June 28, 2006

Mr. James A. Spina, Vice President
Calvert Cliffs Nuclear Power Plant, Inc.
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657-4702

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 - RELIEF REQUEST TO USE WELD OVERLAY AND ASSOCIATED ALTERNATIVE TECHNIQUES (TAC NOS. MC8530 AND MC8531)

Dear Mr. Spina:

By letter dated January 18, 2006, as supplemented on February 10, 2006, Calvert Cliffs Nuclear Power Plant, Inc. (the licensee) submitted a relief request to use alternative techniques for the repair and examination of unacceptable indications in welded nozzles at Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (Calvert Cliffs Units 1 and 2). Specifically, the licensee requested relief from the requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI to repair dissimilar metal welds with unacceptable indications in existing Alloy 82/182 welds attributed to primary water stress-corrosion cracking by using a full structural weld overlay modification. In the relief request, the licensee proposed the use of weld overlay for repair and the Performance Demonstration Initiative (PDI) program for inspection as an alternative to the requirements of ASME Code, Section XI. The repair technique also includes the use of Code Case Nos. N-638-1 and N-504-2 with some modifications. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the licensee has requested authorization to use these alternative repair and inspection techniques.

The Nuclear Regulatory Commission staff has reviewed and evaluated the information regarding the relief request. The results are provided in the enclosed safety evaluation.

The staff concludes that the proposed alternatives for the repair and examination of the indication in these dissimilar metal welds provide an acceptable level of quality and safety. Therefore, the proposed alternatives are authorized, pursuant to 10 CFR 50.55a(a)(3)(i), for Calvert Cliffs Units 1 and 2 for the remainder of the third 10-year inservice inspection interval, which ends on June 30, 2009.

All other requirements of the ASME Code, Section XI for which relief has not been specifically requested remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Sincerely,

/RA/

Richard J. Laufer, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosure:
As stated

cc w/encl: See next page

All other requirements of the ASME Code, Section XI for which relief has not been specifically requested remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

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Docket Nos. 50-317 and 50-318

Enclosure:
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cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING ALTERNATIVE REPAIR AND EXAMINATION TECHNIQUES

FOR STRUCTURAL WELD OVERLAY

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

CALVERT CLIFFS NUCLEAR POWER PLANT, INC.

DOCKET NUMBERS 50-317 AND 50-318

1.0 INTRODUCTION

By letter dated January 18, 2006, as supplemented on February 10, 2006 (Agencywide Documents Access and Management System Accession Nos. ML060240110 and ML060460040, respectively), Calvert Cliffs Nuclear Power Plant, Inc. (the licensee) submitted a relief request pertaining to the repair and inspection of Alloy 82/182 dissimilar metal welds with unacceptable conditions, due to primary water stress-corrosion cracking (PWSCC), at Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (Calvert Cliffs Units 1 and 2) for the remainder of the third 10-year inservice inspection (ISI) interval. In the relief request, the licensee proposed the use of weld overlay for repair and the Performance Demonstration Initiative (PDI) program for inspection as an alternative to the requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI. The licensee's repair technique includes the use of Code Case Nos. N-638-1 and N-504-2 with some modifications.

2.0 REGULATORY REQUIREMENTS

In accordance with Section 50.55a(g)(4) of Part 50 to Title 10 of the *Code of Federal Regulations* (10 CFR), ASME Code Class 1, 2, and 3 components must meet the requirements set forth in ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plants Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that all inservice examinations and system pressure tests conducted during the first 10-year interval, and subsequent intervals, comply with the requirements in the latest edition and addenda of ASME Code, Section XI, incorporated by reference in 10 CFR 50.55a(b) on the date 12 months prior to the start of the 10-year interval. For Calvert Cliff Units 1 and 2, the 1998 Edition with no Addenda of ASME Code, Section XI (except Subsections IWE and IWL), is the applicable edition for the current third 10-year ISI interval.

In accordance with 10 CFR 50.55a(g)(6)(ii)(C), the implementation of Supplements 1 through 8, and 10 of Appendix VIII to Section XI, of the 1995 Edition with the 1996 Addenda of the ASME Code is required on a phased schedule ending on November 22, 2002. Supplement 11,

"Qualification Requirements for Full Structural Overlaid Wrought Austenitic Piping Welds," was required to be implemented by November 22, 2001.

Pursuant to 10 CFR 50.55a(a)(3), alternatives to these requirements may be authorized by the Nuclear Regulatory Commission (NRC) if the licensee demonstrates that: (i) the proposed alternatives provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The licensee submitted the subject relief request, pursuant to 10 CFR 50.55a(a)(3)(i), as proposed alternatives to the requirements of ASME Code, Section XI.

3.0 TECHNICAL EVALUATION

3.1 Code Requirements

The licensee requested relief from certain requirements of the 1998 Edition, with no Addenda, of ASME Code, Section XI, Article IWA-4000, "Repair/Replacement Activities," and Appendix VIII, Supplement 11, "Qualification Requirements for Full Structural Overlaid Wrought Austenitic Piping Welds," and Code Cases N-504-2, "Alternative Rules for Repair of Class 1, 2 and 3 Austenitic Stainless Steel Piping," and N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temperbead Technique," as conditionally approved in NRC Regulatory Guide (RG) 1.147, Revision 14.

