UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 28, 2013

Mr. Edward D. Halpin
Senior Vice President and Chief Nuclear Officer
Pacific Gas and Electric Company
Diablo Canyon Power Plant
P.O. Box 56, Mail Code 104/6
Avila Beach, CA 93424

SUBJECT: DIABLO CANYON POWER PLANT, UNIT NO. 2 – REQUEST FOR APPROVAL OF AN ALTERNATIVE TO THE ASME CODE, SECTION XI, FOR PREEMPTIVE FULL STRUCTURAL WELD OVERLAYS (TAC NO. MF0880)

Dear Mr. Halpin:

By letter dated March 5, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML130780374), as supplemented by letter dated March 7, 2013 (ADAMS Accession No. ML13067A343), Pacific Gas and Electric Company (the licensee) submitted Relief Request No. REP-1 U2, Revision 2, for U.S. Nuclear Regulatory Commission (NRC) review and authorization. The licensee requested relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWA-4000, at Diablo Canyon Power Plant (DCPP), Unit 2 (U2).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3(ii), the licensee requested to use an alternative in Relief Request REP-1 U2, Revision 2, to disposition the detected laminar indications on the basis that complying with the ASME Code, Section XI, IWA-4000 requirement to remove the laminar indications would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The NRC staff reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(ii). Therefore, the NRC staff authorizes use of the proposed alternative in Relief Request REP-1 U2, Revision 2, at DCPP Unit 2, for the fuel cycle following the 2013 refueling outage (2R17). On March 8, 2013, the NRC verbally authorized the use of Relief Request REP-1 U2, Revision 2, for one fuel cycle following 2R17 (ADAMS Accession No. ML13081A074).

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

If you have any questions, please contact the Project Manager, Jennivine Rankin, at 301-415-1530 or via e-mail at jennivine.rankin@nrc.gov.

Sincerely,

Michael T. Markley

Michael T. Markley, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-323

Enclosure:
As stated

cc w/encl: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST REP-1 U2, REVISION 2

ALTERNATIVE ACCEPTANCE CRITERIA FOR FLAWS

IN PRESSURIZER NOZZLE WELDS

DIABLO CANYON POWER PLANT, UNIT 2

PACIFIC GAS AND ELECTRIC COMPANY

DOCKET 50-323

1.0 INTRODUCTION

By letter dated March 5, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML130780374), as supplemented by letter dated March 7, 2013 (ADAMS Accession No. ML13067A343), Pacific Gas and Electric Company (the licensee) submitted Relief Request No. REP-1 U2, Revision 2, for U.S. Nuclear Regulatory Commission (NRC) review and authorization. The licensee requested relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWA-4000, at Diablo Canyon Power Plant (DCPP) Unit 2 (U2).

The licensee preemptively applied full structural weld overlays (SWOLs) on the six dissimilar metal welds (DMWs) and adjacent stainless steel pipe-to-safe end similar metal welds in accordance with Relief Request REP-1 U2, Revision 1, dated March 28, 2007 (ADAMS Accession No. ML070990060), which the NRC approved by letter dated February 6, 2008 (ADAMS Accession No. ML080110001), during the U2 14th refueling outage (2R14) in 2008. In the 2013 refueling outage, 2R17, the licensee detected laminar indications associated with the overlaid DMWs at safety nozzles A, B, and C and the spray nozzle of the U2 pressurizer using qualified phased array ultrasonic testing (UT). The licensee did not detect these indications after weld overlay installation in 2008 nor during the subsequent inservice inspection (ISI) in October 2009 using qualified conventional UT. For the 2013 inspection results, the licensee reported that the indications in the weld overlay installed on safety nozzles A and B and the spray nozzle exceeded the acceptance standards for the acceptance examinations in Relief Request REP-1 U2, Revision 1.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3(ii), the licensee requested to use an alternative in Relief Request REP-1 U2, Revision 2, to disposition the detected laminar indications on the basis that complying with the ASME Code, Section XI, IWA-4000 requirement to remove the laminar indications would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Enclosure

On March 8, 2013, the NRC verbally authorized the use of Relief Request REP-1 U2, Revision 2, for one fuel cycle following 2R17 (ADAMS Accession No. ML13081A074).

