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PG&E Letter DCL-10-050

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
180-Day Steam Generator Report for Diablo Canyon Power Plant Unit 2 Fifteenth Refueling Outage

Dear Commissioners and Staff:

Pursuant to Diablo Canyon Power Plant (DCPP) Technical Specification (TS) 5.6.10, a report shall be submitted within 180 days after initial entry into Mode 4 (Hot Shutdown) following completion of steam generator (SG) inspections performed in accordance with TS 5.5.9. The enclosure provides the 180-day report for SG inspections performed during the DCPP Unit 2 Fifteenth Refueling Outage.

There are no new commitments in this report.

If you have any questions, please contact John Arhar at (805) 545-4629.

Sincerely,

James R. Becker

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180-DAY STEAM GENERATOR REPORT FOR DIABLO CANYON POWER PLANT UNIT 2 FIFTEENTH REFUELING OUTAGE

Pacific Gas and Electric Company (PG&E) performed eddy current inspections of the Diablo Canyon Power Plant (DCPP) Unit 2 steam generators (SGs) during the DCPP Unit 2 fifteenth refueling outage (2R15), October 2009. The inspections were conducted in accordance with DCPP Technical Specification (TS) 5.5.9. These were the first inservice inspections conducted on the Unit 2 SGs, as they were replaced in the DCPP Unit 2 fourteenth refueling outage. The four replacement SGs are Westinghouse Model Delta 54, with the following tubing design: 4444 tubes per SG, nominal diameter of 0.75 inch (OD), nominal wall thickness of 0.043 inch, tubes arranged on a triangular pitch.

Pursuant to TS 5.6.10, a report shall be submitted within 180 days after initial entry into Hot Shutdown (Mode 4) following completion of an inspection performed in accordance with TS 5.5.9. The report shall include:

a. *The scope of inspections performed on each SG.*
b. *Active degradation mechanisms found.*
c. *Nondestructive examination techniques utilized for each degradation mechanism.*
d. *Location, orientation (if linear), and measured sizes (if available) of service induced indications.*
e. *Number of tubes plugged during the inspection outage for each active degradation mechanism.*
f. *Total number and percentage of tubes plugged to date.*
g. *The results of condition monitoring, including the results of tube pulls and in-situ testing.*

PG&E's response to each item is provided below.

a. The scope of inspections performed on each SG.

TS 5.5.9.d requires inspection of 100 percent of the tubes in each SG during the first refueling outage following SG replacement. In 2R15, the first refueling outage following SG replacement, 100 percent of the tubes in each SG were inspected full length by bobbin coil. In addition, +Point rotating probe inspections were conducted on the following:

- 100 percent of bobbin indication ("I") codes, which included DNI (dent/ding with possible indication), ADI (absolute drift indication), DSI (distorted support indication), and NQI (non-quantifiable indication).
- A sample of dents and dings based on 100 percent inspection of DNI calls.
- 100 percent of manufacturing burnish mark (MBM) signals
- 100 percent of tube to tube proximity indications (PRO). PRO indications

are discussed in Section g.2 of this enclosure.

- 100 percent of tubes (9) that were mechanically impacted during manufacturing. These tubes are discussed in Section g.2 of this enclosure.

b. Active degradation mechanisms found.

Tube wear at a tube support plate (TSP) intersection was found on one tube.

c. Nondestructive examination techniques utilized for each degradation mechanism.

The tube wear indication was detected by the bobbin probe as a DSI. +Point rotating probe inspection was then performed and confirmed the DSI as tube wear. Detection of wear at TSP structures using the bobbin probe is qualified in accordance with EPRI examination technique sheet (ETSS) 96004.1. Detection and depth sizing of wear at TSP structures using the +Point probe is qualified in accordance with EPRI ETSS 96910.1.

d. Location, orientation (if linear), and measured sizes (if available) of service induced indications.

The location of the tube wear indication described in sections b and c above is at TSP elevation 5C in SG 2-4 Row 49 Column 15. The measured depth of the indication is 5 percent through-wall (TW) as sized by +Point. The indication is volumetric, not linear. The tube wear indication was left in service because the 5 percent TW depth is less than the 40 percent TW plugging criteria defined in TS 5.5.9.c, and because SG tube integrity will be maintained until the next SG inspection based on performance of an operational assessment.

e. Number of tubes plugged during the inspection outage for each active degradation mechanism.

No tubes were plugged in 2R15.

f. Total number and percentage of tubes plugged to date.

Three tubes in SG 2-4 were plugged in the factory using weld plugs in both ends of the tubing. The percentage plugging in SG 2-4 is 0.07 percent. No tubes are plugged in SG 2-1, SG 2-2, and SG 2-3.

g. The results of condition monitoring, including the results of tube pulls and in-situ testing.

There were no tube pulls or in-situ testing performed in 2R15.

