IWA-4610  GENERAL REQUIREMENTS FOR TEMPER BEAD WELDING

(a) The area to be welded shall be preheated and maintained as specified in IWA-4620, IWA-4630, IWA-4640, IWA-4670, or IWA-4680, as applicable. Except as permitted by IWA-4672(c), thermocouples and recording instruments shall be used to monitor the process temperatures. Their attachment and removal shall be in accordance with Section III.

(b) The welding procedure and the welders or welding operators shall be qualified in accordance with Section IX and the additional requirements of this Subarticle.

(1) Procedure Qualification

(a) The test assembly material for the welding procedure qualification test shall be of the same P-Number and Group Number. Prior simulated postweld heat treatment on the qualification test assembly is neither required nor prohibited. However, if used, the simulated postweld heat treatment shall not exceed the time or temperature already applied to the base material to be welded.

(b) Consideration shall be given to the effects of welding in a pressurized environment. If they exist, they shall be bounded in the test assembly within the limits of Table IWA-4662.1-1.

(c) Consideration shall be given to the effects of irradiation on the properties of material, including weld material for applications in the core belt line region of the reactor vessel. Special material requirements in the Design Specification shall also apply to the test assembly materials for these applications.

(d) If qualifying ambient temperature temper bead procedures of IWA-4670 or IWA-4680, the maximum interpass temperature for the first three layers of the procedure qualification test assembly shall be 150°F (66°C).

(e) Temper bead welding procedures used in IWA-4620, IWA-4630, IWA-4640, IWA-4670, or IWA-4680 shall be qualified in accordance with Section IX, QW-290. For clad procedures, the impact test essential variables of Section IX, QW-290.4 shall apply; however, impact qualification testing and hardness testing of the procedure qualification test assembly are not required. For all other procedures, the impact test essential variables of Section IX, QW-290.4 shall apply, and the following impact test requirements for the procedure qualification shall be met:

(1) The test assembly base material for the welding procedure qualification shall meet the impact test requirements of the Construction Code and Owner’s Requirements. If such requirements are not in the Construction Code and Owner’s Requirements, the impact properties shall be determined by Charpy V-notch impact tests of the procedure qualification base material at or below the lowest service temperature of the item to be repaired. For all qualification tests, the base metal Charpy V-notch specimens shall be taken from approximately the same depth as the HAZ specimens and should be aligned in the same manner as the HAZ specimens. The location and orientation of the test specimens shall be as specified in (3) below but shall be in the base metal. Impact testing of austenitic materials (nickel-based P-No. 4X and stainless steel P-No. 8) is not required.

(a) As an alternative to (1), the Charpy V-notch test temperature requirements of (1), the Charpy V-notch test temperature for procedure qualification may be determined in accordance with (+1), (+2), or (+3). The Charpy V-notch test temperature shall be in the transition temperature range for the test assembly ferritic base material.

(+1) The test temperature for the test assembly base metal shall be derived from the full transition temperature curve in the Certified Material Test Report.

(+2) A full transition temperature curve for the test assembly base metal shall be developed using Charpy V-notch testing.

(+3) The test temperature shall be in the range where one or more Charpy V-notch tests in the test assembly base metal exhibit 35 mils to 50 mils (0.89 mm to 1.3 mm) lateral expansion.

(2) Charpy V-notch tests of weld metal of the procedure qualification shall meet the requirements as determined in (-1) above. Drop weight tests, when required for the weld metal by the Construction Code in (-1), need not be performed.
(3) Charpy V-notch tests of the heat-affected zone (HAZ) shall be performed at the same temperature as the base metal test of (-1) above. Number, location, and orientation of test specimens shall meet the requirements of (-4) below.

(-4) The specimens shall be removed from a location as near as practical to a depth of one-half the thickness of the deposited weld metal. The coupons for HAZ impact specimens shall be taken transverse to the axis of the weld and etched to define the HAZ. The notch of the Charpy V-notch specimen shall be cut approximately normal to the material surface in such a manner as to include as much HAZ as possible in the resulting fracture. When the material thickness permits, the axis of a HAZ specimen shall be inclined to allow the root of the notch to align parallel to the fusion line.

(-5) If the test material is in the form of a plate or a forging, the axis of the weld shall be oriented parallel to the principal direction of rolling or forging.

