and must be purchased separately from ASTM International if needed.

1.2 There are three volumes of reference radiographs based on seven nominal weld thicknesses as follows:

Vol I—Set of 16 plates (8½ by 11 in.) covering base material up to and including ¼ in. (6.4 mm) in thickness.

Vol II—Set of 29 plates (8½ by 11 in.) covering base material over ¼ to and including 3 in. (6.4 to 76 mm) in thickness.

Vol III—Set of 32 plates (8½ by 11 in.) covering base material over 3 to including 8 in. (76 to 203 mm) in thickness.

1.3 The values stated in inch-pound units are to be regarded as the 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 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:²

E94 Guide for Radiographic Examination

E1316 Terminology for Nondestructive Examinations² E1316 Terminology for Nondestructive Examinations

2.2 ASTM Adjuncts:³

Reference Radiographs for Steel Fusion Welds:

Volume I, Thickness Up to and Including ¼ in. (6.4 mm) in. (6.4 mm)⁴

Volume II, Thickness Over ¼ to 3 in. (6.4 to 76 mm) in. (6.4 to 76 mm), incl⁵

Volume III, Thickness Over 3 to 8 in. (76 to 203 mm) in. (76 to 203 mm), incl⁶

3. Terminology

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

3.2 The terms relating to discontinuities present in these reference radiographs are described based upon radiographic appearance. The terms “darker” and “lighter” as used in this standard refer to the optical density of a radiographic film. Where other

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 Radiographs.

Current edition approved Feb. 1, 2006. Published February 2006. Originally approved in 1969. Last previous edition approved in 2001 as E390-01. DOI: 10.1520/E0390-01R06E01 on Reference Radiological Images.

Current edition approved Aug. 1, 2011. Published August 2011. Originally approved in 1969. Last previous edition approved in 2006 as E390-01(2006). DOI: 10.1520/E0390-11.

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 ASTM Headquarters.

⁴ Order RRE039001.

⁵ Order RRE039002.

⁶ Order RRE039003.

radiographic media are used, these terms should be understood to refer to areas of greater or lesser radiologic transmission, respectively.

4. Significance and Use

4.1 These reference radiographs may be used as a means for establishing the types and severity levels of discontinuities that are revealed by radiographic examination of steel fusion welds.

4.2 Each volume contains illustrations of representative graded and ungraded discontinuities applicable to seven thickness ranges, as shown in Table 1. Table 2 lists the discontinuity types and severities illustrated for each thickness of base material. Each of the graded discontinuity types has five severity levels, 1 through 5 in order of increasing severity. The ungraded discontinuities are included for informational purposes.

4.3 These reference radiographs may be used in contractual specifications, for which agreement has been reached between purchaser and supplier, to establish acceptance limits of the types and severity levels of discontinuities revealed by radiographic examination.

4.4 The use of this document is not intended to be restricted to the specific energy levels given in Table 3 or to the thickness limits given in Table 1. This 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. Preparation of Reference Radiographs

5.1 The illustration in Vol I and the first two thicknesses of Vol II are radiographic while those in the thick section of Vol II (2 in.) and Vol III are photographic reproductions.

5.2 The radiographs were made to a quality level of at least 2-2T penetrameter sensitivity.

5.3 Table 3 lists the technique used in producing the original radiographs. The data are included for information and are not to be construed as the recommended technique.

5.4 The radiographic exposure was controlled so as to produce an optical density of from 2.00 to 2.25 in a selected location on the weld bead. The reproductions used in Vol III were prepared to the same density requirements and they substantially retain the contrast and detail of the original radiographs.

6. Description of Discontinuities

6.1 *Porosity* occurs as voids caused by gas trapped in the weld metal deposit. The voids may occur as spherical, elongated, or “worm hole” shapes and in patterns that are random, clustered, or linear. On a radiograph the spherical voids have the appearance of a rounded dark area while the nonspherical voids have an elongated dark area with a smooth outline.

6.2 *Tungsten Inclusions* are tungsten particles entrapped in the weld deposit. These inclusions are particles broken off or melted from the electrodes and may be caused by faulty equipment or poor manipulation. On the radiograph the tungsten inclusions are lighter than the surrounding areas and may be rounded or irregularly shaped.

6.3 *Incomplete Penetration* is a discontinuity that occurs at the root of welds designed for through penetration where full penetration has not been achieved. The discontinuity appears on a radiograph as a straight dark line that may be either continuous or intermittent. The indication may be thin and sharp, broad and diffuse or two parallel lines depending upon the specific geometry of the joint and the width of the discontinuity.

TABLE 1 Applicable Thickness Ranges

Illustration Thickness, in.† (mm)‡	Base Material Thickness Range, in.† (min)‡m) ^A
Vol I	
0.030 (0.8)	to and including 0.050 (3.3)
0.030 (0.8)	to and including 0.050 (1.2)
0.080 (2.0)	over 0.050 (1.3) to and including 1/8 (3.2)
0.080 (2.0)	over 0.050 (1.2) to and including 1/8 (3.2)
3/16 (4.8)	over 1/8 (3.2) to and including 1/4 (6.4)
3/16 (4.8)	over 1/8 (3.2) to and including 1/4 (6.4)
Vol II	
3/8 (9.5)	over 1/4 (6.4) to and including 1/2 (13)
3/8 (9.5)	over 1/4 (6.4) to and including 1/2 (13)
3/4 (19)	over 1/2 (13) to and including 1 1/2 (48)
3/4 (19)	over 1/2 (13) to and including 1 1/2 (38)
2 (51)	over 1 1/2 (48) to and including 3 (76)
2 (51)	over 1 1/2 (38) to and including 3 (76)
Vol III	
5 (127)	over 3.0 (75) to and including 8 (203)
5 (127)	over 3.0 (76) to and including 8 (203)

^A In the special cases of joining two members of unequal thickness, the standard applicable to the thinner member shall be used.