A condition monitoring evaluation of the SG tube bundles is performed to verify that the condition of the tubes, as reflected in the inspection results, is in compliance with the structural and leakage integrity requirements.

g.1 Condition Monitoring Assessment of Tube Wear

During 2R15, no tube degradation was detected, with one exception. One tube with wear at a TSP intersection was detected by bobbin coil and reported as a DSI. Subsequent +Point inspection confirmed the indication as tube wear. The tube location is SG 2-4 Row 49 Column 15 at 5C. The wear indication was retested by +Point using a TSP wear standard and depth sized as 5 percent TW maximum depth in accordance with EPRI ETSS 96910.1. The width and length were estimated as 0.20 inch and 0.55 inch, respectively. The width of the wear scar is slightly larger than the width of the flat lands of the tre-foil broach (about 0.12 inch) that caused the wear. Since the overall length of the TSP is 1.125 inch, the degradation extends about half the length of the TSP land contact. Additional line by line sizing showed that the indication is tapered over its length, with the deeper section near the upper edge of the land contact. This geometry is typical for wear at a broached TSP.

The +Point voltage of the TSP wear indication is 0.27 volts. This voltage is less than the 0.5 volt threshold value for in-situ proof testing, and less than the 15.2 volt threshold value for in-situ leak testing of TSP wear. These threshold voltages are defined in the EPRI SG In Situ Pressure Test Guidelines, Revision 3. As such, no in-situ proof testing or leak testing was required.

In accordance with EPRI ETSS 96910.1, depth sizing of TSP wear with +Point coil has a mean non destructive examination (NDE) regression correlation equal to 1.01* percent TW + 4.30 percent, with a standard error of 6.68 percent. The total standard error (analyst plus technique) is accounted for by multiplying the technique error (6.68 percent) by 1.12 per the EPRI SG Integrity Assessment Guidelines, Revision 2. This 1.12 factor assumes that the analyst error is 50 percent of the technique error. The 95th percentile total NDE system uncertainty is obtained by multiplying the standard error by 1.645, and is equal to 12.31 percent TW (1.645 * 6.68 * 1.12).

The 5 percent NDE depth is adjusted to an actual mean depth of 9.35 percent applying the ETSS 96910.1 regression (1.01 * 5 percent TW + 4.30 percent TW = 9.35 percent TW). Adjusting the depth to include the upper

95th percentile NDE uncertainty increases the NDE depth an additional 12.31 percent, such that the actual depth could be as high as 21.7 percent TW.

The structural limit for TSP wear is 56.05 percent TW at 3 times normal operation differential pressure (3NOdP), in accordance with Westinghouse WCAP-16798-P Revision 1, "Regulatory Guide 1.121 Analysis of Structural Integrity Performance Criterion Application for the Diablo Canyon Units 1 and 2 Delta 54 Replacement Steam Generators." The structural limit assumes uniform wear over a limited axial distance of 1.125 inches (the full thickness of the TSP). Since 21.7 percent TW is less than the 56.05 percent TW structural limit for TSP wear, the structural integrity performance criteria (SIPC) is satisfied with large margins. Because the indication is tapered over its length, there is additional conservatism to the SIPC.

For volumetric degradation such as tube wear, satisfying the SIPC will also satisfy the accident induced leakage performance criteria (AILPC). For pressure loading of volumetric degradation that is predominantly axial in character with a circumferential extent that is less than 135 degrees (which is the case for TSP wear), the onset of pop-through and burst is coincident. Therefore, since structural integrity is demonstrated at 3NOdP, leakage integrity at steam line break (SLB) pressure differential is also demonstrated.

g.2 Assessment of Other Relevant Non-Degradation Indications

g.2.1 Proximity Indications (PRO)

During the preservice inspection (PSI) bobbin coil inspection of the Diablo Canyon Unit 2 SGs conducted in the factory, 12 tubes were reported with PRO signals in the U-bend region. These U-bend signals were attributed to the proximity of a given tube to another tube. Signals were reported in pairs of adjacent tubes in the same column at nearly the same axial location along the tube. This confirms that the signal pairs were related to each other in that each tube contributed to the signal in the other. +Point examination was conducted on the two largest signals during PSI, confirmed the signals, and no degradation was detected.

During 2R15, these 12 tubes were examined with bobbin coil and the PRO signals were again identified. +Point inspections were conducted on the PRO locations and confirmed the indications. There was no tube-to-tube contact or wear associated with the signals, based on the bobbin and +Point inspections. Lead analyst review of the PSI and 2R15 signal characteristics concluded that there were no changes evident (i.e., no worsening of the condition) compared to the PSI. Because no tube degradation was detected, condition monitoring was satisfied for these tubes.

g.2.2 Factory Impacted Tubes

During SG fabrication at the factory, antivibration bar (AVB) retainer bars in SG 2-4 were removed and relocated. During the removal process, 12 tubes in SG 2-4 were visibly damaged in the periphery of the U-bend by a grinding tool. In order to assess the condition of the tubes resulting from the event, eddy current inspection (both bobbin and +Point) of the 12 tubes was performed at the factory, prior to the PSI. Of these, 3 tubes were repaired by weld plugging at the factory, thus leaving 9 tubes inservice that had no indication of degradation. Eight of these tubes had ding signals at the visibly damaged area.

