Entergy

Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, MA 02360

Stephen J. Bethay
Director, Nuclear Assessment

May 7, 2009

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

SUBJECT: Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
Docket No. 50-293
License No. DPR-35

Response to NRC Request for Additional Information (RAI) dated May 7, 2009, Regarding Pilgrim Relief Request (PRR)-19, Jet Pump Instrumentation Nozzle Weld, RPV-N9A-1 Repair Plan

REFERENCE: 1. Entergy Letter, 2.09.032, Pilgrim Relief Request (PRR)-19, Jet Pump Instrumentation Nozzle Weld, RPV-N9A-1 Repair Plan, dated May 1, 2009

LETTER NUMBER: 2.09.037

Dear Sir or Madam,

This letter provides Entergy's response to NRC request for additional information (RAI) transmitted to Pilgrim staff to complete their review of Pilgrim Relief Request, PRR-19, that was submitted by Reference 1.

Part 1 of this letter provides a written response to each question in the NRC RAI. Part 2 of this letter provides a revised PRR-19 submittal with changes noted. The responses to the NRC RAI and the revised submittal continue to support the conclusion that the Pilgrim proposed alternative provides an acceptable level of quality and safety.

Therefore, Entergy requests NRC approval of the proposed alternative pursuant to 10 CFR 50.55a(a)(3)(i), by May 12, 2009, which is consistent with the schedule requested in Reference 1.

A047
NRR

There are no new commitments made in this submittal.

If you have any questions, please call Mr. Joseph Lynch, Pilgrim Licensing Manager at 508-830-8403.

Sincerely,

Joseph R Lynch for

Stephen J. Bethay
Director, Nuclear Safety Assurance

SJB/wgl

PART 1: Response to NRC Request for Additional Information Regarding PRR-19 (3 pages)

PART 2: Revised Pilgrim Relief Request (PRR)-19 (36 pages)

cc:

Regional Administrator, Region 1
U.S. Nuclear Regulatory Commission
475 Allendale Road
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Senior Resident Inspector
Pilgrim Nuclear Power Station

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PART 1

TO ENTERGY LETTER 2.09.037

Response to NRC Request for Additional Information Regarding PRR-19 (3 pages)

Response to NRC Request for Additional Information Regarding Pilgrim Relief Request Transmitted on May 7, 2009

NRC Question 1:

Clarify the paragraph at the top of page 1 of Attachment 2 to Enclosure 1. The second sentence states, ""The area limitation in Attachment 3 is 500 square inches." Is "Attachment 3" referring to "ASME Code Case N-638, Revision 3?" If not, please explain what is being referred as Attachment 3.

Entergy Response:

There is no Attachment 3. It was a typographical error. It should be Revision 3 of ASME Code Case N-638-1. Page 1 of Attachment 2 to Enclosure 1 has been corrected. The right side vertical line indicates the correction.

NRC Question 2:

What evidence (e.g., operating experience) is there that the existing Alloy 82 weld overlay will maintain its integrity for the life of the plant, i.e., has there ever been a field or laboratory failure of this material in a boiling-water reactor environment? In support of this response, please provide the reference to Section V.A.2.(b) on page 8 of PRR-19, i.e., the documentation that supports the sentence, "Buisine, et al. evaluated the IGSCC resistance..." Also, revise the reference list shown on page 1 of PRR-19 to include the EPRI Topical Report MRP-115 and all other applicable references used to address this question.

Entergy Response:

Alloy 82 has been one of the primary nickel base weld metals used in the BWR environment for fabrication of similar and dissimilar metal welds (DMW) since the early 1980's. The alloy composition ranges from 18 to 22% chromium, with a nominal composition of 20% chromium. In addition to its use in the fabrication of girth welds in the BWR, it has also been used in the fabrication of nickel base weld overlays for dissimilar metal welds.

The initial use of Alloy 82 for dissimilar metal weld overlays involving temper bead welding occurred at Vermont Yankee during the 1985-1986 outage. An Alloy 82 full structural weld overlay was applied to a core spray nozzle-to safe-end weld in which probable IGSCC indications were identified. The weld joined an Alloy 600 safe end to a low alloy steel SA 508 Class 2 nozzle. An extensive procedure and weld qualification program was undertaken, following and amplifying the information provided in Code Case N-432. The results of this qualification program and implementation activity are presented in Reference 1. These weld overlay repairs remain in service today, and no evidence of degradation of the weld overlay repair has been observed.

Subsequent to this application, Alloy 82 was the only weld overlay material used for repair of dissimilar metal welds, until Alloy 52 was code qualified, and accepted by the industry and the NRC for use. Several such dissimilar metal weld overlays were applied in the 1980s and early 1990s using Alloy 82. We are not aware of any reports of degradation of any of these overlays, some of which have service lives to date approaching 25 years.

Alloy 82 has been extensively examined in laboratory tests in simulations of the normal the BWR environment and in accelerating environments. These studies have indicated that among the family of Alloy 600 materials, including Alloy 600, Alloy 182 and Alloy 82, Alloy 82 is far more resistant to IGSCC initiation than are the other alloys. One study performed by Southwest Research Institute [2] indicated that in oxygen containing pure water in an un-creviced condition, all of these alloys are resistant to IGSCC initiation. In a creviced environment in this same water, Alloys 600 and 182 were susceptible to IGSCC whereas for Alloy 82, only slight susceptibility to SCC initiation was noted.

Alloy 82 has been evaluated in a PWR-type environment that is typically characterized by corrosion potentials lower that the currently used BWR hydrogen water chemistry (HWC) environment, where testing has been performed on U-bend specimens exposed to impurity doped steam and primary water [3]. These tests were generally done at temperatures that were well above typical BWR operating temperatures. These tests indicated that Alloy 182, with approximately 14.5% chromium, was the most susceptible to primary water stress corrosion cracking (PWSCC) while Alloy 82 with 18–20% chromium took three or four times longer to initiate cracking. For example, PWSCC appeared in one of the Alloy 182 specimens at the first test interruption after 500 hours of exposure and the second specimen cracked after 1,500 hours. The first Alloy 82 specimen cracked after 2,000 hours and all were cracked at 6,500 hours. However, for chromium contents between 21 and 22%, i.e., the upper range chromium content for Alloy 82, no PWSCC initiation was observed for tests lasting between 18,000 and 27,000 hours.

The NRC has recognized the effectiveness of Alloy 82 in resisting IGSCC by noting in NUREG-0313, Revision 2, that among that Alloy 600 family of materials, Alloy 82 was the only resistant material [Reference 4, Section 2.1]. In BWRVIP-75A [7], page 2-1, it states "Additionally, Inconel 82 and low carbon weld metals with controlled ferrite (such as 308L) are resistant. This BWRVIP document has been accepted by the NRC. In addition, Section XI Code Case N-740 [5] and MRP-169 Revision 1 [6], have identified the initial dilution layer of a dissimilar metal weld overlay repair to be considered resistant to IGSCC if that layer contains a minimum of 20% chromium, the nominal chromium level present in Alloy 82. The historical performance of Alloy 82 in the BWR environment provided a substantial amount of the justification for this chromium level in the Code Case.

In summary, the laboratory and field performance of Alloy 82 has indicated that it is very resistant to IGSCC initiation in the BWR environment. It was recognized as IGSCC resistant in NUREG-0313, Revision 2 in 1988, and its performance prior to and since that time has been excellent, with no evidence of IGSCC initiating or growing in this alloy in BWR primary coolant.

References:

1. EPRI NP-7085-D, "Inconel Weld-Overlay Repair for Low-Alloy Steel Nozzle to Safe-End Joint", Final Report, January 1991

2. EPRI NP-5882S, "Stress Corrosion Cracking Resistance of Alloys 600 and 690 and Compatible Weld Metals in BWRs", Final Report, July 1988.

3. D. Buisine, et al., "PWSCC Resistance of Nickel Based Weld Metals with Various Chromium Contents," Proceedings: 1994 EPRI Workshop on PWSCC of Alloy 600 in PWRs, EPRI, Palo Alto, CA: 1995. TR-105406, Paper D5.

4. ASME Boiler and Pressure Vessel Code, Code Case N-740, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items, Section XI, Division 1, October 12, 2006."

5. NUREG-0313 Revision 2, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping, Final Report, January 1988.

6. "Materials Reliability Program; Technical Basis for Preemptive Weld Overlays for Alloy 82/182 Butt Welds in PWRs (MRP-169)," EPRI, Palo Alto, CA, and Structural Integrity Associates, Inc., San Jose, CA: 2005, 1016602, Revision 1, April 2008.

7. EPRI, "BWRVIP-75A: BWR Vessel and Internals Project, Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules", Report 1012621, Final Report, October 2005.

NRC Question 3:

Provide dates for each of the references shown on page 1 of PRR-19.

Entergy Response:

The publication dates of each applicable reference have been provided and additional References 13 to 17 have been added. Page 1 of Enclosure 1 has been corrected. The right side vertical line indicates the correction.

Enclosure 3 is added to the PRR-19, which provides the document: D. Buisine, et al., "PWSCC Resistance of Nickel Based Weld Metals with Various Chromium Contents," Proceedings: 1994 EPRI Workshop on PWSCC of Alloy 600 in PWRs, EPRI, Palo Alto, CA: 1995. TR-105406, Paper D5.

PART 2

ENTERGY LETTER 2.09.037

Revised Pilgrim Relief Request, (PRR)-19

(36 Pages)

Entergy

Entergy Nuclear Operations, Inc.
Pilgrim Station
600 Rocky Hill Road
Plymouth, MA 02360

May 1, 2009

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

SUBJECT: Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
Docket No. 50-293
License No. DPR-35

Pilgrim Relief Request (PRR)-19, Jet Pump Instrumentation Nozzle Weld, RPV-N9A-1 Repair Plan

REFERENCES:

1. NRC Letter, Pilgrim Nuclear Power Station - Relief Request No. PRR-15, Rev. 01, Approval to Include Remaining Reactor Pressure Vessel (RPV) Safe-End Welds in Contingency Repair Plan for Full Structural Weld Overlays (TAC No. MD2663), dated April 2, 2007

2. NRC Letter, Pilgrim Nuclear Power Station - Pilgrim Relief Request PRR-39, Alternative Contingency Repair Plan for Reactor Pressure Vessel Nozzle Safe-End and Dissimilar Metal Piping Welds Using ASME Code Cases N-638 and N-504-2, With Exceptions (TAC No. MC2496), dated April 12, 2005

3. NRC Letter, Arkansas Nuclear One, Unit No. 1-Approval of Relief Request ANO1-R&R-011 to Use a Proposed Alternative to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code Requirements for Weld Overlay Repairs (TAC No. MD6958), dated June 18, 2008

4. NRC Letter, James A. FitzPatrick Nuclear Power Plant- Request for Alternative JAF RR-7, Rev. 1 to Install a Weld Overlay on N2C Nozzle to Recirculation Inlet Piping Safe-End Dissimilar Metal Weld (TAC No. MD9780), dated April 1, 2009

LETTER NUMBER: 2.09.032

Dear Sir or Madam,

Pursuant to 10 CFR 50.55a(a)(3)(i), Entergy requests NRC approval of Pilgrim Relief Request (PRR)-19, to perform an alternative repair of Reactor Pressure Vessel Nozzle (RPV) Safe-End Weld RPV-N9A-1 using the provisions of ASME Code Cases N-638-1 and N-504-3. NRC has previously approved similar alternatives for repairs of Safe-End Welds at Pilgrim, ANO-1, and James A. Fitzpatrick (JAF) Nuclear Power Plants (References 1, 2, 3, and 4).

