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United States Nuclear Regulatory Commission
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Subject: Response to Request for Additional Information Regarding Proposed Alternative to American Society of Mechanical Engineers Code Section XI Repair Requirements (TAC No. MD4452)

Ladies and Gentlemen:

By letter dated February 15, 2007, as supplemented by letter dated June 28, 2007, the FirstEnergy Nuclear Operating Company (FENOC) requested Nuclear Regulatory Commission (NRC) approval of a proposed alternative to American Society of Mechanical Engineers Code Section XI requirements in support of weld overlay repairs for the Davis-Besse Nuclear Power Station pressurizer welds. Subsequently, by letter dated August 16, 2007, the NRC issued a request for additional information (RAI). Attachment 1 provides FENOC's response to the RAI.

Additionally, during a teleconference on July 12, 2007, the NRC noted that approving the request in its current format would constitute NRC approval of Code Case N-740, for which the NRC review process is not complete. To clarify that FENOC is not requesting specific approval of Code Case N-740, the previous request is being supplemented to revise appropriate passages. To aid in the review process, Attachment 2 contains the request in its entirety with supplemental changes indicated by revision bars.

As stated in the February 15, 2007 letter, FENOC requests approval of this proposed alternative by November 30, 2007 to allow installation of the pressurizer weld overlays during the next maintenance and refueling outage, which is currently scheduled to commence in December 2007.

As indicated in Attachment 3, the regulatory commitments associated with the February 15, 2007 request remain in effect, and no additional commitments are established in this

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letter. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager – FENOC Fleet Licensing, at (330) 761-6071.

Very truly yours,

Mark B. Bezilla, Vice President - Nuclear

Attachments

1. Response to Request for Additional Information Davis-Besse Nuclear Power Station (DBNPS) 10 CFR 50.55a Request Regarding Installation of Structural Weld Overlays (TAC No. MD4452)
2. FirstEnergy Nuclear Operating Company Davis-Besse Nuclear Power Station Third 10-Year Interval Request RR-A30, Revision 2
3. Commitment List

cc: Regional Administrator, NRC Region III
NRC/NRR Project Manager
N. Dragani, Ohio Emergency Management Agency
NRC Senior Resident Inspector
Utility Radiological Safety Board

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION DAVIS-BESSE NUCLEAR POWER STATION (DBNPS) 10 CFR 50.55a REQUEST REGARDING INSTALLATION OF STRUCTURAL WELD OVERLAYS (TAC NO. MD4452)

To complete their review, the NRC staff has requested additional information regarding the proposed structural weld overlays to be installed at the Davis-Besse Nuclear Power Station. FENOC's response is provided below.

Question 1:

Discuss whether the candidate welds in the proposed Request RR-A30 will be examined by ultrasonic testing (UT) prior to installation of weld overlays in accordance with the American Society of Mechanical Engineers (ASME) Code, Section XI.

FENOC Response:

FENOC does not intend to UT examine the dissimilar metal welds identified in Section 1 of Relief Request RR-A30 prior to the application of the weld overlays. Because the weld overlay design is the same regardless of the presence of flaws, performing UT examinations prior to application of the weld overlay would result in unnecessary radiological exposure to personnel. Estimated radiation dose to perform pre-overlay UT examination is approximately 400 mR.

In Refueling Outage 14, spring 2006, the Pressurizer Alloy 600 welds and the Surge Line to Hot Leg Nozzle weld were examined in accordance with American Society of Mechanical Engineers (ASME) Section XI utilizing Performance Demonstration Initiative (PDI) qualified procedures and personnel as noted below with no indications noted. The Decay Heat Elbow to Hot Leg Nozzle weld was not examined in Refueling Outage 14.

PRESSURIZER / HOT LEG ALLOY 600 WELD UT COVERAGES

Weld	Axial Scan Coverage (Circumferential Flaw)	Circumferential Scan Coverage (Axial Flaw)	Total Coverage	14R (S2006) Inspection Results
RC-PZR-WP-102 (Spray Nozzle to Safe End)	100%	75%	87.5%	No Indications
RC-MK-A-90-FW56 (Spray Safe End to Pipe)	64.5%	32%	48%	No Indications

Weld	Axial Scan Coverage (Circumferential Flaw)	Circumferential Scan Coverage (Axial Flaw)	Total Coverage	14R (S2006) Inspection Results
RC-PZR-WP-91 W/X (3" Safety Nozzle)	100%	100%	100%	No Indications
RC-PZR-WP- 91 Y/Z (3" Safety Nozzle)	100%	100%	100%	No Indications
RC-PZR-WP-91 Z/W (2½" Relief Valve Nozzle)	91%	100%	95.5%	No Indications
RC-PZR-WP-23 (Surge to Pressurizer Nozzle)	31%	32.5%	32%	No Indications
RC-MK-A-82-FW54 (Surge to Hot Leg Nozzle)	39%	0%	19.5%	No Indications

Question 2:

The NRC staff does not find the practice of applying a new weld overlay over the top of an existing weld overlay that has been in service to be acceptable or appropriate because the material properties of the weld overlay may change with more than one weld overlay application. Discuss whether this application is included in the proposed Request RR-A30.

FENOC Response:

The practice of applying a new weld overlay over an existing weld overlay does not apply to RR-A30.

Question 3:

Regarding Section 1, *ASME Code Components Affected*, of Request RR-A30:

(a) For each candidate weld, identify the material specification and P number of each affected component (e.g., nozzles, safe ends, flanges, piping, and hot leg branch connections).

(b) Weld RC-PZR-FW22 is the similar metal weld joining the 4-inch pressurizer relief nozzle safe end and the valve flange. This weld is associated with weld RC-PZR-WP-91-W/X which joins the 3-inch W/X axis pressurizer relief nozzle and the safe end. Explain why these two welds have two different diameters even though they seem to belong to the same relief valve piping.

(c) Provide drawings or sketches of the weld configuration of each of the components listed in Section 1 of request RR-A30.

FENOC Response:

(a)

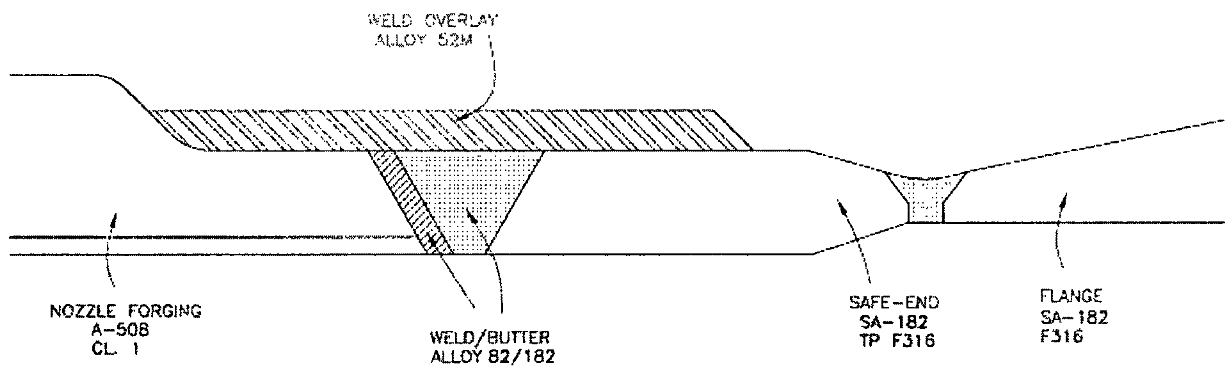
Materials

Location	Nozzle	Safe End	Pipe/Fitting
3" Pressurizer Safety Nozzles – Welds RC-PZR-WP-91-W/X RC-PZR-WP-91-Y/Z	A-508 CL 1 (P-No. 1 Group 2)	SA-182 TP F316 (P-No. 8 Group 1)	SA-182 TP F316 Flange (P-No. 8 Group 1)
10" Hot Leg Surge Nozzle Weld – RC-MK-A-82-FW54	A-105 GR 2 (P-No. 1 Group 2)	N/A	A-376 TP 316 Pipe (P-No. 8 Group 1)
2½" Pressurizer Relief Valve Nozzle – Welds RC-PZR-WP-91-Z/W RC-30-CCA-8-1-FW10	A-508 CL 1 (P-No. 1 Group 2)	SA-182 TP F316 (P-No. 8 Group 1)	SA-376 TP 316 Pipe (P-No. 8 Group 1)
12" Hot Leg Decay Heat Nozzle Weld – DH-33A-CCA-4-1-FW1	A-105 GR 2 (P-No. 1 Group 2)	N/A	SA-403 WP 316 Elbow (P-No. 8 Group 1)
10" Pressurizer Surge Nozzle – Weld RC-PZR-WP-23	A-508 CL 1 (P-No. 1 Group 2)	A-336 CL F8M (P-No. 8 Group 1)	N/A
4" Pressurizer Spray – Welds RC-PZR-WP-102 RC-MK-A-90-FW56	A-508 CL 1 (P-No. 1 Group 2)	SB-166 (P-No. 43)	A-376 TP 316 Pipe (P-No. 8 Group 1)

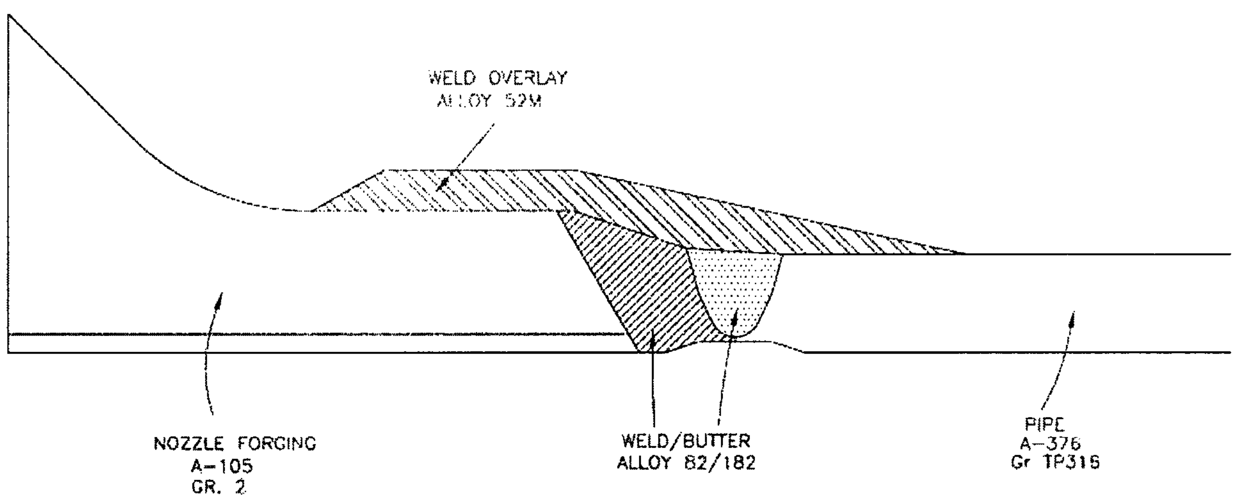
(b) Weld RC-PZR-FW22 joins the stainless steel Pressurizer Safety Valve safe end to a stainless steel flange. At this weld, the 3-inch inside diameter piping configuration opens up to match with a 4-inch Schedule 120 flange upon which the safety valve is bolted. The "Pressurizer 3″ Safety/Relief Nozzle Weld Overlay" sketch in the response to Item (c) in this question illustrates this configuration.

Note: Revision 1 to Relief Request RR-A30 removed weld RC-PZR-FW22 from the overlay scope.

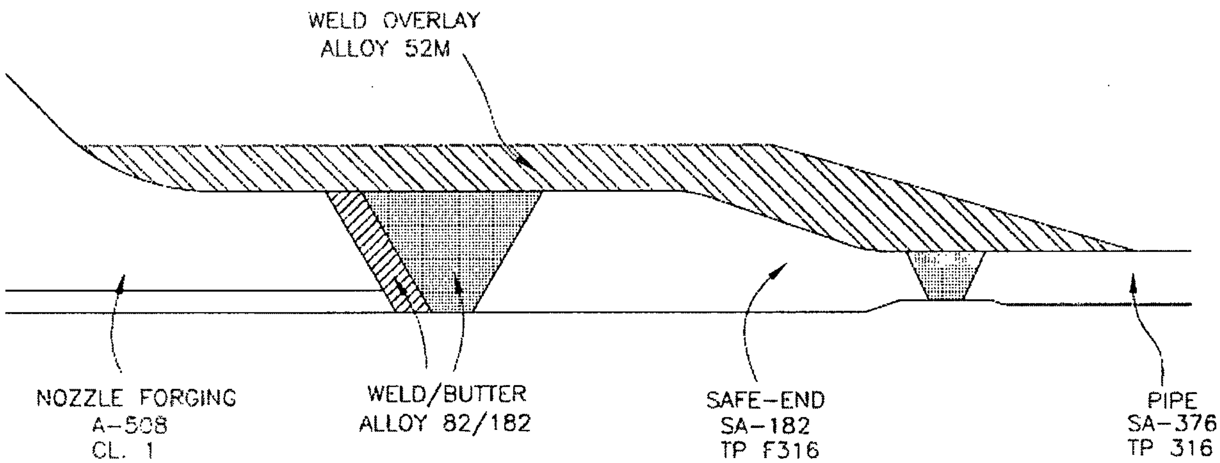
(c) Sketches are as follows:



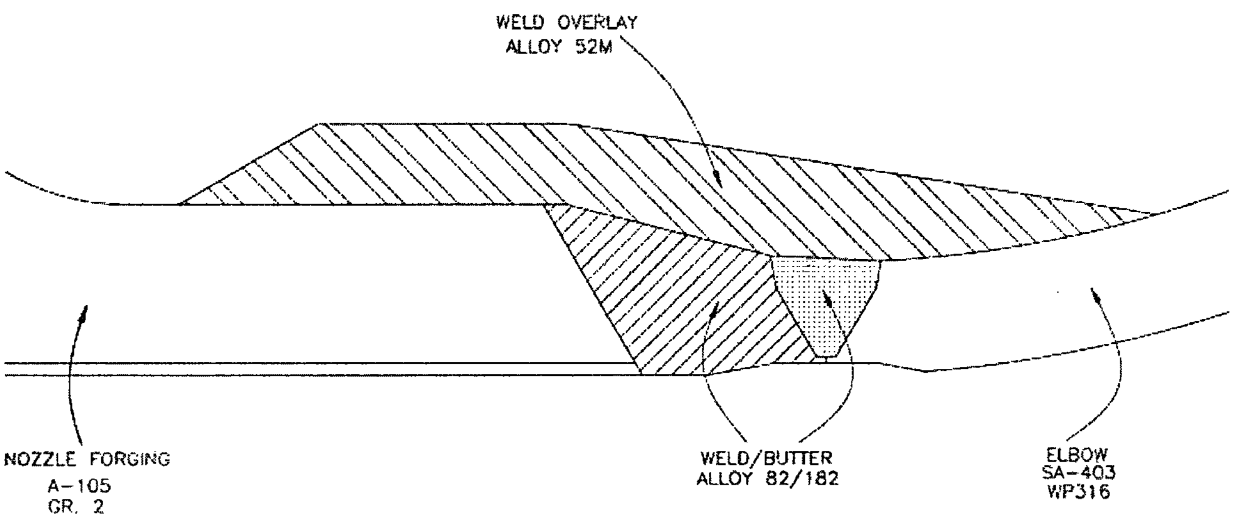
Pressurizer 3" Safety/Relief Nozzle Weld Overlay



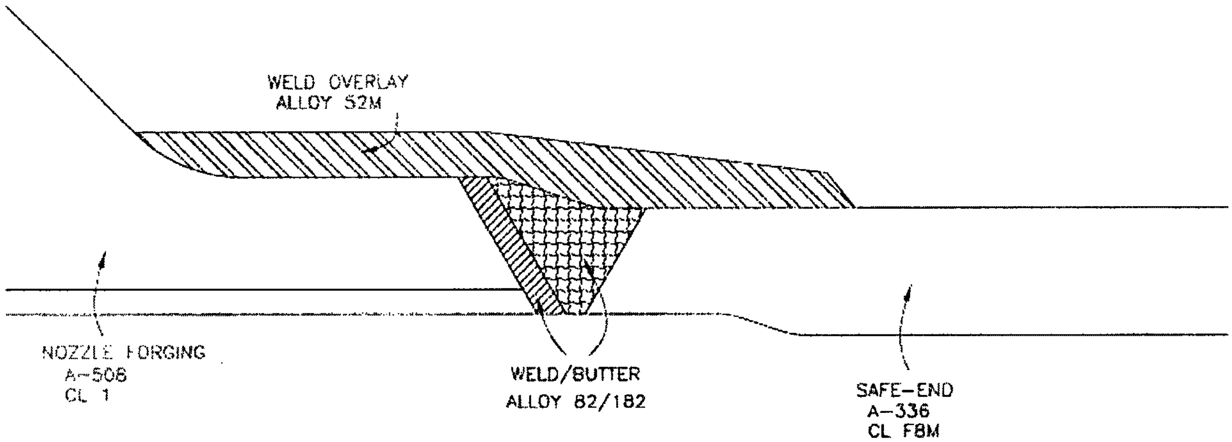
Hot Leg Surge Nozzle Weld Overlay



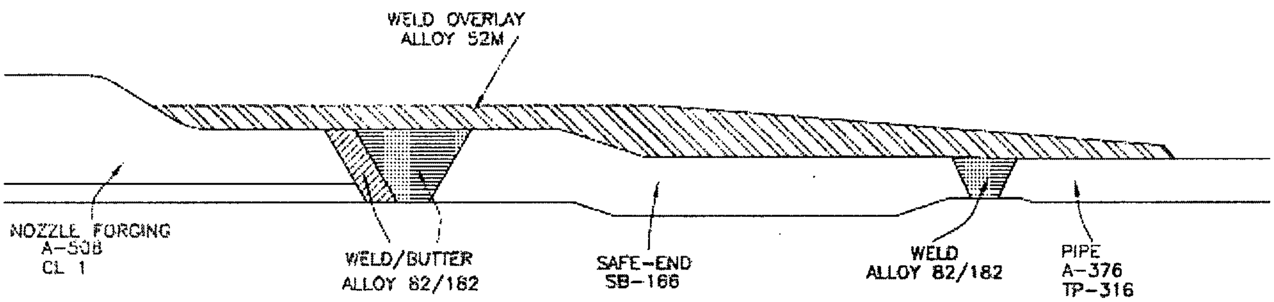
Pressurizer 2 ½" Relief Valve Nozzle Weld Overlay



Hot Leg Decay Heat Nozzle Weld Overlay



Pressurizer Surge Nozzle Weld Overlay



Pressurizer Spray Nozzle Weld Overlay

Question 4:

On page 1 of RR-A30, the licensee states that the weld overlay will be applied to the dissimilar metal welds between the pressurizer relief valve nozzles to the flanges (e.g. Weld RC-PZR-FW22). Discuss whether the weld shrinkage from the weld overlay on the flange would cause distortion resulting in leakage of the valve flange or exert unanalyzed forces on the flange bolting. Discuss whether the relief valve will be removed from the flange prior to the weld overlay installation to reduce weld shrinkage.

FENOC Response:

Each of the two pressurizer safety valves has a tee with rupture discs attached to the valve discharge. The tee is drained to the Pressurizer Quench Tank via flexible tubing. There is no hard pipe connection to the valve discharge. If actuated, these valves discharge directly to the containment atmosphere. As there is no hard pipe connection to the valve discharge, distortion or movement of the flange as a result of welding will not affect the fit up of these valves or exert any abnormal stresses on the flange connections.

FENOC intends to remove the two pressurizer safety valves from the nozzle flanges prior to weld overlay installation.

Question 5:

Regarding Section 2 (page 2) of Request RR-A30: Confirm that the code of record for the third 10-year inservice interval is the 1995 edition through the 1996 Addenda of the ASME Code, Section XI.

FENOC Response:

The code of record for the third 10-year inservice interval is the 1995 edition through the 1996 addenda of the ASME Code, Section XI.

Question 6:

On page 5, Item 1, of RR-A30, the licensee states that the inside diameter weld repairs will be assumed in the nozzle stress analyses to bound any actual weld repairs that may have occurred in the nozzles. Explain in detail how the assumption of inside diameter weld repairs will bound the outside diameter overlay repairs in terms of component stresses.

FENOC Response:

Electric Power Research Institute (EPRI) studies have been performed for cases of weld repairs of dissimilar metal butt welds. Results of these studies show that maximum hoop stresses typically exceed maximum axial stresses and that a weld repair to the inside diameter (ID) surface after completing the main weld significantly increases both the axial and hoop stresses on the ID surface. EPRI guidance states that the primary purpose of preemptive weld overlays is to modify the as-welded residual stresses to provide compressive stresses on the inside surface of the nozzle to inhibit crack growth or initiation. To adequately demonstrate the favorable residual stress effects of a weld overlay one must start with a highly unfavorable, pre-overlay residual stress condition such as that which would result from an ID surface weld repair.

Just as an outside surface weld overlay repair will place the inside surface in compression, it is felt that outside surface weld repairs will perform in a similar fashion, and an inside surface repair will be bounding.

Question 7:

Paragraph 1(d)2 of Code Case N-740 (page 18) discusses the chromium content and dilution zone. There can be sufficient variations in chemistry within a specific weld group to affect the chemical reproducibility in a field weld. To minimize the effects of chemical dilution and reproducibility between the procedure qualification record (PQR) and of a given weld layer applied in the field, the weld material specification used for the PQR should be the same weld specification used for the weld overlay. Discuss whether this practice will be maintained in accordance with the ASME Code, Section IX.

FENOC Response:

FENOC intends to maintain welding qualifications in accordance with the latest edition of ASME Section IX. The same filler metal specification is planned to be used for both the PQR and the actual field welding.

Question 8:

Paragraph 2(a) of Code Case N-740 (page 19) states that flaw characterization and evaluation requirements shall be based on the as-found flaw. However, if ultrasonic testing (UT) will not be performed on the base metal prior to installing the weld overlay, the condition of the inner 75 percent of the base metal or original weld may not be known after the weld overlay installation. This is because UT is qualified to inspect the inner 75 percent of the base metal or the original weld wall thickness after the weld overlay installation. It is not clear to the NRC staff what flaw size would be modeled in the crack growth calculation if a flaw existed in the original weld which was not inspected prior to overlay installation. Also, the flaw in the base metal, if it exists, may be squeezed tightly by the compressive stresses produced by the weld overlay, such that post-installation UT will be unable to detect it. With respect to the foregoing discussion regarding the limitation on the UT examination coverage, discuss the flaw size that will be used in the flaw characterization and evaluation per Paragraph 2(a).

FENOC Response:

The pre-outage crack growth analyses consider a 360° circumferential flaw that is 75 percent through-wall, and an axial flaw that is 75 percent through-wall. If the preservice examinations detect cracking in the outer 25 percent of the original weld metal, then an additional crack growth analysis is performed that considers the same 75 percent through-wall flaw assumptions stated above plus any flaws detected in the outer 25 percent of the original weld metal.

Question 9:

Paragraph 2(b)(6) of Code Case N-740 (page 23) allows planar flaws in the weld overlay to be accepted by IWX-3640 of the ASME Code, Section XI. This is contrary to the NRC staff position that flaws detected in the weld overlay, during preservice or acceptance examination, need to satisfy the requirements of IWX-3500, not IWX-3640 because the acceptance criteria of IWX-3600 are not as conservative as the acceptance criteria of IWX-3500. Revise Paragraph 2(b)(6) or provide a technical justification for your proposed acceptance criteria.

FENOC Response:

FENOC intends to repair or accept in accordance with IWB-3500 any flaws detected in the weld overlay material. Paragraph 2(b)(6) has been revised as indicated in Attachment 2. Page 6, "Suitability of Proposed Nondestructive Examination," of the Relief Request contains additional clarification.

Question 10:

Based on Paragraph 3(b)2 of Code Case N-740 (page 28), if a flaw is detected in the outer 25 percent of the base metal (or original weld) during the pre-service examination, the actual flaw size would be used for the crack growth evaluation. It is the NRC staff's position that this flaw size is not conservative for the crack growth calculation when the original weld is not examined prior to weld overlay installation. The current ultrasonic examination is qualified only to detect flaws in the outer 25 percent of the pipe base metal after a weld overlay is installed on the pipe. Therefore, the condition in the inner 75 percent of the pipe base metal would not be known. A conservative assumption for the crack growth calculation of the base metal is to assume the existence of a crack of 75 percent through-wall depth in the inner 75 percent pipe base metal plus an as-found flaw depth in the outer 25 percent of the pipe base metal. This worst case crack should be used to calculate crack growth. Discuss the basis for using the actual flaw size in the crack growth calculation of base metal.

FENOC Response:

FENOC does not intend to solely use the as-found flaw size for characterization and evaluation. Instead, the pre-outage crack growth analyses consider a 360°

circumferential flaw that is 75 percent through-wall, and an axial flaw that is 75 percent through-wall. If the preservice examinations detect cracking in the outer 25 percent of the original weld metal, then an additional crack growth analysis is performed that considers the same 75 percent through-wall flaw assumptions stated above plus any flaws detected in the outer 25 percent of the original weld metal.

Question 11:

Paragraph 3(c)3 of Code Case N-740 (page 29) requires that "The inservice examination acceptance standards of Table IWB-3514-2 shall be met for the weld overlay. Alternatively, for Class 1, 2, or 3 piping systems, the acceptance criteria of IWB-3600, IWC-3600, and IWD-3600, as applicable, shall be met for the weld overlay ..." The above requirement may cause different interpretations. The licensee should revise this requirement to read: "The inservice examination acceptance standards of Table IWB-3514-2 shall be met for the weld overlay. If the acceptance criteria of Table IWB-3514-2 cannot be met, the acceptance criteria of IWB-3600, IWC-3600, and IWD-3600, as applicable, shall be met for the weld overlay ...", or provide clarification of the acceptance criteria for this paragraph.

FENOC Response:

Paragraph 3(c)(3) has been revised as indicated in Attachment 2.

Question 12:

Regarding Paragraph 3(c)3 of Code Case N-740 (page 29): The NRC staff does not agree that the use of IWX-3600 to accept overlay flaws that are caused by primary water stress corrosion cracking (PWSCC) is appropriate because the growth rate of PWSCC can be rapid, which would challenge the integrity of the weld. The NRC staff's position is that any PWSCC flaws in the weld overlay that are rejected by Table IWB-3514-2 per Paragraph 3(c)3 need to be removed. The licensee should either prohibit the use of IWX-3600 for PWSCC flaws or provide technical justification for your proposed acceptance criteria.

FENOC Response:

FENOC intends to repair or accept in accordance with the requirements of IWB-3500 any flaws in the weld overlay material characterized as PWSCC. Page 6, "Suitability of Proposed Nondestructive Examination," of the Relief Request contains additional clarification.

<u>Question 13:</u>

Paragraph 3(e) of Appendix 1 to Code Case N-740 (page 42) requires that any of the three methods in paragraphs 3(e)(1), 3(e)(2), or 3(e)(3) may be used to determine the interpass temperature of the weld overlay. It is NRC staff's position that the temperature measurements of Paragraph 3(e)(1) (e.g., pyrometers, temperature indicating crayons, and thermocouples) should be used to the extent possible because the 3(e)(1) method provides direct and more accurate temperature measurement than 3(e)(2) or 3(e)(3). Therefore, the licensee should either revise Paragraph 3(e)(1) to read: "... If it is impractical to use the interpass temperature measurements described in this paragraph due to situations where the weldment area is not accessible, such as internal bore welding or when there are extenuating radiological concerns, either Paragraphs 3(e)(2) or 3(e)(3) may be used ..." or provide technical justification for your proposed methodology.