3.1.1 System/Component(s) for which Relief is Requested

The licensee requested relief for Class 1 dissimilar metal welds, with unacceptable indications attributed to PWSCC in existing Alloy 82/182 welds. The specific welds that are included in this relief request are listed in the attached Tables 1 and 2 for Calvert Cliffs Units 1 and 2, respectively.

3.2 Licensee's Proposed Alternative and Bases

> For dissimilar-metal welds with unacceptable indications in existing Alloy 82/182 welds attributed to PWSCC, a full structural weld overlay modification is proposed. The nozzle material is ferritic steel (either P1 or P3 depending on the nozzle). The pipe is austenitic stainless steel (P8). The existing weld filler material is Alloy 82/182 (F43 equivalent to P43). The overlay will be designed as a full structural overlay in accordance with ASME Section XI Code Case N-504-2. The temperbead welding technique will be implemented in accordance with ASME Section XI Code Case N-638-1 for that portion of the overlay over ferritic base material for which the Construction Code required post-weld heat treatment. This full structural overlay will satisfy all the structural design requirements of the pipe as if the pipe were not there. The structural weld overlay (weld reinforcement) will completely cover the existing Alloy 82/182 weld metal and extend onto the ferritic and austenitic stainless steel material on each end.

Tables 1, 2, and 3 [in Attachment 1 to the January 18 letter] provide the detailed requirements, the proposed alternatives, and the bases for the alternatives. The modification will be performed as a repair/replacement activity in compliance with Article IWA-4000 of the 1998 Edition, no Addenda, of ASME Section XI. Certain requirements of IWA-4000 will be accomplished using the methodology of Code Case N-504-2 (Alternative Rules for Repairs of Classes 1, 2, and 3 Austenitic Stainless Steel Piping) modified as shown in Table 1, and the methodology of Code Case N-638-1 "Similar and Dissimilar Metal Welding using Ambient Temperature Machine GTAW (Gas Tungsten Arc Welding) Temperbead Technique," Section XI, Division I, modified as shown in Table 2. Ultrasonic examination of the completed structural overlay will be accomplished in accordance with ASME Section XI, Appendix VIII, Supplement 11 modified to comply with the Performance Demonstration Initiative (PDI) program as shown in Table 3. Any applicable requirements not modified by Tables 1, 2, and 3 will be met as described in IWA-4000, Appendix VIII Supplement 11, and Code Cases N-504-2 and N-638-1, as stated in NRC Regulatory Guide 1.147, Revision 14.

Code Case N-504-2 was conditionally approved for generic use in Regulatory Guide 1.147, Revision 14, and was developed for austenitic stainless steel material. The provisions of ASME Section XI, Nonmandatory Appendix Q, Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments, will be met except as noted in Table 1. An alternate application for nickel based and ferritic materials is proposed due to the specific configuration of the subject weldments. Therefore, Calvert Cliffs intends to follow the methodology of Code Case N-504-2, except for the differences identified in Table 1.

Code Case N-638-1 was conditionally approved for generic use in Regulatory Guide 1.147, Revision 14, and was developed for similar and dissimilar metal welding using ambient temperature machine GTAW temperbead technique. As stated in Regulatory Guide 1.147, Revision 14, ultrasonic testing examinations will be demonstrated for the repaired volume using representative samples which contain construction type flaws. Also, the acceptance criteria of NB-5330 of Section III edition and addenda approved in 10 CFR 50.55a will apply to all flaws identified within the repair volume. Calvert Cliffs intends to follow the methodology of Code Case N-638-1 for any welding on ferritic or ferritic/austenitic interfaces where the Construction Code required post-weld heat treatment, except for the differences identified in Table 2.

[. . .]

Appendix VIII of Section XI cannot be used for the structural weld overlay required nondestructive examination. Relief is requested to use the PDI program implementation of Appendix VIII. A detailed comparison of Appendix VIII and PDI requirements is summarized in Table 3 below (see licensee's letter of January 18, 2006).

Relief is requested to allow closer spacing of flaws provided they do not interfere with detection or discrimination. The specimens used to date for qualification to the Tri-party (NRC/BWROG [Boiling Water Reactor Owners Group]/EPRI

> [Electric Power Research Institute]) agreement have a flaw population density greater than allowed by current Code requirements. These samples have been used successfully for all previous qualifications under the Tri-party agreement program. To facilitate their use and provide continuity from the Tri-party agreement program to Supplement 11, the PDI program has merged the Tri-party test specimens into their weld overlay program.

