FPL Energy
Seabrook Station

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February 13, 2008
Docket No. 50-443

SBK-L-08022

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Seabrook Station

Supplement to Request for Use of Structural Weld Overlays as an Alternative Repair Technique

References:

1. FPL Energy Seabrook, LLC (FPL Energy Seabrook) letter SBK-L-07120, Request for Use of Structural Weld Overlays as an Alternative Repair Technique, July 3, 2007.

Pursuant to 10 CFR 50.55a(a)(3)(i), FPL Energy Seabrook, LLC (FPL Energy Seabrook) requested approval to use the American Society of Mechanical Engineers (ASME) Code Case N-740-1, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items Section XI, Division 1," draft May 2007, to apply dissimilar metal weld overlays for repair/replacement activities (Reference 1). The request contained alternative requirements for the inservice inspection (ISI) program for structural weld overlays (SWOLs) that are planned to mitigate the potential for primary water stress corrosion cracking (PWSCC) susceptibility at Seabrook Station Unit 1. Subsequent to the submittal, FPL Energy Seabrook determined that it was prudent to supplement the previous submittal with an additional information regarding the application of the SWOLs. Attachment 1 contains FPL Energy Seabrook's Alternative Request and Enclosure 1 to Attachment 1 contains the Performance Demonstration Initiative (PDI) Program Modifications to American Society of Mechanical Engineers (ASME) Code, Appendix VIII, Supplement 11. Enclosure 2 provides the "Alternative Requirements for Dissimilar Metal Weld Overlays" and Enclosure 3 is entitled, "Barrier Layer to Prevent Hot Cracking in High Sulfur Stainless Steel."

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 Seabrook Unit 1, and SWOLs for mitigation of potential PWSCC susceptible areas are scheduled for the

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cycle 12 refueling outage and no pre-weld overlay UT examinations are planned. FPL Energy Seabrook 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.

FPL Energy Seabrook requests review and approval of this proposal be expedited to support the Seabrook Unit 1 refueling outage scheduled to begin in April of 2008. Similar alternatives have been submitted for NRC review and approval and are referenced in the attached request. Details of the design analysis for the planned weld overlays are being developed to support the Seabrook Unit 1 2008 refueling outage. The analysis will be available at Seabrook Station for NRC review at the beginning of OR12.

If you have any questions regarding this submittal, please contact Mr. James M. Peschel, Regulatory Programs Manager, at (603) 773-7194.

Very truly yours,

FPL Energy Seabrook, LLC

Gene St. Pierre
Site Vice President

cc: S. J. Collins, NRC Region I Administrator
G. E. Miller, NRC Project Manager
W. J. Raymond, NRC Resident Inspector

Attachment 1 to SBK-L-08022

ATTACHMENT 1

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

USE OF WELD OVERLAYS AS AN ALTERNATIVE REPAIR TECHNIQUE

1.0 ASME Code Components Affected

Code components associated with this request are high safety significant (HSS) Class 1 dissimilar metal welds (DMWs) with Alloy 82/182 weld metal in the pressurizer that are believed to be susceptible to Primary Water Stress Corrosion Cracking (PWSCC). There are six (6) welds that are scheduled to have preemptive full structural weld overlays (SWOLs) applied. In addition the SWOLs will extend across the six (6) adjacent stainless steel pipe-to-safe end similar metal welds. These welds are scheduled to have SWOLs applied during refueling outage 12 (OR12) that is currently scheduled to commence in April 2008.

1.1 Category and System Details:

Code Class:	Class 1
System Welds:	Reactor Coolant System
Examination Categories:	R-A*

*Welds are included in the Risk Informed Inservice Inspection Program

1.2 Component Descriptions:

The application of this alternative to apply SWOLs on one (1) potentially PWSCC susceptible safe end–to-pressurizer surge nozzle DMW, three (3) safe end-to safety nozzle DMWs, one (1) safe end-to-relief nozzle DMW and one (1) safe end-to-spray nozzle DMW. The SWOLs will extend outward across the adjacent stainless steel pipe-to-safe end welds. The applicable weld identifications are shown in Table 1. The general configuration for the different nozzle locations is shown in Figure 1.

TABLE 1

WELD NUMBERS BY ISI DESIGNATION

		Weld Number by ISI Designation	
Item	**Location**	**Safe End to Nozzle Weld**	**Pipe to Safe End Weld**
1	Pressurizer Spray Nozzle	RC E-10 SP-SE	RC 0048-03 06
2	Pressurizer Relief Nozzle B	RC E-10 B-SE	RC 0080-01 01
3	Pressurizer Safety Nozzle A	RC E-10 A-SE	RC 0074-01 01
4	Pressurizer Safety Nozzle C	RC E-10 C-SE	RC 0075-01 01
5	Pressurizer Safety Nozzle D	RC E-10 D-SE	RC 0076-01 01
6	Pressurizer Surge Nozzle	RC E-10 S-SE	RC 0049-01 05

1.3 Component Materials:

The applicable materials are depicted in Table 2. There are no cast stainless steel materials.

TABLE 2

MATERIALS

Location	**Nozzle (P-No. 3 Group 3)**	**Nozzle Buttering (F-No. 43)**	**Safe End to Buttering Weld**	**Safe End (P-No. 8 Group 1)**	**Pipe to Safe End Weld (A-No. 8)**	**Pipe (P-No. 8 Group 1)**
Spray	SA-508 Cl 2a	Alloy 182	Alloy 82/182	SA-182 GR F316L	ER308/E308	SA-376 TP316
Safety & Relief	SA-508 Cl 2a	Alloy 182	Alloy 82/182	SA-182 GR F316L	ER308/E308 with ER308L Root Insert	SA-376 TP316
Surge	SA-508 Cl 2a	Alloy 182	Alloy 82/182	SA-182 GR F316L	ER308/E308	SA-376 TP304

2.0 Applicable Code Edition and Addenda

Seabrook Station is currently in the 2nd 10-year Inservice Inspection (ISI) interval. The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) of record for the current 10-year ISI interval is Section XI, 1995 Edition, including Addenda through 1996 (Reference 1) for the Repair/Replacement Program.

3.0 Applicable Code Requirement

The applicable Code requirement for which the relief is requested is ASME Code Section XI, 1995 Edition including Addenda through 1996 (Reference 1), IWA-4410, IWA-4611 and Appendix VIII, Supplement 11.

IWA-4410(a) states:

"Repair/replacement activities shall be performed in accordance with the Owner's Requirements and the original Construction Code of the component or system, except as provided in IWA-4410(b), (c), and (d)."

IWA-4410(c) states in part the following:

"Alternatively, the applicable requirements of IWA-4600 may be used for welding….."

IWA-4611.1(a) states in part the following:

"Defects shall be removed or reduced in size in accordance with this Paragraph."

IWA-4611.1(b) states:

The original defect shall be removed:

IWA-4611.1(b)(2) states:

"when welding is required in accordance with IWA-4630 or IWA-4640 and the defect penetrates the base material."

IWA-4611.4(a) states in part the following:

"After final grinding, 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 IWA-3000…."

Appendix VIII provides requirements for performance demonstration for ultrasonic examination systems. Supplement 11 provides qualification requirements for full structural overlaid wrought austenitic piping welds.

4.0 Reason for Request

DMWs, primarily consisting of Alloy 82/182 weld metal are frequently used in pressurized water reactor (PWR) construction to connect stainless steel pipe and safe ends to vessel and pipe nozzles that are typically constructed of carbon or low alloy ferritic steel. These welds have shown a tendency for PWSCC degradation, especially in components subjected to higher operating temperatures, such as the pressurizer. See EPRI MRP-169 "Technical basis for Preemptive Weld Overlays for Alloy 82/182 Butt Welds in PWRs", October 2005 (Reference 2).

