

May 1, 2001

Mr. Gregory M. Rueger
Senior Vice President, Generation and
Chief Nuclear Officer
Pacific Gas and Electric Company
Diablo Canyon Nuclear Power Plant
P. O. Box 3
Avila Beach, CA 94177

SUBJECT: DIABLO CANYON NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 -
SUPPLEMENT 2 TO LICENSE AMENDMENT REQUEST 00-06, "ALTERNATE
REPAIR CRITERIA FOR AXIAL PRIMARY WATER STRESS-CORROSION
CRACKING (PWSCC) AT DENTED INTERSECTIONS IN STEAM
GENERATOR TUBING" (TAC NOS. MB1494 AND MB1495)

Dear Mr. Rueger:

By letter dated February 20, 2001, you submitted a request for approval of an alternate repair criteria (ARC) for axially oriented PWSCC at dented steam generator (SG) tube support plate (TSP) intersections. The staff is currently reviewing this request. In the same letter, you also requested that the staff approve (1) the use of the bobbin coil for the detection of axial PWSCC in less than or equal to (\leq) 2 volt dented TSP intersections, and (2) elimination of axial outside diameter stress corrosion cracking not detectable by bobbin (AONDB) at less than ($<$) 5 volt dented TSP intersections as a criterion for determining initial Plus Point inspection scope and expansion requirements.

You requested these two items independent of the PWSCC ARC technical specification (TS) change. Specifically, you requested a change to the inspection commitments documented in the staff's March 12, 1998 safety evaluation (SE) that supported the implementation of the Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," ARC at Diablo Canyon Nuclear Power Plant (DCPP), Unit Nos. 1 and 2. Your staff clarified the proposed dent inspection program in a phone call on April 4, 2001, and provided revision of dent inspection program requirements to the staff by letter dated April 16, 2001.

The staff has evaluated your request and has determined that your proposed changes to the inspection commitments for implementing the GL 95-05 ARC for ODSCC at TSP intersections,

Mr. Gregory M. Rueger

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as outlined in your letter dated April 16, 2001, are acceptable, with the one exception discussed in the enclosed staff evaluation.

Sincerely,

/RA/

Stephen Dembek, Chief, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-275
and 50-323

Enclosure: Staff Evaluation

cc w/encls: See next page

Mr. Gregory M. Rueger

-2-

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Diablo Canyon Power Plant, Units 1 and 2

cc:

NRC Resident Inspector
Diablo Canyon Nuclear Power Plant
c/o U.S. Nuclear Regulatory Commission
P.O. Box 369
Avila Beach, CA 93424

Dr. Richard Ferguson, Energy Chair
Sierra Club California
1100 11th Street, Suite 311
Sacramento, CA 95814

Ms. Nancy Culver
San Luis Obispo
Mothers for Peace
P.O. Box 164
Pismo Beach, CA 93448

Chairman
San Luis Obispo County Board of
Supervisors
Room 370
County Government Center
San Luis Obispo, CA 93408

Mr. Truman Burns
Mr. Robert Kinoshian
California Public Utilities Commission
505 Van Ness, Room 4102
San Francisco, CA 94102

Mr. Steve Hsu
Radiologic Health Branch
State Department of Health Services
P.O. Box 942732
Sacramento, CA 94327-7320

Diablo Canyon Independent Safety
Committee
ATTN: Robert R. Wellington, Esq.
Legal Counsel
857 Cass Street, Suite D
Monterey, CA 93940

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
Harris Tower & Pavilion
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

Christopher J. Warner, Esq.
Pacific Gas & Electric Company
Post Office Box 7442
San Francisco, CA 94120

Mr. David H. Oatley, Vice President
Diablo Canyon Operations and
Plant Manager
Diablo Canyon Nuclear Power Plant
P.O. Box 3
Avila Beach, CA 93424

Telegram-Tribune
ATTN: Managing Editor
1321 Johnson Avenue
P.O. Box 112
San Luis Obispo, CA 93406

Mr. Ed Bailey, Radiation Program Director
Radiologic Health Branch
State Department of Health Services
P.O. Box 942732 (MS 178)
Sacramento, CA 94327-7320

Mr. Robert A. Laurie, Commissioner
California Energy Commission
1516 Ninth Street (MS 31)
Sacramento, CA 95814

