Dominion Nuclear Connecticut, Inc.
5000 Dominion Boulevard, Glen Allen, Virginia 23060
Web Address: www.dom.com

October 17, 2006

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Serial No. 06-731
MPS Lic/PRW R0
Docket No. 50-423
License No. NPF-49

DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 3
ALTERNATIVE REQUEST IR-2-47, USE OF WELD OVERLAYS AS AN ALTERNATIVE REPAIR TECHNIQUE

Pursuant to 10 CFR 50.55a(a)(3)(i), Dominion Nuclear Connecticut, Inc. (DNC), requests approval to use the American Society of Mechanical Engineers (ASME) Code Case N-740,[1] to apply dissimilar metal weld overlays for repair/replacement activities. This request contains alternative requirements for the inservice inspection (ISI) program for scheduled preemptive weld overlays (PWOLs) that are planned to mitigate the potential for primary water stress corrosion cracking (PWSCC) susceptibility at Millstone Power Station Unit 3 (MPS3). Attachment 1 contains Request IR-2-47 and Enclosure 1 to Attachment 1 contains a copy of Code Case N-740.

Without PWOLs, extensive machining would be required to perform required ultrasonic testing (UT) of the welds to which this request applies. Consequently, PWOLs for mitigation of potential PWSCC susceptible areas are scheduled for the cycle 11 refueling outage and no pre-weld overlay UT examinations are planned. This is the initial phase of the control and remediation plan for Alloy 600/82/182 dissimilar metal piping butt welds susceptible to potential PWSCC at MPS3. DNC will use the alternatives in this request to implement the Electric Power Research Institute's Materials Reliability Program (EPRI/MRP) and the Primary System Piping Butt Weld Inspection and Evaluation Guideline (MRP-139) under the ISI program and the risk-informed ISI (RI-ISI) program.

DNC requests review and approval of this proposal be expedited to support the upcoming MPS3 refueling outage in the spring of 2007. Similar alternatives have been submitted for NRC review and approval and are referenced in the attached request. DNC is submitting this request based on the recent ASME approval of Code Case N-740. Details of the design analysis for the planned weld overlays are being developed to support the MPS3 spring 2007 refueling outage. DNC will provide that information for NRC staff review in support of this proposal prior to startup from the upcoming refueling outage.

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[1] ASME Code Case N-740, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items Section XI, Division 1," dated July 14, 2006.

If you have any questions regarding this submittal, please contact Mr. Paul R. Willoughby at (804) 273-3572.

Very truly yours,

Gerald T. Bischof
Vice President – Nuclear Engineering

Attachment:

1. Alternative Request IR-2-47, Use Of Weld Overlays As An Alternative Repair Technique

Commitments made in this letter:

1. DNC will submit the required design analysis for the weld overlays to the NRC prior to entering Mode 4 during startup from the upcoming refueling outage (3R11). *[See section 4.2 of Attachment 1]*

cc: U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road
King of Prussia, PA 19406-1415

Mr. V. Nerses
NRC Senior Project Manager - Millstone Power Station
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Mail Stop 8C2
Rockville, MD 20852-2738

Mr. S. M. Schneider
NRC Senior Resident Inspector
Millstone Power Station

ATTACHMENT 1

ALTERNATIVE REQUEST IR-2-47, USE OF WELD OVERLAYS AS AN ALTERNATIVE REPAIR TECHNIQUE

DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 3

ALTERNATIVE REQUEST IR-2-47, USE OF WELD OVERLAYS AS AN ALTERNATIVE REPAIR TECHNIQUE

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ALTERNATIVE REQUEST IR-2-47, USE OF WELD OVERLAYS AS AN ALTERNATIVE REPAIR TECHNIQUE

Proposed Alternative
In Accordance with 10 CFR 50.55a(a)(3)(i)

- Alternative Provides Acceptable Level Of Quality And Safety -

1.0 REASON FOR THE REQUEST

For the upcoming cycle 11 refueling outage (3R11), five high safety significant (HSS) dissimilar metal welds located on the pressurizer are currently scheduled to have full structural preemptive weld overlays (PWOLs) applied. Repair/replacement activities associated with PWOL repairs are required to address the materials, welding parameters, ALARA concerns, operational constraints, examination techniques and procedure requirements for repairs. Comprehensive and generic NRC approved criteria are, however, not currently available for application of PWOL repairs to dissimilar metal welds constructed of Alloy 82/182 weld material for mitigation of potential primary water stress corrosion cracking (PWSCC).

2.0 CODE COMPONENTS FOR WHICH THE ALTERNATIVE IS REQUESTED

Code components associated with this request are the high safety significant (HSS) Class 1 dissimilar metal piping welds with Alloy 82/182 weld metal that are believed to be susceptible to PWSCC and scheduled for examination in accordance with the risk-informed inservice inspection (RI-ISI) program[1] and the guidelines of MRP-139 (Reference 3). There are five welds that are scheduled to have full structural PWOLs applied. The additional examination requirements of the RI-ISI program and MRP-139 will be met with application of these five PWOLs.

2.1 Category and System Details:

Code Class:	All listed welds are ASME Code Class 1 welds.
System Welds:	Components are located in the Reactor Coolant System (RCS) pressure boundary.
Code Category:	Examination Category R-A, "Risk-Informed Piping Examinations"
Code Item No.:	R1.15, "Elements Subject to PWSCC"

(1) NRC letter, "Safety Evaluation of Relief Request For A Risk-Informed Inservice Inspection Program, Millstone Power Station, Unit No. 3 (TAC No. MA9740)," dated March 12, 2002, (ADAMS Accession No. ML020570312).