In its February 10, 2006, letter, the licensee added the following to its January 18, 2006, request (as stated):

> American Society of Mechanical Engineers Code Section XI, IWA-4610(a) states, "Thermocouples and recording instruments shall be used to monitor the process temperatures. Their attachment and removal shall be in accordance with Section III."
>
> In lieu of weld-attached thermocouples and recording instruments as required under ASME Code Section XI IWA-4610(a), Calvert Cliffs Nuclear Power Plant proposes to monitor the process temperatures with contact pyrometers and provide a manual record of the process temperatures. This method will provide an acceptable alternative because the calibrated contact pyrometers will provide an accurate record while reducing the radiation exposure necessary to install, remove, and perform nondestructive examinations on the welded areas.

3.3 Staff Evaluation

The licensee's relief request for its alternative full structural weld overlay and inspection is intended to be used, as a contingency, should flaws be identified and require repair during the remainder of the third 10-year ISI interval at Calvert Cliffs Units 1 and 2. The welds associated with this request are dissimilar metal welds (DMWs) between ferritic (ASME base metal classification P1 or P3) material and stainless steel (P8) using Alloy 82/182 weld filler metal. Alloy 82/182 filler metal is susceptible to PWSCC. The DMW welds included in the licensee's request are on nozzles ranging from 2 inches to 30 inches in size.

A complete list of the welds for which the licensee sought relief is located on pages 1 and 2 of Attachment 1 to the licensee's January 18, 2006, letter and included as an attachment to this SE. The list includes 27 welds for Unit 1 and 25 welds for Unit 2.

In the relief request, the licensee proposed a weld overlay repair plan that consists of the use of ASME Code Cases N-504-2, with modification, and N-638-1, with modification. The weld overlay repair plan is proposed as an alternative to the ASME Code, Section XI requirements in IWA-4000. For the inspection of the weld overlay, the licensee proposed the use of the PDI program as an alternative to the ASME Code requirements of Section XI of Appendix VIII, Supplement 11. The NRC staff has evaluated the licensee's bases for the proposed alternatives as provided in the licensee's submittal.

The NRC staff notes that both code cases are conditionally approved for use by the NRC in RG 1.147, Revision 14. Both code cases provide acceptable alternatives to the ASME Code requirements. The bases of the licensee's proposed alternatives are provided in Tables 1, 2, and 3 in Attachment 1 to its January 18, 2006, submittal and in the February 10, 2006,

supplement to its relief request. The staff's evaluation of the proposed alternatives relating to the relief/modifications to IWA-4000 of ASME Code, Section XI, Code Case N-504-2, Code Case N-638-1, and Appendix VIII, Supplement 11, are provided below:

Relief Requests Related to IWA-4000

In IWA-4610(a), thermocouples (TC) and recording instruments are required to be used to monitor the process temperatures for welding. In lieu of the weld-attached thermocouples and recording instruments, the licensee proposed to use contact pyrometers and manual recording of the process temperatures. The licensee stated that the contact pyrometers will be calibrated. The NRC staff concludes that the licensee's use of contact pyrometers in lieu of TC is acceptable because the contact pyrometer used in this repair has the capability of monitoring the process temperatures (500 EF, minimum preheat temperature, and 3500 EF, maximum interpass temperature) and will be properly calibrated.

Modifications to Code Case N-504-2

Code Case N-504-2 allows the use of weld overlay repair by deposition of weld reinforcement on the outside surface of the pipe in lieu of mechanically reducing the defect to an acceptable flaw size. However, the subject code case is written for repairing austenitic stainless steel piping. Therefore, the material requirements regarding the carbon content limitation (0.035% maximum) and the delta ferrite content of at least 7.5 FN (ferrite number) as delineated in Code Case N-504-2 paragraphs (b) and (e), respectively, apply only to austenitic stainless steel weld filler metals. The carbon content limitation of 0.035% is to ensure its resistance to intergrannular stress-corrosion cracking (IGSCC) and a minimum ferrite content of at least 7.5 FN is to prevent weld solidification cracking. These requirements are not applicable to Alloys 52/52M/152; the nickel-based materials that the licensee will use for weld overlay repair. For material compatibility in welding, the NRC staff considers Alloys 52/52M/152 to be a better choice of filler material than austenitic stainless steel material for this weld joint configuration. Use of a stainless steel filler material would result in a very low FN due to dilution of nickel from the existing Alloy 82/182 weld. As a result, the weld would be highly susceptible to weld solidification cracking. Alloys 52M/52/152 are fully austenitic and do not rely on primary solidification as ferrite to resist cracking. Alloys 52/52M are bare wire filler metals that the licensee proposes for the weld overlay using the gas tungsten arc welding (GTAW) process and Alloy 152 (ENiCrFe-7) using the shielded manual arc welding process may be used to seal weld the initial base metal surfaces or to perform repair on the weld reinforcement.