(-6) Charpy V-notch tests shall be performed on the weld metal, the heat-affected zone, and unaffected base metal in accordance with SA-370. Specimens shall be in accordance with SA-370, Figure 11, Type A. A test shall consist of a set of three full-size 10 mm x 10 mm specimens. The lateral expansion, percentage shear, absorbed energy, test temperature, orientation, and location of all test specimens shall be reported in the Procedure Qualification Record.

(-7) The average lateral expansion value of the three HAZ Charpy V-notch specimens shall be equal to or greater than the average lateral expansion value of the three unaffected base metal specimens. However, if the average lateral expansion value of the HAZ Charpy V-notch specimens is less than the average value for the unaffected base metal specimens and the procedure qualification meets all other requirements, then either of the following shall be performed:

(a) The welding procedure shall be requalified.

(b) An Adjustment Temperature for the procedure qualification shall be determined in accordance with the applicable provisions of NB-4335.2 of the 2004 Edition of Section III. The Adjustment Temperature for the procedure qualification meets all other requirements, then either of the following shall be performed:

(b) An Adjustment Temperature for the procedure qualification shall be determined in accordance with the applicable provisions of NB-4335.2 of the 2004 Edition or later.

IWA-4611 Defect Removal
IWA-4611.1 General Requirements.
(a) Defects shall be removed in accordance with IWA-4422.1. A defect is considered removed when it has been reduced to an acceptable size.
(b) Examination of defect removal areas shall comply with IWA-4624, IWA-4634, and IWA-4644, as applicable.
(c) Metal removal by thermal methods shall comply with IWA-4413.

IWA-4611.2 Examination Following Defect Removal.
(a) After final processing, the affected surfaces, including surfaces of cavities prepared for welding, shall be examined by the magnetic particle or liquid penetrant method to ensure that the indication has been reduced to an acceptable size in accordance with IWB-3500, IWC-3500, or Article IWD-3000, as applicable. For supports and containment vessels, the provisions of IWA-4422.1(b) may be used. No examination of the defect removal area is required when defect elimination removes the full thickness of the weld and the back side of the weld joint is not accessible for removal of examination materials.
(d) Temper bead welding shall not be used for repair of materials from inside the reactor vessel within the beltline region or on vessel internals within the beltline region, under the following conditions.

1. Ferritic material where fast neutron fluence exposure is greater than $1 \times 10^{17}$ n/cm$^2$ ($E > 1$ MeV).
2. Nickel-base material where thermal neutron fluence exposure is greater than $1 \times 10^{17}$ n/cm$^2$ ($E < 0.5$ eV).
3. Austenitic stainless steel (P-No. 8), where thermal neutron fluence exposure is greater than $1 \times 10^{17}$ n/cm$^2$ ($E < 0.5$ eV) and measured or calculated helium concentration in the P-No. 8 material is greater than 0.1 atomic parts per million (appm).

(e) For repairs on the outside of the reactor vessel shell on ferritic material where fast neutron fluence exposure is indeterminate or greater than $1 \times 10^{17}$ n/cm$^2$ ($E > 1$ MeV), the applicable examinations of IWA-4624(c), IWA-4634(b), IWA-4673(b), or IWA-4683(b) shall also include the adjacent vessel base material as follows.

1. The surface examination shall include 1/2 inch (13 mm) of the reactor vessel base material beyond the deposited weld metal.
2. Where practical, the volumetric examination shall include the following:
   - (a) the heat affected zone below the weld deposit
   - (b) the reactor vessel base material adjacent to the deposited weld metal to a distance of 1/2 inch (13 mm) and to a depth of 3/16 inch (5 mm)
(b) Indications detected as a result of the excavation that are not associated with the defect being removed shall be subject to an NDE evaluation for acceptability in accordance with Article IWA-3000.

IWA-4620 TEMPER BEAD WELDING OF SIMILAR MATERIALS

IWA-4621 General Requirements

(a) Repair/replacement activities on P-Nos. 1 and 3 materials and associated welds may be performed without the specified postweld heat treatments, provided the requirements of (b), (c), (d), IWA-4623, and IWA-4624 are met.

(b) The maximum area of an individual weld based on the finished surface shall be 500 in.² (325 000 mm²), and the depth of the weld shall not be greater than one-half of the base metal thickness.

(c) Weld metal and heat-affected zones may be peened to control distortion. Peening shall not be used on the final weld surfaces, except as permitted in (d) below.

(d) Peening demonstrated to reduce residual surface tensile stresses is permitted on the final weld surfaces after any required surface examinations are completed. A VT-1 visual examination in accordance with IWA-4610(c) shall be performed after this peening.

