



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

December 8, 2015

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 – RELIEF REQUEST NDE-SG-MS-IR, MAIN STEAM NOZZLE INNER RADIUS EXAMINATION IMPRACTICALITY, THIRD 10-YEAR INTERVAL AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE, SECTION XI, INSERVICE INSPECTION PROGRAM (CAC NOS. MF6646 AND MF6647)

Dear Mr. Halpin:

By letter dated August 24, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15236A376), Pacific Gas and Electric Company (the licensee) submitted a relief request (RR) NDE-SG-MS-IR to the U.S. Nuclear Regulatory Commission (NRC) requesting relief from Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) volumetric examination requirements for the steam generator (SG) main steam nozzle inner radius examinations for the third 10-year inservice inspection (ISI) interval at Diablo Canyon Power Plant (DCPP), Unit Nos. 1 and 2. Specifically, pursuant to paragraph 50.55a(g)(5)(iii) of Title 10 of the *Code of Federal Regulations* (10 CFR), on a schedule consistent with 10 CFR 50.55a(g)(5)(iv), the licensee requested relief from the requirements for ISI items on the basis that the ASME Code requirement is impractical.

The NRC staff has completed its review of the relief request as discussed in the enclosed safety evaluation. The NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(g)(5)(iii). The NRC staff has determined that the proposed periodic visual 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 main steam outlet nozzle inside radii. 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 could result if the requirements were imposed on the facility. Therefore, pursuant to 10 CFR 50.55a(g)(6)(i), the NRC staff grants RR NDE-SG-MS-IR for the third 10-year ISI intervals at DCPP, Unit Nos. 1 and 2. The DCPP Unit No. 1 third inspection interval ended on May 6, 2015, and is nominally scheduled to end on March 12, 2016, for Unit No. 2.

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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

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

RELIEF REQUEST NDE-SG-MS-IR FOR THE MAIN STEAM NOZZLE

INNER RADIUS EXAMINATION IMPRACTICALITY

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 August 24, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15236A376), Pacific Gas & Electric Company (PG&E, the licensee) submitted a request for relief (NDE-SG-MS-IR) 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) main steam nozzle inside radius sections. The ASME Code, Section XI, Table IWC-2500-1, Code Category C-B, Item Number C2.22, requires that a volumetric examination of the inner-radius section of nozzles at terminal ends of piping runs be performed in accordance with Figure IWC-2500-4(a), (b), or (d) each inspection interval. The licensee has requested relief from the ASME Code, Section XI requirement for a volumetric examination of the inner-radius section of the DCPP, Unit Nos. 1 and 2, SG main steam outlet nozzles because compliance with the requirement is impractical and the configuration of the nozzles precludes obtaining meaningful volumetric examination results. No alternative examination is proposed in lieu of the volumetric examination because the visual examination of the subject area is also precluded by the configuration. 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.

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

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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 DCP, 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 main steam outlet nozzle. The SG main steam outlet nozzle is an ASME Code, Section XI, Class 2 component. Figures 1, 2, and 3 of the Enclosure to PG&E's August 24, 2015, submittal show the general configuration and material information for the DCP SG main steam outlet 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. C2.22,] requires that volumetric examination of the inside-radius section of nozzles at terminal ends of piping runs be performed in accordance with Figure IWC-2500-4(a), (b), or (d) each inspection interval. The applicable nozzles include those welded to or integrally cast in vessels that connect to piping runs selected for examination under Examination Category C-F (manways and handholes are excluded).

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

Pursuant to 10 CFR 50.55a(g)(5)(iv), Pacific Gas and Electric Company (PG&E) hereby requests NRC approval of Inservice Inspection (ISI) Request for Relief NDE-SG-MS-IR for the Diablo Canyon Power Plant (DCPP) Units 1 and 2 third ISI interval. The request is associated with the impracticality of applying the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI volumetric examination requirements for inside radius

examinations of Class 2 pressure retaining main steam nozzles in the replacement steam generators at DCPD. The details of the request are included in the Enclosure [of the licensee's August 24, 2015, submittal].

The DCPD replacement steam generator (RSG) main steam outlet nozzles are a flow limiting design that is comprised of a set of seven holes bored parallel to the nozzle centerline in the one-piece elliptical top head forging. Venturi inserts are installed in each of the bore holes and attached by welding to 0.25" thick weld deposited cladding. See Figures 1, 2 and 3 [of the licensee's August 24, 2015, submittal] for sketches of the general nozzle configuration and materials of construction.

