

FED. SUPPLY CLASS

1.0 SCOPE

This specification defines and establishes the allowable limits for discontinuities in fusion welded joints as determined by radiographic inspection. The specification is applicable to fusion welds in all materials .001 inches to 8.0 inches thick.

2.0 REFERENCED SPECIFICATIONS AND DOCUMENTS

2.1 The following Specifications form a part of this standard.

- ③ ASTM E1742/E1742M Standard Practice for Radiographic Examination
AWS A3.0M/A3.0 Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying

3.0 REQUIREMENTS

3.1 Weld Classification. The distinction between classes is based upon a measurable allowable quantity for each type of discontinuity for each class of weld. In general, five (5) classes of welds having gradations of soundness from Class I with the fewest discontinuities to Class V with the greatest amount of discontinuities are defined as follows:

- Class I – Highest weld quality practical to produce in production. (It is anticipated that this weld be produced by mechanized means but not restricted to this method.)
- Class II – An intermediate weld quality between Class I and Class III.
- Class III – A weld quality capable of being consistently produced manually by a competent qualified welding operator knowing the requirements and provided with the necessary equipment, fixtures, materials, etc.
- Class IV – An intermediate weld quality between Class III and Class V.
- Class V – Lowest weld quality for which use of radiographic inspection is normally justified.

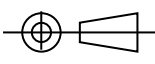
The designation of the required weld classification shall be used to indicate the standard of soundness required in each area to be inspected radiographically.

3.2 Determination of Acceptability

3.2.1 Single Type Discontinuity. When the radiograph shows but one type of discontinuity and the discontinuity is equal to or of less magnitude than the applicable class, the weldment or increment thereof shall be considered acceptable.

3.2.2 More than One Type of Discontinuity. When the radiograph shows more than one type of discontinuity, the following procedure shall be used in determining acceptability.

3.2.2.1 Governing External Discontinuity. When one type of external discontinuity predominates and the other types are equal to or of less magnitude than an acceptable condition for the applicable standard, the predominating discontinuity shall govern without regard to the other types of discontinuities present.

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- 3.2.2.2 No Governing Discontinuities. When all discontinuities are within the applicable class, the weldment or increment thereof shall be considered acceptable.
- 3.2.3 Internal Discontinuities. All internal discontinuities whether located by themselves or in combination with other types of discontinuities shall be considered as defined in Section 4.1.
- 3.2.4 Measurement of Discontinuity Limits. Determination of the magnitude of a discontinuity or group of discontinuities in the overall weld being radiographed shall be based upon the value obtained when any weld area having the largest discontinuity or concentration of discontinuities is evaluated.

4.0 QUALITY ASSURANCE PROVISION

4.1 Internal Discontinuities

- 4.1.1 Individual Internal Discontinuities. The allowable limits for individual discontinuities are given in Table II.
- 4.1.2 Total Internal Discontinuities. The allowable limits for total (all) internal discontinuities which occur in any linear one (1) inch of weld are given in Table III. Two (2) or more adjacent discontinuities, other than aligned (see Item 5.5) shall be treated as one discontinuity (including the space between) when the spacing between them is less than one-half (1/2) the longest dimension of the smaller adjacent discontinuity. Porosity less than Ø.005 inches or Ø("T"/10), whichever is the smaller, and over one-half (1/2) the longest dimension apart shall not be considered.
- 4.1.3 Aligned Internal Discontinuities. The allowable limits for aligned internal discontinuities which occur in any linear one (1) inch of weld are given in Table III. Porosity less than Ø.005 inches or Ø("T"/10), whichever is the smaller, and over one-half (1/2) the longest dimension apart shall not be considered.