STAFF EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
USE OF THE BOBBIN COIL FOR THE DETECTION OF AXIAL PRIMARY WATER
STRESS CORROSION CRACKING AND ELIMINATION OF AXIAL OUTSIDE
DIAMETER STRESS CORROSION CRACKING NOT DETECTABLE BY BOBBIN
PACIFIC GAS & ELECTRIC COMPANY
DIABLO CANYON NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-275 AND 50-323

On March 12, 1998, the NRC staff issued a license amendment for the Pacific Gas and Electric Company's (PG&E) Diablo Canyon Nuclear Power Plant (DCPP), Unit Nos. 1 and 2, granting approval for an alternate repair criteria (ARC) for steam generator (SG) tubes at both units. The ARC allows the implementation of voltage-based repair criteria for axially oriented outside diameter stress corrosion cracking (ODSCC) indications at SG tube support plate (TSP) intersections, consistent with the guidance in Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking." The conditions of the SG tubes at Diablo Canyon, particularly Unit 1, are relatively unique among plants that implement GL 95-05 ARCs in that the SG tubes are highly dented at the TSP intersections. This dented condition renders DCPP Unit 1 SG tubes susceptible to not only ODSCC at the TSP intersections but also primary water stress corrosion cracking (PWSCC) and circumferential cracking (which can be either PWSCC or ODSCC). PG&E has reported axially oriented ODSCC indications at nondented and dented TSP intersections, axially and circumferentially oriented PWSCC at dented TSP intersections, and circumferentially oriented ODSCC at dented TSP intersections. PG&E has also reported a few instances of mixed mode cracking (e.g., axial ODSCC and PWSCC occurring at the same TSP intersection, axial and circumferential PWSCC occurring at the same TSP intersection).

Most plants implementing the GL 95-05 ARC for ODSCC at TSP intersections use a bobbin coil probe to detect ODSCC indications except for specific instances described in GL 95-05 (e.g., in dented intersections where the dent signal voltage is greater than or equal to (\geq) 5.0 volts). Because of their plant-specific conditions described in the preceding paragraph, PG&E recognized that additional inspection measures were warranted. These additional inspection measures include an increased use of the Plus Point probe in addition to the bobbin coil probe primarily because of the bobbin coil probe's insensitivity to circumferential cracking. Therefore, PG&E applies the Plus Point probe to prevent two situations: (1) leaving circumferential cracking (either PWSCC or ODSCC) at dented TSP intersections in service, and (2) leaving mixed mode indications in service (i.e., PWSCC and ODSCC occurring at the same TSP

intersection or axial and circumferential cracking occurring at the same TSP intersection). These two situations are not within the scope of GL 95-05. Therefore, tubes identified with such indications are removed from service. In Section 3.1.2 of the March 12, 1998, safety evaluation (SE) that supported the implementation of the GL 95-05 ARC at DCPD Units 1 and 2, the staff described the additional inspection commitments made by PG&E.

By letter dated February 20, 2001, PG&E submitted a request for approval of an ARC for axially oriented PWSCC at dented SG TSP intersections. The staff is currently reviewing this request. In the same letter, PG&E also requested that the staff approve (1) the use of the bobbin coil for the detection of axial PWSCC in less than or equal to (\leq) 2 volt dented TSP intersections, and (2) elimination of axial outside diameter stress corrosion cracking not detectable by bobbin (AONDB) at less than ($<$) 5 volt dented TSP intersections as a criterion for determining initial Plus Point inspection scope and expansion requirements. PG&E requested these latter two items independent of the PWSCC ARC. This specific PG&E request is not related to a technical specification (TS) change but to the inspection commitments documented in the staff's March 12, 1998, SE discussed above. After a phone discussion with PG&E on April 4, 2001, PG&E clarified its proposed dent inspection program and provided it to the staff on April 16, 2001. This evaluation documents the staff's review of PG&E's request to modify two specific commitments concerning their GL 95-05 ARC, as follows.

Request 1: Use of the bobbin coil for the detection of axial PWSCC in \leq 2 volt dented TSP intersections.