2.2 Component Descriptions:

The application of this alternative for the five potentially susceptible nozzle-to-safe end welds using PWOL includes the weld overlay of the adjacent stainless steel safe end-to-pipe welds any time a PWOL is applied.

1. Weld No. 03-X-5551-X-T: 14-inch RCS Safe End-To-Surge Nozzle and adjacent Safe End-To–Pipe (Weld No. RCS-SL-FW-4),
2. Weld No. 03-X-5644-A-T: 6-inch Safety Nozzle-To-Safe End Weld at 81º Azimuth and adjacent Safe End-To- Pipe (Weld No. RCS-516-FW-1),
3. Weld No. 03-X-5648-B-T: 6-inch Safety Nozzle-To-Safe End Weld at 147º Azimuth and adjacent Safe End-To-Pipe (Weld No. RCS-516-FW-3),
4. Weld No. 03-X-5649-C-T: 6-inch Safety Nozzle-To-Safe End Weld at 212º Azimuth and adjacent Safe End-To-Pipe (Weld No. RCS-516-FW-5), and
5. Weld No. 03-X-5650-D-T: 6-inch Relief Nozzle-To-Safe End Weld at 278º Azimuth and adjacent Safe End-To-Pipe (Weld No. RCS-513-FW-1).

2.3 Component Materials:

1. All Nozzles are (P-3) Alloy Steel, SA-508 CL2,
2. Nozzle-To-Safe End Weld and Butter are Alloy 82/182 (F-43),
3. Safe Ends are (P-8) Wrought Stainless Steel (SS), SA-182 GR F316C, and
4. Surge Line, Safety Line, and Relief Line Pipes, are (P-8) Wrought SS.

3.0 CODE REQUIREMENTS FOR WHICH THE ALTERNATIVE IS REQUESTED

MPS3 is currently in the second 10-year ISI interval that began on April 23, 1999, and is scheduled to end October 23, 2008. The ASME Boiler and Pressure Vessel Code (ASME Code) of record for the current 10-year ISI interval and the RI-ISI program is the 1989 Edition of Section XI of the ASME Code.

The ASME Code, Section XI, 1998 Edition, no Addenda, IWA-4000 (Reference 1), is used for the MPS3 Section XI repair/replacement program,[2] which does not have the needed requirements for this type of repair. The ASME Code requirements for which the relief is requested are contained in the following:

1. 1998 Edition with no Addenda of the American Society of Mechanical Engineers (ASME) Code Section XI, IWA-4000, (Reference 1).
2. 1995 Edition with the 1996 Addenda, of the ASME Code, Section XI, Appendix VIII, Supplement 11, (Reference 5).

The alternative described in Section 4.0 is proposed to permit the implementation of

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[2] NRC letter, "Millstone Power Station, Unit Nos. 2 and 3 RE: Request to Use 1998 Edition, with No Addenda, of ASME Section XI for Repair/Replacement Activities (TAC Nos. MC7347 and MC7348)," dated September 13, 2005, (ADAMS No. ML052210033).

scheduled PWOLs at MPS3, as an alternative for the repair/replacement requirements of the ASME Code Section XI, 1998 Edition with no Addenda, IWA-4000 (Reference 1).

The ultrasonic examination of the completed structural weld overlay will be accomplished in accordance with the ASME Code Section XI, 1995 Edition with the 1996 Addenda, Appendix VIII, Supplement 11 (Reference 5). These examinations will be in accordance with the requirements of 10 CFR 50.55a(g)(6)(ii)(C), that apply to implementing Appendix VIII, with the alternatives used for complying with the Performance Demonstration Initiative (PDI) program that are documented for MPS3 in NRC approval of Relief Request IR-2-39, dated January 20, 2006 (ADAMS Accession No. ML053260012).

4.0 PROPOSED ALTERNATIVES AND SUPPORTING INFORMATION

The ASME has recently approved Code Case N-740, for dissimilar metal weld overlay for repair of Class 1, 2, and 3 items, (Reference 2). Because this Code Case has not been approved yet for use in NRC Regulatory Guide 1.147, the Case is submitted for NRC staff review in Enclosure 1 for use under the provisions of 10 CFR 50.55a(a)(3)(i). This Code Case is the result of the industry's experience with weld overlay repairs for flaws suspected or confirmed to be from PWSCC, and for the first time provides guidance which is being directly applied to the Alloy 52/152 weld material that is used for these overlay repairs.

This proposal requests the use of the Code Case N-740 for implementing the five scheduled full structural PWOLs for the potentially PWSCC susceptible nozzle-to-safe end welds of the pressurizer. These PWOLs will include the adjacent stainless steel safe end-to-pipe welds. This request applies to each of the welds listed in Section 2.2, which are generically depicted in Figure 1 of this section.