Alloys 52/152 are listed in ASME Section II, Part C and are acceptable to use on ASME Class 1 components. Alloy 52M contains 28-31.5% chromium, which provides excellent resistance to IGSCC in the reactor coolant environment. Alloy 52M is identical to Alloy 52 in chemistry with the exception that Alloy 52M has a higher content of Niobium (0.5 - 1.0%) for the purpose of improving its weldability. This filler metal (ERNiCrFe-7A with classification UNS N06054) identified as F-No. 43 Grouping per Code Case 2142-2 and has been widely used in the nuclear industry to make weld repairs similar to the licensee's proposal. Therefore, the licensee's proposed use of Alloys 52/52M/152 for the weld overlay repair as an alternative to the requirements of Code Case N-504-2 paragraphs (b) and (e) is acceptable as it will provide an acceptable level of quality and safety.

Modifications to Code Case N-638-1

Code Case N-638-1 is listed as being conditionally acceptable for use per RG 1.147, Revision 14. RG 1.147 allows use of the code case provided that the following is satisfied.

> UT [ultrasonic testing] examinations shall 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.

The licensee indicates that it will follow the Code Case N-504-2 condition to use the acceptance criteria of ASME Code, Section XI, Nonmandatory Appendix Q, as stipulated in the conditions in RG 1.147, Revision14. Given that the licensee is using the temperbead welding technique to apply a weld overlay and Appendix Q as required by Code Case N-502-4, and is intended specifically for weld overlay repair of piping weldments, the NRC staff finds this acceptable.

Section 1.0 (a) of Code Case N-638-1 states "The maximum area of an individual weld based on the finished surface shall be 100 in^2, and the depth of the weld shall not be greater than one-half of the ferritic base metal thickness." The licensee seeks to increase the maximum allowable finished weld surface area above the current allowable 100 in^2. The staff is actively engaged in Code activities related to increasing the allowable size of the repair area specified in Code Case N-638-1. In support of its request, the licensee submitted a white paper "Relaxation of the 100 Square Inch Size Limitation-Code Case N-638." The white paper describes analytical and experimental programs that indicate that residual stress distributions for weld overlay repairs of 100 in^2 up to 500 in^2 are comparable. The staff has approved requests for some licensees to perform weld overlays that cover over 100 in^2 and, to date, operational experience has shown that these larger weld overlay areas provide reasonable assurance of structural integrity. Based on operational experience with structural weld overlays and the information provided by the licensee, the NRC staff concludes that the licensee's alternative to perform full structural weld overlay on areas up to 500 in^2 provides reasonable assurance of structural integrity of repaired welds.

Modifications to Appendix VIII, Supplement 11

The U.S. nuclear utilities created the PDI to implement performance demonstration requirements contained in Appendix VIII to Section XI of the ASME Code. To this end, PDI has developed a program for qualifying equipment, procedures, and personnel for examinations of weld overlays in accordance with the UT criteria of Appendix VIII, Supplement 11. Prior to the Supplement 11 program, the Electric Power Research Institute (EPRI) maintained a performance demonstration program for weld overlay qualification under the Tri-party Agreement.[1] Instead of having two programs with similar objectives, the NRC staff recognized

[1] The Tri-party Agreement is between NRC, EPRI, and the Boiling Water Reactor Owners Group (BWROG), "Coordination Plan for NRC/EPRI/BWROG Training and Qualification Activities of NDE (Nondestructive Examination) Personnel," July 3, 1984.

the PDI program for weld overlay qualifications as an acceptable alternative to the Tri-party Agreement.[2]

The PDI program does not fully comport with the existing requirements of Supplement 11. PDI presented the differences at public meetings in which the NRC participated.[3, 4] The differences are in flaw location within test specimens and fabricated flaw tolerances. The changes in flaw location permitted using test specimens from the Tri-party Agreement, and the changes in fabricated flaw tolerances provide UT acoustic responses similar to the responses associated with IGSCC.

There are differences between the PDI program and Supplement 11. The differences are identified in the following Supplement 11 paragraphs and are evaluated below:

a. Paragraph 1.1(b) of Supplement 11 states limitations to the maximum thickness for which a procedure may be qualified. The ASME Code states that, "The specimen set must include at least one specimen with overlay thickness within minus 0.10-inch to plus 0.25-inch of the maximum nominal overlay thickness for which the procedure is applicable." The ASME Code requirement addresses the specimen thickness tolerance for a single specimen set, but is confusing when multiple specimen sets are used. The PDI proposed alternative states that "the specimen set shall include specimens with overlay not thicker than 0.10-inch more than the minimum thickness, nor thinner than 0.25-inch of the maximum nominal overlays thickness for which the examination procedure is applicable." The proposed alternative provides clarification on the application of the tolerance. The tolerance is unchanged for a single specimen set; however, the proposed alternative clarifies the tolerance for multiple specimen sets by providing tolerances for both the minimum and maximum thicknesses. The proposed wording eliminates confusion while maintaining the intent of the overlay thickness tolerance. Therefore, the NRC staff finds this PDI program alternative maintains the intent of the Supplement 11 requirements and is acceptable.

b. Paragraph 1.1(d)(1) requires that all base metal flaws be cracks. PDI determined that certain Supplement 11 requirements pertaining to location and size of cracks would be extremely difficult to achieve. For example, flaw implantation requires excavating a volume of base material to allow a pre-cracked coupon to be welded into this area. This process would add weld material to an area of the specimens that typically consists of only base material, and could potentially make ultrasonic examination more difficult and not representative of actual field conditions. In an effort to satisfy the requirements, PDI developed a process for fabricating flaws that exhibit crack-like reflective characteristics.

