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

February 26, 2016

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 NOS. 1 AND 2 – AMERICAN SOCIETY OF MECHANICAL ENGINEERS SECTION XI INSERVICE INSPECTION PROGRAM RELIEF REQUEST NDE-FWNS-U1/U2 TO ALLOW USE OF ALTERNATE EXAMINATION VOLUME COVERAGE REQUIREMENTS (CAC NOS. MF6689 AND MF6690)

Dear Mr. Halpin:

By letter dated September 3, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15246A244), as supplemented by letter dated January 27, 2016 (ADAMS Accession No. ML16027A358), Pacific Gas & Electric Company (the licensee) submitted a request for relief (NDE-FWNS-U1/U2) from the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," non-destructive examination requirements applicable to the Diablo Canyon Power Plant (DCPP), Unit Nos. 1 and 2, steam generator (SG) feedwater (FW) nozzle-to-shell welds. ASME Code, Section XI, Table IWC-2500-1, Code Category C-B, Item Number C2.21, requires that surface and volumetric examinations of the nozzle-to-shell weld of nozzles at terminal ends of piping runs be performed in accordance with Figure IWC-2500-4(a), (b), or (d) during each inspection interval. The licensee requested relief from the ASME Code, Section XI requirement for an essentially 100 percent volumetric examination of the inner one-third volume of the welds of the DCPP, Unit Nos. 1 and 2, SG FW nozzle-to-shell welds because compliance with the requirement is impractical and the configuration of the nozzles precludes obtaining complete volumetric examination coverage.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's submittal and concludes, as set forth in the enclosed safety evaluation, that compliance with the ASME Code, Section XI, Table IWC-2500-1, Examination Category C-B, Item No. C2.21 nozzle-to-shell weld volumetric examination requirement to examine essentially 100 percent of the inner one-third volume of the SG FW nozzle-to-shell welds for DCPP, Unit Nos. 1 and 2, is impractical because the configuration of the nozzles precludes obtaining 100 percent volumetric examination coverage. The volumetric examination coverages achieved for the DCPP, Unit Nos. 1 and 2, FW nozzle-to-shell welds (84 percent and 79 percent, respectively), combined with the complete surface examinations of these welds, as well as the periodic visual [VT-2] examinations of the SGs performed during each refueling outage in conjunction with the system leakage test, provide reasonable assurance of structural integrity of the SG FW nozzle-to-shell welds. Therefore, the NRC staff grants relief for the subject examinations of the items contained in relief request NDE-FWNS-U1/U2, as requested for DCPP, Unit Nos. 1 and 2, for

the third 10-year inservice inspection intervals, which nominally ended on May 6, 2015, for Unit No. 1, and is nominally scheduled to end on March 12, 2016, for Unit No. 2.

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

If you have any questions, please contact the Project Manager, Siva P. Lingam, at 301-415-1564 or via e-mail at Siva.Lingam@nrc.gov.

Sincerely,

Robert J. Pascarelli, Chief
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-275 and 50-323

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NDE-FWNS-U1/U2 FOR FEEDWATER NOZZLE-TO-SHELL WELD TO ALLOW USE OF ALTERNATE EXAMINATION VOLUME COVERAGE REQUIREMENTS

PACIFIC GAS AND ELECTRIC COMPANY

DIABLO CANYON POWER PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-275 AND 50-323

1.0 INTRODUCTION

By letter dated September 3, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15246A244), as supplemented by letter dated January 27, 2016 (ADAMS Accession No. ML16027A358), Pacific Gas & Electric Company (PG&E, the licensee) submitted a request for relief (NDE-FWNS-U1/U2) from the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," non-destructive examination requirements applicable to the Diablo Canyon Power Plant (DCPP), Unit Nos. 1 and 2, steam generator (SG) feedwater (FW) nozzle-to-shell welds. ASME Code, Section XI, Table IWC-2500-1, Code Category C-B, Item Number C2.21, requires that surface and volumetric examinations of the nozzle-to-shell weld of nozzles at terminal ends of piping runs be performed in accordance with Figure IWC-2500-4(a), (b), or (d) during each inspection interval. The licensee requested relief from the ASME Code, Section XI requirement for an essentially 100 percent volumetric examination of the inner one-third volume of the welds of the DCPP, Unit Nos. 1 and 2, SG FW nozzle-to-shell welds because compliance with the requirement is impractical and the configuration of the nozzles precludes obtaining complete volumetric examination coverage. Volumetric examination to the maximum extent possible coupled with complete surface examination of the subject welds are proposed to provide reasonable assurance of the structural integrity of the welds.

