

QUALIFICATION TEST ACCEPTANCE CRITERIA

- A. Visually inspect the welded coupon in accordance with the weld procedure used to make the test.
- B. ASME Section IX Destructive Test:
1. The weld and heat affected zone shall be completely within the bent portion of the specimen after bending.
 2. No open defects in the weld or heat affected zone exceeding $\frac{1}{8}$ in. measured in any direction on the convex surface of the specimen after bending shall be permitted.
 3. Cracks occurring on the corners of the specimens during bending shall not be considered unless there is definite evidence that they result from slag inclusions or other internal defects.
- C. ASME Section IX Radiographic Examination:
1. No type of crack or zone of incomplete fusion or penetration shall be permitted.
 2. No elongated slag inclusion that has a length greater than the following restrictions shall be permitted:
 - $\frac{1}{8}$ in. (3 mm) for thicknesses up to $\frac{3}{8}$ in. (10 mm), inclusive.
 - $\frac{1}{3}$ rd of the thickness for thicknesses over $\frac{3}{8}$ in. (10 mm) to $2\frac{1}{4}$ in. (56 mm), inclusive.
 - $\frac{3}{4}$ in. (19 mm) for thicknesses over $2\frac{1}{4}$ in. (56 mm).
 3. No groups of slag inclusions in a line that have an aggregate length greater than the thickness, in a length of 12x the thickness, except when the distance between the successive imperfections exceed 6x the longest imperfection in the group, shall be permitted.
 4. The maximum permissible dimension for rounded indications shall be the lesser of 20% of the thickness or $\frac{1}{8}$ in. (3 mm).
 5. For welds in material less than $\frac{1}{8}$ in. (3 mm) in thickness, the maximum number of acceptable rounded indications shall not exceed 12 in a 6 in. (150 mm) length of weld. A proportionately fewer number of rounded indications shall be permitted in welds less than 6 in. (150 mm) in length.
 6. For welds in material $\frac{1}{8}$ in. (3 mm) and greater in thickness, Attachment 11 represents the maximum acceptable types of rounded indications illustrated in typically clustered, assorted, and randomly dispersed configurations. Rounded indications less than $\frac{1}{32}$ in. (0.8 mm) in maximum diameter shall not be considered relevant in this range of material thickness.
- D. AWS D1.1 Destructive Test:
1. The weld and heat affected zone shall be completely within the bent portion of the specimen after bending.
 2. The convex surface of the bend test specimen shall contain no discontinuities (defects) exceeding the following dimensions:
 - $\frac{1}{8}$ in. (3 mm) measured in any direction on the surface.
 - $\frac{3}{8}$ in. (10 mm) for the sum of the greatest dimensions at all discontinuities exceeding $\frac{1}{32}$ in. (0.8 mm), but less than or equal to $\frac{1}{8}$ in. (3 mm), i.e. no more than three $\frac{1}{8}$ in. (3 mm) defects allowed in each bend strap.

- $\frac{1}{4}$ in. (6 mm) maximum corner crack; except when the corner crack resulted from visible slag inclusions or other fusion type discontinuities, then the $\frac{1}{8}$ in. maximum shall apply. Specimens with corner cracks exceeding $\frac{1}{4}$ in. (6 mm) with no evidence of slag inclusions or other fusion type discontinuities may be disregarded, and a replacement test specimen from the original weldment shall be tested.

E. AWS D1.1 Radiographic Test:

1. No cracks shall be permitted.
2. The greatest dimension of any porosity or fusion-type discontinuity that is $\frac{1}{16}$ in. (1.5 mm) or larger in greatest dimension shall not exceed "B" indicated in Attachment 12 for the effective weld size involved.
3. The distance from any porosity or fusion-type discontinuity, described in section 5.4.5(b), to each other or to the edge of the weld shall not be less than the minimum clearance allowed by "C" indicated in Attachment 11.
4. Discontinuities having the greatest dimension of less than $\frac{1}{16}$ in. (1.5 mm) shall be unacceptable if the sum of their greatest dimensions exceeds $\frac{3}{8}$ in. (10 mm) in any linear inch (25 mm) of weld.
5. Attachment 11 illustrates the application of the requirements given above.