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2 US NRC Letter from William H. Bateman to Michael Bratton, "Weld Overlay Performance Demonstration Administered by PDI as an Alternative for Generic Letter 88-01 Recommendations," January 15, 2002. (ML020160532)

3 US NRC Memorandum from Donald G. Naujock to Terence Chan, "Summary of Public Meeting Held January 31 - February 2, 2002, with PDI Representatives," March 22, 2002. (ML010940402)

4 US NRC Memorandum from Donald G. Naujock to Terence Chan, "Summary of Public Meeting Held June 12 through June 14, 2001, with PDI Representatives," November 29, 2001. (ML013330156)

Instead of all flaws being cracks, as required by Paragraph 1.1(d)(1), the PDI weld overlay performance demonstrations contain at least 70% cracks with the remainder being fabricated flaws exhibiting crack-like reflective characteristics. The fabricated flaws are semi-elliptical with tip widths of less than 0.002-inches. The licensee provided further information describing a revision to the PDI program alternative to clarify when real cracks, as opposed to fabricated flaws, will be used: "Flaws shall be limited to the cases where implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws." The NRC has reviewed the flaw fabrication process, compared the reflective characteristics between actual cracks and PDI-fabricated flaws, and found the fabricated flaws for this application provide assurance that the PDI program meets the intent of the Supplement 11 requirements. Therefore, the NRC staff finds the proposed alternative to the Supplement 11 requirements is acceptable.

c. Paragraph 1.1(e)(1) requires that at least 20% but less than 40% of the flaws shall be oriented within ±20 degrees of the axial direction (of the piping test specimen). Flaws contained in the original base metal heat-affected zone satisfy this requirement; however, PDI excludes axial fabrication flaws in the weld overlay material. PDI has concluded that axial flaws in the overlay material are improbable because the overlay filler material is applied in the circumferential direction (parallel to the girth weld); therefore, fabrication anomalies would also be expected to have major dimensions in the circumferential direction. The NRC finds that this approach to implantation of fabrication flaws is reasonable for meeting the intent of the Supplement 11 requirements. Therefore, the NRC staff concludes that the PDI's exclusion of flaws oriented in the axial direction in the overlay material is acceptable.

d. Paragraph 1.1(e)(1) also requires that the rules of IWA-3300 shall be used to determine whether closely spaced flaws should be treated as single or multiple flaws. PDI treats each flaw as an individual flaw and not as part of a system of closely spaced flaws. PDI controls the flaws going into a test specimen set such that the flaws are free of interfering reflections from adjacent flaws. In some cases this permits flaws to be spaced closer than what is allowed for classification as a multiple set of flaws by IWA-3300, thus potentially making the performance demonstration more challenging than the existing requirements. Hence, the NRC staff concludes that PDI's control for closely spaced flaws is acceptable.

e. Paragraph 1.1(e)(2) requires that specimens be divided into base metal and overlay grading units. The PDI program adds clarification with the addition of the word "fabrication" and ensures flaw identification by ensuring all flaws will not be masked by other flaws with the addition of, "Flaws shall not interfere with ultrasonic detection or characterization of other flaws." PDI's alternative provides clarification and assurance that the flaws are identified. Therefore, the staff finds the PDI alternative to the Supplement 11 requirements is acceptable.

f. Paragraph 1.1(e)(2)(a)(1) requires that a base grading unit shall include at least 3 inches of the length of the overlaid weld, and the base grading unit includes the outer 25% of the overlaid weld and base metal on both sides. The PDI program reduced the criteria to 1 inch of the length of the overlaid weld and eliminated from the grading unit the need to include both sides of the weld. The proposed change permits the PDI program to continue using test specimens from the existing weld overlay program, which

have flaws on both sides of the welds. These test specimens have been used successfully for testing the proficiency of personnel for over 16 years. The weld overlay qualification is designed to be a near-side (relative to the weld) examination, and it is improbable that a candidate would detect a flaw on the opposite side of the weld due to the sound attenuation and re-direction caused by the weld microstructure. However, the presence of flaws on both sides of the original weld (outside the PDI grading unit) may actually provide a more challenging examination, as candidates must determine the relevancy of these flaws, if detected. The NRC staff concludes that PDI's use of the 1-inch length of the overlaid weld base grading unit and the elimination of the need to include both sides of the weld from the grading unit, as described in the PDI program alternative, is an acceptable alternative to the Supplement 11 requirements. Therefore, the NRC staff finds the proposed alternative acceptable.