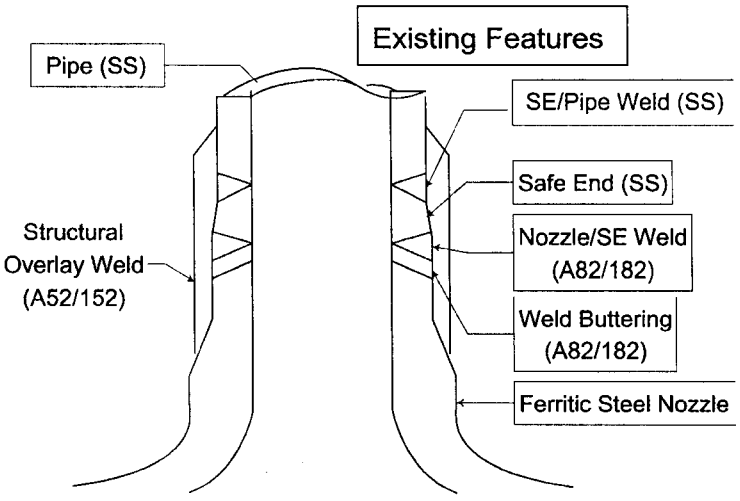

Figure 1 –Typical Weld Overlay Repair Configuration

A full structural PWOL (designed for the worst case flaw) will be applied in accordance with the requirements of Code Case N-740 (Reference 2) with a UT examination following the application of the PWOL.

4.1 The Structural Weld Overlay Assembly:

The ferritic material of the nozzles is (P-3), the safe ends and pipes are wrought stainless steel (P8) material. The existing weld filler material is Alloy 82/182 (F43 equivalent to P43).

The full structural weld overlay satisfies all the structural design requirements of the pipe assuming no strength contributed by the pipe, as if the pipe were not there. As shown in Figure 1 of this section, this structural weld overlay (weld reinforcement) will completely cover the existing Alloy 82/182 weld metal and will extend onto the ferritic and austenitic stainless steel material on each end of the weld, including the adjacent safe end-to-pipe weld. Although the weld overlay extends the full 360° around the nozzle, a cross section depicting only half is shown in Figure 1 for clarity.

4.2 Weld Overlay Design:

The PWOLs will be designed as full structural overlays (assumed worst case flaw) in accordance with section 2.0 of ASME Section XI, Code Case N-740 (Reference 2). The details surrounding the design analysis for the PWOLs are being developed to support the MPS3 spring 2007 refueling outage and our vendor has committed to supplying this analysis to DNC by April 1, 2007. As soon as this analysis is available it will be submitted for NRC review, but no later than prior to entry into Mode 4 in startup from 3R11. *[See Commitment]*

4.3 Examinations:

All examinations will meet requirements of the Code Case N-740, excluding a UT examination after a completed PWOL. The UT examination after a completed PWOL will be performed in accordance with ASME Code Section XI, 1995 Edition with the 1996 Addenda, Appendix VIII, Supplement 11 (Reference 5) with the alternatives that are used to comply with the Performance Demonstration Initiative (PDI) program, as described in the NRC review and approval of MPS3 request IR-2-39, dated January 20, 2006 (ADAMS Accession No. ML053260012).

The current configuration of these welds does not permit an ASME Code Section XI, Appendix VIII, Supplement 10 (Reference 4), UT weld examination without extensive machining. Therefore, none of these welds will receive a pre-weld overlay UT examination. However, if the welds are found with PWSCC or other unacceptable flaws during the post weld overlay UT examination, no additional weld examinations of other similar welds will be performed because there will be no remaining similar trimetallic welds that are associated with the

pressurizer environment that will not have been overlay repaired during this activity.

5.0 DURATION OF THE PROPOSED REQUEST

The alternative requirements of this request will be applied for the duration of, up to and including, the last outage of the current, second 10-year ISI interval which includes inservice examination requirements of Code Case N-740 (Reference 2) for any applied weld overlays. Future inservice examinations of weld overlays at MPS3 beyond this inspection interval will be as required by the NRC in the regulations or as stipulated in the guidance provided under MRP-139 (Reference 3).

6.0 PRECEDENTS

The only other PWSCC susceptible weld located within the pressurizer environment at MPS3 is the spray nozzle-to-safe end weld (Weld No. 03-X-5641-E-T) that was weld overlay repaired in 3R10 under NRC approved relief request IR-2-39 (ADAMS Accession No. ML053260012) along with its adjacent safe end-to-pipe weld (Weld No. RCS-517-FW-12). Both of these welds, which are now weld overlay repaired, will receive their first inservice UT examination during the upcoming 3R11 refueling outage.

Similar requests have been submitted to address the issues that are contained in this request. These include requests from the Indiana Michigan Power Company's, D. C. Cook Unit 2. NRC verbal approval was received on March 23, 2006, for their request, which included the application of full structural PWOLs applied to their pressurizer steam space dissimilar metal butt welds.

Additionally, the following requests associated with WOL repairs have been approved by the NRC: AmerGen Energy Company, Three Mile Island Nuclear Station, Unit 1, on July 21, 2004;[3] Constellation Energy's Calvert Cliffs Nuclear Power Plant, Unit 2, on July 20, 2005;[4] Millstone Unit 3, on January 20, 2006;[5] and Indiana Michigan Power Company, Donald C. Cook Unit 1, on February 10, 2006.[6]

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(3) NRC letter, "Safety Evaluation of Request For Relief From Flaw Removal, Heat Treatment and Nondestructive Examination (NDE) Requirements For The Third 10-Year Inservice Inspection Interval, Three Mile Island Nuclear Station, Unit 1 (TMI-1), (TAC No. MC1201), dated: July 21, 2004, (ADAMS Accession No. ML041670510).

(4) NRC Letter, "Safety Evaluation for Calvert Cliffs Nuclear Power Plant, Unit No. 2, Relief Request for Use Weld Overlay and Associated Alternative Inspection Techniques (TAC Nos. MC6219 and MC6220), dated July 20, 2005, (ADAMS Accession No. ML051930316).