4.2 External Surface Discontinuities

- 4.2.1 Incomplete penetration. The allowable limits for voids in the penetration zone are given in Table IV.
- 4.2.2 Weld Interface Imperfect Fusion. The allowable limits for lack of fusion between any weld bead or weld bead base metal interface are given in Table IV.
- 4.2.3 Undercutting. Allowable limits for undercutting are given in Table V.
- 4.2.4 Weld Metal Thinning. Allowable limits for weld metal thinning are given in Table VI.
- 4.2.5 Cold Shut. This type of discontinuity extending below the original surface of the base metal shall be considered in the same category as cracks. Cold shuts which do not extend below the original surface of the base metal shall be considered in the same category as lack of fusion.
- 4.2.6 Underbead Concavity. Allowable limits for underbead concavities are given in Table V.
- 4.2.7 Weld Overlap. Allowable limits for weld overlap are given in Table VII.

5.0 DEFINITIONS

- 5.1 Individual Discontinuity. Any single discontinuity regardless of location or orientation with respect to other discontinuities.
- 5.2 Internal Discontinuity. Any discontinuity (porosity and inclusion – metallic or nonmetallic) occurring entirely within the weld metal or immediately adjacent base metal. May appear in the radiograph as regular or irregular shaped areas of varying density. Can occur singularly, scattered or aligned.
- 5.3 External Discontinuity. Any discontinuity occurring totally or in part at the surface of the weld area.

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- 5.4 Total Internal Discontinuities. All porosity and inclusions (metallic, nonmetallic, isolated, scattered and aligned) which occur within a specified length of weld.
- 5.5 Aligned Internal Discontinuities. Any group of five (5) or more individual discontinuities within a specified weld length whose radiographic images (any part) are intersected by a straight line (regardless of orientation within the weld) and the distance between adjacent discontinuities of the group being considered is less than four (4) times the longest dimensions of the smaller adjacent discontinuity.
- 5.6 Internal Discontinuity Diameter "ØD". Longest dimension of the radiographic image of the discontinuity.
- 5.7 Internal Discontinuity Area "A". Calculated as $\pi \text{ØD}^2/4$ based upon the radiographic image of the discontinuity. The areas for representative circle diameters are given in Table VIII.
- 5.8 Porosity. Minute gas holes or voids in the weld metal or in the base metal heat-affected zone immediately adjacent to the fusion line.
- 5.9 Crack. A fissure-like rupture without complete separation of the metal. Appears in the radiograph as generally irregular lines of varying density and in any orientation with respect to the weld area. They can appear singly and be continuous throughout their length or can be of variable length or width and with numerous branches. The sharpest image is obtained when the source of radiation is directly parallel to the plane in which the crack lies.
- 5.10 Incomplete Penetration (Voids in Penetration Zone). An area at the root of the weld joint which did not melt and subsequently fuse together. Appears in the radiograph as a straight dark line of varied length and width coincident with the root of the joint.
- 5.11 Weld Interface Imperfect Fusion (Lack of Fusion). An area between successive weld beads or between the weld metal and the base metal which did not fuse together. Appears in the radiograph as a dark zone of varying length, width and continuity. Occurs at the weld bead interfaces or between the weld metal and the base metal.
- 5.12 Undercut. A groove melted into the base metal adjacent to the toe of the weld and left unfilled by weld metal. Appears in the radiograph as a dark area or band of varying length and width adjacent to the toe of the weld.
- 5.13 Weld Metal Thinning. A reduction in the thickness of the weld metal at the face or underbead of the weld. Appears in the radiograph as a dark band or area of varied density located generally at the edge of the weld metal, but can occur along the longitudinal axis of the weld.
- 5.14 Cold Shut. Lack of coalescence in the weld underbead which extends for varying depths into the weld metal. Appears in the radiograph as a distinct dark line in the weld metal and may occur in any direction.
- 5.15 Underbead Concavity. An intermittent recessed area below the original surface of the base metal at the toe of the underbead or within the underbead itself. Appears in the radiograph as an irregular dark band or area of varied density located generally along the longitudinal axis of the weld.
- 5.16 Weld Overlap. A protrusion of the weld metal beyond the limits of fusion at the toe of the weld.
- 5.17 Base Metal Thickness "T". Nominal thickness of the thinnest base metal immediately adjacent to the fusion weld at the time the radiograph is taken.

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