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April 18, 2002

PG&E Letter DCL-02-045

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response to Final NRC Request for Additional Information Regarding Supplement 3 to License Amendment Request 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing"

Dear Commissioners and Staff:

On March 11, March 21, April 2, April 3, April 5, and April 9, 2002, the NRC staff identified additional information required in order to complete its evaluation associated with Supplement 3 to License Amendment Request (LAR) 00-06. LAR 00-06 proposes Technical Specification (TS) changes to incorporate alternate repair criteria for axial primary water stress corrosion cracking (PWSCC) at dented steam generator tube support plate locations. LAR 00-06 was submitted to the NRC in PG&E Letter DCL-01-110, "Supplement 3 to License Amendment Request 00-06, 'Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing,'" dated November 13, 2001. Responses to prior NRC requests for additional information on LAR 00-06 were submitted in PG&E Letter DCL-02-019, "Response to NRC Request for Additional Information Regarding Supplement 3 to License Amendment Request 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing,'" dated February 26, 2002, and PG&E Letter DCL-02-023, "Response to NRC Request for Additional Information Regarding Supplement 3 to License Amendment Request 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing,'" dated March 11, 2002.

PG&E's response to the request for additional information received on March 11, 2002, is included in Enclosure 1. Copies of Electric Power Research Institute (EPRI) documents referenced as part of Supplement 3 to LAR 00-06 and requested by the NRC staff on March 21, 2002, are included in Enclosure 2. The EPRI documents included in Enclosure 2 should be treated as EPRI licensed material. The response to the requests for additional information received on April 2, April 3, and April 5, 2002, are included in Enclosure 3. The response to the request for additional information received on April 9, 2002, is included in Enclosure 4.

A001

Enclosures 5 and 6 contain markups of the existing TS pages and revised TS pages, respectively. These enclosures contain changes to TS 5.5.9.d.1.f and TS 5.6.10.g.2 that were required to address the April 9, 2002, request for additional information. Enclosure 7 provides corrections to errors found in axial PWSCC growth rate tables and figures that were submitted in PG&E Letter DCL-02-023. These errors have negligible effects on the growth rate distributions, and have no effect on the conclusions made in Letter DCL-02-023.

This additional information does not affect the results of the safety evaluation and no significant hazards determination previously transmitted in PG&E Letter DCL-01-110.

If you have any questions regarding this response, please contact Patrick Nugent at (805) 545-4720.

Sincerely,

Gregory M. Rueger
Senior Vice President – Generation and Chief Nuclear Officer

kjs/4328
Enclosures

cc:	Diablo Distribution
cc/enc:	Edgar Bailey, DHS
	Ellis W. Merschoff
	David L. Proulx
	Girija S. Shukla

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

	)	Docket No. 50-275
In the Matter of	)	Facility Operating License
PACIFIC GAS AND ELECTRIC COMPANY	)	No. DPR-80
	)	
Diablo Canyon Power Plant	)	Docket No. 50-323
Units 1 and 2	)	Facility Operating License
	)	No. DPR-82

AFFIDAVIT

Gregory M. Rueger, of lawful age, first being duly sworn upon oath says that he is Senior Vice President - Generation and Chief Nuclear Officer of Pacific Gas and Electric Company; that he has executed this response to the final request for additional information regarding Supplement 3 to License Amendment Request 00-06 on behalf of said company with full power and authority to do so; that he is familiar with the content thereof; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

Gregory M. Rueger
Senior Vice President – Generation and Chief Nuclear Officer

Subscribed and sworn to before me this 18th day of April, 2002.
County of San Luis Obispo
State of California

Notary Public

CHUCK MACKEY
Commission # 1204640
Notary Public - California
San Luis Obispo County
My Comm. Expires Dec 12, 2002

PG&E Response to NRC Request for Additional Information Received on March 11, 2002, Regarding Supplement 3 to LAR 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing"

Question 1

The leak rate regression Equation 6-18 in WCAP-15573, Revision 1, was developed on the basis of throughwall crack lengths measured by post test destructive method. In the proposed use of this equation during the steam line break leak rate evaluation for operational assessment, the throughwall crack lengths are determined by a variation of the weakest link method applied to eddy current/nondestructive examination (EC/NDE) data. How does PG&E ensure that these throughwall crack lengths are conservative estimates of the actual throughwall crack lengths? Stated differently, shouldn't Equation 6-18 have been determined on the basis of throughwall crack lengths as estimated from data rather than from EC/NDE post test fractography measurements for the lab leak rate tests?

PG&E Response to Question 1

To answer the question, two issues need to be addressed. The first issue to be addressed is the use of correlations based upon known dependent and known independent variables versus correlations based on known dependent and estimated independent variables. With respect to application of the correlations, the issue is whether or not to consider "truth" versus "truth" as compared to considering "truth" versus an NDE parameter. Examples of the first comparison are measured leakage versus measured crack length or measured burst pressure versus measured crack parameters, and examples of the second comparison are measured leakage versus NDE crack length or measured burst pressure versus NDE crack parameters.

The second issue to be addressed is the conservatism in applying the leak rate correlation based upon measured throughwall lengths from fractography rather than calculated ligament tearing throughwall lengths from measured crack profiles from fractography.

For the primary water stress corrosion cracking (PWSCC) alternate repair criteria (ARC), both the burst and leak rate correlations are intended to be "truth" versus "truth" correlations using a calculation model applied to the destructive examination crack information. As noted in the question, the leak rate correlation relates measured leak rates to the measured throughwall length from fractography using the CRACKFLO code to relate the throughwall length to the leak rate. In comparison, the burst correlation relates measured burst pressures to the measured crack profile from fractography using the Cochet and ASME burst pressure models to relate the measured crack profile to the burst pressure. For leakage, "truth" is the measured throughwall length. For condition monitoring (CM) or operational assessment (OA) analyses, the best estimate of "truth" is the NDE measured profile adjusted to account for the NDE measurement uncertainties. This application of defining the best estimate of "truth" is the primary purpose for quantifying the NDE uncertainties. When the NDE uncertainties are applied to the NDE profiles, the leak rate correlation is entered with a "true" depth profile consistent with the correlation development. When correlations are developed as "truth" versus "truth," the correlations have general applicability to all the degradation mechanisms included in the correlation. The fact that the calculations use ligament tearing lengths from the uncertainty corrected NDE profile rather than the throughwall length is a conservatism that is addressed in later paragraphs.

The burst and leakage correlations could, in principle, be developed relating "truth" as measured leakage to the NDE crack profile using calculation models applied to the NDE profiles. This process is amenable to the burst correlation since a burst pressure can always be calculated from a crack profile. If this process is used, the NDE uncertainties are built into the burst pressure versus NDE correlation, and separate accounting for NDE uncertainties would not be included in the CM and OA analyses. It can be noted that the voltage based outer diameter stress corrosion cracking ARC has double accounting for NDE uncertainties since the uncertainties are included in the burst and leakage correlations and then also applied to the NDE voltage in CM and OA analyses. For the PWSCC ARC application, the correlations are limited and rigorously tied to the NDE method used to develop the NDE crack profiles. There can be no changes to NDE techniques from that used to develop the correlations. Consequently, there is little generality for multiple applications with NDE based correlations.

The method to develop a leak rate correlation based on NDE measured crack profiles is not as straightforward as that for the burst correlation. Ideally, the correlation would be based upon the nominal (no corrections for NDE uncertainties) NDE profile. However, the nominal profile may not be throughwall (or not throughwall by ligament tearing), as the profile could be one that is underestimated, in which case there is no NDE calculated leak rate to correlate with the measured leak rate. The leak rate correlation could be developed applying some arbitrary NDE uncertainty increase to the NDE profile and then applying the same NDE uncertainty increase to the NDE profile in the CM and OA analyses. This process would effectively eliminate the statistical basis of the Monte Carlo analyses with leak rates calculated at a specified confidence level. An alternate method could be to develop a leak rate correlation based upon nominal NDE profiles with ligament tearing lengths and a probability of leak correlation based on whether the model did or did not predict leakage for the indications that leak. If the NDE based model with ligament tearing predicted leakage for an indication with measured leakage, the data would be included in the leak rate calculation based upon the ligament tearing length and measured leakage. The prediction of whether or not leakage occurs has three potential outcomes: the model predicted leakage and indication leakage occurred, the model predicted leakage but the indication did not leak, and the model predicted no leakage but the indication leaked. These three outcomes would somehow have to be factored into some form of a prediction probability of leakage. The third outcome becomes even more complicated when a throughwall length has to be assigned. In either case, a correlation of measured leakage with NDE lengths is more complicated to implement than the WCAP-15573, Revision 1, methodology (Section 6.3, Equation 6-18).

In the CM and OA analyses, the throughwall lengths for some indications may not always be conservative. It is expected that variations in the NDE profiles above or below nominal are more influential on the leakage predictions (probability of leaking and leakage magnitude) than uncertainties associated with the ligament tearing model. Some NDE profiles are underestimated in depth and some are overestimated. When the leak rate correlation is based on "truth" versus "truth" rather than "truth" versus NDE, the over and under estimates of the depth profiles are accounted for by the NDE uncertainty application. For example, an indication that would leak based on a true profile may leak only a small fraction of the time (i.e., less than 50 percent), in the Monte Carlo analysis if the nominal profile is underestimated. However, another flaw of slightly smaller true depth that would not leak may be overestimated by the nominal NDE profile and could be predicted to leak more than 50 percent of the time. In other words, the application of the NDE uncertainties offsets the potential effects of underestimated nominal NDE depths. Application of ligament tearing in the analysis increases the potential for predicting a leak and increases the potential for a larger leak rate due to a longer throughwall crack length. It can be expected that the analysis adding NDE uncertainties to the NDE profile (also adding growth for OA analyses) and computing the ligament tearing length provides conservative throughwall lengths compared to the corrosion only throughwall lengths used as the basis for the steam line break (SLB) leak rate correlation.

The second issue to be addressed is the conservatism in applying the leak rate correlation based upon measured throughwall lengths from fractography rather than ligament tearing lengths calculated from measured crack profiles from fractography. Either of these correlations would be considered a "truth" versus "truth" correlation with different models applied to the destructive examination profiles to develop the correlation. The overall conservatisms in the leak rate model are described in Section 6.5 of the WCAP-15573, Revision 1. The WCAP-15573, Revision 1, leak rate calculation uses the ligament tearing length to enter the leak rate correlation whereas the correlation is based on destructive examination measured throughwall lengths. If a ligament tearing model is applied to a destructive examination crack profile with a throughwall length, the minimum throughwall length at SLB pressure differentials would be the throughwall length since this length has zero tearing pressure. In most applications, the ligament tearing length would be longer than the throughwall length, but it can never be shorter than the throughwall length. The leak rate predicted from the correlation using the ligament tearing length must be greater than or equal to (no ligament tearing) that obtained from the throughwall length only. Consequently, the use of the correlation based upon corrosion throughwall lengths when applied to crack lengths that include ligament tearing is inherently conservative. This conservatism could be eliminated by developing the correlation between measured leak rates and crack lengths calculated from applying a ligament tearing model to the corrosion depth profiles. However, the conservatism based on the correlation with throughwall corrosion lengths is the basis for the WCAP-15573, Revision 1 leakage model and is the same as licensed by another utility and described in WCAP-15128.

If ligament tearing occurred during leak testing for one or more of the crack profiles used in the leak rate correlation, the application of only the corrosion throughwall length for the correlation increases the correlation prediction error variance (e.g., the predicted leak rate would be expected to be less than the measured value due to the shorter crack length in the prediction). In this case, the correlation prediction error variance is larger than would be expected if a ligament tearing length were used for the correlation. This increase in the correlation variance adds to the conservatism obtained by basing the correlation only on corrosion throughwall lengths.

Overall, it is concluded that basing the correlation in WCAP-15573, Revision 1, Equation 6-18 on leak rate measurements and destructive exam depths is the appropriate methodology for the correlation, and the use of only corrosion throughwall lengths for the correlation, adds inherent conservatism for the calculated leak rates.

Supplemental Information

The following supplemental question and response summarizes discussions with PG&E and the NRC staff on March 21 and 22, 2002.

Supplemental Question

What additional evaluations can be performed to demonstrate that the throughwall crack lengths and leak rates are conservative for partial depth indications evaluated using the ligament tearing model with the weakest link method?

PG&E Response to Supplemental Question

There is no known test data that can quantify the ligament tearing length at SLB conditions. However, in an effort to assess predicted leak rates compared to measured leak rates, the PWSCC and outside diameter stress corrosion cracking (ODSCC) ARC databases were reviewed to identify deep, partial depth indications that either leaked or did not leak at SLB conditions. The databases include one PWSCC and two ODSCC deep partial depth indications that leaked at SLB conditions. These data permit an assessment of whether the model does or does not predict ligament tearing. When the model predicts ligament tearing for these indications, the analysis results provide a comparison of calculated leak rates with measured leak rates. The databases also include one PWSCC and eight ODSCC deep partial depth indications that did not leak at SLB conditions. These data permit an assessment of whether the model conservatively predicts ligament tearing for indications that did not leak. When the model predicts ligament tearing, the results provide conservatively predicted leak rates.

All analyses used the PWSCC ARC methods for ligament tearing documented in WCAP-15573, Revision 1. These methods (i.e., the weak link model) apply the Argonne National Laboratory (ANL) ligament tearing model, a search of the crack profile for one or more sections of the crack that tear at SLB conditions, rectangular approximations for the crack profile in the ligament tearing analyses and the SLB leak rate correlations of WCAP-15573, Revision 1. Analyses were performed for the two PWSCC indications using both NDE and destructive examination profiles. NDE profiles are available for three sizing analyses from the PWSCC NDE Performance Test results. The axial ODSCC indications were analyzed using only destructive exam profiles since the NDE profiling guidelines in WCAP-15573, Revision 1, only apply to axial PWSCC. The analyses using the PWSCC NDE profiles were performed with inclusion of the PWSCC NDE sizing uncertainties. The analyses using the PWSCC and ODSCC destructive examination profiles were performed with and without the inclusion of the PWSCC NDE sizing uncertainties. Although the NDE uncertainties are not applicable to the destructive examination profiles, the results demonstrate the variability of Monte Carlo results from inclusion of uncertainties, and the results provide the expected prediction when the NDE analyses accurately predict the true crack profile. This is appropriate because it is the overall analysis model that is being evaluated.

The results of the SLB leak rate analyses for partial depth indications are given in Table 2 in this letter for both the PWSCC and ODSCC indications. For the PWSCC indication that leaked (specimen Lab 11-3 Crack 1), the predicted SLB leak rates with ligament tearing are over-estimated using both NDE profiles and destructive examination profiles. The predicted leak rates are nearly the same for both the destructive examination and NDE profiles. No SLB leakage was predicted using NDE profiles for the PWSCC indication that did not leak (specimen DC PT R12C32). No leakage was also predicted using the destructive examination profile without NDE uncertainties although a small leak rate is predicted when including NDE uncertainties in the analysis. For the PWSCC indication that did not leak (specimen DC PT R12C32), the NDE profiles slightly underestimate the destructive examination profile such that leakage is not predicted.

As noted above, the ODSCC indications were analyzed using the destructive examination profiles with and without inclusion of PWSCC NDE sizing uncertainties. The ODSCC Model Boiler (MB) specimen MB 607-3 is predicted to leak at much larger leak rates (1.87 gpm) than the measured leak rate of 0.02 gpm indicating conservatism in the tearing model. The leak rate for ODSCC specimen A-1 PT R28C35 is over-predicted by more than a factor of 50 when NDE uncertainties are included in the analysis. No leakage was predicted for ODCSS specimen A-1 PT R28C35 without NDE uncertainties in the analysis. The destructive examination profile for this indication is unusual with very short deep segments of 96 percent depth (0.04 inch, 0.009 inch, and 0.008 inch) separated by 83 percent to 88 percent deep segments that are 0.075 inch and 0.031 inch long as shown in Figure 2 in this letter. The remainder of the indication is less than or equal to 83 percent deep. Because the ligaments are relatively shallow (83 percent to 88 percent) and the deep segments are short, it is probable that models would not predict ligament tearing for this profile. For the indications that did not leak, only ODSCC specimen MB 543-4 is predicted to leak without inclusion of NDE uncertainties. The conservatism of adding NDE uncertainties, as typical of cases where the NDE profile is very close to or deeper than the destructive examination profile, leads to predicted leakage for six of the eight ODSCC indications that did not leak as well as the one PWSCC indication that did not leak.

It is concluded that the PWSCC ARC analysis methods applying NDE profiles, including sizing uncertainties, conservatively predict leakage for the available partial depth indications. When ligament tearing occurred for the indication evaluated, leak rates are over-predicted.

Additional Information, Applicable to SLB Differential Pressure of 2405 psi

The PWSCC ARC can be applied at Diablo Canyon Power Plant (DCPP) Units 1 and 2 for projected SLB differential pressures of either 2560 pounds per square inch (psi) when crediting the pressurizer safety valve setpoint or 2405 psi when crediting the pressurizer power-operated relief valve (PORV) setpoint. The 2405 psi pressurizer PORV setpoint value is based on the 2335 psig pressurizer PORV setpoint, plus 3 percent uncertainty. The 2335 psig pressurizer PORV setpoint is referenced in the DCPP Technical Specification Bases page B 3.4-45. The uncertainty value of 3 percent was adopted by the industry because it is consistent with Generic Letter (GL) 95-05 guidance. That is, GL 95-05 specifies a 3 percent adjustment for the pressurizer safety valve setpoint, and recommends a similar adjustment for the pressurizer PORV setpoint.

The information presented in Table 6-4 of WCAP-15573, Revision 1, was developed from test data and conditions near, but variant of the predicted SLB conditions. As such, the variance of the prediction errors should be such as to account for the difference between a SLB differential pressure of 2405 and 2560 psi. In other words, the parameters of the related equation 6-18 in WCAP-15573, Revision 1, are acceptable for both 2405 psi and 2560 psi. The SLB leak rate data in Table 6-5 of WCAP-15573, Revision 1, reflects CRACKFLO code leak rates at 2560 psi, and must be adjusted to reflect the difference in differential pressures. The data and regression parameters for differential pressures of 2405 and 2560 psi are provided in Table 1 and Figure 1 of this letter. In each, the information from WCAP-15573, Revision 1, is repeated for the 2560 psi differential pressure condition and new information is presented for the 2405 psi differential pressure condition. The equation parameters shown in Figure 1 are used as input to the PWSCC ARC code for the evaluation of the plant data. The relationship is of the form,

$$Q = AL^B$$

where Q is the leak rate in gallons per minute and L is the throughwall length of the PWSCC crack. The correction factors for the flow stress provided in Table 6-5 of WCAP-15573, Revision 1, are unchanged by the difference in SLB differential pressures.

Table 1
Leak Rate as a Function of Crack Length for Different Steam Line Break Pressures

Crack Length (inch)	Gallons per Minute at 2405 psid	Gallons per Minute at 2560 psid
0.05	8.32E-06	1.00E-05
0.10	2.06E-04	3.00E-04
0.15	1.43E-03	1.93E-03
0.20	5.35E-03	7.13E-03
0.30	3.85E-02	5.13E-02
0.40	1.90E-01	2.49E-01
0.50	7.82E-01	1.08E+00
0.60	2.49E+00	3.68E+00
Note: The information in the right column is a repeat of information in Table 6-5 of WCAP-15573, Revision 1		

Figure 1
Leak Rate as a Function of Crack Length
for Different Steam Line Break Differential Pressures

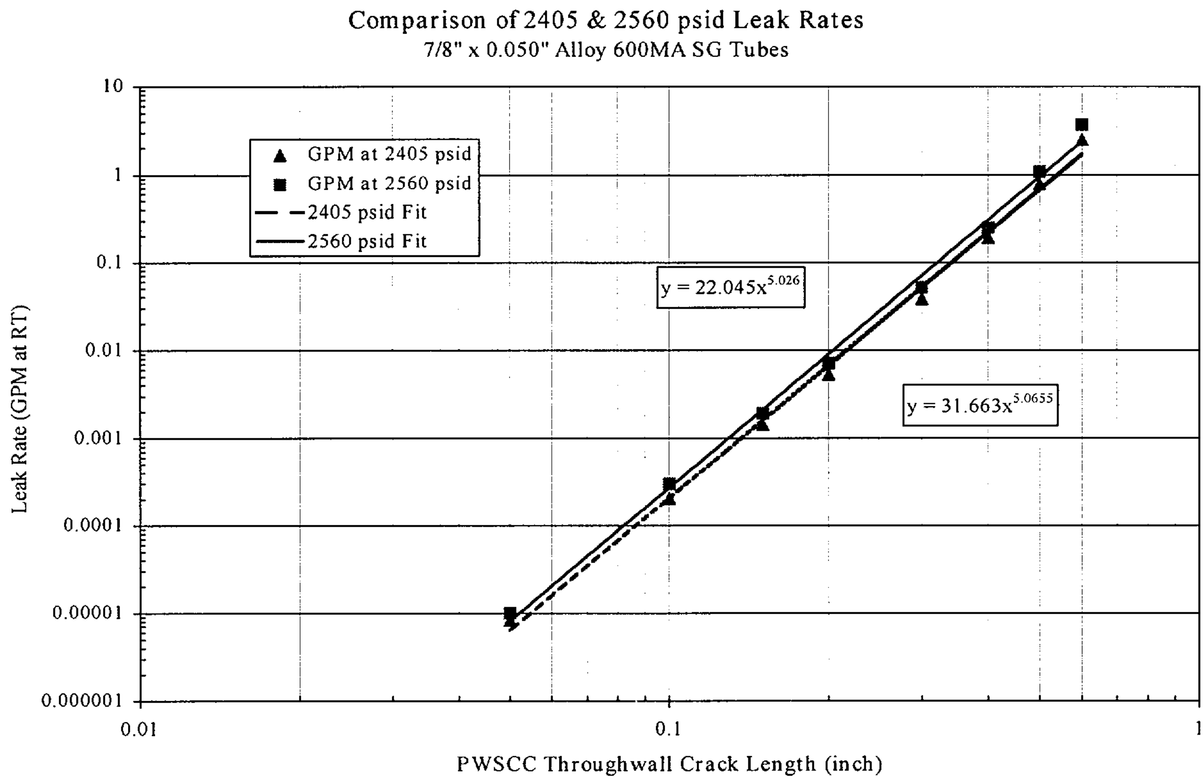


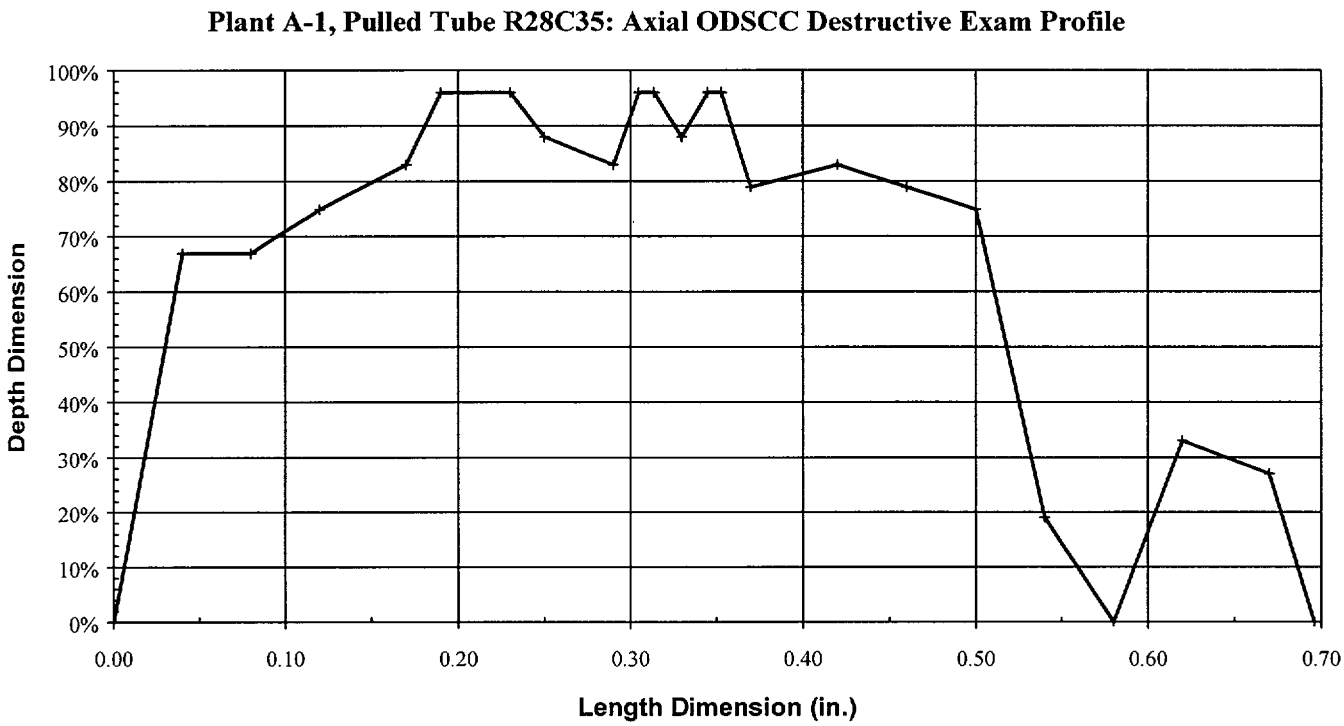
Table 2
SLB Leak Rate Analyses for Partial Depth Indications Based on PWSCC ANL Ligament Tearing Model

						Calculated SLB Leak Rates[2] - gpm				
	Destructive Exam				Measured SLB Leak Rate (Hot, RT) - gpm	Destructive Exam Profiles		NDE Profiles - PWSCC Indications Only		
Specimen	Max. Depth	Avg. Depth	Length	Flow Stress Hot - ksi		No NDE Unc.	With NDE Unc.	Analyst 1	Analyst 2	Analyst 3
PWSCC										
Lab 11-3 Crack 1	99.5	75.2	1.072	74.7	<2.14[1]	6.45	6.45	5.69	5.18	6.16
DC PT R12C32	97.0	58.0	0.702	82.1	0.0	0.00	0.01	0.00	0.00	0.00
ODSCC - 7/8" Tubing										
A-1 PT R28C35	96.0	63.0	0.696	78.5	0.0081	0.00	0.25	-	-	-
MB 607-3	98.0	89.9	0.490	67.0	0.020	1.87	1.64	-	-	-
A-2 PT R27C54	92.0	56.2	0.500	72.3	0.0	0.00	0.0002	-	-	-
L PT R8C66	96.0	54.4	0.750	77.3	0.0	0.00	0.00	-	-	-
L PT R8C69	98.0	59.5	0.860	77.3	0.0	0.00	0.19	-	-	-
L PT R12C70	97.0	59.9	0.780	78.0	0.0	0.00	0.35	-	-	-
MB 543-4	98.0	74.8	0.520	67.0	0.0	0.56	1.09	-	-	-
ODSCC - 3/4" Tubing										
AA-1 R16C42	97.0	74.4	0.330	68.5	0.0	0.00	0.11	-	-	-
R-1 PT R9C76	91.0	66.7	0.380	73.8	0.0	0.00	0.00	-	-	-
AB-1 PT R20C102	96.0	60.8	0.380	75.9	0.0	0.00	0.036	-	-	-

Notes:

1. Leak rate was measured in a Room Temperature (RT) test. Correction to steam line break (SLB) hot conditions would be expected to slightly reduce the leak rate.
2. Calculated using primary stress corrosion cracking (PWSCC) alternate repair criteria (ARC) methods for ligament tearing and leak rate analyses. Calculated leak rates based on hot SLB conditions with RT gpm values.