F. ASME IX Hard Facing Weld Metal Overlay:

1. The surface of the hard facing, after surface conditioning for Liquid Penetrant (LP) inspection, shall be a minimum of 1 in. (25 mm) wide and 4 in. (100 mm) long and of a minimum thickness specified on the Welding Technique Sheet.
2. The surface shall be examined by LP. Indications whose major dimensions are greater than $\frac{1}{16}$ in. (1.5 mm) shall be considered relevant. The following relevant indications are unacceptable:
 - Cracks or linear indications.
 - Rounded indications with dimensions $>\frac{1}{16}$ in. (1.5 mm).
 - Four or more rounded indications in a line separated by $\frac{1}{16}$ in. (1.5 mm) or less edge to edge.
 - Ten or more rounded indications in any 6 sq. in. (37.5 sq. cm) of surface with the major dimension of this area not to exceed 6 in. (150 mm) with the area taken in the most unfavorable location relative to the indications being evaluated.
3. Following the acceptable LP examination, the specimen shall be sectioned transversely to the direction of the hard facing weld metal overlay. The two faces of the hard facing exposed by sectioning shall be polished and etched with a solution consisting of 4 grams of CuSO₄, 20 milliliters of distilled water, and 20 milliliters of concentrated HCl. The etched surfaces shall be examined with a 5x magnification for cracks in the base metal or heat affected zone, for lack of fusion, or for other linear defects.

G. ASME IX Corrosion-Resistant Weld Metal Overlay:

1. The surface of the weld metal overlay shall be conditioned for LP examination. The weld metal overlay surface shall be examined by LP inspection and considered unacceptable when any of the following limits are exceeded:
 - Relevant linear indications.
 - Relevant rounded indications greater than $\frac{3}{16}$ in. (5 mm).

- Four or more relevant rounded indications in a line separated by $\frac{1}{16}$ in. (1.5 mm) or less, edge-to-edge.
2. The following definition of indications shall be utilized:
 - Relevant Indications - Indications with major dimensions greater than $\frac{1}{16}$ in. (1.5 mm).
 - Linear Indications - An indication having a length greater than 3x the width.
 - Rounded Indications - An indication of circular or elliptical shape with the length equal to or less than 3x the width.

H. API 1104 Visual Examination:

1. The weld shall be free from cracks, incomplete penetration, and burn-through, and must present a neat, workman-like appearance. The depth of undercut adjacent to the final bead on the outside of the pipe shall not be more than $\frac{1}{32}$ in. (0.8 mm) or 12.5% of the pipe wall thickness, whichever is smaller, and there shall not be more than 2 in. (50 mm) of undercut in any continuous 12 in. (300 mm) length of weld. When semiautomatic or automatic welding is used, filler wire protruding into the inside of the pipe shall be kept to a minimum.

I. API 1104 Destructive Test:

1. Tensile Tests – The tensile strength of butt welds, including the fusion zone, shall be greater than or equal to the specified minimum tensile strength of the pipe material. Specimens that break in the base material and meet the specified minimum tensile strength are acceptable. Specimens that break in the weld or fusion zone and meet the specified minimum tensile strength are acceptable if they meet the requirements of Section 5.4.I(2).
2. Nick Break Tests - Specimens for butt welds shall show complete penetration and fusion. The greatest dimension of any porosity shall not exceed $\frac{1}{16}$ in. (1.6 mm) and combined area of all porosity shall not exceed 2% of the exposed surface area. Slag inclusions shall not be more than $\frac{1}{32}$ in. (0.8 mm) in depth and shall not be more than $\frac{1}{8}$ in. (3 mm) or more than $\frac{1}{2}$ the nominal wall thickness in length, whichever is less. There shall be at least $\frac{1}{2}$ in. (13 mm) separation between adjacent slag inclusions. Fisheyes are not cause for rejection.
3. Bend Tests - Specimens (i.e. side, face, root) for butt welds shall be acceptable if no cracks or other imperfection exceeding $\frac{1}{8}$ in. (3 mm) or $\frac{1}{2}$ the nominal wall thickness, whichever is less, in any direction are present in the weld or between the weld and the fusion zone after bending. Cracks that originate on the outer radius of the bend along the edges of the specimen during testing that are less than $\frac{1}{4}$ in. (6 mm), measured in any direction, shall not be considered unless an obvious imperfection.

