STEAM GENERATOR TUBE INSPECTION DISCUSSION POINTS

PREPARED BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DIABLO CANYON NUCLEAR GENERATING STATION,

DOCKET NO. 05000275

The following discussion points have been prepared to facilitate the phone conference arranged with Pacific Gas and Electric to discuss the results of the SG tube inspections to be conducted during the upcoming Diablo Canyon Power Plant, Unit 1 refueling outage 13. This phone call is scheduled to occur towards the end of the planned SG tube inspection interval, but before the unit completes the inspections and repairs.

The staff plans to document a brief summary of the conference call as well as any material that is provided in support of the call.

1. *Discuss any trends in the amount of primary-to-secondary leakage observed during the recently completed cycle.*

PG&E Response: In Unit 1 Cycle 14, a small leak (0.02 gpd) was detected and measured in the steam jet air ejector. Subsequent weekly sampling showed no increase in leak rate.

2. *Discuss whether any secondary side pressure tests were performed during the outage and the associated results.*

PG&E Response: No secondary side pressure tests were performed.

3. *Discuss any exceptions taken to the industry guidelines.*

PG&E Response: There are no deviations to industry guidelines, with the exception of one minor deviation of “shall” requirements of Revision 6 of the Secondary Water Chemistry Guidelines. Tables 5-2 and 5-3 of the Guidelines establish limits for exceeding 5% power. Diablo Canyon Units 1 and 2 apply these limits to 8% power.

4. *For each steam generator, provide a description of the inspections performed including the areas examined and the probes used (e.g., dents/dings, sleeves, expansion-transition, U-bends with a rotating probe), the scope of the inspection (e.g., 100% of dents/dings greater than 5 volts and a 20% sample between 2 and 5 volts), and the expansion criteria.*

PG&E Response: Table 1 provides a summary of all inspections performed, and expansion criteria.

5. *For each area examined (e.g., tube supports, dent/dings, sleeves, etc), provide a summary of the number of indications identified to-date of each degradation*

mode (e.g., number of circumferential primary water stress corrosion cracking indications at the expansion transition). For the most significant indications in each area, provide an estimate of the severity of the indication (e.g., provide the voltage, depth, and length of the indication). In particular, address whether tube integrity (structural and accident induced leakage integrity) was maintained during the previous operating cycle. In addition, discuss whether any location exhibited a degradation mode that had not previously been observed at this location at this unit (e.g., observed circumferential primary water stress corrosion cracking at the expansion transition for the first time at this unit).

PG&E Response: Table 2 provides the 1R14 Repairable indications and Tube Status Report as of 5-14-07 at 1200, and provides the number of indications identified to date of each degradation mode and steam generator tube location. Table 3 provides a list of the most significant indications of each damage mechanism. For SCC, the largest voltage indications are listed. Axial ODSCC in the sludge pile region was detected for the first time in Unit 1 (never detected in Unit 2).

6. Describe repair/plugging plans.

PG&E Response: Table 2 provides the number of tubes to be plugged as of 5-14-07 at 1200. All repairs are performed by tube plugging at both hot and cold legs. Tubes being plugged with circumferential indications are evaluated for stabilization in accordance with vendor criteria.

7. Describe in-situ pressure test and tube pull plans and results (as applicable and if available).

PG&E Response: To date, there are no indications that require in-situ pressure testing or tube pull.

8. Provide the schedule for steam generator-related activities during the remainder of the current outage.

PG&E Response: SG inspections are completed in SG 1-2 and 1-4, and all inspections will be completed on May 15. SG tube plugging will begin on May 14 and continue through May 16.

9. Discuss the following regarding loose parts:

- *what inspections are performed to detect loose parts*
- *a description of any loose parts detected and their location within the SG, and if the loose parts were removed from the SG*
- *indications of tube damage associated with the loose parts*
- *the source or nature of the loose parts if known*

PG&E Response:

Inspections performed to detect loose parts.

There is no EPRI qualified eddy current technique for detection of loose parts. The techniques used at Diablo Canyon, described below, are consistent with industry practice and have proven effective in finding loose parts at Diablo Canyon and many other sites. Tubes with loose part signals are included on the site specific performance demonstration (SSPD) which all analysts are required to pass.