In 2R15, these 9 inservice tubes were inspected by both bobbin and +Point in the region of interest. No tube degradation was detected. Therefore, condition monitoring was satisfied for these tubes.

g.3 Assessment of SG Secondary Side Integrity

In accordance with EPRI SG Integrity Assessment Guidelines, Revision 2, Condition Monitoring shall include aspects of the secondary side inspection that affect tube integrity such as secondary side inspections performed, foreign material removed, and foreign material remaining in the SGs.

This section describes the Condition Monitoring of the SG secondary side, covering aspects of the 2R15 SG top of tubesheet secondary side cleaning, top of tubesheet visual inspections, and results achieved. The handhole covers (4) on each SG were removed to facilitate this maintenance. The secondary manways were not removed and no upper internals inspections were conducted.

g.3.1 SG 2-1 Pre-Lance Visual Inspection

In SG 2-1, prior to sludge lancing, in-bundle visual inspections were conducted in the center 10 columns of the hot leg top of tubesheet region to determine the as found condition of the top of tubesheet. The exams showed a relatively clean tubesheet with a few small pieces of loose scale floating on the water surface.

g.3.2 Sludge Lancing

Sludge lancing was conducted in each SG. In SGs 2-1, 2-2, 2-3, and 2-4, the weight in pounds of sludge removed was 3.5, 3, 2.75, and 2.5, respectively.

Loose parts that were collected in the sludge lance trailer filter system were assessed. Between 10 to 30 objects per SG were found in the filter. The objects were small, had insignificant mass, and were mostly magnetic. The

non-magnetic objects were rounded and easily broken apart. The objects are evaluated in Section g.3.4.

g.3.3 Top of Tubesheet Visual Exam

After sludge lancing, in each SG, an in-bundle inspection tool was inserted into the SG no tube lane. The tube rows adjacent to each side of the no tube lane were inspected by a camera located on the inspection tool. The following in-bundle inspections were performed using the tool: center 10 columns of the hot leg top of tubesheet (columns 55 to 65), and columns 20, 40, 80, and 100 in both legs, for a total of 18 in-bundle inspections.

No loose parts were identified during the in-bundle exams.

The trough region was also inspected in each SG. One small wire was identified in the SG 2-1 trough, and was not retrieved. This wire is evaluated in Section g.3.4.

A crawler was inserted in the handholes and driven on the SG shell just above the trough region. The crawler camera was able to view several tubes in-bundle. No loose parts were identified on the periphery shelf or in-bundle.

g.3.4 Tube Integrity Evaluation of Loose Parts

As discussed above, a small wire was found by visual exam in SG 2-1 and was not retrieved. The estimated dimension of the wire is 0.5 inch long and 0.05 inch diameter, with insignificant mass (estimated as less than 1 gram). Because the mass and dimensions of this small wire are significantly bounded by a prior Westinghouse analysis for potential loose parts provided in Westinghouse Letter LTR-NCE-08-45, dated March 24, 2008, there was sufficient justification for leaving this wire inservice.

As discussed above, foreign material that was removed from the SGs by sludge lancing was found in the sludge lance filters (between 10 to 30 objects per SG). The objects were small. The total weight of the objects in each SG was about 0.1 ounce, such that the mass of each individual object was insignificant. Most of the objects were metallic. The non-magnetic objects were rounded and easily broken apart. The objects consist of various machine curls, weld splatter, weld slag (largest piece was about 0.5 inch long and 0.13 inch wide in SG 2-1), a small copper wire that was bent (0.02 inch diameter and 0.75 inch long), and a piece of weld drop-through in SG 2-4 (1.1 inch long, 0.2 inch wide, weight of 1 gram).

The exact sources of the above material could not be conclusively determined. Possible sources could be from SG fabrication, or could have migrated from upstream systems and entered the SGs through the 0.27 inch

diameter holes in the feedring spray nozzles. The piece of weld drop-through likely originated from the SG downcomer annulus because other weld drop-through material was identified in the downcomer annulus during the PSI of the Unit 2 SGs (reference INPO OE26333). As a corrective action, during the preservice visual exam, loose weld drop-through material was removed from the SG downcomer region. Westinghouse Letter LTR-NCE-08-45 assessed the potential tube integrity impact for postulated weld material that could have been inadvertently left inservice.

The foreign objects that were in the SGs in Cycle 15 did not cause tube damage. This is based on the small mass of the objects (1 gram or less), and the results of 2R15 eddy current tube inspections. No tube degradation by loose parts was detected in 2R15 based on 100 percent bobbin coil exam, which supports the conclusions that the loose parts in Cycle 15 were small and not capable of causing tube wear. The bobbin exam was augmented by the following additional analyses: (1) a special potential loose part (PLP) analysis of the outer periphery tubes was conducted from the top of tubesheet to the first TSP to detect potential loose parts that could be missed by the normal analysis process; (2) a bobbin "turbo-mix" (three frequency) evaluation at the top of tubesheet was conducted in order to detect potential tube degradation that could be missed by the normal analysis process.

In conclusion, condition monitoring was satisfied because no loose part wear was detected by eddy current inspections in 2R15, and the loose parts found in the sludge lance filter and by visual examination had insignificant mass.