During OR12, six (6) DMWs located on the pressurizer are scheduled to have SWOLs applied. ASME Code Section XI, 1995 Edition, including Addenda through 1996 (Reference 1), IWA-4410 and IWA-4611, does not provide all the needed requirements for this type of repair since potential existing defects will not be removed or reduced in size and weld overlay of potential existing flaws in DMWs will be performed. In addition, ASME Code Section XI, 1995 Edition, including Addenda through 1996 (Reference 1), Appendix VIII, Supplement 11 cannot be implemented as written for ultrasonic examination of a structural weld overlay repair. Enclosure 1 includes a discussion of the Performance Demonstration Initiative (PDI) Program alternatives and their bases with respect to Appendix VIII, Supplement 11 requirements. Comprehensive and generic NRC approved criteria are not currently available for application of SWOL repairs to DMWs constructed of Alloy 82/182 weld material for mitigation of potential PWSCC.

The alternative described in Section 5.0 is proposed to permit the implementation of SWOLs at Seabrook Station, as an alternative for the repair and replacement requirements of the ASME Code Section XI, 1995 Edition including Addenda through 1996 (Reference 1), IWA-4410, IWA-4611 and Appendix VIII, Supplement 11.

5.0 Proposed Alternative And Basis for Use

This proposal requests the use of the Alternative Requirements shown in Enclosure 2 for implementing the six (6) scheduled SWOLs for potentially PWSCC susceptible safe end-to-nozzle welds of the pressurizer. These SWOLs will include the six (6) adjacent stainless steel pipe-to-safe end welds. This request applies to each of the welds listed in Section 1.2, which are generically depicted in Figure 1. The proposed Alternative is scheduled to be performed during the Seabrook Station Spring 2008 refueling outage.

This proposed alternative (Enclosure 2) is the result of industry's experience with weld overlay modifications for flaws suspected or confirmed to be caused by PWSCC and directly applies to the Alloy 52 or 52M weld material that is primarily being used for these SWOL's.

The ultrasonic examination of the completed SWOLs will be accomplished using personnel and procedures qualified in accordance with ASME Code Section XI, 1995 Edition, including Addenda through 1996 (Reference 1), Appendix VIII, Supplement 11 (as specified in Enclosure 2, Section 3 therein), with the alternatives used for complying with the PDI Program. See Enclosure 1 for the PDI Program changes to Appendix VIII, Supplement 11.

5.1 SWOL Design

The SWOLs satisfy all the structural design requirements of the pipe as specified in the Alternative Requirements shown in Enclosure 2 for the original safe end-to-nozzle welds and the pipe -to-safe end welds. As shown in Figure 1, the SWOLs will completely cover the existing Alloy 82/182 weld and will extend onto the ferritic nozzle and austenitic stainless steel material on each end of the weld, including the adjacent pipe -to-safe end weld. The SWOL's extend around the entire circumference of the nozzle. Alloy 52M and 52 filler metals are compatible with all the wrought materials and the DMW and similar metal welds that will be covered by the SWOL.

The SWOLs will be designed as full structural overlays. Postulated 100% through wall flaws shall be assumed as specified in 2(b)(3), Enclosure 2, for SWOL length and thickness sizing as specified in 2(b)(4) Enclosure 2. No ultrasonic examination will be performed prior to SWOL application. For flaw growth evaluations, since no ultrasonic examination will be performed prior to SWOL application, postulated 75% through wall flaws will be assumed as specified in 2(a)(2) and 2(a)(2)(a), Enclosure 2, for the welds on all nozzle locations where SWOLs will be applied. Planar flaws detected during the acceptance examination will be characterized and flaw growth calculations performed using the flaw(s) detected plus the postulated 75% through wall flaws.

Note that the details surrounding the design analysis for the SWOLs are being developed to support the Seabrook Station Spring 2008 refueling outage (OR12) and our vendor has committed to supplying this analysis to FPL. The analysis will be available at the plant for NRC review at the beginning of the OR12 refuel outage.

Paragraph 3(a)(3) of Enclosure 2 states that "for planar indications outside this examination volume, the nominal wall thickness shall be "t_2" as shown in Fig 1(c) for volumes A-E-H-D and F-B-C-G." Initial 100% through wall axial and circumferential flaws are assumed for SWOL design and 75% through wall axial and circumferential flaws are assumed for flaw growth evaluations at all nozzle locations where SWOLs will be installed. "t_2" is ½ in. outside the PWSCC susceptible DMW. The portion of the pipe, safe end or nozzle material outside the PWSCC susceptible material is assumed unflawed. These volumes are also outside any other Section XI ISI volume other than associated with the original weld ISI as shown in Figure IWB-2500-8(c) so service related flaws therein are not expected to occur. Surface examination is also performed on these areas before the SWOLs are applied to verify absence of surface flaws. The volume of the overlay which is more than ½ inch from the susceptible region is treated as a cross section which is the SWOL thickness plus the original underlying base metal wall thickness. The acceptance standard for a flaw in the SWOL from Table IWB-3514-2 is thus based on" t_2". The approach is consistent with other examinations in Section XI including pipe to pipe welds where the examination volume does not include the entire thickness but the acceptance criteria does. Furthermore indications in the overlay will be required to be sized. This requirement will assure that the indications which may extend into the base metal are not excluded.

5.2 Welding

The welding will be performed in accordance with Enclosure 2 using a remote machine gas tungsten-arc welding (GTAW) process and using the ambient temperature temper bead method with ERNiCrFe-7A (Alloy 52M) weld metal. Manual GTAW, using ERNiCrFe-7 (Alloy 52) or Alloy 52M will be used if local repairs of weld defects are necessary or additional weld metal is required locally to form the final SWOL contour in locations at least 3/16 in. away from the low alloy steel nozzles.

During recent DMW overlay activities, where use of ERNiCrFe-7A (Alloy 52M) and ERNiCrFe-7 (Alloy 52) has been used for the filler metal, flaws in the first layer have occurred in the portion of the overlay deposited on the austenitic stainless steel portions (safe ends, pipe etc.) of the assemblies in some cases.

The flaw characteristics observed above are indicative of hot cracking. This phenomenon has not been observed on the ferritic steel or ENiCrFe-3 (Alloy 182) DMW portions of the assemblies when welding Alloy 52M thereon.

Further studies have determined that this problem may occur when using Alloy 52M filler metal on austenitic stainless steel materials with high sulfur content.

Limited tests and evaluations recently performed by AREVA have resulted in the conclusion that welding with Alloy 52M on stainless steel base material with 0.020 wt% sulfur results in cracking while welding on stainless steel base materials with less than 0.010 wt% have resulted in no cracking.

Seabrook Station will use the barrier layer on all the stainless steel items prior to overlay. The barrier layer will use ER309L on the stainless steel and Alloy 82 on the stainless steel near the DMW to stainless steel fusion zone only.

The barrier layer will not be used in the structural analysis or in the crack growth analysis. The inside diameter of the portion of the SWOL over the barrier layer will be the outside diameter of the barrier layer that is applied over the stainless steel material beneath the SWOL. See Enclosure 3 for more information.

The Cr content of the 1st layer was verified by weld deposition on an A-106 Grade B pipe mockup using double up progression (starting at bottom and welding upward to top on each side). Welding was performed in the 6G position with Cr measured at 90 degree increments starting at 45 degrees from top. All welding parameters were recorded and the 24% minimum Cr value specified in 1(e), Enclosure 2, was attained. The same heat of wire, or wire heat with equal or greater Cr content than that used in qualification, will be used in situ for the first layer. The same welding parameters will be specified in the WPS as was used in the mockup for the portion of the first layer extending over the austenitic base material, austenitic filler material weld and the associated dilution zone from the adjacent ferritic steel nozzle base material at the edge of the DMW, as specified in paragraph 1.0(e), Enclosure 2.

The SWOL will require welding on more than 100 square inches of surface on the pressurizer surge nozzle low alloy steel base material but less than 300 square inches which is permitted in Appendix I, I-1(b), Enclosure 2. The SWOL will extend toward the pressurizer onto the ferritic steel nozzle base material for a sufficient length so that qualified ultrasonic examination of the required volume can be performed after the SWOL is applied.