The request is for the third 10-year inservice inspection (ISI) interval for both units. For DCPP, Unit No. 1, the ISI interval began on January 1, 2006, and nominally ended on May 6, 2015; for DCPP, Unit No. 2, the ISI interval began on July 1, 2006, and is nominally scheduled to end on March 12, 2016. Actual end dates of the intervals are dependent on the completion dates of the 19th refueling outages for each unit, in accord with ASME Code, Section XI, Paragraph IWA-2430(d)(1).

2.0 REGULATORY EVALUATION

The ISI of ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g), except where specific relief has been granted by the U.S. Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(g)(6)(i). Pursuant to 10 CFR 50.55a(z), alternatives to the requirements of paragraph (g) may be used, when authorized by the Commission, if (i) the proposed alternatives would 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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except design and access provisions and preservice examination requirements, set forth in ASME Code, Section XI 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) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The regulations in 10 CFR 50.55a(g)(4)(iv) states that inservice examination of components and system pressure tests may meet the requirements set forth in subsequent editions and addenda that are incorporated by reference in paragraph 10 CFR 50.55a(a), subject to the limitations and modifications listed in 10 CFR 50.55a(b) and subject to Commission approval. Portions of editions or addenda may be used provided that all related requirements of the respective editions or addenda are met. The ASME Code of record for the third 10-year ISI interval at DCPP, Unit Nos. 1 and 2, is the 2001 Edition with Addenda through 2003.

3.0 TECHNICAL EVALUATION

3.1 Affected Components

The component affected by this request is the SG FW nozzle. The SG FW nozzle is an ASME Code, Section XI, Class 2 component. The four figures on pages 6 through 9 of PG&E's September 3, 2015 submittal show the general configuration and examination coverage illustrations for the DCPP SG FW nozzles.

3.2 ASME Code Requirements (as stated by the licensee)

> ASME [Code,] Section XI, Table IWC-2500-1, Examination Category C-B, Item No. C2.21 requires that SG feedwater nozzle-to-shell welds be volumetrically examined once during the ISI interval. Essentially 100 percent of the inner one-third volume of the weld, and adjacent base material, is to be examined in accordance with the requirements of [ASME Code, Section XI,] Appendix I, [Paragraph] I-2120. The applicable examination volume is defined by [ASME Code, Section XI,] Figure IWC-2500-4(a) and the examination is performed per

the rules of ASME [Code,] Section V, Article 4, as supplemented by [ASME Code, Section XI, Appendix I,] Table I-2000-1.

3.3 Licensee's Basis for Requesting Relief (as stated by the licensee)

Pursuant to 10 CFR 50.55a(g)(5)(iii), Pacific Gas and Electric Company (PG&E) hereby requests NRC approval of Inservice Inspection Request for Relief NDE-FWNS-U1/U2 for the Diablo Canyon Power Plant Unit No. 1 and Unit No. 2 third Inservice Inspection Interval. Relief is requested from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, for examination coverage of Class 2 feedwater nozzle-to-vessel welds. The details of the proposed request are enclosed [in the licensee's September 3, 2015 submittal].

"Essentially 100 percent" coverage of the exam volume from the outside surface would require redesign of the SG to move the weld farther back from the nozzle reinforcement or eliminate the weld by integrally incorporating the nozzle into the shell. Either of these two modifications would effectively result in performing major redesign and rework or replacement of the entire SG to accommodate full coverage of the exam area as specified by [the ASME] Code.

Performing examinations from the inside diameter of the SGs would require accessing the secondary side of the generators which involves substantial effort to remove the manway cover, making provisions for personnel access into a confined space, and work in a high risk foreign material exclusion area.

These efforts required to attain a small incremental increase in coverage would incur increased personnel radiation exposure and an increase in personnel safety risk due to work in a difficult to access and highly constrained work environment without a commensurate increase in examination effectiveness.

PG&E proposes that the alternative ultrasonic examinations conducted to the maximum extent practicable from the outside surface provide reasonable assurance that the structural integrity of the subject welds remains intact.

The [DCPP, Unit Nos. 1 and 2, seventeenth refueling outages] 1R17 and 2R17 examinations were implemented to the extent practicable using manual scan techniques and small footprint search units in effort to attain the greatest possible coverage of the required examination volume. The volume examined on both of the subject feedwater nozzle-to-shell welds includes the weld and surrounding base material near the inside surface of the weld joint, which are typically the highest stress regions and where degradation would likely manifest, should it occur.

The radial-in and circumferentially oriented angle beam scans fully interrogated the ASME [Code, Section] XI Code exam volume, whereas, the radial-out scans covered a portion of the volume. Examination of ferritic materials from a single

side of the weld has been demonstrated as effective in studies (Reference 1 [of the licensee's September 3, 2015 submittal]) and by successful single side ferritic ASME [Code, Section] XI, Appendix VIII qualifications per the Performance Demonstration Initiative program. Therefore, it is expected that the ultrasonic techniques employed on the DCPP FW nozzle-to-shell welds would have detected structurally significant flaws if extant within the examination area.