Entergy also requests NRC approval of the alternative to commence the 48-hour hold time at the completion of the third temper bead weld overlay instead of commencing the 48-hour hold-time at the completion of the entire weld. The justification to commence the 48-hour hold time after third temper bead weld overlay is included in PRR-19. NRC has approved this 48-hour hold-time alternative for ANO-1 and JAF plants in Reference 3 and 4. Thus, the proposed alternative repair of RPV-N9A-1 safe-end weld as described in the enclosed PRR-19 falls within the NRC approved precedents (References 1, 2, 3, and 4). The Pilgrim proposed alternative follows the NRC approved precedents and the past weld overlays have maintained the reactor pressure boundaries. Therefore, the Pilgrim proposed alternative provides an acceptable level of quality and safety.

The Pilgrim RPV-N9A-1 weld consists of a RPV safe-end dissimilar metal weld (DMW) and a Jet Pump Instrumentation (JPI) penetration stainless steel pipe weld. The nozzle is 4" inside diameter (ID) and approximately 5" outside diameter (OD). The penetration side weld was repaired in 1984 with a weld overlay to the standards that were in effect at that time because of a detected flaw. The design of that weld overlay partially covered the safe-end to nozzle weld.

In response to Generic Letter (GL) 88-01, "NRC Position on Intergranular Stress Corrosion Cracking (IGSCC) in BWR Austenitic Stainless Steel Piping", this weld was classified as Category "E" under the GL 88-01 criteria "Cracked, reinforced by weld overlay or mitigated by SI." Under GL 88-01, the Category "E" weld is required to be inspected once per 10 years because it was the subject of a repair.

This weld was inspected in 1999 and no flaws were observed at that time. The weld is currently scheduled for RFO-17 examination under ASME Section XI, Appendix VIII, Supplement 11, Performance Demonstration Initiative (PDI) methodology.

During the preparation of the weld for Non-Destructive Examination (NDE) in RFO-17, Entergy observed that the configuration of this weld was not inspectable per the current NDE standards, because of the configuration of the weld overlay and weldments at the safe-end side. Therefore, Entergy has elected to perform a full "structural weld overlay" over the entire weld to meet the current NDE standards. This structural weld overlay would be performed as an alternative to the ASME Section XI weld repair, as described in the attached PRR-19.

Pursuant to 10 CFR 50.55a(a)(3)(i), Entergy requests NRC approval of the proposed alternative by May 12, 2009, to complete the RPV-N9A-1 weld repair within the Refueling Outage 17 schedule.

The commitments made in this submittal are identified in Enclosure 2.

If you have any questions, please call Mr. Joseph Lynch, Pilgrim Licensing Manager at 508-830-8403.

Sincerely,

Joseph R Lynch – for

Stephen J. Bethay
Director, Nuclear Safety Assurance

SJB/wgl

Enclosure: Pilgrim Relief Request (PRR)-19 (20 pages)

cc:

Regional Administrator, Region 1
U.S. Nuclear Regulatory Commission
475 Allendale Road
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Senior Resident Inspector
Pilgrim Nuclear Power Station

Mr. James S. Kim, Project Manager
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Entergy Letter No.: 2.09.032
Pilgrim Relief Request (PRR)-19

Pilgrim Nuclear Power Station
Docket No. 50-293

PILGRIM RELIEF REQUEST (PPR)-19, JET PUMP INSTRUMENTATION NOZZLE WELD, RPV-N9A-1, REPAIR PLAN

<u>Enclosure 1</u>

Relief Request PPR-19	15 Pages
Attachment 1 Jet Pump Instrumentation Nozzle N-9A Details	2 Pages
Attachment 2 Technical Basis for Alternative to ASME Code Case N-638-1, Area Limitation Change to 500 Square Inches	2 Pages

<u>Enclosure 2</u>

List of Regulatory Commitments	1 Page

<u>Enclosure 3</u>

"PWSCC Resistance of Nickel Based Weld Metals With Various Chromium Contents", Buisine, et al, Section D5, EPRI TR 105406, Proceedings: 1994 EPRI Workshop on PWSCC of Alloy 600 in PWRs, dated August 1995 (16 pages)

ENTERGY NUCLEAR OPERATIONS, INC.
Pilgrim Nuclear Power Station
REQUEST FOR RELIEF

I. ASME CODE COMPONENTS AFFECTED

Components: ISI Weld RPV-N9A-1 Jet Pump Instrumentation Nozzle "N-9A"

Code Class: 1

References:

1. ASME Section XI, 1998 Edition/2000 Addenda except as listed in Reference 2
2. Appendix Q of ASME Section XI, 2004 Edition/2005 Addenda as required by Regulatory Guide 1.147, Rev. 15, dated October, 2007
3. ASME Section III, 1965 Edition/Winter 1966 Addenda
4. ASME/ANSI B31.1, 1989 Edition/No Addenda
5. PNPS-RPT-05-001, *Pilgrim Fourth Ten Year Inspection Interval Inservice (ISI) Program Plan,* dated June 29, 2006
6. EPRI Report 1011898, *Justification for the Removal of the 100 Square Inch Temperbead Weld Repair Limitation,* dated November 16, 2005
7. EPRI Report GC-111050, *Ambient Temperature Preheat for Machine GTAW Temperbead Applications,* dated December 10, 1988
8. EPRI Report 1013558, *Temperbead Welding Applications – 48 hour Hold for Ambient Temperature Temperbead Welding,* dated December 18, 2006
9. EPRI Report BWRVIP-75-A, *Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules (1012621),* dated October 11, 2005
10. ASME Code Case N-504-3, *Alternate Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping,* dated August 4, 2004
11. ASME Code Case N-638-1, *Similar and Dissimilar Metal Welding using Ambient Temperature Machine GTAW Temper Bead Technique,* dated February 13, 2003
12. Pilgrim Relief Request PPR-9, *Relief from ASME Section XI Appendix VIII, Supplement 11 Requirements for Structural Overlay Welds (PDI Examination)*, dated March 26, 2006
13. EPRI Report NP-7085-D, *Inconel Weld-Overlay Repair for Low-Alloy Steel Nozzle to Safe-End Joint,* dated January 1991
14. EPRI Report 1006696, *Materials Reliability Program Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 82, 182, and 132 Welds (MRP-115),* dated November 2004
15. *"PWSCC Resistance of Nickel Based Weld Metals With Various Chromium Contents",* Buisine, et al, Section D5, EPRI TR 105406, Proceedings: 1994 EPRI Workshop on PWSCC of Alloy 600 in PWRs, dated August 1995
16. NRC Generic Letter 88-01, *NRC Position on Intergranular Stress Corrosion Cracking (IGSCC) in BWR Austenitic Stainless Steel Piping,* dated January 25, 1988
17. NUREG-0313, *Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping*, Rev. 2, dated January 1988

Unit / Inspection Interval Applicability: Pilgrim Nuclear Power Station (PNPS) / Fourth (4th) 10-Year Interval

II. APPLICABLE CODE REQUIREMENT

ASME Section XI, IWA-4421(a) and IWA-4520 require that repair/replacement activities be performed and examined in accordance with the Owner's Requirements and the original Construction Code of the component or system. Alternatively, IWA-4421(b) and (c) allow use of later Editions/Addenda of the Construction Code (or a later different Construction Code such as ASME Section III) and revised Owner Requirements. IWA-4430 and IWA-4600(b) provide alternative welding methods such as temper bead welding when the requirements of Subsection IWA-4421 cannot be met. IWA-4520 requires that welds and weld repairs be performed in accordance with the Construction Code identified in the Repair/Replacement Plan. IWA-4530(a) requires the performance of pre-service examinations based on Subsection IWB-2200 for Class 1 components. Table IWB-2500 prescribes inservice inspection requirements for Class 1 butt welds in piping.

As an alternative to the above, ASME Section XI Code Cases N-504-3 and N-638-1 specify requirements for performing the following:

- Code Case N-504-3 provides alternative requirements to reduce a defect to a flaw of acceptable size in austenitic stainless steel materials by deposition of a structural weld overlay (WOL) on the outside surface of the pipe or component. The NRC has conditionally approved this Case in Regulatory Guide 1.147 with the following condition:

  "The provisions of Section XI, Nonmandatory Appendix Q, *Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments*, must be met."

- Code Case N-638-1 establishes requirements for performing ambient temperature temper bead welding as an alternative to the preheat and post-work heat treat (PWHT) requirements of the Construction Code. The NRC has conditionally approved this Case in Regulatory Guide 1.147 with the following condition:

  "UT volumetric examinations shall be performed with personnel and procedures qualified for the repaired volume and qualified by demonstration using representative samples which contain construction type flaws. The acceptance criteria of NB-5330 in the 1998 Edition through 2000 Addenda of Section III apply to all flaws identified within the repaired volume."

III. REASON FOR PROPOSED ALTERNATIVE

Intergranular stress corrosion cracking (IGSCC) in boiling water reactor (BWR) piping was identified as a problem in the United States in the early 1970s. Initially, cracking was only observed in small-bore piping. However, in 1982 cracking caused by IGSCC was also identified in large-bore piping. PNPS manages this condition by performing routine inservice inspections in accordance with ASME Section XI and the inspection requirements of BWRVIP-75-A.