There have been a number of temper bead SWOLs applied to safe-end to nozzle welds in the nuclear industry, and SWOLs having more than 100 square inch surface area on the nozzle ferritic steel surfaces have been used. The ASME Committee has indicated the inside diameter compressive stress levels remain essentially the same for both 100 square inches and 500 square inches related to SWOL applications. The justification entitled "Bases for 500 Sq. In. Weld Overlay Over Ferritic Material", was provided to the NRC staff in the January 10, 2007 meeting (Accession No. ML070470565). Additional justification is provided in Appendix F of EPRI Report 1014351, Repair and Replacement Applications Center: Topical Report Supporting Expedited NRC Review of Code Cases for Dissimilar Metal Weld Overlay Repairs" July 2006 (Reference 4).

The thickness of the SWOLs may exceed ½ the carbon and low alloy ferritic steel nozzle base metal thickness as specified in Code Case N-638-1. The requirement therein applies to excavated cavities in the ferritic steel base material that are subsequently welded flush. This requirement is not applicable to SWOLs since they are applied to the nozzle surface and limited to 3/8 in. depth into the ferritic steel as specified in Enclosure 2, Appendix I, I-1(d). Additional justification is provided in Appendix F of Reference 4.

I-3.0(d), Appendix I, Enclosure 2, specifies the maximum interpass temperature shall be limited to 350F maximum, even though the maximum interpass temperature is limited to 150F maximum for the first three layers in the test assembly specified in I-2.1(c). This is greater than the maximum 100F interpass temperature increase permitted by QW-406.3. The following is a clarification of the intent of Code Case N-638-1 that has been included in Code Case N-638-2. The limitation on the procedure qualification maximum interpass temperature(150F) is to ensure the cooling rates achieved during procedure qualification are more severe than those encountered during field welding (are not slower than those achievable during field welding). The higher interpass temperature is permitted during field welding because it would only result in slower cooling rates which could be helpful in producing more ductile transformation products in the ferritic steel heat affected zone (HAZ). Additional justification information is also included in Appendix D, Reference 4.

5.3 Examination

Appendix VIII Supplement 10 ultrasonic examination will not be performed on the DMWs prior to the SWOLs being applied. Since the structural integrity at the DMW locations will be restored by the SWOLs the ultrasonic examination of the DMWs prior to SWOL application is unnecessary and the increased personnel dose that would be incurred performing the examinations is also undesirable and not consistent with good ALARA practice. All welds have postulated 100% through wall cracks for the SWOL design and postulated 75% through wall cracks for the flaw growth evaluations.

The ultrasonic and surface examinations will be performed on the temper bead portion of the SWOLs no sooner than 48 hours after completion of the third temper bead layer as specified in 3(a)(2) and 3(a)(3), Enclosure 2.

The 48 hour delay is intended to provide time for delayed hydrogen cracking occurrence. Enclosure 2, Appendix 1 requires the machine or automatic GTAW process to be used for temper bead welding thereby eliminating the use of welding processes requiring flux for arc shielding.

The machine GTAW temper bead process uses a welding process that is inherently free of hydrogen. The GTAW process relies on bare welding electrodes and bare wire filler metal with no flux to absorb moisture. An inert gas blanket provides shielding for the weld and surrounding metal, which protects the region during welding from the atmosphere and the moisture it may contain and typically produces porosity free welds. In accordance with the weld procedure qualification, welding grade argon is used for the inert gas blanket. To further reduce the likelihood of any hydrogen effects, specific controls will be used to ensure the welding electrodes, filler metal and weld region are free of all sources of hydrogen.

In addition, the use of the machine GTAW temper bead process provides precise control of heat input, bead placement, bead size and contour. The very precise control over these factors afforded by the machine GTAW process provides effective tempering of the nozzle ferritic steel HAZ resulting in achievement of lower hardness and tempered martensite. This further reduces susceptibility to hydrogen induced cracking.

EPRI Report 1013558, Temperbead Welding Applications, 48 Hour Hold Requirements for Ambient Temperature Temperbead Welding, Technical Update, December 2006 (Reference 3) provides justification for reducing the 48 hour hold time on P-No. 3 Group No. 3 ferritic steel base material to start after completion of the third temper bead layer, as specified in Enclosure 2. Report 1013558 addresses microstructural issues, hydrogen sources, tensile stress and temperature, and diffusivity and solubility of hydrogen in steels.

Past industry experience with the use of the machine or automatic GTAW process has resulted in no detection of hydrogen induced cracking after the 48 hour hold nondestructive examination (NDE) or subsequent in-service inspections.

Code Case N-638-4, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique Section XI Division 1," specifies NDE to be performed on the final weld no sooner than 48 hours after completion of the third temper bead layer.

All examinations will meet the requirements of Enclosure 2, excluding qualification of the ultrasonic examination for the completed SWOLs. The ultrasonic examination qualification will be in accordance with ASME Code Section XI, 1995 Edition including Addenda through 1996 (Reference 1), Appendix VIII, Supplement 11 with the alternatives that are used to comply with the PDI Program. See Enclosure 1 for the PDI Program changes to Appendix VIII Supplement 11. Inservice inspection will be performed as specified in Enclosure 2 with the exceptions that the ultrasonic examination procedures and personnel will be qualified in accordance Appendix VIII, Supplement 11 as modified by the PDI Program as specified in Enclosure 1.

The final ultrasonic examination report will be submitted to the NRC within 60 days after completion thereof. Any flaws detected that exceed the acceptance standards of Table IWB-3514-2 will be reported to the NRC as soon as possible. A discussion and reason for any SWOL or base metal repairs will be provided.

The ultrasonic examination requirements specified in NRC Regulatory Guide 1.147 Revision 14 as conditional acceptance of Code Case N-638-1 are not applicable to SWOLs. Ultrasonic examination (UT) of the SWOLs will be performed in accordance with Section XI, Appendix VIII, Supplement 11 qualified procedures and personnel as modified by PDI. The PDI modifications are shown in Enclosure 1. Supplement 11 was prepared to be specifically applicable to weld overlays. The ultrasonic examination requirements in Section 3, Enclosure 2, are similar to the ultrasonic examination requirements provided in Appendix Q which have been developed specifically for austenitic weld overlays. The UT to be performed, in conjunction with the surface examinations to be performed, as specified in Section 3 Enclosure 2 are based on the latest industry experience and practice and completely satisfactory for the SWOL application.

The uninspectable volume noted in 3(a)(3)(c), Enclosure 2, is defined in 3(a)(3)(b) as the volume in the weld overlay underneath the laminar flaw(s) for which coverage cannot be achieved using the angle beam examination method. It is the hypothetical volume that is created by the angle beam shadow from the laminar flaw.

Flaws in the SWOL that do not comply with the preservice examination acceptance standards of Table IWB-3514-2 will be removed.

5.4 Conclusion

The proposed alternative shown in Enclosure 2 has been developed to cover the most recent operating experience and NRC approved criteria that are associated with similar SWOL applications. Similar NRC approved requests have been used to produce acceptable weld overlays when applied to DMWs with Alloy 82/182 weld material. Therefore FPL considers that Enclosure 2 and the PDI Program provides an acceptable level of quality and safety, consistent with provisions of 10 CFR 50.55a(a)(3)(i).

6.0 Precedents

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 weld overlays applied to their pressurizer nozzle DMWs.

In a letter dated, March 13, 2007, a similar request was submitted for North Anna Units 1 and 2 by Virginia Electric and Power Company (Dominion). NRC verbal approval was received March 29, 2007 and final NRC approval was documented and provided in December 2007.

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

(1) 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), Docket No. 50-289, (TAC No. MC1201), dated: July 21, 2004, (ADAMS Accession No. ML041670510).

(2) NRC letter, Safety Evaluation for Calvert Cliffs Nuclear Power Plant, Unit No. 2, Docket No. 550-318, Relief Request for Use Weld Overlay and Associated Alternative Inspection Techniques (TAC Nos. MC6219 and MC6220), dated July 20, 2005, (ADAMS Accession No. ML051930316).