g. Paragraph 1.1(e)(2)(a)(2) requires, when base metal cracking penetrates into the overlay material, that a portion of the base grading unit shall not be used as part of the overlay grading unit. The staff finds that the PDI program adjusts for the changes in Paragraph 1.1(e)(2)(a)(2) and conservatively states that when base metal flaws penetrate into the overlay material, no portion of it shall be used as part of the overlay fabrication grading unit. The NRC staff finds that the PDI program also provided clarification by the addition of the term "flaws" for "cracks" and the addition of "fabrication" to "overlay grading unit." The NRC staff concludes that the PDI program alternative provides clarification and conservatism and, therefore, is acceptable.

h. Paragraph 1.1(e)(2)(a)(3) requires that for unflawed base grading units, at least 1 inch of unflawed overlaid weld and base metal shall exist on either side of the base grading unit. This is to minimize the number of false identifications of extraneous reflectors. The PDI program stipulates that unflawed overlaid weld and base metal exists on all sides of the grading unit and flawed grading units must be free of interfering reflections from adjacent flaws which addresses the same concerns as the ASME Code. Hence, the NRC staff concludes that the PDI's application of the variable flaw-free area adjacent to the grading unit meets the intent of the Supplement 11 requirements and is, therefore, acceptable.

i. Paragraph 1.1(e)(2)(b)(1) requires that an overlay grading unit shall include the overlay material and the base metal-to-overlay interface of at least 6 square inches. The overlay grading unit shall be rectangular, with minimum dimensions of 2 inches. 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 (Tri-party Agreement, July 1984). This criterion may be more challenging to meet than that of the ASME Code because of the variability associated with the shape of the grading unit. Therefore, the staff concludes that PDI's application of the grading unit is an acceptable alternative to the Supplement 11 requirements and is acceptable.

j. Paragraph 1.1(e)(2)(b)(2) requires that unflawed overlay grading units shall be surrounded by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 inch around its entire perimeter. The PDI program redefines the area by noting unflawed overlay fabrication grading units shall be separated by at least 1 inch of

unflawed material at both ends and sufficient area on both sides to preclude interfering reflections from adjacent flaws. The NRC staff determined that the relaxation in the required area on the sides of the specimens, while still ensuring no interfering reflections, may provide a more challenging demonstration than required by ASME Code because of the possibility for having a parallel flaw on the opposite side of the weld. Therefore, the NRC staff concludes that the PDI's application is an acceptable alternative to the Supplement 11 requirements.

k. Paragraph 1.1(e)(2)(b)(3) requirements are retained in the PDI program. The PDI program allows procedure qualification to be performed separately from personnel and equipment qualification. Historical data indicate that, if ultrasonic detection or sizing procedures are thoroughly tested, personnel and equipment using those procedures have a higher probability of successfully passing a qualification test. In an effort to increase this passing rate, PDI has elected to perform procedure qualifications separately. In addition, the PDI program requires that initial procedure qualification contain three times the number of flaws required for a personal qualification. To qualify new values of essential variables, the equivalent of at least one personal qualification set is required. The NRC staff concludes that PDI's additions enhance the ASME Code requirements and are, therefore, acceptable because it provides for a more stringent qualification criteria.

l. Paragraph 1.1(f)(1) requirements are retained in the PDI program, with the clarification change of the term "flaws" for "cracks." In addition, the PDI program includes the requirements that sizing sets shall contain a distribution of flaw dimensions to verify sizing capabilities. The PDI program also requires that initial procedure qualification contain three times the number of flaws required for a personal qualification. To qualify new values of essential variables, the equivalent of at least one personal qualification set is required. The NRC staff concludes that PDI's additions enhance the ASME Code requirements and are, therefore, acceptable because they provide a more stringent qualification criteria.

m. Paragraphs 1.1(f)(3) and 1.1(f)(4) requirements are clarified by the PDI program by replacing the term "cracking" with "flaws" because of the use of alternative flaw mechanisms. The NRC staff concludes that this clarification in the PDI program meets the intent of the ASME Code requirements and is acceptable.

n. Paragraph 2.0 requirements are retained in the PDI program alternative. In addition, the PDI program provides clarification that the overlay fabrication flaw test and the base metal flaw test may be performed separately. The NRC staff concludes that this clarification in the PDI program meets the intent of the ASME Code requirements and is acceptable.

o. Paragraphs 2.1 and 2.2(d) requirements are clarified by the PDI program by the addition of the terms "metal" and "fabrication." The NRC staff determined that the clarifications provide acceptable classification of the terms they are enhancing. Therefore, the staff concludes that the PDI program meets the intent of the ASME Code requirements and is acceptable.

p. Paragraph 2.3 requires that, for depth sizing tests, 80% of the flaws shall be sized at a specific location on the surface of the specimen identified to the candidate. This

requires detection and sizing tests to be performed separately. The PDI revised the weld overlay program to allow sizing to be conducted either in conjunction with, or separately from, the flaw detection test. If performed in conjunction with detection and the detected flaws do not meet the Supplement 11 range criteria, additional specimens will be presented to the candidate with the regions containing flaws identified. Each candidate will be required to determine the maximum depth of flaw in each region. For separate sizing tests, the regions of interest will also be identified and the maximum depth and length of each flaw in the region will similarly be determined. In addition, PDI stated that grading units are not applicable to sizing tests, and that each sizing region will be large enough to contain the target flaw, but small enough such that candidates will not attempt to size a different flaw. The NRC staff determined that the above clarification provides a basis for implementing sizing tests in a systematic, consistent manner that meets the intent of Supplement 11. Therefore, the NRC staff concludes that the PDI's method is acceptable.