PNPS is presently in Refueling Outage RFO-17. During this outage, the weld overlay (WOL) for the *Jet Pump Instrumentation Nozzle N-9A* was scheduled for ultrasonic (UT) examination to comply with the inspection requirements of BWRVIP-75-A for Category "E"[1] welds. The UT examination procedure and personnel were qualified in accordance with Appendix VIII,

[1] As defined in BWRVIP-75-A, Category "E" welds "are those with known cracks that have been reinforced by an acceptable weld overlay... with subsequent examination by qualified examiners and procedures to verify the extent of cracking."

Supplement 11 as implemented by the Performance Demonstration Initiative (PDI). However, prior to performing the UT examination, PNPS determined that the subject WOL could not be appropriately examined due to its present configuration. See Table 1 and Figure 1 of Attachment 1 for additional details on the existing WOL configuration and materials. The Inservice Inspection (ISI) weld number for the subject WOL is RPV-N9A-1.

The N-9A nozzle WOL was originally installed in September 1984 to repair detected flaws discovered in the 304 stainless steel safe-end base material. The flaws (two) were located in the heat affected zone (HAZ) of the stainless steel safe end base material adjacent to the nozzle N-9A dissimilar metal weld (DMW). The WOL was designed to provide full structural reinforcement of the flawed material assuming a postulated 360° through-wall crack while maintaining ASME Code safety margins. The WOL was installed with Alloy 82 (ERNiCr-3) weld metal.

PNPS performs repair/replacement activities in accordance with the 1998 Edition/2000 Addenda of ASME Section XI. This Edition of ASME Section XI does not include requirements for application of full structural WOLs on DMWs and non-austenitic stainless steels. Moreover, requirements for installing full structural WOLs on DMWs and non-austenitic stainless steels are not presently included in any Edition/Addenda of ASME Section XI (including Code Cases) approved by the NRC. However, the NRC has conditionally approved Code Case N-504-3 in Regulatory Guide 1.147 for installation of WOLs on austenitic stainless steel materials.

Structural weld overlays have been used for years on piping of both BWRs and pressurized water reactors (PWRs) to arrest the growth of existing flaws while establishing a new structural pressure boundary. WOLs on DMWs and non-austenitic stainless steels in BWRs have generally been applied in accordance with various revisions of ASME Code Cases N-504 and N-638. At present, code case revisions N-504-3 and N-638-1 are "conditionally accepted" by the NRC in Regulatory Guide 1.147. Application of these code cases to DMWs and non-austenitic stainless steels requires a relief request since Code Case N-504-3 was written specifically for austenitic stainless steel weldments and Code Case N-638-1 contains some restrictions and requirements that are not applicable to WOLs.

Entergy has initiated this request to propose an alternative to the ASME Section XI Code. PNPS intends to use Code Cases N-504-3 and N-638-1 to modify the existing WOL of the Jet Pump Instrumentation Nozzle N-9A (ISI weld RPV-9A-1). The modification will be performed using Alloy 52M (ERNiCrFe-7A) filler metal to facilitate performance of the required Appendix VIII, Supplement 11 UT examination. See Figure 2 of Attachment 1 for additional details.

IV. <u>PROPOSED ALTERNATIVE</u>

Pursuant to 10 CFR 50.55a(a)(3), Entergy proposes an alternative to specific ASME Section XI Code requirements in Code Cases N-504-3 and N-638-1, as conditionally approved by the NRC in Regulatory Guide 1.147. The proposed alternatives for each ASME Section XI code case are specified below:

A. Code Case N-504-3 (as conditionally approved in Regulatory Guide 1.147)

   1. Code Case N-504-3 and Appendix Q apply strictly to austenitic stainless steel piping and weldments. As an alternative, Entergy proposes to use Code Cases N-504-3 and Appendix Q to perform WOL welding on SA-508, Class 2 low alloy

steel, Alloy 82 welds, and austenitic stainless steel using Alloy 52M (ERNiCrFe-7A) filler metals.

2. Code Case N-504-3, paragraph (b) and Appendix Q, paragraph Q-2000(a) require that weld metal used to fabricate WOLs be low carbon steel (0.035%) austenitic stainless steel. As an alternative, Entergy proposes to perform WOL welding using Alloy 52M (ERNiCrFe-7A). Therefore, this requirement does not apply.

3. Code Case N-504-3, paragraph (e) and Appendix Q, paragraph Q-2000(d) require that as-deposited austenitic weld metal used to fabricate WOLs have a delta ferrite content of at least 7.5 FN or 5 FN under certain conditions. As an alternative, Entergy proposes to perform WOL welding using Alloy 52M (ERNiCrFe-7A) which is purely austenitic. Therefore, this delta ferrite requirement does not apply.

4. Code Case N-504-3, paragraph (f)(1) and Appendix Q, paragraph Q-3000(b)(2) require that the end transition slope of the WOL "not exceed 45°". As an alternative, Entergy proposes to allow the end transition slope to exceed 45° provide the following two conditions are met:

   - A physical restriction along the Jet Pump Instrument Penetration Seal Assembly prevents the WOL end transition slope from being 45° or less.

   - The as-built configuration of the WOL is analyzed by Finite Element Analysis to demonstrate compliance with the applicable stress limits of the Construction Code.

5. Code Case N-504-3, paragraph (h) requires that a system hydrostatic test be performed in accordance with IWA-5000. As an alternative, Entergy proposes to perform a system leakage test in accordance with IWA-5000.

B. Code Case N-638-1 (as conditionally approved in Regulatory Guide 1.147)

1. Code Case N-638-1, paragraph 1.0(a) limits the maximum area of an individual weld to 100 square inches. As an alternative, Entergy proposes to limit the surface area on the ferritic base material to 500 square inches.

2. Code Case N-638-1, paragraph 2.1(j) specifies that the "average values of the three HAZ impact tests shall be equal to or greater than the average values of the three unaffected base metal tests." This requirement applies to acceptance criteria for Charpy V-notch HAZ tests of the welding procedure qualification test coupon. As an alternative, Entergy proposes to use the following acceptance criteria: "The average lateral expansion value of the three HAZ impact test specimens shall be equal to or greater than the average lateral expansion value of the three unaffected base metal test specimens."

3. Code Case N-638-1, paragraph 3.0(c) requires the deposition and removal of at least one weld reinforcement layer for "similar materials" (i.e., ferritic materials). As an alternative, Entergy proposes to exclude this requirement because it does not apply to austenitic weld filler metals.

4. Code Case N-638-1, Section 3.0 does not specifically address verification or monitoring of welding preheat and interpass temperatures. As an alternative, Entergy proposes the following:

   "Preheat and interpass temperatures will be measured using a contact pyrometer. In the first three layers, the interpass temperature will be measured every three to five passes. After the first three layers, interpass temperature measurements will be taken every six to ten passes for the subsequent layers. Contact pyrometers will be calibrated in accordance with approved calibration and control program documents."

5. Code Case N-638-1, paragraph 4.0(b) requires that the final weld surface and the "band" around the final weld surface be examined using surface and ultrasonic examination methods. The "band" referred to in this requirement is defined in paragraph 1.0(d) of N-638-1 as a dimension equal to "1-1/2 times the component thickness or 5 inches, whichever is less". As an alternative, Entergy proposes the following:

   - The WOL and adjacent base material that is within ½" of the WOL (on each side) shall be examined by the liquid penetrant method.
   - The WOL examination volume A-B-C-D in Figure Q-4100-1 of ASME Section XI, Appendix Q shall be UT examined.

6. Code Case N-638-1, paragraph 4.0(b) specifies that surface and volumetric examinations cannot be performed until the completed weld (i.e. WOL) "has been at ambient temperature for at least 48 hours". As an alternative, Entergy proposes that the surface and ultrasonic examinations cannot be performed until at least 48 hours after completion of the third temper bead layer of the WOL.

7. Code Case N-638-1, paragraph 4.0(b) and (e) state that the ultrasonic examination shall be performed in accordance with Appendix I of ASME Section XI and meet the acceptance criteria of IWB-3000. Regarding this UT examination, Regulatory Guide 1.147 includes the following condition:

   "UT volumetric examinations shall be performed with personnel and procedures qualified for the repaired volume and qualified by demonstration using representative samples which contain construction type flaws. The acceptance criteria of NB-5330 in the 1998 Edition through 2000 Addenda of Section III apply to all flaws identified within the repaired volume.

   As an alternative, Entergy proposes to perform this UT acceptance examination in accordance with the requirements and acceptance criteria of Appendix Q, Section Q-4000.

V. BASIS FOR PROPOSED ALTERNATIVE

A. Proposed Alternative for Modifying the Existing WOL

Entergy intends to modify the existing WOL on Jet Pump Instrumentation Nozzle N-9A in accordance with ASME Section XI Code Case N-504-3 (as supplemented by Nonmandatory Appendix Q) and Code Case N-638-1 using the proposed alternatives specified in Section IV of this Request. As previously mentioned, these code cases have been conditionally approved by the NRC in Regulatory Guide 1.147, Revision 15.

The modification of the nozzle N-9A WOL provide an acceptable methodology for preventing potential failures of susceptible materials due to IGSCC. This position is based on several facts. First, the existing WOL will be modified with Alloy 52M weld metal which is resistant to IGSCC. See Attachment 1, Figure 2. The WOL modification should result in improved compressive residual stress profiles in the underlying weld and base materials. However, due to the complexities associated with the modification, this assumption will be validated by finite element analysis. Post-overlay preservice and inservice inspection requirements will ensure that structural integrity is maintained for the life of the plant. The proposed weld overlays will also meet the applicable stress limits from ASME Section III. Crack growth evaluations of conservatively postulated flaws, considering IGSCC and fatigue, will demonstrate that structural integrity of the component will be maintained.

As stated above, the modification to the subject WOL will be applied using Alloy 52M filler metal. However, Alloy 52M weld metal has a demonstrated sensitivity to certain impurities, such as sulfur, when deposited onto austenitic stainless steel base materials. Therefore, if the impurity level is sufficiently high, it may become necessary to deposit an austenitic buffer layer prior to installation of the WOL. While this condition has been limited to PWR applications, Entergy has developed a contingency to install a buffer layer should this unexpected condition occur. If required, a buffer layer of ER308L austenitic stainless steel filler metal will be deposited across the austenitic stainless steel materials. While the balance of this layer could be deposited with Alloy 52M weld metal, an Alloy 82 bridge bead (or transitional bead) would be deposited over the fusion line between the existing Alloy 82 weld and stainless steel safe-end. The bridge bead will be deposited with ERNiCrFe-3 filler metal. The ER308L filler metal will have a delta ferrite content of 5 – 15 FN as reported on the CMTR. It will be deposited with a welding procedure and welders that have been qualified in accordance with ASME Section XI. Liquid penetrant (PT) examinations will be performed prior to and after deposition of the buffer layer. The second PT examination is performed to ensure that the completed buffer layer is free from cracks and other unacceptable indications prior to deposition of the Alloy 52M WOL. The austenitic stainless steel buffer layer, if required, will not be credited toward the design thickness of the structural WOL.