IWA-4623 Welding Procedure

IWA-4623.1 Shielded Metal-Arc Welding. The procedure shall include the requirements of (a) through (f):

(a) Welding electrodes shall meet the requirements for supplemental designators R, indicating a moisture-resistant coating, and “H4,” indicating that they are low in diffusible hydrogen (<4 mL/100 g), as defined in the applicable specifications in Section II, Part C. Welding electrodes shall be supplied in unopened, hermetically sealed containers or vacuum-sealed packages.

(b) Electrodes shall be used directly from vacuum-sealed packages or hermetically sealed containers, or shall be placed in storage at 225°F to 350°F (110°C to 180°C) prior to use.

(c) Electrodes not consumed within 8 hr for E70XX electrodes or 4 hr for E80XX and E90XX after removal from vacuum-sealed packages, hermetically sealed containers, or storage at 225°F to 350°F (110°C to 180°C) shall not be used for temper bead welding. The use of re-heated or re-baked electrodes is not permitted.

(d) The area to be welded plus a band around the area of at least 1.5 times the component thickness or 5 in. (125 mm), whichever is less, shall be preheated and maintained at a minimum temperature of 350°F (175°C). The maximum interpass temperature shall be 450°F (230°C).

(e) Weld the cavity in accordance with the qualified Section IX, QW-290 WPS described in IWA-4610(b).

(f) The weld area shall receive a postweld hydrogen bakeout by maintaining it at 450°F to 550°F (230°C to 290°C) for a minimum of 2 hr after completion of the weld in P-No. 1 materials. For P-No. 3 materials, the holding time shall be a minimum of 4 hr.

IWA-4623.2 Gas Tungsten-Arc Welding. The procedure shall include the requirements of (a) through (d):

(a) The weld metal shall be deposited by the automatic or machine gas tungsten-arc weld process using cold wire feed.

(b) The area to be welded plus a band around the area of at least 1.5 times the component thickness or 5 in. (125 mm), whichever is less, shall be preheated and maintained at a minimum temperature of 300°F (150°C). The maximum interpass temperature shall be 450°F (230°C).

(c) Weld the cavity in accordance with the qualified Section IX, QW-290 WPS described in IWA-4610(b).

(d) The weld area shall receive a postweld hydrogen bakeout by maintaining it at 450°F to 550°F (230°C to 290°C) for a minimum of 2 hr after completion of the weld repair in P-No. 1 materials. For P-No. 3 materials, the holding time shall be a minimum of 4 hr.

IWA-4624 Examination

IWA-4624.1 Examination Criteria.

(a) Prior to welding, surface examination shall be performed on the area to be welded. Surface examination and acceptance criteria shall comply with IWA-4611.2

(b) The initial layer shall be examined by the magnetic particle method after grinding or machining. Each subsequent layer shall be examined by the magnetic particle method if a final volumetric examination will not be performed.

(c) Nondestructive examinations shall be performed after the completed weld has cooled to ambient temperature. The nondestructive examination of the welded region shall include both volumetric [except as permitted in (b)] and surface examination.

(d) Areas from which weld attached thermocouples have been removed shall be ground and examined by a surface examination method.

IWA-4624.2 Acceptance Criteria. Acceptance criteria for examinations required by IWA-4624.1(b) and IWA-4624.1(c) shall be in accordance with the Construction Code or Section III.

IWA-4630 TEMPER BEAD WELDING OF DISSIMILAR MATERIALS

IWA-4631 General Requirements

(a) Repair/replacement activities on welds that join P-No. 8 or P-No. 43 material to P-Nos. 1 and 3 materials may be made without the specified postweld heat treatment, provided the requirements of (b), (c), (d), IWA-4633 and IWA-4634 are met.
Section IX, QW-290 WPS described in IWA-4610(b).

-ambient temperature preheat and a maximum interpass temperature shall be 450°F (230°C).

-Subsequent to the above postweld hydrogen bakeout, the balance of the welding may be performed using ambient temperature preheat and a maximum interpass temperature of 350°F (180°C).

**IWA-4634 Examination**

- Prior to welding, surface examination shall be performed on the area to be welded. Surface examination and acceptance criteria shall comply with IWA-4611.2.

- Nondestructive examinations shall be performed after the completed weld has cooled to ambient temperature. The examination of the welded region shall include both volumetric and surface examination.

**IWA-4634.2 Acceptance Criteria.** Acceptance criteria for examinations required by IWA-4634.1(b) shall be in accordance with the Construction Code or Section III.