(5) NRC letter, "Safety Evaluation of Relief Request IR-2-39 Pertaining to the Repair and Inspection of Nozzle to Safe End Weld, Weld No. 03-X-5641-E-T at Millstone Power Station Unit No. 3 (MPS3)," (TAC No. MC8609), dated January 20, 2006, (ADAMS Accession No. ML053260012).

(5) NRC letter, Safety Evaluation of Alternative Request Regarding Repair of Safe-End-To-Elbow Weld 1-RC-9-01F at the Donald C. Cook Nuclear Plant Unit 1, (TAC No. MC8807), dated February 10, 2006, (ADAMS Accession No. ML060240355).

7.0 REFERENCES

1. ASME Code, Section XI, 1998 Edition, no Addenda, IWA-4000.
2. ASME Code Case N-740, Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items Section XI, Division 1, July 14, 2006.
3. Material Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline (MRP-139), EPRI, Palo Alto, CA: 2005. 1010087.
4. ASME Code, Section XI, 1995 Edition with the 1996 Addenda, Appendix VIII, Supplement 10.
5. ASME Code, Section XI, 1995 Edition with the 1996 Addenda, Appendix VIII, Supplement 11.

8.0 CONCLUSION

Similar NRC approved requests have been used to produce acceptable weld overlays when applied to dissimilar metal welds with Alloy 82/182 weld material. The proposed alternative uses ASME Code Case N-740 (Reference 2) that was developed to cover the most recent operating experience and NRC approved criteria that are associated with similar PWOL applications. Therefore, DNC considers that this Case provides an acceptable level of quality and safety, consistent with provisions of 10 CFR 50.55a(a)(3)(i).

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ENCLOSURE 1

ASME CODE CASE N-740, "DISSIMILAR METAL WELD OVERLAY FOR REPAIR OF CLASS 1, 2, AND 3 ITEMS SECTION XI, DIVISION 1", DATED JULY 14, 2006

DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 3

Case number: CASE N-740

Approval Date: July 14, 2006

The ASME Boiler and Pressure Vessel Standards Committee took action to eliminate Code Case expiration dates effective March 11, 2005. This means that all Code Cases listed in this Supplement and beyond will remain available for use until annulled by the ASME Boiler and Pressure Vessel Standards Committee.

Case N-740
Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items
Section XI, Division 1

Inquiry: As an alternative to the provisions of IWA-4410 and IWA-4611 for reducing a defect to an acceptable size in accordance with the provisions of the Construction Code or Section XI, is it permissible to reduce a defect to a flaw of acceptable size by increasing the wall thickness by deposition of weld overlay on the outside surface of the piping, component, or associated weld?

Reply: It is the opinion of the Committee that, in lieu of the requirements of IWA-4410 and IWA-4611, a defect in austenitic stainless steel or austenitic nickel alloy piping, components, or associated welds may be reduced to a flaw of acceptable size in accordance with IWB-3640 by the addition of a weld overlay. All Section XI references are to the 2004 Edition with the 2005 Addenda. For the use of this Case with other editions and addenda, refer to Table 1. The weld overlay shall be applied by deposition of weld reinforcement (weld overlay) on the outside surface of the piping, component, or associated weld, including ferritic materials when necessary, provided the following requirements are met:

1 GENERAL REQUIREMENTS

(a) This Case applies to dissimilar metal austenitic welds between P-No. 8 or 43 and P-Nos. 1, 3, 12A, 12B, or 12C[1] materials or between P-Nos. 1, 3, 12A, 12B, and 12C materials. This Case also applies to dissimilar metal welds between P-No. 8 and P-No. 43 materials and to welds between P-No. 8 and P-No. 43 materials joined with an austenitic filler material.

(b) Weld overlay filler metal shall be low-carbon (0.035% max.) austenitic stainless steel or an austenitic nickel alloy (28% Cr min.) applied 360 deg around the circumference of the item and deposited using a Welding Procedure Specification for groove welding, qualified in accordance with the Construction Code and Owner's Requirements and identified in the Repair/Replacement Plan. As an alternative to the post weld heat treatment

requirements of the Construction Code and Owner's requirements, the provisions of Appendix I may be used for ambient-temperature temper bead welding.

(c) Prior to deposition of the weld overlay, the surface to be repaired shall be examined by the liquid penetrant method. Indications larger than $\frac{1}{16}$ in. (1.5 mm) shall be removed, reduced in size, or corrected in accordance with the following requirements:

(1) One or more layers of weld metal shall be applied to seal unacceptable indications in the area to be repaired with or without excavation. The thickness of these layers shall not be used in meeting weld reinforcement design thickness requirements. Peening the unacceptable indication prior to welding is permitted.

(2) If correction of indications identified in 1(c) is required, the area where the weld overlay is to be deposited, including any local repairs or initial weld overlay layer, shall be examined by the liquid penetrant method. The area shall contain no indications greater than $\frac{1}{16}$ in. (1.5 mm) prior to the application of the structural layers of the weld overlay.

(d) Weld overlay deposits shall meet the following requirements:

(1) The austenitic stainless steel weld reinforcement shall consist of at least two weld layers having as-deposited delta ferrite content of at least 7.5 FN. The first layer of weld metal with delta ferrite content of at least 7.5 FN shall constitute the first layer of the weld reinforcement that may be credited toward the required thickness. Alternatively, first layers of at least 5 FN are acceptable, provided the carbon content of the deposited weld metal is determined by chemical analysis to be less than 0.02%.