Figure 2
Pulled Tube Destructive Examination Profile



PG&E Response to NRC Request for Additional Information Received on March 21, 2002, Regarding Supplement 3 to LAR 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing"

NRC Request

Please submit EPRI ETSS 20409.1 and 20510.1 (either pdf version or just copies). These are referred to in WCAP-15573, Revision 1, in regard to +Point sizing of circumferential cracks. Although the methodology is described in the WCAP, we want to see the results/data contained in the ETSS.

PG&E Response

Attached are copies of the following Electric Power Research Institute (EPRI) Examination Technique Specification Sheets (ETSSs).

1. EPRI 21409.1 for axial outer diameter stress corrosion cracking (ODSCC), Revision 0, dated March 2002 (9 pages)

2. ETSS 21410.1 for circumferential ODSCC, Revision 0, dated March 2002 (8 pages)

3. ETSS 20510.1 for circumferential PWSCC, Revision 2, dated March 2002 (9 pages)

Note that since issue of WCAP-15573, Revision 1, ETSS 20409.1 has been retired and replaced with two ETSSs: 21409.1 for axial ODSCC, and 21410.1 for circumferential ODSCC. The attached ETSSs should be treated as EPRI licensed material.

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21409.1

TUBING

Material	Outside Diameter	Wall
I-600	0.75, 0.875 in.	0.043, 0.048, 0.049, 0.05 in.

EXAMINATION SCOPE

Test Application: This technique is qualified for the detection of Axial Outer Diameter Stress Corrosion Cracking (ODSCC) at support structures, freespan regions, sludge pile and tubesheet crevice.

ACQUISITION TECHNIQUE

Coil P/N	Coil Dimension	Coil Type	Coil Swept Peak Freq.
PP11		+Point	240 kHz

DATA ACQUISITION

Instrument	Analog Probe Extension
MIZ30,TC6700	Low-Loss 50 ft.

Acquisition System Software	Probe	
MIZ30: Eddynet98®, Ver. 1	**Manufacturer**	Zetec
TC6700, ANSER®, Ver. 8.3 Rev 39	**Part Number**	D#3371-4-A, D#3371-5-A
	Length	50 ft.
	Diametral Offset*	0 in.

* Maximum distance from coil to tube ID

CONFIGURATION

Differential	Absolute
Frequency/Volts/Gain/Wall_Thickness	**Frequency/Volts/Gain/Wall_Thickness**
200kHz/12/X2/0.048,0.049,0.05 (MIZ30)	
200kHz/5/38/0.048,0.049,0.05 (TC6700)	
300kHz/12/X2/0.043 (MIZ30)	
300kHz/5/38/0.043 (TC6700)	

DATA RECORDING EQUIPMENT

Hewlett Packard	Hard Drive or Optical Disk

Digitizing Rate, Scan Direction & Speed

Bobbin Probe		Rotating Probe	
Min. Digitizing Rate (DR)		**Min. Digitizing Rate (DR)**	400 samples/sec
Min. Sample Rate (SR)		**Min. Sample Rate (SR)**	* 30 samples/inch-circumferentially, 25 samples/inch axially
Probe Speed (PS)		**Max. Withdrawal Speed (WS)**	0.2"/sec
Scan Direction		**Max. Rotation Speed (RPM)**	300/rpm
Additional Notes		**Additional Notes**	Speed changes are allowed provided the min sample rate is met.

DATA ANALYSIS

System	Software
Hewlett Packard 9000/700	Eddynet98®/Eddynet95® Ver. 1/1

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21409.1

Analysis Channels

Analysis Type	Single Frequency
Channel Type	Diff
Span	40% Axial ID notch at 5 Div (Horizontal)
Phase	40% ID Axial notch set at 15 degrees
Calibration Standard	Axial EDM notches 100, 60, and 40%
Calibration Curve	Axial EDM OD notches 100%, 60% and 40%
Volts	20 volts on 100% axial notch
Filtering	N/A
Mixed On	
Frequencies	300, 200

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21409.1

ANALYSIS GUIDELINES

Analysis Guidelines:

The plus point coil is tuned for approximately 200 kHz with a fifty foot low loss cable attached.

Data should be collected on a push for expansion zones.

Monitor the strip chart and scroll the region of interest while viewing the lissajous. Terrain plot the raw and process channels in the area of interest.

With the raw channels set so Axial indications form in the positive direction, circumferential indications will form in the negative direction on the same channel. Also establish a process channel rotating the signal such that the circumferential ID notch is at 15 degrees. It is possible for the indication to form in both directions. Before dispositioning these to volumetric indications, be aware that two closely spaced indications may provide a volumetric response.

Phase Sizing Technique Used for +Point Probe
Axial Indications

Set the 40% ID axial notch to 15 degrees.

Build a curve utilizing the as built dimensions for the following in the "Main Eddy" Lissajous:
OD - 40, 60, 100 Axial Notches

In the absence of the required EDM notches utilize the following:

Phase
100% TWH set to approximately 10 degrees.

With "Measurement Disabled" build the following curve:

300 kHz (0.043" wall)
0 Degrees, 0 Percent
15 Degrees, 40 Percent
20 Degrees, 60 Percent
30 Degrees, 100 Percent
30 Degrees, 100 Percent
75 Degrees, 60 Percent
86 Degrees, 40 Percent

200 kHz (0.048" and 0.050" wall)
0 Degrees, 0 Percent
15 Degrees, 40 Percent
21 Degrees, 60 Percent
28 Degrees, 100 Percent
28 Degrees, 100 Percent
65 Degrees, 60 Percent
83 Degrees, 40 Percent

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21409.1

ANALYSIS GUIDELINES

Voltage Setting
Set the volts on the 100% Axial Notch to 20 volts in the Main Eddy Window.
If the EDM notches are not available set the 100% TWH to 20 volts.

Indication Measurement
Axial Indications: In the Main Eddy lissajous, start the measurement with a 0.00 volt and 0 percent entry. Make a measurement at each scan line using the main Eddy Window until the end of the indication. End the measurements with a 0.00 volt and 0 percent entry. For max depth sizing find the maximum depth and record.

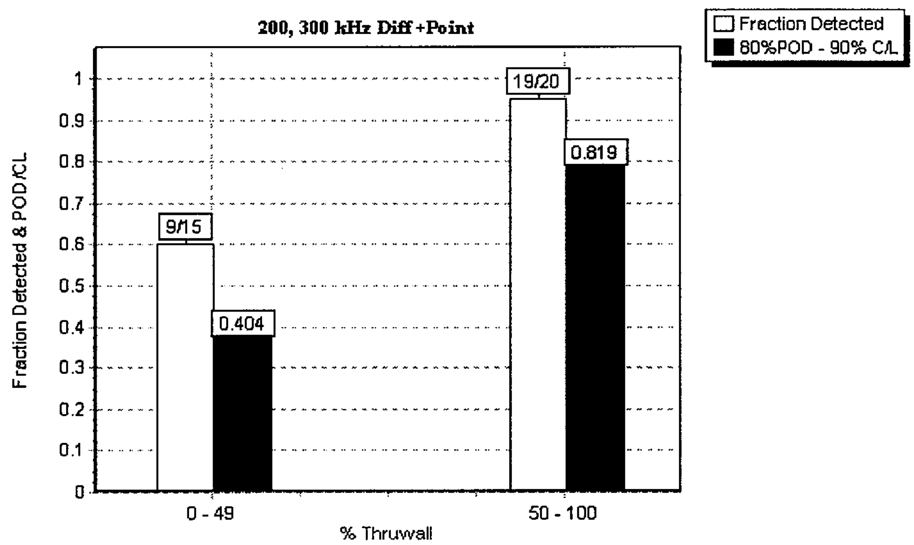
Note: For eddy current estimates vs. met, a value of 1% was used for phase angles that were flaw-like but non-quantifiable.

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

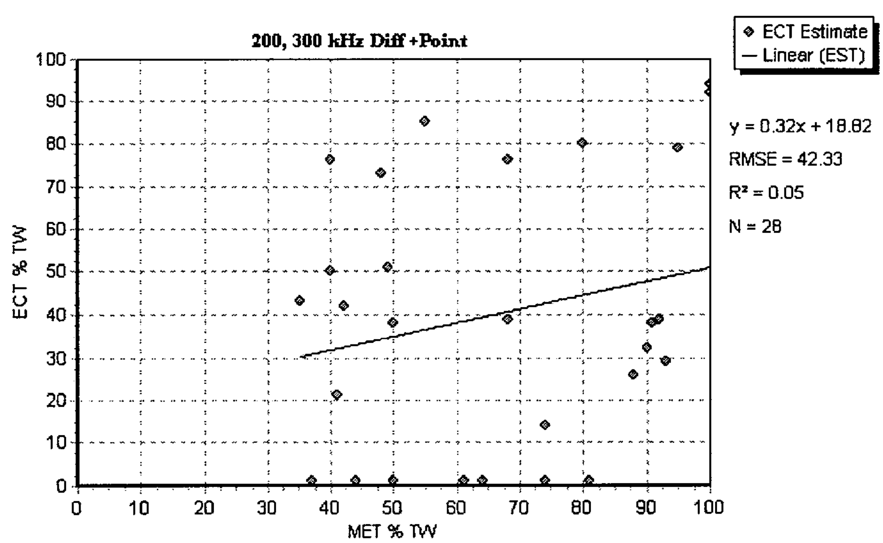
ETSS # 21409.1

TECHNIQUE PERFORMANCE

DETECTION



MAXIMUM DEPTH % TW

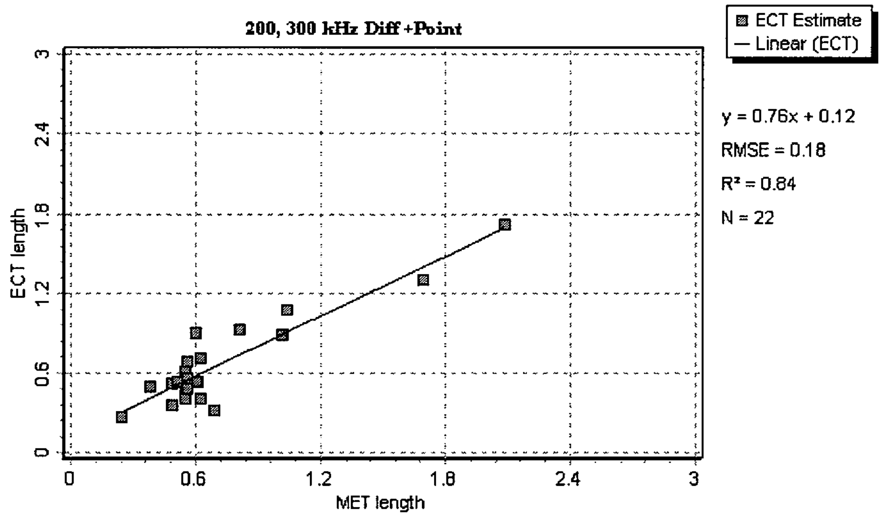


EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

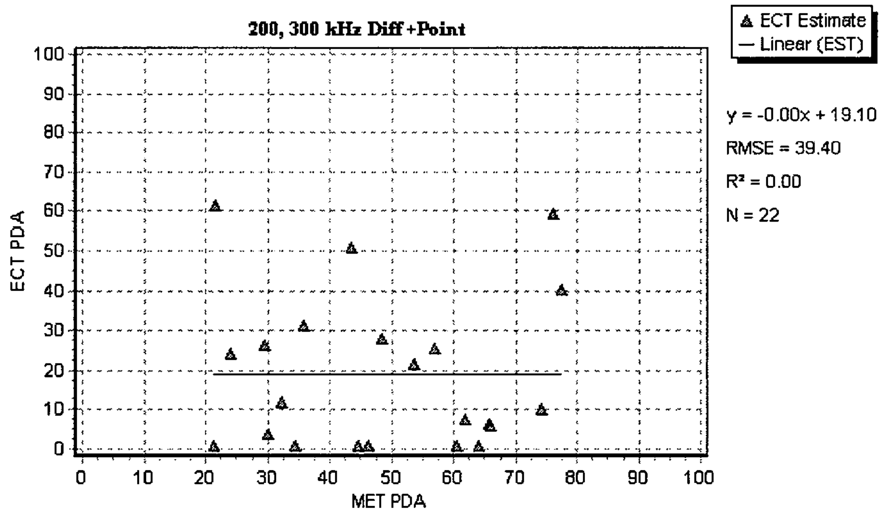
ETSS # 21409.1

TECHNIQUE PERFORMANCE

LENGTH MEASUREMENT (Inches)



PERCENT DEGRADED AREA
(circ: over 360 degrees, axial: area under flaw)

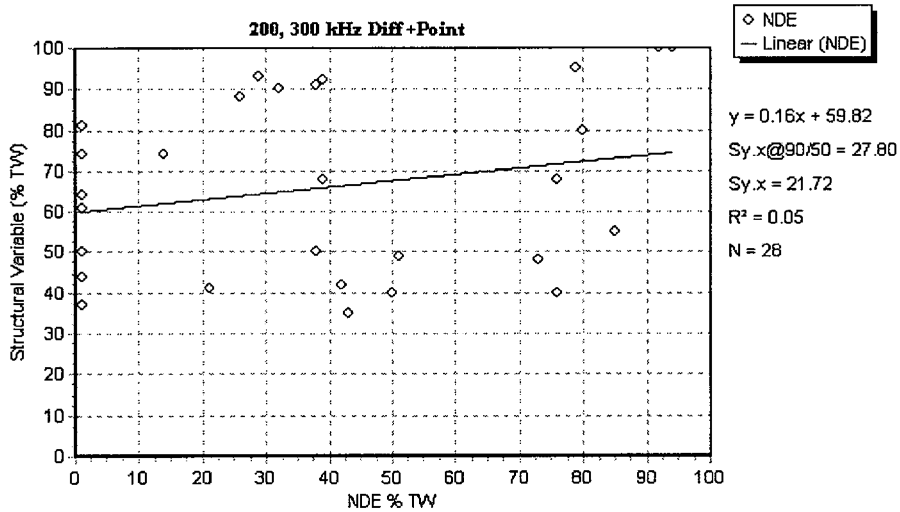


EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21409.1

INTEGRITY ASSESSMENT

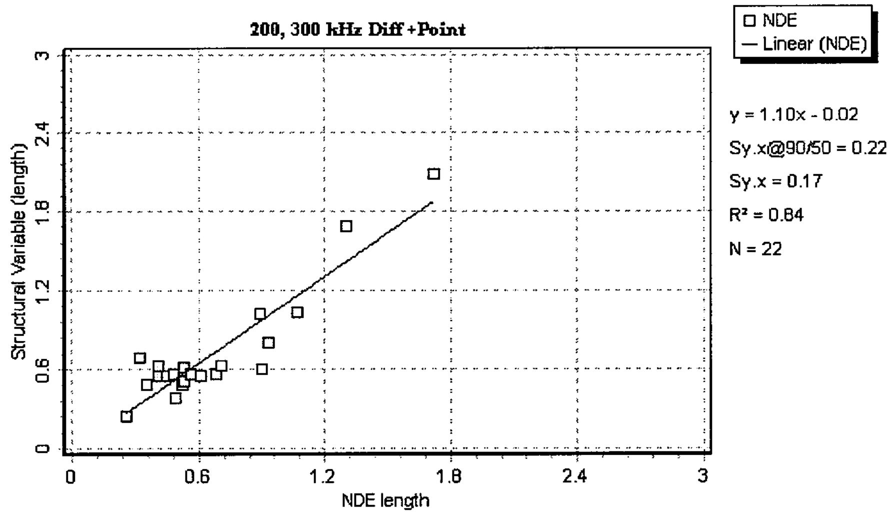
MAXIMUM DEPTH % TW



Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

LENGTH MEASUREMENT (Inches)



Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

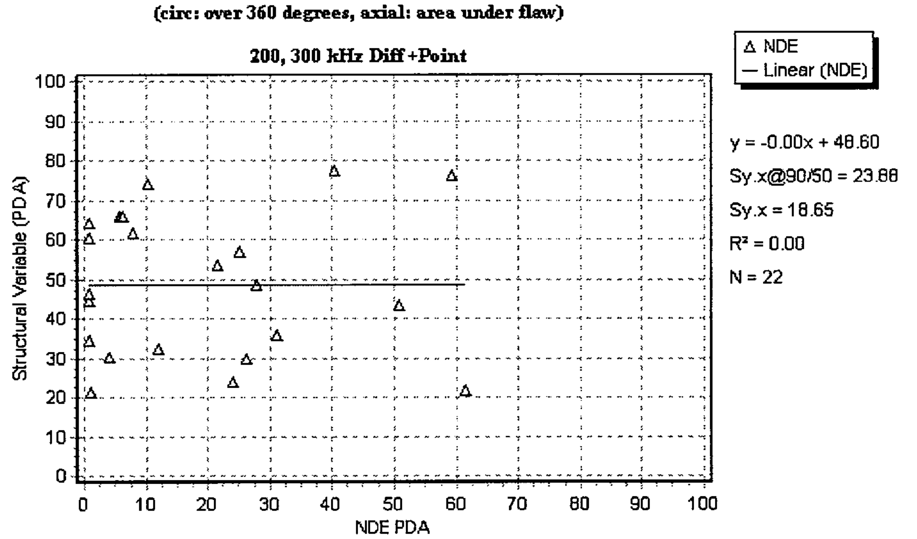
EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21409.1

INTEGRITY ASSESSMENT

PERCENT DEGRADED AREA
(circ: over 360 degrees, axial: area under flaw)

200, 300 kHz Diff +Point



Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

DATA SET

PLANT	TYPE	MODE	ROW	COL	THRUWALL* MET%	THRUWALL* EST%	LENGTH MET	LENGTH EST	PDA MET	PDA EST	LOCATION	PEDIGREE **	NOISE
EPRI	Lab Crack	AXIAL	13599A	C-82°	95	79	0.6	0.9	77.45	40.43	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599A	C-143°	60	NDD	0.49	0	42.9	0	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599A	C-233°	88	26	0.56	0.56	61.91	7.82	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599A	C-345°	49	NDD	0.62	0	38.55	0	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	D-50°	64	1	0.56	0.48	46.39	0.94	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	D-124°	68	76	0.55	0.61	48.58	27.98	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	D-213°	80	80	0.61	0.53	56.95	25.26	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	D-337°	93	29	0.56	0.68	74.18	10.32	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	E-41°	90	32	0.56	0.56	66.12	5.8	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	E-125°	74	1	0.51	0.53	60.43	0.92	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	E-222°	41	NDD	0.55	0	32.56	0	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	E-333°	61	1	0.55	0.45	44.75	0.91	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	F-39°	44	1	0.49	0.52	34.59	0.94	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	F-122°	81	1	0.63	0.41	64.05	0.9	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	F-221°	91	38	0.63	0.71	65.83	6.21	TUBE_SUPPO	Q	
EPRI	Lab Crack	AXIAL	13599B	F-321°	50	38	0.55	0.41	32.45	11.9	TUBE_SUPPO	Q	
COMANCHE PEAKE 1	Pulled Tube	AXIAL	25	81	48	73	0.24	0.26	35.79	31.19	TUBE_SUPPO	Q	
COMANCHE PEAKE 1	Pulled Tube	AXIAL	31	81	55	85	0.38	0.49	21.54	61.55	TUBE_SUPPO	Q	
COMANCHE PEAKE 1	Pulled Tube	AXIAL	31	81	40	76	0.49	0.35	23.99	23.99	TUBE_SUPPO	Q	
COMANCHE PEAKE 1	Pulled Tube	AXIAL	25	81	42	NDD	0.12	0	19.5	0	TUBE_SUPPO	Q	
ZION 2	Pulled Tube	AXIAL	21	57	92	39	0	0	0	0	TUBESHEET C	GF	
ZION 2	Pulled Tube	AXIAL	3	68	74	14	0	0	0	0	TUBESHEET C	GF	
ZION 2	Pulled Tube	AXIAL	19	48	40	50	0	0	0	0	SLUDGE PILE	GF	
CALVERT CLIFFS 2	Pulled Tube	AXIAL	87	91	68	39	1.04	1.07	53.59	21.58	SLUDGE PILE	GF	
CALVERT CLIFFS 1	Pulled Tube	AXIAL	46	76	49	51	0	0	0	0	FREESPAN	GF	
CALVERT CLIFFS 1	Pulled Tube	AXIAL	111	67	35	43	0	0	0	0	FREESPAN	GF	
DIABLO CANYON 1	Pulled Tube	AXIAL	12	32	10	NDD	0.2	0	5.35	0	TUBE_SUPPO	GF	
DIABLO CANYON 1	Pulled Tube	AXIAL	21	43	26	NDD	0.25	0	13.61	0	TUBE_SUPPO	GF	
SEQUOYAH 1	Pulled Tube	AXIAL	11	61	41	21	0.69	0.32	30.04	3.97	TUBE_SUPPO	GF	
FARLEY 1	Pulled Tube	AXIAL	29	47	100	92	1.69	1.3	43.46	50.74	SLUDGE PILE	GF	
FARLEY 1	Pulled Tube	AXIAL	6	28 (TTS+9.06")	42	42	2.08	1.72	29.6	26.15	FREESPAN	GF	
FARLEY 1	Pulled Tube	AXIAL	6	28	50	1	0	0	0	0	TUBE_SUPPO	GF	

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21409.1

DATA SET

PLANT	TYPE	MODE	ROW	COL	THRUWALL*		LENGTH		PDA		LOCATION	PEDIGREE **	NOISE
					MET%	EST%	MET	EST	MET	EST			
FARLEY 1	Pulled Tube	AXIAL	6	28 (TSP1+2.07")	37	1	1.02	0.89	21.24	0.97	FREESPAN	GF	
FARLEY 1	Pulled Tube	AXIAL	2	85	100	94	0.81	0.93	76.14	59.32	TUBE_SUPPO	GF	
FARLEY 1	Pulled Tube	AXIAL	2	85	33	NDD	0.43	0	22.73	0	FREESPAN	GF	

* NDD = No Detectable Degradation

** Q = 10CFR50 Appdx B, GF = Grandfathered

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21410.1

TUBING

Material	Outside Diameter	Wall
I-600	0.75, 0.875 in.	0.043, 0.05 in.

EXAMINATION SCOPE

Test Application: This technique is qualified for the detection of circumferential (ODSCC) at expansion transitions.

ACQUISITION TECHNIQUE

Coil P/N	Coil Dimension	Coil Type	Coil Swept Peak Freq.
PP11		+Point	240 kHz

DATA ACQUISITION

Instrument	Analog Probe Extension
MIZ18,MIZ30,TC6700	Low-Loss 50 ft.

Acquisition System Software	Probe	
MIZ18: Eddynet®, Ver. 27	Manufacturer	Zetec
MIZ30, Eddynet95®, Ver. 1	Part Number	D#3371-4-A, D#3371-5-A
TC6700, ANSER®, Ver. TC 1 2.3	Length	50 ft.
	Diametral Offset*	0 in.

* Maximum distance from coil to tube ID

CONFIGURATION

Differential Frequency/Volts/Gain/Wall_Thickness	Absolute Frequency/Volts/Gain/Wall_Thickness
200kHz/12/X2/0.05 (MIZ30)	
200kHz/5/38/0.05 (TC6700)	
300kHz/12/X2/0.043 (MIZ30)	
300kHz/5/38/0.043 (TC6700)	

DATA RECORDING EQUIPMENT

Hewlett Packard	Hard Drive or Optical Disk

Digitizing Rate, Scan Direction & Speed

Bobbin Probe		Rotating Probe	
Min. Digitizing Rate (DR)		Min. Digitizing Rate (DR)	400 samples/sec
Min. Sample Rate (SR)		Min. Sample Rate (SR)	* 30 samples/inch-circumferentially, 25 samples/inch axially
Probe Speed (PS)		Max. Withdrawal Speed (WS)	0.2"/sec
Scan Direction		Max. Rotation Speed (RPM)	300/rpm
Additional Notes		Additional Notes	Speed changes are allowed provided the min sample rate is met.

DATA ANALYSIS

System	Software
Hewlett Packard 9000/700	Eddynet95®/Eddynet98® Ver. 1/1

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21410.1

Analysis Channels

Analysis Type	Single Frequency
Channel Type	Diff
Span	ID Circ notch at 5 Div (Horizontal)
Phase	40% ID Circ set at 15 degrees
Calibration Standard	Circ EDM notches 100%, 60% and 40%
Calibration Curve	Circ 100%, 60%, and 40% OD Notches
Volts	20 volts on 100% circ notch
Filtering	Filters were used on a best effort basis to obtain sizing info
Mixed On	
Frequencies	300, 200

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21410.1

ANALYSIS GUIDELINES

Analysis Guidelines:
The plus point coil is tuned for approximately 200 kHz with a fifty foot low loss cable attached.

Data should be collected on a push for expansion zones.

Monitor the strip chart and scroll the region of interest while viewing the lissajous. Terrain plot the raw and process channels in the area of interest.

With the raw channels set so Axial indications form in the positive direction, circumferential indications will form in the negative direction on the same channel. Also establish a process channel rotating the signal such that the 40% circumferential ID notch is at 15 degrees. It is possible for the indication to form in both directions. Before dispositioning these to volumetric indications, be aware that two closely spaced indications may provide a volumetric response.

Phase Sizing Technique used for Circumferential Indications with +Point Probe
Make a process channel for the measurement frequency.

Set the 40% ID circ indication to 15 degrees.