2.0 REGULATORY EVALUATION

The licensee requested relief from the ASME Code, Section XI, IWA-4000, which requires removing the unacceptable laminar indications detected in the overlaid DMWs. In addition, the licensee requested relief from the acceptance standards of the acceptance examination in NRC-approved Relief Request REP-1 U2, Revision 1. In lieu of the requirements of IWA-4000 of the ASME Code, Section XI, and Relief Request REP-1 U2, Revision 1, the licensee proposed to use Relief Request REP-1 U2, Revision 2, to allow the unacceptable laminar indications to remain in service.

Pursuant to 10 CFR 50.55a(g)(4), "Inservice inspection requirements," ASME Code Class 1, 2, and 3 components (including supports) will meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components 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 Section XI of the ASME Code, incorporated by reference in 10 CFR 50.55a(b), "Standards approved for incorporation by reference," 12 months prior to the start of the 120-month inspection interval, subject to the conditions listed therein.

The NRC approved the installation of the SWOL as specified in Relief Request REP-1 U2, Revision 1, which contains requirements for the design, installation (welding), analyses, and examinations of the SWOL.

The regulations in 10 CFR 50.55a(a)(3), state, in part, that alternatives to the requirements of 10 CFR 50.55a(g) may be used, when authorized by the NRC if (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.

Based on analysis of the regulatory requirements, the NRC staff concludes that the NRC has the regulatory authority to authorize the licensee's proposed alternative on the basis that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Accordingly, the staff has reviewed and evaluated the licensee's request pursuant to 10 CFR 50.55a(a)(3)(ii).

3.0 TECHNICAL EVALUATION

3.1 Relief Request REP-1 U2, Revision 2

3.1.1 ASME Code Component Affected

As stated in the licensee's submittal dated March 5, 2013:

a) Weld No. WIB-439SE Safe End -To-Surge Nozzle Weld and adjacent Pipe-to-Safe End Weld No. WIB-438 Line Identifier 2-*-16-14SPL (Surge Nozzle)
b) Weld No. WIB-369SE Safe End-to-8010A Safety Nozzle Weld and adjacent Pipe-to-Safe End Weld No. WIB-369 Line Identifier 2-S6-729-6 (Safety Nozzle A)
c) Weld No. WIB-423SE Safe End-to-8010B Safety Nozzle Weld and adjacent Pipe-to-Safe End Weld No. WIB-423 Line Identifier 2-S6-728-6 (Safety Nozzle B)
d) Weld No. WIB-359SE Safe End-to-8010C Safety Nozzle Weld and adjacent Pipe-to-Safe End Weld No. WIB-359 Line Identifier 2-S6-727-6 (Safety Nozzle C)
e) Weld No. WIB-380SE Safe End-to-Relief Nozzle Weld and adjacent Pipe-to-Safe End Weld No. WIB-380 Line Identifier 2-S6-730-6 (PORV Nozzle)
f) Weld No. WIB-345SE Safe End-to-Spray Nozzle Weld and adjacent Pipe-to-Safe End Weld No. WIB-345 Line Identifier 2-S6-15-4SPL (Spray Nozzle)

The NRC staff notes that the licensee did not find any laminar indications in the surge nozzle and power-operated relief valve (PORV) nozzle in its examination conducted in refueling outage 2R17. These two nozzles are not affected by the proposed alternative in Relief Request REP-1 U2, Revision 2. Therefore, the NRC staff has not evaluated the surge nozzle and PORV nozzle as part of relief request REP-1 U2, Revision 2. These two nozzles are included here for references and completeness because they are part of Relief Request REP-1 U2, Revision 1.

As stated in the licensee's submittal dated March 5, 2013, the component material specifications are as follows:

a) Nozzles are Low Alloy Steel SA-508 CL2 (P-No. 3 Group No. 3)
b) Safe End-to-Nozzle Welds and Buttering are Alloy 82/182 (F-No. 43)
c) Safe Ends are Wrought Stainless Steel SA-182 GR F316L (P-No. 8)
d) Attached Pipe is Wrought Seamless Stainless Steel SA-376 Type 316 (P-No. 8) and Welds are Stainless Steel (A-No. 8)
e) Pre-SWOL barrier layers were applied as follows: ER309L for the stainless steel base and weld metal, and ERNiCr-3 (Alloy 82) used locally at the interface between the Alloy 182 DMW and the stainless steel.
f) SWOL consisting of ERNiCrFe-7A (Alloy 52M) weld metal. The welding was performed to the requirements of Revision 1 using a remote machine gas tungsten arc welding (GTAW) process and the ambient temperature temper bead method.