J. API 1104 Radiographic Test:

1. Butt welds may be examined by radiography in lieu of destructive testing. Radiographic examination shall not be used to locate sound areas or areas that contain imperfections for the purpose of making tests of such areas to qualify or disqualify a welder.
2. Inadequate Penetration (IP) without high-low (i.e. fit-up misalignment) shall be considered a defect when the length of any individual indication exceeds 1 in. (25 mm), the aggregate length of indications in any continuous 12 in. (300 mm) length of weld exceeds 1 in. (25 mm), or the aggregate length of indications exceeds 8% of the weld length in any weld less than 12 in. (300 mm).

- IP due to high-low shall be considered a defect when the length of any individual indication exceeds 2 in. (50 mm) or the aggregate length of indications in any continuous 12 in. (300 mm) length of weld exceeds 3 in. (75 mm).
3. Inadequate cross penetration shall be considered a defect when the length of any individual indication exceeds 2 in. (50 mm) or the aggregate length of indications in any continuous 12 in. (300 mm) length of weld exceeds 2 in. (50 mm).
 4. Incomplete Fusion (IF) shall be considered a defect when the length of any individual indication exceeds 1 in. (25 mm), the aggregate length of indications in any continuous 12 in. (300 mm) length of weld exceeds 1 in. (25 mm), or the aggregate length of indications exceeds 8% of the weld length in any weld less than 12 in. (300 mm).
 - IF due to cold lap shall be considered a defect when the length of any individual indication exceeds 2 in. (50 mm), the aggregate length of indications in any continuous 12 in. (300 mm) length of weld exceeds 2 in. (50 mm), or the aggregate length of indications exceeds 8% of the weld length.
 5. Any length of internal concavity is acceptable provided the density of the radiographic image of the internal cavity does not exceed that of the thinnest adjacent parent material. For areas that exceed the density of the thinnest adjacent parent material, the criteria of section 5.4.J(8) shall apply.
 6. Burn-through shall be considered a defect for pipe with an $OD \geq 2 \frac{3}{8}$ in. (60.3 mm) when:
 - The maximum dimension exceeds $\frac{1}{4}$ in. (6 mm) and the density of the image exceeds that of the thinnest adjacent parent material.
 - The maximum dimension exceeds the thinner of the nominal wall thicknesses joined, and the density of the image exceeds that of the thinnest adjacent parent material.
 - The sum of the maximum dimensions of separate indications whose image density exceeds that of the thinnest adjacent parent material exceeds $\frac{1}{2}$ in. (13 mm) in any continuous 12 in. (300 mm) length of weld or the total length, whichever is less.
 7. Burn-through shall be considered a defect for pipe with an $OD < 2 \frac{3}{8}$ in. (60.3 mm) when:
 - The maximum dimension exceeds $\frac{1}{4}$ in. (6 mm) and the density of the image exceeds that of the thinnest adjacent parent material.
 - The maximum dimension exceeds the thinner of the nominal wall thicknesses joined, and the density of the image exceeds that of the thinnest adjacent parent material.
 - More than one indication of any size is present and the density of more than one of the images exceeds that of the thinnest adjacent parent material.
 8. Slag Inclusion (SI) shall be considered a defect for pipe with an $OD \geq 2 \frac{3}{8}$ in. (60.3 mm) when:
 - The length of an elongated SI exceeds 2 in. (50 mm).
 - The aggregate length of elongated SI in any continuous 12 in. (300 mm) length of weld exceeds 2 in. (50 mm).
 - The width of an elongated SI exceeds $\frac{1}{16}$ in. (1.6 mm).
 - The aggregate length of isolated SI in any continuous 12 in. (300 mm) length of weld exceeds $\frac{1}{2}$ in. (13 mm).
 - The width of an isolated SI exceeds $\frac{1}{8}$ in. (3 mm).
 - More than 4 isolated SI with the maximum width of $\frac{1}{8}$ in. (3 mm) are present in any continuous 12 in. (300 mm) length of weld.
 - The aggregate length of elongated and isolated SI indications exceeds 8% of the weld length.