(2) The austenitic nickel alloy weld overlay shall consist of at least two weld layers deposited from a filler material with a Cr content of at least 28%. The first layer of weld metal deposited may not be credited toward the required thickness. Alternatively, for PWR applications, a diluted layer may be credited toward the required thickness, provided the portion of the layer over the austenitic base material, austenitic filler material weld, and the associated dilution zone from an adjacent ferritic base material contain at least 24% Cr, and the Cr content of the deposited weld metal is determined by chemical analysis of the production weld or of a representative coupon taken from a mockup prepared in accordance with the WPS for the production weld. Alternatively, for BWR applications, a diluted layer may be credited toward the required thickness, provided the portion of the layer over the austenitic base material, austenitic filler material weld, and the associated dilution zone from an adjacent ferritic base material contain at least 20% Cr, and the Cr content of the deposited weld metal is determined by chemical analysis of the production weld or of a representative coupon taken from a mockup prepared in accordance with the WPS for the production weld.

(e) This Case is only for welding in applications predicted not to have exceeded thermal neutron fluence of 1×10^{17} ($E < 0.5$ eV) neutrons per cm^2 prior to welding.

2 DESIGN

(a) Flaw characterization and evaluation requirements shall be based on the as-found flaw. However, the size of all flaws shall be projected to the end of the design life of the overlay. Crack growth, including both stress corrosion and fatigue crack growth, shall be evaluated in the materials in accordance with IWB-3640. If the flaw is at or near the boundary of two different materials, evaluation of flaw growth in both materials is required.

(b) The design of the weld overlay shall satisfy the following, using the assumptions and flaw characterization restrictions in 2(a). The following design analysis shall be completed in accordance with IWA-4311:

(1) The axial length and end slope of the weld overlay shall cover the weld and heat-affected zones on each side of the weld and provide for load redistribution from the item into the weld overlay and back into the item without violating applicable stress limits of NB-3200. Any laminar flaws in the weld overlay shall be evaluated in the analysis to ensure that load redistribution complies with the above. These requirements will usually be satisfied if the weld overlay full thickness length extends axially beyond the projected flaw by at least $0.75\sqrt{Rt}$, where R is the outer radius of the item and t is the nominal wall thickness of the item.

(2) Unless specifically analyzed in accordance with 2(b)(1), the end transition slope of the overlay shall not exceed 45 deg. A slope of not more than 1:3 is recommended.

(3) For determining the combined length of circumferentially oriented flaws, multiple flaws shall be treated as one flaw of length equal to the sum of the lengths of the individual flaws characterized in accordance with IWA-3300.

(4) For circumferentially oriented flaws, if the combined length is greater than 10% of the item's circumference, the flaws shall be assumed to be 100% through the original wall thickness of the item for the entire circumference of the item. For circumferentially oriented flaws, if the combined length does not exceed 10% of the item's circumference, the flaws shall be assumed to be 100% through the original wall thickness of the item for a circumferential length equal to the combined length of the flaws.

(5) For axial flaws 1.5 in. (38 mm) or longer, or for five or more axial flaws of any length, the flaws shall be assumed to be 100% through the original wall thickness of the item for the entire axial length of the flaw or combined flaws, as applicable.

(6) The overlay design thickness of items meeting the requirements of 2(b)(4) or (5) above shall be based on the measured diameter, using only the weld overlay thickness conforming to the deposit analysis requirements of 1(d). The combined wall thickness at the weld overlay, any planar flaws in the weld overlay, and the effects of any discontinuity (e.g., another weld overlay or reinforcement for a branch connection) within a distance of 2.5 $\sqrt{Rt}$ from the toes of the weld overlay shall be evaluated

and meet the requirements of IWB-3640, IWC-3640, or IWD-3640, as applicable.

(7) The effects of any changes in applied loads, as a result of weld shrinkage from the entire overlay, on other items in the piping system (e.g., support loads and clearances, nozzle loads, and changes in system flexibility and weight due to the weld overlay) shall be evaluated. Existing flaws previously accepted by analytical evaluation shall be evaluated in accordance with IWB-3640, IWC-3640, or IWD-3640, as applicable.

3 EXAMINATION AND INSPECTION

In lieu of all other examination requirements, the examination requirements of this Case shall be met. Nondestructive examination methods shall be in accordance with IWA-2200, except as specified herein. Nondestructive examination personnel shall be qualified in accordance with IWA-2300. Ultrasonic examination procedures and personnel shall be qualified in accordance with Appendix VIII, Section XI.

(a) Acceptance Examination

(1) The weld overlay shall have a surface finish of 250 μin. (6.3 μm) RMS or better and a flatness sufficient to allow for adequate examination in accordance with procedures qualified per Appendix VIII. The weld overlay shall be examined to verify acceptable configuration.

(2) The weld overlay and the adjacent base material for at least ½ in. (13 mm) from each side of the weld shall be examined using the liquid penetrant method. The weld overlay shall satisfy the surface examination acceptance criteria for welds of the Construction Code or NB-5300. The adjacent base metal shall satisfy the surface examination acceptance criteria for base material of the Construction Code or NB-2500. If ambient temperature temper bead welding is used, the liquid penetrant examination shall be conducted at least 48 hr after the completed overlay has returned to ambient temperature.