3.1.2. Applicable Code Edition and Addenda

As stated in the licensee's submittal dated March 5, 2013:

> DCPP Unit 2 is currently in the third 10-year ISI interval. The ASME Boiler and Pressure Vessel Code (Code) of record is Section XI, 2001 Edition, including Addenda through 2003 (Reference 8.1) for the current 10-year ISI interval and the Repair/Replacement and ISI Program. ASME Code Section XI, 2001 Edition, no Addenda, Appendix VIII, Supplement 11, (Reference 8.2) as implemented by the Performance Demonstration Initiative (PDI) Program, is used for ultrasonic examination qualification for SWOLs. ASME Code Section XI, Appendix Q, 2004 Edition with 2005 Addenda (Reference 8.5) is used for SWOL ISI requirements for the remainder of the third inspection interval, nominally scheduled to end March 13, 2016.

3.1.3. Applicable Code Requirement

As stated in the licensee's submittal dated March 5, 2013:

> The applicable Code requirement for which relief is requested is ASME Code Section XI, 2001 Edition, including Addenda through 2003, IWA-4410 and IWA-4611 (Reference 8.1), and ASME Code Section XI, 2001 Edition, no Addenda, Appendix VIII, Supplement 11. (Reference 8.2)
>
> IWA-4410 states, in part, the following:
>
> *"Welding, brazing, defect removal, ...and installation shall be performed in accordance with this Subarticle."*
>
> IWA-4611.1(a) states, in part, the following:
>
> *"Defects shall be removed in accordance with IWA-4422.1. A defect is considered removed when it has been reduced to an acceptable size."*
>
> IWA-4611.2(a) states, in part, the following:
>
> *"After final processing, the affected surfaces, including surfaces of cavities prepared for welding, shall be examined by the magnetic particle or liquid penetrant method to ensure that the indication has been reduced to an acceptable size in accordance with IWB-3500."*
>
> Appendix VIII provides requirements for performance demonstration for ultrasonic examination systems. Supplement 11 provides qualification requirements for full structural overlaid wrought austenitic piping welds.

3.1.4 Reason for Request

The licensee needs to disposition the following circumferential, laminar indications detected in the overlaid DMWs at pressurizer nozzles that are unacceptable in accordance with the acceptance standards of Relief Request REP-1 U2, Revision 1.

Safety nozzle A has two laminar indications (No. 1 and 1A) and both indications have a length of 16.3 inches and a width of 0.4 inches. (Reference: Enclosure 7 to the March 5, 2013, submittal, AREVA Calculation #32-9200291-000, Figure 4-1.)

Safety nozzle B has 3 laminar indications (No. 1, 2, and 3) and the combined length of the three indications is 4.7 inches and each indication has a width of 0.25 inches. (Reference: Enclosure 7 to the March 5, 2013, submittal, AREVA Calculation #32-9200291-000, Figure 4-2.)

Spray nozzle has a laminar indication (No. 1) of 1.72 inches in length and 0.4 inches in width, and a laminar indication (No. 4) that has an intermittent length of 20.1 inches with a width of 0.25 inches. Two laminar indications (Nos. 2 and 3) at the spray nozzle were found to be acceptable in accordance with the acceptance standards of Relief Request REP-1 U2, Revision 1. (Reference: Enclosure 7 to the March 5, 2013, submittal, AREVA Calculation #32-9200291-000, Figure 4-3.)

The licensee found two laminar indications (Nos. 3 and 4) at safety nozzle C to be acceptable in accordance with the acceptance standards of Relief Request REP-1 U2, Revision 1. They are included herein for accounting purposes.

3.1.5 Proposed Alternative and Basis for Use

The licensee proposed Relief Request REP-1 U2, Revision 2, to permit the unacceptable laminar indications to remain in service based on the evaluations of the laminar indications in accordance with the analytical requirements of the ASME Code, Section XI, IWB-3600 and stress analysis requirements of the ASME Code, Section III, NB-3227.2.