Plot the indication in the cscan display and measure the 40% ID circ indication and confirm that the indication is reading 15 degrees in the Axial Lissajous window. If necessary adjust the phase in the "Main Eddy" lissajous until the indication is 15 degrees in the Axial Lissajous.

Build a curve utilizing the as built dimensions for the following in the "Axial" Lissajous window:
OD - 100, 60, 40 Circ Notches

In the absence of the required EDM notches utilize the following:

Phase
100% TWH set to approximately 10-15 degrees. If a 100% axial notch is available set to 210 degrees.

With "Measurement Disabled" build the following curve:

300 kHz (0.043" wall)
0 Degrees, 0 Percent
15 Degrees, 40 Percent
20 Degrees, 60 Percent
30 Degrees, 100 Percent
30 Degrees, 100 Percent
75 Degrees, 60 Percent
86 Degrees, 40 Percent

200 kHz (0.048" and 0.050" wall)
0 Degrees, 0 Percent
15 Degrees, 40 Percent
21 Degrees, 60 Percent
28 Degrees, 100 Percent
28 Degrees, 100 Percent
65 Degrees, 60 Percent
83 Degrees, 40 Percent

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21410.1

ANALYSIS GUIDELINES

Voltage Setting
Set the volts of the 100% Circ Notch to 20 volts in the Axial Lissajous Window of the process channel, if the Circ notch is not available set the 100% axial notch at 20 volts . If the EDM notches are not available set the 100% TWH to 20 volts.

Indication Measurement
Circumferential Indications: In the Axial Lissajous, start the measurement with a 0.00 volt and 0 percent entry. Use the arrow buttons at the lower part of the Axial lissajous to "step" through the circumferential indication and take measurements every 10 degrees. End the measurements with a 0.00 volt and 0 percent entry. For max depth sizing find the maximum depth and record.

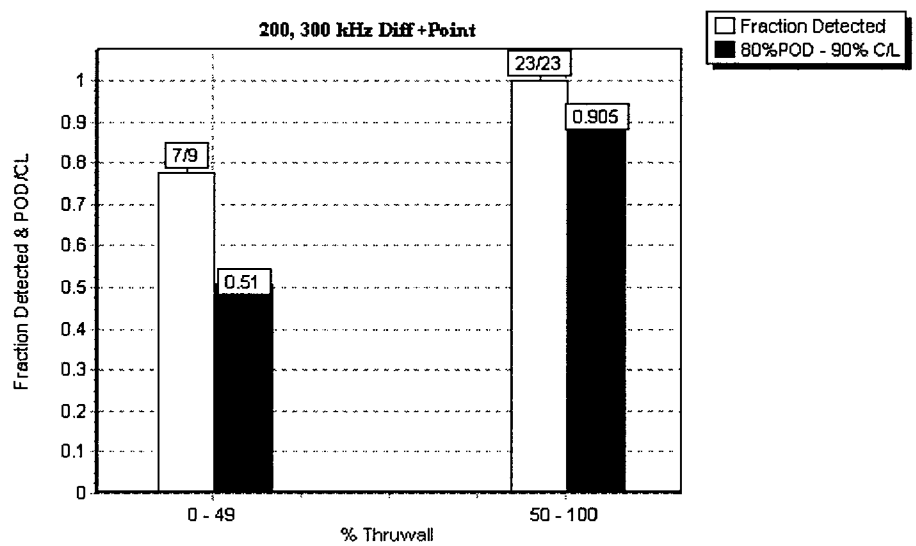
Note: For eddy current estimates vs. met, a value of 1% was used for phase angles that were flaw-like but non-quantifiable.

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

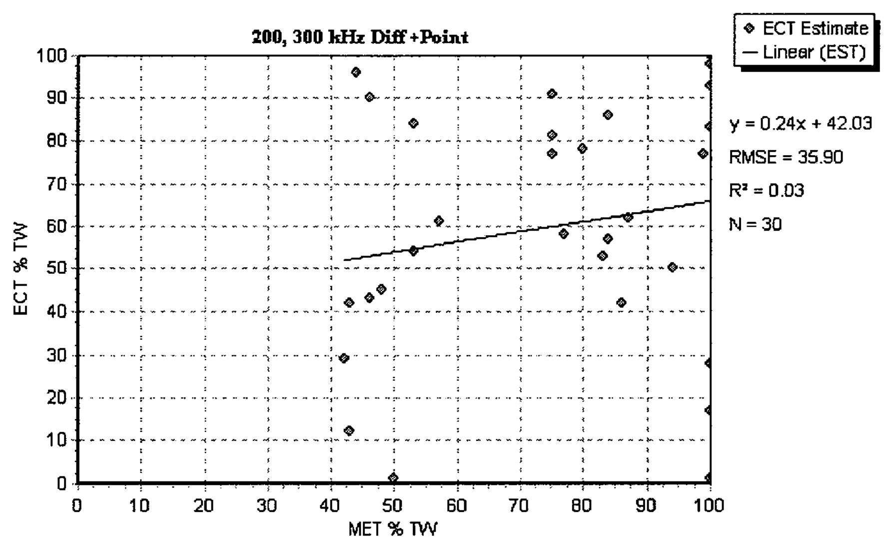
ETSS # 21410.1

TECHNIQUE PERFORMANCE

DETECTION



MAXIMUM DEPTH % TW

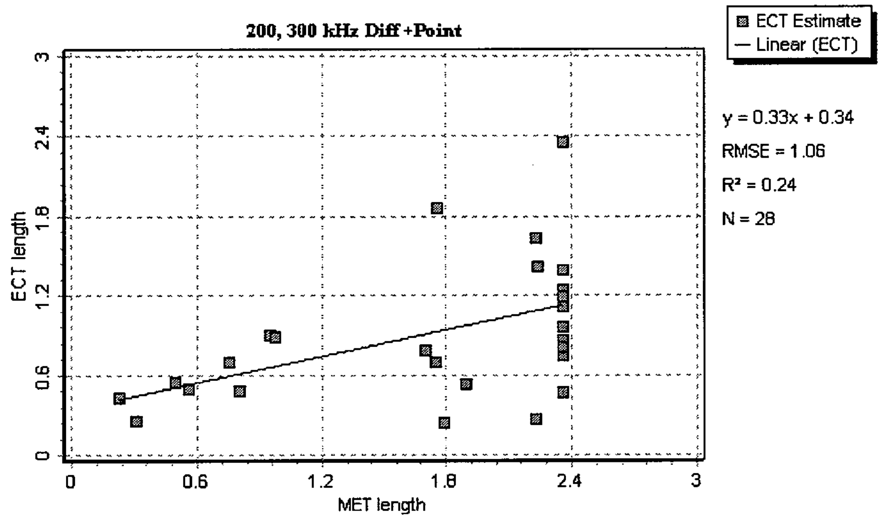


EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

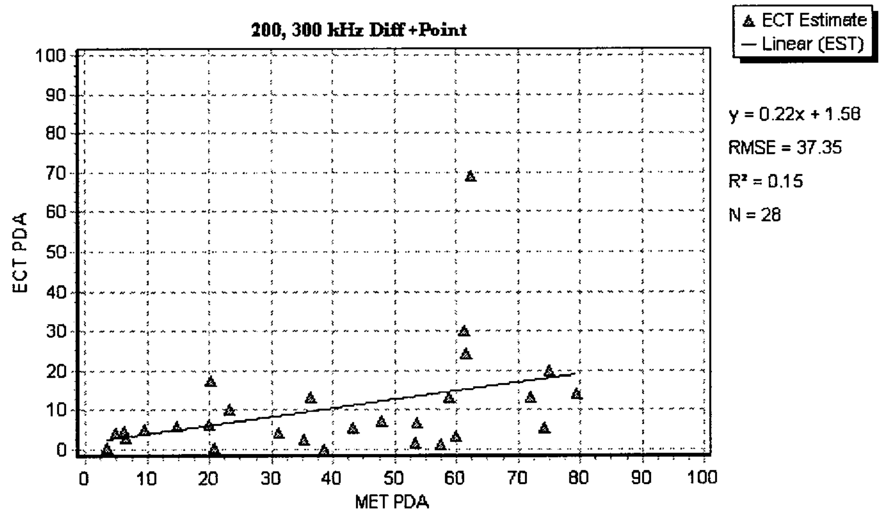
ETSS # 21410.1

TECHNIQUE PERFORMANCE

LENGTH MEASUREMENT (Inches)



PERCENT DEGRADED AREA
(circ: over 360 degrees, axial: area under flaw)

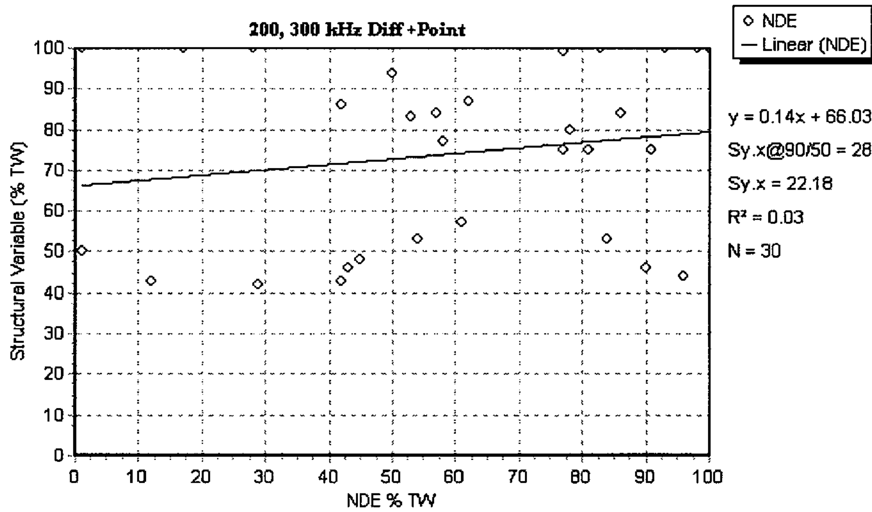


EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21410.1

INTEGRITY ASSESSMENT

MAXIMUM DEPTH % TW

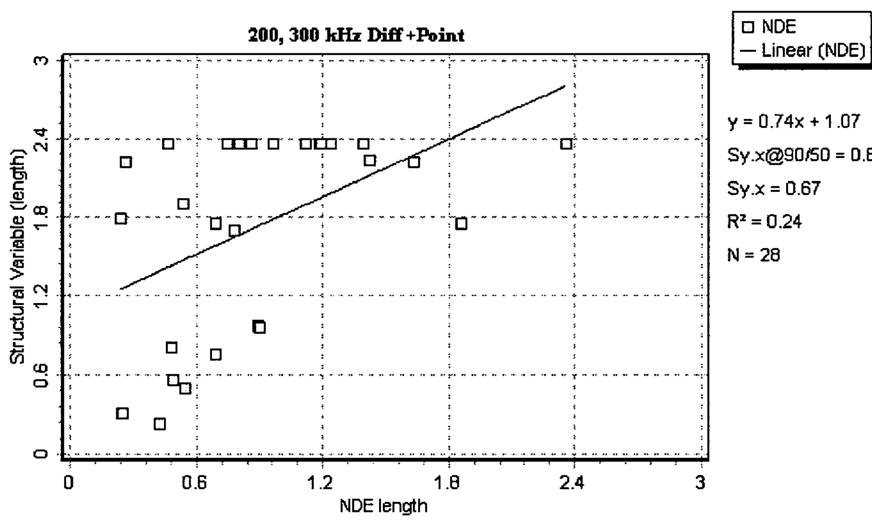


y = 0.14x + 66.03
Sy.x@90/50 = 28.39
Sy.x = 22.18
R^2 = 0.03
N = 30

Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

LENGTH MEASUREMENT (Inches)



y = 0.74x + 1.07
Sy.x@90/50 = 0.86
Sy.x = 0.67
R^2 = 0.24
N = 28

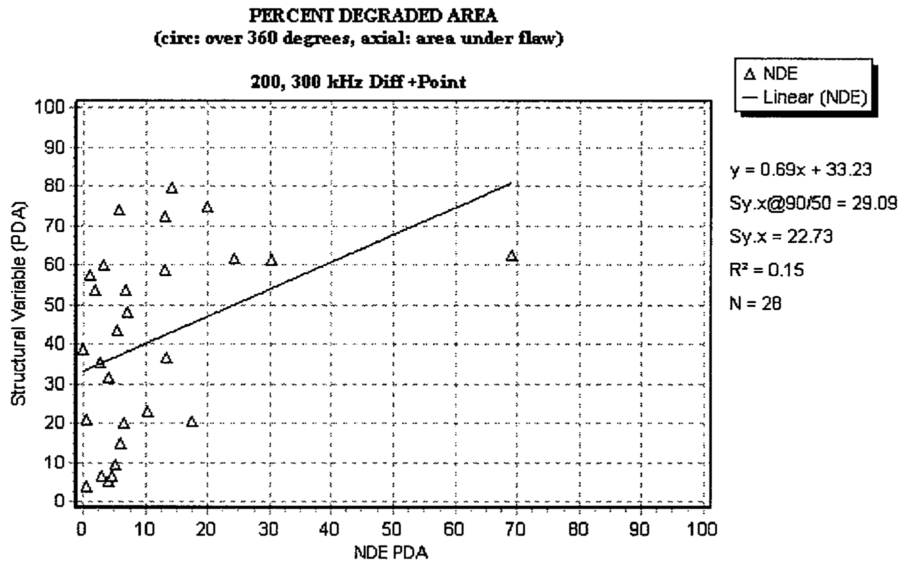
Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 21410.1

INTEGRITY ASSESSMENT



Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

DATA SET

PLANT	TYPE	MODE	ROW	COL	THRUWALL* MET%	THRUWALL* EST%	LENGTH MET	LENGTH EST	PDA MET	PDA EST	LOCATION	PEDIGREE **	NOISE
EPRI	Lab Crack	CIRC	21	96 - A	53	54	0	0	0	0	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	21	96 - B	57	61	0	0	0	0	EXP_TRANS	GF	
SOUTH TEXAS PROJ 1	Pulled Tube	CIRC	26	63	36	NDD	299	0	16.46	0	EXP_TRANS	GF	
SOUTH TEXAS PROJ 1	Pulled Tube	CIRC	15	25	75	91	115	106	20	6.53	EXP_TRANS	GF	
SOUTH TEXAS PROJ 1	Pulled Tube	CIRC	23	76	86	42	360	360	74.15	5.68	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	14	93	46	90	360	171	23.16	10.29	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	24	91	50	1	360	189	20.78	0.48	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	14	37	77	58	360	181	53.78	6.74	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	27	48	75	81	360	182	48.03	7.2	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	38	55	75	77	340	249	36.39	13.34	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	38	44	80	78	290	82	35.28	2.71	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	20	85	94	50	360	123	59.92	3.21	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	24	42	100	98	360	147	61.54	24.22	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	28	68	100	1	340	41	38.69	0.09	EXP_TRANS	GF	
BYRON 1	Pulled Tube	CIRC	23	43	100	93	360	212	75	19.84	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	20	96 B	48	45	149	136	14.7	6.1	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	24	96 B	43	42	123	74	9.49	5.27	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	49	96 B	42	29	86	75	6.56	2.92	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	58	96 A	43	12	47	38	3.62	0.59	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	15	499 B	100	83	259	119	58.86	13	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	15	599 A	100	28	273	37	57.51	1.2	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	15	799 A	99	77	341	217	61.3	30.29	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	15	799 B	100	100	268	284	62.48	68.99	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	15	899	100	17	267	106	53.54	1.83	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	16	199 A	83	53	360	131	72.19	13.04	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	16	199 B	87	62	360	114	79.44	14.17	EXP_TRANS	Q	
COMANCHE PEAKE 1	Pulled Tube	CIRC	7	84	44	96	360	71	31.31	4.07	EXP_TRANS	Q	
COMANCHE PEAKE 1	Pulled Tube	CIRC	22	89	53	84	360	213	43.34	5.51	EXP_TRANS	Q	
COMANCHE PEAKE 1	Pulled Tube	CIRC	25	81	39	NDD	360	0	29.68	0	EXP_TRANS	Q	
SEQUOYAH 1	Pulled Tube	CIRC	11	61	46	43	65	72	6.43	4.62	TUBE_SUPPO	GF	
EPRI	Lab Crack	CIRC	95	802	84	57	30	56	4.93	4.08	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	95	803	84	86	125	118	20.26	17.57	EXP_TRANS	GF	

* NDD = No Detectable Degradation

** Q = 10CFR50 Appdx B, GF = Grandfathered

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

TUBING

Material	Outside Diameter	Wall
I-600	0.75, 0.875 in.	0.043, 0.048, 0.05 in.

EXAMINATION SCOPE

Test Application: This technique is qualified for the detection of circumferential Primary Water Stress Corrosion Cracking (PWSCC) at expansion transitions.

ACQUISITION TECHNIQUE

Coil P/N	Coil Dimension	Coil Type	Coil Swept Peak Freq.
PP11		+Point	240 kHz

DATA ACQUISITION

Instrument	Analog Probe Extension
MIZ18,MIZ30,TC6700	Low-Loss 50 ft.

Acquisition System Software	Probe	
MIZ18: Eddynet®, Ver. 27	Manufacturer	Zetec
MIZ30, Eddynet98®, Ver. 1	Part Number	D#3371-4-A, D#3371-5-A
TC6700, ANSER®, Ver. 27	Length	50 ft.
	Diametral Offset*	0 in.
	* Maximum distance from coil to tube ID	

CONFIGURATION

Differential	Absolute
Frequency/Volts/Gain/Wall_Thickness	Frequency/Volts/Gain/Wall_Thickness
200kHz/12/X2/0.048,0.05 (MIZ30)	
200kHz/5/38/0.048,0.05 (TC6700)	
300kHz/12/X2/0.043 (MIZ30)	
300kHz/5/38/0.043 (TC6700)	

DATA RECORDING EQUIPMENT

Hewlett Packard	Hard Drive or Optical

Digitizing Rate, Scan Direction & Speed

Bobbin Probe		Rotating Probe	
Min. Digitizing Rate (DR)		Min. Digitizing Rate (DR)	400 samples/sec
Min. Sample Rate (SR)		Min. Sample Rate (SR)	* 30 samples/inch-circumferentially, 25 samples/inch axially
Probe Speed (PS)		Max. Withdrawal Speed (WS)	0.2"/sec
Scan Direction		Max. Rotation Speed (RPM)	300/rpm
Additional Notes		Additional Notes	Speed changes are allowed provided the min sample rate is met.

DATA ANALYSIS

System	Software
Hewlett Packard 9000/700	Eddynet95®/Eddynet98®/Eddynet® Ver. 1/1/27

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

Analysis Channels

Analysis Type	Single Frequency
Channel Type	Diff
Span	40% ID Circ notch at 5 Div (Horizontal)
Phase	Set 40% ID Circ Notch at 15 degrees in raw and process
Calibration Standard	Circ EDM notches 100, 60, 40, and 20%
Calibration Curve	100%, 60%, and 40% ID Notches
Volts	20 volts on 100% circ notch
Filtering	See NOTE in Analysis Guidelines section
Mixed On	
Frequencies	300, 200

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

ANALYSIS GUIDELINES

Analysis Guidelines:

The plus point coil is tuned for approximately 200 kHz with a fifty foot low loss cable attached.

Data should be collected on a push for expansion zones.

Monitor the strip chart and scroll the region of interest while viewing the lissajous. Terrain plot the raw and process channels in the area of interest.

With the raw channels set so Axial indications form in the positive direction, circumferential indications will form in the negative direction on the same channel. Also establish a process channel rotating the signal such that the 40% circumferential ID notch is at 15 degrees. It is possible for the indication to form in both directions. Before dispositioning these to volumetric indications, be aware that two closely spaced indications may provide a volumetric response.

Circumferential Indication Measurement
In the Axial Lissajous, start the measurement with a 0.00 volt and 0 percent entry. Use the arrow buttons at the lower part of the Axial lissajous to "step" through the circumferential indication and take measurements every 10 degrees. End the measurements with a 0.00 volt and 0 percent entry.

Phase Sizing Technique used for Circumferential Indications with +Point Probe
Make a process channel for the measurement frequency.

Set the 40% ID circ indication to 15 degrees.

Plot the indication in the cscan display and measure the 40% ID circ indication and confirm that the indication is reading 15 degrees in the Axial Lissajous window. If necessary adjust the phase in the "Main Eddy" lissajous until the indication is 15 degrees in the Axial Lissajous.

Build a curve utilizing the as built dimensions for the following in the "Axial" Lissajous window:
ID - 0, 40, 60, 100 Circ Notches

In the absence of the required EDM notches utilize the following:

Phase
100% TWH set to approximately 10-15 degrees. If a 100% axial notch is available set to 210 degrees.

With "Measurement Disabled" build the following curve:
300 kHz (0.043" wall)
0 Degrees, 0 Percent
15 Degrees, 40 Percent
20 Degrees, 60 Percent
30 Degrees, 100 Percent

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

ANALYSIS GUIDELINES

Voltage Setting

Set the volts of the 100% Circ Notch to 20 volts in the Axial Lissajous Window of the process channel, if the Circ notch is not available set the 100% axial notch at 20 volts . If the EDM notches are not available set the 100% TWH to 20 volts.

Indication Measurement

Circumferential Indications: In the Axial Lissajous, start the measurement with a 0.00 volt and 0 percent entry. Use the arrow buttons at the lower part of the Axial lissajous to "step" through the circumferential indication and take measurements every 10 degrees. End the measurements with a 0.00 volt and 0 percent entry. For max depth sizing find the maximum depth and record.

NOTE: The Maine Yankee pulled tube data analyzed results reflect the use of an axial average filter. The use of this filter is only applied on a best effort basis and is not recommended in this technique when sizing can be accomplished without filters. This applies to tubes 79-90, 87-78 and 90-57 only.

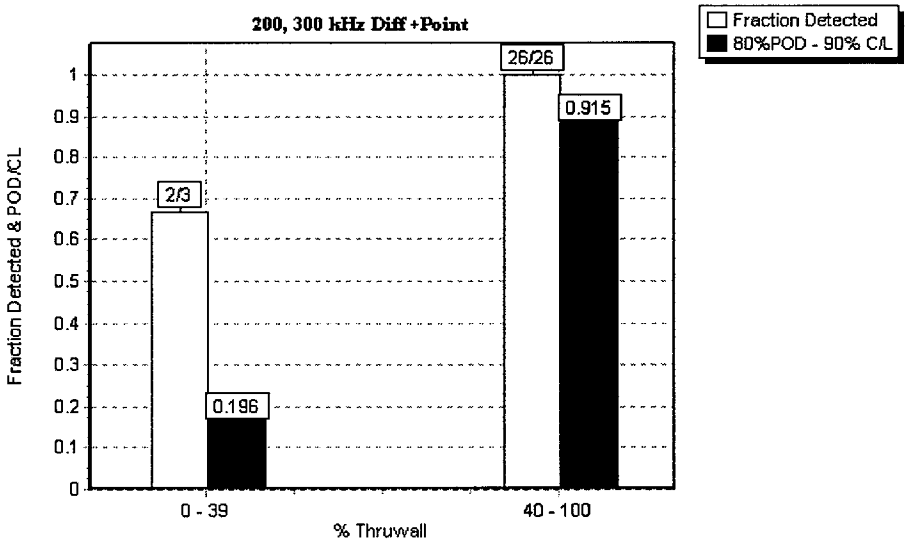
EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

ANALYSIS GUIDELINES

TECHNIQUE PERFORMANCE

DETECTION

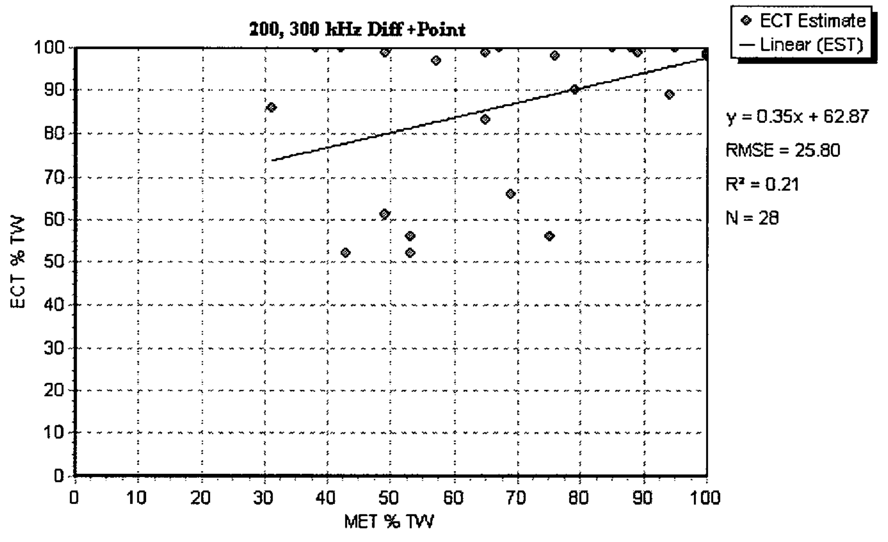


EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

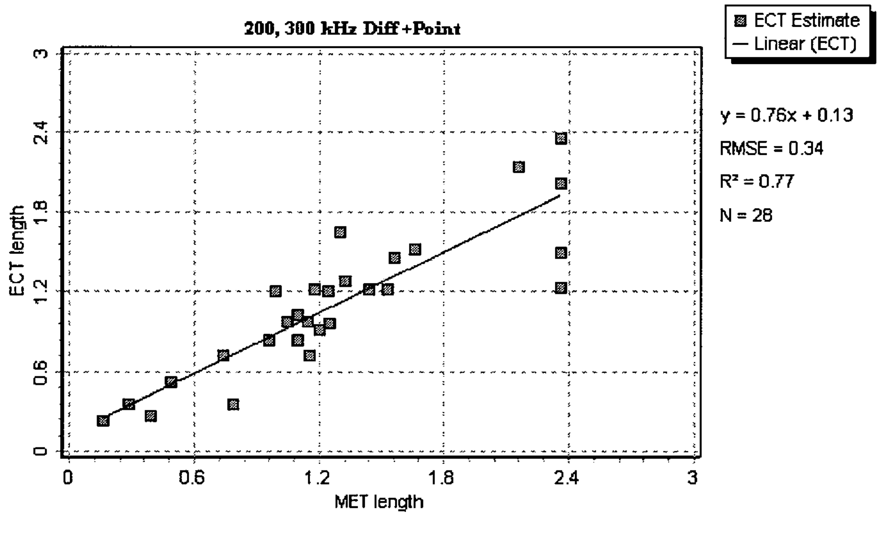
ETSS # 20510.1

TECHNIQUE PERFORMANCE

MAXIMUM DEPTH % TW



LENGTH MEASUREMENT (Inches)