(3) 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) Docket No. 50-423, (TAC No. MC8609), dated January 20, 2006, (ADAMS Accession No. ML053260012).

(4) NRC letter, Safety Evaluation of Alternative Regarding Repair of Safe-End-To-Elbow Weld 1-RC-9-01F at the Donald C. Cook Nuclear Plant Unit 1, Docket No. 50-315, (TAC No. MC8807), dated February 10, 2006, (ADAMS Accession No. ML060240355).

7.0 Duration of Proposed Alternative

The alternative requirements of this request will be applied for the duration of up to and including the last outage of the current 2^{nd} 10-year ISI interval which includes inservice examination requirements in Enclosure 2 for any applied weld overlays. Future inservice examinations of weld overlays at Seabrook Station beyond this inspection interval will be as required by the NRC in the regulations

8.0 References

1. ASME Code, Section XI, 1995 Edition, including Addenda through 1996.
2. EPRI MRP-169 "Technical Basis for Preemptive Weld Overlays for Alloy 82/182 Butt Welds in PWRs", October 2005.
3. EPRI Report 1013558, Temperbead Welding Applications, 48 Hour Hold Requirements for Ambient Temperature Temperbead Welding, Technical Update, December 2006.
4. EPRI Report 1014351, Topical Report Supporting and Expedited NRC Review of the Content of the Code Case needed for Dissimilar Metal Weld Overlay Repairs, Final Report, July 2006.

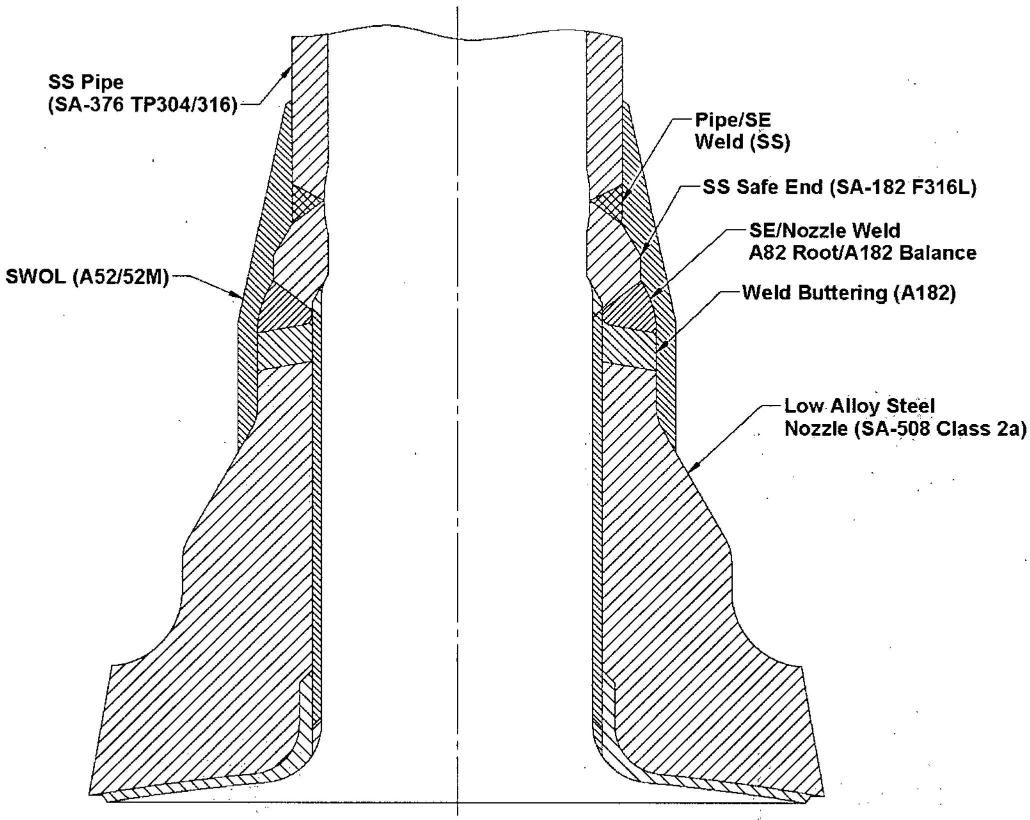


Figure 1 - Typical SWOL Configuration

Enclosure 1 to

Attachment 1 to SBK-L-08022

Enclosure 1
PDI Program Modifications to ASME Code, Appendix VIII, Supplement 11

Appendix VIII, Supplement 11	PDI Modification
1.0 SPECIMEN REQUIREMENTS	
1.1 General	
(b) The specimen set shall consist of at least three specimens having different nominal pipe diameters and overlay thicknesses. They shall include the minimum and maximum nominal pipe diameters for which the examination procedure is applicable. Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent. If the procedure is applicable to pipe diameters of 24 inches or larger, the specimen set must include at least one specimen 24 inches or larger but need not include the maximum diameter. The specimen set must include at least one specimen with overlay thickness within -0.1 inches to +0.25 inches of the maximum nominal overlay thickness for which the procedure is applicable.	Modification: **(b) The specimen set shall consist of at least three specimens having different nominal pipe diameters and overlay thicknesses. They shall include the minimum and maximum nominal pipe diameters for which the examination procedure is applicable. Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent. If the procedure is applicable to pipe diameters of 24 inches or larger, the specimen set must include at least one specimen 24 inches or larger but need not include the maximum diameter. The specimen set shall include specimens with overlays not thicker than 0.1 inches more than the minimum thickness, nor thinner than 0.25 inches of the maximum nominal overlay thickness for which the examination procedure is applicable.** ***Basis:*** *To avoid confusion, the overlay thickness tolerance contained in the last sentence was reworded and the phrase "and the remainder shall be alternative flaws" was added to the next to last sentence in paragraph 1.1 (d) (1).*
(d) Flaw Conditions	
(1) Base metal flaws.	
All flaws must be cracks in or near the butt weld heat-affected zone, open to the inside surface, and extending at least 75% through the base metal wall. Flaws may extend 100% through the base metal and into the overlay material; in this case, intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the cracking. Specimens containing IGSCC shall be used when available.	**Modification**: All flaws must be in or near the butt weld heat-affected zone, open to the inside surface, and extending at least 75% through the base metal wall. Intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the base metal flaws. Specimens containing IGSCC shall be used when available. At least 70% of the flaws in the detection and sizing tests shall be cracks and the remainder shall be alternative flaws. Alternative flaw mechanisms, if used, shall provide crack-like reflective characteristics and shall be limited by the following: (a) The use of alternative flaws shall be limited to when the implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws. (b) Flaws shall be semi elliptical with a tip width of less than or equal to 0.002 inches. ***Basis:*** *This paragraph requires that all base metal flaws be cracks. Implanting a crack requires excavation of the base material on at least one side of the flaw. While this may be satisfactory for ferritic materials, it does not produce a useable axial flaw in austenitic materials because the sound beam, which normally passes only*