(3) The examination volume in Fig. 1 shall be ultrasonically examined to assure adequate fusion (i.e., adequate bond) with the base metal and to detect welding flaws, such as interbead lack of fusion, inclusions, or cracks. The interface C-D shown between the overlay and weld includes the bond and heat-affected zone from the overlay. If ambient temperature temper bead welding is used, the ultrasonic examination shall be conducted at least 48 hr after the completed overlay has returned to ambient temperature. Planar flaws shall meet the preservice examination standards of Table IWB-3514-2. In applying the acceptance standards, wall thickness, t_w shall be the thickness of the weld overlay. Laminar flaws shall meet the following:

(a) Laminar flaws shall meet the acceptance standards of Table IWB-3514-3 with the additional limitation that the total laminar flaw shall not exceed 10% of the weld surface area and that no linear dimension of the laminar flaw area exceed 3 in. (76 mm).

(b) The reduction in coverage of the examination

volume in Fig. 1 due to laminar flaws shall be less than 10%. The dimensions of the uninspectable volume are dependent on the coverage achieved with the angle beam examination of the overlay.

(c) Any uninspectable volume in the weld overlay shall be assumed to contain the largest radial planar flaw that could exist within that volume. This assumed flaw shall meet the inservice examination standards of Table IWB-3514-2. Alternately, the assumed flaw shall be evaluated and meet the requirements of IWB-3640, IWC-3640, and IWD-3640, as applicable. Both axial and circumferential planar flaws shall be assumed.

(4) After completion of all welding activities, affected restraints, supports, and snubbers shall be VT-3 visually examined to verify that design tolerances are met.

(b) Preservice Inspection

(1) The examination volume in Fig. 2 shall be ultrasonically examined. The angle beam shall be directed perpendicular and parallel to the piping axis, with scanning performed in four directions, to locate and size any cracks that might have propagated into the upper 25% of the base material or into the weld overlay.

(2) The preservice examination acceptance standards of Table IWB-3514-2 shall be met for the weld overlay. In applying the acceptance standards, wall thickness, t_w, shall be the thickness of the weld overlay. Cracks in the outer 25% of the base metal shall meet the design analysis requirements of 2.

(c) Inservice Inspection

(1) The weld overlay examination volume in Fig. 2 shall be added to the inspection plan and ultrasonically examined during the first or second refueling outage following application.

(2) The weld overlay examination volume in Fig. 2 shall be ultrasonically examined to determine if any new or existing cracks have propagated into the upper 25% of the base material or into the overlay. The angle beam shall be directed perpendicular and parallel to the piping axis, with scanning performed in four directions.

(3) The inservice examination acceptance standards of Table IWB-3514-2 shall be met for the weld overlay. Alternatively, for Class 1, 2, or 3 piping systems, the acceptance criteria of IWB-3600, IWC-3600, or IWD-3600, as applicable, shall be met for the weld overlay. Cracks in the outer 25% of the base metal shall meet the design analysis requirements of 2.

(4) Weld overlay examination volumes that show no indication of crack growth or new cracking shall be placed into a population to be examined on a sample basis. A quarter of this population shall be examined once every 10 years.

(5) If inservice examinations reveal crack growth, or new cracking, meeting the acceptance standards, the weld overlay examination volume shall be reexamined during the first or second refueling outage following discovery of the growth or new cracking.

(6) For weld overlay examination volumes with unac-

ceptable indications as described in 3(c)(2) and (3), the weld overlay shall be removed, including the original defective weld, and the item shall be corrected by a repair/replacement activity in accordance with IWA-4000.

(d) Additional Examinations. If inservice examinations reveal an unacceptable indication, crack growth into the weld overlay design thickness, or axial crack growth beyond the specified examination volume, additional weld overlay examination volumes, equal to the number scheduled for the current inspection period, shall be examined prior to return to service. If additional unacceptable indications are found in the second sample, 50% of the total population of weld overlay examination volumes shall be examined prior to operation. If additional unacceptable indications are found, the entire remaining population of weld overlay examination volumes shall be examined prior to return to service.

4 PRESSURE TESTING

A system leakage test shall be performed in accordance with IWA-5000.

5 DOCUMENTATION

Use of this Case shall be documented on Form NIS-2.

MANDATORY APPENDIX I
AMBIENT-TEMPERATURE TEMPER BEAD WELDING

1 GENERAL REQUIREMENTS

(a) This Appendix applies to dissimilar austenitic filler metal welds between P-Nos. 1, 3, 12A, 12B, and 12C[1] materials and their associated welds and welds joining P-No. 8 or 43 materials to P-Nos. 1, 3, 12A, 12B, and 12C[1] materials with the following limitation. This Appendix shall not be used to repair SA-302 Grade B material unless the material has been modified to include from 0.4% to 1.0% nickel, quenching, tempering, and application of a fine grain practice.

(b) The maximum area of an individual weld overlay based on the finished surface over the ferritic base material shall be 500 in.^{2} (325 000 mm^2).

(c) Repair/replacement activities on a dissimilar-metal weld in accordance with this Appendix 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 in accordance with this Appendix, provided the depth of repair in the base material does not exceed $\frac{3}{8}$ 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) Welding materials shall meet the Owner's Requirements and the Construction Code and Cases specified in the Repair/Replacement Plan. Welding materials shall be controlled so that they are identified as acceptable until consumed.

(g) Peening may be used, except on the initial and final layers.

2 WELDING QUALIFICATIONS

The welding procedures and operators shall be qualified in accordance with Section IX and the requirements of 2.1 and 2.2.