q. Paragraph 3.1 requires that examination procedures, equipment and personnel (as a complete ultrasonic system) are qualified for detection or sizing of flaws, as applicable, when certain criteria are met. For a procedure to be qualified, the PDI program requires all the flaws within the scope of the procedure be detected which is a more stringent criteria than the detection in Table VIII S2-1; therefore, the PDI program criteria exceed the ASME Code requirements for procedures and equipment qualification, and the personnel will meet the existing code requirements. Therefore, the NRC staff concludes that the PDI program criteria are acceptable.

r. Paragraph 3.2(a) requirements are clarified by the PDI program by replacing the term "cracking" with "flaws" because of the use of alternative flaw mechanisms. The NRC staff concludes that this clarification in the PDI program maintains the intent of the ASME Code requirement and is acceptable.

s. Paragraph 3.2(b) requires that all extensions of base metal cracking into the overlay material by at least 0.10-inch are reported as being intrusions into the overlay material. The PDI program omits this criterion because of the difficulty in actually fabricating a flaw with a 0.10-inch minimum extension into the overlay, while still knowing the true state of the flaw dimensions. However, the PDI program requires that cracks be depth-sized to the tolerance specified in the ASME Code which is 0.125-inches. Since the ASME Code tolerance is close to the 0.10 inch value of Paragraph 3.2(b), any crack extending beyond 0.10 inch into the overlay material would be identified as such from the characterized dimensions. The NRC staff determined that reporting of an extension in the overlay material is redundant for performance demonstration testing because of the flaw sizing tolerance. Therefore, the staff concludes that PDI's omission of highlighting a crack extending beyond 0.10 inch into the overlay material is acceptable.

t. Paragraph 3.2(c) is renumbered to Paragraph 3.2(b) in the PDI program. The NRC staff concludes that this PDI program change is administrative in nature and is, therefore, acceptable.

Based on the above evaluation, the NRC staff has determined that the licensee's proposed alternative to use the PDI qualification program for the UT examination of overlay repaired piping welds is acceptable because it will provide an acceptable level of quality and safety.

4.0 CONCLUSION

The NRC staff has reviewed the licensee's relief request and determined that the proposed alternatives will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the use of the proposed alternatives for the full structural weld overlay repair and inspection of dissimilar metal welds with unacceptable indications in existing Alloy 82/182 welds attributed to PWSCC for the remainder of the third 10-year ISI interval at Calvert Cliffs Units 1 and 2.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: R. Davis

Date: June 28, 2006

Attachments: Table 1, Calvert Cliffs Unit 1 welds
Table 2, Calvert Cliffs Unit 2 welds

Table 1, Calvert Cliffs Unit 1

Designator/ID	Weld Material	Nozzle Size	Location	Function	Base Material
102300/30-RC-11A-W7	182/82	30”	11A Reactor Coolant Pump (RCP) Inlet	Reactor Coolant Sysyem (RCS) Loop	A516-70/A351-CF8M
102450/30-RC-11A-W10	182/82	30”	11A RCP Outlet	RCS Loop	A516-70/A351-CF8M
104550/30-RC-11B-W7	182/82	30”	11B RCP Inlet	RCS Loop	A516-70/A351-CF8M
104700/30-RC-11B-W10	182/82	30”	11B RCP Outlet	RCS Loop	A516-70/A351-CF8M
107450/30-RC-12A-W7	182/82	30”	12A RCP Inlet	RCS Loop	A516-70/A351-CF8M
107600/30-RC-12A-W10	182/82	30”	12A RCP Outlet	RCS Loop	A516-70/A351-CF8M
109600/30-RC-12B-W7	182/82	30”	12B RCP Inlet	RCS Loop	A516-70/A351-CF8M
109750/30-RC-12B-W10	182/82	30”	12B RCP Outlet	RCS Loop	A516-70/A351-CF8M
110450/12-PSL-W1	182/82	12”	Bottom Head of Pressurizer (PZR)	PZR Surge	SA508-Cl2/ SA351-CF8M
111100/12-PSL-W13	182/82	12”	Top of 11 Hot Leg	PZR Surge	A105-GrII/ A351-CF8M
113150/12-SC-1004-W1	182/82	12”	Bottom of 12 Hot Leg	Shutdown Cooling	A105-GrII/ A351-CF8M
114350/12-SI-1009-W16	182/82	12”	Top of 11A Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
115200/12-SI-1010-W14	182/82	12”	Top of 11B Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
116000/12-SI-1011-W13	182/82	12”	Top of 12A Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
116750/12-SI-1012-W13	182/82	12”	Top of 12B Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
118500/4-PS-1003-W6	182/82	4”	Top Head of PZR	PZR Spray	SA508-Cl2/SA-182-F316
118550/3-PS-1001-W1	182/82	3”	Top of 11A Cold Leg	PZR Spray	A105-GrII/A-182-TP316
120350/3-PS-1002-W1	182/82	3”	Top of 11B Cold Leg	PZR Spray	A105-GrII/A-182-TP316
123100/4-SR-1005-W1	182/82	4”	Top of PZR	PZR Relief	SA508-Cl2/SA-182-F316
123450/4-SR-1006-W1	182/82	4”	Top of PZR	PZR Relief	SA508-Cl2/SA-182-F316
125050/2-LD-1004-W1	182/82	2”	Bottom of 12A Cold Leg	Letdown/Drain	A105-GrII/A-182-TP316
128900/2-CV-1004-W19	182/82	2”	12B Cold Leg	Charging Inlet	A105-GrII/A-182-TP316
130450/2-CV-1005-W29	182/82	2”	11A Cold Leg	Charging Inlet	A105-GrII/A-182-TP316
131200/2-DR-1003-W1	182/82	2”	Bottom of 11A Cold Leg	Loop Drain	A105-GrII/A-182-TP316
131500/2-DR-1004-W1	182/82	2”	Bottom of 11B Cold Leg	Loop Drain	A105-GrII/A-182-TP316
132150/2-DR-1006-W1	182/82	2”	Bottom of 12B Cold Leg	Loop Drain	A105-GrII/A-182-TP316
132450/2-DR-1007-W1	182/82	2”	Bottom of 11 Hot Leg	Loop Drain	A105-GrII/A-182-TP316