The 1R17 and 2R17 ultrasonic examinations with combined coverage values of approximately 84 percent and 79 percent for the selected Unit No. 1 and Unit No. 2 subject welds, respectively, provide reasonable assurance that the structural integrity of these welds remains intact and provide an acceptable level of quality and safety.

Potential Failure Consequences

A failure of the feedwater nozzle-to-shell weld could result in a loss of feedwater to a SG. Depending on the size of the postulated break (leak) the specific consequences will vary. At the smallest end of the break size spectrum, the feedwater system would be capable of maintaining SG level through normal makeup. Larger break sizes would result in depressurization of the SG and loss of heat transfer capability. The worst case consequence would occur if the nozzle-to-shell weld was to suffer 360 degree circumferential cracking. In this case, the break is bounded by the feedwater line break assumed in the DCPP design basis analysis.

Essentially no change to overall plant safety is expected due to implementation of the proposed alternative in lieu of the [ASME] Code [, Section XI] requirement. This assumption is based on the effectiveness of ultrasonic examination on ferritic material as previously described, and little or no historical occurrence of large service induced planar flaws in this type of weldment.

3.4 NRC Staff Evaluation

During a telephone call with the licensee on September 23, 2015 (ADAMS Accession No. ML15267A387), the NRC staff requested the following clarification regarding the licensee's September 3, 2015, relief request (RR):

- The RR submittal requests relief under the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.55a(g)(5)(iii), "*ISI program update: Notification of impractical ISI Code requirements.*" However, the submittal also discusses and requests approval for "proposed alternatives." Proposed alternatives are addressed under the provision of 10 CFR 50.55a(z), "*Alternatives to codes and standards requirements.*" Clarify whether or not an alternative pursuant to 10 CFR 50.55a(z) is also being requested in this RR.

During the call, the licensee clarified that the request is solely for relief under the provisions of 10 CFR 50.55a(g)(5)(iii), and that no proposed alternatives under 10 CFR 50.55a(z) are requested. In response to this clarification, the NRC staff sent an e-mail to the licensee on September 24, 2015 (ADAMS Accession No. ML15267A387), stating that the licensee's submittal would be reviewed in accordance with the provisions of 10 CFR 50.55a(g)(6), "*Actions by the Commission for evaluating impractical and augmented ISI Code requirements.*"

During its review, the NRC staff noted that according to Appendix 9.5A of Revision 20 to the DCPP Final Safety Analysis Report Update (November 2011), the SGs were replaced in 2008 and 2009 at DCPP, Unit Nos. 1 and 2, respectively. Therefore, similar requests for the DCPP SG FW nozzles for relief during previous 10-year ISI intervals were not available to the staff for comparison during its review of PG&E's submittal. However, precedent requests for similar relief for DCPP dated September 29, 1999 (ADAMS Legacy Library Accession No. 9902220262), and the Calvert Cliffs Nuclear Power Plant dated July 27, 2001 (ADAMS Accession No. ML011860464), were identified in PG&E's September 3, 2015, submittal, and were reviewed by the staff for consistency.

In its September 3, 2015, submittal, the licensee identified that the DCPP replacement SG shell and nozzle forgings are fabricated from SA-508 Grade 3 Class 2 material with a nominal shell thickness of approximately 3.50 inches. The FW nozzles intersect the shell cylinder at a right angle and are joined by a weld extending concentrically around the nozzle forging and through the full thickness of the shell. The weld joint design is an unequal depth double U-groove design with an included groove angle of 7 degrees. The nozzle-to-shell welds were made using high strength filler metals (i.e., E9018M, ER80S-2, and S3NiMo1) whose composition and mechanical properties are similar to the joined base metals.

The licensee also identified that the subject welds were examined in the 1R17 and 2R17 refueling outages to the extent practicable using a combination of 35-, 45-, and 60-degree angled shear waves and zero degree longitudinal waves. The 35- and 45-degree angles were used for radial-out examinations in order to achieve the maximum possible coverage of the ASME Code specified examination volume. The 60-degree angle was not able to interrogate the ASME Code examination volume in the radial-out direction due to the restricted setback caused by the nozzle boss configuration. Forty-five and 60- degree angles were used for radial-in and circumferential scan examinations. No flaws were detected in any of the examinations of the subject welds.

The licensee identified that the combined examination volume coverage attained for the DCPP, Unit Nos. 1 and 2, welds was 84 percent and 79 percent, respectively. Although the entire ASME Code examination volume was interrogated by the zero degree longitudinal wave scan, these coverage values were based on the 35-, 45-, and 60-degree angles since they would be expected to detect service-induced planar flaws emanating from the inside surface. The licensee provided four figures that illustrate the coverage for each of the inspection angles and directions used to determine the coverage values.