**IWA-4640 TEMPER BEAD WELDING OF CLADDING**

**IWA-4641 General Requirements**

- Repair/replacement activities on austenitic stainless steel and nickel base cladding on P-No. 1 and 312 base materials when the ferritic material is within 3/16 in. (5 mm) of being exposed may be performed by welding without the specified postweld heat treatments provided the requirements of IWA-4643 and IWA-4644 are met.

- The maximum area of an individual cladding repair based on the finished surface shall be 500 in.² (325,000 mm²), and the depth of the weld into the ferritic material shall not be greater than 1/8 in. (6 mm) or 10% of the base metal thickness, whichever is less.
IWA-4643  Welding Procedure

IWA-4643.1 Shielded Metal-Arc Welding. The procedure shall include the requirements of (a) through (h).

(a) The welds shall be made using A-No. 8 weld metal (Section IX, Table QW-442) for austenitic stainless steel cladding or F-No. 43 weld metal (Section IX, Table QW-432) for either austenitic stainless steel or nickel base cladding.

(b) Welding electrodes shall be supplied in unopened, hermetically sealed containers or vacuum-sealed packages.

(c) Electrodes shall be used directly from vacuum-sealed packages or hermetically sealed containers, or shall be placed in storage at 225°F to 350°F (110°C to 180°C) prior to use.

(d) Electrodes not consumed within 8 hr after removal from vacuum-sealed packages, hermetically sealed containers, or storage at 225°F to 350°F (110°C to 180°C) shall not be used for temper bead welding. Use of reheated or rebaked electrodes is not permitted.

(e) The area to be welded plus a band around the area of at least 1.5 times the component thickness or 5 in. (125 mm), whichever is less, shall be preheated and maintained at a minimum temperature of 350°F (175°C). The maximum interpass temperature shall be 450°F (230°C).

(f) Weld the cavity in accordance with the qualified Section IX, QW-290 WPS described in IWA-4610(b).

(g) After completion of welding or when at least 3/16 in. (5 mm) of weld metal has been deposited, the weld area shall receive a postweld hydrogen bakeout by maintaining it at 450°F to 550°F (230°C to 290°C) for a minimum of 2 hr in P-No. 1 materials. For P-No. 3 materials, the holding time shall be a minimum of 4 hr.

(h) Subsequent to the above postweld hydrogen bakeout, the balance of the welding, if any, may be performed using ambient temperature preheat and a maximum interpass temperature of 350°F (180°C).

IWA-4644  Examination

IWA-4644.1 Examination Requirements.

(a) Prior to welding, surface examination shall be performed on the area to be welded. Examination and acceptance criteria shall comply with IWA-4611.2.

(b) Nondestructive examinations shall be performed after the completed weld has cooled to ambient temperature. The examination of the welded region shall include both volumetric and surface examination.

IWA-4644.2 Acceptance Criteria. Acceptance criteria for examinations required by IWA-4644.1(b) shall be in accordance with the Construction Code or Section III.
IWA-4670 AMBIENT TEMPERATURE TEMPER BEAD WELDING USING GAS TUNGSTEN ARC WELDING

Ambient temperature preheat may be used for welding similar materials, dissimilar materials, inlays, onlays, and overlays, with the additional requirements in IWA-4671 through IWA-4673.

IWA-4671 General Requirements

(a) Repair/replacement activities are limited to P-Nos. 1 and 3\textsuperscript{12} materials, and their associated welds, and welds joining P-No. 8 or P-No. 43 materials to P-Nos. 1 and 3\textsuperscript{12} materials. Welding shall not be used to repair SA-302, Grade B material, unless the material has been modified to include nickel content of 0.4% to 1.0%, quenching and tempering, and application of a fine grain practice.

(b) The maximum area of an individual weld based on the finished surface over the ferritic material shall be 1,000 in.\textsuperscript{2} (650 000 mm\textsuperscript{2}) for full circumferential weld overlays and 500 in.\textsuperscript{2} (325 000 mm\textsuperscript{2}) for all other applications, and, except as permitted in (1), the depth of the weld shall not be greater than one-half of the ferritic base metal thickness.

(1) Through-wall circumferential welds are permitted if the following requirements are met:

(-a) For repair/replacement activities associated with existing welds, the existing weld (including any associated buttering) shall be removed in its entirety.

(-b) Temper bead buttering shall be applied across the entire face of the weld preparation area on the base materials requiring tempering and shall extend around the full circumference of the joint.