Since the time of the staff's approval of PG&E's GL 95-05 ARC, the use of the bobbin coil probe to detect axially oriented PWSCC in \leq 2 volt dents has been validated using, in part, dented TSP intersections from tubes removed from DCPD Unit 1. The staff accepted the use of the bobbin coil probe to detect PWSCC in \leq 2 volt dents as documented in the staff's approval of Tennessee Valley Authority's license amendment request for an ARC for axial PWSCC at dented TSP intersections at the Sequoyah nuclear power plants, dated March 8, 2000. Although the staff's review of the PWSCC ARC was focused on its use at Sequoyah, our review of the eddy current test inspection technique validation efforts was more general in nature. Based on that general review and the fact that several DCPD Unit 1 SG tubes were used in the technique validation effort, the staff considers the results of that validation effort to be applicable also to the DCPD Units 1 and 2 SGs. Therefore, the use of the bobbin coil probe in lieu of the Plus Point probe to detect axially oriented PWSCC in \leq 2 volt dents is acceptable.

If PG&E applies the bobbin coil probe as its primary detection tool for TSP intersections with dent signals \leq 2 volts, there remains an issue with detection of circumferential cracking. The bobbin coil probe is insensitive to circumferential cracking and recent experience at the Sequoyah plants indicates that circumferential cracking can occur in small voltage dents. To cover this aspect, PG&E plans to implement an augmented Plus Point inspection plan for low voltage dents based on the two previous inspections as well as current inspection findings. If circumferential cracking has been detected in a dent of "x" volts, PG&E will use the Plus Point probe to inspect 100 percent of dents greater than "x-0.3" volts up to the affected TSP elevation in the affected SG, plus 20 percent of dents greater than "x-0.3" volts at the next higher TSP. The definition of "x" is the lowest dent voltage where a circumferential crack was detected.

In support of this approach for detecting circumferential cracking, PG&E described their inspection results to date which are based on extensive dented TSP intersection inspection results at both DCPD Units 1 and 2. PG&E has used the Plus Point probe to inspect ≤ 2 volt dented TSP intersections in defined critical areas for the last six refueling outages, and no circumferential indications have been detected at ≤ 2 volt dented intersections. Fifty-five circumferential indications at TSPs have been detected by Plus Point and repaired, and all are located in > 2 volt dented intersections at DCPD Units 1 and 2. Forty-three of the circumferential flaws were attributed to PWSCC and twelve were attributed to ODSCC. Circumferential cracking at Diablo Canyon appears to depend on dent voltage, as the majority of the circumferential indications identified to date were located in > 5 volt dented TSP intersections, while only six were located in < 5 volt dented TSP intersections (3.9, 3.5, 3.1, 3.0, 2.8, and 2.4 volts). PG&E concludes that based upon this apparent dependence and the narrow 1.5 volt dent range in which circumferential indications were detected in < 5 volt dents, new low voltage dent circumferential indications can be expected to occur at progressively lower dent voltages rather than sudden occurrences in very low voltage dents.

The 0.3 volt interval for inspection expansion is based on Diablo Canyon's large population of dents less than 2 volts, such that 0.3 volt intervals add a sufficient number of dented TSP intersections for expansion of the inspection. For example, in steam generator 1-2, there are over 1700 hot leg dents less than 2 volts, of which about 13 percent are between 2 and 1.7 volts, 18 percent between 1.7 and 1.4 volts, 20 percent between 1.4 and 1.1 volts, 24 percent between 1.1 and 0.8 volts, and 25 percent less than 0.8 volts. Additionally, PG&E committed to ensuring that any 20 percent sample would contain a minimum of 50 intersections of the dent size under consideration. If the population of dents in the voltage range of interest is less than 50, then 100 percent of the dents in the voltage range of interest at that TSP would be inspected.

With respect to detection of circumferential cracking, the staff finds PG&E's approach and the supporting basis to be acceptable. Their extensive dent inspections performed over the last several refueling cycles support this graduated approach to Plus Point inspections of dented TSP intersections. The initial inspection scope will be based on previous inspection results and appropriate sample expansion criteria are defined in response to inspection findings. In addition, PG&E's commitments are consistent with current industry inspection guidelines.

Request 2: Elimination of AONDBs at < 5 volt dented TSP intersections as a criterion for determining initial Plus Point inspection scope and expansion requirements.

Licensees occasionally find small ODSCC indications that were not detected by the bobbin probe through additional rotating probe coil (RPC) or Plus Point inspections. These indications are referred to as "axial ODSCC not detected by bobbin" or AONDB indications. The staff's March 12, 1998, SE specifically discussed PG&E's Plus Point inspection commitments relative to AONDBs. If an AONDB indication is detected in a < 5 volt dented TSP intersection, PG&E is currently committed to evaluate expansion of the Plus Point dent inspection program to include 100 percent of < 5 volt dents up to and including the affected TSP elevation, plus 20 percent at the next highest TSP elevation. In addition, the initial scope of the next refueling outage inspection must include the same criteria. The industry has since developed a methodology for

treating such indications, and PG&E proposed in its February 20 and April 16, 2001, letters to change its dent inspection commitments relative to AONDBs to conform to the industry methodology.