As depicted in Figures 1, 2 and 3 [of the licensee's August 24, 2015, submittal], the configuration of the main steam outlet nozzles does not correspond to the examples shown in [ASME] Code[, Section XI,] Figures IWC-2500-4(a), (b), or (d), nor does it incorporate a single large radius transition as shown in each of the ASME Code figures. The multiple bore hole with welded venturi design results in a complex internal profile that precludes meaningful ultrasonic examination.

Attachment 1 [of the licensee's August 24, 2015, submittal] contains information about the main steam nozzle design extracted from WCAP-16816-P, Revision 1 (Westinghouse Proprietary Class 2). The figures selected show the vessel layout including the main steam nozzle location and configuration in the top elliptical head. Figure 7-21 [of the licensee's August 24, 2015, submittal] depicts the limiting stress locations in the steam outlet nozzle and Figure 7-23 [of the licensee's August 24, 2015, submittal] depicts the limiting stress locations in the flow limiting insert weld region. The associated Tables 7-38 and 7-39 [of the licensee's August 24, 2015, submittal] respectively present the stress analysis summaries with reference to the limiting stress locations depicted in the Figures. Note 1 to Table 7-39 refers to "Reference 16," which is titled, "CN-NCE-DCPPRSG-14, 'Steam Outlet Nozzle Elliptical Head and Upper Shell Analysis,' Delta 54 Replacement Steam Generator, Diablo Canyon Power Plant Units 1 and 2, Revision 1, February 2008."

Compliance with Code requirements would require redesign and modification of the RSG main steam nozzles. This action would result in removal of the flow limiting design feature of the RSGs that is specifically intended to improve safety by limiting blowdown in the event of a main steam line break and therefore is unwarranted.

Due to their flow restrictor-type design, the DCPD RSG main steam outlet nozzles do not contain a high-stress inside-radius section for which the Section XI volumetric examination is intended. As a result of the multiple flow restrictor orifice nozzle design configuration, volumetric examination is impractical for the DCPD RSGs and no alternative volumetric examinations are proposed.

Code required VT-2 examination of the RSGs are performed each inspection period during the system leakage test.

Relief is requested for the remainder of the DCPD Units 1 and 2 third inservice inspection (ISI) intervals. The DCPD Unit 1 third inspection interval nominally ended on May 6, 2015. The DCPD Unit 2 third inspection interval is nominally scheduled to end on March 12, 2016. Actual end dates of the interval are dependent on the completion dates of the 19th refueling outages for each unit, in accordance with ASME [Code,] Section XI, paragraph IWA-2430(d)(1).

3.4 NRC Staff Evaluation

During a telephone call with the licensee on September 23, 2015, the NRC staff requested the following clarification regarding the licensee's August 24, 2015, submittal:

- The submittal requests relief under the provisions of 10 CFR Part 50, Section 50.55a(g)(5)(iv), "*ISI program update: Schedule for completing impracticality determinations.*" However, request for relief should be made under 10 CFR 50.55a(g)(5)(iii), "*ISI program update: Notification of impractical ISI Code requirements*" on a schedule consistent with 10 CFR 50.55a(g)(5)(iv). Clarify that this relief request was submitted pursuant to 10 CFR 50.55a(g)(5)(iii) on a schedule consistent with 10 CFR 50.55a(g)(5)(iv).

During the call, the licensee clarified that the request for relief is under the provisions of 10 CFR 50.55a(g)(5)(iii). In response to this clarification, the NRC staff sent an e-mail to the licensee on September 24, 2015 (ADAMS Accession No. ML15267A386), 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.*"

Selected figures that show the vessel layout, the main steam nozzle location and configuration in the top elliptical head, and the limiting stress locations in the steam outlet nozzle and the flow limiting insert weld region were provided in proprietary attachments to the licensee's August 24, 2015, submittal, along with relevant stress analysis summaries from two proprietary Westinghouse reports. In an e-mail dated November 10, 2015 (ADAMS Accession No. ML15334A203), the licensee clarified the applicability of the results from the two proprietary reports as follows: (1) Proprietary Westinghouse Report No. WCAP-16816-P, Revision 1 contains results applicable to DCPD Unit No. 1, and (2) Proprietary Westinghouse Report No. WCAP-16815-P, Revision 3 contains results applicable to DCPD Unit No. 2. The licensee's e-mail also clarified that the discussion presented in the last paragraph in Section 4 of the Enclosure to its August 24, 2015, submittal inadvertently refers to only WCAP-16816-P, which is applicable to DCPD Unit No. 1, and that reference should also have been included to WCAP-16815-P applicable to Unit No. 2. However, the licensee indicated that the discussion presented in the last paragraph in Section 4 of its August 24, 2015, submittal is equally applicable to both DCPD Unit Nos. 1 and 2.

