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SUBJECT: Submits response to NRC RAI,dtd 990129 re W* SG tube repair criteria.Util proposes to limit implemementation of W* SG tube repair criteria to two operating cycles for each unit. Attachments D & E provide proposed TS page.

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January 29, 1999

PG&E Letter DCL-99-011

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

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response To NRC Request For Additional Information, Dated January 29, 1999, Regarding Proposed W* Steam Generator Tube Repair Criteria

Dear Commissioners and Staff:

PG&E submitted License Amendment Request (LAR) 97-04, "Steam Generator Tube Alternate Repair Criteria for Indications in the Westinghouse Explosive Tube Expansion (WEXTEX) Region," to the NRC on March 10, 1997. The LAR requested NRC review and approval of implementation of steam generator (SG) tube alternate plugging criteria for axial indications in the WEXTEX region that exceed the current Technical Specifications (TS) depth-based plugging limit.

On March 13, 1998, PG&E responded to a January 6, 1998, NRC request for additional information (RAI) in PG&E Letter DCL-98-039, "Response to Request for Additional Information License Amendment Request 97-04." On August 28, 1998, PG&E responded to a June 23, 1998, NRC RAI in PG&E Letter DCL-98-119, "Response To NRC Request For Additional Information, Dated June 23, 1998, Regarding Proposed W* Steam Generator Tube Repair Criteria." On October 22, 1998, PG&E responded to an August 6, 1998, NRC RAI in PG&E Letter DCL-98-148, "Response To NRC Request For Additional Information, Dated August 6, 1998, Regarding Proposed W* Steam Generator Tube Repair Criteria."

The NRC staff requested additional information regarding proposed W* SG tube repair criteria in an RAI dated January 29, 1999. PG&E's response is provided in Attachments B and C.

PG&E proposes to limit the implementation of the W* SG tube repair criteria to two operating cycles for each Unit. The limited time use of this alternate repair criteria was discussed with the NRC staff.

A001

Attachments D and E provide proposed TS pages that supersede the corresponding proposed TS pages previously provided in PG&E Letter DCL-98-148.

PG&E will provide the NRC with marked-up improved TS pages for LAR 97-09, "Technical Specification Conversion License Amendment Request," in a future submittal.

The additional information does not affect the results of the no significant hazards consideration performed for LAR 97-04.

Sincerely,

David H. Oatley

cc: Edgar Bailey, DHS
Steven D. Bloom
Ellis W. Merschoff
David L. Proulx
Linda J. Smith
Diablo Distribution

Attachments

GPS/

[illegible]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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

AFFIDAVIT

David H. Oatley, of lawful age, first being duly sworn upon oath says that he is Vice President - Diablo Canyon Operations and Plant Manager of Pacific Gas and Electric Company; that he has executed this response to the NRC request for additional information, dated January 29, 1999, regarding proposed W* steam generator tube repair criteria 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.

D H Oatley

David H. Oatley
Vice President - Diablo Canyon
Operations and Plant Manager

Subscribed and sworn to before me this 29th day of January 1999.
County of San Luis Obispo
State of California

Chuck Mackey

Notary Public

Commission
Notary Public -
San Luis Obispo
My Comm. Expires Dec

1-29-99

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

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION, DATED JANUARY 29, 1999, REGARDING PROPOSED W* STEAM GENERATOR TUBE REPAIR CRITERIA

Introduction

PG&E submitted License Amendment Request (LAR) 97-04, "Steam Generator Tube Alternate Repair Criteria for Indications in the Westinghouse Explosive Tube Expansion (WEXTEX) Region," on March 10, 1997.

On March 13, 1998, PG&E responded to a January 6, 1998, NRC request for additional information (RAI) in PG&E Letter DCL-98-039, "Response to Request for Additional Information License Amendment Request 97-04." On August 28, 1998, PG&E responded to a June 23, 1998, NRC RAI in PG&E Letter DCL-98-119, "Response To NRC Request For Additional Information, Dated June 23, 1998, Regarding Proposed W* Steam Generator Tube Repair Criteria." On October 22, 1998, PG&E responded to a August 6, 1998, NRC RAI in PG&E Letter DCL-98-148, "Response To NRC Request For Additional Information, Dated August 6, 1998, Regarding Proposed W* Steam Generator Tube Repair Criteria."