(c) Repair/replacement activities on a dissimilar-metal weld are limited to those along the fusion line of a nonferritic weld to ferritic base material on which \(\frac{1}{8}\) in. (3 mm) or less of nonferritic weld deposit exists above the original fusion line.

(d) If a defect penetrates into the ferritic base material, repair of the base material, using a nonferritic weld filler material, may be performed, provided the depth of repair in the base material does not exceed \(\frac{3}{16}\) in. (10 mm).

(e) Prior to welding, the area to be welded and a band around the area of at least 1\(\frac{1}{2}\) times the component thickness or 5 in. (130 mm), whichever is less, shall be at least 50°F (10°C).

(f) Weld metal and heat-affected zones may be peened to control distortion. Peening shall not be used on the final weld surfaces, except as permitted in (g) below.

(g) Peening demonstrated to reduce surface tensile stresses is permitted on the final weld surfaces after any required surface examinations are completed. A VT-1 visual examination in accordance with IWA-4610(c) shall be performed after this peening.

IWA-4672 Welding Procedure Requirements

The procedure shall include the following requirements:

(a) The weld metal shall be deposited using the automatic or machine GTAW process.

(b) The maximum interpass temperature for field applications shall be 350°F (180°C) for all weld layers, regardless of the interpass temperature used during qualification. The interpass temperature limitations of Section IX, QW-406.3 and QW-406.8 need not be applied.

(c) The interpass temperature shall be determined by direct measurement (e.g., pyrometers, temperature-indicating crayons, thermocouples) during welding. If direct measurement is impractical (e.g., because of geometric limitations or radiological reasons), interpass temperature shall be determined in accordance with the following:

(1) heat flow calculations, including the following variables:

(-a) welding heat input

(-b) initial base material temperature

(-c) configuration, thickness, and mass of the item being welded

(-d) thermal conductivity and diffusivity of the materials being welded

(-e) time per weld pass and delay time between each pass

(-f) time to complete the weld

(2) Measurement of the actual interpass temperature on a test coupon not thicker than the item to be welded. The maximum heat input of the welding procedure shall be used in the welding of the test coupon.

(d) Particular care shall be given to ensure that the weld region is free of potential sources of hydrogen. The surfaces to be welded, filler metal, and shielding gas shall be suitably controlled.

IWA-4673 Examination

Except as permitted in (a), the following examinations shall be performed in accordance with the Construction Code or Section III:

(a) Prior to repair welding, surface examination shall be performed on the area to be welded. If surface examination materials cannot be cleaned from crevices in the area to be welded (e.g., trapped in crevices remaining after removal of the full thickness of a partial penetration or fillet weld), VT-1 visual examination shall be performed, provided the requirements of IWA-4610(c) are met.
(b) If ferritic materials are used, the weld shall be non-destructively examined after the completed weld has been at ambient temperature for at least 48 hr. If austenitic materials are used, the weld shall be nondestructively examined after the three tempering layers (i.e., layers 1, 2, and 3) have been in place for at least 48 hr. Examination of the welded region shall include both volumetric and surface examination methods. Demonstration for ultrasonic examination of the repaired volume is required using representative samples containing construction-type flaws.

(c) Areas from which weld-attached thermocouples have been removed shall be ground and examined using a surface examination method.

(d) Acceptance criteria for surface and volumetric examination shall be in accordance with the Construction Code or Section III.

IWA-4680 AMBIENT TEMPERATURE TEMPER BEAD WELDING USING SHIELDED METAL ARC WELDING

Ambient temperature preheat may be used for welding similar materials and dissimilar materials, with the following additional requirements.

IWA-4681 General Requirements

(a) Repair/replacement activities are limited to P-Nos. 1 and 3 materials and their associated welds and welds joining P-No. 8 or P-No. 43 materials to P-Nos. 1 and 3 materials. Temper bead welding shall not be used to repair SA-302, Grade B material, unless the material has been modified to include 0.4% to 1.0% nickel, quenching and tempering, and application of a fine-grain practice.

(b) The maximum area of an individual weld based on the finished surface over the ferritic material shall be 500 in.² (325 000 mm²), and except as permitted in (1), the depth of the weld shall not be greater than one-half of the ferritic base metal thickness.