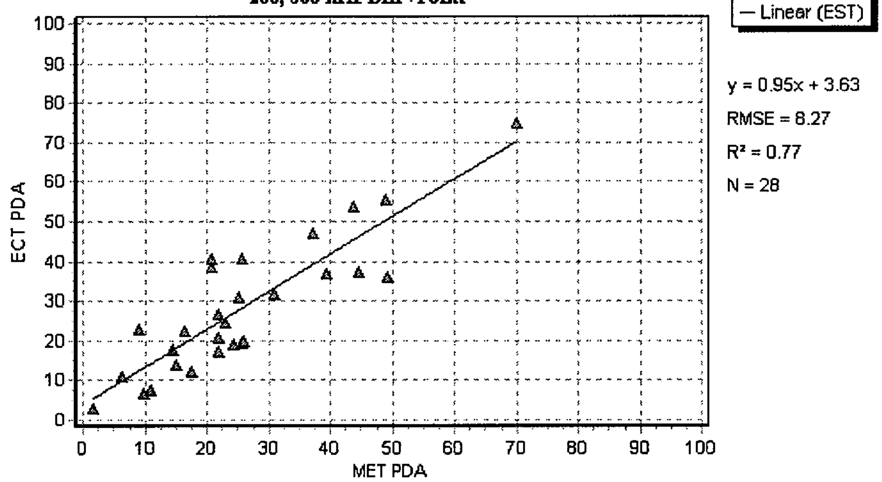
EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

TECHNIQUE PERFORMANCE

PERCENT DEGRADED AREA
(circ: over 360 degrees, axial: area under flaw)

200, 300 kHz Diff +Point

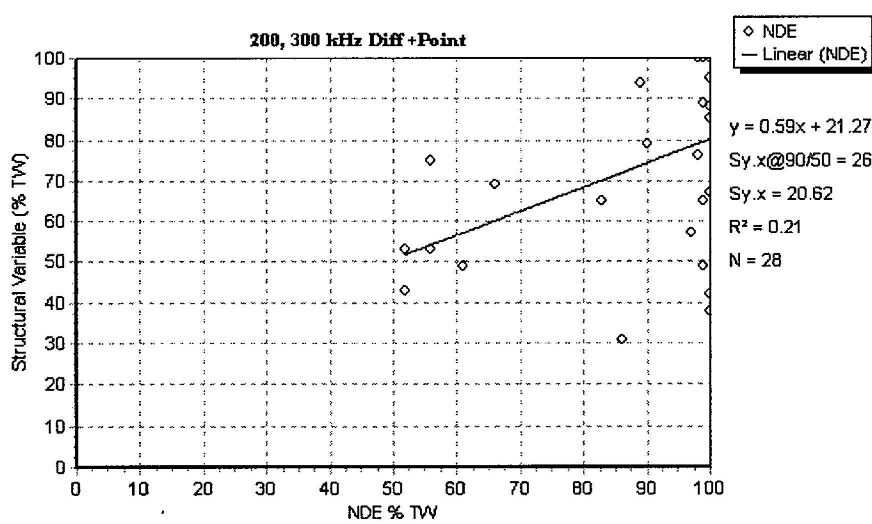


y = 0.95x + 3.63
RMSE = 8.27
R^2 = 0.77
N = 28

INTEGRITY ASSESSMENT

MAXIMUM DEPTH % TW

200, 300 kHz Diff +Point



y = 0.59x + 21.27
Sy.x@90/50 = 26.40
Sy.x = 20.62
R^2 = 0.21
N = 28

Condition Monitoring & Operation Assessment

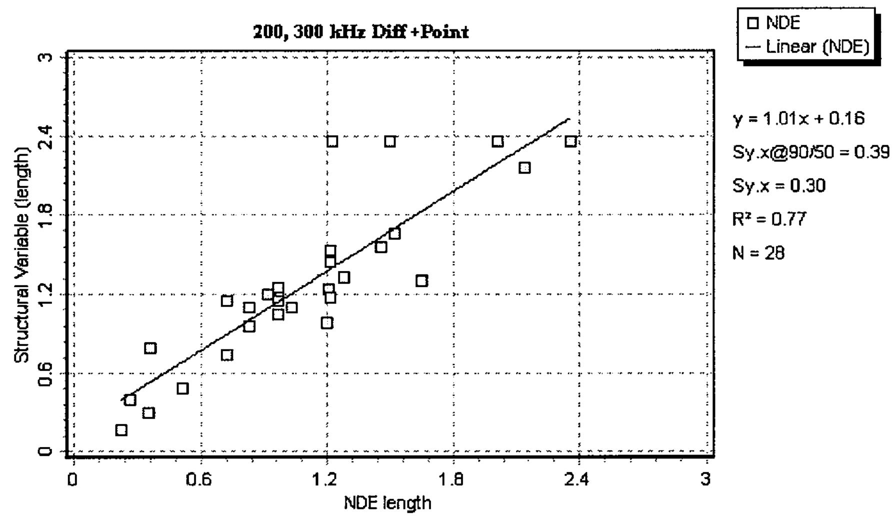
(Sy.x = Standard Error of Regression)

EDDY CURRENT
EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

INTEGRITY ASSESSMENT

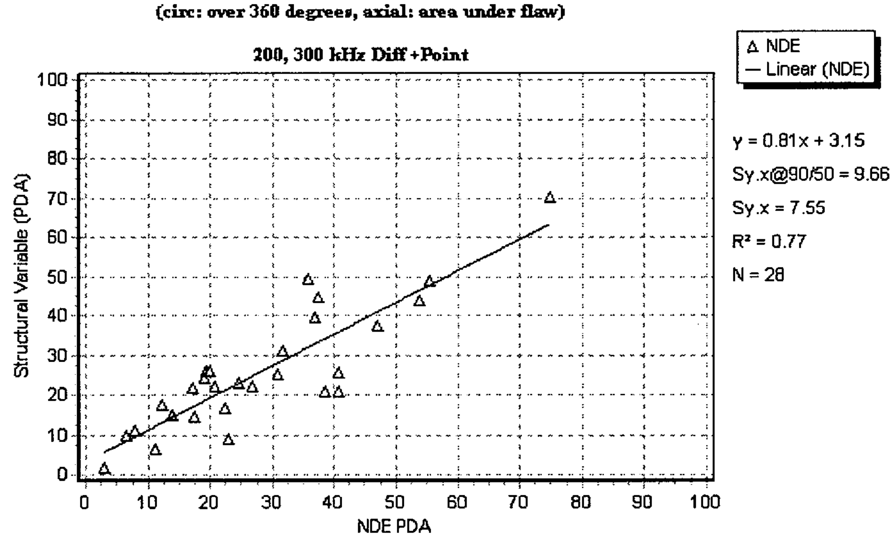
LENGTH MEASUREMENT (Inches)



Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

PERCENT DEGRADED AREA
(circ: over 360 degrees, axial: area under flaw)



Condition Monitoring & Operation Assessment

(Sy.x = Standard Error of Regression)

EDDY CURRENT EXAMINATION TECHNIQUE SPECIFICATION SHEET

ETSS # 20510.1

DATA SET

PLANT	TYPE	MODE	ROW	COL	THRUWALL* MET%	THRUWALL* EST%	LENGTH MET	LENGTH EST	PDA MET	PDA EST	LOCATION	PEDIGREE **	NOISE
EPRI	Lab Crack	CIRC	50	96-E	31	86	160	148	9.04	22.87	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	45	96-F	53	56	113	111	9.76	6.64	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	44	96-B	49	99	220	185	20.93	40.77	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	50	96-C	49	61	168	157	16.45	22.29	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	50	96-F	53	52	175	148	15.04	13.91	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	44	96-C	67	100	203	195	25.69	40.7	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	50	96-B	75	56	180	185	21.89	17.18	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	44	96-A	100	100	238	223	44.56	37.4	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	44	96-F	100	100	254	232	43.83	53.76	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	50	96-A	100	100	234	185	49.29	35.88	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	29	96-A	17	NDD	108	0	2.19	0	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	23	96-A	79	90	360	360	70.27	74.9	EXP_TRANS	GF	
EPRI	Lab Crack	CIRC	3096	SP2	88	100	75	79	14.58	17.62	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	3196	SP1	65	83	329	327	49.04	55.43	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	3296	SP1	76	98	44	54	6.28	11.17	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	3296	SP2	65	99	151	183	20.93	38.63	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	3396	SP1	89	99	121	55	17.53	12.37	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	4696	SP1	100	99	190	184	37.35	46.93	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	4696	SP2	100	99	168	127	31.02	31.65	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	4696	SP3	100	100	191	147	39.42	36.98	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	12596	SP1	69	66	184	140	26.05	19.84	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	12796	SP1	100	98	176	110	21.95	20.78	EXP_TRANS	Q	
EPRI	Lab Crack	CIRC	12796	SP2	95	100	146	127	25.22	30.94	EXP_TRANS	Q	
CALVERT CLIFFS 2	Pulled Tube	CIRC	51	113	94	89	60	40	10.96	7.82	EXP_TRANS	GF	
MAINE YANKEE	Pulled Tube	CIRC	87	78	38	100	360	307	22.94	24.55	EXP_TRANS	GF	
MAINE YANKEE	Pulled Tube	CIRC	90	57	57	97	360	187	25.86	19.42	EXP_TRANS	GF	
MAINE YANKEE	Pulled Tube	CIRC	79	90	42	100	360	229	24.31	19.19	EXP_TRANS	GF	
SEQUOYAH 1	Pulled Tube	CIRC	15	23	85	100	170	216	21.95	26.64	EXP_TRANS	GF	
DIABLO CANYON 1	Pulled Tube	CIRC	14	69	43	52	21	30	1.78	3.03	TUBE_SUPPO	GF	

* NDD = No Detectable Degradation ** Q = 10CFR50 Appdx B, GF = Grandfathered

PG&E Response to NRC Requests for Additional Information Received on April 2, April 3, and April 5, 2002, Regarding Supplement 3 to LAR 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing"

Question 1

Clarify whether 2 or 3 cycles of growth rate data will be used, and clarify the process for excluding growth data (e.g., conservative). WCAP-15573, Revision 1, appears to use 3 cycles of growth data for some of the assessments?

Please clarify how you are going to assess the data for Units 1 and 2. That is, when you are looking at the growth data, will you make sure that both units are operating similarly (in terms of growth rates), and if they are not, will you split them or use the more conservative one?

PG&E Response to Question 1

Unless there are a minimum of 200 points over the last two cycles on the single unit planned for the operational assessment, the number of cycles needed to total 200 growth points is determined (i.e., 2 or 3 cycles – currently 3 cycles). The growth rate population to be evaluated would include the data for both units over the 2 or 3 cycles needed to obtain at least 200 points. The data from each cycle included in the population are then compared for consistency in growth magnitude. If a given cycle has lower growth rates than other cycles, it is not included in the growth distribution used for the operational assessments. This selection process, as described previously in PG&E Letter DCL-02-023, increases the conservatism in the growth distributions compared to utilization of the total growth rate population.

If there are a total of at least 200 points over the last two cycles on one Unit, the growth distribution used for operational assessments would be the more conservative of the Unit's combined data or either of the two cycles.

If there are a minimum of 200 points per cycle for the last two cycles on one Unit, the growth distribution used for operational assessments would be the more conservative of the Unit's two cycles of data.

Question 2

Clarify when condition monitoring will be performed. There are write ups in Section 7.8.1 and 7.8.2. In addition, there is a write up in Section 7.12, "Underpredictions of Inspection Results for Indications Left in Service." It is not clear how Section 7.12 can be implemented without doing condition monitoring for all indications (which was the impression we were left with). Basically, in reading these write ups, it is not clear when condition monitoring would be performed. In addition, wouldn't it be better to have criteria based on percentage changes in leak rate and burst (rather than 0.2 gpm and

500 psi)? Also, the basis for the 1.1 factor for correcting the growth distribution doesn't appear justified (South Texas plant experience). Wouldn't it be more appropriate to look at the rate of increase in the growth rates and make a correction based on this (i.e., the methodology should be described - for example, look at the increase in the average growth rate, apply to all, ensure have a conservative tail, etc.)?

PG&E Response to Question 2

The term "condition monitoring" in WCAP-15573, Revision 1, applies to the evaluation of indications found in the inspection for structural and leakage integrity consistent with the requirements of WCAP-15573, Revision 1, and Nuclear Energy Institute (NEI) report NEI 97-06. The condition monitoring assessment is performed to support every inspection. The discussion in Section 7.12 of WCAP-15573, Revision 1, relative to assessing under-predictions left in service, would be classified as a methods evaluation rather than part of the condition monitoring assessment included in the 120-day report.

The methods evaluation supporting Section 7.12 is performed to compare the prior cycle projections with the indications found in the inspection, and would be performed in preparation of the 120-day report. This evaluation compares projected burst pressures and leak rates for each indication with that obtained for the same indication found in the inspection being evaluated. Tabulations of the projected and subsequent outage burst pressures and leak rates for each indication will be included in the 120-day report.

The criteria of 0.2 gpm and 500 pounds per square inch (psi) included in Section 7.12 were selected to define changes of some significance to leakage and structural integrity such that corrective actions would be taken as described in Section 7.12. It is more difficult to define significant percentage changes when the magnitudes of the values are not known. A percentage selected to be significant for a relatively large leak rate could be inconsequential when the leak rate is very small.

Section 7.12 defines the growth rate factor as "1.1 or more." The intent of a 1.1 factor is a minimum value. The factor that would be applied depends on the growth rate evaluation and would be selected to provide a conservative growth distribution. The factor may be based upon the rate of increase in growth but would be dependent upon the details of the evaluation. It should be emphasized that the PG&E goal is to perform conservative projections to maximize the potential for satisfying condition monitoring performance requirements.

Section 7.12 requires that the last inspection burst pressure be less than 5600 psi to perform the comparisons with prior cycle projections. The primary water stress corrosion cracking (PWSCC) alternate repair criteria (ARC) computer code used for burst pressure analyses groups all burst pressures above 6100 psi in order to reduce memory requirements and enhance calculation speed. The distribution for indications above 6100 psi burst pressures is not considered to be important to the tube integrity assessments. The 5600 psi threshold for evaluation is then 500 psi below the 6100 psi upper bound analysis value in order to limit the evaluation to burst pressure changes of significance for the methods evaluation.

Question 3

Clarify how the leakage values from the various ARCs will be combined. The specific concern is whether the limit for the ARCs (GL 95-05, W, PWSCC ARC) has been reduced by 1 gpm to account for leakage from the freespan sources. If not, why not?*

PG&E Response to Question 3

For condition monitoring and operational assessment of steam line break (SLB) leakage, PG&E will combine predicted leakage from all sources (Generic Letter 95-05 Outer Diameter Stress Corrosion Cracking (ODSCC) ARC, W* ARC, PWSCC ARC, and non-ARC flaws) for each steam generator and compare the aggregate result to the allowable limit determined from the licensing basis dose calculation for the postulated SLB accident. These results will be included in the 120-day report.

Question 4

Question 4.1

Mixed Mode Effects - Are there reporting requirements/conditions to bound the limits of the mixed mode tests. There appears to be a reporting requirement, license condition, and/or a methodology change needed to address what actions are needed for non-interacting mixed mode indications. That is, there is a potential to have a 10 percent to 15 percent reduction in burst pressure for non-interacting mixed mode indications.

Why is it acceptable to permit this reduction? Shouldn't the burst criterion for these indications be increased (e.g., 1.15 x 1.4 x at steam line break pressure)? This may also be needed to address situations when the flaws are interacting and the circumferential indication is less than 80 percent average depth. Also, there may need to be an axial through-wall length limit for which a detailed mixed mode effects assessment may be needed (e.g., 0.25 inch to bound the tests).

PG&E Response to Question 4.1

The intent of the WCAP-15573, Revision 1, commitments is to evaluate any mixed mode indication that may have the potential for a significant burst pressure reduction. Per the first paragraph on page 7-23 of Section 7.9.5 in WCAP-15573, Revision 1, the evaluation would "include interacting axial and circumferential indications having the average circumferential depth greater than 80 percent or an axial indication having a throughwall length greater than 0.25 inch." The 80 percent depth value includes non-destructive examination uncertainties and the evaluation would be performed for indications within a few percent of 80 percent (i.e., 75 percent) as well as greater than 80 percent. Based on the burst test results of Table 5-8 of WCAP-15573, Revision 1, for intersecting axial and circumferential indications, either an axial indication throughwall length greater than 0.25 inch or a long (0.6 inch in test data) indication with greater than or equal to 80 percent average depth is required for burst pressure reductions greater than 10 percent for circumferential depths near 80 percent. There are no data indicating a potential burst pressure reduction greater than 10 percent unless the axial throughwall length exceeds these values. For conservatism, the commitment to perform detailed evaluations of interacting mixed mode indications is extended to include average circumferential depths greater than 75 percent or axial indications with a throughwall length greater than 0.25 inch or an average depth of greater than 80 percent with a length greater than 0.5 inch. The 10 percent reduction factor is intended to define a level of significance to a mixed mode indication that is small compared to the burst margin requirement of 1.4 times SLB differential pressure for constrained indications. Given the low probability (estimates given in Table 7-1 of WCAP-15573, Revision 1) of finding an axial throughwall length greater than 0.25 inch 'intersecting' a circumferential indication near 80 percent average depth, there is a negligible likelihood of actually having a 10 percent or larger burst pressure reduction. The conditional commitment (1^{st} bullet on page 7-23 of WCAP-15573, Revision 1) relative to finding a mixed mode indication with a burst pressure reduction of more than 10 percent and to less that 4000 psi provides for an increase in the burst margin requirements for all indications under the low likelihood event that a significant mixed mode indication is found in an inspection.

The test data of Table 5.9 of WCAP-15573, Revision 1, at separation distances of 0.25 inch, show burst pressure reductions of less than 10 percent for circumferential average depths of about 70 percent and throughwall axial indications of 0.50 inch with a shallow extension of the axial indication, and for 100 percent deep circumferential indications with no extension of a 100 percent deep axial indication. Since the test data do not bound all non-interacting (separation distances greater than 0.25 inch) conditions, a detailed mixed mode evaluation will be performed for all mixed mode indications found to have an axial crack throughwall length of greater than 0.25 inch and a circumferential average depth greater than 75 percent. These detailed evaluations will utilize existing burst test data and analysis methods as much as possible. Additional burst testing will be performed only if necessary to supplement existing data.

In summary, detailed evaluations will be performed for mixed mode indications as follows:

- Interacting mixed mode indications having a circumferential average depth greater than 75 percent or an axial indication with either a throughwall length greater than 0.25 inch or an average depth of greater than 80 percent over a length greater than 0.5 inch.

- Non-interacting mixed mode indications having a circumferential average depth greater than 75 percent and an axial throughwall length greater than 0.25 inch.

Additional Question on Response to Question 4.1

With regard to the response to question 4.1, we believe there is one more instance in which you will perform a detailed evaluation. This is referenced on page 7-22 (1st paragraph under 7.9.5): "if the mixed mode indication is found to be interacting (separation distance of 0.25" not demonstrated by NDE null points or both the axial and circ indications are throughwall at any point), the indication shall be evaluated for a reduction.."

PG&E Response to Additional Question on Response to Question 4.1

PG&E will evaluate all mixed mode indications for potential burst and leakage effects and provide the results of the assessment in the 120-day report. A trending analysis will be performed to assess the potential for increasing mixed mode effects (e.g., circumferential crack depths, burst pressure reductions, increased leakage rates) over time. Since it is expected that the axial cracks will increase in size with time as indications are left in service based upon the ARC, the assessment will emphasize tracking of circumferential crack sizes occurring at TSP intersections as mixed mode indications. If the trending indicates a need to modify the criteria that cause an increase in the burst margin requirements (WCAP-15573, Revision 1, page 7-23, "more than 10% and to less than 4000 psi") to ensure that no performance criteria is violated, these criteria will be made more conservative.

The indications that are most likely to require a detailed mixed mode evaluation are:

1. Interacting mixed mode indications having a circumferential average depth greater than 75 percent or an axial indication with either a throughwall length greater than 0.25 inch or an average depth of greater than 80 percent over a length greater than 0.5 inch.

2. Non-interacting mixed mode indications having a circumferential depth greater than 75 percent and an axial throughwall length greater than 0.25 inch.

3. If a mixed mode indication is found to be interacting (separation distance of 0.25 inch not demonstrated by NDE null points or both the axial and circ indications are throughwall at any point), the indication shall be evaluated for a reduction in the burst pressure below the acceptance limits based on the mixed mode test results of WCAP-15573, Revision 1, Section 5.4.

It is anticipated that most of the indications found in an inspection will be able to be readily evaluated using the existing burst pressure test results given in the WCAP-15573, Revision 1, tables and would not require a more detailed evaluation.

As discussed in Section 7.9.4 of WCAP-15733, Revision 1, there is a very low probability that mixed mode indications will contribute to challenging burst or leakage integrity based on an evaluation of historical data and estimates of future flaw populations. The trending described above will provide a built in mechanism to modify burst margin requirements if the probability estimates prove to be inaccurate.

The mixed mode burst pressure reduction for the axial indication can be interpreted as equivalent to an increase in the axial length of the indication. Based on the reductions in burst pressure for throughwall axial cracks, short cracks show larger reductions in burst pressure than long cracks for the same increase in length. That is, the slope, of the differential pressure divided by the differential length, of the burst correlation is much steeper for short indications. The less than 4000 psi criterion for a reduced burst pressure was included to exclude the short cracks that may have larger burst pressure reductions but do not challenge structural integrity.

Question 4.2

Are there similar issues with the leak rate evaluation for interacting/non-interacting mixed mode indications?

PG&E Response to Question 4.2

Whether or not to expect such interactions regarding the leak rate can be addressed by considering the extent of the plastic zone ahead of the crack tip. One estimate of the extent of material involved in resisting burst was developed and documented in WCAP-15573, Revision 0. This section of the WCAP was removed in Revision 1. However, this analysis work concluded that the length of material involved in resisting burst of a crack with a critical length corresponding to a differential pressure on the order of 3584 psi at 650 degrees F was about 0.17 inch. The test results of Table 5.9 of WCAP-15573, Revision 1, at a separation distance of 0.25 inch are reasonably consistent with this model based upon a burst pressure reduction of about 8 percent for an axial indication having a burst pressure of 4928 psi (4490 psi at 650 degrees F). Since the 0.17 inch length is significantly less than the minimum separation distance of 0.25 inch and the effective pressure is significantly greater than the expected SLB pressure of 2405 psi, it would be expected that an adjustment to the leak rate procedure would not be necessary for separations as small as 0.25 inch. A second determination was made by considering the length of the plastic zone ahead of a potential leaking axial crack. If some of the material in the ligament separating the axial crack from the circumferential crack is expected to remain elastic, then it would also be expected that although an interaction might affect the burst pressure, it would not affect the leak rate. The plastic zone extent was calculated using the Zahoor expressions from the Electric Power Research Institute Ductile Fracture Handbook and the Paris equations in NUREG/CR-3464. Both expressions gave the same results as illustrated on Figure 4.2-1 of this letter for a differential pressure of 2405 psi. Up to a throughwall length of about 0.5 inch the length of the plastic zone ahead of the crack tip remains less than 0.25 inch. Hence, no meaningful interaction effect on the leak rate from such cracks would be expected.

Question 5

In several places it is indicated that the +Point coil inspection is the supplementary method to the bobbin coil inspection. Is +Point coil a generic term that refers to a 3-coil rotating pancake coil probe or is it specifically referring to the +Point coil alone?

PG&E Response to Question 5

The rotating coil probe used for the inspections supporting the PWSCC ARC includes a mid-range +Point coil, a high frequency 0.080 inch (80 mil coil) and a mid-range 0.115 inch (115 mil) coil. The ARC applications for the +Point and 80 mil coils are described in WCAP-15573, Revision 1.

The above identifies the currently applied probe. Alternate probes that permit the WCAP-15573, Revision 1, required applications of the +Point coil and the 80 mil coil are considered acceptable probes.

When WCAP-15573, Revision 1, identifies a +Point inspection (e.g., detection and crack sizing), the NDE analyses are conducted using the +Point coil. When WCAP-15573, Revision 1, identifies that an 80 mil coil is to be used (e.g., separation distance measurements), the NDE analyses for that part of the inspection are conducted using the 80 mil coil.

Question 6

In determining the 0.25 inch separation distance for mixed mode cracks, it appears that this is based on T-shaped flaws with a 0.5 inch 100 percent through-wall axial flaw. Discuss the basis for using T-shaped flaws rather than L-shaped flaws in these tests. For 100 percent TW flaws, are L-shaped flaws more limiting than T-shaped flaws?

PG&E Response to Question 6

All of the test specimen results that were reported in Table 5.9 of WCAP-15573, Revision 1, were T-shaped type specimens. That is, the axial indication would intersect the center of the circumferential indication if extended to the circumferential indication. There were no similar tests performed for L-shaped type specimens where extension of the axial indication would result in intersection with the end of the circumferential indication. The configurations under discussion are illustrated on Figure 6-1 in this letter. The T-shape type configuration was used to develop the effect of the mixed mode separation distance. For burst of the tube to occur, the material at the tips of the crack must deform until a critical crack tip opening displacement (CTOD) is reached. When the critical CTOD is achieved, unstable propagation of the crack ensues. The presence of the crack causes the material at the tip of the crack to be subjected to a significant concentration of the applied hoop stress. Since the tube material is very ductile, a sizable (relatively) plastic zone develops and the tip of the crack opens to a blunted configuration. The width of the blunted opening is the CTOD.

It is known that the size of the plastic zone at the tip of a crack is reduced if an axial stress is applied to the specimen in addition to the hoop stress. The CTOD is likewise reduced and the pressure induced hoop stress needed to result in unstable extension of the crack is increased. Inspection of the geometry of the test specimens implies that the T-shaped type specimen would be expected to be weakened by the presence of the circumferential crack because of an attendant reduction of the axial stress at the tip of the axial crack. The axial pressure stress is not transmitted across the flanks of the circumferential crack. The same magnitude of reduction would not be expected to occur for the L-shaped type cracking configuration. This is because there is a near direct material path ahead of the axial crack along the length of the tube. Therefore, if there is a meaningful difference in stress between the T-shaped type specimens and L-shaped type specimens, the testing results for separation distance from T-shaped type specimens would be expected to bound results from similar L-shaped type specimens. For intersecting axial and circumferential indications (WCAP-15573, Revision 1, Table 5-8 results), the crack opens as a flap and no significant difference in applied stress would be expected between L-shaped and T-shaped indications.