The NRC staff requested additional information regarding proposed W* SG tube repair criteria in an RAI dated January 29, 1999. PG&E's response is provided in this attachment.

NRC Question 1:

Chapter 8 of WCAP 14797, Revision 1, states that a crack growth rate of 0.25 inches per EFPY is assumed for W. This value was determined as the 95% cumulative probability value using data from three plants. The NRC notes that this value is inconsistent with the 95% cumulative probability value (0.28 inches) stated in Section 7.4. Discuss which value will be assumed in W* applications.*

PG&E Response to NRC Question 1:

A W* crack growth value of 0.25 inches per effective full power year (EFPY) as stated in Chapter 8 of WCAP 14797, Revision 1, "Generic W* Tube Plugging Criteria for 51 Series Steam Generator Tubesheet Region WEXTEX Expansions," will initially be applied to W* tubes. The 95 percent cumulative probability value of 0.28 inches per EFPY stated in Section 7.4 was entered in error. Please refer to PG&E Letter DCL-97-095, "Transmittal of Errata Sheets for WCAP-14797 and WCAP-14798," dated May 20, 1997.

NRC Question 2:

A fixed, upper bound crack growth rate is used in the application of W repair criteria. However, crack growth rate data in WCAP 14797, Revision 1, may not be representative of crack growth rates for more mature PWSCC flaws that may remain in service for several cycles under W*. Discuss provisions in the proposed repair criteria for updating the assumed upper bound crack growth rates to address the potential for more rapid flaw progression in the future. Also discuss whether the use of a larger growth rate, if applicable, would be required.*

PG&E Response to NRC Question 2:

PG&E will assess W* crack growth rates every outage in which W* is implemented as provided for in WCAP-14797, Section 8.7. The upper bound crack growth rate will be updated each cycle to reflect the latest operational experience data, and to address the potential for more rapid flaw progression in the future. As primary water stress corrosion cracking (PWSCC) axial flaws are left in service under the W* criteria, their growth data will be added to the WCAP database, and a new 95 percent cumulative probability growth rate will be calculated and applied in the operational assessment. Updated W* crack growth distributions and the operational assessment will be provided in the 90 day report. As a practical limitation, the growth rate developed for the prior cycle tube integrity assessment will be applied to the current cycle W* flexible length calculations.

NRC Question 3:

The NDE uncertainty for measuring the distance between the bottom of the WEXTEX transition (BWT) and the crack tip was determined by combining the uncertainties from measuring the distance between the top of the tubesheet (TTS) and the BWT and the distance separating the TTS and the crack tip. The NDE measurement uncertainty assumed in the W repair criteria for three rotating probe inspection coils (i.e., 0.115-inch, Plus Point, and 0.080-inch coils) was determined using the uncertainty in measuring the distance between the TTS and the BWT for the 0.115-inch pancake coil. Explain why the uncertainty in the measurement of this distance using the 0.115-inch diameter coil is applicable to the other rotating coils considered in the study.*

PG&E Response to NRC Question 3:

The nondestructive examination (NDE) analysts tested to develop the W* NDE uncertainties were not instructed to use a specific pancake coil for determining the bottom of the WEXTEX transition (BWT), since prior experience indicated that there was little difference in the accuracy between the two coils. Although Tables 7.3-1 and 8.3-1 of WCAP-14797 refer to only the 0.115 inch pancake coil with respect to the top of tubesheet (TTS) to BWT NDE uncertainty, the

uncertainty determination as derived from Table 7.3-4 of WCAP-14797, does in fact include results from both the 0.080 inch and 0.115 inch coils. Of the 18 data points, eight were obtained from the 0.080 inch coil; therefore, the more appropriate label would have been "Combined Coil Uncertainty." The individual coil values for the TTS to BWT uncertainty yielded a mean of 0.006 inches with a standard deviation of 0.089 inches for the 0.080 inch coil, and a mean of -0.020 inches with a standard deviation of 0.103 inches for the 0.115 inch coil. These results are essentially the same as the mean of -0.010 inches and standard deviation of 0.100 inches for the combined data reported as the 0.115 inch coil in WCAP-14797. Consequently, it is acceptable to use the WCAP-14797 values for both the 0.080 and 0.115 inch pancake coils.