(1) Through-wall circumferential welds are permitted if the following restrictions are met:
   (-a) For repair/replacement activities associated with existing welds, the existing weld (including any associated buttering) shall be removed in its entirety.
   (-b) Temper bead buttering shall be applied across the entire face of the weld preparation area on the base materials requiring tempering, and shall extend around the full circumference of the joint.
   (c) Repair/replacement activities on a dissimilar-metal weld are limited to those along the fusion line of a nonferritic weld to ferritic base material on which ¹⁄₈ in. (3 mm) or less of nonferritic weld deposit exists above the original fusion line.
   (d) If a defect penetrates into the ferritic base material, repair of the base material, using a nonferritic weld filler material, may be performed provided the depth of repair in the base material does not exceed ³⁄₈ in. (10 mm).

(e) Prior to welding, the area to be welded and a band around the area of at least ¹½ times the component thickness or 5 in. (130 mm), whichever is less, shall be at least 50°F (10°C).

(f) Weld metal and heat-affected zones may be peened to control distortion. Peening shall not be used on the final weld surfaces, except as permitted in (g) below.

(g) Peening demonstrated to reduce residual surface tensile stresses is permitted on the final weld surfaces after any required surface examinations are completed. A VT-1 visual examination in accordance with IWA-4610(c) shall be performed after this peening.

IWA-4682 Welding Procedure Requirements

The procedure shall include the requirements of (a) through (f).

(a) The weld metal shall be deposited using the manual SMAW process.

(b) Ferritic weld metal used shall meet the following additional requirements:
   (1) Welding electrodes shall meet the requirements for supplemental designators R, indicating a moisture-resistant coating, and "H4," indicating that they are low in diffusible hydrogen (<4 mL/100 g), as defined in the applicable specifications in Section II, Part C. Welding electrodes shall be supplied in unopened, hermetically sealed containers or vacuum-sealed packages.
   (2) Electrodes shall be used directly from vacuum-sealed packages or hermetically sealed containers, or shall be placed in storage at 225°F to 350°F (110°C to 180°C) prior to use.
   (3) Electrodes not consumed within 8 hr for E70XX electrodes or 4 hr for E80XX and E90XX after removal from vacuum-sealed packages, hermetically sealed containers, or storage at 225°F to 350°F (110°C to 180°C) shall not be used for temper bead welding. Use of reheated or rebaked electrodes is not permitted.
   (c) Austenitic or nickel-based weld metal used shall meet the following requirements:
      (1) Welding electrodes shall be supplied in unopened, hermetically sealed containers or vacuum-sealed packages.
      (2) Electrodes shall be used directly from vacuum-sealed packages or hermetically sealed containers, or shall be placed in storage at 225°F to 350°F (110°C to 180°C) prior to use.
      (3) Electrodes not consumed within 8 hr after removal from vacuum-sealed packages, hermetically sealed containers, or storage at 225°F to 350°F (110°C to 180°C) shall not be used for temper bead welding. Use of reheated or rebaked electrodes is not permitted.
      (d) The maximum interpass temperature for field applications shall be 350°F (180°C) for all weld layers, regardless of the interpass temperature used during qualification. The interpass temperature requirements of Section IX, QW-406.3 need not be met.
(e) The interpass temperature shall be determined by direct measurement (e.g., pyrometers, temperature-indicating crayons, thermocouples) during welding.

(f) Particular care shall be given to ensure that the weld region is free of potential sources of hydrogen. The surfaces to be welded and filler metal shall be suitably controlled.

IWA-4683 Examination

Except as permitted in (a), the following examinations shall be performed in accordance with the Construction Code or Section III.

(a) Prior to repair welding, surface examination shall be performed on the area to be welded. When surface examination materials cannot be cleaned from crevices in the area to be welded (e.g., trapped in crevices remaining after removal of the full thickness of a partial penetration or fillet weld), VT-1 visual examination may be performed, provided the requirements of IWA-4610(c) are met.

(b) If ferritic materials are used, the weld shall be non-destructively examined after the completed weld has been at ambient temperature for at least 48 hr. If austenitic materials are used, the weld shall be nondestructively examined after the initial three temper bead layers (i.e., layers 1, 2, and 3) have been in place for at least 48 hr. Examination of the welded region shall include both volumetric and surface examination methods. Demonstration for ultrasonic examination of the repaired volume is required using representative samples containing construction-type flaws.

(c) Areas from which weld-attached thermocouples have been removed shall be ground and examined using a surface examination method.

(d) Acceptance criteria for surface and volumetric examination shall be in accordance with the Construction Code or Section III.

Ultrasonic examination shall be performed using procedures qualified at least in accordance with Section V, Article 14 Low Rigor requirements.