The compound curvature of the nozzle forging boss to shell contour transition zone and the forging design diameter constitute geometric restrictions that preclude full examination volume coverage from the outside surface. The coverage limitations are associated with the radial-out

oriented scans. An inherent design characteristic of the flange type nozzle configuration is that there is often insufficient setback distance for the radial-out scan beams to cover the entire ASME Code specified examination area at the inside surface of the weld.

In a request for additional information (RAI) dated December 15, 2015 (ADAMS Accession No. ML15350A039), the NRC staff noted that the licensee's submittal did not identify whether the surface examinations required by ASME Code, Section XI, Table IWC-2500-1, Code Category C-B, Item Number C2.21 were performed. Therefore, in the RAI, the staff requested the licensee (1) to identify whether the surface examinations required by ASME Code, Section XI, Table IWC-2500-1, Code Category C-B, Item Number C2.21 were performed for the SG FW nozzle-to-shell welds; (2) to provide a summary of the results for any surface examinations performed for the SG FW nozzle-to-shell welds; (3) to identify whether relief is also being requested from any of the applicable ASME Code, Section XI surface examination requirements for the SG FW nozzle-to-shell welds; and (4) to provide a description of the impact of any surface examinations performed for the SG FW nozzle-to-shell welds on the burden and bases assessments included in the RR.

In its RAI response dated January 27, 2016, the licensee stated that the surface examinations required by the ASME Code, Section XI, Table IWC-2500-1, Code Category C-B, Item Number C2.21 were performed for the SG FW nozzle-to-shell welds, and that 100 percent coverage was achieved. Additionally, the licensee stated that the surface examinations did not detect any relevant indications and that no defects were noted. The licensee noted that the magnetic particle examination used is sensitive to defects that initiate or propagate to the outside surface of the weld and adjoining examination area and provides assurance that no surface breaking flaws exist on these nozzle welds.

ASME Code, Section XI also requires that the SGs receive a visual (VT-2) examination during each inspection period. The VT-2 examinations of the SGs, which will continue to be performed during each refueling outage in conjunction with the system leakage test, will provide reasonable assurance of the leak tightness of the SG FW nozzle-to-shell welds because the system leakage test will provide for detection of flaws when they are small and can be repaired prior to the SG FW nozzle-to-shell welds losing their ability to perform their intended function.

Based on the volumetric examination coverage achieved, as well as the complete surface examinations that were performed, the NRC staff concludes that there is reasonable assurance that degradation of the SG FW nozzle-to-shell welds is unlikely to occur. With the limited inaccessibility of the FW nozzle-to-shell welds for volumetric examination and the full access of the FW nozzle-to-shell welds for surface examination, the replacement of the SG FW nozzle design with a design that is conducive to essentially 100 percent volumetric examination is impractical. Furthermore, the periodic VT-2 examinations performed on the SGs provide reasonable assurance of structural integrity of the SG FW nozzle-to-shell welds for DCPP, Unit Nos. 1 and 2.

4.0 CONCLUSION

Based on the above, the NRC staff concludes that compliance with the ASME Code, Section XI, Table IWC-2500-1, Examination Category C-B, Item No. C2.21 nozzle-to-shell weld volumetric

examination requirement to examine essentially 100 percent of the inner one-third volume of the SG FW nozzle-to-shell welds for DCPP Unit Nos. 1 and 2 is impractical because the configuration of the nozzles precludes obtaining 100 percent volumetric examination coverage. The volumetric examination coverages achieved for the DCPP, Unit Nos. 1 and 2, FW nozzle-to-shell welds (84 percent and 79 percent, respectively), combined with the complete surface examinations of these welds, as well as the periodic VT-2 examinations of the SGs performed during each refueling outage in conjunction with the system leakage test, provide reasonable assurance of structural integrity of the SG FW nozzle-to-shell welds.

Therefore, pursuant to 10 CFR 50.55a(g)(6)(i), request for relief NDE-FWNS-U1/U2 is granted to DCPP, Unit Nos. 1 and 2, for the third 10-year ISI intervals, which nominally ended on May 6, 2015, for Unit No. 1, and is nominally scheduled to end on March 12, 2016, for Unit No. 2. Granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that would result if the requirements were imposed on the facility.

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

Date: February 26, 2016

the third 10-year inservice inspection intervals, which nominally ended on May 6, 2015, for Unit No. 1, and is nominally scheduled to end on March 12, 2016, for Unit No. 2.

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

If you have any questions, please contact the Project Manager, Siva P. Lingam, at 301-415-1564 or via e-mail at Siva.Lingam@nrc.gov.

Sincerely,

/RA/

Robert J. Pascarelli, Chief
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-275 and 50-323

Enclosure:
Safety Evaluation

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