Appendix VIII, Supplement 11	PDI Modification
	through base material, must now travel through weld material on at least one side, producing an unrealistic flaw response. To resolve this issue, the PDI Program revised this paragraph to allow use of alternative flaw mechanisms under controlled conditions. For example, alternative flaws shall be limited to when implantation of cracks precludes obtaining an effective ultrasonic response, flaws shall be semi elliptical with a tip width of less than or equal to 0.002 inches, and at least 70% of the flaws in the detection and sizing test shall be cracks and the remainder shall be alternative flaws. To avoid confusion, the overlay thickness tolerance contained in paragraph 1.1(b) last sentence, was reworded and the phrase "and the remainder shall be alternative flaws" was added to the next to last sentence. Paragraph 1.1(d)(1) includes the statement that intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the base metal flaws.
(e) Detection Specimens	
(1) At least 20% but less than 40% of the flaws shall be oriented within ±20 degrees of the pipe axial direction. The remainder shall be oriented circumferentially. Flaws shall not be open to any surface to which the candidate has physical or visual access. The rules of IWA-3300 shall be used to determine whether closely spaced flaws should be treated as single or multiple flaws.	Modification: **(1) At least 20% but less than 40% of the base metal flaws shall be oriented within ±20 degrees of the pipe axial direction. The remainder shall be oriented circumferentially. Flaws shall not be open to any surface to which the candidate has physical or visual access.** ***Basis:*** *The requirement for axially oriented overlay fabrication flaws was excluded from the PDI Program as an improbable scenario. Weld overlays are typically applied using automated GTAW techniques with the filler metal applied in a circumferential direction. Because resultant fabrication induced discontinuities would also be expected to have major dimensions oriented in the circumferential direction axial overlay fabrication flaws are unrealistic. The requirement for using IWA-3300 for proximity flaw evaluation was excluded, instead indications will be sized based on their individual merits.*
(2) Specimens shall be divided into base and overlay grading units. Each specimen shall contain one or both types of grading units.	**Modification:** (2) Specimens shall be divided into base metal and overlay fabrication grading units. Each specimen shall contain one or both types of grading units. Flaws shall not interfere with ultrasonic detection or characterization of other flaws.
(a)(1) A base grading unit shall include at least 3 inches of the length of the overlaid weld. The base grading unit includes the outer 25% of the overlaid weld and base metal on both sides. The base grading unit shall not include the inner	**Modification:** (a)(1) A base metal grading unit includes the overlay material and the outer 25% of the original overlaid weld. The base metal grading unit shall extend circumferentially for at least 1 inch and shall start at the weld centerline and be wide enough in the axial direction to encompass one half of the original weld crown and a minimum of 0.50 inch of the adjacent base material.

Appendix VIII, Supplement 11	PDI Modification
75% of the overlaid weld and base metal overlay material, or base metal-to-overlay interface.	***Basis:*** *The phrase "and base metal on both sides," was inadvertently included in the description of a base metal grading unit, The PDI Program intentionally excludes this requirement because some of the qualification samples include flaws on both sides of the weld. To avoid confusion several instances of the term "cracks" or "cracking" were changed to the term "flaws" because of the use of alternative flaw mechanisms. Modified to require that a base metal grading unit include at least 1 inch of the length of the overlaid weld, rather than 3 inches.*
(a)(2) When base metal cracking penetrates into the overlay material, the base grading unit shall include the overlay metal within 1 inch of the crack location. This portion of the overlay material shall not be used as part of any overlay grading unit.	**Modification:** (a)(2) When base metal flaws penetrate into the overlay material, the base metal grading unit shall not be used as part of any overlay fabrication grading unit.
(a)(3) When a base grading unit is designed to be unflawed, at least 1 inch of unflawed overlaid weld and base metal shall exist on either side of the base grading unit. The segment of weld length used in one base grading unit shall not be used in another base grading unit. Base grading units need not be uniformly spaced around the specimen.	**Modification:** (a)(3) Sufficient unflawed overlaid weld and base metal shall exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws. ***Basis:*** *Modified to require sufficient unflawed overlaid weld and base metal to exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws, rather than the 1 inch requirement.*
(b)(1) An overlay grading unit shall include the overlay material and the base metal-to-overlay interface of at least 6 square inches. The overlay grading unit shall be rectangular, with minimum dimensions of 2 inches.	**Modification:** (b)(1) An overlay fabrication grading unit shall include the overlay material and the base metal-to-overlay interface for a length of at least 1 inch. ***Basis:*** *Modified to require sufficient unflawed overlaid weld and base metal to exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws, rather than the 2 inch requirement.*
(b)(2) An overlay grading unit designed to be unflawed shall be surrounded by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 inch around its entire perimeter. The specific area used in one overlay grading unit shall not be used in another overlay grading unit. Overlay grading units need not be spaced uniformly about the specimen.	**Modification:** (b)(2) Overlay fabrication grading units designed to be unflawed shall be separated by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 inch at both ends. Sufficient unflawed overlaid weld and base metal shall exist on both sides of the overlay fabrication grading unit to preclude interfering reflections from adjacent flaws. The specific area used in one overlay fabrication grading unit shall not be used in another overlay fabrication grading unit. Overlay fabrication grading units need not be spaced uniformly about the specimen.

Appendix VIII, Supplement 11	PDI Modification
	Basis: *Paragraph 1.1 (e)(2)(b)(2) states that overlay fabrication grading units designed to be unflawed shall be separated by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 in. at both ends, rather than around its entire perimeter.*
(b)(3) Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base grading units, ten unflawed base grading units, five flawed overlay grading units, and ten unflawed overlay grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units.	**Modification:** (b)(3) Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base metal grading units, ten unflawed base metal grading units, five flawed overlay fabrication grading units, and ten unflawed overlay fabrication grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units. For initial procedure qualification, detection sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required.
(f) Sizing Specimen	
(1) The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws shall be cracks open to the inside surface.	**Modification:** (1) The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws shall be open to the inside surface. Sizing sets shall contain a distribution of flaw dimensions to assess sizing capabilities. For initial procedure qualification, sizing sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required.
(3) Base metal cracking used for length sizing demonstrations shall be oriented circumferentially.	Modification: **(3) Base metal flaws used for length sizing demonstrations shall be oriented circumferentially.**
(4) Depth sizing specimen sets shall include at least two distinct locations where cracking in the base metal extends into the overlay material by at least 0.1 inch in the through-wall direction.	Modification: **(4) Depth sizing specimen sets shall include at least two distinct locations where a base metal flaw extends into the overlay material by at least 0.1 inch in the through-wall direction.**
2.0 CONDUCT OF PERFORMANCE DEMONSTRATIONS	
The specimen inside surface and identification shall be concealed from the candidate. All examinations shall be completed prior to grading the results and presenting the results to the candidate. Divulgence of particular specimen results or candidate viewing of	Modification: **The specimen inside surface and identification shall be concealed from the candidate. All examinations shall be completed prior to grading the results and presenting the results to the candidate. Divulgence of particular specimen results or candidate viewing of unmasked specimens after the performance demonstration is prohibited. The overlay fabrication flaw test and the base metal flaw test may be**

Appendix VIII, Supplement 11	PDI Modification
unmasked specimens after the performance demonstration is prohibited.	**performed separately.**
2.1 Detection Test.	
Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base or overlay) that are present for each specimen.	**Modification:** Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base metal or overlay fabrication) that are present for each specimen.
2.2 Length Sizing Test	
(d) For flaws in base grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25% of the base wall thickness.	**Modification:** (d) For flaws in base metal grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25% of the base metal wall thickness.
2.3 Depth Sizing Test.	
For the depth sizing test, 80% of the flaws shall be sized at a specific location on the surface of the specimen identified to the candidate. For the remaining flaws, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region.	**Modification:** (a) The depth sizing test may be conducted separately or in conjunction with the detection test. (b) When the depth sizing test is conducted in conjunction with the detection test and the detected flaws do not satisfy the requirements of 1.1(f), additional specimens shall be provided to the candidate. The regions containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region. (c) For a separate depth sizing test, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region.
3.0 ACCEPTANCE CRITERIA	
3.1 Detection Acceptance Criteria.	
Examination procedures, equipment, and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls. The criteria shall be satisfied separately by the demonstration results for base grading units and for overlay grading units. 3.2 Sizing Acceptance Criteria.	**Modification:** Examination procedures are qualified for detection when: (a) All flaws within the scope of the procedure are detected and the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for false calls. (b) At least one successful personnel demonstration has been performed meeting the acceptance criteria defined in (c). (c) Examination equipment and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls. (d) The criteria in (b) and (c) shall be satisfied separately by the demonstration results for base metal grading units and for overlay fabrication grading units.
(a) The RMS error of the flaw length measurements, as compared to the true flaw lengths, is less than or equal to 0.75 inch. The	**Modification:** (a) The RMS error of the flaw length measurements, as compared to the true flaw lengths, is less than or equal to 0.75 inch. The length of base metal