Detection of loose parts is accomplished using the bobbin probe for 100% of the tubes. Both groups of analysts (primary and secondary) are required to review channel 8 (15 kHz) bobbin data in the strip chart and lissajous looking for potential loose part (PLP) indications. In addition, designated analysts perform a separate in-depth PLP analysis in the full length of tubes (including TSPs and top of tubesheet) in rows 1 to 3 and the three outer periphery tubes. If PLP indications are found, the indications require examination with a three coil rotating probe (0.115 pancake/+Point/0.080 pancake). PLP detection with the three coil rotating probe is accomplished by screening the 15 kHz pancake coil. PLPs confirmed with the three coil rotating probe also require that the surrounding tubes be examined with the three coil rotating probe to bound the PLP.

Detection of potential loose parts is also accomplished by both analysis parties screening all three coil rotating probe data.

Description of any loose parts detected and their location within the SG, and if they were removed from the SG. There were no PLP signals detected in 1R14.

Indications of tube damage associated with the loose parts. No tube degradation or tube wear has been detected that could have resulted from loose parts. Detection of potential loose part wear was accomplished using the bobbin probe. EPRI ETSS 96004.1 for detection of wear at tube supports and AVB bars is extended for detection of loose part wear. A special bobbin turbo-mix evaluation at 100% of tubes at the cold leg top of tubesheet was also conducted as an augmented exam.

Detection of potential loose part wear is also accomplished by both analysis parties screening all three coil rotating probe data.

10. Discuss the results of any secondary side inspections.

PG&E Response: The SG hand hole covers were not removed in 1R14. No secondary side inspections (FOSAR) were performed, and no sludge lancing was performed.

11. Discuss any unexpected or unusual results.

PG&E Response: There were no unexpected or unusual results.

Table 1 – 1R14 Eddy Current Inspection and Expansion Plan					
Item	Area	Probe	Inspection Criteria	Expansion Criteria	Expansion Performed
1	Full Length	Bobbin	100% (Except Rows 1 and 2 U-bend)	N/A	
2	WEXTEX TTS Region	+Point	100% of hot leg TTS, +2" to -8" Note: WEXTEX anomaly extent is same as above, except NTE anomaly extent is +2" to tube end.	If a C-3 condition is identified in the hot leg TTS inspection, inspect 20% of the cold leg TTS region in the affected SG in the current or subsequent outage. The 20% inspection should be biased to an area where degradation has the greatest potential to occur.	Not required
				If cold leg TTS cracking is detected, then either: Inspect 100% of the cold leg TTS region in the affected SG, plus 20% cold leg sample in the other SGs. If cracking is detected in the 20% sample, then inspect 100% of the cold leg TTS in the affected SGs. OR Define a critical area (CA) and buffer zone and inspect 100% of the tubes in the CA and buffer zone in the affected SG, plus 20% of the cold leg CA sample in the other SGs.	Not required
				If cold leg TTS non-crack-line indications are detected, then either: Define a critical area (CA) and buffer zone and inspect 100% of the tubes in the CA and buffer zone in the affected SG, plus 20% cold leg CA sample in the other SGs. OR For Category C-2 cold leg results, inspect an additional 20% cold leg sample in the affected SG. For Category C-3 cold leg results, inspect 100% of the cold leg TTS region in the affected SG, plus 20% cold leg sample in the other SGs.	Not required
3		+Point	100% of hot leg WEXTEX anomalies	If crack-like indications are detected in hot leg WEXTEX anomalies, then inspect 100% of the cold leg WEXTEX anomalies.	Not required
4		+Point	100% of previous W* indications within the W* length	N/A	N/A
5		+Point	Distorted tubesheet signals (DTS): 100% of DTS in the hot leg W* length. 100% of DTS in the cold leg, independent of elevation.	N/A	N/A
6	Low Row U-bends	+Point	100% of Rows 1 and 2	N/A	N/A

