FPL Energy
Seabrook Station

FPL Energy Seabrook Station
P.O. Box 300
Seabrook, NH 03874
(603) 773-7000

JUL 3 2007

Docket No. 50-443
SBK-L-07120

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

Seabrook Station

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

Pursuant to 10 CFR 50.55a(a)(3)(i), FPL Energy Seabrook, LLC (FPL Energy Seabrook) requests 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. This request contains 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. Attachment 1 contains FPL Energy Seabrook's Alternative Request and Enclosure 1 to Attachment 1 contains the PDI Program Modifications to American Society of Mechanical Engineers (ASME) Code, Appendix VIII, Supplement 11. Enclosure 2 provides details on the use of a barrier layer.

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 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 in the spring of 2008. Similar alternatives have been submitted for NRC review and approval and are referenced in the attached request. FPL Energy Seabrook is submitting this request based on the recent ASME Subcommittee XI approval of Code Case N-740-1. Details of the design analysis for the planned weld overlays are being developed to support the Seabrook Unit 1 spring 2008

A047
NRR

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-07120

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

Item	Location	Weld Number by ISI Designation	
		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.

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

The ASME Subcommittee XI has recently approved Section XI Code Case N-740-1, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items" Draft May 2007 (Reference 3). This Draft 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 directly applies to the Alloy 52M weld material that is primarily being used for these overlay repairs.

This application requests the approval to use Code Case N-740-1, Draft May 2007 (Reference 3) 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 OR12 in April 2008.

The ultrasonic examination of the completed SWOLs will be accomplished in accordance 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 Code Case N-740-1 Draft May 2007 (Reference 3) 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 will be designed in accordance with ASME Section XI Code Case N-740-1 Draft May 2007 (Reference 3). The detailed design analysis for the SWOLs is being developed to support OR12 in April 2008 outage by AREVA, the design and welding contractor. The analysis will be available at Seabrook Station for NRC review at the beginning of OR12.

The SWOLs will satisfy all the structural design requirements of the pipe with the assumption that no strength is contributed by the original safe end-to-nozzle welds or the pipe-to-safe end welds, as if the welds were removed. As depicted 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 SWOLs will extend around the entire circumference of the nozzle. Alloy 52M and Alloy 52 filler metals are compatible with all the wrought base materials and the DMWs and similar metal welds that will be covered by the SWOL.

5.2 Welding

The welding will be performed in accordance with Code Case N-740-1, Draft May 2007 (Reference 3) 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.

Based on the qualification work performed on representative mockups, the Chromium content of the initial Alloy 52M layer will be $\geq$ 24%, therefore an initial Alloy 52M sacrificial layer will not be required.

In the event that a flaw(s), having major dimension exceeding 1/16 in., is/(are) observed on the surfaces to be welded and flaw size reduction to an acceptable size is impractical, a seal weld layer will be applied over these flaw(s) and will not be credited for the required SWOL thickness.

5.3 Barrier Layer to Prevent Hot Cracking in High Sulfur Stainless Steel

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. FPL Energy Seabrook will utilize a barrier layer as a precaution to prevent hot cracking in the first layer of Alloy 52 filler metal. Enclosure 2 provides details on the use of a barrier layer.

5.4 Examination

Examinations will meet the requirements of the Code Case N-740-1, Draft May 2007 (Reference 3), 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.

The PDI Program allows closer spacing of flaws provided they don't interfere with detection or discrimination. The specimens used to date for qualification to the Tri-party (NRC/BWROG/EPRI) agreement have a flaw population density greater than allowed by current Code requirements. These samples have been used successfully for all previous qualifications under the Tri-party agreement program. To facilitate their use and provide continuity from the Tri-party agreement program to Supplement 11, the PDI Program has merged the Tri-party test specimens into their structural weld overlay program.

The current configuration of these DMWs does not permit an ASME Code Section XI, Appendix VIII, Supplement 10 ultrasonic examination to obtain greater than 90% coverage of the required examination volume without extensive machining. Therefore, none of these welds will receive a pre-weld overlay ultrasonic examination

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 Code Case N-740-1 Draft May 2007 (Reference 3), Paragraphs 3(a)(2). The 48-hour delay provides time for delayed hydrogen cracking to occurr.

Code Case N-740-1 Draft May 2007 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 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 in accordance with SFA-5.32, SG-A 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 heat affected zone (HAZ) resulting in achievement of lower hardness and tempered martensite. This further reduces susceptibility to hydrogen induced cracking. Furthermore, 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 NDE or subsequent in-service inspections.

EPRI Report 1013558, Temperbead Welding Applications, 48 Hour Hold Requirements for Ambient Temperature Temperbead Welding, Technical Update, December 2006 (Reference 4) provides justification for 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 currently specified in Code Case N-740-1 Draft May 2007 (Reference 3). Report 1013558 addresses microstructure issues, hydrogen sources, tensile stress and temperature, and diffusivity and solubility of hydrogen in steels.

In addition, the NRC has approved starting the 48 hour hold time after the third structural layer has been completed for Arkansas Nuclear One (ANO).