Section 3.a.(3)(a) of Attachment 1 in Enclosure 1 of Relief Request REP-1 U2, Revision 2, states the following:

i) During 2R17, the SWOLs at Safety Nozzles A and B, and the Spray Nozzle were examined with enhanced sensitivity phased array ultrasonic techniques and each found to have a narrow fabrication-related laminar flaw oriented circumferentially over the low alloy steel nozzle base material as identified in Table 1 [of the March 5, 2013 submittal]. These flaws exceed 3.0 inches in length and shall be subject to quantitative analysis for acceptability.

ii) Quantitative analysis has shown that the structural integrity of the weld overlay in each case is assured as demonstrated in Enclosures 3 and 4 to PG&E Letter DCL-13-021, "ASME Section XI Inservice Inspection Program Relief Request REP-1 U2, Revision 2," dated March 5, 2013. Therefore, the indications are acceptable as-is.

3.1.6 Duration of Proposed Alternative

As stated in the licensee's submittal dated March 5, 2013:

> The alternative requirements of this request will be applied to installation of weld overlays during the current third 10-year ISI interval.
>
> Overlay installation and acceptance requirements are applicable for the expected life of the overlay, which is 20 years beyond the current license expiration date of August 26, 2025.
>
> Overlay ISI examination requirements stated in this request are applicable for the remainder of the third inspection interval, nominally scheduled to end March 13, 2016.
>
> Successive ISI examinations of Safety Nozzle A, B, and C and the Spray Nozzle will extend into and be performed during the first and second periods of the fourth inspection interval, in accordance with Section XI, IWB-2420.

3.2 NRC Staff Evaluation

The NRC staff has two concerns regarding the proposed alternative, which are listed below and explained in further detail in the following safety evaluation.

(1) Reasons the qualified conventional UT conducted on the subject welds did not detect the laminar indications in the 2008 and 2009 refueling outages and assurances that the phased array technique found all unacceptable flaws.

(2) The impact of the laminar indications on the structural integrity of the overlaid welds, if they are permitted to remain in service.

3.2.1 Ultrasonic Testing

The licensee provided an apparent cause, in lieu of a root cause, of why the conventional UT did not detect the indications in 2008 and 2009. The licensee stated in the March 5, 2013 submittal the following:

> There are inherent differences between the conventional UT techniques and the phased array [UT] techniques used to examine these weld overlays. The conventional [UT] technique utilizes 6 discrete and fixed examination angles (0^o, 40^o, 45^o, 60^o, 70^o and OD [outside diameter] creeping wave), whereas the phased array [UT] technique generates a range of angles from 0^o through 85^o.
>
> Additionally there is a significant difference in examination sensitivity used for detecting lack of fusion/bond flaws in the overlay material. The phased array [UT] technique examination sensitivity is generally twice (+6dB) that of the conventional [UT] technique. This can result in the phased array [UT] having

increased sensitivity to small flaws detected with 0° through 25° angle range as compared to the 0° conventional [UT] techniques. This increased sensitivity can also result in small flaws being more readily detectable with the phased array [UT] technique versus the conventional [UT] technique.

The flaw present in the subject weld overlays generally has a small cross section, and limited in through-wall extent and axial (width) dimension to one weld bead or less in size. Due to the small size, the reflective area of this flaw type is limited and thus produces conventional UT responses that are relatively low level and at times difficult to discriminate from the inherent background signal noise associated with performing UT on weld material.

Based on the characteristics and sizes of these flaws [laminar indications] it is likely that the conventional 0° UT technique applied during the original acceptance examinations may not have produced a significant enough flaw response to alert the NDE examiner to the presence of these flaws [laminar indications]. This is substantiated by the fact that a portion of the flaw(s) [laminar indications] identified in Safety Nozzle A was detected during the acceptance examination; however an increased flaw length dimension was reported with the phased array [UT] technique.