Question 7

Page 7-23 (Section 7.9.5) of WCAP-15573, Revision 1, indicates that the measured average depths (and presumably the maximum depths) are to be adjusted by deterministic or Monte Carlo Methods for NDE uncertainty at the upper 95 percent probability level to define the average circumferential crack depth for the mixed mode evaluations. Page 4-36 (last paragraph prior to Section 4.10.6) indicates: "for evaluating mixed mode indications under the PWSCC ARC, the NDE uncertainties of Tables 4-18 are applied, which increases the average depth sizing uncertainties." Page 4-37 (last paragraph before 4.11) indicates that "the NDE uncertainty regression parameters of Tables 4-19 to 4-21 are used in evaluations requiring the use of circumferential crack NDE sizing uncertainties....." It goes on to say that ..."the unadjusted DE correlations would be used for operational assessments of circumferential cracks".

Please clarify, how NDE uncertainties will be used in assessing mixed mode Indications? Please clarify when an operational assessment for a circumferential crack would be needed (i.e., all are plugged).

PG&E Response to Question 7

For mixed mode evaluations involving potential interaction between the axial and circumferential cracks, only circumferential average depths are used in the evaluations to assess potential reductions in the axial indication burst pressure or increase in the axial indication leakage. In this case, the ODSCC database of WCAP-15573, Revision 1, Table 4-18 is applied as used to develop the NDE uncertainty correlations of Figures 4-33 and 4-35. The correlations are always applied rather than the mean and standard deviations of the total database population given at the bottom of Tables 4-16 to 4-18, which are provided for general interest only. The databases of Tables 4-16 to 4-18 were used for the regression analyses. The regression parameters are listed in Tables 4-19 through 4-21. Table 4-18 excludes shallow tails of the ODSCC indications, which are not of interest for mixed mode interaction effects. The circumferential ODSCC average depth uncertainties of Table 4-18 are more conservative at the 95 percent level than the uncertainties of Table 4-17 that include the shallow tails in the uncertainty evaluation. The PWSCC database of Table 4-16 and the NDE uncertainty correlations of Figures 4-36 to 4-38 are used for all PWSCC analyses since the database does not include significant shallow tails in the indications.

When the circumferential indications are to be evaluated for structural and leakage integrity rather than a mixed mode evaluation, the ODSCC database of Table 4-17 and the NDE uncertainties of Figures 4-30 to 4-32 are applied for the analysis. For structural analysis of the circumferential indication, the total length and depth uncertainty are important since the burst correlation is dependent upon the 360 degrees percent degraded area. Average depth uncertainties are applied for structural analyses and maximum depth uncertainties are applied for leakage analyses, consistent with the WCAP-15573, Revision 1, methods for axial PWSCC. The above is described in Section 4.10.6 of WCAP-15573, Revision 1.

The methods description given in the question adequately describes the deterministic and Monte Carlo methods with the clarification that the regression correlations applied at the NDE indication size are used to obtain the 95 percent uncertainties or corrected indication sizes in the deterministic analyses.

WCAP-15573, Revision 1, Section 7.9.5 identifies that either deterministic or Monte Carlo analyses may be used to develop the upper 95th percentile for the average circumferential depth in mixed mode analyses. Either method is acceptable. The deterministic method of adding the 95th percentile uncertainty to the NDE average depth is a simple analysis that is generally expected to be more conservative than the detailed Monte Carlo analysis.

Operational assessments are required for all degradation mechanisms found in an inspection per the requirements of NEI 97-06, which are implemented at PG&E. This assessment for circumferential indications will be included in the overall outage operational assessment rather than the PWSCC ARC 120 report. Although all circumferential indications are repaired, potential changes in detection capability (magnitude of undetected indications that may be left in service) or growth rates can influence the operational assessment for repaired indications.

Figure 4.2-1
Plastic Zone as a Function of Crack Length

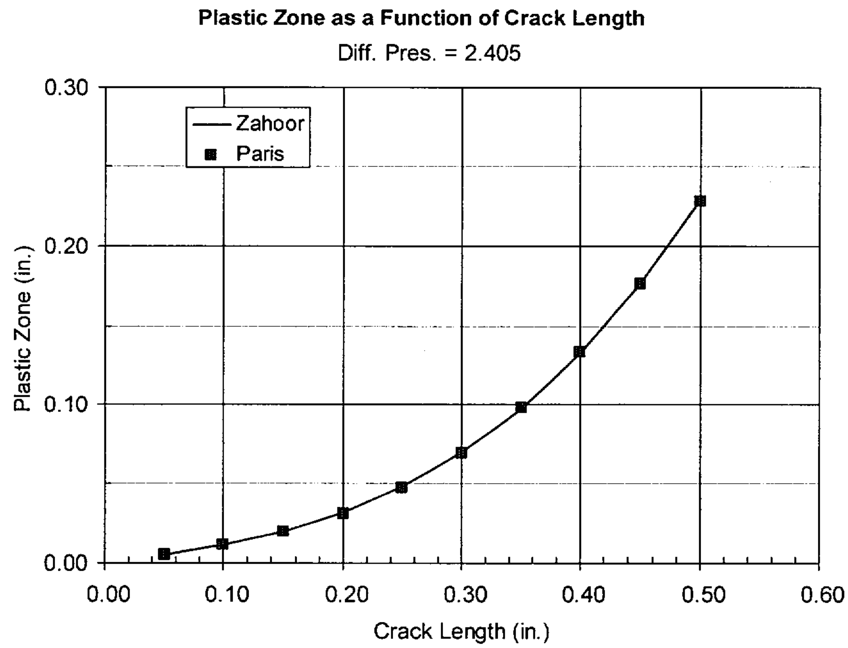
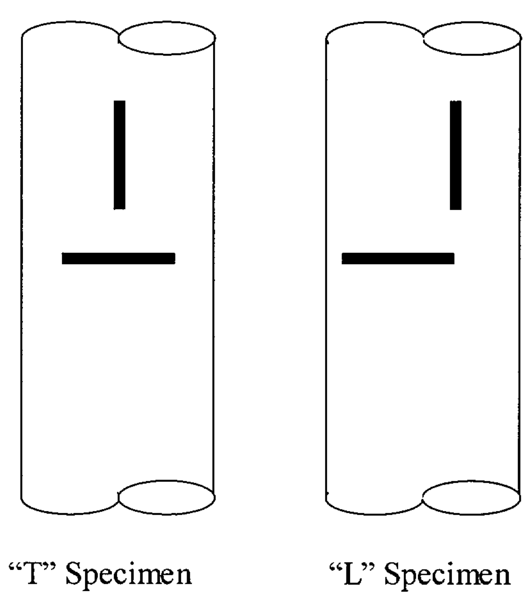


Figure 6-1
Potential Specimen Configurations for Separation Distance Evaluation



PG&E Response to NRC Requests for Additional Information Received on April 9, 2002, Regarding Supplement 3 to LAR 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing"

Questions Related to Leak Rate Model

<u>Question 1</u>

For a mixed mode indication, first the leak rate from an axial PWSCC indication is determined. If there is no leakage predicted, it is assumed that the presence of the circumferential flaw would not result in leakage (i.e., the circumferential flaw would not lower the tearing pressure of the axial flaw). Although this may be an adequate assumption for most mixed mode indications, there may be a need for a more detailed assessment when the axial flaw is deep (e.g., 80 percent through-wall). Please discuss your plans in this area.

<u>PG&E Response to Question 1</u>

All mixed mode indications are evaluated as part of the condition monitoring evaluation required by Nuclear Energy Institute (NEI) report NEI 97-06. The more limiting indications are expected to be interacting mixed mode indications having a circumferential average depth greater than 75 percent or an axial indication with either a throughwall length greater than 0.25 inch or an average depth of greater than 80 percent over a length greater than 0.5 inch. The evaluations include assessments of both a potential reduction in the axial indication burst pressure and a potential increase in leakage. If the assessment indicates a reduction in burst pressure, the indication would be evaluated for a potential reduction in the ligament tearing pressure. The potential reduction would be dependent upon whether the ligament tearing pressure is higher than or less than the throughwall burst pressure for the crack length. If the evaluation indicates a reduction in the ligament tearing pressure to less than or equal to the steam line break (SLB) pressure differential, the ligament tearing length would be estimated for the leakage calculation. Although the analysis details are dependent upon the specific mixed mode conditions, one method could be to calculate the ligament tearing length at the SLB pressure difference increased by a factor corresponding to the reduction in the tearing or burst pressure. When detailed mixed mode evaluations are required, the assessment will be described in the 120-day report. No leakage corrections are required when the mixed mode indications are non-interacting.

<u>Question 2</u>

The adjustment factor of 10 for when a leaking axial PWSCC crack intersects a 100 percent through-wall circumferential indication is based, in part, on the through-wall length of the axial indication (e.g., less than 0.2-inch). Discuss your plans for performing a detailed assessment of mixed mode indications when the circumferential *depth exceeds 80 percent through-wall and the axial through-wall (or near through-wall) length is "large".*

PG&E Response to Question 2

All mixed mode indications are evaluated. Detailed evaluations may be required for interacting mixed mode indications having a circumferential average depth greater than 75 percent or an axial indication with a throughwall length greater than 0.25 inch. If an adjustment to the axial crack leak rate is found to be necessary, the methods discussed in Section 6.6.1 and Figures 6-14 and 6-15 of WCAP-15573, Revision 1, for developing a leak rate correction, can be applied to the specific lengths of the axial and circumferential indications. Results will be reported in the 120-day report.

Question 3

The leak rate multiplier, ML, will be used to adjust the 95/95 leak rate. In cases where there are only mixed mode indications with circumferential indications between one of the two depth ranges (i.e., 50 percent to 80 percent, greater than 80 percent), this correction is straightforward since there will only be one leak rate multiplier. However, the correction becomes more complicated if there are 2 interacting mixed mode indications where the circumferential depths are say 70 percent through-wall and 95 percent through-wall (i.e., in both depth ranges). In this case, describe how the leak rate multipliers will be applied.

PG&E Response to Question 3

When applying the first bullet on page 7-23 of Section 7.9.5 of WCAP-15573, Revision 1, under the multiple significant conditions described in the question, the mixed mode leak rate multipliers for operational assessments will be applied as a weighted average of the multiplier for 50 percent to 80 percent depth and the multiplier for greater than 80 percent depth. The weighted average is calculated by:

- M_{Lg} = generic SLB leak rate multiplier
- F_1 = fraction of interacting mixed mode indications that have greater than 50 percent and less than or equal to 80 percent average circumferential depth
- F_2 = fraction of interacting mixed mode indications that have greater than 80 percent average circumferential depth
- f = fraction of detected axial primary water stress corrosion cracking (PWSCC) indications found to be interacting independent of depth
- L_{F1} = 1.7
- L_{F2} = 10
- $M_{Lg} = 1 + (L_{F1} - 1) f F_1 + (L_{F2} - 1) f F_2$

The generic mixed mode leak rate multiplier was developed under the expected condition that mixed mode indications with predicted leakage would be a small fraction of the population predicted to leak. If the mixed mode indications that leak contribute a significant fraction to total condition monitoring PWSCC ARC leakage, the generic multiplier may not be conservative. In this case, an outage specific leakage multiplier, M_{Los}, is defined as follows:

- M_{Los} = outage specific leak rate multiplier obtained from condition monitoring analyses that is applied for the operational assessment of the next cycle
- LR_{MM} = total condition monitoring PWSCC ARC leakage including adjustments for mixed mode indications
- $LR_{w/oMM}$ = total condition monitoring PWSCC ARC leakage without any adjustments for mixed mode indications
- M_{Los} = $LR_{MM}/LR_{w/oMM}$

The mixed mode leakage multiplier applied for the operational assessment of the next cycle will be the larger of M_{Lg} or M_{Los}, where M_{Los} is updated on a cycle by cycle basis and M_{Lq} is the generic multiplier with f defined in WCAP-15573, Revision 1, as the largest f value from historical data. As more indications are left in service based upon application of the ARC, it is expected that M_{Los} would decrease from cycle to cycle under the assumption that the number of mixed mode indications remains relatively constant between cycles. Once it is determined that a leakage correction is required, the leakage multiplier for operational assessments would never be less than M_{Lg}.

Any such adjustments will be reported in the 120 day report.

Question 4

It was indicated that the leak rate multiplier adjustments should be made for all subsequent operational assessments. Please discuss how this will be performed.

PG&E Response to Question 4

As described in WCAP-15573, Revision 1, Section 6.6.2, page 6-22, "The observed fraction (f) of intersecting axial and circumferential cracks will be determined based on the larger of the current inspection results or historical data."

Question 5

On page 7-23 of WCAP-15573, Revision 1, there are two instances discussed for when the leak rate multiplier would be applied (i.e., 2nd and 3rd bullets on the page). Please clarify the difference between these two instances.

PG&E Response to Question 5

The first bullet on page 7-23 of WCAP-15573, Revision 1, defines the condition monitoring corrections and the operational assessment corrections that are dependent upon the circumferential average depth. The paragraph states that the corrections for the operational assessment are applied to each steam generator (SG) (i.e., all SGs).

The second bullet is more general in requiring that the larger leak rate multiplier must be applied if any previously +Point inspected intersection is found to have a circumferential indication with an average depth greater than 80 percent. This statement does not require that the circumferential indication be part of a mixed mode indication. The second paragraph also states that the corrections for the operational assessment are applied to each SG (i.e., all SGs).

Question 6

Clarify whether tube 11-3, crack 1 is included in the leakage database and reflected in the regression results provided in Table 6-4. Discuss your plans for incorporating new data and providing the updated database to the NRC.

PG&E Response to Question 6

Tube 11-3, crack 1 is not included in the leakage database used in the regression results in Table 6-4 of WCAP-15573, Revision 1, as the correlation is dependent on throughwall lengths and the 11-3 indication was not throughwall. The addition of the few available indications having part throughwall depths leading to ligament tearing and leakage would not significantly influence the correlation due to the large database for corrosion throughwall indications in the correlation. If the correlation was based upon ligament tearing to include the partial depth indications, application of the ligament tearing model to corrosion throughwall indications would increase the throughwall lengths for a large fraction of these indications while assigning the same measured leak rate. Consequently, there are no current plans to update the leak rate correlation. The leak rate correlation based on throughwall length is conservative when applied in conjunction with a ligament tearing model.

Question 7

There is very little data confirming the conservatism of the entire leakage model. In particular, there is very little data verifying (1) that the ANL model conservatively predicts the length of the through-wall regions of a stress corrosion crack, and (2) the resultant leak rate calculated from CRACKFLO (based on these through-wall lengths) conservatively predicts the measured leakage from these flaws. In fact, there is only one PWSCC data point that can be used to validate the entire model. In this regard, discuss your plans to assess these various components of the leak rate model. For example (as discussed in the Sequoyah safety evaluation for this ARC), will crack profiles be determined by NDE prior to steam line break testing, will crack profiles be determined by post-test destructive examination, will the crack profiles then be input into the ANL model to determine predicted length of the pop-through region, will these results then be used to confirm the adequacy of the model?

PG&E Response to Question 7

There is a substantial database supporting the CRACKFLO code correlation with measured leak rates. Current data limitations apply only to the lack of data to compare ligament tearing lengths with that predicted with the Argonne National Laboratory (ANL) model since these measurements have not been a part of the scope of leakage tests or destructive examinations.

The data limitations apply only to the tearing lengths for part throughwall indications. The total predicted leakage is comprised of the following:

- Indications predicted by the analysis to be throughwall: The non-destructive examination (NDE) analyses with uncertainties included lead to the corrosion throughwall lengths, which are the basis for the CRACKFLO code leak rate correlation. Application of the ligament tearing model will increase the throughwall lengths for a large fraction of the indications, which then leads to over-predictions of leak rates when applying the CRACKFLO code correlation based upon corrosion lengths. Since any ligament tearing increases crack lengths beyond the corrosion length, uncertainties on the tearing lengths only vary the degree of overestimates of the leak rates. It would be expected that using corrosion lengths in the CRACKFLO code correlation rather than tearing lengths would increase the variance for the correlation and lead to increased leak rates at 95 percent confidence. This leakage contribution is expected to dominate the predicted leak rate since there is only a narrow band of part throughwall depths and lengths that lead to ligament tearing.

- Indications predicted to tear and leak that actually do not tear and leak: The ligament tearing model is based upon axially aligned cracks as simulated by axial notches for the tests supporting the model. Corrosion cracks are rarely perfectly aligned axially. The indications initiate as microcracks that are offset by ligaments in the circumferential direction. The cracks grow to macrocracks by joining of the microcracks so that the macrocracks are staggered in the axial direction. This reduces the potential for ligament tearing compared to the basis for the model. This staggering effect is likely to be a contributor to the small number of partial depth corrosion cracks found to tear throughwall during leak testing.

- Indications not predicted to tear and leak that actually do tear and leak: This population can be expected to be small since the ANL ligament tearing model includes uncertainties for this effect that are included in the evaluation of leakage at 95 percent confidence.

- Indications predicted to tear and leak that actually do tear and leak: It is only this population of leaking indications that uncertainty in the tearing length could lead to underestimates of the leak rate. Ligament tearing at SLB conditions occurs only for a narrow range of crack lengths and depths. As a consequence, this population can be expected to be small compared to the indications that grow throughwall and dominate the predicted leak rates. Since predicted leakage is at the 95 percent prediction level, it is very unlikely that this condition would significantly affect the actual margin.

The effects of including ligament tearing in leak rate analyses can be assessed from an available evaluation performed for normal operating leak rates. This evaluation was performed to support axial outside diameter stress corrosion cracking (ODSCC) analyses and most of the indications included are ODSCC except for a few short PWSCC indications (e.g., PWSCC specimen 11-3 was not included) and only one ODSCC indication was found that demonstrated partial throughwall ligament tearing with leakage. Most of the leak rate indications in the WCAP-15573, Revision 1, CRACKFLO code leak rate correlation were included in this study. The ANL ligament tearing model was used to predict the ligament tearing throughwall (TW) lengths at a normal operating pressure differential of 1250 pounds per square inch. Figure 7-1 contained in this letter shows the cumulative distribution of the increases in TW length from ligament tearing (i.e., TW length from ligament tearing minus the corrosion TW length). It is seen, even at normal operating pressure differentials, that ligament tearing increases the TW for all but about 28 percent of the indications. The increases in TW length are as large as 0.43 inch. Figure 7-2 shows the increase in TW length as a function of the corrosion TW length. From this figure, it is seen that the tearing length increases for very short (less than 0.15 inch) corrosion TW lengths are negligible. The increases in length occur for the larger lengths and would result in substantial increases in the predicted leak rates. Figure 7-3 shows the trends of measured leak rates versus TW length for both corrosion TW lengths and ligament tearing TW lengths. It is seen that the ligament tearing TW lengths decrease the slope of the correlation although the uncertainties, as indicated by R^2, are the same for both throughwall lengths. The Figure 7-3 results show that the mean length for ligament tearing is about 0.1 inch longer for a leak rate of about 0.01 gallons per minute and increases for larger leak rates. An approximate estimate of the mean increase in leak rates using ligament tearing rather than corrosion lengths for the CRACKFLO code correlation is the difference in the two regression fits for a given length. The difference is about a factor of 2 to 3 on leak rates with the difference increasing with TW length. Since the CRACKFLO code dependence on TW length has an exponent of about three, the effect of decreasing the slope between measured leak rates and the CRACKFLO code leak rates is magnified compared to that of Figure 7-3. Figure 7-4 shows that the slope of the measured versus the CRACKFLO code normal operating leak rate correlation is much lower than the ideal 45 degree line using the ligament tearing lengths for the CRACKFLO code analyses. The corresponding slope for the CRACKFLO code leak rates based on corrosion TW lengths would be steeper and closer to the ideal line but likely a little less than 45 degrees since the CRACKFLO code tends to overestimate leak rates. Although these results are for normal operating pressure differentials, the results clearly show that predicted leak rates using ligament tearing lengths in a the CRACKFLO code correlation based on corrosion lengths leads to conservative leak rate predictions as noted in the first bullet above.

Both pre-pull and post-pull rotating coil NDE data prior to leakage testing are a standard part of any pulled tube examination. These data can be used to obtain crack profiles.

The crack profiles obtained by post-test destructive examinations are the corrosion induced crack profiles as the causes of ligament tearing can be from the leak test, the burst test and/or the opening of the crack face to permit fractography for the crack profile. Consequently, the currently available data do not provide information on tearing lengths at SLB conditions.

If PG&E removes any tubes either for axial PWSCC or axial ODSCC, PG&E will attempt to identify ligament tearing following the SLB leak test. If tearing following the SLB test can be identified, the difference in the corrosion lengths and the torn length following the SLB leak test would be conservatively assumed to have torn during the leak test. Tearing could have occurred during the tube removal and this would be classified as tearing during leak testing.

Experimental methods for identifying ligament tearing are not currently well-developed. Oxidation to darken the surface prior to ligament tearing, such as from burst testing, has been used in the past with mixed success. PG&E will apply oxidation, or an improved technique if available, to the indication following SLB leak testing to attempt to identify SLB ligament tearing as the difference in the throughwall length between the corrosion profile and the oxidized (darkened) throughwall length. PG&E will also collect rotating coil NDE data following the SLB leak test. These efforts would only be applied if the indication leaks at SLB conditions. Measurements of ligament tearing lengths would be compared with predictions from the ANL ligament tearing model. Comparisons of the measured and predicted leak rates would also be made applying the PWSCC ARC leakage model with both the NDE profile and the destructive exam profile. If the indication is outside diameter, available NDE sizing uncertainties for axial ODSCC indications would be applied.

Questions Related to Technical Specifications

Question 8

Revise Technical Specification 5.6.10.g to indicate that leakage from all sources (ARC and non-ARC) will be compared to the licensing basis steam line break dose calculation and that the 1 gpm limit would still apply to freespan leakage (i.e., could have up to licensing basis value but only 1 gpm can be from freespan sources).

PG&E Response to Question 8

PG&E will revise Technical Specification (TS) 5.6.10.g.2 with the following wording: "*The calculated SG leakage for condition monitoring from all sources (all alternate repair criteria and non-alternate repair criteria indications) exceeds the leakage limit determined from the licensing basis steam line break dose calculation*". The marked up TS 5.6.10.g.2 for this change is contained in Insert C of Enclosure 5 to this letter and is highlighted by a revision bar. The revised proposed TS 5.6.10.g.2 for this change is contained in Enclosure 6 to this letter.

As discussed in Section 7.8.1 and Section 7.11 of WCAP-15573, Revision 1, PG&E commits to a SLB condition monitoring and operational assessment limit of 1 gpm for SG leakage from freespan indication sources.

Question 9

Clarify how a TSP intersection with axial ODSCC (GL 95-05) and axial PWSCC (PWSCC ARC) will be dispositioned. Will the tube be plugged? If not, why not?

PG&E Response to Question 9

Tube support plate (TSP) intersections with both ODSCC and PWSCC indications will be repaired. PG&E will revise TS 5.5.9.d.1.f by adding a new item 4 with the following wording: "*A tube which contains a tube support plate intersection with both an axial ODSCC indication and an axial PWSCC indication will be removed from service.*" The marked up TS 5.5.9.d.1.f for this change is contained in Insert B of Enclosure 5 to this letter and is highlighted by a revision bar. The revised proposed TS 5.5.9.d.1.f for this change is contained in Enclosure 6 to this letter.

Question Related to General NDE

Question 10

In approving the Sequoyah amendment, Tennessee Valley Authority committed to enhancing their analyst guidelines to ensure correct probe positioning and movement (i.e., through the use of axial encoders and observation of the trigger pulse). Has PG&E made a similar commitment? If not, why not?

PG&E Response to Question 10

The dent sizes at DCPP are moderate and have not required probe downsizing. All dents are inspected with a 0.720 inch probe and no cases of probe stall have been observed during dent inspections.

The current DCPP eddy current procedure requires recording and observing either pull-out data or axial encoder data to ensure that the correct support plate elevation is being tested.

The current DCPP eddy current procedure requires monitoring the trigger pulse when setting up the calibration group to ensure that the C-scan plotting is correctly initialized. Data quality monitoring during analysis of the calibration group is required to detect probe stalling or skipping. However, to insure that PWSCC ARC inspection data is acquired with proper probe motion, the procedure will be revised to require that during analysis of eddy current rotating pancake coil data from each inspected dented TSP intersection, the trigger pulse channel shall be monitored to ensure that the rotating probe data is acceptable in terms of evenness around the tube circumference.

Questions Related to Mixed Mode Indications

Question 11

Regarding mixed mode indications, please clarify whether the assessments to be performed are consistently performed after adjusting the NDE data for the uncertainty in the measurement. Also, please clarify that all assessments for mixed mode indications will be made using the upper 95 percent probability value for the size/uncertainty.

PG&E Response to Question 11

As described in WCAP-15573, Revision 1, Section 7.9.5, page 7-22, the mixed mode evaluations are performed using circumferential average depths adjusted for NDE uncertainties at the upper 95 percent probability level.

Question 12

As additional data becomes available regarding the sizing of circumferential flaws, are there any plans to assess this data to confirm that the existing sizing models are conservative. If the assessment indicates the results are not conservative, will the uncertainty models (and technique) be updated so that the more conservative models are used?

PG&E Response to Question 12

When the industry develops total (technique plus analyst variability such as from testing of multiple analysts) NDE sizing uncertainties for circumferential indications using specimens that adequately represent sizing of circumferential indications at dented TSP intersections, it is expected that these data will be used to replace the current NDE uncertainties. Assuming these data represent an improved database, the updated NDE uncertainties would be applied if they lead to larger uncertainties at the upper 95 percent confidence level. If the improved correlations lead to smaller uncertainties at the upper 95 percent confidence level, NRC review and approval would be requested prior to application for alternate repair criteria analyses. NDE sizing for circumferential indications is a function of the NDE techniques, analyst training and experience, processing of the NDE profiles, and the adequacy of the specimens to represent the degradation of interest. Testing of multiple NDE analysts is considered necessary to define the sizing uncertainties for circumferential cracks. PG&E has no current plans to conduct another multiple analyst test for circumferential indications or any knowledge of a better specimen database than used to support WCAP-15573, Revision 1.

Question 13

In determining the 0.25 inch separation distance for mixed mode cracks, it appears that this is based on T-shaped flaws with a 0.5 inch 100 percent through-wall axial flaw. Discuss the basis for using T-shaped flaws rather than L-shaped flaws in these tests.