Table 1 – 1R14 Eddy Current Inspection and Expansion Plan					
Item	Area	Probe	Inspection Criteria	Expansion Criteria	Expansion Performed
7	High Row U-bends for Circ PWSCC	+Point	20% of Rows 3 to 8 in each SG. 40% of Rows 5 and 6 in SG 1-4.	If circ PWSCC detected in Rows 3 to 8, expand to 100% of Rows 3 to 10 in the affected SGs.	Not required
				If circ PWSCC detected in Rows 9 to 10, expand to 100% of rows 11 to 20 in the affected SGs.	Not required
				If circ PWSCC detected in Rows 11 through 14, redefine critical area (CA) and buffer zone based on review of Figure 10 of WOG U-Bend report and application of a factor of two reduction in longitudinal strain, and inspect 100% of the new CA and buffer zone in the affected SGs.	Not required
				If circ PWSCC detected in Rows 15 or higher, expand to 100% of all remaining rows in the affected SGs.	Not required
8	High Row U-bends for Axial PWSCC	+Point	20% of Rows 3 to 4 in each SG	If axial PWSCC detected in Rows 3 to 4, expand to 100% of Rows 3 to 4 and 20% of Rows 5 to 7 in the affected SGs.	Not required
				If axial PWSCC detected in Rows 5 or greater, then review Figure 5 and Figure 8 of the WOG U-Bend report to define a critical area and buffer zone based on tube ovality data and tube total strain data, and inspect 100% of the CA and buffer zone in the affected SGs.	Not required
9	≥ 5 Volt Dented TSP	+Point	• SG 1-1: 100% 1H to 4H; 20% 5H to 7H • SG 1-2: 100% 1H to 7C; 20% 6C • SG 1-3: 20% 1H to 7H • SG 1-4: 100% 1H to 6H; 20% 7H For any 20% sample, a minimum of 50 ≥ 5 volt dents shall be inspected. If the population of ≥ 5 volt dents at that TSP elevation is less than 50, then 100% of the ≥ 5 volt dents at that TSP shall be inspected.	If PWSCC (at any size dent), circumferential indications (at any size dent), or AONDB (at ≥5 volt dent) are detected at a TSP elevation where 100% inspections were not required, expand the Plus Point inspections (in a step-wise manner, 100% to affected TSP and 20% at next TSP) up through the hot leg side of the SG and down the cold leg side until a 20% sample is obtained that is free from PWSCC, circumferential cracking, or AONDB at ≥5 volt dent.	SG 1-1: Axial PWSCC at 7C (1.26 volt dent) detected by bobbin and confirmed by Plus Point, expansion required: 100% of >2 volt dents 5H to 7C, 20% at 6C. Actual expanded scope was more conservative and includes 100% of >2 volt dents in cold leg. SG 1-3: Preliminary eval of signal at 7C was potential axial PWSCC, which initiated an expansion program, but signal was subsequently dispositioned as NDD based on tracing bobbin signal to baseline inspection. 100% of >2 volt cold leg dents (103 cold leg dents) and 33% of >2 volt hot leg dents that were not originally planned for inspection (140 hot leg dents) were inspected as part of expanded scope prior to termination of the expansion program.

Table 1 – 1R14 Eddy Current Inspection and Expansion Plan					
Item	Area	Probe	Inspection Criteria	Expansion Criteria	Expansion Performed
10	> 2 Volt and <5 Volt Dented TSP	+Point	• SG 1-1: 100% 1H to 4H; 20% 5H • SG 1-2: 100% 1H to 7C; 20% 6C • SG 1-3: 20% 1H • SG 1-4: 100% 1H to 6H; 20% 7H For any 20% sample, a minimum of 50 > 2 volt and < 5 volt dents shall be inspected. If the population of > 2 volt and < 5 volt dents at that TSP elevation is less than 50, then 100% of the > 2 volt and < 5 volt dents at that TSP shall be inspected.	If PWSCC (at any size dent), circumferential indications (at any size dent), or ≥ 2 inferred volt AONDB (at >2 and <5 volt dent) are detected at a TSP elevation where 100% inspections were not required, expand the Plus Point inspections (in a step-wise manner, 100% to affected TSP and 20% at next TSP) up through the hot leg side of the SG and down the cold leg side until a 20% sample is obtained that is free from PWSCC, circumferential cracking, or ≥ 2 inferred volt AONDB.	See above expansion scope.
11	≤ 2 Volt Dented TSP	+Point	SG 1-1: 100% at 1H, 20% at 2H. +Point inspection of ≤ 2 volt dents is not required in SGs 1-2, 1-3, and 1-4, unless dictated by expansion requirements. Note: Bobbin is used for detection of axial PWSCC in ≤2 volt dents, and +Point is used to confirm bobbin calls.	Generic criteria: On a SG-specific basis, if a circ indication or ≥2 inferred volt AONDB is detected in a dent of "x" volts, where "x" is less than or equal to 2.3 volts, then expand Plus Point inspections to include 100% of dents greater than "x – 0.3" volts up to the affected TSP, plus 20% of dents greater than "x – 0.3" volts at the next higher TSP. Note: For any 20% sample, a minimum of 50 "x – 0.3" volt dents shall be inspected. If the population of "x – 0.3" volt dents at that TSP elevation is less than 50, then 100% of the "x – 0.3" volt dents at that TSP shall be inspected. Specific criteria for 1R14: If a circumferential indication or >2 inferred volt AONDB is detected in a dent less than 2.3 volts in SG 1-1 (at 2H or higher), or any TSP elevation in SGs 1-2, 1-3, or 1-4, then expansion to less than 2 volt dents would be required.	Not required
12	Repeat PWSCC ARC Indications at Dents	+Point	100%	N/A	N/A
13	DIS	+Point	100% of distorted ID support plate bobbin signals (DIS) at dented TSP	N/A	N/A