Additionally, it is concluded that due to the characteristics and orientations of the flaws [laminar indications], the phased array [UT] techniques are more likely to produce readily recognizable UT responses over a larger surface scanning area thereby increasing the probability of flaw detection by the NDE examiner. This conclusion is substantiated by the fact that the flaws [laminar indications] obtained with the phased array [UT] technique produced responses with angles ranging from approximately 15° through 30°. This range of angles is not present in the conventional UT technique.

Both the conventional UT and phased array UT techniques have been qualified for use through the PDI program's implementation of Section XI, Appendix VIII requirements. As such both techniques have met the same qualification acceptance criteria and level of qualification rigor. Both of these UT techniques have been widely used by the nuclear industry and both techniques have demonstrated the ability to readily detect and characterize flaws of safety significance, during multiple qualifications.

Based on the previous discussion Pacific Gas and Electric Company (PG&E) has concluded that the apparent cause for the subject flaws [laminar indications] not being identified during the original NDE acceptance examinations is directly related to flaw size and orientation, the differences in the applied NDE examination technology, and the examination sensitivity used. When using the conventional [UT] technique, the physical manipulation necessary to develop recordable indications is more demanding than that required when using the phased array [UT] technique with its additional angles. Additional rigor was required [when using the conventional UT] in order to obtain the responses, which could be the contributing cause for the examiners not reporting the flaws during the acceptance examination [using the conventional UT].

The NRC staff acknowledges the differences in operating characteristics of the phased array UT versus a conventional UT examination where fewer discrete inspection angles are used to scan the components. Phased array UT has typically shown superior detection capability than the conventional UT in operating experience because phased array UT is capable of using multiple angle beams and is more sensitive in reflector response. However, the NRC staff does not agree that the flaw size and orientation are contributors to the cause of conventional UT deficiencies. The conventional UT should have detected at minimum the large laminar indications (e.g., the laminar indications that were seen intermittently for 20.1 inches in the Spray nozzle), but did not. The NRC staff needs to understand why the conventional UT procedure which was qualified in accordance with the PDI program was not able to detect the large-sized laminar indications.

In addition, the NRC staff is concerned that the conventional UT not only could not detect the indications during the acceptance examination in 2008 but also during the inservice examination conducted in 2009. The licensee used the same UT qualification procedure in the 2008 and 2009 examinations. This raised the question of whether there is an inherent deficiency within the conventional UT qualification procedure.

The licensee stated that it used the conventional UT to re-inspect the subject welds after the phased array UT had detected the laminar indications. The conventional UT was able to confirm the laminar indications during the re-inspection. The NRC staff questions why the conventional UT was able to detect the laminar indications in the re-inspection in 2013 but not in 2008 and 2009 besides the fact that the examiner knew the exact locations of the laminar indications as a result of the phased array UT.

The NRC staff notes that while the manual phased array UT technique may be more effective than the conventional UT technique, both ultrasonic techniques were qualified to the requirements of the ASME Code, Section XI, Appendix VIII, Supplement 11. The licensee's conventional UT was qualified under the PDI program which is administered by the Electric Power Research Institute. The NRC staff has approved the PDI program as stated in the NRC's safety evaluation of Revision 1 of the relief request dated February 6, 2008.

The NRC staff's concern regarding the effectiveness of the qualification procedures for the conventional UT leads to questions regarding the effectiveness of the qualification procedures for the phased array UT techniques even though the phased array UT was able to detect many laminar indications in the Unit 2 pressurizer nozzles. The NRC staff's question is whether the phased array UT was able to identify all potential fabrication defects in the subject overlaid DMWs. The NRC is concerned whether an inherent deficiency in the UT qualification process for either the conventional UT or phased array UT would miss additional indications that may have a long term impact over the remaining service life of the subject overlaid DMWs.

The NRC staff concludes that the deficiency in the qualified conventional UT may have generic implications because other licensees have used the same conventional UT procedures to examine their overlaid DMWs.

3.2.2 Examination Coverage

The licensee evaluated the potential for the reflectors (laminar indications) to mask a portion of the ISI volume from ultrasonic examinations in accordance with Attachment 1, Section 3(a)3(b) of Relief Request REP-1 U2, Revision 2, which requires that the reduction in coverage of the examination volume due to laminar flaws shall be less than 10 percent.