For 100 percent TW flaws, are L-shaped flaws more limiting than T-shaped flaws? For 100 percent through-wall cracks in an L configuration, the burst pressure may be significantly reduced due to "peeling" effect from the junction of the two cracks. Tecnatom of Spain conducted some tests and observed this phenomenon. They found that a circumferential crack interacting with a single axial crack in an L configuration has a much lower burst pressure than the same circumferential crack intersecting two parallel axial cracks in a T configuration.

PG&E Response to Question 13

The Tecnatom data are described in Westinghouse WCAP-15579 (Reference 8-33 of WCAP-15573, Revision 1). It is shown that the sealing system led these slots combinations to act as L-shaped indications. The tests were conducted with a thick foil that elevates the burst pressure by 10 percent to 30 percent. The tests are U-shaped geometries for which it is well established from mixed mode tests that the U-shaped mixed mode geometries are the weakest of all configurations due to opening of the flap between the two axial indications. Substantial test data for the U-shaped indications are given in WCAP-15579. The Westinghouse data in WCAP-15579 show that the interpretation of these tests is dependent on the test condition (no seal, bladder, foil – Figure 5.6) and that lowering the circumferential indication to 0.04 inch below the top of the tubesheet increases the flap opening pressure by a factor of three. Similarly, test data for L-shaped indications in WCAP-15579 show the L-shaped indication burst pressures increase rapidly with small distances of the circumferential crack within a support as would be found at dented TSP intersections. The U-shaped configurations were defined to bound mixed mode effects in hard rolled expansion transitions and are not found at dented TSP intersections where the axial flaws tend to be separated by about 180 degrees.

Due to the limited data in Table 5-8 of WCAP-15573, Revision 1, for L-shaped throughwall axial and circumferential indications, PG&E may find the need to supplement the burst database if mixed mode indications are found in an inspection with nearly throughwall axial and circumferential indications. The need would be dependent on the available database at the time such an indication was identified. However, there is a very low probability of finding a mixed mode indication with both axial and circumferential throughwall indications.

Figure 7-1
Increase in Through Wall Crack Length from Ligament Tearing

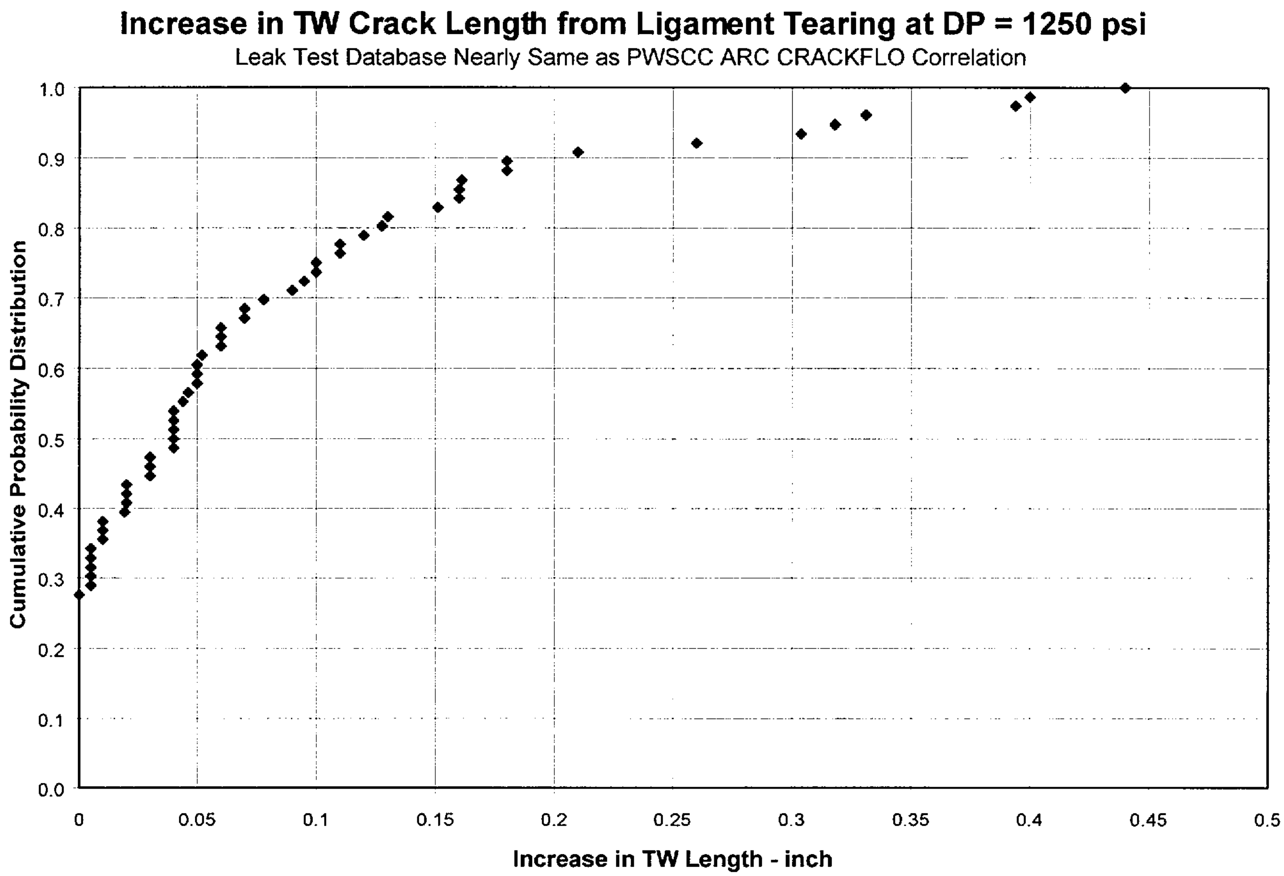


Figure 7-2
Increase in Trough Wall Length By Ligament Tearing Versus Corrosion Through Wall Length

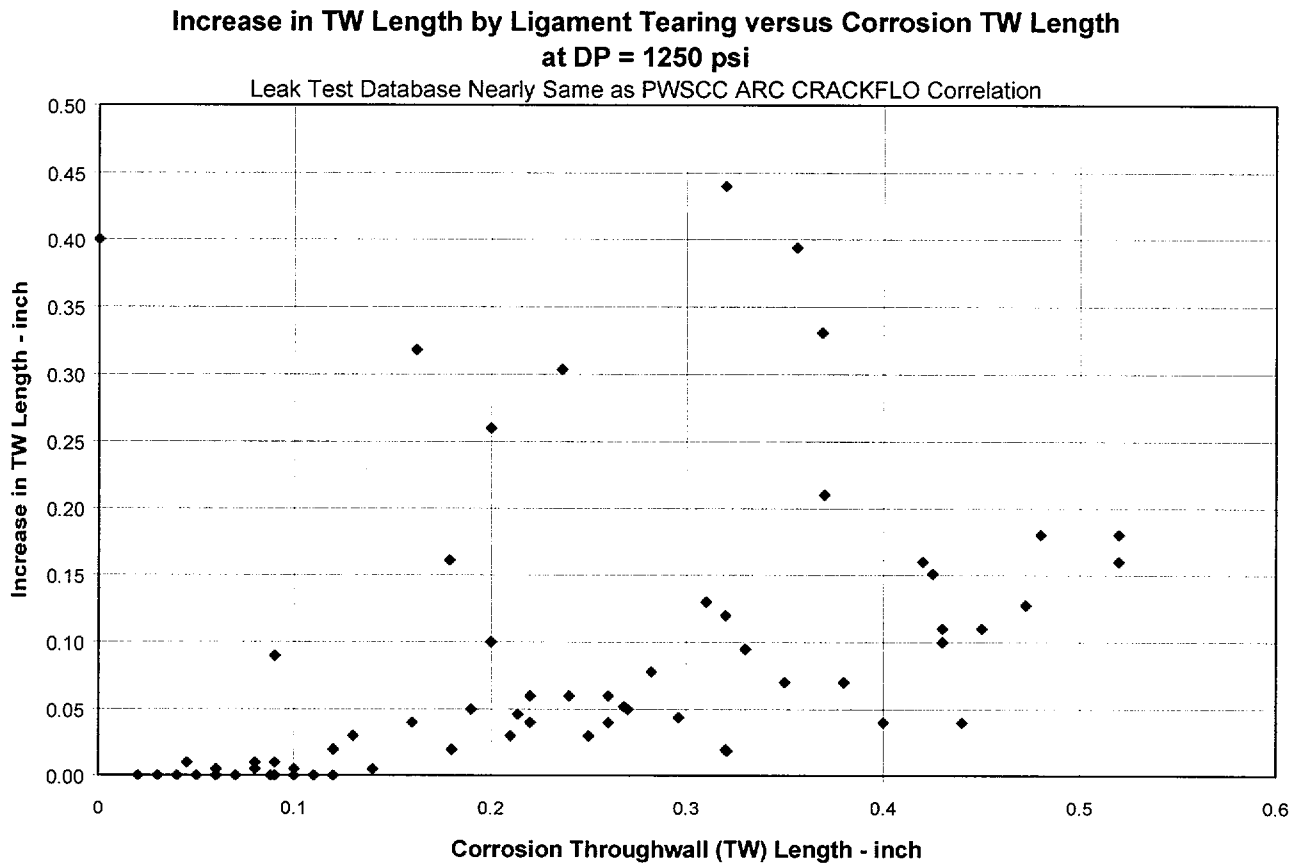


Figure 7-3
Measured Leak Rate Versus Through Wall Length

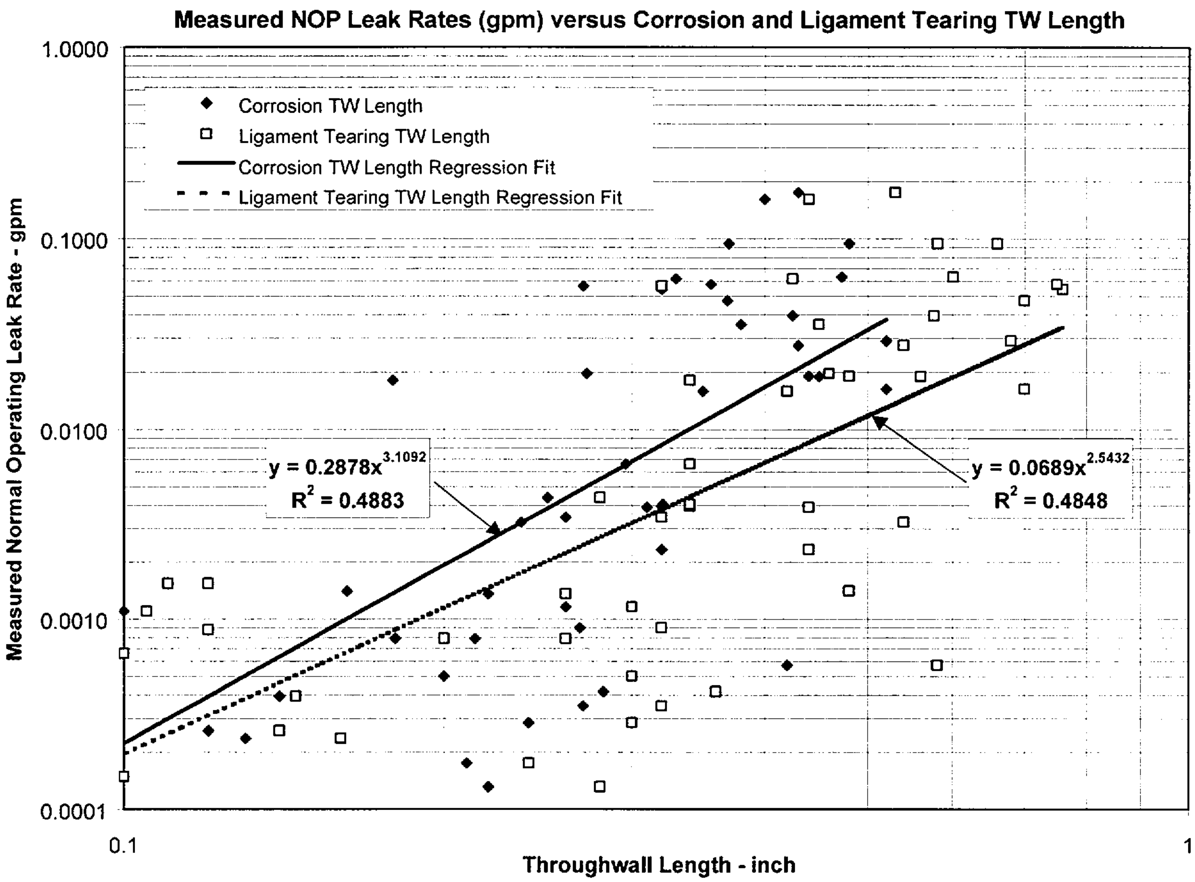
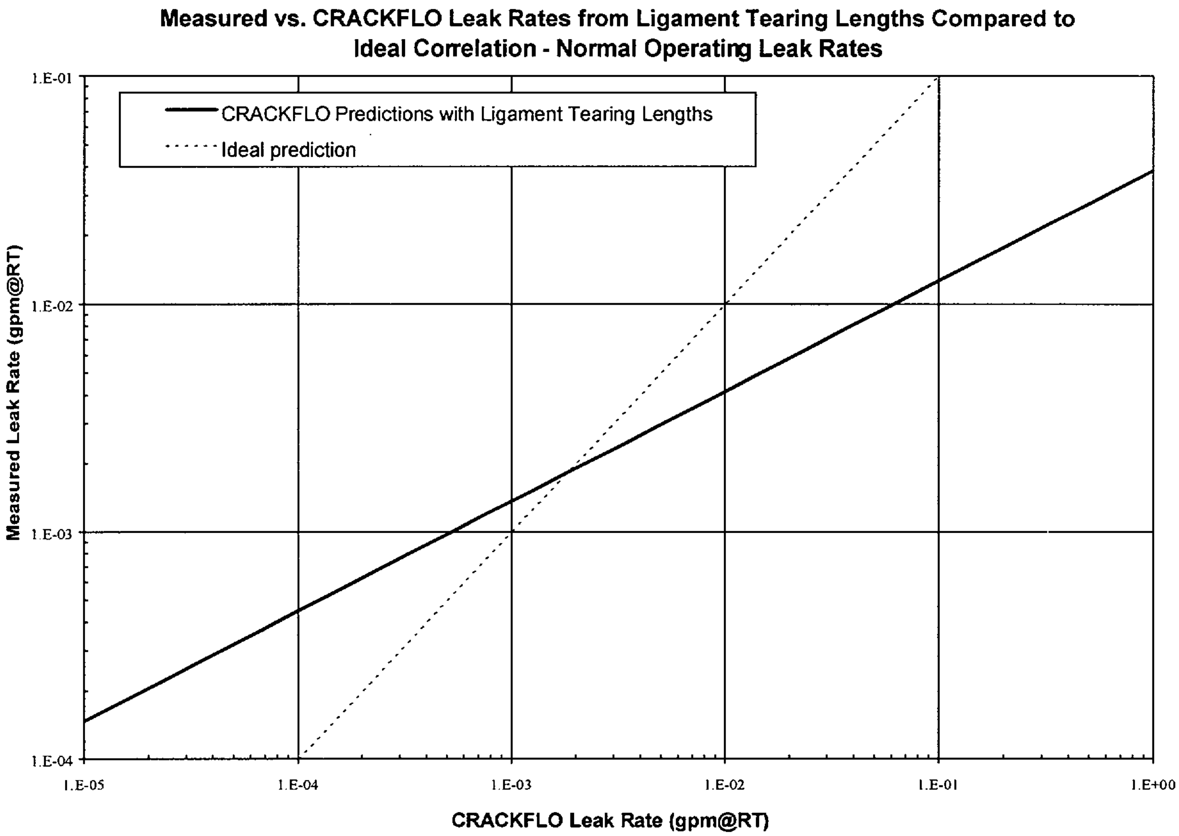


Figure 7-4
Measured Versus CRACKFLO Code Leak Rates



MARKED-UP TECHNICAL SPECIFICATIONS

Remove Page	Insert Page
5.0-11	5.0-11 5.0-11a
5.0-13	5.0-13 5.0-13a
5.0-30	5.0-30 5.0-30a

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

3. The tubes selected as the second and third samples (if required by Table 5.5.9-2) during each inservice inspection may be subjected to a partial tube inspection provided:

   a) The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found, and

   b) The inspections include those portions of the tubes where imperfections were previously found.

4. Implementation of the steam generator tube/tube support plate repair criteria requires a 100% bobbin coil inspection for hot-leg and cold-leg support plate intersections down to the lowest cold-leg tube support plate with known outside diameter stress corrosion cracking (ODSCC) indications. The determination of the lowest cold-leg tube support plate intersection having ODSCC indications shall be based on the performance of at least a 20% random sampling of tubes inspected over their full length.

Insert A

The results of each sample inspection shall be classified into one of the following three categories:

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

Note: In all inspections, previously degraded tubes must exhibit significant (greater than 10%) further wall penetrations to be included in the above percentage calculations.

c. Inspection Frequencies - The above required inservice inspections of SG tubes shall be performed at the following frequencies:

1. The first inservice inspection shall be performed after 6 Effective Full Power Months but within 24 calendar months of initial criticality. Subsequent inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If two consecutive inspections not including the preservice inspection, result in all inspection results falling into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval may be extended to a maximum of once per 40 months;

(continued)

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

Insert B

2) This definition does not apply to the portion of the tube within the tubesheet below the W* length. Acceptable tube wall degradation within the W* length shall be defined as in 5.5.9.d.1.k. *

g) Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of a Double Design Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in 5.5.9.c.3, above;

h) Tube Inspection means an inspection of the SG tube from the tube end (hot leg side) completely around the U-bend to the top support of the cold leg;

i) Preservice Inspection means an inspection of the full length of each tube in each SG performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed after the field hydrostatic test and prior to initial Power Operation using the equipment and techniques expected to be used during subsequent inservice inspections;

j) Tube Support Plate Plugging Limit is used for the disposition of an alloy 600 steam generator tube for continued service that is experiencing predominantly axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates. At tube support plate intersections, the plugging limit is based on maintaining steam generator tube serviceability as described below:

(i) Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with bobbin voltages less than or equal to the lower voltage repair limit (NOTE 1), will be allowed to remain in service.

(ii) Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (NOTE 1), will be repaired or plugged, except as noted in 5.5.9.d.1.j (iii) below.

(iii) Steam generator tubes, with indication of potential degradation attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (NOTE 1) but less than or equal to the upper voltage repair limit (NOTE 2), may remain in service if a rotating pancake coil inspection does not detect degradation. Steam generator tubes, with indications of outside diameter stress corrosion cracking degradation with a bobbin voltage greater than the upper voltage repair limit (NOTE 2) will be plugged or repaired.

(continued)

* Applicable for Units 1 and 2, Cycles 10 and 11 only.

5.6 Reporting Requirements (continued)

5.6.10 Steam Generator (SG) Tube Inspection Report

e. (*) The results of the inspection of W* tubes shall be reported to the Commission pursuant to 10 CFR 50.4 within 90 days following return to service of the steam generators. This report shall include:

1) Identification of W* tubes.

2) W* inspection distance measured with respect to the BWT or the top of the tubesheet, whichever is lower.

3) Elevation and length of axial indications within the flexible W* distance and the angle of inclination of clearly skewed axial cracks (if applicable).

4) The total steam line break leakage for the limiting steam generator per WCAP-14797.

f. (*) The aggregate calculated steam line break leakage from application of all alternate repair criteria shall be reported to the Commission pursuant to 10 CFR 50.4 within 90 days following return to service of the steam generators.

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* Applicable for Units 1 and 2, Cycles 10 and 11 only.

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5. Inspection of dented tube support plate intersections will be performed in accordance with WCAP-15573, Revision 1, to implement axial primary water stress corrosion cracking (PWSCC) depth-based repair criteria. The extent of required inspection is:

   a) 100 percent bobbin coil inspection of all tube support plate (TSP) intersections.

   b) Plus Point coil inspection of all bobbin coil indications at dented TSP intersections.

   c) Plus Point coil inspection of all prior PWSCC indications left in service.

   d) If bobbin coil is relied upon for detection of axial PWSCC in less than or equal to 2 volt dents, then on a SG basis perform Plus Point coil inspection of all TSP intersections having greater than 2 volt dents up to the highest TSP for which PWSCC has been detected in the prior two inspections or current inspection and 20% of greater than 2 volt dents at the next higher TSP. If a circumferential indication is detected in a dent of "x" volts in the prior two inspections or current inspection, Plus Point inspections will be conducted on 100% of dents greater than "x - 0.3" volts up to the affected TSP elevation in the affected SG, plus 20% of dents greater than "x – 0.3" volts at the next higher TSP. "x" is defined as the lowest dent voltage where a circumferential crack was detected.

   e) If bobbin coil is not relied upon for detection of axial PWSCC in less than or equal to 2 volt dents, then on a SG basis perform Plus Point coil inspection of all dented TSP intersections (no lower dent voltage threshold) up to the highest TSP for which PWSCC has been detected in the prior two inspections or current inspection and 20% of all dents at the next higher TSP.

   f) For any 20% dent sample, a minimum of 50 dents at the TSP elevation shall be inspected. If the population of dents is less than 50 at the TSP elevation, then 100% of the dents at the TSP elevation shall be inspected.

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3) This definition does not apply to axial PWSCC indications, or portions thereof, which are located within the thickness of dented tube support plates which exhibit a maximum depth greater than or equal to 40 percent of the initial tube wall thickness. WCAP-15573, Revision 1, provides repair limits applicable to these intersections.

4) A tube which contains a tube support plate intersection with both an axial ODSCC indication and an axial PWSCC indication will be removed from service.

INSERT C

g. For implementation of the repair criteria for axial PWSCC at dented TSPs, the NRC shall be notified prior to startup, pursuant to 10CFR50.72, of the following conditions that indicate a failure of performance criteria:

    1) The calculated SG probability of burst for condition monitoring exceeds 1×10^{-2}.

    2) The calculated SG leakage for condition monitoring from all sources (all alternate repair criteria and non-alternate repair criteria indications) exceeds the leakage limit determined from the licensing basis steam line break dose calculation.

h. For implementation of the repair criteria for axial PWSCC at dented TSPs, the results of the condition monitoring and operational assessments will be reported to the NRC within 120 days following completion of the inspection. The report will include:

    1) Tabulations of indications found in the inspection, tubes repaired, and tubes left in service under the ARC.

    2) Growth rate distributions for indications found in the inspection and growth rate distributions used to establish the tube repair limits.

    3) Plus Point confirmation rates for bobbin detected indications when bobbin is relied upon for detection of axial PWSCC in less than or equal to 2 volt dents.

    4) For condition monitoring, an evaluation of any indications that satisfy burst margin requirements based on the Westinghouse burst pressure model, but do not satisfy burst margin requirements based on the combined ANL ligament tearing and throughwall burst pressure model.

5) Performance evaluation of the operational assessment methodology for predicting flaw distributions as a function of flaw size.

6) Evaluation results of number and size of previously reported versus new PWSCC indications found in the inspection, and the potential need to account for new indications in the operational assessment burst evaluation.

7) Identification of mixed mode (axial PWSCC and circumferential) indications found in the inspection and an evaluation of the mixed mode indications for potential impact on the axial indication burst pressures or leakage.

8) Any corrective actions found necessary in the event that condition monitoring requirements are not met.

PROPOSED TECHNICAL SPECIFICATIONS PAGES

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

3. The tubes selected as the second and third samples (if required by Table 5.5.9-2) during each inservice inspection may be subjected to a partial tube inspection provided:

    a) The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found, and

    b) The inspections include those portions of the tubes where imperfections were previously found.

4. Implementation of the steam generator tube/tube support plate repair criteria requires a 100% bobbin coil inspection for hot-leg and cold-leg support plate intersections down to the lowest cold-leg tube support plate with known outside diameter stress corrosion cracking (ODSCC) indications. The determination of the lowest cold-leg tube support plate intersection having ODSCC indications shall be based on the performance of at least a 20% random sampling of tubes inspected over their full length.

5. Inspection of dented tube support plate intersections will be performed in accordance with WCAP-15573, Revision 1, to implement axial primary water stress corrosion cracking (PWSCC) depth-based repair criteria. The extent of required inspection is:

    a) 100 percent bobbin coil inspection of all tube support plate (TSP) intersections.

    b) Plus Point coil inspection of all bobbin coil indications at dented TSP intersections.

    c) Plus Point coil inspection of all prior PWSCC indications left in service.

    d) If bobbin coil is relied upon for detection of axial PWSCC in less than or equal to 2 volt dents, then on a SG basis perform Plus Point coil inspection of all TSP intersections having greater than 2 volt dents up to the highest TSP for which PWSCC has been detected in the prior two inspections or current inspection and 20% of greater than 2 volt dents at the next higher TSP. If a circumferential indication is detected in a dent of "x" volts in the prior two inspections or current inspection, Plus Point inspections will be conducted on 100% of dents greater than "x - 0.3" volts up to the affected TSP elevation in the affected SG, plus 20% of dents greater than "x - 0.3" volts at the next higher TSP. "x" is defined as the lowest dent voltage where a circumferential crack was detected.

(continued)

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

e) If bobbin coil is not relied upon for detection of axial PWSCC in less than or equal to 2 volt dents, then on a SG basis perform Plus Point coil inspection of all dented TSP intersections (no lower dent voltage threshold) up to the highest TSP for which PWSCC has been detected in the prior two inspections or current inspection and 20% of all dents at the next higher TSP.

f) For any 20% dent sample, a minimum of 50 dents at the TSP elevation shall be inspected. If the population of dents is less than 50 at the TSP elevation, then 100% of the dents at the TSP elevation shall be inspected.

The results of each sample inspection shall be classified into one of the following three categories:

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

Note: In all inspections, previously degraded tubes must exhibit significant (greater than 10%) further wall penetrations to be included in the above percentage calculations.

c. Inspection Frequencies - The above required inservice inspections of SG tubes shall be performed at the following frequencies:

1. The first inservice inspection shall be performed after 6 Effective Full Power Months but within 24 calendar months of initial criticality. Subsequent inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If two consecutive inspections not including the preservice inspection, result in all inspection results falling into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval may be extended to a maximum of once per 40 months;

(continued)

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

2) This definition does not apply to the portion of the tube within the tubesheet below the W* length. Acceptable tube wall degradation within the W* length shall be defined as in 5.5.9.d.1.k. *

3) This definition does not apply to axial PWSCC indications, or portions thereof, which are located within the thickness of dented tube support plates which exhibit a maximum depth greater than or equal to 40 percent of the initial tube wall thickness. WCAP-15573, Revision 1, provides repair limits applicable to these intersections.