The standard deviation of the BWT location uncertainty is 0.10 inches for both the bobbin and 0.080 / 0.115 inch coils. As noted in Table 8.3-1, the mean error defined as "Truth" minus NDE is -0.01 inches for the 0.080 / 0.115 inch coil, and -0.08 inches for the bobbin coil, which indicates that both coils overestimate the TTS to BWT length for the average value. As discussed in Section 7.3.4, since a negative mean error reduces the NDE uncertainty at +95 percent confidence, it is conservative to use the mean error for the 0.080 / 0.115 inch coils even when the bobbin coil is used for locating the BWT. Therefore, the NDE uncertainty on the TTS to BWT distance for the 0.080 / 0.115 inch coils is used to combine the uncertainty with the TTS to crack tip distance uncertainty to obtain the uncertainty for the BWT to crack tip.

For flaw location, the W* criteria permit use of the Plus Point, 0.080 or 0.115 inch coils. Therefore, the acceptable options for locating the crack tip relative to the BWT are bobbin or 0.080 / 0.115 inch coils (equivalent NDE uncertainties) for BWT location relative to the TTS combined with either of the three rotating coils for flaw location relative to the TTS. The combined uncertainties for BWT to crack tip given for each coil in WCAP-14797 are appropriate and slightly conservative when the bobbin coil is used to locate the BWT.

As discussed in PG&E's response to NRC Question 7, PG&E will employ the bobbin coil for locating the BWT in order to utilize existing NDE software for bobbin coil profilometry.

[illegible]

[illegible]

NRC Question 4:

Because of their design, Plus Point coils may have difficulty resolving crack inclination angles approaching 45° and identifying the location of the bottom of the tubesheet expansion-transitions. However, the staff notes that the analysis guidelines included as Appendix A in WCAP-14797 do not require data analysts to use alternate coils for locating the tips of the crack (for crack angles) and the expansion-transition. Discuss the need to include restrictions on the use of Plus Point coils in the data analysis guidelines.

PG&E Response to NRC Question 4:

As discussed in WCAP-14797, Section 8.6, crack inclination angles greater than approximately 20° require individual sizing. PG&E procedures will require that all W* cracks initially identified by Plus Point, as having inclination angles greater than 20° based on review of terrain plots, will be sized using a pancake coil. This process will eliminate the possibility of mislocating crack tips using a Plus Point coil for those indications having inclination angles approaching 45°. WCAP-14797 allows indications less than 2 inches long to remain in service provided their inclination angles relative to the tube axis is ≤ 45°, less the NDE uncertainty for the crack angle (Table 8.3-1, "Summary of NDE Uncertainties for W* Applications," specifies pancake coil uncertainty as 11.7°). Conversely, all W* cracks initially identified by Plus Point as having inclination angles of 20° or less, will be documented as having an inclination angle of 0°.

NRC Question 5:

Expansion-transitions in explosively expanded tubesheets tend to have more gradual changes in tube diameter over a given length of tube. This complicates the ability to accurately locate the position of the BWT. Describe the procedure that eddy current data analysts are to follow to locate the BWT.

PG&E Response to NRC Question 5:

The procedural steps for locating the BWT are incorporated in PG&E's response to NRC Question 7.

NRC Question 6:

According to the submittal dated October 22, 1998, the licensee has committed to perform in-situ pressure testing of a number of tubes with expansion-transition flaws. It was stated that the tubes will be pressurized to P_{NO} to assess their leakage integrity. Will the licensee in-situ pressure test tubes to P_{SLB} that no longer satisfy the W repair criteria regardless of whether the crack leaks at normal operating differential pressures?*

PG&E Response to NRC Question 6:

Prior W* indications that no longer satisfy the W* criteria will be evaluated as candidates for in-situ pressure testing using the screening protocol and the test procedure contained in the draft EPRI in-situ pressure testing guidelines. Current NDE threshold values used in the screening protocol were described in PG&E Letter DCL-98-148. For indications that no longer satisfy the W* criteria and require testing, leak testing will be conducted at ΔP_{SLB} per the EPRI guidelines to demonstrate compliance with the accident leakage performance criteria contained in NEI 97-06, "Steam Generator Program Guidelines." The results of the leak test could be used to support condition monitoring, and provide a comparison between the projected and actual end of cycle (EOC) leak rates to help validate the W* leak rate methodology.

NRC Question 7:

In the submittal dated October 22, 1998, it was stated the BWT would be redefined to be within 0.7 inches of the tube-to-tubesheet contact point "when profiles such as Figure 2-4 are identified." Describe, in further detail, the criteria that will be followed to redefine the BWT.