2.1 Procedure Qualification

(a) The base materials for the welding procedure qualification shall be of the same P-Number and Group Number as the materials to be welded. The materials shall be post-weld heat treated to at least the time and temperature that was applied to the materials being welded.

(b) The root width and included angle of the cavity in the test assembly shall be no greater than the minimum specified for the repair.

(c) The maximum interpass temperature for the first three layers of the test assembly shall be 150°F (66°C).

(d) The test assembly cavity depth shall be at least 1 in. (25 mm). The test assembly thickness shall be at least twice the test assembly cavity depth. The test assembly shall be large enough to permit removal of the required test specimens. The test assembly dimensions surrounding the cavity shall be at least the test assembly thickness and at least 6 in. (150 mm). The qualification test plate shall be prepared in accordance with Fig. I-1.

(e) Ferritic base material for the procedure qualification test 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. The location and orientation of the test specimens shall be similar to those required in para. 2.1(f) but shall be in the base metal.

(f) Charpy V-notch tests of the ferritic heat-affected zone (HAZ) shall be performed at the same temperature as the base metal test of 2.1(e). Number, location, and orientation of test specimens shall be as follows:

(1) 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 specimen shall be inclined to allow the root of the notch to be aligned parallel to the fusion line.

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

(3) The Charpy V-notch test shall be performed in accordance with SA-370. Specimens shall be in accordance with SA-370, Fig. 11, Type A. The test shall consist of a set of three full-size 10 mm × 10 mm specimens. The lateral expansion, percent shear, absorbed energy, test temperature, orientation, and location of all test specimens shall be reported in the Procedure Qualification Record.

(g) 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 of this Appendix, either of the following shall be performed:

(1) The welding procedure shall be requalified.

(2) An Adjustment Temperature for the procedure qualification shall be determined in accordance with the applicable provisions of NB-4335.2 of Section III, 2001 Edition with the 2002 Addenda. The RT_{NDT} or lowest service temperature of the materials for which the welding procedure will be used shall be increased by a temperature equivalent to that of the Adjustment Temperature.

2.2 Performance Qualification

Welding operators shall be qualified in accordance with Section IX.

3 WELDING PROCEDURE REQUIREMENTS

The welding procedure shall include the following requirements:

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

(b) Dissimilar metal welds shall be made using A-No. 8 weld metal (QW-442) for P-No. 8 to P-No. 1, 3, or 12 (A, B, or C) weld joints or F-No. 43 weld metal (QW-432) for P-No. 8 or 43 to P-No. 1, 3, or 12 (A, B, or C) weld joints.

(c) The area to be welded shall be buttered with a deposit of at least three layers to achieve at least $\frac{1}{8}$ in. (3 mm) overlay thickness with the heat input for each layer con-

trolled to within ±10% of that used in the procedure qualification test. The heat input of the first three layers shall not exceed 45,000 J/in. (1 800 J/mm) under any conditions. Particular care shall be taken in the placement of the weld layers of the austenitic overlay filler material at the toe of the overlay to ensure that the HAZ and ferritic base metal are tempered. Subsequent layers shall be deposited with a heat input not exceeding that used for layers beyond the third layer in the procedure qualification.

(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 limitation of QW-406.3 need not be applied.

(e) The interpass temperature shall be determined by one of the following methods:

(1) temperature measurement (e.g., pyrometers, temperature-indicating crayons, and thermocouples) during welding

(2) heat-flow calculations using the variables listed below as a minimum

(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) arc time per weld pass and delay time between each pass

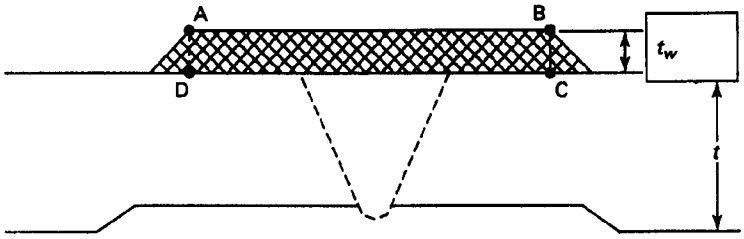
(f) arc time to complete the weld

(3) measurement of the maximum interpass temperature on a test coupon that is equal to or less than the thickness of the item to be welded. The maximum heat input of the welding procedure shall be used in the welding of the test coupon.