Appendix VIII, Supplement 11	PDI Modification
length of base metal cracking is measured at the 75% through-base-metal position.	flaws is measured at the 75% through-base-metal position.
(b) All extensions of base metal cracking into the overlay material by at least 0.1 inch are reported as being intrusions into the overlay material.	**Modification:** This requirement is omitted. ***Basis:*** *The requirement for reporting all extensions of cracking into the overlay is omitted from the PDI Program because it is redundant to the RMS calculations performed in paragraph 3.2(c) and its presence adds confusion and ambiguity to depth sizing as required by paragraph 3.2(c). This also makes the weld overlay program consistent with the Supplement 2 depth sizing criteria.*

Enclosure 2 to

Attachment 1 to SBK-L-08022

Enclosure 2

Alternative Requirements for Dissimilar Metal Weld Overlays

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 repair weld overlay. All Section XI references are to the 2004 Edition with the 2006 Addenda. For the use of Enclosure 2 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) A full-structural weld overlay shall be applied by deposition of weld reinforcement (weld overlay) on the outside surface of circumferential welds of the low alloy steel components, including nozzles (P-No. 3) to safe ends or piping components (P-No. 8 or 43), inclusive of the UNS N06082 or W86182 welds that join the two items. The design of the overlay may be extended to include the adjacent stainless steel to stainless steel welds (P-No. 8 to P-No. 8).

(b) Enclosure 2 applies to dissimilar metal welds between P-No. 8 or 43 and P-Nos. 1, 3, 12A, 12B, or 12C[1] materials. Attachment 2 also applies to dissimilar metal welds between P-No. 8 and P-No. 43 materials joined with austenitic F-No. 43 filler metal, and to welds between P-No. 8 and P-No. 8 materials as described in 1(a) above.

(c) Weld overlay filler metal shall be austenitic nickel alloy (28% Cr min., ERNiCrFe-7 or ERNiCrFe-7A) applied 360 deg. around the circumference of the item, and deposited using a Welding Procedure Specification (WPS) 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 (PWHT) requirements of the Construction Code and Owner's requirements, the following provisions may be applied.

(1) Appendix I shall be used for ambient-temperature temper bead welding.

(d) Prior to deposition of the weld overlay, the surface to be weld overlaid shall be examined using the liquid penetrant method. Indications with major dimension greater than 1/16 in. (1.5 mm) shall be removed, reduced in size, or weld repaired in accordance with the following requirements:

(1) One or more layers of weld metal shall be applied to seal unacceptable

[1] P-Nos. 12A, 12B, and 12C designations refer to specific material classifications originally identified in Section III and subsequently reclassified in a later Edition of Section IX.

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 weld repair of indications identified in 1(d) is required, the area where the weld overlay is to be deposited, including any local weld repairs or initial weld overlay layer, shall be examined by the liquid penetrant method. The area shall contain no indications with major dimension greater than 1/16 in. (1.5 mm) prior to the application of the structural layers of the weld overlay.

(e) Weld overlay deposits shall meet the following requirements:
The austenitic nickel alloy weld overlay shall consist of at least two weld layers deposited *using* 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 first 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 taken from a mockup prepared in accordance with the WPS for the production weld.

(f) Enclosure 2 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.

(g) A new weld overlay shall not be installed over the top of an existing weld overlay that has been in service.

2 CRACK GROWTH AND DESIGN

(a) Crack Growth Calculation of Flaws in the Original Weld or Base Metal.
The size of all flaws postulated in the original weld or base metal shall be used to define the life of the overlay. In no case shall the inspection interval be longer than the life of the overlay. The inspection interval shall be as specified in 3(c). Crack growth in the original weld or base metal, due to both stress corrosion and fatigue, shall be evaluated. Flaw characterization and evaluation shall be based on the postulated flaw, if ultrasonic examination of the weld and base material is not performed.

(1)For repair overlays, the initial flaw size for crack growth in the original weld or base metal shall be based on the postulated flaw, if no pre-overlay ultrasonic examination is performed.

(2) For postulated flaws in the original weld or base metal the axial flaw length shall be set at 1.5 in. (38 mm) or the combined width of the weld plus buttering, whichever is greater. The circumferential flaw length shall be assumed to be 360 deg.

(a) If no examination is performed prior to application of the overlay, initial inside-surface-connected planar flaws equal to 75% through the original wall thickness shall be assumed, in both the axial and circumferential directions, consistent with the overlay examination volume in Fig. 2.

(b) In determining the expected life of the overlay, any inside surface connected planar flaw found by the overlay preservice inspection of 3(b) that exceeds the depth of (2)(a) above shall be used as part of the initial flaw depth. The flaw depth assumed is the detected flaw depth plus the postulated worst-case flaw depth in the unqualified ultrasonic examination region of the pipe wall thickness. An overlay meeting this condition shall be considered a repair.

(b) Structural Design and Sizing of the Overlay. 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 shall 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 taper of the overlay shall not exceed 30 deg. A slope of not more than 1:3 is recommended..

(3) For full structural overlays, when ultrasonic examination is not performed prior to installation of the weld overlay, the assumed flaw in the underlying base material or weld shall be based on the limiting case of the two below:

(a) 100% through-wall for the entire circumference, or

(b) 100% through-wall for 1.5 in. (38 mm) or the combined width of the weld plus buttering, whichever is greater, in the axial direction.

(4) The overlay design thickness shall be verified using only the weld overlay thickness conforming to the deposit analysis requirements of 1(e). The combined wall thickness at the weld overlay and the effects of any discontinuities (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, including the flaw size assumptions defined in 2(b)(3) above, shall be evaluated and meet the requirements of IWB-3640

(5) 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

In lieu of all other examination requirements, the examination requirements herein shall be met for the life of the weld overlay. 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, Supplement 11.

(a) Acceptance Examination

(1) The weld overlay shall have a surface finish of 250 micro-in. (6.3 micrometers) RMS or better and a contour that provides for ultrasonic examination in accordance with procedures qualified in accordance with Appendix VIII. The weld overlay shall be inspected to verify acceptable configuration.

(2) The weld overlay and the adjacent base material for at least 1/2 in. (13 mm) from each side of the weld shall be examined using the liquid penetrant method. Surface examination shall be performed on weld attached thermocouple removal areas in accordance with NB-4435(b)(3). 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 required, the liquid penetrant examination of the completed weld overlay shall be conducted after the three tempering layers (i.e., layers 1, 2, and 3) have been in place for at least 48 hr after completion of the third temper bead layer over the ferritic steel.

(3) The acceptance examination volume A-B-C-D in Fig. 1(a) plus the heat-affected zone beneath the fusion zone C-D 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. If ambient-temperature temper bead welding is required, the ultrasonic examination of the completed weld overlay shall be conducted after the three tempering layers (i.e., layers 1, 2, and 3) over the ferritic steel have been in place for at least 48 hr.

Planar flaws detected in the weld overlay acceptance examination shall meet the preservice examination standards of Table IWB-3514-2. In applying the acceptance standards to planar indications within the volume E-F-G-H, in Fig. 1(b), the thickness "t_1" shall be used as the nominal wall thickness in Table IWB-3514-2. For planar indications outside this examination volume, the nominal wall thickness shall be "t_2" as shown in Fig. 1(c), for volumes A-E-H-D and F-B-C-G.

Laminar flaws in the weld overlay 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 exceeds 3.0 in. (76 mm) or 10 % of the nominal pipe circumference, whichever is greater.

(b) The reduction in coverage of the examination volume A-B-C-D in Fig. 1(a), due to laminar flaws shall be less than 10%. The uninspectable volume is the volume in the weld overlay underneath the laminar flaws for which coverage cannot be achieved with angle beam examination.

(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 preservice examination acceptance standards of Table IWB-3514-2, with nominal wall thickness as defined above for planar flaws. 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 planar flaws that might have propagated into the upper 25% of the base material or into the weld overlay.

(2) The pre-service 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(b).

(3) The flaw evaluation requirements rules of IWB-3640 shall not be applied to planar flaws identified during pre-service examination that exceed the preservice examination acceptance standards of Table IWB-3514-2.