Table 2, Calvert Cliffs Unit 2

Designator/ID	Weld Material	Nozzle Size	Location	Function	Base Material
109280/30-RC-21A-W7	182/82	30”	21A RCP Inlet	RCS Loop	A516-70/A351-CF8M
109310/30-RC-21A-W10	182/82	30”	21A RCP Outlet	RCS Loop	A516-70/A351-CF8M
110280/30-RC-21B-W7	182/82	30”	21B RCP Inlet	RCS Loop	A516-70/A351-CF8M
110310/30-RC-21B-W10	182/82	30”	21B RCP Outlet	RCS Loop	A516-70/A351-CF8M
111280/30-RC-22A-W7	182/82	30”	22A RCP Inlet	RCS Loop	A516-70/A351-CF8M
111310/30-RC-22A-W10	182/82	30”	22A RCP Outlet	RCS Loop	A516-70/A351-CF8M
112280/30-RC-22B-W7	182/82	30”	22B RCP Inlet	RCS Loop	A516-70/A351-CF8M
112310/30-RC-22B-W10	182/82	30”	22B RCP Outlet	RCS Loop	A516-70/A351-CF8M
113010/12-PSL-W1	182/82	12”	Bottom Head of PZR	PZR Surge	SA508-Cl2/ SA351-CF8M
113130/12-PSL-W13	182/82	12”	Top of 21 Hot Leg	PZR Surge	A105-GrII/ A351-CF8M
114900/12-SC-2004-W1	182/82	12”	Bottom of 22 Hot Leg	Shutdown Cooling	A105-GrII/ A351-CF8M
115140/12-SI-2009-W15	182/82	12”	Top of 21B Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
116190/12-SI-2010-W13	182/82	12”	Top of 21A Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
117120/12-SI-2011-W13	182/82	12”	Top of 22B Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
118120/12-SI-2012-W13	182/82	12”	Top of 22A Cold Leg	Safety Injection	A182-F-1/ A351-CF8M
136090/4-PS-2003-W8	182/82	4”	Top Head of PZR	PZR Spray	SA508-Cl2/SA-182-F316
137010/3-PS-2001-W1	182/82	3”	Top of 21A Cold Leg	PZR Spray	A105-GrII/A-182-TP316
138010/3-PS-2002-W1	182/82	3”	Top of 21B Cold Leg	PZR Spray	A105-GrII/A-182-TP316
141000/4-SR-2005-W1	182/82	4”	Top of PZR	PZR Relief	SA508-Cl2/SA-182-F316
142000/4-SR-2006-W1	182/82	4”	Top of PZR	PZR Relief	SA508-Cl2/SA-182-F316
152440/2-CV-2005-W30	182/82	2”	21A Cold Leg	Charging Inlet	A105-GrII/A-182-TP316
156530/2-CV-2021-W34	182/82	2”	22B Cold Leg	Charging Inlet	A105-GrII/A-182-TP316
157010/2-DR-2003-W1	182/82	2”	Bottom of 21A Cold Leg	Loop Drain	A105-GrII/A-182-TP316
158010/2-DR-2004-W1	182/82	2”	Bottom of 21B Cold Leg	Loop Drain	A105-GrII/A-182-TP316
160010/2-DR-2006-W1	182/82	2”	Bottom of 22B Cold Leg	Loop Drain	A105-GrII/A-182-TP316