1. Modified WOL Design and Verification

The fundamental design basis for full structural WOLs is to maintain the original design margins with no credit taken for the underlying IGSCC-susceptible weldments. The assumed design basis flaw for the purpose of structural sizing of the WOL is a flaw completely around the circumference (360°) and 100% through the original wall thickness of the dissimilar metal and stainless steel welds. The specific analyses and verifications to be performed are summarized as follows:

- A nozzle-specific stress analysis will be preformed to establish a residual stress profile in the WOL and the underlying welds and base materials. The analyses will simulate application of the existing WOL and the current modification to determine the final residual stress profile. Entergy believes that the post-WOL residual stress profile will be improved due to the WOL modification.
- Fracture mechanics analyses will also be performed to predict crack growth of all postulated and previously detected flaws. Crack growth due to IGSCC and fatigue will be analyzed. The crack growth analyses will consider all design loads and transients, plus the post-WOL and through-wall residual stress distributions. The analyses should demonstrate that postulated flaws will not degrade the design basis for the WOL.
- The analyses will demonstrate that applying the weld overlays does not impact the conclusions of the existing nozzle stress reports. The ASME Code, Section III primary stress criteria will continue to be met.
- Shrinkage will be measured during the WOL application. Shrinkage stresses at other locations in the piping systems arising from the WOL will be demonstrated not to have an adverse effect on the systems. Clearances of affected supports and restraints will be checked after the overlay repair and will be reset within the design ranges if required.
- The total added weight on the piping systems due to the WOL will be evaluated for potential impact on piping system stresses and dynamic characteristics.
- The as-built dimensions of the WOL will be measured and evaluated to demonstrate that they meet or exceed the minimum design dimensions of the WOL.

2. Suitability of Proposed Alternatives to ASME Section XI Code Case N-504-3 and Appendix Q

WOLs have been used for repair and mitigation of cracking in BWRs since the early 1980s. In Generic Letter (GL) 88-01, *NRC Position on Intergranular Stress Corrosion Cracking (IGSCC) in BWR Austenitic Stainless Steel Piping*, the NRC approved the use of ASME Section XI acceptance standards for determining the acceptability of installed WOLs. Accordingly, the existing WOL associated with nozzle N-9A will be modified in accordance with ASME Section XI Code Case N-504-3 and Appendix Q. Compliance with Appendix Q is required by Regulatory Guide 1.147. However, as described in Section IV of this Request, Entergy has proposed several alternatives to Code Case N-504-3 and Appendix Q that are necessary to support the modification of the existing WOL associated with nozzle N-9A. The suitability of the proposed alternatives is provided below.

(a) Code Case N-504-3 and Appendix Q apply strictly to austenitic stainless steel piping and weldments. As an alternative, Entergy has proposed to use Code Cases N-504-3 and Appendix Q to perform WOL welding on SA-508, Class 2 low alloy steel, Alloy 82 welds, and austenitic stainless steel using Alloy 52M (ERNiCrFe-7A) filler metals. This proposed alternative is acceptable because the WOL design, fabrication, examination, and preservice/inservice inspection requirements of Code Case N-504-3 and Appendix Q may also be applied to nickel alloy WOLs of non-asustenitic stainless steels such as low alloy steels and nickel alloys. While some material requirements in Code Case N-504-3 and Appendix Q may only apply to austenitic stainless steels, Entergy has identified these requirements and proposed alternatives to appropriately address them.

(b) Code Case N-504-3, paragraph (b) and Appendix Q, paragraph Q-2000(a) require that weld metal used to fabricate WOLs be low carbon steel (0.035%) austenitic stainless steel. This requirement was included in Code Case N-504-3 and Appendix Q to reduce the sensitization potential of the austenitic stainless steel WOL, thereby reducing its susceptibility to IGSCC. As an alternative, Entergy has proposed to perform WOL welding using Alloy 52M (ERNiCrFe-7A) weld metal. While carbon content is not a critical factor in assessing resistance of nickel alloys to IGSCC, the chromium content is. This point has been clearly documented in Section 2.2 of EPRI Technical Report MRP-115.

> "The only well explored effect of the compositional differences among the weld alloys on IGSCC is the influence of chromium. Buisine, et al. evaluated the IGSCC resistance of nickel-based weld metals with various chromium contents ranging from about 15% to 30% chromium. Testing was performed in doped steam and primary water. Alloy 182, with about 14.5% chromium, was the most susceptible. Alloy 82 with 18-20% chromium took three or four times longer to crack. For chromium contents between 21 and 22%, no stress corrosion crack initiation was observed..."

To conclude, Alloy 52M weld metal has high chromium content (28 – 31.5%); therefore, it has excellent resistance to IGSCC.

(c) Code Case N-504-3, paragraph (e) and Appendix Q, paragraph Q-2000(d) require that as-deposited austenitic weld metal used to fabricate WOLs have a delta ferrite content of at least 7.5 FN or 5 FN under certain conditions. This requirement was included in Code Case N-504-3 and Appendix Q to reduce the sensitization potential of the austenitic stainless steel WOL, thereby reducing its susceptibility to IGSCC. As an alternative, Entergy has proposed to perform WOL welding using Alloy 52M (ERNiCrFe-7A) weld metal which has a purely austenitic microstructure. Therefore, the requirement to measure delta ferrite does not apply in this application. The susceptibility of nickel alloys to IGSCC is dependant on its chromium content as explained above. Furthermore, the chromium content of the first layer of Alloy 52M weld metal could be reduced due to dilution with the underlying base and weld materials. Because this is the case, Entergy has self-imposed the following restriction on the first layer of the WOL:

> "The first layer of Alloy 52M weld metal deposited may not be credited toward the required thickness. Alternatively, a diluted layer may be credited toward the required thickness, provided the portion of the layer

over the austenitic base material, austenitic weld, and the associated dilution zone from an adjacent ferritic base material contains at least 20% chromium. The chromium content of the deposited weld metal may be determined by chemical analysis of the production weld or from a representative coupon taken from a mockup prepared in accordance with the WPS (or a representative WPS) for the production weld."

(d) Code Case N-504-3, paragraph (f)(1) and Appendix Q, paragraph Q-3000(b)(2) require that the end transition slope of the WOL "not exceed 45°". It is Entergy's intent to comply with this requirement. However, the close proximity of the WOL to the instrument lines of the Jet Pump Instrument Penetration Seal Assembly limits Entergy's ability to lengthen the WOL along the penetration seal assembly. This interference could necessitate the design and installation of an end transition slope that exceeds 45°. Should this condition exists, Entergy will analyze the as-built configuration of the WOL using Finite Element Analysis to demonstrate compliance with the applicable stress limits of the Construction Code or ASME Section III.

(e) Code Case N-504-3, paragraph (h) requires that a system hydrostatic test be performed in accordance with IWA-5000 when a flaw penetrates the full thickness of the pressure boundary. For non-through-wall flaw conditions, Code Case N-504-3 allows performance of a system leakage test. Pressure testing is not addressed by Appendix Q. As an alternative, Entergy proposes to perform a system leakage test in accordance with IWA-5000. This proposal is consistent with the pressure testing requirements of IWA-4540 and Code Case N-416-3, except that, the NDE requirements of IWA-4540/N-416-3 would not apply to a WOL. The WOL acceptance examination will include both liquid penetrant and UT examinations. Liquid penetrant examinations will be performed in accordance with ASME Section III while the UT examination will be performed in accordance with Appendix VIII, Supplement 11 of ASME Section XI as implemented by PDI. The UT acceptance standards are as specified in Tables IWB-3514-2 and 3.

3. Suitability of Proposed Alternatives to Code Case N-638-1

An ambient temperature temper bead welding technique will be used when welding on the ferritic base material of RPV nozzle N-9A in lieu of the post-weld heat treatment requirements of ASME Section III. Research by the Electric Power Research Institute (EPRI) and other organizations on the use of an ambient temperature temper bead process using the machine gas tungsten arc welding (GTAW) process is documented in EPRI Report GC-111050 (Reference 7). According to the EPRI report, repair welds performed with an ambient temperature temper bead procedure utilizing the machine GTAW process exhibit mechanical properties equivalent to or better than those of the surrounding base material. Laboratory testing, analysis, successful procedure qualifications, and successful repairs have all demonstrated the effectiveness of this process.

The ambient temperature temper bead technique of Code Case N-638-1 will be used. Code Case N-638-1 was conditionally approved by the NRC in Regulatory Guide 1.147. The suitability of the proposed alternatives is provided below.

(a) Code Case N-638-1, paragraph 1.0(a) limits the maximum area of an individual weld to 100 square inches. Entergy's proposed alternative limits the surface area to 500 square inches. The technical basis for this change is provided in Attachment 2.

(b) Code Case N-638-1, paragraph 2.1(j) specifies that the "average values of the three HAZ impact tests shall be equal to or greater than the average values of the three unaffected base metal tests." As an alternative, Entergy proposes to use the following alternative acceptance criteria:

> "The average lateral expansion value of the three HAZ impact test specimens shall be equal to or greater than the average lateral expansion value of the three unaffected base metal test specimens."

The acceptance criteria for Charpy V-notch HAZ testing in Code Case N-638-1 is misleading and inconsistent with the specified acceptance criteria in Section XI applicable to other Class 1 components, since it implies that all three parameters - lateral expansion, absorbed energy, and percent shear fracture – must be equal to or exceed the base material values. Code Case N-638-2 corrected paragraph 2.1(j) to state that Charpy V-notch acceptance criteria is based on the "average lateral expansion values" rather than the average of all three values. This change clarified the intent of the code case and aligned its acceptance criteria with NB-4330 of ASME Section III and IWA-4620 and IWA-4630 of ASME Section XI.