(c) Inservice Inspection

(1) The weld overlay examination volume in Fig. 2 shall be added to the inspection plan. The weld overlay inspection interval shall not be greater than the life of the overlay defined in 2(a) above. The weld overlay shall be ultrasonically examined during the first or second refueling outage following application.

(2) Subarticle Q-4300 will be used with the exception that qualified procedures and personnel will be used in accordance with Appendix VIII, Supplement 11 as modified by the PDI Program. The weld overlay will be examined in accordance with the PDI qualified procedure from both sides to the fullest extent possible.

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

(4) The inservice examination acceptance standards of Table IWB-3514-2 shall be met for the weld overlay. Planar flaws in the outer 25% of the base metal or underlying

weld thickness, when applicable, shall meet the design analysis requirements of Paragraph 2(b). If flaw growth in the weld overlay occurs and inservice examination acceptance standards of Table IWB-3514-2 cannot be met, a determination will be made to prove that the flaw is not PWSCC. If the cause is determined to be PWSCC or the cause of the flaw cannot be determined, the flaw shall be repaired and IWB-3600 shall not be used to accept these types of flaws. Flaws due to stress corrosion cracking in the weld overlay that exceed the inservice examination acceptance standards of Table IWB-3514-2 shall not be accepted and result in removal of the weld overlay and the item shall be repaired or replaced.

(5) Weld overlay examination volumes in Fig. 2 that show no indication of planar flaw growth or new planar flaws shall be placed into a population to be examined on a sample basis, except as required by 3(c)(1). Twenty-five percent of this population shall be examined at least once during every 10 years.

(6) If inservice examinations reveal planar flaw growth, or new planar flaws that meet the inservice examination acceptance standards of IWB-3514 or acceptance criteria of IWB-3600, the weld overlay examination volume shall be reexamined during the first or second refueling outage following discovery of the growth or new planar flaws.

(7) For weld overlay examination volumes with unacceptable indications in accordance with 3(c)(4), 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.

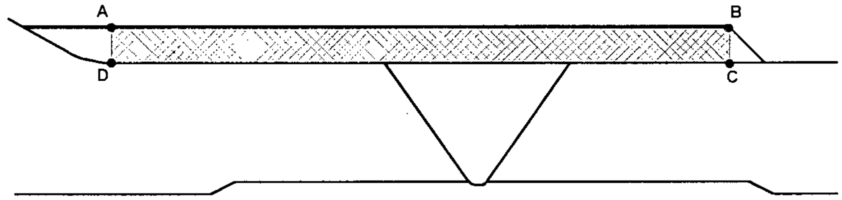
(d) Additional Examinations. If inservice examinations reveal an unacceptable indication according to 3(c)(4), planar flaw growth into the weld overlay design thickness, or axial flaw growth beyond the specified examination volume, additional weld overlay examination volumes, equal to the number scheduled 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 return to service. 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

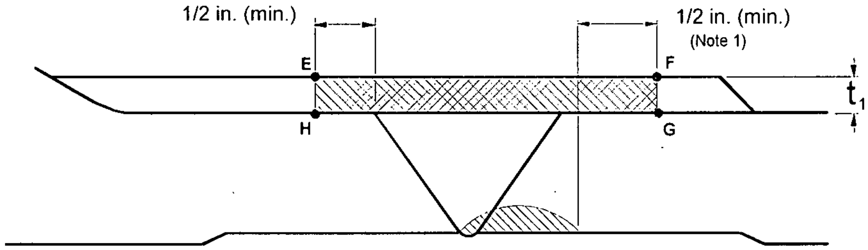
A system leakage test shall be performed in accordance with IWA-5000.

5 DOCUMENTATION

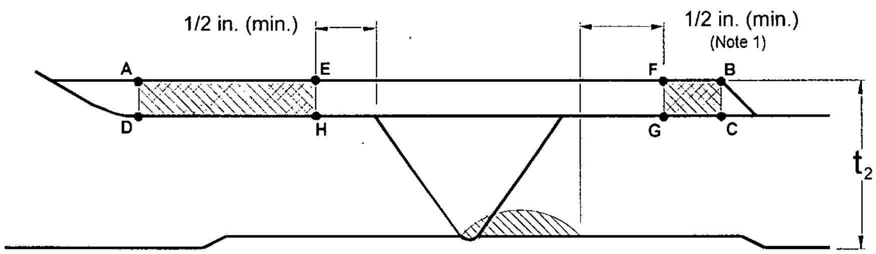
Use of Attachment 1 shall be documented on Form NIS-2.



a. Acceptance Examination Volume A-B-C-D



b. Thickness (t_1) for Table IWB-3514-2



c. Thickness (t_2) for Table IWB-3514-2

Fig. 1 Acceptance Examination Volume and Thickness Definitions

Notes:

(1) For axial or circumferential flaws, the axial extent of the examination volume shall extend at least ½ in.(13 mm) beyond the toes of the original weld.

(2) The weld includes the weld end butter, where applied.

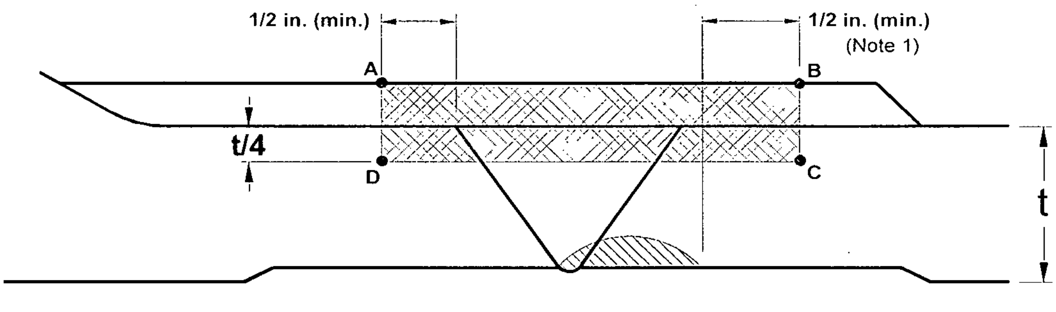


Fig. 2

Preservice and Inservice Examination Volume

NOTES:

(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.

(2) The weld includes weld end butter, where applied.

MANDATORY APPENDIX I
AMBIENT TEMPERATURE TEMPER BEAD WELDING

I-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-Nos. 8 or 43 materials to P-Nos. 1, 3, 12A, 12B, and 12C[2] 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 300 in.^{2} (195,000 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 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 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) 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.

I-2 WELDING QUALIFICATIONS

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

I-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

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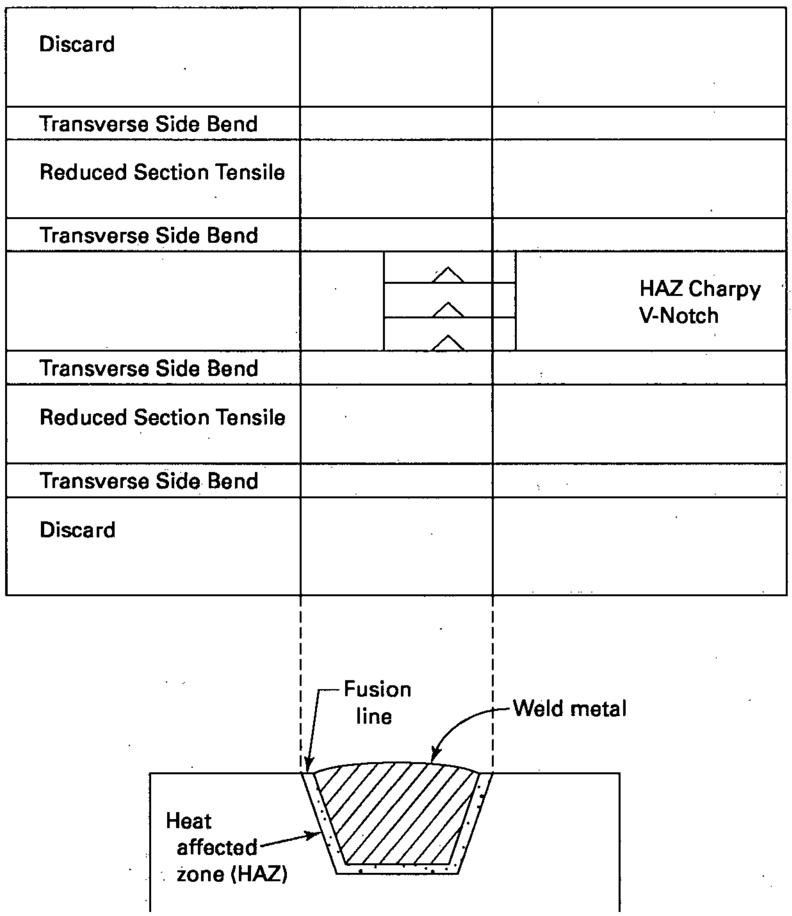
[2] P-Nos. 12A, 12B, and 12C designations refer to specific material classifications originally identified in Section III and subsequently reclassified in a later Edition of Section IX.

shall be 150°F (66°C).