PG&E Response to NRC Question 7:

PG&E's response to NRC Question 7 also responds to the NRC Question 5 request for the procedural steps used in defining the BWT. As discussed in WCAP-14797, and PG&E Letter DCL-98-148, the W* criteria include an allowance of 0.7 inches for no contact between the tube and tubesheet below the BWT. Based on tubesheet profilometry data currently available, this allowance bounds the noncontact distance for nearly all WEXTEX expansions. This response identifies the exceptions to the 0.7 inch distance.

The procedural steps in defining the BWT are supplemented by training material for the analysts, to aid in interpretation of the potentially irregular tubesheet holes. The procedural steps in defining BWT, and key elements of the training materials are described below. The procedural steps are:

1. Locate the TTS using low frequency data.

2. Establish the length scale for the bobbin profile measurements. The design thickness using the top and bottom of the tubesheet as reference points can be used for this scale.

3. Locate the BWT.

   a. Read the highest frequency absolute data using the tubesheet profile software. The unexpanded diameter should be set at 775 mils, and the expanded inside diameter (ID) set at 794 mils in the hardrolled region within 2.5 inches of the bottom of the tubesheet. Although not necessary for BWT location, a calibration standard may be used to establish the diameters, if more accurate absolute diameter measurements are desired for other purposes.

   b. Report BWT as the point at which the extrapolated tube profile in the first 3 inches below the transition intersects the elevation of the bottom of the expansion transition (i.e., the slope of transition approaches zero relative to the tube profile). This is the conventional BWT definition with the extrapolated tube profile line setting up the step 3c evaluation.

   c. Observe if an indicated gap > 0.7 inches in length exists under the extrapolated full expansion profile and the BWT. If the length of this gap exceeds 0.7 inches, report the BWT at 0.7 inches above the point of full expansion, instead of as the point found in step 3b.

4. Print graphics supporting the bobbin profile analysis.

The training materials are used to provide guidance for steps 3b and 3c of the above procedural steps, and to inform the NDE analysts of the types of profiles encountered in WEXTEX expansions. Classifications of the expansions with examples for each classification have been identified. Step 3b directs that the point of intersection between the extrapolated full expansion profile and the elevation of the bottom of the expansion transition be identified. Figure 1 shows an example of the line (the horizontal line in Figure 1) for the extrapolated expansion profile and intersection with the BWT. The full length profile of Figure 2 for this tube shows that the "bumps" in the Figure 1 profile are irregularities in the expansion, and not part of an overall taper. The line for the extrapolated profile leads to an intersection with the bobbin coil profile of the tube diameter. The gap between the extrapolated profile and the bobbin coil profile defines the taper in the WEXTEX expansion. For most tubes, the intersection point will lie no more than 0.7 inches below the BWT, and a 0.7 inch allowance for tapered expansion below BWT has been made in the W* justification.

[illegible]

[illegible]

The profile plots, such as Figures 1 and 2, provide the basis for classifying the signals based on the intersection of the extrapolated profile and the bobbin coil profile. Classifications from A to C have been defined to assist in NDE analyst training.

Class A tubes have no identifiable taper below the BWT (i.e., essentially ideal profiles). Figure 2-1 in PG&E Letter DCL-98-148 is an example of a Class A expansion.

Class B tubes exhibit a variable or tapered diametral variation within the tubesheet, and exhibit ≤ 0.7 inches taper length below the BWT. Figures 2-2, 2-3, 2-5, and 2-6 in PG&E Letter DCL-98-148 are examples of Class B expansions. Class B tubes are acceptable as the diametral variations more than 0.7 inches below the BWT are attributable to tubesheet bore variations with the explosive expansion taking the shape of the tubesheet.

Class C tubes display a fairly uniform taper below the BWT that is potentially > 0.7 inches. These tubes require that the BWT position be reported as 0.7 inches above the end of the taper. Figure 2-4 in PG&E Letter DCL-98-148 shows a Class C tube, and the BWT for this tube should be reported at 1.3 inches below the TTS (i.e., 0.7 inches above the end of the taper). The profile may be acceptable, but tubesheet contact is not as well defined as for the other profiles. Therefore, BWT is lowered to within 0.7 inches of the contact point. Figure 2-7 in PG&E Letter DCL-98-148 is also a Class C tube (a laboratory specimen). Its measured pull forces were very high, which indicated that tube to tubesheet contact existed over the tapered profile, and the expansion would be acceptable for W* applications. However, the BWT would be lowered for this indication if found as a W* candidate in the field, since it falls into the Class C expansion category.