(c) Code Case N-638-1, paragraph 3.0(c) requires the deposition and removal of at least one weld reinforcement layer for "similar materials" (i.e., ferritic materials). As an alternative, Entergy proposes to exclude this requirement because it does not apply to austenitic weld materials. This requirement only applies when welding is performed using ferritic weld metal. When temper bead welding is performed with ferritic weld metal, each ferritic weld layer must be tempered by the heat supplied from a subsequent weld layer. Because the final layer of a completed weld or weld repair would be untempered, paragraph 3.0(c) requires the deposition and removal of an additional layer (weld reinforcement) to ensure that the final layer of the completed weld is tempered. Since only austenitic weld metal (i.e., Alloy 52M) will be used to fabricate the proposed WOL, deposition and removal of a weld reinforcement layer is not required.

(d) Code Case N-638-1, Section 3.0 does not specifically address verification or monitoring of welding preheat or interpass temperatures. Therefore, Entergy has proposed the following controls:

> "The preheat and interpass temperatures will be measured using a contact pyrometer. In the first three layers, the interpass temperature will be measured every three to five passes. After the first three layers, interpass temperature measurements will be taken every six to ten passes for the subsequent layers. Contact pyrometers will be calibrated in accordance with approved calibration and control program documents."

The proposed preheat and interpass temperature controls are based on field experience with depositing WOLS. Interpass temperatures beyond the third layer have no impact on the metallurgical properties of the low alloy steel heat affected zone.

(e) Code Case N-638-1, paragraph 4.0(b) requires that the final weld surface and the band around the weld area (1.5t or 5", whichever is less) shall be examined using surface and ultrasonic examination methods. As an alternative, Entergy has proposed the following as an alternative:

- The WOL and adjacent base material within ½" of the WOL shall be examined by the liquid penetrant method.
- The WOL examination volume A-B-C-D in Figure Q-4100-1 of ASME Section XI, Appendix Q shall be ultrasonically examined.

The requirement in Code Case N-638-1, paragraph 4.0(b) to nondestructively examine the entire 1.5T band was established to address hydrogen cracking concerns. While the code case requirement is overly conservative, the proposed alternative is more than capable of detecting hydrogen cracking in ferritic materials. First of all, if hydrogen cracking were to occur, it would occur in the heat affected zone of the ferritic base material either below or immediately adjacent to the WOL. Therefore, it is unnecessary to examine the entire 1.5T band. Hydrogen cracking is not a concern in austenitic materials. If it occurs in the ferritic base material below the WOL, it will be detected by the ultrasonic examination which will interrogate the entire WOL including the interface and heat affected zone beneath the WOL. If it occurs in the ferritic base material immediately adjacent to the WOL, it will be detected by the liquid penetrant examination which is performed at least ½ inch on each side of the WOL.

(f) Code Case N-638-1, paragraph 4.0(b) specifies that surface and volumetric examinations cannot be performed until the completed weld (i.e. WOL) "has been at ambient temperature for at least 48 hours". As an alternative, Entergy proposes that surface and ultrasonic examinations cannot be performed until at least 48 hours after completion of the third temper bead layer of the WOL. The 48-hour hold is specified to allow sufficient time for hydrogen cracking to occur (if it is to occur) in the heat affected zone of ferritic materials prior to performing final NDE. However, based on extensive research and industry experience, EPRI has provided a technical basis for starting the 48-hour hold after completing the third temper bead weld layer rather than waiting for the weld overlay to cool to ambient temperature (weld layers beyond the third layer are not designed to provide tempering to the ferritic heat affected zone when performing ambient temperature temper bead welding). EPRI has documented their technical basis in technical report 1013558, *Temper bead Welding Applications – 48 Hour Hold Requirements for Ambient Temperature Temper bead Welding* (Reference 8). The technical data provided by EPRI in their report is based on testing performed on SA-508, Class 2 low alloy steels and other P-Number 3, Group 3 materials. This point is important because the PNPS

N-9A nozzle was manufactured from SA-508, Class 2 steel. After evaluating the issues relevant to hydrogen cracking such as microstructure of susceptible materials, availability of hydrogen, applied stresses, temperature, and diffusivity and solubility of hydrogen in steels, EPRI concluded the following on page 5-2 of the report: "There appears to be no technical basis for waiting 48 hours after cooling to ambient temperature before beginning the NDE of the completed weld. There should be no hydrogen present, and even if it were present, the temper bead welded component should be very tolerant of the moisture." Page 5-2 of the report also notes that over 20 weld overlays and 100 repairs have been performed using temper bead techniques on low alloy steel components over the last 20 years. During this time, there has never been an indication of hydrogen cracking by the nondestructive examination performed after the 48 hour hold or by subsequent inservice inspection.

In addition, the ASME Section XI Committee approved Revision 4 to Code Case N-638 (i.e., N-638-4) in October 2006 to allow the 48-hour hold to begin after completing the third weld layer when using austenitic filler metals. Paragraph 4(a)(2) of the code case states in part: "When austenitic materials are used, the weld shall be nondestructively examined after the three tempering layers (i.e., layers 1, 2, and 3) have been in place for at least 48 hours." The ASME Section XI technical basis for this change is documented in the white paper contained in ASME C&S Connect for Code Case N-638-4. The ASME white paper points out that introducing hydrogen to the ferritic heat affected zone is limited to the first weld layer since this is the only weld layer that makes contact with the ferritic base material. While the potential for introducing hydrogen to the ferritic heat affected zone is negligible during subsequent weld layers, these layers provide a heat source that accelerates the dissipation of hydrogen from the ferritic heat affected zone in non-water backed applications. Furthermore, the solubility of hydrogen in austenitic materials such as Alloy 52M is much higher than that of ferritic materials, while the diffusivity of hydrogen in austenitic materials is lower than that of ferritic materials. As a result, hydrogen in the ferritic heat affected zone tends to diffuse into the austenitic weld metal which has a much higher solubility for hydrogen. This diffusion process is enhanced by heat supplied in subsequent weld layers. Like the EPRI report, the ASME white paper concludes that there is sufficient delay time to facilitate detecting potential hydrogen cracking when NDE is performed 48 hours after completing the third weld layer.

(g) Code Case N-638-1, paragraph 4.0(b) and (e) state that the ultrasonic examination shall be performed in accordance with Appendix I of ASME Section XI and meet the acceptance criteria of IWB-3000. Regarding this UT examination, Regulatory Guide 1.147 includes the following condition:

> "UT volumetric examinations shall be performed with personnel and procedures qualified for the repaired volume and qualified by demonstration using representative samples which contain construction type flaws. The acceptance criteria of NB-5330 in the 1998 Edition through 2000 Addenda of Section III apply to all flaws identified within the repaired volume.

As an alternative, Entergy has proposed to perform the UT acceptance examination in accordance with the requirements and acceptance criteria of Appendix Q, Article Q-4000. The UT examination requirements and acceptance standards in Appendix Q, Article Q-4000 were developed specifically for WOLs unlike those in Code Case N-638-1. According to Article Q-4000, UT examination procedures and personnel are qualified in accordance with Appendix VIII of ASME Section XI. Supplement 11 of Appendix VIII specially addresses qualification requirements for WOLs. When UT examinations are performed in accordance with Appendix VIII, Supplement 11 (as implemented through PDI), the examinations are considered more sensitive for detecting fabrication and service-induced flaws than traditional radiographic and ultrasonic examination methods. Furthermore, construction-type flaws have been included in the PDI qualification sample sets for evaluating procedures and personnel. Appendix Q, Article Q-4100 also establishes UT acceptance standards for WOL examinations. Similar to NB-5330, the UT examination must assure adequate fusion with the base material and detect welding flaws such as interbead lack of fusion, inclusions, and cracks. Detected planar and laminar flaws are required to meet the acceptance standards of Tables IWB-3514-2 and 3, respectively. Paragraph Q-4100(c) also limits the reduction in coverage due to a laminar flaw to less than 10% while uninspectable volumes are assumed to contain the largest radial planar flaw that could exist within the volume. Therefore, the Article Q-4100 qualification requirements and acceptance standards are equivalent or more conservative than those specified in Regulatory Guide 1.147.

4. Additional NDE Information

The length, surface finish, and flatness requirements will be specified in the WOL overlay design to facilitate inspection of the examination volumes shown in Figures Q-4100-1 and Q-4300-1 of ASME Section XI, Appendix Q. Figure Q-4100-1 describes the examination volume for acceptance examinations while Figure Q-4300-1 describes the examination for preservice and inservice examinations. The examinations required by Code Case N-504-3/Appendix Q and Code Case N-638-1 as amended by the proposed alternatives of this Request will provide adequate assurance that the integrity of the Nozzle N-9A WOL is consistent with the structural integrity assumptions of the design. The following should also be noted:

- As discussed above, the modified WOL will be UT examined in accordance with Appendix VIII, Supplement 11 as implemented by PDI. Examination coverage for the acceptance examination has been estimated to be 100%. Examination coverage for the preservice/inservice examination has been estimated to be greater than 90%.
- The EPRI PDI qualification program for full structural weld overlays does not comply with all provisions of Appendix VIII, Supplement 11 of ASME Section XI as endorsed by the NRC in 10CFR50.55a. However, PNPS has addressed this issued under Pilgrim Relief Request PRR-9 which was approved by the NRC in an SER dated March 22, 2006.

5. NRC Submittals

As listed in Enclosure 2, Entergy will submit the following information to the NRC within fourteen (14) days from completing the final ultrasonic examinations of the completed weld overlays:

- Weld overlay examination results including a listing of indications detected[2]
- Disposition of indications using the standards of ASME Section XI, Subsection IWB-3514-2 and/or IWB-3514-3 criteria and, if possible, the type and nature of the indications[3]
- A discussion of any repairs to the WOL material and/or base metal and the reason for the repairs.

Entergy will also submit to the NRC a stress analysis summary demonstrating that the N-9A nozzle WOL perform its intended design function after WOL installation. The stress analysis report will include results showing that the requirements of NB-3200 and NB-3600 of the ASME Code, Section III are satisfied. The stress analysis will also include results showing that the requirements of Subsection IWB-3000 of the ASME Code, Section XI, are satisfied. The results will show that the postulated crack including its growth in the nozzles will not adversely affect the integrity of the overlaid welds. This information will be submitted to the NRC within 60 days of completing PNPS refueling outage RFO-17.