(d) The weld overlay shall be qualified using a groove weld coupon. The test assembly groove depth shall be at least 1 in. (25 mm). The test assembly thickness shall be at least twice the test assembly groove depth. The test assembly shall be large enough to permit removal of the required test specimens. The test assembly dimensions on either side of the groove shall be at least 6 in. (150 mm). The qualification test plate shall be prepared in accordance with Fig. I-1.



GENERAL NOTE: Base metal Charpy impact specimens are not shown.

FIG. I-1 QUALIFICATION TEST PLATE

(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 I-2.1(f) below, 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 I-2.1(d) above. 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.

(2) 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.

(3) 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.

(f) 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 x 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 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.

I-2.2 Performance Qualification

Welding operators shall be qualified in accordance with Section IX.

I-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)[1] 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)[1] weld joints.

(c) The area to be welded shall be buttered with a deposit of at least three layers to achieve at least 1⁄8 in. (3 mm) overlay thickness with the heat input for each layer controlled to within ±10% of that used in the procedure qualification test. The heat input of the first three layers shall not exceed 45 kJ/in. (1.8 kJ/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.

(1) The interpass temperature shall be determined by one of the following methods: (e. g. pyrometers, temperature indicating crayons,or thermocouples.)

(e) 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.

2001 Edition with 2003 Addenda through 2004 Edition with 2006Addenda	**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**
IWA-4000 Repair/Replacement Activities	IWA-4000	IWA-4000	IWA-4000	IWA-4000 & IWA-7000
IWA-4311 Configuration Changes	IWA -4311	IWA -4311	NA	NA
IWA-4410Welding, Brazing, Metal Removal, and Installation – General Requirements	IWA 4410	IWA 4410	IWA 4170	IWA 4120
IWA-3300 Flaw Characterization	IWA-3300	IWA-3300	IWA-3300	IWA-3300
IWA-4611 Defect Removal	IWA-4611	IWA-4421 & IWA-4424	IWA-4170 (b)	IWA-4120
IWB-3514 Standards for Category B-F	IWB-3514	IWB-3514	IWB-3514	IWB-3514
IWB/C/D -3600 Analytical Evaluation	IWB/C-3600	IWB/C-3600	IWB/C-3600	IWB/C-3600
IWB/C/D-3640 Evaluation Procedures	IWB/C-3640 or IWB/C-3650	IWB/C-3640 or IWB/C-3650	IWB/C-3640 or IWB/C-3650[1]	IWB/C-3640

[1] Starting with the 1989 Edition with the 1989 Addenda

TABLE 1 REFERENCES FOR ALTERNATIVE EDITIONS AND ADDENDA OF SECTION XI

Enclosure 3 to

Attachment 1 to SBK-L-08022

ENCLOSURE 3

Barrier Layer to Prevent Hot Cracking in High Sulfur Stainless Steel

Background

During recent dissimilar metal weld (DMW) overlay activities, where use of ERNiCrFe-7A (Alloy 52M) and ERNiCrFe-7 (Alloy 52) has been used for the filler metal, flaws in the first layer have occurred in the portion of the overlay deposited on the austenitic stainless steel portions (safe ends, pipe etc.) of the assemblies in some cases.

The applicable stainless steel materials at Seabrook Station (SS) where the full structural weld overlay (SWOL) will be deposited are as follows:

- Pressurizer nozzle safe ends are SA-182 Grade F316L.
- Pressurizer safety, relief and spray piping attached to the corresponding nozzle safe ends are SA-376 TP316.
- Pressurizer surge piping attached to the surge nozzle safe end is SA-376 TP304.
- Pipe to nozzle safe end welds are ER308/E308.

Discussion

The characteristics of the flaws described above are indicative of hot cracking. This phenomenon has not been observed on the ferritic steel or ENiCrFe-3 (Alloy 182) DMWs.

Further studies have determined that this problem may occur when using Alloy 52M filler metal on austenitic stainless steel materials with high sulfur content.

Limited tests and evaluations recently performed by AREVA have resulted in the conclusion that welding with Alloy 52M on stainless steel base material with 0.020 wt% sulfur results in cracking while welding on stainless steel base materials with less than 0.010 wt% have resulted in no cracking.

To reduce the susceptibility of hot cracking occurrence due to welding Alloy 52M on the stainless steel base materials with high sulfur, AREVA has selected ER309L filler metal as the preferred filler metal to provide a barrier layer between the Alloy 52M and the high sulfur stainless steel base material. This filler metal is compatible with the base material and promotes primary weld metal solidification as ferrite rather than austenite. The ferrite is more accommodating of residual elements therein and in the underlying base material thereby significantly reducing the susceptibility to hot cracking. ER309L is also compatible with the Alloy 52M. However, the barrier layer will necessarily consist of ERNiCr-3 (Alloy 82) being used locally at the interface between the Alloy 182 DMW and the stainless steel item. ER309L welding on Alloy 182 may result in cracking of the ER309L weld. Welding on high sulfur stainless steel with Alloy 82 has not been a concern relevant to hot cracking occurrence.

AREVA welded a mockup to evaluate the interactive effects, such as hot cracking and lack of fusion, between the Alloy 182 DMW, the stainless steel base material, the ER309L and Alloy 82 barrier layer, and the subsequent Alloy 52M weld overlay. The mockup assembly consisted of a stainless steel pipe (0.020 wt% sulfur) with an Alloy 182 groove weld The barrier layer and overlay were welded in the same sequence as performed in the field (barrier layer ER309L and Alloy 82 and then two layers of Alloy 52M overlay). The barrier layer and overlay welding parameters used in the mockup were similar to those used in the field however slightly reduced wire feed rates were used for conservatism.

The following examinations were performed on the final mockup and no recordable indications were detected:

PT examination was performed on the:

- High sulfur stainless steel base material
- Alloy 182 Groove Weld
- ER309L Barrier Layer
- Alloy 82 Barrier Layer
- Alloy 52M Overlay

Limited PDI UT examination

- 0° Transducer with Full Coverage
- 45° Transducer with Full Coverage
- OD Creeper Transducer with Full Coverage
- 60° Transducer with limited coverage (Focal depth exceeded UT procedure allowable in places due to overlay being of insufficient thickness. Only two layers of Alloy 52M were deposited.)

Eight (8) specimens were removed from the around the overlay circumference at approximately 45 degree intervals. Metallographic examination searching for any type of discontinuity, flaw or other anomaly has been performed. No anomalies were observed.

The barrier layer was been successfully implemented on various nozzle SWOLs at North Anna 2 earlier this year.

Conclusion

The barrier layer would use ER309L on the stainless steel and Alloy 82 on the stainless steel near the DMW to stainless steel fusion zone only.

Structural credit would not be assumed for the barrier layer in determining the required minimum overlay thickness.

The barrier layer welding would be performed in accordance with ASME Code Section IX qualified welding procedure specification(s). PT examination would be performed on the barrier layer surface and its volume would be included in the final UT of the overlay.