FENOC Response:

Paragraph 3(e)(1) has been revised as indicated in Attachment 2. The preheat and interpass temperatures are measured using a contact pyrometer in accordance with Paragraph 3(e)(1). Contact pyrometers are calibrated in accordance with approved calibration and control program documents. If it is impractical to use contact pyrometers to measure interpass temperature due to situations where the weldment area is not accessible, such as internal bore welding or when there are extenuating radiological concerns, Paragraph 3(e)(3) may be used. FENOC does not intend to use the method described in Paragraph 3(e)(2) to determine interpass temperature.

<u>Question 14:</u>

If the pressurizer surge line at DBNPS has been approved for leak-before-break, are the original leak-before-break analyses still valid and the associated acceptance criteria (e.g., the safety margin on crack size and leak rates as specified in Standard Review Plan 3.6.3) still met?

FENOC Response:

Credit is not taken for leak-before-break on the Pressurizer Surge Line Piping.

FIRSTENERGY NUCLEAR OPERATING COMPANY
DAVIS-BESSE NUCLEAR POWER STATION
THIRD 10-YEAR INTERVAL REQUEST RR-A30, REVISION 2

PROPOSED ALTERNATIVE IN ACCORDANCE WITH 10 CFR 50.55a(a)(3)(i)

NOTE
The revision bars contained in this request indicate changes from the previous revision submitted June 28, 2007.

1. ASME Code Components Affected

Component Number:	Weld RC-PZR-WP-91-W/X – 3" W/X Axis Pressurizer Relief Nozzle to Safe End Weld (MK 124 to MK 125)
Code Class:	Class 1
Examination Category:	B-F
Code Item Number:	B5.50

Component Number:	Weld RC-PZR-WP-91-Y/Z – 3" Y/Z Axis Pressurizer Relief Nozzle to Safe End Weld (MK 124 to MK 125)
Code Class:	Class 1
Examination Category:	B-F
Code Item Number:	B5.50

Component Number:	Weld RC-PZR-WP-91-Z/W – 2½" X/W Axis Pressurizer Relief Nozzle to Safe End Weld (MK 31 to MK 32)
Code Class:	Class 1
Examination Category:	B-F
Code Item Number:	B5.50

Component Number:	Weld RC-30-CCA-8-1-FW10 – 2½" Pressurizer Relief Nozzle Safe End to Pipe Weld
Code Class:	Class 1
Examination Category:	B-J
Code Item Number:	B9.11 (Note: This weld is a similar metal weld which will be affected by the overlay applied to weld RC-PZR-WP-91-Z/W)

Component Number:	Weld RC-PZR-WP-102 – 4" Pressurizer Spray Nozzle to Safe End Weld (MK 9 to MK 45)
Code Class:	Class 1
Examination Category:	B-F
Code Item Number:	B5.40

Component Number: Weld RC-MK-A-90-FW56 – 4" Pipe to Pressurizer Spray Nozzle Safe End Weld (MK 90 to MK 45)
Code Class: Class 1
Examination Category: B-J
Code Item Number: B9.11

Component Number: Weld RC-PZR-WP-23 – 10" Pressurizer Surge Nozzle to Safe End Weld (MK 8 to MK 37)
Code Class: Class 1
Examination Category: B-F
Code Item Number: B5.40

Component Number: Weld RC-MK-A-82-FW54 – 10" Hotleg Branch Connection to Surge Piping Weld (MK 25 to MK 140)
Code Class: Class 1
Examination Category: B-J
Code Item Number: B9.11

Component Number: Weld DH-33A-CCA-4-1-FW1 – 12" Hotleg Branch Connection to Decay Heat Piping Elbow Weld
Code Class: Class 1
Examination Category: B-J
Code Item Number: B9.11

2. Applicable Code Edition and Addenda

1995 Edition through the 1996 Addenda of American Society of Mechanical Engineers (ASME) Section XI

3. Applicable Code Requirements

IWA-4410(a) of ASME Section XI 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(b) of ASME Section XI states:
"Later Editions and Addenda of the Construction Code, or a later different Construction Code, either in its entirety or portions thereof, and Code Cases may be used, provided the substitution is as listed in IWA-4221(b). Filler material requirements shall be reconciled as required, in accordance with IWA-4224."

IWA-4410(c) of ASME Section XI states:
"Alternatively, the applicable requirements of IWA-4600 may be used for welding and the applicable requirements of IWA-4700 may be used for heat exchanger tube plugging and sleeving."

Section XI, Appendix VIII, Supplement 11 provides qualification requirements for the ultrasonic examination of Full Structural Overlaid Wrought Austenitic Piping Welds.

4. Reason for Request

Dissimilar metal welds made with nickel based Alloy 82 and Alloy 182 weld material have been shown to be susceptible to primary water stress corrosion cracking (PWSCC) degradation in components such as the pressurizer that are subjected to higher operating temperatures. As a result, the FirstEnergy Nuclear Operating Company (FENOC) is proposing to take a proactive approach to apply preemptive full structural weld overlays to the welds listed in Section 1 of this attachment. These welds operate at either pressurizer or hot leg temperatures.

The 1995 Edition, through the 1996 Addenda, of ASME Section XI and later NRC approved editions of ASME Section XI do not contain criteria for applying a preemptive full structural weld overlay to dissimilar metal welds constructed of Alloy 600 base material or Alloy 82/182 weld material. Nozzle to safe-end overlays have been applied as repairs to plants in accordance with Code Cases N-504-2 and N-638-1, which are currently accepted for use in NRC Regulatory Guide 1.147, Revision 14. Application of these Code Cases to nozzle dissimilar metal welds requires a series of relief requests since N-504-2 was written specifically for stainless steel, pipe to pipe welds and N-638-1 contains requirements that are not applicable to weld overlay applications. Code Case N-740 has been developed by the ASME Code Committee to address weld overlays for Alloy 600/82/182 dissimilar metal welds. It also incorporates Code Case N-638-3, which has been approved by ASME. Code Case N-740 has been approved through the ASME Main Committee, but has not yet been published or accepted by the NRC in Regulatory Guide 1.147. Therefore, this request is submitted to permit the use of an overlay alternative as outlined in Tables 2 and 3 in the application of full structural weld overlays at the Davis-Besse Nuclear Power Station Unit 1 (DBNPS). This alternative is based on the overlay methodology described in Code Case N-740.

5. Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(a)(3)(i), FENOC proposes, as an alternative to the Code requirements stated above, the use of the proposed overlay alternative described in Tables 2 and 3 for the full structural weld overlays for the dissimilar metal welds listed in Section 1 of this request. For background information, a tabular comparison of the proposed overlay alternative with the currently accepted Code Cases N-504-2 and N-638-1 is provided in Table 2 and Table 3.

A full-structural Alloy 52/52M overlay will be applied to each of the dissimilar metal Alloy 82/182 safe-end welds identified in Section 1 of this request. In lieu of using the existing IWA-4000 repair procedures in the 1995 Edition through the 1996 Addenda of ASME Section XI, FENOC proposes to use the alternative requirements contained in Tables 2 and 3 for the design, fabrication, pressure testing, and examination of the weld overlay repairs. This will provide an acceptable methodology for preventing future PWSCC and for reducing any defects that may be contained in these welds to an acceptable size by increasing the wall thickness through the deposition of the weld overlays. The use of weld overlay filler materials that are resistant to PWSCC (Alloy 52/52M), weld overlay procedures that create compressive residual stress profiles in the original weld, and post overlay preservice and inservice inspections provides assurance that the structural integrity of these welds will be maintained for the life of the plant. The applicable stress limits from ASME Section III are applicable to the weld overlays. Crack growth evaluations for PWSCC and fatigue of any as-found (or conservatively postulated) flaws demonstrate that structural integrity of the welds will be maintained.

FENOC intends to install the preemptive weld overlays using Alloy 52M filler metal. However, experience at one plant has shown that Alloy 52M can be susceptible to hot cracking when excessive concentrations of surface impurities, such as sulfides, silicates or phosphates, exist in the underlying stainless steel piping or safe-end. If high levels of impurities are discovered in the nozzle welds to be overlaid, FENOC intends to apply a stainless steel buffer layer over the stainless steel piping or safe-end. The buffer layer would be installed using a machine Gas Tungsten Arc Welding process and installed up to, but not touching, the dissimilar metal butt weld joining the safe-end to the low alloy steel nozzle. Stainless steel weld deposits have been shown to be substantially more resistant to hot cracking resulting from impurity effects than austenitic nickel based filler materials, such as Alloy 52M. After dye penetrant surface examination of the buffer layer, the first Alloy 52M weld overlay layer would be deposited, using proven and demonstrated overlay welding parameters, over the buffer layer and continuing over the dissimilar metal weldment and the low alloy steel nozzle material. Individual qualifications would be used for the stainless steel buffer layer and the Alloy 52M weld overlay, and a mockup would be prepared to validate the entire process for the range of configurations that may be used. If the austenitic stainless steel buffer layer is installed, the buffer layer would not be included in the structural weld overlay thickness, and the effect of the buffer layer would be reconciled in the weld overlay design and residual stress analyses. The thickness of the buffer layer would be typical of that used for structural weld overlay layers (0.080 to 0.100 inches), with specific welding parameters to be defined during the aforementioned procedure qualification and mockup programs.

WELD OVERLAY DESIGN AND VERIFICATION

The fundamental design basis for full structural overlays is to maintain the original safety margins, with no credit taken for the underlying PWSCC susceptible weldments. The assumed design basis flaw for the purpose of structural sizing of the overlays is 360° and 100% through the original wall thickness of the dissimilar metal welds. For the crack growth analyses, initial flaw sizes will be assumed based upon Performance Demonstration Initiative (PDI) qualified inspection of the overlay at the conclusion of the weld overlay process, including the outer 25% of the original weld or susceptible base material.

Following is a list of the specific analyses and verifications that will be performed.

1. Nozzle specific stress analyses will be performed to establish a residual stress profile in the nozzle. Inside diameter (ID) weld repairs will be assumed in these analyses to effectively bound any actual weld repairs that may have occurred in the nozzles. The analysis will then simulate application of the weld overlays to

determine the final residual stress profile. Post weld overlay residual stresses at normal operating conditions will be shown to result in beneficial compressive stresses on the inside surface of the components, assuring that further crack initiation due to PWSCC is highly unlikely.

2. Fracture mechanics analyses will be performed to predict crack growth. Crack growth will be evaluated due to PWSCC and fatigue crack growth in the original dissimilar metal weld. The crack growth analyses will consider all design loads and transients, plus the post weld overlay through-wall residual stress distributions, and will demonstrate that the assumed cracks will not grow beyond the design basis for the weld overlays (i.e. through the original dissimilar metal weld thickness) for the time period until the next scheduled inservice inspection. The crack growth analyses will determine the time period for the assumed cracks to grow to the design basis for the weld overlays.

3. The analyses will demonstrate that the application of the weld overlays does not impact the conclusions of the existing nozzle stress reports. ASME Section III stress and fatigue criteria will be met for the regions of the overlays remote from observed (or assumed) cracks.

4. Shrinkage will be measured during the overlay application. Shrinkage stresses arising from the weld overlays at other locations in the piping systems 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 as required.

5. The total added weight on the piping systems due to the overlays will be evaluated for potential impact on piping system stresses and dynamic characteristics.

6. The as-built dimensions of the weld overlays will be measured and evaluated to demonstrate that they equal or exceed the minimum design dimensions of the overlays.

Summaries of the results of the analyses listed in Items 1 through 3 above will be submitted to the NRC prior to entry into Mode 4 following completion of the repairs. Items 4 though 6 are performed following the repairs and results will be included in the design modification package closure documents.

SUITABILITY OF PROPOSED NONDESTRUCTIVE EXAMINATION

As a part of the design of the weld overlay, the weld length, surface finish, and flatness are specified to allow qualified ASME Section XI, Appendix VIII ultrasonic (UT) examinations, as implemented through the PDI program, of the weld overlay and the required volume of the base material and original weld. The examinations will provide adequate assurance of structural integrity for the following reasons.

- The UT examinations are performed in accordance with ASME Section XI, Appendix VIII, Supplement 11, as implemented by the PDI program. These examinations are considered to be more sensitive for detection of defects, either from fabrication or service induced, than either ASME Section III radiographic (RT) or UT methods. Further, fabrication flaws have been included in the PDI qualification sample sets for evaluating UT procedures and personnel. The PDI Program alternatives to Appendix VIII Supplement 11 and their basis are shown in Table 4.

- ASME Section XI includes specific acceptance criteria and evaluation methodology to be utilized with the results from these more sensitive examinations. Consider are made for the materials in which the flaw indications are detected, orientation and size of the indications, and ultimately their potential structural effects on the component. The acceptance criteria include allowable flaw indication tables for planar flaws (Table IWB-3514-2) and for laminar flaws (Table IWB-3514-3).

- A laminar flaw is defined in ASME Section XI as a flaw oriented within 10° of a plane parallel to the surface of the component (IWA-3360). This definition is applicable to welds and weld overlays as well as base materials. The standard imposed for evaluating laminar flaws in ASME Section XI is more restrictive than the ASME Section III standard for evaluating laminations. The ASME Section XI laminar flaw standards, Table IWB-3514-3, are supplemented in Table 2 such that the laminar flaw shall not exceed 10% of the weld overlay surface area and no linear dimension of the laminar flaw shall exceed 3 inches. For weld overlay areas where examination is precluded by the presence of the flaw, it is required to postulate the area as being cracked.

- Any planar flaws found during either the weld overlay acceptance or preservice examinations are required to meet the preservice standards of Table IWB-3514-2. In applying the planar flaw standards, the thickness of the component will be defined as the thickness of the weld overlay.