The SG main steam outlet nozzle is an integral part of the head forging. The nozzle has seven bored holes for steam exiting into the large diameter piping system. The nozzle surface facing inside the SG head is clad with SFA 5.14 Cl. ERNiCrFe-7 weld material. Inserted into the holes are forged Alloy 690 venturis that are welded to the nozzle and SG head surface cladding. The venturis extend beyond the pipe side of the holes. Accessibility to the pipe side of the nozzle for examination is restricted by the venturis, the narrow gap between holes, and the proximity of the attached piping. On the inside SG surface, the configuration of the venturis overlapping the hole completely covers the nozzle inside radius.

The SG main steam outlet nozzle design is not conducive to any meaningful volumetric examination. For the licensee to examine the inner radius, the outlet nozzle design in the SG head would have to be modified and replaced, which is impractical. The configuration of nozzles precludes obtaining meaningful volumetric examination results.

During the review, the NRC staff noted that, according to Appendix 9.5A of Revision 20 to the DCP Final Safety Analysis Report Update (November 2011), the SGs were replaced in 2008 and 2009 at DCP, Unit Nos. 1 and 2, respectively. Therefore, similar requests for DCP 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 relief for the Seabrook Station, Unit No. 1, dated June 27, 2012 (ADAMS Accession No. ML120880245), and for the South Texas Project, Units 1 and 2, dated April 20, 2011 (ADAMS Accession No. ML110980347), were identified in PG&E's August 24, 2015, submittal, and were reviewed by the staff for consistency.

The requirement for examinations of inner nozzle radii is associated with the discovery of cracks located in the inner radius section of feedwater nozzles. The cracks were identified as cyclic thermal fatigue from internal water temperature fluctuations. The NRC staff considered the likelihood of this degradation mechanism on the inner radius of the main steam outlet nozzle.

The main steam outlet nozzle is located at the top of the SG head. The steam vapor at this location has traveled through the dryers, which remove excess water droplets. During plant operations, this location is subjected to relatively constant high temperature that prevents the accumulation of liquid moisture at the pipe-to-nozzle location. The only temperature fluctuations are associated with reactor heatup and cooldown, and these are controlled for the thermal effects on components. The licensee performed stress analyses for different operating loading conditions. These analyses show that nozzle stresses are maintained below ASME Code allowable values. The absence of thermal fluctuations, standing water, and stresses above allowable values during operating conditions minimize the likelihood of cyclic thermal-fatigue cracking of the main steam outlet nozzle inner radius.

In addition, as indicated in the licensee's August 24, 2015, submittal, the SGs receive a visual (VT-2) examination during each inspection period. The VT-2 visual 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 main steam outlet nozzles because the system leakage test will provide for detection of flaws when they are small and can be repaired prior to the SG main steam outlet nozzles losing their ability to perform their intended function.

Based on the absence of conditions conducive to crack initiation and acceptable stress under loading conditions, the NRC staff concludes that there is reasonable assurance that degradation of the SG main steam outlet nozzle inner radii is unlikely to occur. With the inaccessibility of the main steam outlet nozzle inner radii, the replacement of the SG outlet nozzle design with a design that is conducive to volumetric examination is impractical. Furthermore, the staff determined that the ASME Code examination requirements are impractical for the SG main steam outlet nozzle inside radii. The periodic VT-2 examinations performed on the SGs provide reasonable assurance of structural integrity of the SG main steam outlet nozzle inside radii 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. C2.22 inner radius volumetric examination of the SG main steam outlet nozzles for DCPP, Unit Nos. 1 and 2 is impractical. Also, the configuration of the nozzles precludes obtaining meaningful volumetric examination results. Furthermore, stress analyses performed by the licensee for different operating loading conditions show that nozzle stresses are maintained below ASME Code allowable values. The absence of thermal fluctuations, standing water, and stresses above allowable values during operating conditions minimize the likelihood of cyclic thermal-fatigue cracking of the main steam outlet nozzle inner radius. Finally, 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 main steam outlet nozzle inside radii.

Therefore, pursuant to 10 CFR 50.55a(g)(6)(i), request for relief NDE-SG-MS-IR 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.

Principal Contributor: Gary Stevens, NRR/DE/EVIB

Date: December 8, 2015.

E. Halpin

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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

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