Code Case N-638-4 "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique Section XI, Division 1" (Reference 5) published in Nuclear Code Cases Supplement 11 specifies NDE 48 hours after completion of the third temper bead layer.

The SWOL ultrasonic examination results will be provided to the NRC within fourteen (14) days after completion of the ultrasonic examinations.

5.5 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 Section XI Code Case N-740-1, Draft May 2007 (Reference 3) that has been developed to cover the most recent operating experience and NRC-approved criteria that are associated with similar SWOL applications. Therefore FPL Energy Seabrook considers that this Case 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 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 2nd 10-year ISI interval which includes inservice examination requirements of Code Case N-740-1, Draft May 2007 Draft (Reference 3) for any applied weld overlays. The use of Code Case N-740-1, Draft May 2007 is requested until the NRC publishes the Code Case as a future revision of Regulatory Guide 1.147. Future inservice examinations of weld overlays at Seabrook beyond this inspection interval will be as required by the NRC in the regulations

7.0 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.

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,

---

(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).

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)]

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. ASME Code Case N-740-1 Tracking No. BC06-1651, Changes from N-740, SWGER Edits 05-17-2007, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items Section XI, Division 1"
4. EPRI Report 1013558, Temperbead Welding Applications, 48 Hour Hold Requirements for Ambient Temperature Temperbead Welding, Technical Update, December 2006.
5. Code Case N-638-4 "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temperature Bead Technique Section XI, Division 1"

(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).

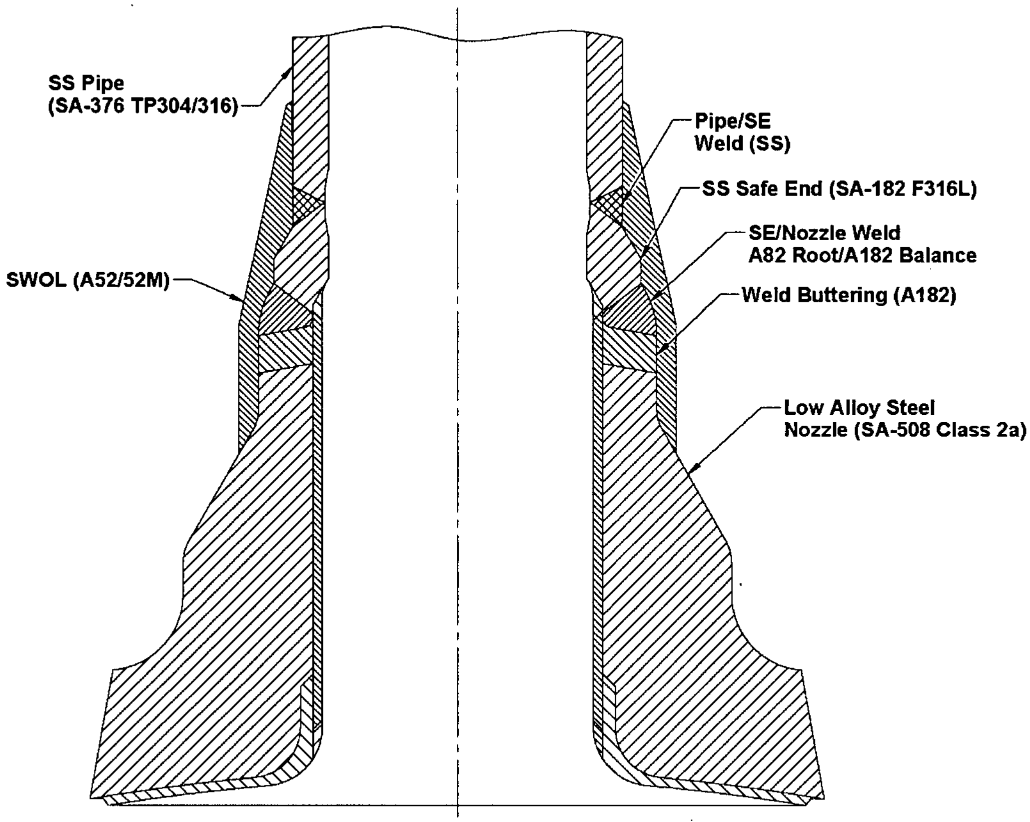

Figure 1 - Typical SWOL Configuration

Enclosure 1
PDI Program Modifications to 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.

Appendix VIII, Supplement 11	PDI Modification
	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 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	**Modification:** (2) Specimens shall be divided into base

Appendix VIII, Supplement 11	PDI Modification
overlay grading units. Each specimen shall contain one or both types of grading units.	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 75% of the overlaid weld and base metal overlay material, or base metal-to-overlay interface.	**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. ***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)(l) 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)(l) 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.*

Appendix VIII, Supplement 11	PDI Modification
(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. ***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	Modification: **(4) Depth sizing specimen sets shall include at least two distinct locations where a base**

Appendix VIII, Supplement 11	PDI Modification
the base metal extends into the overlay material by at least 0.1 inch in the through-wall direction.	**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 unmasked specimens after the performance demonstration is prohibited.	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 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.

Appendix VIII, Supplement 11	PDI Modification
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 length of base metal cracking is measured at the 75% through-base-metal position.	**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 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

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.