VI. <u>CONCLUSION</u>

10 CFR 50.55a(a)(3) states:

"Proposed alternatives to the requirements of (c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that:

(i) The proposed alternatives would provide an acceptable level of quality and safety, or

(ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

Entergy believes that the proposed alternatives of this request provide an acceptable level of quality and safety. The proposed WOL will be installed using Nickel Alloy 52M filler metal that is resistant to IGSCC. While this is the case, the WOL is expected to create compressive residual stresses along the inside diameter of the original weld, which prevents the initiation of new IGSCC. Finally, preservice and inservice inspection of the weld overlay will be performed to

[2] The recording criteria of the ultrasonic examination procedure to be used for the WOL examination requires that all indications, regardless of amplitude, be investigated to the extent necessary to provide accurate characterization, identity, and location. Additionally, the procedure requires that all indications, regardless of amplitude, that cannot be clearly attributed to the geometry of the overlay configuration be considered flaw indications.

[3] The ultrasonic examination procedure requires that all suspected flaw indications are to be plotted on a cross-sectional drawing of the weld and that the plots should accurately identify the specific origin of the reflector.

ensure structural integrity is maintained. Therefore, Entergy requests that the NRC staff authorize the proposed alternative in accordance with 10 CFR 50.55a(a)(3).

VII DURATION OF PROPOSED ALTERNATIVE

The proposed alternative is applicable to the fourth (4th) 10-Year ISI interval for PNPS (July 1, 2005 to June 30, 2015).

Entergy Letter No.: 2.09.032, PRR-19

Attachment 1 to Enclosure 1

Jet Pump Instrumentation Nozzle N-9A Details

TABLE 1

JET PUMP INSTRUMENTATION NOZZLE N-9A DETAILS

Nozzle Description	Nozzle Material	Nozzle to Safe End Weld Material	Safe End Material	Safe End to Penetration Seal Weld Material	Penetration Seal Material	Figure No.
Jet Pump Instrumentation Nozzle N-9A	A-508, Class 2[1]	Alloy 182[2]	SA-182, F304[3]	Alloy 182[4]	SA-182, F304[3]	1

Notes:

1. A-508, Class 2 is P-Number 3, Group 3 low alloy steel.
2. Weld includes butter on nozzle and safe end.
3. SA-182, F304 is P-Number 8 stainless steel.
4. Weld includes butter on safe end and penetration seal.

Pilgrim RPV N9A Jet Pump Instrumentation Nozzle 5" OD

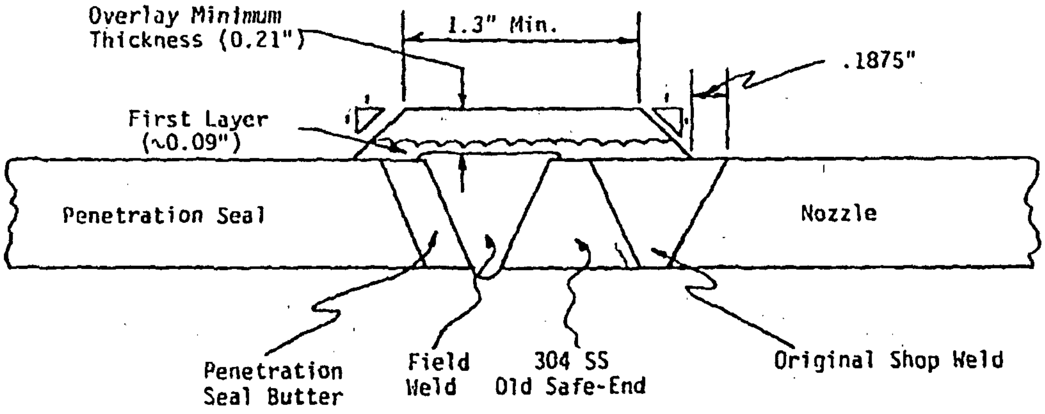
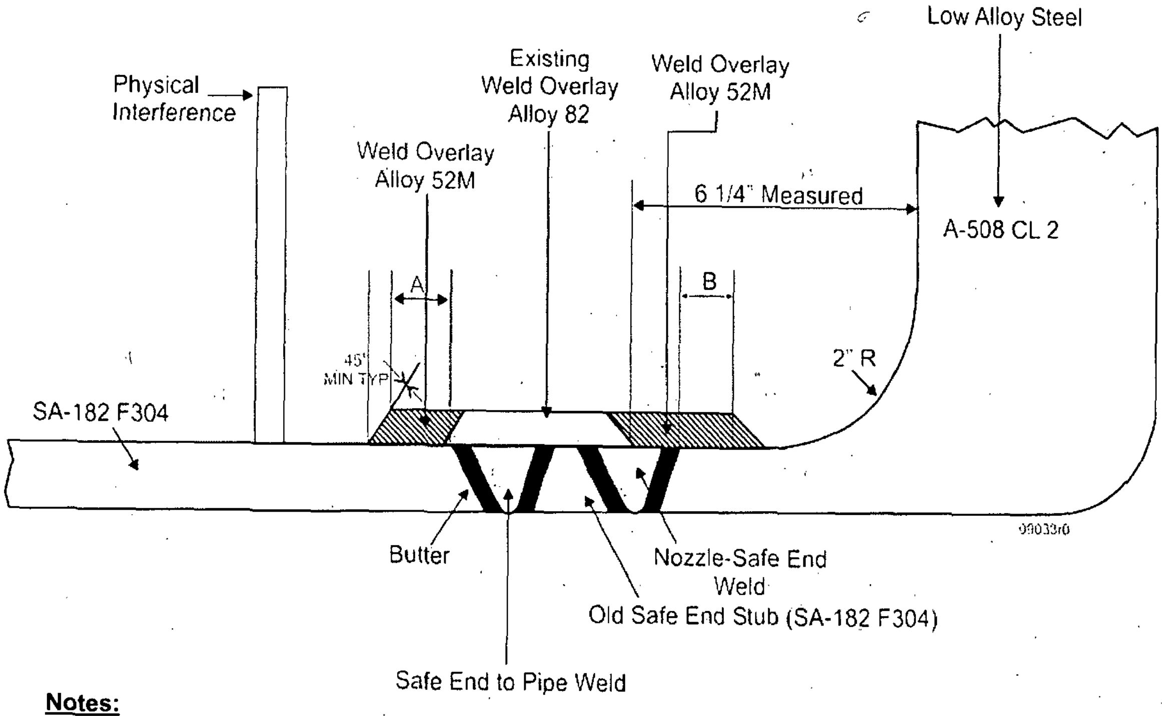


Figure 1 Existing N9A Weld Configuration (1984 Repair)



Notes:
0.22"min WOL Thickness A ≅ 0.6" Due to Physical Interference B ≅ 1" Minimum
Final configuration of the WOL will include one to two layers of 52M over the entire length of the overlay.

Figure 2 Proposed Weld Overlay

Entergy Letter No.: 2.09.032, PRR-19

Attachment 2 to Enclosure 1

Technical Basis for Alternative to ASME Code Case N-638-1, Area Limitation Change to 500 Square Inches

TECHNICAL BASIS FOR ALTERNATIVE TO ASME CODE CASE N-638-1, AREA LIMITATION CHANGE TO 500 SQUARE INCHES

IWA-4600 and versions of ASME Code Case N-638 prior to Revision 3 contained a limit of 100 square inches for the surface area of a temperbead weld over ferritic base metal. The area limitation in Revision 3 is 500 square inches. The proposed weld overlay will be greater than 100 square inches but less than 500 square inches.

Technical justification for allowing weld overlays on ferritic materials with surface areas up to 500 square inches is provided in the white paper supporting the changes in ASME Code Case N-638-3 and EPRI Report 1011898 (Ref. 6). The ASME white paper notes that the original limit of 100 square inches in Code Case N-638-1 was arbitrary. It cites evaluations of a 12-inch diameter nozzle weld overlay to demonstrate adequate tempering of the weld heat affected zone (HAZ) (Section 2a of the white paper), residual stress evaluations demonstrating acceptable residual stresses in weld overlays ranging from 100 to 500 square inches (Section 2b of the white paper), and service history in which weld repairs exceeding 100 square inches were NRC approved and applied to DMW nozzles in several BWR and PWR (Section 3c of the white paper) applications. Some of the cited repairs are greater than 15 years old, and have been inspected several times with no evidence of any continued degradation.

It is important to note that the above theoretical arguments and empirical data have been verified in practice by extensive field experience with temperbead weld overlays, with ferritic material coverage ranging from less than 10 square inches up to and including 325 square inches. The table below provides a partial list of such applications.

Date	Plant	Component	Nozzle Diameter (in)	Approx. LAS Coverage (in^2)
April 2007	Pilgrim	Recirc. Inlet N2K	28	300
November 2006	SONGS Unit 3	PZR spray nozzle Safety/relief nozzles PZR surge nozzle	5.1875 8 12.75	40 60 110
November 2006	Catawba Unit 1	PZR spray nozzle Safety/relief nozzles PZR surge nozzle	4 6 14	30 50 120
November 2006	Oconee Unit 1	PZR spray nozzle Safety/relief nozzles PZR surge nozzle HL Surge Nozzle	4.5 4.5 10.875 10.75	30 30 105 70
October 2006	McGuire Unit 2	PZR spray nozzle Safety/relief nozzles PZR surge nozzle	4 6 14	30 50 120
April 2006	Davis-Besse	Hot leg drain nozzle	4	16
February 2006	SONGS Unit 2	PZR spray nozzle Safety/relief nozzles	8 6	50 28

Date	Plant	Component	Nozzle Diameter (in)	Approx. LAS Coverage (in^2)
November 2005	Kuosheng Unit 2	Recirc. outlet nozzle	22	250
April 2004	Susquehanna Unit 1	Recirc. inlet nozzle Recirc. outlet nozzle	12 28	100 325
November 2003	TMI Unit 1	Surge line nozzle	11.5	75
October 2003	Pilgrim	CRD return nozzle	5	20
October 2002	Peach Bottom Units 2 & 3	Core spray nozzle Recirc. outlet nozzle CRD return nozzle	10 28 5	50 325 20
October 2002	Oyster Creek	Recirc. outlet nozzle	26	285
December 1999	Duane Arnold	Recirc. inlet nozzle	12	100
June 1999	Perry	Feedwater nozzle	12	100
June 1998	Nine Mile Point Unit 2	Feedwater nozzle	12	100
March 1996	Brunswick Units 1 & 2	Feedwater nozzle	12	100
February 1996	Hatch Unit 1	Recirc. inlet nozzle	12	100
January 1991	River Bend	Feedwater nozzle	12	100
March 1986	Vermont Yankee	Core spray nozzle	10	50

It can be seen from the information above that the original DMW weld overlay was applied over 20 years ago, and weld overlays with low alloy steel coverage in the 100-square inch range have been in service for 5 to 15 years. Several overlays have been applied with low alloy steel coverage significantly greater than the 100 square inches. These overlays have been examined with PDI qualified techniques, in some cases multiple times, and none have shown any signs of new cracking or growth of existing cracks.