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Item	Area	Probe	Inspection Criteria	Expansion Criteria	Expansion Performed
14	TSP Inspection for ODSCC ARC	+Point	100% of bobbin distorted OD support signals (DOS) at dented intersections (no lower voltage cutoff)	N/A	N/A
15		+Point	100% of DOS $\geq$ 1.7 volt	N/A	N/A
16		+Point	DOS with suspected TSP ligament cracking (SLC)	N/A	N/A
17		+Point	Any bobbin indication in the wedge region exclusion zone	N/A	N/A
18		+Point	DOS at 7th TSP exclusion zone	N/A	N/A
19		+Point	DOS that extend outside the TSP crevice	N/A	N/A
20		+Point	100% of hot leg intersections with >2.3 volt SPR (mixed residual signal), and minimum of 5 largest hot leg SPR per SG.	N/A	N/A
21		+Point	TSP with copper signals	N/A	N/A
22		+Point	100% of prior cycle AONDB (bounds commitment to inspect 100% of AONDB that continue to be NDD by bobbin in current inspection)	N/A	N/A
23		+Point	100% of prior cycle TSP SAI-OD that are NDD by bobbin in current inspection	N/A	N/A
24	TSP Ligament Cracking	+Point	100% of existing baseline Plus Point confirmed TSP ligament cracking (LIC or LIG) indications.	N/A	N/A
25		+Point	100% of new bobbin SLC indications.	N/A	N/A
26	Free Span Dings	+Point	20% of >5 volt dings in U-bend 20% of >5 volt dings in straight legs, biased to cold leg straight sections. Note: Bobbin is credited for detection of axial SCC in ≤5 volt dings	If ding ODSCC is detected, then inspect 100% of > 5 volt dings in affected SGs	Not required
27		+Point	100% of paired dings that were not inspected in 1R12 or 1R13, to ensure that 100% are inspected in 60 EFPM, and to ensure that at least 20% are inspected in 1R14.	If circumferential ODSCC is detected in a paired ding that is greater than or equal to 2 volts (voltage cutoff for ding calling criteria), then inspect 100% of paired dings in the affected SGs.	Not required
28		+Point	20% of $\geq$ 2 volt dings in the U-bend that are coincident with AVB location	If ODSCC is detected at dings in the U-bend coincident with AVB locations, then inspect 100% of $\geq$ 2 volt ding indications coincident with AVB structures.	Not required
29	Free span bobbin indications (MBI, FSI, DNI)	+Point	100% of free span bobbin indications that are new or exhibit growth or change.	N/A	N/A
30	Cold leg thinning at TSP	+Point	100% of new CLT indications and indications >= 40%TW. 100% of >1.5 volt repeat CLT indications from 1R9 to 1R12, plus CLT never inspected.	If ODSCC detected at CLT TSP, inspect 100% of CLT indications in each SG.	Not required

Table 1 – 1R14 Eddy Current Inspection and Expansion Plan					
Item	Area	Probe	Inspection Criteria	Expansion Criteria	Expansion Performed
31	Possible loose parts and loose part damage	Bobbin and +Point	Bobbin turbo mix is used to augment normal bobbin analysis techniques at cold leg TTS for detection of loose part wear. If possible loose part (PLP) indication is detected by eddy current, perform eddy current inspection to bound the loose part.	N/A	N/A

TABLE 2

DIABLO CANYON UNIT 1 R14
Preliminary Repairable Indication and Tube Status Report