- The NRC staff imposed conditions on Code Case N-638-1 in NRC Regulatory Guide 1.147, Revision 14, regarding ultrasonic examination and the use of acceptance criteria based on NB-5330 of the ASME Section III, will not be applied by FENOC during these repairs. Code Case N-638-1 was not prepared specifically for weld overlay applications. Instead, Code Case N-638-1 (and the temperbead welding techniques in IWA-4600) was written to address repair welds where a defect is excavated and the resulting cavity is filled using a temperbead technique. An excavated cavity configuration differs significantly from the weld overlay configuration. Tables 2 and 3 provide more appropriate examinations and acceptance criteria than the Code Case N-638-1 condition as Table 2 and 3 are written to specifically address weld overlays.

  Conversely, the imposition of ASME Section III acceptance standards to weld overlays is inconsistent with years of NRC precedence. Weld overlays for repair of cracks in piping are not addressed by ASME Section III. ASME Section III utilizes nondestructive examination (NDE) procedures and techniques with flaw detection capabilities that are within the practical limits of workmanship standards for welds. These standards are most applicable to volumetric examinations conducted using the radiographic examination (RT) method. RT of weld overlays is not practical because the presence of radioactive material in the reactor coolant system and water in the piping. The ASME Section III acceptance standards are written for a range of fabrication flaws, including lack of fusion, incomplete penetration, cracking, slag inclusions, porosity, and concavity. However, experience and fracture mechanics have demonstrated that many of the flaws that would be rejected using the ASME Section III acceptance standards do not have a significant effect on the structural integrity of the component. The ASME Section XI acceptance standards are appropriate for the evaluation of potential flaw indications in post-overlay examinations, avoiding unnecessary repairs to the overlays that would result in additional personnel radiation exposure without a compensating increase in safety and quality. Additionally, the unnecessary repairs could potentially degrade the effectiveness of the overlays by affecting the favorable residual stress field that is produced. The ASME Section XI acceptance standards are consistent with previous criteria approved by the NRC for weld overlay installations.

Weld overlays have been used for repair and mitigation of cracking in Boiling Water Reactors (BWR) for many years. In Generic Letter 88-01, the NRC approved the use of ASME Section XI inspection procedures for determining the acceptability of installed weld overlays. In addition, for a number of years, the NRC has accepted various versions of Code Case N-504 in NRC Regulatory Guide 1.147 with no conditions regarding the use of ASME Section XI acceptance standards for determining the acceptability of weld overlays. Code Case N-504, and its later versions, were developed to codify the BWR weld overlay experience and NRC approval is consistent with the NRC acceptance of BWR weld overlays. The NRC staff found the use of ASME Section XI, Appendix VIII, Supplement 11, acceptable for identifying both construction and service induced flaws in the Safety Evaluation Report (SER) for the D C Cook Plant dated February 16, 2006 and tacitly approved the associated ASME Section XI acceptance criteria, Tables IWB-3514-2 and IWB-3514-3. The NRC also accepted the use of ASME Section XI acceptance standards in a SER dated July 21, 2004 for Three Mile Island for the disposition of flaws identified in a weld overlay by PDI qualified UT examinations, with additional restrictions similar to those proposed herein for regions in which inspection is precluded by the flaws.

The following information will be submitted to the NRC within 14 days of completion of the final UT of the overlaid welds. Also included in the results will be a discussion of any repairs to the overlay material and/or base metal and the reason for the repair.

- A listing of indications detected[1]

[1] The recording criteria of the UT procedure to be used for the examination of the weld overlays 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.

- The disposition of all indications using the acceptance standards of ASME Section XI, IWB-3514-2 and/or IWB-3514-3 criteria and, if possible, the type and nature of the indications[2]

SUITABILITY OF PROPOSED AMBIENT TEMPERATURE TEMPERBEAD TECHNIQUE

As described in Table 3, the overlays addressed by this Relief Request will be performed using ambient temperature temperbead welding in lieu of post weld heat treatment. Research by the EPRI and other organizations on the use of an ambient temperature temperbead process using the machine Gas Tungsten Arc Welding (GTAW) process is documented in EPRI Report GC-111050. According to this EPRI report, repair welds performed with an ambient temperature temperbead procedure utilizing the machine GTAW welding 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 effects of the ambient temperature temperbead welding process of Table 3 on mechanical properties of repair welds, hydrogen cracking, cold restraint cracking, and extent of overlay coverage of ferritic base metal are addressed in the following paragraphs:

Mechanical Properties

The principal reasons to preheat a component prior to repair welding is to minimize the potential for cold cracking. The two cold cracking mechanisms are hydrogen cracking and restraint cracking. Both of these mechanisms occur at ambient temperature. Preheating slows down the cooling rate resulting in a ductile, less brittle microstructure, thereby lowering susceptibility to cold cracking. Preheating also increases the diffusion rate of monatomic hydrogen that may have been trapped in the weld during solidification. As an alternative to preheating, the ambient temperature temperbead welding process utilizes the tempering action of the welding procedure to produce tough and ductile microstructures. Because precision bead placement and heat input control are utilized in the machine GTAW process, effective tempering of the weld heat affected zones is possible without the application of preheat. According to Section 2.1 of EPRI Report GC-111050, "the temperbead process is carefully designed and controlled such that successive weld beads supply the appropriate quantity of heat to the untempered heat affected zone such that the desired degree of carbide precipitation (tempering) is achieved. The resulting microstructure is very tough and ductile."

[2] The UT 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.

The IWA-4630 temperbead process also includes a postweld soak requirement. Performed at 300°F for 2 hours (P-No. 1 base materials), this postweld soak assists diffusion of any remaining hydrogen from the repair weld. As such, the postweld soak is a hydrogen bake-out and not a postweld heat treatment as defined by the ASME Code. At 300°F, the postweld soak does not stress relieve, temper, or alter the mechanical properties of the weldment in any manner. The alternative described in Table 3 establishes detailed welding procedure qualification requirements for base materials, filler materials, restraint, impact properties, and other procedure variables. The qualification requirements provide assurance that the mechanical properties of the repair welds will be equivalent to or superior to those of the surrounding base material.

Hydrogen Cracking

Hydrogen cracking is a form of cold cracking. It is produced by the action of internal tensile stresses acting on low toughness heat affected zones. The internal stresses are produced from localized build-ups of monatomic hydrogen. Monatomic hydrogen forms when moisture or hydrocarbons interact with the welding arc and molten weld pool. The monatomic hydrogen can be entrapped during weld solidification and tends to migrate to transformation boundaries or other microstructure defect locations. As concentrations increase, the monatomic hydrogen will recombine to form molecular hydrogen – thus generating localized internal stresses at these internal defect locations. If these stresses exceed the fracture toughness of the material, hydrogen cracking will occur. This form of cracking requires the presence of hydrogen and low toughness materials. It is manifested by intergranular cracking of susceptible materials and normally occurs within 48 hours of welding.

IWA-4600 establishes elevated preheat and postweld soak requirements. The elevated temperature of 300°F increases the diffusion rate of hydrogen from the weld. The postweld soak at 300°F was also established to bake-out or facilitate diffusion of any remaining hydrogen from the weldment. However, while hydrogen cracking is a concern for Shielded Metal Arc Welding (SMAW), which uses flux covered electrodes, the potential for hydrogen cracking is significantly reduced when using the machine GTAW process.

The machine GTAW process is inherently free of hydrogen. Unlike the SMAW process, GTAW welding filler materials do not rely on flux coverings which may be susceptible to moisture absorption from the environment. Conversely, the GTAW process utilizes dry inert shielding gases that cover the molten weld pool from oxidizing atmospheres. Any moisture on the surface of the component being welded will be vaporized ahead of the welding torch. The vapor is prevented from being mixed with the molten weld pool by the inert shielding gas that blows the vapor away before it can be mixed. Furthermore, modern filler metal manufacturers produce wires having very low residual hydrogen. This is important because filler metals and base materials are the most realistic sources of hydrogen for automatic or machine GTAW temperbead welding. Therefore, the potential for hydrogen-induced cracking is greatly reduced by using the machine GTAW process. The liquid penetrant and ultrasonic NDE examinations discussed in 3(a)(2) and 3(a)(3) of Attachment 3 Table 2 are capable of detecting hydrogen cracking in ferritic materials. If hydrogen cracking were to occur, it would occur in the heat-affected zone (HAZ) of the ferritic base material either below or immediately adjacent to the weld overlay. Hydrogen cracking is not a concern in austenitic materials. If it occurs in the ferritic base material below the weld overlay, it would be detected by the ultrasonic examination which will interrogate the entire weld overlay including the interface and HAZ beneath the weld overlay. If it occurs in the ferritic base material immediately adjacent to the weld overlay, it will be detected by the liquid penetrant examination which is performed at least ½ inch on each side of the weld overlay. To provide sufficient time for hydrogen cracking to occur, the liquid penetrant and ultrasonic examinations will not be performed until at least 48 hours after completing the third layer of the weld overlay.

Code Case N-638-1 requires a 48-hour hold prior to performing NDE when performing ambient temperbead welding. This hold period starts after the weld overlay cools to ambient temperature. This 48-hour hold is specified to allow sufficient time for hydrogen cracking to occur (if it is to occur) in the HAZ of the ferritic materials prior to performing the final NDE. Based on extensive research and industry experience, EPRI has provided a technical basis for starting the 48-hour hold after completing the third temperbead weld layer rather than waiting for the weld overlay to cool to ambient temperature. This technical basis is documented in EPRI Report 1013558, *Temper Bead Welding Applications – 48-hour Hold Requirements for Ambient Temperature Temper Bead Welding* (Ref 10). 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 the 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 temperbead 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 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.

Although 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, Group 3 materials, the conclusions are bounding and applicable to P-Number 1 materials which have a lower carbon equivalent and lower hardenability. The Davis-Besse Pressurizer Nozzles are manufactured from A-508 Class 1 material and the Hot Leg Nozzles are manufactured from A-105 Grade II material, both of which are P-Number 1 materials.

In addition, the ASME Section XI Committee approved Revision 4 to Code Case N-638 (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 ASME White Paper for Code Case N-638-4 (ADAMS Accession No. ML070790679). The ASME White Paper points out that introducing hydrogen to the HAZ is limited to the first weld layer since this is the only weld layer that makes contact with the base material.

While the potential for introducing hydrogen to the HAZ is negligible during subsequent layers, these layers provide a heat source that accelerates the dissipation of hydrogen from the HAZ in non-water backed applications. For water-backed applications, the base material acts as an infinite heat sink during welding which contributes to a moderate HAZ temperature, which effectively enables "time at ambient temperature" to occur while the fourth and subsequent layers are applied. Furthermore, since austenitic filler materials have a much greater affinity for hydrogen than carbon steel base materials, hydrogen can be assumed to move rapidly away from the HAZ through the austenitic material matrix, further reducing chances of HAZ cracking. The ASME White Paper determines that there is sufficient delay time to facilitate detecting potential hydrogen cracking when NDE is performed 48 hours after completing the third weld layer.

Cold Restraint Cracking

Cold restraint cracking generally occurs during cooling at temperatures approaching ambient temperature. As stresses build under a high degree of restraint, cracking may occur at defect locations. Brittle microstructures with low ductility are subject to cold restraint cracking. However, the ambient temperature temperbead process is designed to provide a sufficient heat inventory so as to produce the desired tempering for high toughness. Because the machine GTAW temperbead process provides precision bead placement and control of heat, toughness and ductility of the heat affected zone will typically be superior to the base material. Therefore, the resulting structure will be appropriately tempered to exhibit toughness sufficient to resist cold restraint cracking.

Area Limitation

IWA-4600 and early versions of Code Case N-638 for temperbead welding contained a limit of 100 square inches for the surface area of temperbead weld over the ferritic base metal. The associated limitation proposed in this request is 300 square inches. It is anticipated that some overlays applied under this alternative will exceed 100 square inches, but will not exceed 300 square inches.

EPRI Technical Report 1011898, November 2005, describes the technical justification for allowing increased overlay areas up to 500 square inches. This report 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 feedwater nozzle weld overlay to demonstrate adequate tempering of the weld heat affected zone, residual stress evaluations demonstrating acceptable residual stresses in weld overlays ranging from 100 to 500 square inches, and service history in which weld repairs exceeding 100 square inches were NRC approved and applied to dissimilar metal weld nozzles in several BWRs and Pressurized Water Reactors (PWR). 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 16 square inches up to and including 325 square inches. Table 1 provides a partial list of such applications. It is seen from this table that dissimilar metal weld overlays, and weld overlays with ferritic material coverage in the

100 square inch range have been in service 5 to 15 years. Several overlays have been applied with ferritic material coverage significantly greater than 100 square inches. Relief requests for these large overlays have been previously approved. These overlays have been examined with qualified techniques, and there is no known industry experience to date in which these overlays have shown any signs of new cracking or growth in existing cracks.

6. Conclusion

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

"Proposed alternatives to the requirements of paragraphs (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 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."

Implementation of this alternative will produce effective repairs for potential PWSCC in the identified welds and improve piping geometries to permit Appendix VIII UT examinations as implemented through the PDI Program. Weld overlay repairs of dissimilar metal welds have been installed and performed successfully for many years in similar applications. The alternative provides improved structural integrity and reduced likelihood of leakage for the primary system. Accordingly, the use of the alternative provides an acceptable level of quality and safety in accordance with 10 CFR 50.55a(a)(3)(i).

7. Duration of Proposed Alternative

This alternative repair is requested for the life of component. Once a structural overlay is installed it will remain in place for the life of the repair. The Code Case N-740 methodology as modified in Tables 2 and 3 is proposed as the basis for the repairs to be made as outlined in this alternative.