Enclosure 2

Entergy Letter No.: 2.09.032, PRR-19

List of Regulatory Commitments

List of Regulatory Commitments

The following table identifies those actions committed to by Entergy in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
Weld overlay examination results including a listing of indications detected.	X		14 days after completing the final ultrasonic examinations of the completed weld overlays
Disposition of indications using the standards of ASME Section XI, Subsection IWB-3514-2 and/or IWB-3514-3 criteria and, if possible, the type and nature of the indications	X		14 days after completing the final ultrasonic examinations of the completed weld overlays
A discussion of any repairs to the weld overlay material and/or base metal and the reason for the repairs.	X		14 days after completing the final ultrasonic examinations of the completed weld overlays
Submit to the NRC a stress analysis summary demonstrating that the N-9A nozzle to safe-end DMW will perform its intended design function after weld overlay installation	X		Within 60 days of completing PNPS Refueling Outage RFO 17

Enclosure 3

Entergy Letter No.: 2.09.032, PRR-19

"PWSCC Resistance of Nickel Based Weld Metals With Various Chromium Contents",
Buisine, et al, Section D5, EPRI TR 105406, Proceedings: 1994 EPRI Workshop on PWSCC of Alloy 600 in PWRs, dated August 1995 (16 pages)

boundary. Measurement included at least five sampling areas of the microstructure for each count.

- Question: Have you made TEM micrographs and studied dislocation structures?
  Response: We use TEM to look for strain fields.

PWSCC Resistance of Nickel Based Weld Metals With Various Chromium Contents

This presentation was given by D. Buisine of Electricité de France (refer to Paper D5). The main points made in this presentation were as follows:

- EdF and Framatome have conducted tests to determine the effect of chromium in Inconel weld materials. Materials tested included 15.0%, 18.0%, 19.9% and 29.2% chromium. Tests included four point bent-beam specimens (1% strain) and U-bend specimens (12.5% strain) in doped steam and reverse U-bends (RUB's), CERT and constant load tests in primary water at 360°C (680°F).

- The tests clearly demonstrated the role of chromium in providing PWSCC resistance. Weld metals with 30% chromium were found to be resistant to PWSCC. The threshold for PWSCC resistance appears to be between 22 and 30% chromium.

Questions and responses following the presentation were as follows:

- Question: Alloy 625 weld metal showed a good resistance to PWSCC. What do you think of the effect of Mo?
  Response: If you compare the CERT results in primary water performed on Alloy 625 and 21% chromium modified 182, you observe that Alloy 625 is at least as susceptible as the 21% chromium modified 182. So, I think that Mo seems to have no effect.

- Question: Have you tested weld metal with the cold worked surface removed (such as by electropolishing)?
  Response: Constant load tests have been performed without electropolishing. CERT and RUB tests have been performed after electropolishing.

- Question: Does the effect of machining (cold working) weld specimens for lab tests explain the greater susceptibility in tests vs. the field (as deposited)?
  Response: Surface finishing can be an explanation. Investigation of this aspect is in progress.

- Question: Have you checked the weldability for each material?
  Response: Yes. We have observed that Alloy 152 alloy is more susceptible to hot cracking than the Alloy 182. But the 152 has been improved and the new heats are better in terms of hot cracking susceptibility.

- Question: Yield strength has shown to be important for the SCC susceptibility of Alloy 600 in primary water. Could you give the yield strengths of the weld metals you tested?
  Response: The yield strengths were 350 MPa (50.7 ksi) at test temperatures for both 182 and 152 alloys.

- Question: To my knowledge Alloy 182 has shown very little susceptibility to cracking in the field, yet it appears to be susceptible to PWSCC in the lab tests. Please comment.
  Response: The difference may be related to a different dependence of cracking on stress and temperature than Alloy 600. Therefore, extrapolations to field conditions may be difficult.

- Question: What were the levels of P and S for each filler metal?
  Response: These values are as follows:

Material	S	P
182 (1)	0.004	0.003
82 (1)	0.002	<0.004
625	0.007	0.005
22% exp	0.007	0.005
30% exp	0.007	0.008
152	0.010	0.006

EDF/FRAMATOME

1994 EPRI WORKSHOP ON PWSCC OF ALLOY 600 IN PWRs

PWSCC resistance of nickel based weld metals with various chromium contents

D BUISINE, F VAILLANT, P VIDAL (Electricité de France)
C GIMOND (Framatome)

EDF/FRAMATOME

1 PURPOSE

Alloy 182 (15% chromium) is known to be PWSCC sensitive in laboratories

to improve this situation, nickel based weld metals with higher chromium content (30%) are proposed

- ➨ **investigation of the effect of chromium on PWSCC resistance of these materials**
- ➨ **evaluation of PWSCC resistance of 30% chromium content alloys**

EDF/FRAMATOME

2 Materials investigated

Identification and chemical composition (% Wt)

Chromium range	Type of weld metal	Welding process	C	Si	Mn	Ni	Cr	Mo	Fe	Nb
14/15	182 from SOUDOMETAL	SMAW	0.023	0.36	7.32	bal	14.5	0.05	7.9	2.0
			0.027	0.32	6.65	bal	15.0	-	6	1.96
18/20	82	GTAW	0.014	0.20	3.02	bal	18.1	<0.01	3.8	2.47
			0.015	0.24	3.12	bal	18.0	-	0.07	2.3
	modified 182 from SOUDOMETAL	SMAW	0.036	0.38	3.51	bal	19.8	-	2	2.07
21/22	625 from SOUDOMETAL	SMAW	0.024	0.41	0.76	bal	21.1	8.87	1.3	3.64
	Experimental weld metal from SOUDOMETAL	SMAW	0.022	0.34	4.35	bal	21.1	0.01	9.6	1.76
29/30	Experimental weld metal from SOUDOMETAL	SMAW	0.041	0.53	4.33	bal	29.7	0.18	10.2	1.78
	152 from INCO	SMAW	0.040	0.44	3.60	bal	29.2	0.24	10.7	1.60

All materials have been studied in as-welded conditions

EDF/FRAMATOME

3 SCC TESTS PROCEDURE

1 Tests in doped steam

Environment : Doped steam (400°C, P = 200 bar, pH_2 = 0,8 bar, Cl^- = 30 ppm, F^- = 30 ppm, $SO_4^=$ = 30 ppm)

Type of tests : Bend specimens :
- 4 points bent-beam specimens (1% strained)
- U-bend specimens (≈12.5% strained)

2 Tests in primary water

Environment : Primary water (360°C, 1000 ppm B, 2 ppm LiOH, 4 bar H_2 overpressure (at 125°C),

Type of tests :
. Reverse U bend specimens (RUBs)
. Constant Elongation rate test (CERT) - strain rate range : 5 10^{-8} s^{-1}
. Constant load tests

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4 CORROSION TESTS RESULTS - TESTS ON BEND SPECIMENS IN DOPED STEAM

Chromium content (%)	Type of weld metal	Results after 50h exposure	Results after 100h exposure
15.0	182	a) 4 cracked / 6 b) 2 cracked / 3	
18.0	82	a) 1 cracked / 3 b) 3 cracked / 3	
19.9	modified 182	a) 3 cracked / 6 b) 3 cracked / 3	
29.2	152		a) 0 cracked / 3 b) 0 cracked / 3

a) 1% strained
b) 12.5% strained

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4 CORROSION TESTS RESULTS - TESTS ON RUBs IN PRIMARY WATER

Chromium content	type of weld metal	initial	500 h	1000 h	1500 h	2000 h	2500 h	3000 h	3500 h	4000 h	4500 h	5000 h	5500 h
14%	182	–	SCC										
		–			SCC								
18%	82	–				SCC							
		–							➡				
		–							➡				
		–							➡				
21%	625	–											➡
		–											➡
		–											➡
30%	Experimental weld metal	Small defects (< 1 mm)	No evolution				SEM examination ➡ welding defects						
			No evolution										
			No evolution										
			No evolution										➡
	152	Small defects (< 0.6 mm)	No evolution				SEM examination ➡ welding defects						
			No evolution										
			No evolution										➡

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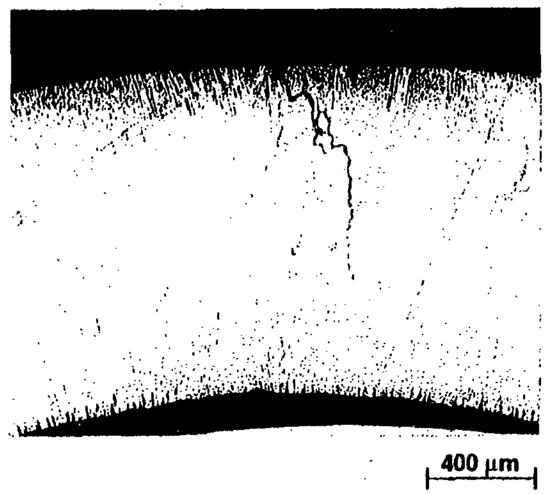
4 CORROSION TESTS RESULTS - TESTS ON RUBs IN PRIMARY WATER (continued)



Micrographic examination of a stress corrosion crack in Alloy 182 RUB after 1500 h in primary water at 360°C