The industry methodology for dispositioning and inspecting for AONDB indications is documented in Addendum 3 to EPRI Report NP-7480-L, "Steam Generator Tubing ODSCC at Tube Support Plates for Alternate Repair Limits, Database Update 1999," November 1999. This was submitted to the staff on September 22, 1999. Section 8.1.3 of Addendum 3 defines a process for assigning an inferred bobbin voltage to AONDB indications using a plant-specific correlation of bobbin voltage to RPC voltage, and states that "the RPC voltage corresponding to 2 volts bobbin voltage at the upper, one-sided 95 percent confidence bound on the mean can be used to define tube repair requirements as well as the threshold to determine the need for expansion of the augmented RPC inspection of dented intersections and mixed residual signals." To be consistent with industry practice, PG&E proposes that the augmented inspection threshold for AONDBs be established as the lower voltage repair limit for axial ODSCC, currently 2.0 volts for 7/8-inch tubing. Therefore, if the inferred bobbin voltage is less than 2.0 volts, and the dent voltage at which an AONDB is detected is less than 5 volts, the tube will be left in service, no expansion is required, and the initial scope of the next inspection is not affected. However, if the inferred bobbin voltage is greater than or equal to 2.0 volts, regardless of the dent size in which the AONDB indication was found, the tube will be repaired, and Plus Point inspection expansions will be performed if needed to ensure inspection of 100 percent of dented TSP intersections up to the affected TSP with repairable AONDB indications, plus 20 percent at the next higher TSP.

As discussed in a meeting summary issued December 3, 1999, summarizing an August 25, 1999, meeting with industry to discuss open issues related to GL 95-05, the industry supports the application of voltage-based repair criteria to indications at low voltage dents detected by rotating probes but not detected by bobbin coil probes (i.e., AONDBs located in less than 5 volt dents). The staff considers this position to be an interpretation of the guidance in GL 95-05. The staff and industry briefly discussed the technical basis that supports the industry position. The staff has not completed its review of this issue. However, in the meantime, the staff stated in the memorandum that industry may continue to rely on this interpretation of GL 95-05. This conclusion also applies to the Diablo Canyon steam generators. The staff notes that the latest DCP Unit 1 inspection results of AONDB indications all had inferred bobbin voltages less than the lower repair limit of 2.0 volts. All AONDB indications found in ≥ 5 volt dents will be repaired, regardless of inferred bobbin voltage. If the staff generically approves an alternative to this approach for AONDB indications at ≥ 5 volt dents, PG&E may implement such an approach without prior staff review and approval.

In its April 16, 2001 letter, PG&E also proposed that the inspection requirements be based on where degradation was found in the *prior* outage. This is a change from PG&E's original commitment documented in the March 12, 1998, SE as well as its February 20, 2001, request where inspection requirements were based on where degradation was found in *previous* outages. PG&E stated that this would allow for a gradual reduction in inspection scope over time if susceptible tubes are removed from service and degradation rates decline over time. In a phone call discussion held April 19, 2001, the staff told PG&E that this was not acceptable.

PG&E agreed to modify its dent inspection program. The initial Plus Point inspections will instead be based on where degradation was found in the previous two outage inspections. The staff finds this acceptable because it provides a basis for identifying trends in degradation behavior while still allowing for a gradual reduction in inspection scope over time as susceptible tubes are removed from service and degradation rates decline over time.

In summary, the staff finds that PG&E's proposed changes to their inspection commitments for implementing the GL 95-05 ARC for ODSCC at TSP intersections to be acceptable because they provide for an adequate inspection scope and expansion criteria with qualified inspection techniques that are consistent with industry guidelines and staff expectations. The staff concludes that the inspection criteria outlined in PG&E's April 16, 2001 letter, with the one exception discussed in the preceding paragraph, is appropriately based on past inspection experience. The staff notes that it is not possible to anticipate every possible situation that could occur in the future. Therefore, it is incumbent upon PG&E to undertake additional inspections beyond those discussed in the April 16, 2001, letter if warranted by new circumstances.

Principal Contributor: Stephanie Coffin

Date: May 1, 2001