Table 1 – Dissimilar Metal Weld Overlay Experience

Date	Plant	Component	Nozzle Diameter (in)	Approximate Low Alloy Steel Coverage (in^2)
November 2006	SONGS Unit 3	PZR Spray Nozzle Safety/Relief Nozzles	5.1875 8	40 60
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	Cold Leg Drain Nozzle	4	16
February 2006	SONGS Unit 2	PZR Spray Nozzle Safety/Relief Nozzles	8 6	50 28
November 2005	Kuosheng Unit 2	Recirculation Outlet Nozzle	22	250
April 2004	Susquehanna Unit 1	Recirculation Inlet Nozzle Recirculation Outlet Nozzle	12 28	100 325
November 2003	TMI Unit 1	Surge Line Nozzle	11.5	75
October 2003	Pilgrim	Core Spray Nozzle CRD Return Nozzle	10 5	50 20
October 2002	Peach Bottom Units 2 & 3	Core Spray Nozzle Recirculation Outlet Nozzle CRD Return Nozzle	10 28 5	50 325 20
October 2002	Oyster Creek	Recirculation Outlet Nozzle	26	285
December 1999	Duane Arnold	Recirculation 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	Recirculation Inlet Nozzle	12	100
January 1991	River Bend	Feedwater Nozzle	12	100
March 1986	Vermont Yankee	Core Spray Nozzle	10	50

8. Precedents

The following precedents demonstrate previous NRC acceptance of the use of Code Case N-504-2 and N-638-1. The proposed overlay alternative updates the requirements of N-504-2 and N-638-3 to specifically address the dissimilar metal weld overlays. This alternative is based on the methodology described in Code Case N-740. Therefore, the following precedents are applicable to this request.

1. Letter from Richard J. Laufer, NRC, to Christopher M. Crane, AmerGen, "Three Mile Island Nuclear Station, Unit 1 (TMI-1) Request for Relief from Flaw Removal, Heat Treatment, and Nondestructive Examination Requirements for the Third 10-year Inservice Inspection (ISI) Interval (TAC No. MC1201)," Accession Number ML041670510, dated July 21, 2004.

2. Letter from Richard J. Laufer, NRC, to Bryce L. Shriver, PPL Susquehanna, "Susquehanna Steam Electric Station, Unit 1 - Relief from American Society of Mechanical Engineers, Boiler and Pressure Vessel Code (ASME Code), Section XI, Appendix VIII, Supplement 11, Requirements and Code Cases N-504-2 and N-638 Requirements (TAC Nos. MC2450, MC2451 and MC2594)," Accession Number ML051220568, dated June 22, 2005.

3. Letter from Richard J. Laufer, NRC, to George Vanderheyden, Calvert Cliffs, "Calvert Cliffs Nuclear Power Plant, Unit No. 2 - Relief Request for Use Weld Overlay and Associated Alternative Inspection Techniques (TAC Nos. MC6219 and MC6220)," Accession Number ML051930316, dated July 20, 2005.

4. Letter from Darrell J. Roberts, NRC, to David A. Christian Dominion Nuclear Connecticut, Inc., "Millstone Power Station, Unit No. 3 – Issuance of Relief from Code Requirements (TAC No. MC8609)," Accession Number ML053260012, dated January 20, 2006.

5. Letter from David Terao, NRC, to Timothy G. Mitchell, Entergy Operations, Inc., "Arkansas Nuclear One, Unit 1 – Request for Alternative ANO1-R&R-010 to Use Proposed Alternative to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code Requirements for Pressurizer Nozzle Weld Overlay Repairs (TAC No. MD4019)," dated April 6, 2007.

9. References

1. ASME Section XI, 1995 Edition through the 1996 Addenda

2. Generic Letter 88-01, NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping

3. NRC Regulatory Guide 1.147, Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1, Rev. 14

4. Code Case N-504-2, Alternative Rules for Repair of Class 1, 2, and 4 Austenitic Stainless Steel Piping, Section XI, Division 1

5. Code Case N-638-1, Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique, Section XI, Division 1

6. Code Case N-638-4, Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique, Section XI, Division 1

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

8. EPRI Report GC-111050, Ambient Temperature Preheat for Machine GTAW Temperbead Applications

9. EPRI Report 1011898, RRAC Code Justification for the Removal of the 100 Square Inch Temper Bead Weld Repair Limitation

10. WSI Document 102987-MR-001, Rev. 0, Surge Line Welding Issue Southern California Edison (SCE) – SONGS Unit 3

11. EPRI Report 1013558, Repair and Replacement Applications Center: Temper Bead Welding Applications – 48-hour Hold Requirements for Ambient Temperature Temper Bead Welding

12. RRA 05-08 Technical Basis Paper, N-638-x, Ambient Temperature Temperbead Welding: Begin 48 Hour Hold After 3rd Layer Completion, dated 06/18/06.

Table 2 Comparison of Proposed Overlay Alternative with Code Case N-504-2

Code Case N-504-2 was accepted in NRC Regulatory Guide 1.147, Revision 14, with the provision that Section XI, Nonmandatory Appendix Q, "Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Welds" must also be met. Nonmandatory Appendix Q was written to incorporate the requirements of Code Case N-504-2 into ASME Section XI. Therefore, Appendix Q is reconciled with this proposed overlay alternative. This proposed overlay alternative is based on the methodology described in Code Case N-740.

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
Provides rules for Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments	Provides alternative rules for dissimilar metal weld overlay for repair of Classes 1, 2, and 3 Items	
	<1 GENERAL REQUIREMENTS> (a) This alternative applies to dissimilar metal austenitic welds between P-No 8 or 43 and P-No 1, 3, 12A, 12B, or 12C materials or between P-No 1, 3, 12A, 12B, and 12C materials. This alternative also applies to dissimilar metal welds between P-No. 8 to P-No. 43 material and to welds between P-No. 8 to P-No. 8 or P-No. 43 to P-No. 43 materials joined with an austenitic filler material.	Welds to be repaired at Davis-Besse are between P-No. 1 and P-No. 8 materials or between P-No. 1 and P-No. 43 or between P-No. 43 and P-No. 8 materials. These welds were made with Alloy 82/182 filler metal.

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
-2000 Prerequisites (a) Reinforcement weld material shall be low carbon (0.035% max.) austenitic stainless steel applied 360 deg. around the circumference of the pipe, and shall be deposited using a Welding Procedure Specification for groove welding, qualified in accordance with the Construction Code and Owner's Requirements and identified in the Repair/Replacement Plan.	<1 GENERAL REQUIREMENTS> (b) Weld overlay filler metal shall be low-carbon (0.035% max.) austenitic stainless steel or an austenitic nickel alloy (28% Cr min.) applied 360 deg. around the circumference of the item, and shall be deposited using a Welding Procedure Specification for groove welding, qualified in accordance with the Construction Code and Owner's Requirements and identified in the Repair/Replacement Plan. As an alternative to the post weld heat treatment requirements of the Construction Code and Owner's requirements, the provisions of Table 3 may be used for ambient-temperature temper bead welding.	Equivalent with the exception that austenitic nickel alloy filler metal may be used. Table 3 includes provisions from Code Case N-638-1.

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(b) Prior to deposition of the weld reinforcement, the surface to be repaired shall be examined by the liquid penetrant method. Indications greater than 1/16 in. (1.5 mm) shall be removed, reduced in size, or corrected in accordance with the following requirements, prior to application of weld reinforcement. One or more layers of weld metal shall be applied to seal unacceptable indications in the area to be repaired with or without excavation. The thickness of these layers shall not be used in meeting weld reinforcement design thickness requirements. Peening the unacceptable indication prior to welding is permitted.	<1 GENERAL REQUIREMENTS> (c) Prior to deposition of the weld overlay, the surface to be repaired shall be examined by the liquid penetrant method. Indications larger than 1/16 in. (1.5 mm) shall be removed, reduced in size, or corrected in accordance with the following requirements. (1) One or more layers of weld metal shall be applied to seal unacceptable indications in the area to be repaired with or without excavation. The thickness of these layers shall not be used in meeting weld reinforcement design thickness requirements. Peening the unacceptable indication prior to welding is permitted.	Equivalent requirements
(c) If correction of indications in (b) above is required, the area where the weld reinforcement is to be deposited, including any local repairs or initial weld overlay layers, shall be examined by the liquid penetrant method. The area shall contain no indications greater than 1/16 in. (1.5 mm) prior to the application of the structural layers of the weld overlay.	<1 General Requirements (c)> (2) If correction of indications identified in 1.0(c) is required, the area where the weld overlay is to be deposited, including any local repairs or initial weld overlay layer, shall be examined by the liquid penetrant method. The area shall contain no indications greater than 1/16 in. (1.5 mm) prior to the application of the structural layers of the weld overlay.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(d) The weld reinforcement shall consist of at least two weld layers having as-deposited delta ferrite content of at least 7.5 FN. The first layer of weld metal with delta ferrite content of at least 7.5 FN shall constitute the first layer of the weld reinforcement that may be credited toward the required thickness. Alternatively, first layers of at least 5 FN are acceptable provided the carbon content of the deposited weld metal is determined by chemical analysis to be less than 0.02%.	<1 GENERAL REQUIREMENTS> (d) Weld overlay deposits shall meet the following requirements: (1) The austenitic stainless steel weld reinforcement shall consist of at least two weld layers having as-deposited delta ferrite content of at least 7.5 FN. The first layer of weld metal with delta ferrite content of at least 7.5 FN shall constitute the first layer of the weld reinforcement that may be credited toward the required thickness. Alternatively, first layers of at least 5 FN are acceptable, provided the carbon content of the deposited weld metal is determined by chemical analysis to be less than 0.02%.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
	<1 GENERAL REQUIREMENTS (d)> (2) The austenitic nickel alloy weld overlay shall consist of at least two weld layers deposited from a filler material with a Cr content of at least 28%. The first layer of weld metal deposited may not be credited toward the required thickness. Alternatively, for PWR applications, a diluted layer may be credited toward the required thickness, provided the portion of the layer over the austenitic base material, austenitic filler material weld and the associated dilution zone from an adjacent ferritic base material contains at least 24% Cr and the Cr content of the deposited weld metal is determined by chemical analysis of the production weld or of a representative coupon taken from a mockup prepared in accordance with the WPS for the production weld. Alternatively, for BWR applications, a diluted layer may be credited toward the required thickness, provided the portion of the layer over the austenitic base material, austenitic filler material weld and the associated dilution zone from an adjacent ferritic base material contains at least 20% Cr and the Cr content of the deposited weld metal is determined by chemical analysis of the production weld or of a representative coupon taken from a mockup prepared in accordance with the WPS for the production weld .	New requirement imposed by this alternative as Code Case N-504-2 and Appendix Q did not address austenitic nickel alloy filler metal.

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
	<1 GENERAL REQUIREMENTS> (e) This alternative is only for welding in applications predicted not to have exceeded thermal neutron fluence of 1×10^{17} (E< 0.5 eV) neutrons per cm^2 prior to welding.	Not applicable to the welds proposed for repair per this alternative.
(e) The submerged arc welding method shall not be used for weld overlays.		Submerged arc welding will not be used for the repairs included in this alternative.
	<2 DESIGN> (a) Flaw characterization and evaluation requirements shall be based on the as-found flaw. However, the size of all flaws shall be projected to the end of the design life of the overlay. Crack growth, including both stress corrosion and fatigue crack growth, shall be evaluated in the materials in accordance with IWB-3640. If the flaw is at or near the boundary of two different materials, evaluation of flaw growth in both materials is required.	New requirement imposed by this alternative. Refer to the ***WELD OVERLAY DESIGN AND VERIFICATION*** section in the body of this alternative.
-3000 Design Considerations Design of the weld reinforcement shall provide access for the examinations required by P-4000 and shall be in accordance with (a) and (b) below.		

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(a) Flaw Characterization and evaluation requirements shall be based on the as-found flaw. (1) For determining the combined length of circumferential flaws, multiple flaws shall be treated as one flaw of length equal to the sum of the lengths of the individual flaws characterized in accordance with IWA-3300.	<2 DESIGN (b)> (3) For determining the combined length of circumferentially-oriented flaws, multiple flaws shall be treated as one flaw of length equal to the sum of the lengths of the individual flaws characterized in accordance with IWA-3300.	Equivalent requirements
(2) For circumferentially-oriented flaws, when the combined length is greater than 10% of the pipe circumference, the flaws shall be assumed to be 100% through the original pipe wall thickness for the entire circumference of the pipe.	<2 DESIGN (b)> (4) For circumferentially-oriented flaws, if the combined length is greater than 10% of the circumference of the item, the flaws shall be assumed to be 100% through the original wall thickness of the item for the entire circumference of the item.	Equivalent requirements
(3) For circumferentially-oriented flaws, when the combined length does not exceed 10% of the pipe circumference, the flaws shall be assumed to be 100% through the original pipe wall thickness for a circumferential length equal to the combined length of the flaws.	<2 DESIGN (b)> (4) For circumferentially-oriented flaws, if the combined length does not exceed 10% of the circumference of the item, the flaws shall be assumed to be 100% through the original wall thickness of the item for a circumferential length equal to the combined length of the flaws.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(4) For axial flaws 1.5 in. (38 mm) or longer, or for five or more axial flaws of any length, the flaws shall be assumed to be 100% through the original pipe wall thickness for the entire axial length of the flaw for the entire circumference of the pipe.	<2 DESIGN (b)> (5) For axial flaws 1.5 in. (38 mm) or longer, or for five or more axial flaws of any length, the flaws shall be assumed to be 100% through the original wall thickness of the item for the entire axial length of the flaw or combined flaws, as applicable.	Equivalent requirements
(5) For weldments with four or fewer axial flaws, each shorter than 1.5 in. (38 mm), and no circumferential flaws, the weld reinforcement shall satisfy the requirements of P-2000(d). No additional structural reinforcement is required. The axial length of the overlay shall cover the weldment and the heat affected zones, and shall extend at least ½ in. (13 mm) beyond the ends of the observed flaws. The requirements of (b)(1), (3), and (4) below need not be met.		Circumferential flaws will be assumed. Refer to the ***WELD OVERLAY DESIGN AND VERIFICATION*** section in the body of this alternative.
(b) The design of the weld overlay shall satisfy the requirements of the Construction Code and Owner's Requirements in accordance with IWA-4221 and the following, using the assumptions and flaw characterization restrictions in (a) above. The design analysis required below shall be completed in accordance with IWA-4311.	<2 DESIGN> (b) The design of the weld overlay shall satisfy the following, using the assumptions and flaw characterization restrictions in 2(a). The following design analysis shall be completed in accordance with IWA-4311.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(1) The axial length and end slope of the weld overlay shall cover the weldment and the heat affected zones on each side of the weldment, and shall provide for load redistribution from the pipe into the weld overlay and back into the pipe without violating applicable stress limits for primary local and bending stresses and secondary and peak stresses, as required by the Construction Code. Any laminar flaws in the weld overlay shall be evaluated in the analysis to ensure that load redistribution complies with the above. These requirements will usually be satisfied if the overlay full thickness length extends axially beyond the projected flaw by at least ¾ $\sqrt{Rt}$, where R is the outer radius of the pipe and t is the nominal wall thickness of the pipe.	<2 DESIGN (b)> (1) The axial length and end slope of the weld overlay shall cover the weld and the heat affected zones on each side of the weld, and shall provide for load redistribution from the item into the weld overlay and back into the item without violating applicable stress limits of NB-3200. Any laminar flaws in the weld overlay shall be evaluated in the analysis to ensure that load redistribution complies with the above. These requirements will usually be satisfied if the weld overlay full thickness length extends axially beyond the projected flaw by at least $0.75\sqrt{Rt}$, where R is the outer radius of the item and t is the nominal wall thickness of the item.	Equivalent requirements
(2) Unless specifically analyzed in accordance with (b)(1), the end transition slope of the overlay shall not exceed 45 deg. A slope of not more than 1:3 is recommended.	<2 DESIGN (b)> (2) Unless specifically analyzed in accordance with 2.0(b) (1), the end transition slope of the overlay shall not exceed 45 deg. A slope of not more than 1:3 is recommended.	Equivalent requirements