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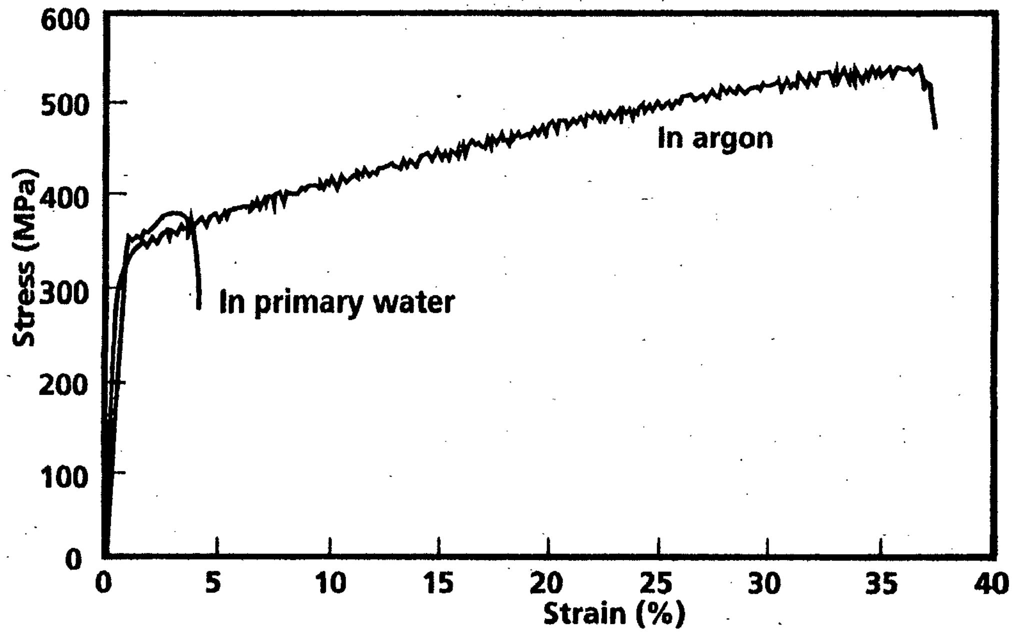
4 CORROSION TESTS RESULTS - CERTs IN PRIMARY WATER



Comparison of CERT test results on 182 alloy in primary water and inert environment (argon)

EDF/FRAMATOME

4 CORROSION TESTS RESULTS - CERTs IN PRIMARY WATER (continued)

Chromium content	Type of weld metal	Normalized elongation * (%)	Fractographic examination of the failure surface	
			Welding defects	Stress corrosion crack
14	182	9	No	Stress corrosion crack (1.8 mm)
18	82	76	No	Stress corrosion cracks (2 x 0.8 mm)
21	625		No	Stress corrosion crack (0.8 mm)
	Experimental weld metal	112	No	Stress corrosion crack (0.15 mm)
30	Experimental weld metal	107	Weld defect of 0.7 mm	No
	152	119	Weld defect of 0.45 mm	No
		82	Weld defect of 0.50 mm	No

* Elongation after test in primary water / elongation in argon

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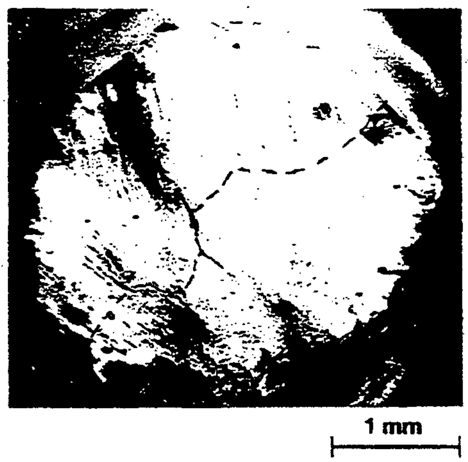
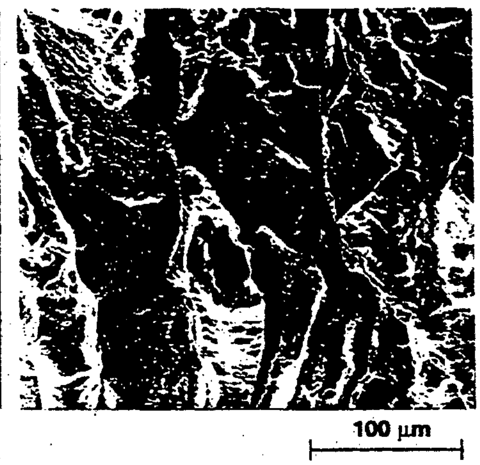
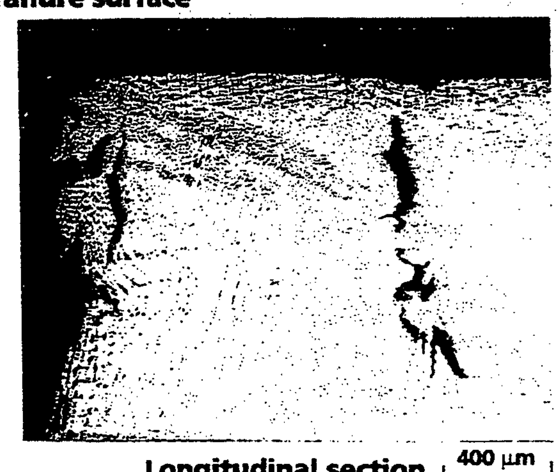
4 CORROSION TESTS RESULTS - CERTs IN PRIMARY WATER (Continued)



Fractographic examination of the failure surface



Aspect of the corrosion crack



Longitudinal section of the specimen

METALLURGICAL EXAMINATION OF 182 CERT SPECIMEN AFTER TEST

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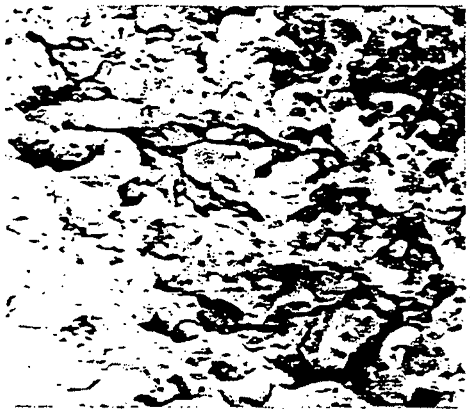
4 CORROSION TESTS RESULTS - CERTs IN PRIMARY WATER (Continued)

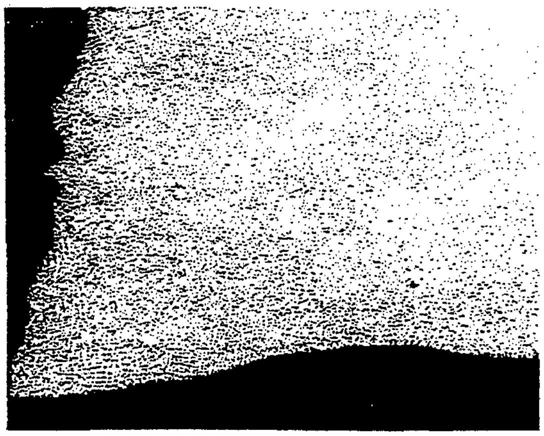
1 mm

Fractographic examination of the failure surface



10 µm

Aspect of the welding crack (hot crack)



400 µm

Longitudinal section of the specimen

METALLURGICAL EXAMINATION OF 152 CERT SPECIMEN AFTER TEST

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4 CORROSION TESTS RESULTS - CONSTANT LOAD TESTS IN PRIMARY WATER

Chromium content	Type of weld metal	Stress applied (MPa)	Time to failure (h)	Fractographic examination
14	182	527	96	stress corrosion crack (1.7 mm)
18	82	580	572	stress corrosion crack (1.5 mm)
30	152	590	> 6000	in progress
		590	> 6000	in progress

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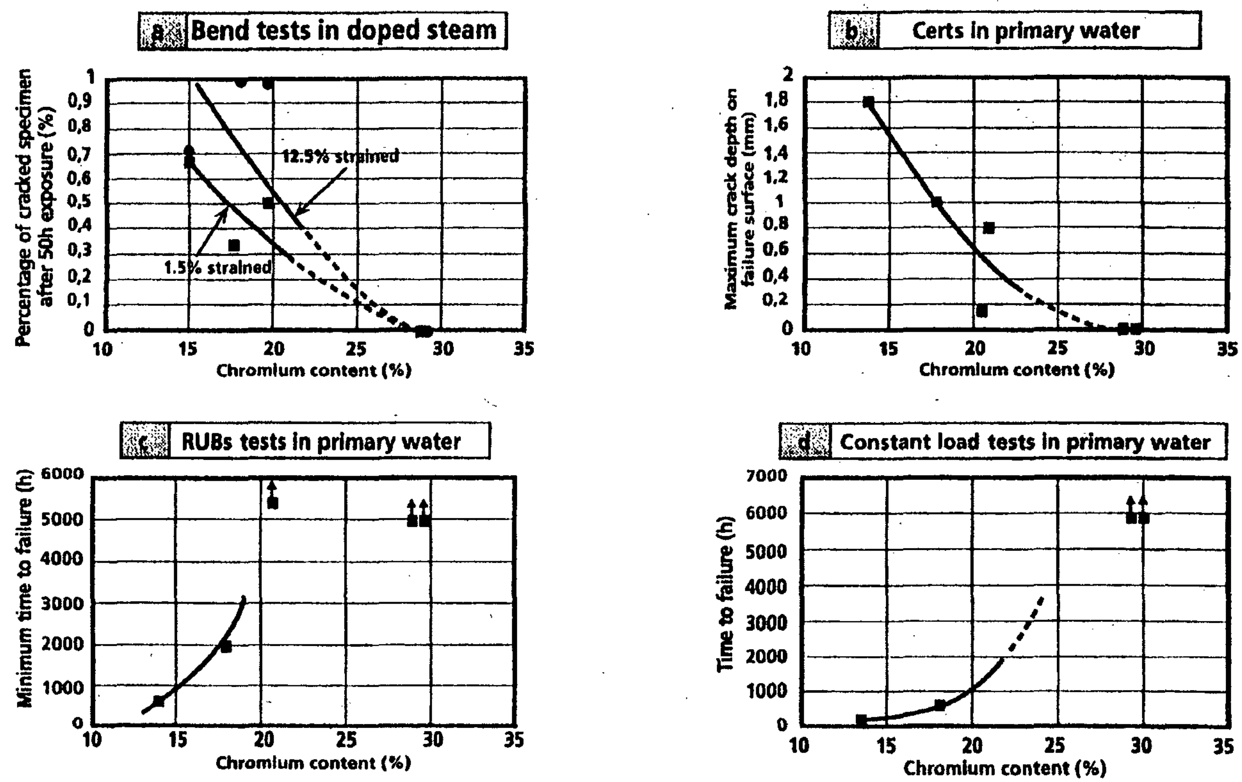
6 SYNTHESIS OF THE RESULTS



RELATIONSHIP BETWEEN PWSCC RESISTANCE AND CHROMIUM CONTENTS OF THE WELD METALS

EDF/FRAMATOME

CONCLUSIONS

BENEFICIAL EFFECT OF CHROMIUM ON PWSCC RESISTANCE OF WELD METALS HAS BEEN SHOWN

WELD METALS WITH 30% OF CHROMIUM (152, ...) ARE PWSCC RESISTANT

LIMIT OF THE PWSCC RESISTANCE SEEMS TO BE BETWEEN 22 AND 30% OF CHROMIUM