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

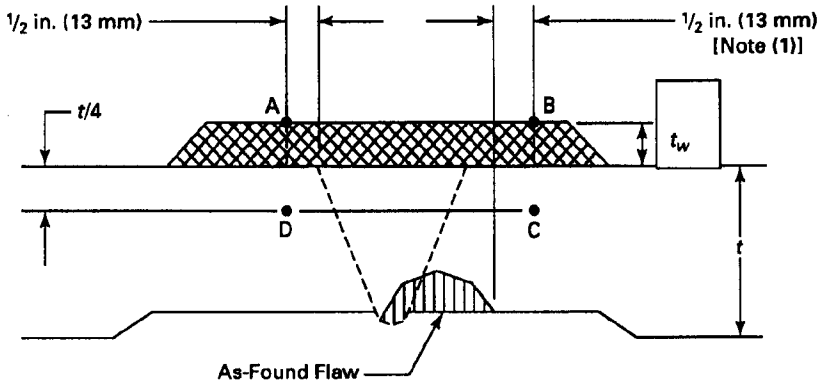
TABLE 1 REFERENCES FOR ALTERNATIVE EDITIONS AND ADDENDA OF SECTION XI

2001 Edition with 2003 Addenda through 2004 Edition with 2005 Addenda	1995 Edition with 1996 Addenda through 2001 Edition with 2002 Addenda	1995 Edition with 1995 Addenda	1989 Edition with 1991 Addenda through 1995 Edition	1986 Edition with 1988 Addenda through 1989 Edition with 1990 Addenda	1983 Edition with Winter 1983 Addenda through 1986 Edition with 1987 Addenda	1980 Edition with Winter 1981 Addenda through 1983 Edition with Summer 1983 Addenda
IWA-4000 Repair/Replacement Activities	IWA-4000	IWA-4000	IWA-4000	IWA-4000 & IWA-7000	IWA-4000 & IWA-7000	IWA-4000 & IWA-7000
IWA-4221 Construction Code and Owner's Requirements Activities	IWA-4220	IWA-4220	IWA-4170	IWA-4120 & IWA-7210	IWA-4120 & IWA-7210	IWA-4120 & IWA-7210
IWA-4311 Configuration Changes	IWA-4311	IWA-4311	N/A	N/A	N/A	N/A
IWA-4410 Welding, Brazing, Metal Removal, and Installation – General Requirements	IWA-4410	IWA-4410	IWA-4410	IWA-4410	IWA-4410	IWA-4110 & IWA-4170
IWA-4411 Welding, Brazing, Fabrication, and Installation	IWA-4410, IWA-4421, IWA-4430	IWA-4410, IWA-4421, IWA-4430	IWA-4170(b)	IWA-4120	IWA-4120	IWA-4120
IWA-3300 Flaw Characterization	IWA-3300	IWA-3300	IWA-3300	IWA-3300	IWA-3300	IWB-3300
IWA-4611 Defect Removal	IWA-4611	IWA-4421 & IWA-4424	IWA-4421 & IWA-4424	IWA-4421 & IWA-4424	IWA-4421 & IWA-4424	IWB-4230
IWB-3514 Standards for Category B-F	IWB-3514	IWB-3514	IWB-3514	IWB-3514	IWB-3514	IWB-3514
IWB/C/D-3600 Analytical Evaluation	IWB/C/D-3600	IWB/C/D-3600	IWB/C/D-3600	IWB/C/D-3600	IWB/C/D-3600	IWB/C/D-3600
IWB/C/D-3640 Evaluation Procedures	IWB/C/D-3640 or IWB/C/D-3650	IWB/C/D-3640 or IWB/C/D-3650	IWB/C/D-3640 or IWB/C/D-3650	IWB/C/D-3640 or IWB/C/D-3650	IWB/C/D-3640 or IWB/C/D-3650	IWB/C/D-3640 or IWB/C/D-3650



Examination Volume A–B–C–D

FIG. 1 ACCEPTANCE EXAMINATION VOLUME

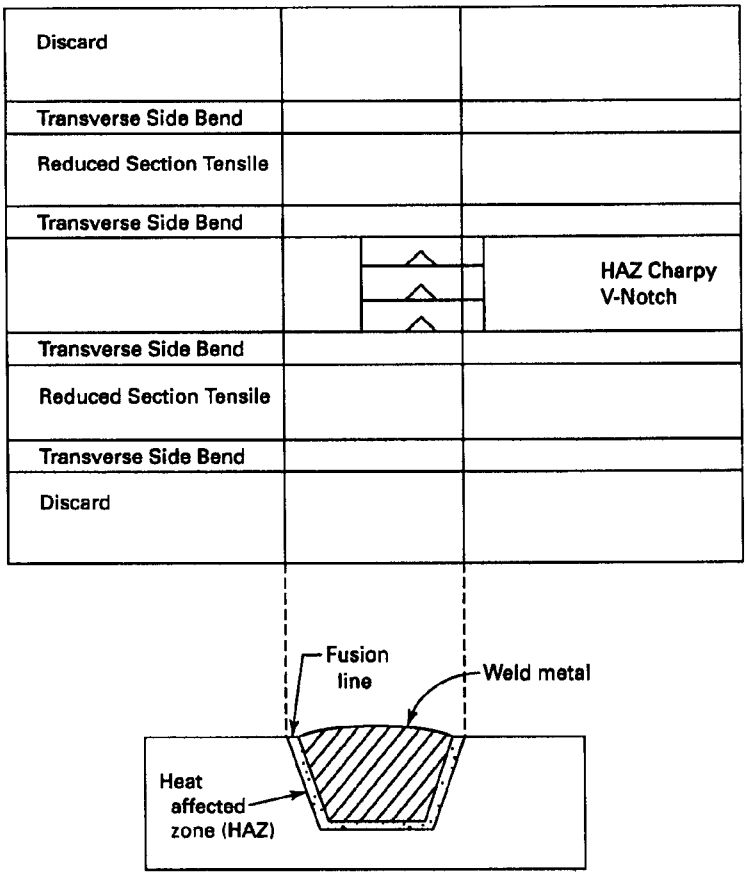


Examination Volume A–B–C–D

NOTE:

(1) For axial or circumferential flaws, the axial extent of the examination volume shall extend at least ½ in. (13 mm) beyond the as-found flaw and at least ½ in. (13 mm) beyond the toes of the original weld, including weld end butter, where applied.

FIG. 2 PRESERVICE AND INSERVICE EXAMINATION VOLUME



GENERAL NOTE: Base metal Charpy impact specimens are not shown. This figure illustrates a similar-metal weld.

FIG. I-1 QUALIFICATION TEST PLATE