Nonmandatory Appendix Q	**Proposed Overlay Alternative**	**Comments**
(3) The pressure design of items meeting (a)(2), (3), or (4) above shall be based on the measured diameter, using the thickness of the weld overlay as restricted by P-2000(d). The wall thickness at the weld overlay, any planar flaws in the weld overlay, and effects of any discontinuity (e.g. another weld overlay or reinforcement for a branch connection) within a distance of $2.5\sqrt{Rt}$ from the toes of the weld overlay, shall be evaluated and shall meet the requirements of IWB-3540, IWC-3640, or IWD-3640, as applicable.	<2 DESIGN (b)> (6) The overlay design thickness of items meeting 2(b)(4) or (5) above shall be based on the measured diameter, using only the weld overlay thickness conforming to the deposit analysis requirements of 1 (d). The combined wall thickness at the weld overlay, any planar flaws in the weld overlay, and the effects of any discontinuity (e.g., another weld overlay or reinforcement for a branch connection) within a distance of $2.5\sqrt{Rt}$ from the toes of the weld overlay, shall be evaluated and shall meet the requirements of IWB-3500, as applicable.	Equivalent requirements
(4) The effects of any changes in applied loads, as a result of weld shrinkage, on existing flaws previously accepted by analytical evaluation, shall be evaluated in accordance with IWB-3640, IWC-3640, or IWD-3640, as applicable.	<2 DESIGN (b)> (7) The effects of any changes in applied loads, as a result of weld shrinkage from the entire overlay, on other items in the piping system (e.g., support loads and clearances, nozzle loads, changes in system flexibility and weight due to the weld overlay) shall be evaluated. Existing flaws previously accepted by analytical evaluation shall be evaluated in accordance with IWB-3640, IWC-3640, or IWD-3640, as applicable.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
-4000 Examination and Inspection Ultrasonic examination personnel shall be certified in accordance with the Owner's written practice. Procedures and personnel shall be qualified in accordance with Appendix VIII.	<3 EXAMINATION AND INSPECTION> In lieu of all other examination requirements, the examination requirements of this alternative shall be met. Nondestructive examination methods shall be in accordance with IWA-2200, except as specified herein. Nondestructive examination personnel shall be qualified in accordance with IWA-2300. Ultrasonic examination procedures and personnel shall be qualified in accordance with Appendix VIII, Section XI.	This alternative adds requirements for qualification of non-UT personnel. UT personnel qualification requirements are equivalent.
-4100 Examination (a) The weld overlay shall have a surface finish of 250 microinch (6.3 micrometers) RMS or better and a flatness of less than 1/32 in./in. (1/32 mm/mm) to allow for adequate examination. The weld overlay shall be examined to verify acceptable configuration.	<3 EXAMINATION AND INSPECTION> (a) Acceptance Examination (1) The weld overlay shall have a surface finish of 250 micro-in. (6.3 micrometers) RMS or better and a flatness sufficient to allow for adequate examination in accordance with procedures qualified per Appendix VIII. The weld overlay shall be examined to verify acceptable configuration.	Equivalent requirements. This alternative eliminates a prescriptive value for flatness and replaces it with flatness suitable for the examination.

Nonmandatory Appendix Q	***Proposed Overlay Alternative***	***Comments***
(b) The weld overlay and the adjacent base material for at least ½ in. (13 mm) from each side of the weld shall be examined using the liquid penetrant method. The weld overlay shall satisfy the surface examination acceptance criteria for welds of the Construction Code or NB-5300. The adjacent base metal shall satisfy the surface examination acceptance criteria for base material of NB-2500.	<3 EXAMINATION AND INSPECTION (a)> (2) The weld overlay and the adjacent base material for at least ½ in. (13 mm) from each side of the weld shall be examined using the liquid penetrant method. The weld overlay shall satisfy the surface examination acceptance criteria for welds of the Construction Code or NB-5300. The adjacent base metal shall satisfy the surface examination acceptance criteria for base material of the Construction Code or NB-2500. If ambient temperature temper bead welding is used, the liquid penetrant examination shall be conducted after completing the third layer of the weld overlay.	Equivalent requirements. Code Case N-638-1 imposed a 48 hour hold after the weld reaches ambient temperature before performing NDE. This alternative commences the 48 hour hold period after completing the third layer of the weld overlay. Refer to the ***SUITABILITY OF PROPOSED AMBIENT TEMPERATURE TEMPERBEAD TECHNIQUE*** section of this request.

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
The examination volume Fig.-4100-1 shall be ultrasonically examined to assure adequate fusion (i.e. adequate bond) with the base metal and detect welding flaws such as interbead lack of fusion, inclusions, or cracks. Planar flaws shall meet the preservice examination standards of Table IWB-3514-2. Laminar flaws shall meet the following:	<3 EXAMINATION AND INSPECTION (a)> (3) The examination volume in Fig.1 shall be ultrasonically examined to assure adequate fusion (i.e., adequate bond) with the base metal and to detect welding flaws, such as interbead lack of fusion, inclusions, or cracks. The interface C-D shown between the overlay and the weld includes the bond and the heat affected zone from the overlay. If ambient temperature temper bead welding is used, the ultrasonic examination shall be conducted at least 48 hours after completing the third layer of the weld overlay. Planar flaws shall meet the preservice examination standards of Table IWB-3514-2. In applying the acceptance standards, wall thickness "t_w" shall be the thickness of the weld overlay. Laminar flaws shall meet the following:	Equivalent requirements. Code Case N-638-1 imposed a 48 hour hold after the weld reaches ambient temperature before performing NDE. This alternative commences the 48 hour hold period after completing the third layer of the weld overlay. Refer to the ***SUITABILITY OF PROPOSED AMBIENT TEMPERATURE TEMPERBEAD TECHNIQUE*** section of this request.

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(1) Laminar flaws shall meet the acceptance standards of Table IWB-3514-3.	<3 EXAMINATION AND INSPECTION (a)(3)> (a) Laminar flaws shall meet the acceptance standards of Table IWB-3514-3 with the additional limitation that the total laminar flaw shall not exceed 10% of the weld surface area and that no linear dimension of the laminar flaw area exceeds 3.0 in. (76 mm).	Equivalent requirements
(2) The reduction in coverage of the examination volume in Figure 4300-1, due to laminar flaws, shall be less than 10%. The dimensions of the uninspectable volume are dependent on the coverage achieved with the angle beam examination of the overlay.	<3 EXAMINATION AND INSPECTION (a)(3)> (b) The reduction in coverage of the examination volume in Figure 4300-1 of Nonmandatory Appendix Q due to laminar flaws shall be less than 10%. The dimensions of the uninspectable volume are dependent on the coverage achieved with the angle beam examination of the overlay.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(3) Any uninspectable volume in the weld overlay shall be assumed to contain the largest radial planar flaw that would exist within that volume. This assumed flaw shall meet the inservice examination standards of Table IWB-3514-2. Both axial and circumferential planar flaws shall be assumed.	<3 EXAMINATION AND INSPECTION (a)(3)> (c) Any uninspectable volume in the weld overlay shall be assumed to contain the largest radial planar flaw that could exist within that volume. This assumed flaw shall meet the inservice examination standards of Table IWB-3514-2. Alternately, the assumed flaw shall be evaluated and shall meet the requirements of IWB-3640, IWC-3640, IWD-3640, as applicable. Both axial and circumferential planar flaws shall be assumed.	Equivalent requirement. Refer to ***SUITABILITY OF PROPOSED NDE*** section of this request.
(4) As an alternative to (3) above, radiography in accordance with the Construction Code shall be used to examine the uninspectable volume. The radiographic acceptance criteria of the Construction Code shall apply.		Radiography will not be used for the weld overlays.
(d) After completion of all welding activities, affected restraints, supports, and snubbers shall be VT-3 visually examined to verify that design tolerances are met.	<3 EXAMINATION AND INSPECTION (a)> (4) After completion of all welding activities, affected restraints, supports, and snubbers shall be VT-3 visually examined to verify that design tolerances are met.	Equivalent requirements.

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
-4200 PRESERVICE INSPECTON (a) The examination volume in Fig.-4300-1 shall be ultrasonically examined. The angle beam shall be directed perpendicular and parallel to the pipe axis, with scanning performed in four directions to locate and size cracks that have propagated unto the upper 25% of the pipe base material or into the overlay.	<3 EXAMINATION AND INSPECTION> (b) Preservice Inspection (1) The examination volume in Fig 2 shall be ultrasonically examined. The angle beam shall be directed perpendicular and parallel to the piping axis, with scanning performed in four directions, to locate and size any cracks that might have propagated into the upper 25% of the base material or into the weld overlay.	Equivalent requirements.
(b) The preservice examination acceptance standards of Table IWB-3514-2 shall be satisfied for the weld overlay. Cracks in the outer 25% of the pipe base metal shall meet the design analysis requirements of P-3000.	<3 EXAMINATION AND INSPECTION (b)> (2) The preservice examination acceptance standards of Table IWB-3514-2 shall be met for the weld overlay. In applying the acceptance standards, wall thickness, t_w, shall be the thickness of the weld overlay. Cracks in the outer 25% of the base metal shall meet the design analysis requirements of 2.	Equivalent requirements.
-4300 INSERVICE INSPECTION (a) The weld overlay examination volume in Fig.-4300-1 shall be added to the inspection plan and shall be ultrasonically examined during the first or second refueling outage following application.	<3 EXAMINATION AND INSPECTION> (c) Inservice Inspection (1) The weld overlay examination volume in Fig. 2 shall be added to the inspection plan and shall be ultrasonically examined during the first or second refueling outage following application.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(b) The weld overlay examination volume in Fig. -4300-1 shall be ultrasonically examined to determine if any new or existing cracks have propagated into the upper 25% of the pipe base material or into the overlay. The angle beam shall be directed perpendicular and parallel to the pipe axis, with scanning performed in four directions.	<3 EXAMINATION AND INSPECTION (c)> (2) The weld overlay examination volume in Fig. 2 shall be ultrasonically examined to determine if any new or existing cracks have propagated into the upper 25% of the base material or into the overlay. The angle beam shall be directed perpendicular and parallel to the piping axis, with scanning performed in four directions.	Equivalent requirements
(c) The inservice examination acceptance standards of Table IWB-3514-2 shall be satisfied for the weld overlay. Alternatively, for Class 1, 2, or 3 piping systems, the acceptance criteria of IWB-3600, IWC-3600, or IWD-3600, as applicable, shall be satisfied for the weld overlay. Cracks in the outer 25% of the pipe base metal shall meet the design analysis requirements of P-3000.	<3 EXAMINATION AND INSPECTION (c)> (3) The inservice examination acceptance standards of Table IWB-3514-2 shall be met for the weld overlay. If the acceptance criteria of Table 3514-2 cannot be met, the acceptance criteria of IWB-3600, IWC-3600, or IWD-3600, as applicable, shall be met for the weld overlay. Cracks in the outer 25% of the base metal shall meet the design analysis requirements of 2.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
(d) Weld overlay examination volumes that show no indication of crack growth or new cracking shall be placed into a population to be examined on a sample basis. Twenty-five percent of this population shall be examined once every ten years.	<3 EXAMINATION AND INSPECTION (c)> (4) Weld overlay examination volumes that show no indication of crack growth or new cracking shall be placed into a population to be examined on a sample basis. A quarter of this population shall be examined once every ten years.	Equivalent requirements.
(e) If inservice examinations reveal crack growth or new cracking, meeting the acceptance standards, the weld overlay examination volumes shall be reexamined during the first or second refueling outage following discovery of the growth or new cracking. Weld overlay examination volumes that show no additional indication of crack growth or new cracking shall be placed into a population to be examined on a sample basis. Twenty-five percent of this population shall be examined once every ten years.	<3 EXAMINATION AND INSPECTION (c)> (5) If inservice examinations reveal crack growth, or new cracking, meeting the acceptance standards, the weld overlay examination volume shall be reexamined during the first or second refueling outage following discovery of the growth or new cracking.	Equivalent requirements. Also see Item (4) above.
(f) For weld overlay examination volumes with unacceptable indications as described in (b) and (c) above, the weld overlay shall be removed, including the original defective piping weldment, and corrected by a repair/replacement activity in accordance with IWA-4000.	<3 EXAMINATION AND INSPECTION (c)> (6) For weld overlay examination volumes with unacceptable indications as described in 3.0(c)(2) and (3), the weld overlay shall be removed, including the original defective weld, and the item shall be corrected by a repair/replacement activity in accordance with IWA-4000.	Equivalent requirements

Nonmandatory Appendix Q	Proposed Overlay Alternative	Comments
-4310 ADDITIONAL EXAMINATIONS If inservice examinations reveal an unacceptable indication, crack growth into the weld overlay design thickness, or axial crack growth beyond the specified examination volume, additional weld overlay examination volumes, equal to the number scheduled for the current inspection period, shall be examined prior to return to service. If additional unacceptable indications are found in the second sample, a total of 50% of the total population of weld overlay examination volumes shall be examined prior to operation. If additional unacceptable indications are found, the entire remaining population of weld overlay examination volumes shall be examined prior to return to service.	<3 EXAMINATION AND INSPECTION> (d) Additional Examinations. If inservice examinations reveal an unacceptable indication, crack growth into the weld overlay design thickness, or axial crack growth beyond the specified examination volume, additional weld overlay examination volumes, equal to the number scheduled for the current inspection period, shall be examined prior to return to service. If additional unacceptable indications are found in the second sample, a total of 50% of the total population of weld overlay examination volumes shall be examined prior to operation. If additional unacceptable indications are found, the entire remaining population of weld overlay examination volumes shall be examined prior to return to service.	Equivalent requirements
Fig. -4100-1 Examination Volume	Fig. 1 Acceptance Examination Volume	Equivalent requirements
Fig. -4300-1 Preservice and Inservice Examination Volume	Fig. 2 Preservice and Inservice Examination Volume	Equivalent requirements
	<4 PRESSURE TESTING> A system leakage test shall be performed in accordance with IWA-5000.	Not contained in Appendix Q, but this proposed alternative is equivalent to Code Case N-504-2.
	<5 DOCUMENTATION> Use of this alternative shall be documented on Form NIS-2.	Not contained in Appendix Q, but this proposed alternative is equivalent to Code Case N-504-2.