Location	Tube Degradation	Steam Generator				Total
		1-1	1-2	1-3	1-4	
DENTED TSP	Number of DIS @ <2v DNT (Excludes known flaws)	32	67	18	16	**133**
	DIS Overcall Rate	100%	91%	100%	100%	**95.5%**
	# of Confirmed SAI in Above DIS		6			**6**
	Axial PWSCC (New)		13	2		**15**
	Axial PWSCC (Repeat)	26	174		19	**219**
	Wedge Region / 7th TSP Bending					
	Axial ID/Axial OD		3			**3**
	SAI ID with TSP LIC/LIG					
	Circ ODSCC		11		1	**12**
	Circ PWSCC	1				**1**
	Mixed Mode (SAI ID+SCI ID)					
	PWSCC Preventive Low Burst					
	Fail PWSCC ARC OA Burst					
	Fail PWSCC ARC DOP >=40% TW		1			**1**
	Repairable Indications	**1**	**15**	**0**	**1**	**17**
TSP ODSCC GL 95-05 ARC	DOS > 2.0 V (Inds)	5	2	3	0	**10**
	DOS =< 2.0 V (Inds)	839	588	285	210	**1922**
	AONDB/OD SAI @ >5 V Dent		4		2	**6**
	Wedge Region / 7th TSP Bending	1				**1**
	SAI OD with TSP LIC/LIG		2			**2**
	Preventative Plugging (High +Pt Voltage)					
	Repairable Indications	**6**	**8**	**3**	**2**	**19**
Tubesheet	Axial PWSCC (New) in W* Length		1		1	**2**
	Axial PWSCC (Repeat) in W* Length	5	3	5	5	**18**
	Axial PWSCC Failed W* Criteria					
	Circ PWSCC @ TTS					
	Axial ODSCC @ TTS				2	**2**
	Axial ODSCC in Sludge Pile	1				**1**
	Circ ODSCC @ TTS	8		9		**17**
	Repairable Indications	**9**	**0**	**9**	**2**	**20**
U-bends	**Axial PWSCC (Inds)**					
	Axial ODSCC (Inds)					
	Circ PWSCC (Inds)					
	Innermost/Outermost Rows with Degradation					
High Row U-bends	**AVB Wear >=40%**		**2**	**1**		**3**
Cold Leg Thinning	**Thinning >=40%**	**1**				**1**
TSP	**Volumetric OD Indication**		**2**	**1**	**1**	**4**
Misc.	**Non-ARC Preventive**					
Total	**Pluggable Indications**	**17**	**27**	**14**	**6**	**64**
Total	**Pluggable Tubes**	**17**	**23**	**14**	**6**	**60**

This table shows the number of indications with each type of degradation (not the number of tubes).

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Table 3
List of Most Significant Indications
DCPP 1R14 (Preliminary Results)

	Degradation	SG	Row	Col	Location	Bobbin Volts	Plus Point Volts	Estimated Max Depth	Estimated Length	
1	Cold Leg Thinning	11	31	81	2C - 0.18	3.69	0.98	45 %TW	-	
2	AVB Wear	12	39	57	7H + 68.69	3.19	-	44 %TW	-	
3	Axial PWSCC @ Dented TSP	12	34	53	2H - 0.11	NA	3.15	83 %TW	0.51	4559 psi Calculated BF
4	Circ PWSCC @ Dented TSP	11	33	37	2H - 0.03	NA	0.91	41 %TW	24 deg	
5	Axial ODSCC @ TSP	11	12	2	1H - 0.00	4.2	TBD	-	-	
6	Circ ODSCC @ Dented TSP	12	5	75	1H + 0.34	NA	0.37	TBD	61 deg	
7	Circ ODSCC @ TTS	11	7	32	TSH - 0.07	NDD	0.52	TBD	36 deg	
8	Axial ODSCC @ TTS	14	30	49	TSH - 0.07	NDD	0.1	23 %TW	0.15	
9	Axial ODSCC in Sludge Pile	11	21	45	TSH + 1.34	0.13	0.11	6%TW Bobbin	0.32	
10	Axial PWSCC in W* Region	12	1	87	TSH - 9.31	NA	2.66	TBD	0.4	

Note: Significance for SCC Indications determined by Plus-point Voltage, except for bobbin coil ARC.