4) A tube which contains a tube support plate intersection with both an axial ODSCC indication and an axial PWSCC indication will be removed from service.

g) Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of a Double Design Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in 5.5.9.c.3, above;

h) Tube Inspection means an inspection of the SG tube from the tube end (hot leg side) completely around the U-bend to the top support of the cold leg;

i) Preservice Inspection means an inspection of the full length of each tube in each SG performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed after the field hydrostatic test and prior to initial Power Operation using the equipment and techniques expected to be used during subsequent inservice inspections;

j) Tube Support Plate Plugging Limit is used for the disposition of an alloy 600 steam generator tube for continued service that is experiencing predominantly axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates. At tube support plate intersections, the plugging limit is based on maintaining steam generator tube serviceability as described below:

(i) Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with bobbin voltages less than or equal to the lower voltage repair limit (NOTE 1), will be allowed to remain in service.

(ii) Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (NOTE 1), will be repaired or plugged, except as noted in 5.5.9.d.1.j (iii) below.

(continued)

* Applicable for Units 1 and 2, Cycles 10 and 11 only.

5.5 Programs and Manuals

5.5.9 Steam Generator (SG) Tube Surveillance Program (continued)

(iii) Steam generator tubes, with indication of potential degradation attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (NOTE 1) but less than or equal to the upper voltage repair limit (NOTE 2), may remain in service if a rotating pancake coil inspection does not detect degradation. Steam generator tubes, with indications of outside diameter stress corrosion cracking degradation with a bobbin voltage greater than the upper voltage repair limit (NOTE 2) will be plugged or repaired.

(continued)

5.6 Reporting Requirements (continued)

5.6.10 Steam Generator (SG) Tube Inspection Report

e. (*) The results of the inspection of W* tubes shall be reported to the Commission pursuant to 10 CFR 50.4 within 90 days following return to service of the steam generators. This report shall include:

1) Identification of W* tubes.

2) W* inspection distance measured with respect to the BWT or the top of the tubesheet, whichever is lower.

3) Elevation and length of axial indications within the flexible W* distance and the angle of inclination of clearly skewed axial cracks (if applicable).

4) The total steam line break leakage for the limiting steam generator per WCAP-14797.

f. (*) The aggregate calculated steam line break leakage from application of all alternate repair criteria shall be reported to the Commission pursuant to 10 CFR 50.4 within 90 days following return to service of the steam generators.

g. For implementation of the repair criteria for axial PWSCC at dented TSPs, the NRC shall be notified prior to startup, pursuant to 10CFR50.72, of the following conditions that indicate a failure of performance criteria:

1) The calculated SG probability of burst for condition monitoring exceeds 1×10^{-2}.

2) The calculated SG leakage for condition monitoring from all sources (all alternate repair criteria and non-alternate repair criteria indications) exceeds the leakage limit determined from the licensing basis steam line break dose calculation.

h. For implementation of the repair criteria for axial PWSCC at dented TSPs, the results of the condition monitoring and operational assessments will be reported to the NRC within 120 days following completion of the inspection. The report will include:

1) Tabulations of indications found in the inspection, tubes repaired, and tubes left in service under the ARC.

2) Growth rate distributions for indications found in the inspection and growth rate distributions used to establish the tube repair limits.

3) Plus Point confirmation rates for bobbin detected indications when bobbin is relied upon for detection of axial PWSCC in less than or equal to 2 volt dents.

4) For condition monitoring, an evaluation of any indications that satisfy burst margin requirements based on the Westinghouse burst pressure model, but do not satisfy burst margin requirements based on the combined ANL ligament tearing and throughwall burst pressure model.

(continued)

* Applicable for Units 1 and 2, Cycles 10 and 11 only.

5.6 Reporting Requirements (continued)

5.6.10 Steam Generator (SG) Tube Inspection Report

5) Performance evaluation of the operational assessment methodology for prediction flaw distributions as a function of flaw size.

6) Evaluation results of number and size of previously reported versus new PWSCC indications found in the inspection, and the potential need to account for new indications in the operational assessment burst evaluation.

7) Identification of mixed mode (axial PWSCC and circumferential) indications found in the inspection and an evaluation of the mixed mode indications for potential impact on the axial indication burst pressures or leakage.

8) Any corrective actions found necessary in the event that condition monitoring requirements are not met.

* Applicable for Units 1 and 2, Cycles 10 and 11 only.

Corrections to Growth Rate Data Submitted in PG&E Letter DCL-02-023 dated March 12, 2002

Errors in Diablo Canyon Power Plant Unit 1 refueling outage 9 (1R9) growth rate data for maximum depth, average depth, and length were found in Table 4.7R1 (and associated tables and figures) of PG&E Letter DCL-02-023, "Response to NRC Request for Additional Information Regarding Supplement 3 to License Amendment Request 00-06, "Alternate Repair Criteria for Axial PWSCC at Dented Intersections in Steam Generator Tubing,"" dated March 11, 2002. These errors have negligible effects on the growth rate distributions, and have no effect on the conclusions made in Letter DCL-02-023. This enclosure provides the following corrected tables and figures:

Table 4.7R2
Table 4.8R2
Figure 4-14R2
Figure 4-15R2
Figure 1R1
Figure 2R1
Figure 3R1
Figure 4R1

There were no errors in the Letter DCL-02-023 figures associated with voltage growth rates. This enclosure includes these figures for completeness and information only:

Figure 4-16R1
Figure 5

Table 4.7R2. Diablo Canyon Axial PWSCC Growth Rate Data Through 2R10 Outages									
						Adjusted NDE Growth/EFPY - DCPP at 603 F.			
Outage	SG	Row	Column	Location	Crack No.	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Max. Volts
1R8	1	17	39	01H	1	-0.09	-25.58	-18.37	0.37
1R8	1	21	42	01H	1	0.02	-15.89	-9.82	0.20
1R8	1	21	44	01H	1	-0.02	4.65	3.39	0.28
1R8	1	18	64	01H	1	0.05	0.78	2.08	0.54
1R8	1	18	64	03H	1	0.01	1.55	1.25	0.29
1R8	2	26	43	02H	1	-0.06	-9.30	0.10	0.17
1R8	2	43	49	03H	1	-0.01	-2.58	-1.05	0.26
1R8	2	35	56	02H	1	-0.07	0.00	-0.77	0.34
1R8	2	5	66	02H	1	0.02	-14.73	-4.98	0.36
1R8	2	35	67	03H	1	0.02	-19.38	-7.27	0.39
1R8	2	7	68	03H	1	-0.02	8.53	8.17	0.19
1R8	2	14	72	02H	1	0.04	-10.85	-8.15	0.23
1R8	2	16	73	01H	1	0.00	-3.10	-1.07	0.28
1R8	2	14	74	01H	1	-0.04	-8.53	-7.05	0.40
1R8	2	35	77	01H	1	-0.02	23.26	12.85	0.30
1R8	2	35	77	01H	2	-0.01	-25.58	-16.36	0.55
1R8	2	13	81	01H	1	0.00	-23.64	-20.30	0.32
1R8	2	16	82	01H	1	-0.05	5.04	7.09	0.06
1R8	3	32	47	03H	1	0.04	-7.75	-4.08	0.65
1R8	4	38	27	01H	1	0.00	-9.30	-4.36	0.55
1R8	4	39	58	01H	1	0.00	-18.99	-11.33	0.32
2R8	2	2	2	01H	1	-0.02	13.58	10.01	-0.01
2R8	2	14	15	01H	1	0.06	1.85	2.89	0.19
2R8	2	19	15	01H	1	0.02	3.09	4.20	0.01
2R8	2	18	16	01H	1	0.04	0.93	3.93	0.18
2R8	2	6	24	01H	1	0.02	1.85	0.15	0.09
2R8	2	4	28	01H	1	0.05	1.85	2.11	0.18
2R8	2	12	28	01H	1	0.02	11.73	12.50	0.25
2R8	2	14	29	01H	1	0.01	0.00	-2.64	0.06
2R8	2	17	36	01H	1	0.02	-19.75	-13.48	0.14
2R8	2	15	42	01H	1	0.00	0.00	1.98	0.04
2R8	2	18	44	01H	1	0.02	8.64	5.40	0.11
2R8	2	22	45	01H	1	0.02	0.00	0.81	0.15
2R8	4	34	34	01H	1	0.02	7.41	4.88	0.07
2R8	4	4	37	01H	1	-0.01	9.26	4.01	0.19
1R9	1	9	6	01H	1	0.01	6.17	3.93	-0.08
1R9	1	22	7	03H	1	0.01	6.79	6.78	0.31
1R9	1	23	14	03H	1	0.02	8.64	6.98	0.11
1R9	1	19	15	03H	1	0.03	3.70	0.87	0.07
1R9	1	24	20	02H	1	-0.01	4.94	5.56	0.07

Table 4.7R2. Diablo Canyon Axial PWSCC Growth Rate Data Through 2R10 Outages

						Adjusted NDE Growth/EFPY - DCPP at 603 F.			
Outage	**SG**	**Row**	**Column**	**Location**	**Crack No.**	**Length (in.)**	**Max. Depth (%)**	**Avg. Depth (%)**	**Max. Volts**
1R9	1	30	21	02H	1	0.05	-2.47	-3.28	0.01
1R9	1	34	24	03H	1	0.07	4.94	1.88	0.03
1R9	1	20	33	01H	1	0.01	3.09	0.11	0.01
1R9	1	38	42	03H	1	-0.01	2.47	2.78	0.04
1R9	1	22	71	02H	1	-0.01	5.56	8.52	0.06
1R9	2	17	9	06H	1	-0.02	14.20	9.61	-0.01
1R9	2	15	10	01H	1	0.02	-15.43	-3.96	0.06
1R9	2	11	27	01H	1	0.01	14.20	14.03	0.10
1R9	2	26	39	02H	1	0.00	4.94	6.64	0.08
1R9	2	11	45	01H	1	0.01	1.23	-0.11	0.01
1R9	2	6	47	01H	1	0.02	3.70	2.08	0.05
1R9	2	11	47	02H	1	-0.01	0.00	-2.58	0.04
1R9	2	20	48	03H	1	-0.09	-7.41	-2.03	0.07
1R9	2	27	50	01H	1	0.00	4.32	1.98	0.17
1R9	2	35	52	03H	1	0.11	4.94	2.81	0.17
1R9	2	7	53	03H	1	-0.07	12.35	8.68	0.03
1R9	2	25	55	02H	1	-0.02	-1.54	-3.29	0.09
1R9	2	16	57	01H	1	-0.01	4.94	1.20	0.20
1R9	2	38	66	01H	1	0.02	1.23	4.20	0.09
1R9	2	33	68	02H	1	-0.14	8.64	5.31	0.02
1R9	2	4	69	01H	1	0.01	0.00	4.69	0.05
1R9	2	19	74	02H	1	0.01	6.79	1.58	0.06
1R9	2	13	75	02H	1	0.01	0.00	-1.06	-0.02
1R9	2	5	77	05H	1	0.01	8.02	5.94	0.07
1R9	2	26	79	01H	1	0.04	8.02	6.86	0.12
1R9	2	8	80	02H	1	0.04	0.00	1.08	0.04
1R9	2	23	82	01H	1	0.00	3.09	2.30	0.00
1R9	2	5	84	01H	1	-0.01	5.56	4.79	0.19
1R9	2	9	87	4H	1	-0.09	-8.02	-9.59	-0.01
1R9	2	8	90	03H	1	0.01	8.64	8.61	0.15
1R9	2	2	92	05H	1	0.02	0.00	-0.34	-0.06
1R9	4	17	24	01H	1	0.03	0.00	0.06	-0.02
1R9	4	20	25	01H	1	-0.02	0.00	1.84	-0.02
1R9	4	46	42	01H	1	0.01	3.70	3.93	-0.05
1R9	4	35	68	03H	1	-0.01	0.62	-0.20	0.12
1R9	4	21	76	01H	1	0.04	5.56	4.60	-0.05
2R9	2	6	3	01H	1	0.02	7.53	3.49	0.05
2R9	2	18	7	01H	1	0.08	10.96	8.09	0.23
2R9	2	5	21	01H	1	0.02	17.81	14.56	0.08
2R9	2	21	23	02H	1	-0.01	7.53	8.46	-0.04
2R9	2	8	26	01H	1	0.01	-10.62	-10.69	0.15
2R9	2	5	33	01H	1	0.00	0.00	0.45	0.12
2R9	2	28	38	01H	1	0.01	6.16	3.83	0.01

Table 4.7R2. Diablo Canyon Axial PWSCC Growth Rate Data Through 2R10 Outages									
						Adjusted NDE Growth/EFPY - DCPP at 603 F.			
Outage	SG	Row	Column	Location	Crack No.	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Max. Volts
2R9	2	16	39	04H	1	-0.04	4.11	4.36	0.09
2R9	2	16	39	04H	2	-0.02	0.68	1.75	0.05
2R9	2	14	40	01H	1	0.02	-4.79	-0.16	0.36
2R9	2	21	40	01H	1	-0.04	2.74	5.64	0.07
2R9	2	22	46	01H	1	-0.01	-0.68	-0.13	0.08
2R9	3	21	78	03H	1	0.09	8.90	10.81	0.08
2R9	4	17	31	03H	1	-0.02	4.11	0.68	0.13
2R9	4	14	53	03H	1	-0.01	0.00	0.33	0.06
1R10	1	22	7	03H	1	0.07	6.71	3.04	0.25
1R10	1	23	14	03H	1	0.01	-4.70	-3.69	0.09
1R10	1	19	15	03H	1	0.03	0.67	0.43	0.09
1R10	1	15	16	02H	1	-0.03	0.67	1.94	0.09
1R10	1	24	20	02H	1	0.02	1.34	-5.35	0.00
1R10	1	30	21	02H	1	-0.05	0.00	-0.05	-0.04
1R10	1	22	23	02H	1	-0.01	2.68	3.86	-0.01
1R10	1	22	23	02H	2	0.00	0.00	4.63	0.05
1R10	1	34	24	03H	1	0.08	-4.70	0.75	0.05
1R10	1	3	28	02H	1	0.01	0.67	4.38	0.21
1R10	1	14	28	02H	1	0.00	-6.71	-5.61	0.11
1R10	1	36	30	02H	1	0.02	-0.67	1.41	0.34
1R10	1	20	33	01H	1	-0.01	-3.36	-0.06	-0.02
1R10	1	4	41	01H	1	0.08	10.07	10.05	0.08
1R10	1	24	67	02H	1	0.04	0.00	0.50	0.10
1R10	1	22	71	02H	1	0.07	1.34	-3.73	0.11
1R10	2	13	10	01H	1	0.01	2.68	1.71	0.17
1R10	2	15	10	01H	1	0.03	-6.71	-6.12	0.05
1R10	2	16	12	05H	1	0.01	0.67	3.89	-0.05
1R10	2	8	15	02H	1	0.01	4.03	1.66	0.14
1R10	2	14	16	04H	1	0.00	-3.36	-1.24	0.15
1R10	2	30	16	01H	1	-0.07	-8.72	-3.69	0.23
1R10	2	25	17	02H	1	0.08	-2.01	-2.72	0.14
1R10	2	23	25	03H	1	0.03	2.68	4.54	0.31
1R10	2	42	28	02H	1	-0.01	6.04	6.25	0.17
1R10	2	7	31	01H	1	0.05	-4.70	-5.33	0.13
1R10	2	19	31	04H	1	-0.05	0.67	-0.53	0.09
1R10	2	9	34	02H	1	-0.03	0.67	-1.22	0.11
1R10	2	33	37	01H	1	0.01	0.00	-0.58	0.08
1R10	2	26	39	02H	1	0.03	-0.67	-1.91	0.30
1R10	2	11	45	01H	1	0.04	8.72	3.57	0.26
1R10	2	14	45	01H	1	0.00	0.00	-0.11	0.02
1R10	2	20	48	03H	1	0.07	3.36	-0.99	0.15

Table 4.7R2. Diablo Canyon Axial PWSCC Growth Rate Data Through 2R10 Outages									
						Adjusted NDE Growth/EFPY - DCPP at 603 F.			
Outage	SG	Row	Column	Location	Crack No.	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Max. Volts
1R10	2	27	50	01H	1	0.01	2.68	0.40	0.24
1R10	2	29	51	02H	1	0.07	-0.67	-3.39	0.20
1R10	2	34	51	06H	1	0.06	-0.67	0.03	0.15
1R10	2	35	52	03H	1	-0.01	-2.68	-0.83	0.13
1R10	2	23	54	01H	1	0.04	0.00	-0.06	0.05
1R10	2	25	55	02H	1	-0.01	-2.01	0.33	-0.08
1R10	2	9	56	01H	1	0.00	1.34	1.81	0.17
1R10	2	27	56	01H	1	0.02	0.00	1.34	0.15
1R10	2	4	57	01H	1	-0.02	0.00	-0.38	-0.01
1R10	2	36	60	04H	1	0.03	-2.68	-6.09	0.09
1R10	2	8	61	02H	1	0.05	-5.37	-2.02	0.21
1R10	2	8	61	02H	2	0.08	3.36	0.32	0.10
1R10	2	32	62	01H	1	0.06	6.71	7.11	0.01
1R10	2	41	62	01H	1	-0.05	4.70	4.21	0.09
1R10	2	38	63	01H	1	0.06	1.34	2.63	0.32
1R10	2	39	64	03H	1	0.00	5.37	5.97	0.11
1R10	2	28	66	02H	1	-0.01	-11.41	-7.59	0.09
1R10	2	38	66	01H	1	0.05	7.38	1.55	0.10
1R10	2	33	68	02H	1	0.03	-4.03	-4.31	0.05
1R10	2	4	69	01H	1	0.01	0.00	-1.23	0.08
1R10	2	27	71	01H	1	0.05	0.67	-1.67	0.12
1R10	2	6	74	03H	1	0.03	0.00	-1.22	0.06
1R10	2	19	74	02H	1	0.01	-4.03	3.03	0.05
1R10	2	25	74	01H	1	0.01	6.71	5.89	0.13
1R10	2	2	76	02H	1	0.04	0.00	-3.46	0.07
1R10	2	5	77	05H	1	0.04	2.01	1.13	0.12
1R10	2	24	77	01H	1	0.05	3.36	4.11	0.11
1R10	2	2	78	01H	1	-0.01	-2.01	0.66	0.27
1R10	2	31	78	05H	1	0.07	4.70	-1.40	0.11
1R10	2	26	79	01H	1	0.01	0.00	1.52	0.21
1R10	2	23	82	01H	1	0.03	3.36	2.52	0.03
1R10	2	13	84	01H	1	0.00	-8.05	-7.42	-0.11
1R10	2	13	84	01H	2	0.03	-2.01	-5.69	-0.23
1R10	2	2	92	05H	1	0.02	0.00	0.29	0.03
1R10	2	2	92	05H	2	0.01	0.00	-0.37	0.05
1R10	2	2	92	05H	3	0.05	0.00	-4.53	0.06
1R10	2	2	93	04H	1	0.02	-14.09	-13.69	0.00
1R10	2	8	93	01H	1	-0.03	-6.71	-4.50	0.10
1R10	4	17	24	01H	1	-0.03	0.00	0.95	0.01
1R10	4	20	25	01H	1	0.02	0.00	0.43	0.01
1R10	4	35	36	02H	1	0.01	0.00	1.09	-0.03

Table 4.7R2. Diablo Canyon Axial PWSCC Growth Rate Data Through 2R10 Outages									
						Adjusted NDE Growth/EFPY - DCPP at 603 F.			
Outage	SG	Row	Column	Location	Crack No.	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Max. Volts
1R10	4	46	42	01H	1	0.13	0.67	-3.12	0.01
1R10	4	39	48	03H	1	0.01	0.00	0.42	-0.03
1R10	4	39	58	01H	1	0.11	0.00	-0.77	0.16
1R10	4	35	61	02H	1	0.01	1.34	5.16	0.07
1R10	4	35	68	03H	1	0.03	-2.01	0.27	-0.09
1R10	4	38	69	02H	1	0.02	5.37	8.42	0.05
1R10	4	21	70	03H	1	0.02	14.09	8.83	0.09
1R10	4	21	76	01H	1	-0.01	3.36	1.98	-0.03
1R10	4	21	84	01H	1	0.07	1.34	3.78	0.01
2R10	2	5	3	01H	1	0.12	8.33	4.41	-0.05
2R10	2	17	12	01H	1	0.02	6.94	4.85	0.33
2R10	2	14	15	02H	1	0.01	6.25	8.11	0.06
2R10	2	19	15	01H	1	0.02	0.00	0.45	0.02
2R10	2	11	19	01H	1	0.03	10.42	4.69	0.13
2R10	2	15	22	01H	1	0.03	7.64	3.79	0.14
2R10	2	2	23	01H	1	0.00	4.86	4.74	0.00
2R10	2	21	23	02H	1	0.03	8.33	7.22	0.06
2R10	2	27	23	01H	1	0.00	14.58	11.87	-0.03
2R10	2	6	24	01H	1	0.04	-3.47	-2.79	-0.04
2R10	2	13	25	03H	1	0.01	4.17	6.57	0.08
2R10	2	2	26	01H	1	0.01	13.19	11.62	0.03
2R10	2	5	26	01H	1	0.02	6.25	4.52	0.10
2R10	2	8	26	01H	1	0.01	18.75	15.74	-0.12
2R10	2	7	27	01H	1	0.05	-1.39	-2.13	0.03
2R10	2	4	28	01H	1	0.02	4.86	3.84	-0.10
2R10	2	6	31	01H	1	0.03	0.00	2.70	0.04
2R10	2	7	32	01H	1	0.01	6.25	3.05	0.09
2R10	2	9	32	01H	1	-0.02	0.69	0.87	-0.01
2R10	2	5	33	01H	1	0.05	11.81	8.28	-0.02
2R10	2	3	34	01H	1	-0.01	6.94	4.90	0.10
2R10	2	4	34	04H	1	0.01	0.00	-0.87	0.04
2R10	2	6	36	01H	1	0.03	7.64	6.36	-0.16
2R10	2	28	38	01H	1	0.01	0.00	-4.91	-0.01
2R10	2	12	39	01H	1	0.01	6.25	2.71	-0.17
2R10	2	16	39	04H	1	0.03	7.64	6.43	0.05
2R10	2	16	39	04H	2	0.01	11.11	6.88	0.03
2R10	2	21	40	01H	1	0.00	1.39	1.95	-0.01
2R10	2	13	41	01H	1	-0.02	8.33	6.55	-0.01
2R10	2	21	41	01H	1	0.03	-3.47	-1.71	0.01
2R10	2	15	42	01H	1	-0.02	-4.17	-2.42	-0.03
2R10	2	8	43	04H	1	0.00	7.64	5.64	0.01

Table 4.7R2. Diablo Canyon Axial PWSCC Growth Rate Data Through 2R10 Outages									
						Adjusted NDE Growth/EFPY - DCPP at 603 F.			
Outage	**SG**	**Row**	**Column**	**Location**	**Crack No.**	**Length (in.)**	**Max. Depth (%)**	**Avg. Depth (%)**	**Max. Volts**
2R10	2	22	44	04H	1	0.03	10.07	2.66	-0.01
2R10	2	25	44	05H	1	0.08	0.00	-0.03	-0.08
2R10	2	14	45	01H	1	0.03	0.00	-4.00	-0.06
2R10	2	22	45	01H	1	0.04	9.72	9.30	-0.06
2R10	2	16	49	01H	1	0.03	5.56	-0.50	-0.06
2R10	2	15	51	01H	1	0.01	-1.39	-2.45	-0.03
2R10	2	27	59	01H	1	0.06	16.67	19.26	0.17
2R10	3	45	56	01H	1	0.01	-5.56	-5.39	0.06
2R10	3	21	78	03H	1	0.02	-5.56	-3.98	0.03
2R10	4	16	11	03H	1	0.06	-6.94	-7.96	0.03
2R10	4	11	17	03H	1	0.04	2.78	0.28	-0.13
2R10	4	12	17	03H	1	0.01	2.08	2.00	0.10
2R10	4	14	53	03H	1	0.03	1.39	-0.96	0.05
				Average Growth		**0.014**	**1.39**	**1.26**	**0.09**
				95th Percentile		**0.075**	**11.81**	**9.61**	**0.33**
				Maximum Growth		**0.128**	**23.3**	**19.3**	**0.6**

Table 4-8R2. Diablo Canyon Axial PWSCC Depth, Length and Voltage Growth/EFPY Distributions							
Average Depth Combined Data from Cycles 1R9, 2R8, 2R9 and 2R10		**Maximum Depth** Combined Data from Cycles 1R9, 2R8, 2R9 and 2R10		**Length** Combined Data from Cycles 1R9, 1R10 and 2R10		**Maximum Volts** Combined Data from Cycles 1R9, 2R8, 2R9 and 2R10	
Growth/EFPY (%)	**CDF**	**Growth/EFPY (%)**	**CDF**	**Growth/EFPY (inch)**	**CDF**	**Growth/EFPY (volt)**	**CDF**
0.0	0.260	0.0	0.261	0.000	0.210	0.000	0.278
0.7	0.320	0.8	0.325	0.007	0.315	0.012	0.330
1.5	0.380	1.7	0.375	0.014	0.430	0.028	0.400
2.9	0.490	2.9	0.435	0.025	0.600	0.050	0.522
4.1	0.590	3.9	0.475	0.031	0.675	0.066	0.600
5.3	0.713	4.9	0.548	0.035	0.720	0.085	0.696
6.5	0.790	6.0	0.625	0.039	0.765	0.100	0.757
7.6	0.840	6.5	0.660	0.043	0.805	0.115	0.800
8.6	0.885	7.4	0.715	0.051	0.852	0.150	0.870
10.0	0.930	7.9	0.760	0.060	0.895	0.170	0.904
12.0	0.957	8.4	0.795	0.067	0.920	0.196	0.948
14.5	0.983	9.4	0.850	0.075	0.945	0.204	0.957
19.3	1.000	11.1	0.895	0.081	0.959	0.230	0.965
		11.7	0.915	0.100	0.976	0.300	0.983
		13.2	0.943	0.120	0.988	0.380	1.000
		15.0	0.965	0.140	1.000		
		20.0	1.000				