Table 3 Comparison of Proposed Overlay Alternative with Code Case N-638-1

Code Case N-638-1 was accepted in NRC Regulatory Guide 1.147, Revision 14, with the provision that UT examinations be demonstrated for the repaired volume using representative samples which contain construction type flaws. The acceptance criteria of NB-5330 of Section III edition and addenda approved in 10 CFR 50.55a apply to all flaws identified within the repaired volume. This proposed overlay alternative is based on the methodology described in Code Case N-740 Appendix I.

Code Case N-638-1	Proposed Overlay Alternative	Comments
	<I-1 GENERAL REQUIREMENTS> (a) This appendix applies to dissimilar austenitic filler metal welds between P-Nos. 1, 3, 12A, 12B, and 12C[1] materials and their associated welds and welds joining P-No. 8 or 43 materials to P-No. 1, 3, 12A, 12B, and 12C[1] materials with the following limitation: This Appendix shall not be used to repair SA-302 Grade B material unless the material has been modified to include from 0.4% to 1.0% nickel, quenching and tempering, and application of a fine grain practice.	Welds to be repaired at Davis-Besse are between P-No. 1 and P-No. 8 materials or between P-No. 1 and P-No. 43 or between P-No. 43 and P-No. 8 materials. These welds were made with Alloy 82/182 filler metal.
1.0 GENERAL REQUIREMENTS (a) The maximum area of an individual weld based on the finished surface shall be 100 sq. in., and the depth of the weld shall not be greater than one-half of the ferritic base metal thickness.	<I-1 GENERAL REQUIREMENTS> (b) The maximum area of an individual weld overlay based on the finished surface over the ferritic base material shall be 300 sq. in.	Refer to ***Area Limitation*** section of this request.

Code Case N-638-1	Proposed Overlay Alternative	Comments
(b) Repair/replacement activities on a dissimilar-metal weld in accordance with this Case are limited to those along the fusion line of a nonferritic weld to ferritic base material on which 1/8 in., or less of nonferritic weld deposit exists above the original fusion line.	<I-1 GENERAL REQUIREMENTS> (c) Repair/replacement activities on a dissimilar-metal weld in accordance with this Appendix are limited to those along the fusion line of a nonferritic weld to ferritic base material on which 1/8 in. (3 mm), or less of nonferritic weld deposit exists above the original fusion line.	Equivalent requirements
(c) If a defect penetrates into the ferritic base material, repair of the base material, using a nonferritic weld filler material, may be performed in accordance with this Case, provided the depth of repair in the base material does not exceed 3/8 in.	<I-1 GENERAL REQUIREMENTS> (d) If a defect penetrates into the ferritic base material, repair of the base material, using a nonferritic weld filler material, may be performed in accordance with this Appendix, provided the depth of repair in the base material does not exceed 3/8 in. (10 mm).	Equivalent requirements
(d) Prior to welding the area to be welded and a band around the area of at least 1 ½ times the component thickness or 5 in., whichever is less shall be at least 50°F.	<I-1 GENERAL REQUIREMENTS> (e) Prior to welding the area to be welded and a band around the area of at least 1½ times the component thickness or 5 in. (130 mm), whichever is less, shall be at least 50°F (10°C).	Equivalent requirements
(e) Welding materials shall meet the Owner's Requirements and the Construction Code and Cases specified in the Repair/Replacement Plan. Welding materials shall be controlled so that they are identified as acceptable until consumed.	<I-1 GENERAL REQUIREMENTS> (f) Welding materials shall meet the Owner's Requirements and the Construction Code and Cases specified in the Repair/Replacement Plan. Welding materials shall be controlled so that they are identified as acceptable until consumed.	Equivalent requirements

Code Case N-638-1	Proposed Overlay Alternative	Comments
(f) Peening may be used, except on the initial and final layers.	<I-1 GENERAL REQUIREMENTS> (g) Peening may be used, except on the initial and final layers.	Equivalent requirements
2.0 WELDING QUALIFICATIONS The welding procedures and the welding operators shall be qualified in accordance with Section IX and the requirements of paras. 2.1 and 2.2.	<I-2 WELDING QUALIFICATIONS> The welding procedures and the welding operators shall be qualified in accordance with Section IX and the requirements of 2.1 and 2.2.	Equivalent requirements
2.1 Procedure Qualification (a) The base materials for the welding procedure qualification shall be of the same P-Number and Group Number, as the materials to be welded. The materials shall be postweld heat treated to at least the time and temperature that was applied to the materials being welded.	<I-2.1 Procedure Qualification> (a) The base materials for the welding procedure qualification shall be of the same P-Number and Group Number, as the materials to be welded. The materials shall be postweld heat treated to at least the time and temperature that was applied to the materials being welded.	Equivalent requirements
(b) Consideration shall be given to the effects of welding in a pressurized environment. If they exist, they shall be duplicated in the test assembly.		Not applicable to this Alternative - Welding will not be performed in a pressurized environment.

Code Case N-638-1	Proposed Overlay Alternative	Comments
(c) Consideration shall be given to effects of irradiation on the properties of material, including weld material for applications in the core belt line region of the reactor vessel. Special material requirements in the Design Specification shall also apply to the test assembly materials for these applications.		Not applicable to this Alternative – Materials being welded are not associated with the core belt line region of the reactor vessel.
(d) The root width and included angle of the cavity in the test assembly shall be no greater than the minimum specified for the repair.	<I-2.1 Procedure Qualification> (b) The root width and included angle of the cavity in the test assembly shall be no greater than the minimum specified for the repair.	Equivalent requirements
(e) The maximum interpass temperature for the first three layers of the test assembly shall be 150°F.	<I-2.1 Procedure Qualification> (c) The maximum interpass temperature for the first three layers of the test assembly shall be 150°F (66°C).	Equivalent requirements
(f) The test assembly cavity depth shall be at least one-half the depth of the weld to be installed during the repair/replacement activity and at least 1 in. The test assembly thickness shall be at least twice the test assembly cavity depth. The test assembly shall be large enough to permit removal of the required test specimens. The test assembly dimensions surrounding the cavity shall be at least the test assembly thickness and at least 6 in. The qualification test plate shall be prepared in accordance with Fig. 1.	<I-2.1 Procedure Qualification> (d) The test assembly cavity depth shall be at least 1 in. (25 mm). The test assembly thickness shall be at least twice the test assembly cavity depth. The test assembly shall be large enough to permit removal of the required test specimens. The test assembly dimensions surrounding the cavity shall be at least the test assembly thickness and at least 6 in. (150 mm). The qualification test plate shall be prepared in accordance with Fig. I-1.	Equivalent requirements

Code Case N-638-1	Proposed Overlay Alternative	Comments
(g) Ferritic base material for the procedure qualification test shall meet the impact test requirements of the Construction Code and Owner's Requirements. If such requirements are not in the Construction Code and Owner's Requirements, the impact properties shall be determined by Charpy V-Notch impact tests of the procedure qualification base material at or below the lowest service temperature of the item to be repaired. The location and orientation of the test specimens shall be similar to those required in (i) below, but shall be in the base metal.	<I-2.1 Procedure Qualification> (e) Ferritic base material for the procedure qualification test shall meet the impact test requirements of the Construction Code and Owner's Requirements. If such requirements are not in the Construction Code and Owner's Requirements, the impact properties shall be determined by Charpy V-notch impact tests of the procedure qualification base material at or below the lowest service temperature of the item to be repaired. The location and orientation of the test specimens shall be similar to those required in I-2.1(f) below, but shall be in the base metal.	Equivalent requirements
(h) Charpy V-notch tests of the ferritic weld metal of the procedure qualification shall meet the requirements as determined in (g) above.		Ferritic weld metal is not used in this proposed overlay alternative
(i) Charpy V-notch tests of the ferritic heat-affected zone (HAZ) shall be performed at the same temperature as the base metal test of (g) above. Number, location, and orientation of the test specimens shall be as follows:	<I-2.1 Procedure Qualification> (f) Charpy V-notch tests of the ferritic heat-affected zone (HAZ) shall be performed at the same temperature as the base metal test of I-2.1(e) above. Number, location, and orientation of test specimens shall be as follows:	Equivalent requirements

Code Case N-638-1	Proposed Overlay Alternative	Comments
(1) The specimens shall be removed from a location as near as practical to a depth of one-half the thickness of the deposited weld metal. The coupons for HAZ impact specimens shall be taken transverse to the axis of the weld and etched to define the HAZ. The notch of the Charpy V-notch specimen shall be cut approximately normal to the material surface in such a manner as to include as much HAZ as possible in the resulting fracture. When the material thickness permits, the axis of a specimen shall be inclined to allow the root of the notch to be aligned parallel to the fusion line.	<I-2.1 Procedure Qualification (f)> (1) The specimens shall be removed from a location as near as practical to a depth of one-half the thickness of the deposited weld metal. The coupons for HAZ impact specimens shall be taken transverse to the axis of the weld and etched to define the HAZ. The notch of the Charpy V-notch specimen shall be cut approximately normal to the material surface in such a manner as to include as much HAZ as possible in the resulting fracture. When the material thickness permits, the axis of a specimen shall be inclined to allow the root of the notch to be aligned parallel to the fusion line.	Equivalent requirements
(2) If the test material is in the form of a plate or a forging, the axis of the weld shall be oriented parallel to the principal direction of rolling or forging.	<I-2.1 Procedure Qualification (f)> (2) If the test material is in the form of a plate or a forging, the axis of the weld shall be oriented parallel to the principal direction of rolling or forging.	Equivalent requirements

Code Case N-638-1	Proposed Overlay Alternative	Comments
(3) The Charpy V-notch test shall be performed in accordance with SA-370. Specimens shall be in accordance with SA-370, Fig. 11, Type A. The test shall consist of a set of three full size 10 mm x 10 mm specimens. The lateral expansion, percent shear, absorbed energy, test temperature, orientation and location of all test specimens shall be reported in the Procedure Qualification Record.	<I-2.1 Procedure Qualification (f)> (3) The Charpy V-notch test shall be performed in accordance with SA-370. Specimens shall be in accordance with SA-370, Fig. 11, Type A. The test shall consist of a set of three full-size 10 mm X 10 mm specimens. The lateral expansion, percent shear, absorbed energy, test temperature, orientation and location of all test specimens shall be reported in the Procedure Qualification Record.	Equivalent requirements

Code Case N-638-1	Proposed Overlay Alternative	Comments
(j) 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.	<I-2.1 Procedure Qualification> (g) The average lateral expansion value of the three HAZ Charpy V-notch specimens shall be equal to or greater than the average lateral expansion value of the three unaffected base metal specimens. However, if the average lateral expansion value of the HAZ Charpy V-notch specimens is less than the average value for the unaffected base metal specimens and the procedure qualification meets all other requirements of this appendix, either of the following shall be performed: (1) The welding procedure shall be requalified. (2) An *Adjustment Temperature* for the procedure qualification shall be determined in accordance with the applicable provisions of NB-4335.2 of Section III, 2001 Edition with 2002 Addenda. The RT_{NDT} or lowest service temperature of the materials for which the welding procedure will be used shall be increased by a temperature equivalent to that of the Adjustment Temperature.	Equivalent with NB-4335.2(e) contained in the 2001 Edition, 2002 Addenda of Section III. This edition of Section III is referenced as acceptable in 10 CFR 50.55a.
2.2 Performance Qualification Welding operators shall be qualified in accordance with Section IX.	<I-2.2 Performance Qualification> Welding operators shall be qualified in accordance with Section IX.	Equivalent requirements