As stated in the licensee's submittal dated March 5, 2013:

> Figure 2 depicts typical techniques used to determine accessible percentages of inspection areas and volumes. In general, scaled drawings for both axial and circumferential orientations are made from outside diameter (OD) surface contours measured before and after the SWOLs are installed. Ultrasonic thickness measurements are used to determine inside diameter location and relative geometric positions. The required examination volumes and any ultrasonic reflectors that may occlude a portion of the volume are then plotted on these drawings. Scan angles are projected through the required volumes as accessible to determine coverage.

The licensee found that for the three safety nozzles and spray nozzle, the examination coverage is acceptable. The licensee did not detect any indications in the overlaid DMWs at the PORV and surge line nozzles; therefore, the issue regarding the indication to mask a portion of the examination volume is not applicable to the PORV and surge line nozzles.

The NRC staff notes that many laminar indications are located at the interface between the nozzle base metal and the first layer of the weld overlay. This means that there is no weld overlay volume underneath these laminar indications. A few laminar indications are located in the middle thickness of the weld overlay which may mask the overlay volume underneath them from UT beams. However, these laminar indications are sufficiently small and short. Therefore, the probability of masking is small as the licensee concluded based on its sonic beam evaluation. The licensee has satisfied the NRC staff's concern because its evaluation shows that the laminar indications will not mask the weld overlay volume for UT beams.

3.2.3 Welding Issue

The licensee provided the apparent cause, in lieu of a root cause, of the laminar indication occurrence. As stated in the licensee's submittal dated March 5, 2013:

> The indications identified during the 2R17 outage ISI examination exhibited characteristics similar to LOB [lack of bond] and ILOF [interbead lack of fusion]....
>
> [Weld] filler metals with 30 percent chromium, such as Alloy 52M, are recognized as being very sluggish (low fluidity) filler metals to weld. This sluggishness is due to its higher viscosity creating an inherent slower response of the filler metal to changes normally occurring during welding. This sluggishness is more noticeable on first layer welds due to the dilution of the low alloy steel substrate of the component, and may even be apparent on the second layer until the weld

chemistry becomes more consistent on the third and remaining layers of the SWOL.

Even though more welding discontinuities might be expected when welding out of position and when using Alloy 52M filler metal, discontinuities may occur regardless of welding position. A typical overlay contains hundreds of weld beads and the small, incomplete fusion (i.e., minimal through thickness dimension) discontinuities are not detrimental to the structural integrity of the SWOL and are mitigated through the robust overlay design criteria.

In summary, to address these concerns, overlays are designed to ensure these small, laminar type (i.e., minimal through thickness dimension) discontinuities are not detrimental to the structural integrity of the SWOL and are mitigated through robust design. The UT acceptance criteria allows for permissible laminar type flaws to address the welding challenge of the 30 percent chromium alloys.

The NRC staff acknowledges that Alloy 52M filler metal is difficult to weld in the field for production as opposed to the qualification weld performed in the shop. The NRC staff notes that all PWR owners who have applied the SWOL onto the DMWs follow the qualified welding procedures including the licensee. Some licensees have reported unacceptable fabrication defects (laminar indications) when installing SWOL and have removed the indications. Some licensees reported no unacceptable fabrication defects. The NRC staff notes that the number and sizes of the laminar indications detected in the overlaid DMWs at Unit 2 may be an outlier.

3.2.4 Flaw Evaluation

The licensee evaluated all recordable indications from safety nozzle A, safety nozzle B, safety nozzle C, and the spray nozzle in accordance with the acceptance criteria contained in Section 3.a.(3)(a) of Enclosure 2 of NRC-approved Relief Request REP-1 U2, Revision 1, dated March 28, 2007. The acceptance criteria states, "Laminar flaws shall meet the acceptance standards of Table IWB-3514-3 [of the ASME Code, Section XI] with the additional limitation that the total laminar flaw shall not exceed 10% of the weld surface area and that no linear dimension of the laminar flaw area exceeds 3.0 in. (76 mm), or 10% of the nominal pipe circumference, whichever is greater." The licensee's flaw evaluation is documented in AREVA Calculation 32-9200249-000 (non-proprietary) of the March 5, 2013 submittal.