Figure 4-14R2

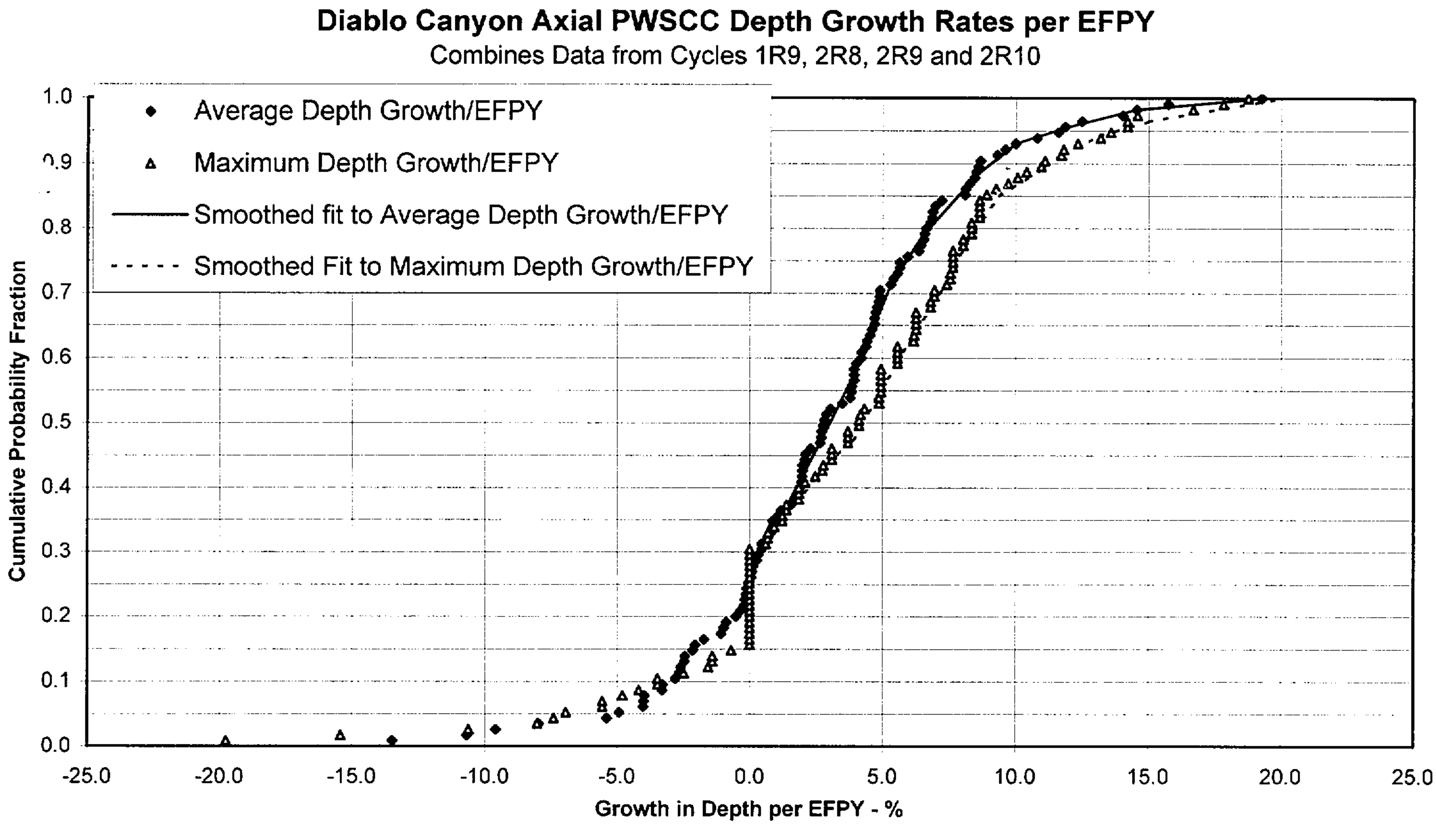

Figure 4-15R2

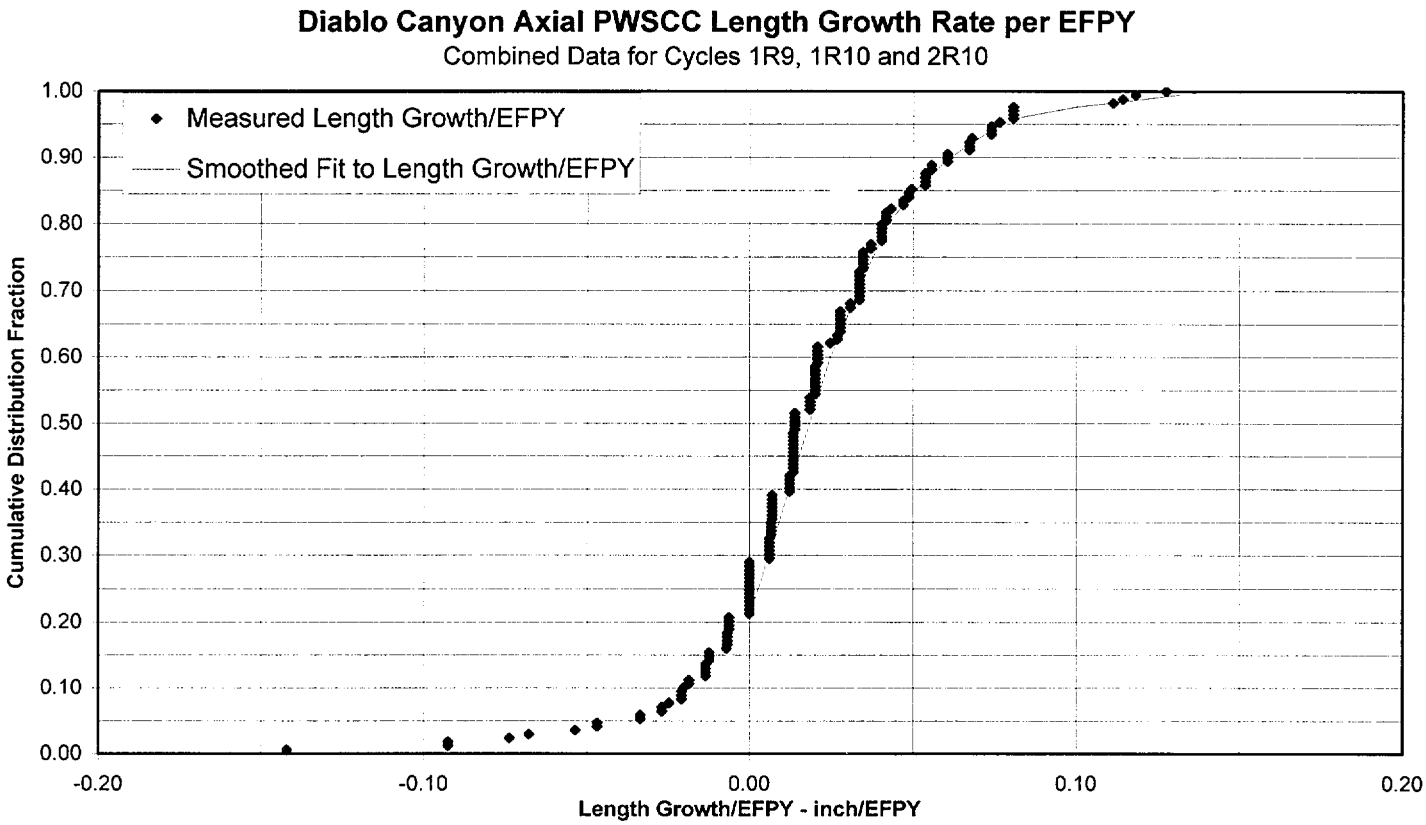

Figure 4-16R1 (no change)

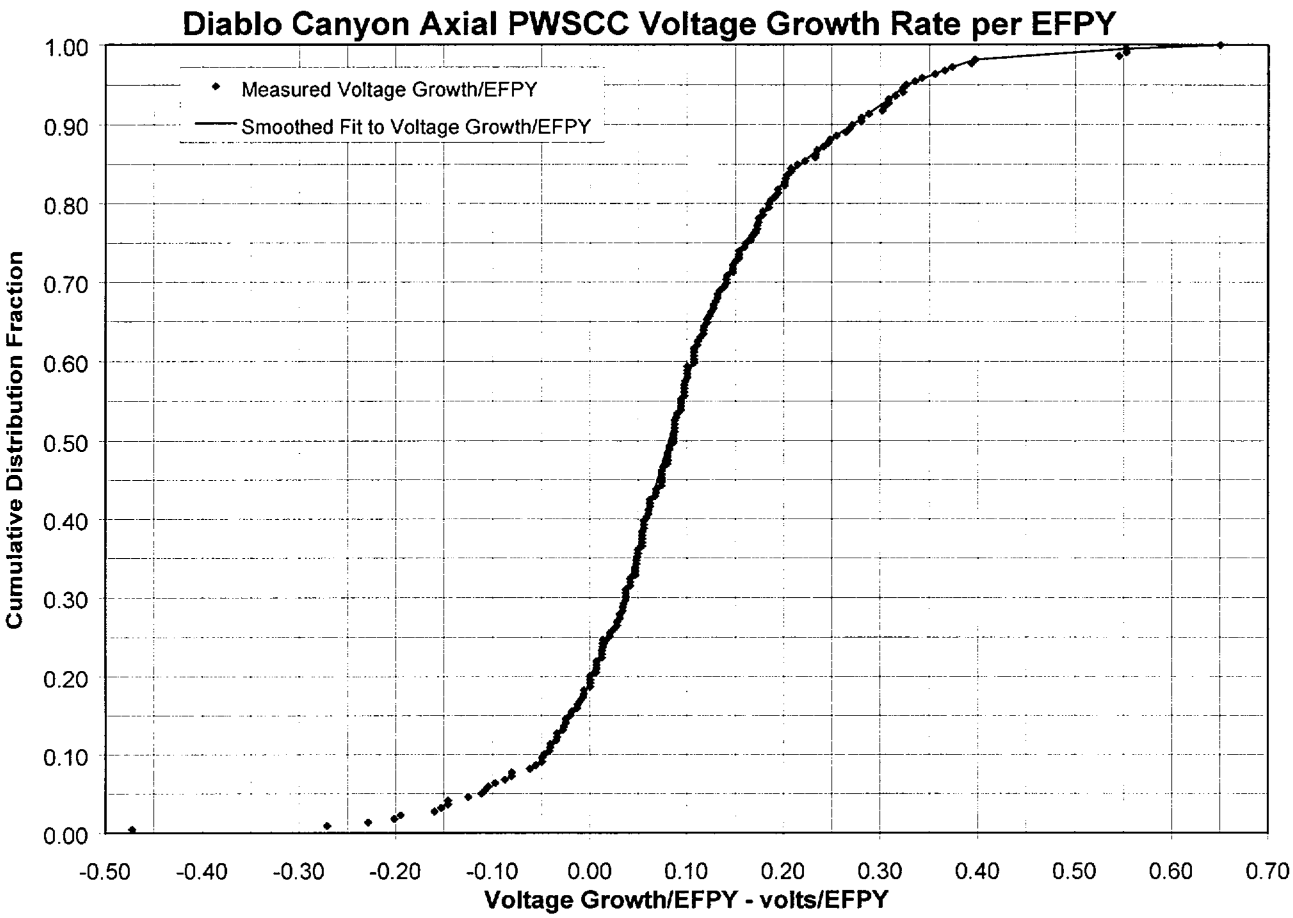

Figure 1R1

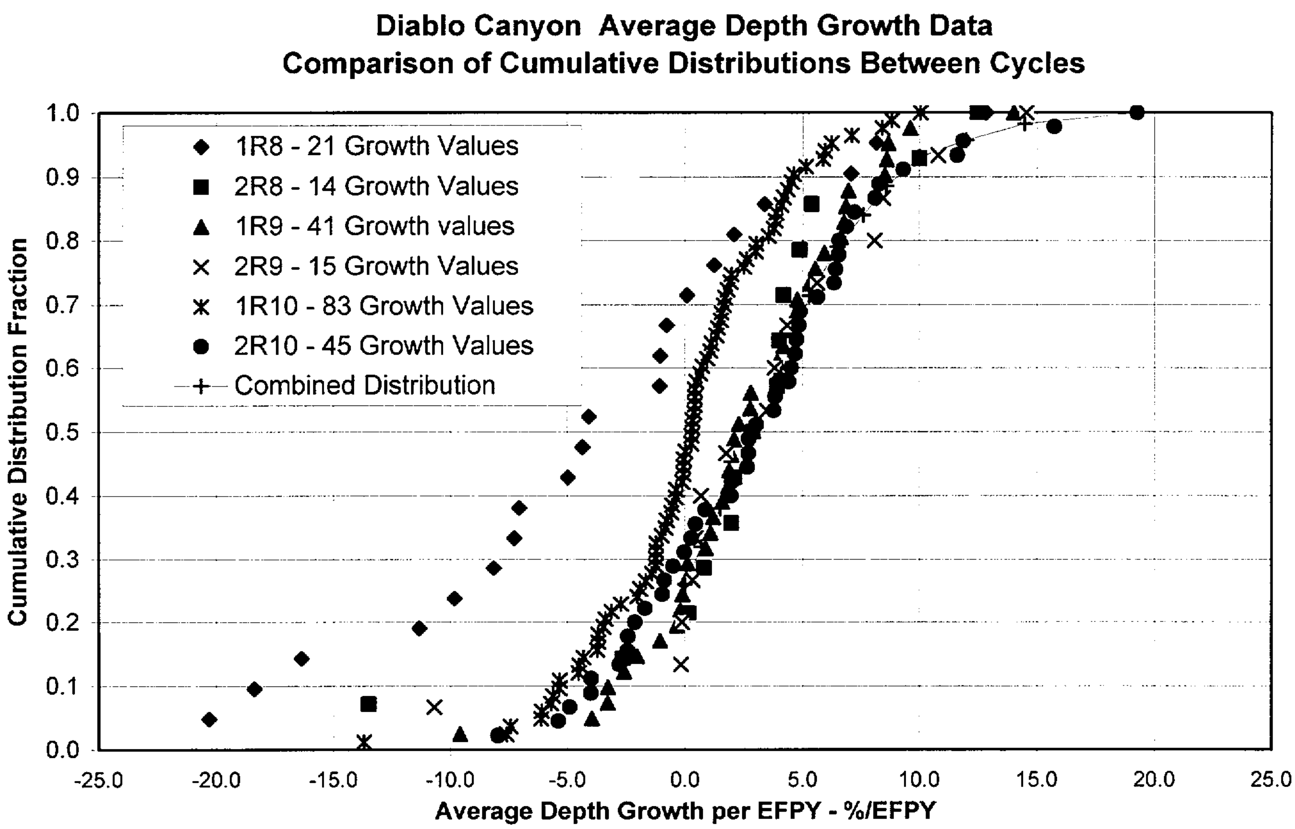
Diablo Canyon Average Depth Growth Data
Comparison of Cumulative Distributions Between Cycles
1R8 - 21 Growth Values
2R8 - 14 Growth Values
1R9 - 41 Growth values
2R9 - 15 Growth Values
1R10 - 83 Growth Values
2R10 - 45 Growth Values
Combined Distribution
Cumulative Distribution Fraction
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-25.0
-20.0
-15.0
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
Average Depth Growth per EFPY - %/EFPY

Figure 2R1

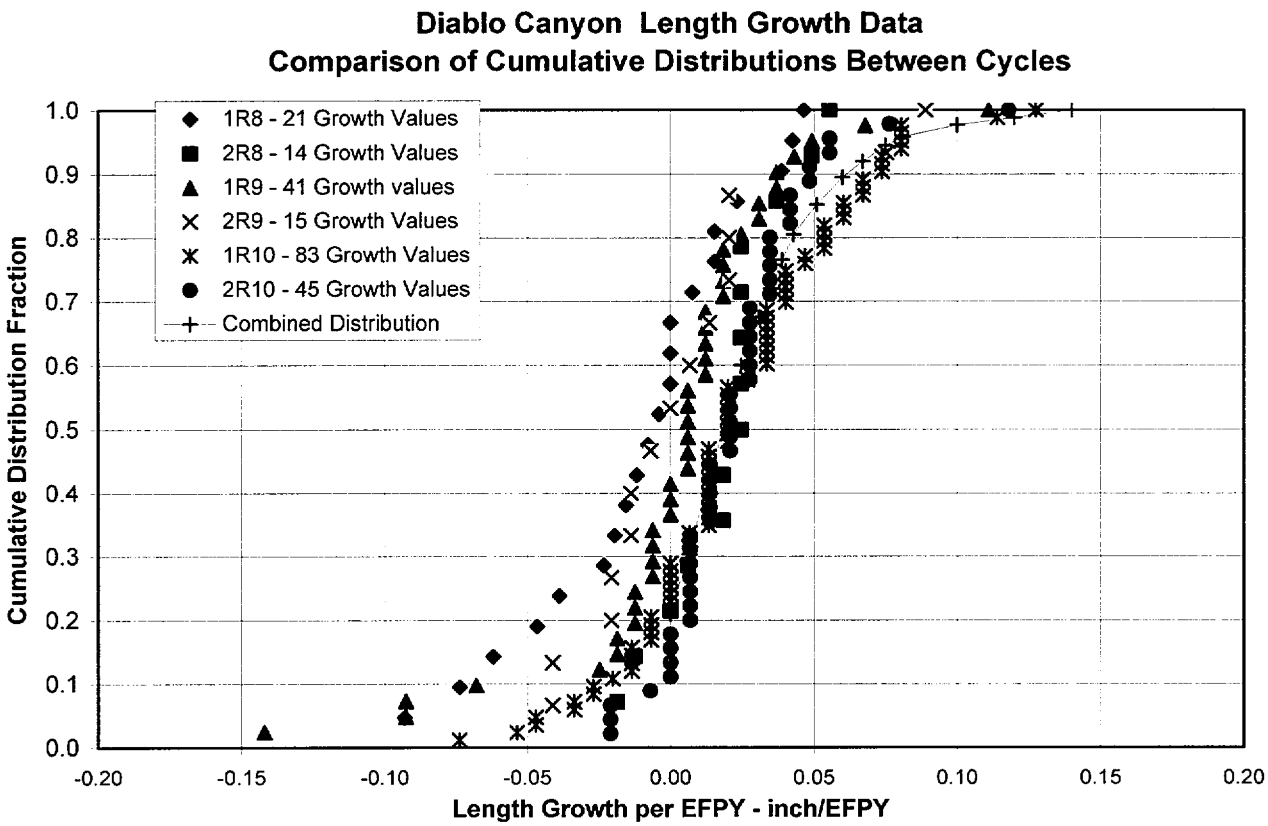
Diablo Canyon Length Growth Data
Comparison of Cumulative Distributions Between Cycles
1R8 - 21 Growth Values
2R8 - 14 Growth Values
1R9 - 41 Growth values
2R9 - 15 Growth Values
1R10 - 83 Growth Values
2R10 - 45 Growth Values
Combined Distribution
Cumulative Distribution Fraction
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
Length Growth per EFPY - inch/EFPY

Figure 3R1

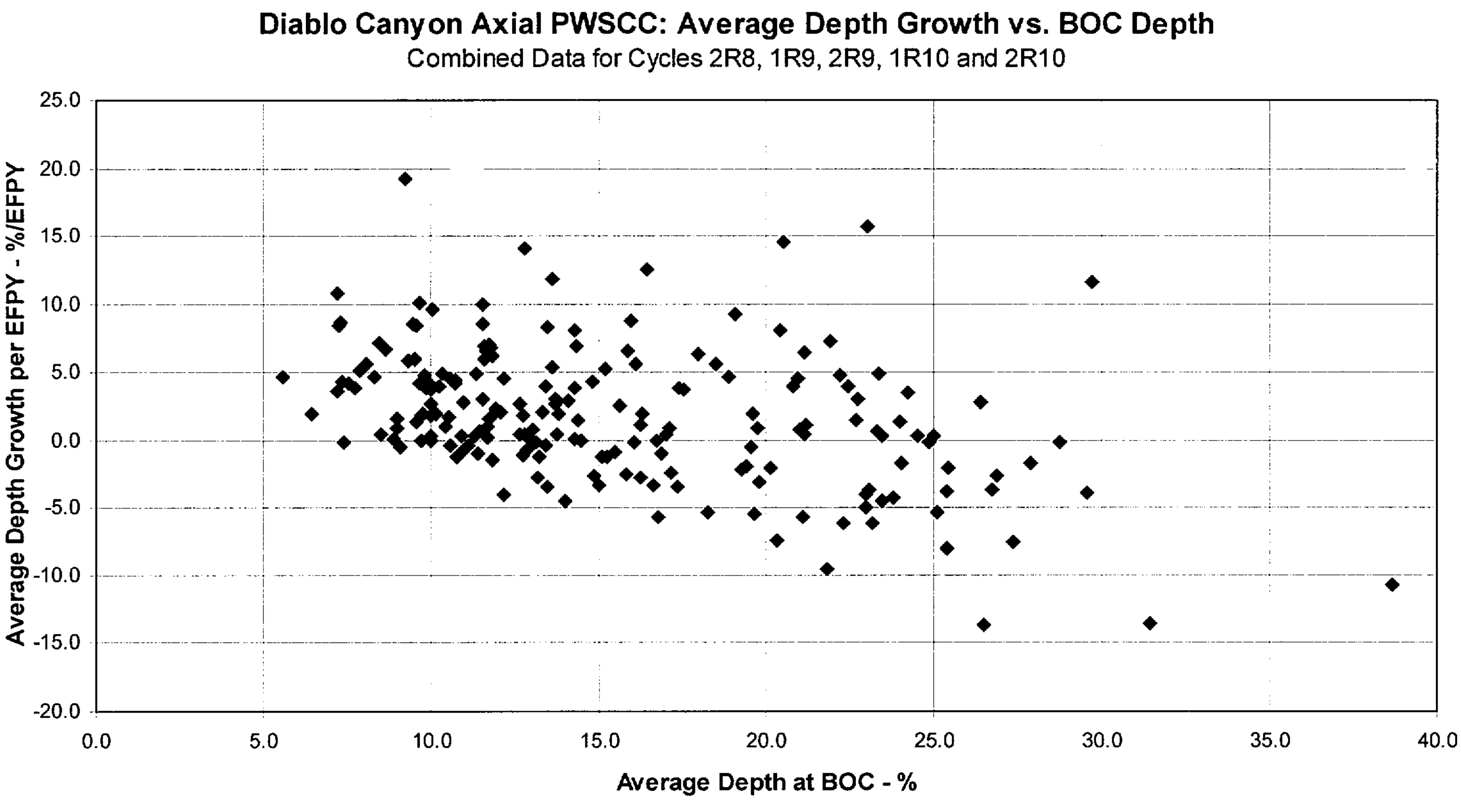
Diablo Canyon Axial PWSCC: Average Depth Growth vs. BOC Depth
Combined Data for Cycles 2R8, 1R9, 2R9, 1R10 and 2R10
Average Depth Growth per EFPY - %/EFPY
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Average Depth at BOC - %

Figure 4R1

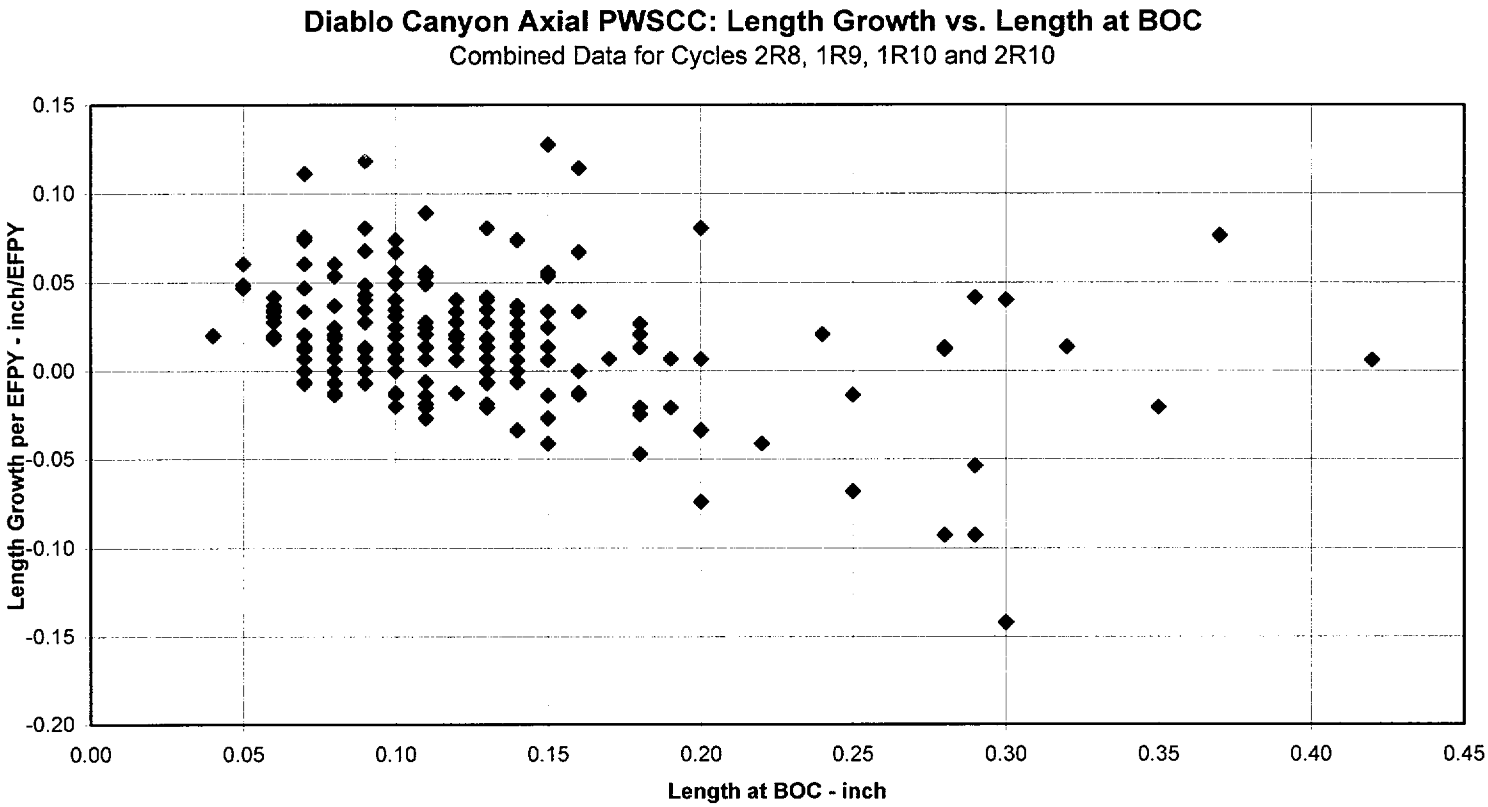
Diablo Canyon Axial PWSCC: Length Growth vs. Length at BOC
Combined Data for Cycles 2R8, 1R9, 1R10 and 2R10
Length Growth per EFPY - inch/EFPY
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
Length at BOC - inch

Figure 5 (no change)