Code Case N-638-1	Proposed Overlay Alternative	Comments
3.0 WELDING PROCEDURE REQUIREMENTS The welding procedure shall include the following requirements. (a) The weld metal shall be deposited by the automatic or machine GTAW process.	<I-3 WELDING PROCEDURE REQUIREMENTS> The welding procedure shall include the following requirements. (a) The weld metal shall be deposited by the automatic or machine GTAW process.	Equivalent requirements
(b) Dissimilar metal welds shall be made using A-No. 8 weld metal (QW-442) for P-No. 8 to P-No.1, 3, or 12 (A, B, or C) weld joints or F-No. 43 weld metal (QW-432) for P-No.8 or 43 to P-N0. 1, 3, or 12 (A, B, or C) weld joints.	<I-3 WELDING PROCEDURE REQUIREMENTS> (b) Dissimilar metal welds shall be made using A-No. 8 weld metal (QW-442) for P-No. 8 to P-No. 1, 3, or 12 (A, B, or C) weld joints or F-No. 43 weld metal (QW-432) for P-No. 8 or 43 to P-No. 1, 3, or 12 (A, B, or C) weld joints.	Equivalent requirements

Code Case N-638-1	Proposed Overlay Alternative	Comments
(c) The area to be welded shall be buttered with a deposit of at least three layers to achieve at least 1/8 in., overlay thickness as shown in Fig. 2, Steps 1 through 3, with the heat input for each layer controlled to within ± 10% of that used in the procedure qualification test. Particular care shall be taken in placement of the weld layers at the weld toe area of the ferritic material to ensure that the HAZ and ferritic weld metal are tempered. Subsequent layers shall be deposited with a heat input not exceeding that used for layers beyond the third layer in the procedure qualification. For similar-metal welding, the completed weld shall have at least one layer of weld reinforcement deposited. This reinforcement shall be removed by mechanical means, so that the finished surface is essentially flush with the surface surrounding the weld (Fig. 3).	<I-3 WELDING PROCEDURE REQUIREMENTS> (c) The area to be welded shall be buttered with a deposit of at least three layers to achieve at least 1/8 in. (3mm) overlay thickness with the heat input for each layer controlled to within ±10% of that used in the procedure qualification test. The heat input of the first three layers shall not exceed 45,000 J/in. (1,800 J/mm) under any conditions. Particular care shall be taken in the placement of the weld layers of the austenitic overlay filler material at the toe of the overlay to ensure that the HAZ and ferritic base metal are tempered. Subsequent layers shall be deposited with a heat input not exceeding that used for layers beyond the third layer in the procedure qualification.	Equivalent requirements. Adds additional heat input requirements. Similar-metal welding is not applicable.
(d) The maximum interpass temperature for field applications shall be 350°F regardless of the interpass temperature during qualification.	<I-3 WELDING PROCEDURE REQUIREMENTS> (d) The maximum interpass temperature for field applications shall be 350°F (180°C) for all weld layers regardless of the interpass temperature used during qualification. The interpass temperature limitation of QW-406.3 need not be applied.	Equivalent requirements. Eliminates conflict with QW-406.3.

Code Case N-638-1	Proposed Overlay Alternative	Comments
	<I-3 WELDING PROCEDURE REQUIREMENTS> (e) The interpass temperature shall be determined by one of the following methods: (1) temperature measurement (e.g. pyrometers, temperature-indicating crayons, and thermocouples) during welding. If it is impractical to use the interpass temperature measurements described in this paragraph due to situations where the weldment area is not accessible, such as internal bore welding or when there are extenuating radiological concerns, either Paragraphs 3(e)(2) or 3(e)(3) may be used. (2) heat flow calculations using the variables listed below as a minimum: (a) welding heat input (b) initial base material temperature (c) configuration, thickness, and mass of the item being welded (d) thermal conductivity and diffusivity of the materials being welded (e) arc time per weld pass and delay time between each pass (f) arc time to complete the weld (3) measurement of the maximum interpass temperature on a test coupon that is equal to or less than the thickness of the item to be welded. The maximum heat input of the welding procedure shall be used in the welding of the test coupon.	Provides options for measuring interpass temperatures. No change to the maximum interpass temperature is made.

Code Case N-638-1	Proposed Overlay Alternative	Comments
(e) Particular care shall be given to ensure that the weld region is free of all potential sources of hydrogen. The surfaces to be welded, filler metal, and shielding gas shall be suitably controlled.	<I-3 WELDING PROCEDURE REQUIREMENTS> (f) Particular care shall be given to ensure that the weld region is free of all potential sources of hydrogen. The surfaces to be welded, filler metal, and shielding gas shall be suitably controlled.	Equivalent requirements
4.0 EXAMINATION (a) Prior to welding, a surface examination shall be performed on the area to be welded.	Refer to Table 2 – 1(c)	Equivalent requirements
(b) The final weld surface and the band around the area defined in para. 1.0(d) shall be examined using a surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours. The ultrasonic examination shall be in accordance with Appendix I.	Refer to Table 2 - 3 (a) (1), (2) and (3).	To provide sufficient time for hydrogen cracking to occur, the liquid penetrant and ultrasonic examinations will not be performed until at least 48 hours after completing the third layer of the weld overlay. The examination surface and volume required by this alternative is used in lieu of the area defined in 1.0(d) of Code Case N-638-1. Refer to ***SUITABILITY OF PROPOSED AMBIENT TEMPERATURE TEMPERBEAD TECHNIQUE*** section of this request.
(c) Areas from which weld-attached thermocouples have been removed shall be ground and examined using a surface examination method.		Not addressed in Table 2, but weld attached thermocouples are considered temporary attachments and require a surface examination following removal per ASME Section III.
(d) NDE personnel shall be qualified in accordance with IWA-2300.	Refer to Table 2 - 3	Equivalent requirements

Code Case N-638-1	**Proposed Overlay Alternative**	**Comments**
(e) Surface examination acceptance criteria shall be in accordance with NB-5340 or NB-5350, as applicable. Ultrasonic examination acceptance criteria shall be in accordance with IWB-3000. Additional acceptance criteria may be specified by the Owner to account for differences in weld configurations.	Refer to Table 2 – 3(a)	IWB acceptance criteria are used. Refer to ***SUITABILITY OF PROPOSED NDE*** section of this request.
Fig. 1 QUALIFICATION TEST PLATE	Fig. I-1 QUALIFICATION TEST PLATE	Equivalent requirements
I-4 DOCUMENTATION Use of this Case shall be documented on Form NIS-2.	Refer to Table 2 – 5	Equivalent requirements

Table 4 Comparison of PDI Program Requirements to Appendix VIII, Supplement 11

Appendix VIII of Section XI cannot be used for NDE of a structural weld overlay repair. Relief is requested to use the PDI program implementation of Appendix VIII. A detailed comparison of Appendix VIII and PDI requirements is summarized below.

SUPPLEMENT 11 - QUALIFICATION REQUIREMENTS FOR FULL STRUCTURAL OVERLAID WROUGHT AUSTENITIC PIPING WELDS	PDI PROGRAM: The Proposed Alternative to Supplement 11 Requirements
1 0 SPECIMEN REQUIREMENTS	
1.1 General. The specimen set shall conform to the following requirements.	
(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 inch or larger, the specimen set must include at least one specimen 24 inch or larger but need not include the maximum diameter. The specimen set must include at least one specimen with overlay thickness within -0.1 inch to +0.25 inch of the maximum nominal overlay thickness for which the procedure is applicable.	**Alternative:** (b) The specimen set shall include specimens with overlays not thicker than 0.1 inch more than the minimum thickness, nor thinner than 0.25 inch 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.	**Alternative:** (1) ... must be in or... intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the base metal flaws. Specimens containing intergranular stress corrosion cracking shall be used when available. At least 70% of the flaws in the detection and sizing tests shall be cracks and the remainder shall be alternative flaws. Alternative flaw mechanisms, if used, shall provide crack-like reflective characteristics and shall be limited by the following: (a) The use of alternative flaws shall be limited to when the implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws. (b) Flaws shall be semi elliptical with a tip width of less than or equal to 0.002 inches. **Basis:** *This paragraph requires that all base metal flaws be cracks. Implanting a crack requires excavation of the base material on at least one side of the flaw. While this may be satisfactory for ferritic materials, it does not produce a useable axial flaw in*

SUPPLEMENT 11 - QUALIFICATION REQUIREMENTS FOR FULL STRUCTURAL OVERLAID WROUGHT AUSTENITIC PIPING WELDS	PDI PROGRAM: The Proposed Alternative to Supplement 11 Requirements
	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° 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.	**Alternative:** (1) At least 20% but less than 40% of the base metal flaws shall be oriented within +/-20° of the pipe axial direction. The remainder shall be oriented circumferentially. Flaws shall not be open to any surface to which the candidate has physical or visual access. **Basis:** *The requirement for axially oriented overlay fabrication flaws was excluded from the PDI Program as an improbable scenario. Weld overlays are typically applied using automated GTAW techniques with the filler metal applied in a circumferential direction. Because resultant fabrication induced discontinuities would also be expected to have major dimensions oriented in the circumferential direction axial overlay fabrication flaws are unrealistic. The requirement for using IWA-3300 for proximity flaw evaluation was excluded; instead indications will be sized based on their individual merits.*
(2) Specimens shall be divided into base and overlay grading units. Each specimen shall contain one or both types of grading units.	**Alternative:** (2) Specimens shall be divided into base metal and overlay fabrication grading units. Each specimen shall contain one or both types of grading units. Flaws shall not interfere with ultrasonic detection or characterization of other flaws. **Basis:** *Inclusion of "metal" and "fabrication" provides clarification. Flaw identification is improved by ensuring flaws are not masked by other flaws.*

SUPPLEMENT 11 - QUALIFICATION REQUIREMENTS FOR FULL STRUCTURAL OVERLAID WROUGHT AUSTENITIC PIPING WELDS	PDI PROGRAM: The Proposed Alternative to Supplement 11 Requirements
(a)(1) A base grading unit shall include at least 3 inch 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.	**Alternative:** (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" 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 least1inch 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.	**Alternative:** (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. **Basis:** *Substituted terms provide clarification and are consistent with 1d(1) above. The PDI program adjusts for this conservative change for excluding this type 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.	**Alternative:** (a)(3) Sufficient unflawed overlaid weld and base metal shall exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws. **Basis:** *Modified to require sufficient unflawed overlaid weld and base metal to exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws, rather than the 1 inch requirement.*
(b)(1) An overlay grading unit shall include the overlay material and the base metal-to-overlay interface of at least 6 in^2. The overlay grading unit shall be rectangular, with minimum dimensions of 2 inch.	**Alternative:** (b)(1) An overlay fabrication grading unit shall include the overlay material and the base metal-to-overlay interface for a length of at least 1 inch **Basis:** *The PDI program reduces the base metal-to-overlay interface to at least 1 inch (in lieu of a minimum of 2 inches) and eliminates the minimum rectangular dimension. This criterion is necessary to allow use of existing examination specimens that were fabricated in order to meet NRC Generic Letter 88-01. This criterion may be more challenging than the ASME Code because of the variability associated with the shape of the grading unit.*

SUPPLEMENT 11 - QUALIFICATION REQUIREMENTS FOR FULL STRUCTURAL OVERLAID WROUGHT AUSTENITIC PIPING WELDS	PDI PROGRAM: The Proposed Alternative to Supplement 11 Requirements
(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.	**Alternative:** (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 inch 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.	**Alternative:** ...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. **Basis:** *Clarified the guidance for initial procedure qualifications versus qualifying new values of essential variables.*
(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.	**Alternative:** (1) The...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. **Basis:** *Clarified the guidance for initial procedure qualifications versus qualifying new values of essential variables and is consistent with 1d(1) above.*
(3) Base metal cracking used for length sizing demonstrations shall be oriented circumferentially.	**Alternative:** (3) Base metal flaws used…circumferentially. **Basis:** *Clarified wording to be consistent with 1d(1) above.*

SUPPLEMENT 11 - QUALIFICATION REQUIREMENTS FOR FULL STRUCTURAL OVERLAID WROUGHT AUSTENITIC PIPING WELDS	PDI PROGRAM: The Proposed Alternative to Supplement 11 Requirements
(4) Depth sizing specimen sets shall include at least two distinct locations where cracking in the base metal extends into the overlay material by at least 0.1 inch in the through-wall direction.	**Alternative:** (4) Depth sizing specimen sets shall include at least two distinct locations where a base metal flaw extends into the overlay material by at least 0.1 inch in the through-wall direction. **Basis:** *Clarified wording to be consistent with 1d(1) above.*
2.0 Conduct of Performance Demonstration	
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.	**Alternative:** The specimen ...prohibited. The overlay fabrication flaw test and the base metal flaw test may be performed separately. **Basis:** *Clarified wording to describe process.*
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.	**Alternative:** Flawed... (base metal or overlay fabrication)...each specimen. **Basis:** *Clarified wording similar to 1(e)2 above.*
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.	**Alternative:** (d) For . . . base metal grading . . . base metal wall thickness. **Basis:** *Clarified wording for consistency.*
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.	**Alternative:** (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

SUPPLEMENT 11 - QUALIFICATION REQUIREMENTS FOR FULL STRUCTURAL OVERLAID WROUGHT AUSTENITIC PIPING WELDS	PDI PROGRAM: The Proposed Alternative to Supplement 11 Requirements
	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. **Basis:** *Clarified wording to better describe process.*
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.	**Alternative:** 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. **Basis:** *Clarified wording to better describe the difference between procedure qualification and equipment and personnel qualifications.*
3.2 Sizing Acceptance Criteria	
(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.	**Alternative:** (a) The...base metal flaws are...position. **Basis:** *Clarified wording to be consistent with 1d(1) above.*
(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.	**Alternative:** 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.*

COMMITMENT LIST

The following list identifies those actions committed to by the Davis-Besse Nuclear Power Station (DBNPS) in this document. Any other actions discussed in the submittal represent intended or planned actions by the DBNPS. They are described only for information and are not regulatory commitments. Please contact Mr. Thomas A. Lentz, Manager – FENOC Fleet Licensing, at (330) 761-6071 with any questions regarding this document or any associated regulatory commitments.

COMMITMENTS	DUE DATE
The regulatory commitments associated with the February 15, 2007 request remain in effect, and no additional regulatory commitments are established in this letter.	Not Applicable.