9. SI shall be considered a defect for pipe with an OD $2 \frac{3}{8}$ in. (60.3 mm) when:
 - The length of elongated SI exceeds 3x the thinner of the nominal wall thicknesses joined.
 - The width of an elongated SI exceeds $\frac{1}{16}$ in. (1.6 mm).
 - The aggregate length of isolated SI exceeds 2x the thinner of the nominal wall thicknesses joined and the width exceeds $\frac{1}{2}$ the thinner of the nominal wall thicknesses joined.
 - The aggregate length of elongated and isolate SI exceeds 8% of the weld length
10. Individual porosity shall be considered a defect when the size of an individual pore exceeds $\frac{1}{8}$ in. (3 mm) or 25% of the thinner of the nominal wall thicknesses joined. The distribution of scattered porosity shall be considered a defect when exceeding the concentration permitted by Reference 2.3. Cluster porosity shall comply with requirements for individual and scattered porosity, except when occurring in the finish weld pass. Cluster porosity in the finish weld pass shall be considered a defect when the diameter of the cluster exceeds $\frac{1}{2}$ in. (13 mm), the aggregate length of the cluster porosity in any continuous 12 in. (300 mm) length of weld exceeds $\frac{1}{2}$ in. (13 mm), or an individual pore within the cluster exceeds $\frac{1}{16}$ in. (2 mm).
11. Cracks (except shallow crater cracks or star cracks) of any size or location in the weld shall be considered a defect. A shallow crater crack or star crack shall be considered a defect when the length exceeds $\frac{5}{32}$ in. (4 mm).
12. Undercut shall be considered a defect when the aggregate length of indications (cover pass and root pass, in any combination) in any continuous 12 in. (300 mm) length of weld exceeds 2 in. (50 mm) or the aggregate length of indications in any combination exceeds 1/6th of the weld length.
13. Any accumulation of imperfections (excluding incomplete penetration due to high low and undercut) shall be considered a defect when the aggregate length of indications in any 12 in. (300 mm) length of weld exceeds 2 in. (50 mm) or the aggregate length of indications exceeds 8% of the weld length.
14. Pipe or fitting imperfections detected by radiography shall not be a consideration in qualification of welders.

K. Sheet Metal Qualification:

1. Test plates as illustrated in Attachment 5, AWS D9.1 Test Positions, shall be visually examined (without aid of magnification) for the following:
 - complete joint fusion
 - partial joint penetration in a butt joint, i.e. welded from one side, is sufficient for visual examination
 - a maximum of $\frac{1}{8}$ in. (3 mm) face reinforcement and $\frac{1}{8}$ in. (3 mm) root reinforcement for butt weld joints
 - not more than one visible pore or slag inclusion per inch (25 mm) of weld that is larger than $0.25t$, where t is the base metal thickness

L. Braze Weld Specimens:

1. In lieu of the section or peel specimens, destructive testing may be accomplished by cross sectioning through the coupon midway of the lap distance of the coupling to expose the junction of the tube and coupling for 360°. A chisel may then be used to drive between the inside diameter of the coupling and outside diameter of the tube to expose the joint interface.

2. The joint may be judged acceptable if the joint cannot be peeled for the full 360°, or if peeled, the faying surfaces total area of defects (unbrazed areas) does not exceed 25% of the total area of any individual faying surface, or the sum of the lengths of defects measured on any one line in the direction of the lap does not exceed 25% of the lap.
3. In no case shall the defect extend continuously from one edge of the joint to the other edge, regardless of the direction of the defect.