The licensee's evaluation showed that all the laminar indications in safety nozzles, A, B, and C and the Spray nozzle satisfy the acceptance standards of the ASME Code, Section XI, IWB-3514-3. However, 2 indications in safety nozzle A, 3 indications in safety nozzle B, and 2 indications in the spray nozzle do not satisfy the 3.0-inch limitation. In lieu of removing the laminar indications, the licensee performed the flaw evaluation of the unacceptable laminar indications in safety nozzles A, B, and C, and the spray nozzle based on the requirements of the ASME Code, Section XI, IWB-3600, assuming planar flaws. The licensee's calculation shows that all the laminar indications satisfy the acceptance criteria of IWB-3640 based on fatigue crack growth in the remaining 38 years of the plant service life. The NRC staff concludes that the licensee's flaw evaluation demonstrates that the laminar indications detected at safety nozzles A, B, and C, and the spray nozzle satisfy the acceptance criteria of the ASME Code, Section XI, IWB-3640.

The NRC staff concludes that although the licensee's flaw evaluation has demonstrated the structural integrity of the overlaid DMWs with the embedded laminar indications, the flaw evaluation in accordance with the ASME Code, Section XI, IWB-3600 is based on the analysis of a single flaw, not a group of flaws in a component. The flaw evaluation does not and could not analyze the impact of all laminar indications on the structural integrity of overlaid DMWs. One possible solution is to use a finite element model that would include all the laminar indications to analyze the impact of combined laminar indications on the overlaid DMWs. The finite element analysis would be able to determine the interactions of all the laminar indications and thus be able to assess the global structural integrity of the overlaid DMWs.

The licensee also performed a stress analysis demonstrating that the interface length between the weld overlay and the nozzle and pipe base metal is sufficient in light of laminar indication occurrence using the rules of the ASME Code, Section III, NB-3227.2. The NRC staff concludes that the weld overlay on each affected nozzle has been verified to have sufficient length to transfer loads back to the base metal without exceeding allowable primary shear stresses of the ASME Code, Section III, NB-3227.2. The NRC staff concludes that the stress calculation based on NB-3227.2 is acceptable to permit the laminar indications to remain in service for a short duration. However, the NRC staff concludes that the stress calculation based on the requirements of NB-3227.2 is not sufficient to show the global impact of all the laminar indications on an overlaid DMW, if the laminar indications were to remain in service permanently. The NB-3227.2 requirement does not provide the rigor of analyzing the weld overlay with many voids (i.e., lack of bond or interbead lack of fusion). A rigorous finite element analysis, modeling the lack of bond and interbead lack of fusion in the weld overlay model where the laminar flaws exist, would support the conclusion that the laminar flaws will not challenge the structural integrity of the overlaid dissimilar metal welds.

3.2.5 <u>Subsequent Inspections</u>

As stated in the licensee's submittal dated March 5, 2013:

> In addition to the scheduled future inservice inspections of the pressurizer nozzle SWOLs, all nozzles except the PORV Nozzle and Surge Nozzle will be reexamined during DCPPS Unit 2's next three ISI periods in accordance with the ASME Code, Section XI, IWB-2420 using qualified phased array UT to assure the identified reflectors [laminar indications] have not increased in size.
>
> The pressurizer nozzles are subject to VT-2 visual examination during pressure test associated with startup every refueling outage.

The NRC staff concludes that the three successive examinations will verify the validity of the above flaw evaluation and stress analyses. The NRC staff notes that the VT-2 visual examination as part of system leakage test (pressure test) is another monitoring method to verify the integrity of the subject welds.

3.2.6 Hardship

As stated in the licensee's submittal dated March 5, 2013:

> Consideration of material removal and localized repair welding of the structural overlays may result in redistribution of the stress profiles and would result in undue hardship. Additionally, the spray and relief nozzle overlays are all located on the top of the pressurizer which creates additional personnel hazards. Work at this location requires personnel to ascend to an elevated platform and would require rigging of equipment to the work location. The small elevated platform is congested with nozzles, piping, structural elements and other plant equipment located in close proximity. To assure safety of personnel and adjacent plant equipment, adequate time is needed to assure proper job planning. Effective dose rates in this area are 4.5 [millirem per hour (mr/hr)]. Personnel requirements for the welding, inspection and associated support activities for the anticipated duration of this work will result in approximately 2.6 Rem additional exposure to individuals involved.

The licensee expanded on the potential hardships in their supplement dated March 7, 2013 which explains how excavation and repair of the overlays has the potential to degrade the overlay and beneficial compressive stress on the inner diameter of the nozzles, how grinding will be required to excavate the flaws prior to the weld repair, and how the installation of the original weld overlays requires rework of pipe hangers and realignment of piping.

The licensee concluded that performing the required ASME Code repair of the subject overlaid dissimilar metal butt welds would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The NRC staff concludes that the introduction of additional cold work and changing of the weld residual stress profile of the overlaid DMWs would constitute a hardship and an unusual difficulty because the licensee has demonstrated that the laminar indications do not significantly challenge the structural integrity of the subject DMWs.

3.2.7 Summary

The NRC staff notes that none of the laminar indications is service-induced because they are not connected to inside or outside surface of the pipe. They are not planar flaws based on the UT data. However, they may grow to become flaws in the future. If they do grow, they would grow based on thermal fatigue degradation mechanism. The thermal fatigue growth rate is slow. The licensee will perform three successive examinations after 2013. After the successive examinations, the subject DMWs will be examined periodically in accordance with Relief Request REP-1 U2, Revision 2 and ASME Code Case N-770-1 as conditioned in 10 CFR 50.55a(g)(6)(ii)(F). These examinations will monitor any growth in the laminar indications.

The NRC staff further notes that all the laminar indications are not located directly above the DMW which is susceptible to primary water stress-corrosion cracking (PWSCC). Therefore, the impact of the laminar indications on the DMWs is minimized. Indications Number 2 and 3 of the spray nozzle are located directly above the similar metal weld (stainless steel weld), WIB-345. These two laminar indications are small and are accepted by the relief request and the acceptance standards of ASME, Code, Section XI, IWB-3514. Also, the stainless steel weld is not as susceptible to PWSCC as the DMW. The periodic inspection will be able to monitor the structural integrity of the stainless steel weld, WIB-345.

While the NRC staff concludes that the licensee's flaw and stress analyses provide reasonable assurance that the laminar indications do not challenge the structural integrity of the subject overlaid DMWs, the NRC staff questions the adequacy of the procedures that qualified the conventional UT and the phased array, and whether the phased array UT used in 2013 had detected all unacceptable indications in the subject welds. The NRC staff also has concerns with the rigor of the licensee's stress analysis performed based on the ASME Code, Section III, NB-3227.2 because it could not analyze the global impact of all laminar indications on an overlaid DMW.

Notwithstanding the above concerns, the NRC staff concludes that Relief Request REP-1 U2, Revision 2 can be authorized for one fuel cycle use only instead of the remainder of the third inspection interval. The NRC staff concludes that the overlaid DMWs with embedded laminar indications will provide reasonable assurance of their structural integrity for one fuel cycle because the NRC staff determines that the laminar indications will not grow to challenge the structural integrity of the SWOL in one fuel cycle. For the NRC to approve the relief request for duration longer than one fuel cycle, the licensee needs to address the above concerns.

4.0 REGULATORY COMMITMENT

The licensee made the following regulatory commitment in Enclosure 8 of its letter dated March 5, 2013:

> ISI examination of Safety Nozzle A, B, and C, and the Spray Nozzle SWOLs will be performed during the next three ISI periods in Accordance with Section XI, IWB-2420.

5.0 CONCLUSION

As set forth above, the NRC staff has determined that the licensee's proposed alternative provides reasonable assurance of structural integrity and leak tightness of the subject overlaid DMWs for one cycle of operation. The NRC staff concludes that complying with the specified ASME Code requirement and previously granted alternative relief request, REP-1 U2, Revision 1, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that for one fuel cycle, the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(ii). Therefore, the NRC authorizes use of the Relief Request REP-1 U2, Revision 2, at the DCPP Unit 2, for the fuel cycle following the 2013 refueling outage, 2R17.

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: John Tsao

Date: August 28, 2013

If you have any questions, please contact the Project Manager, Jennivine Rankin, at 301-415-1530 or via e-mail at jennivine.rankin@nrc.gov.

Sincerely,

/RA/

Michael T. Markley, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-323

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As stated

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