In general, the profiles of the field tube expansions represent contact with the tubesheet hole surface, if the expanded diameter is nominally equal to 0.790 inches. Variations in diameter resulting from hole irregularities may be observed along the tubesheet length. Profile variations that look like "bulges" are indicative of tubesheet contacts, since the expansion would be unlikely to "bulge" inside the tubesheet without tubesheet contact.

The procedural steps outlined above, and analyst training materials for implementing the procedure, define the criteria for redefining the BWT. The Class C expansions requiring the BWT redefinition are distinguishable from the other expansions that are acceptable without a BWT redefinition.

NRC Question 8:

By letter dated August 28, 1998, the licensee submitted leak rate test data for the proposed W steam generator tube repair criteria. The staff's evaluation of this data has concluded that the measured leak rates are functionally dependent on the crevice length. For example, the figure [in the RAI] illustrates the dependence of the loss coefficient obtained from leak rate measurements on the crevice length. As seen in the data, different correlations are evident for the three general categorizations for the crevice length. This dependence, however, varies with each sample number (e.g., W4-018). Based on information provided in WCAP-14797, Revision 1, the crevice leak rate model proposed for W* does not account for this variable. Discuss the root cause for the dependence of the measured leak rate on the specimen crevice length. Also, discuss whether the model will provide accurate (or conservative) estimates of leakage from W* tubes given that crevice lengths were not accounted for in the model relating the contact pressure to the loss coefficient.*

PG&E Response to NRC Question 8:

A discussion of a response to the RAI is included in Attachment C along with corrected database information. It is noted that the loss coefficients reported in Reference 2 are generally in error, having been scaled by one order of magnitude in transferring the data from a spreadsheet to a word processor. There are also other corrections to the data that are discussed in the attachment. The correct test data were used for the analyses performed in support of the preparation of the WCAP-14797.

NRC Question 9:

The proposed alternate tube repair criteria would allow tubes with cracks to remain in service. Although the flaws in these tubes would initially be confined below the tubesheet secondary face, they have the potential to grow into the free span region (i.e., above the top of tubesheet). As documented in NUREG-1570, "Risk Assessment of Severe Accident-Induced Steam Generator Tube Rupture," the staff is concerned with the potential consequences associated with freespan steam generator tube flaws. In order to ensure that a consistent level of risk will exist upon implementation of the proposed repair criteria, the NRC requests that the licensee provide an assessment demonstrating that an acceptable level of risk would be maintained for tubes returned to service using W. Alternatively, the licensee may consider modifying the proposed repair criteria to minimize the potential for developing free span cracking in tubes returned to service using W*.*

PG&E Response to NRC Question 9:

PG&E proposes adopting performance criteria to minimize the potential for developing free span cracking in tubes returned to service using W* that have the potential to grow into the freespan region. This proposal is in lieu of demonstrating the level of risk is consistent with that documented in NUREG-

1570. This performance criteria will specifically consider allowances for NDE measurement uncertainty and crack growth.

PG&E proposes modifying TS 4.4.5.4.11(e)2 as follows:

> "Axial cracks in tubes returned to service using W* shall have the upper crack tip below the BWT by at least the NDE measurement uncertainty, and below the TTS by at least the NDE measurement uncertainty and crack growth allowance, such that at the end of the subsequent operating cycle the entire crack remains below the tubesheet secondary face."

The W* criteria will require that the measured upper crack tip for cracks returned to service be below the TTS by at least the 95 percent confidence level NDE uncertainty on locating the crack tip relative to the TTS, plus the 95 percent cumulative probability growth rate assuming all growth is toward the TTS. Growth rate data developed for the prior cycle assessment will be applied to determine the tube repair criteria as discussed in the PG&E response to NRC Question 2. PG&E will confirm that all tubes returned to service using the W* criteria will meet the above performance criteria. Cracks not meeting the performance criteria will be repaired. PG&E will confirm by condition monitoring that cracks in tubes returned to service using the W* criteria remain below the TTS including an allowance for NDE measurement uncertainty. If condition monitoring demonstrates the performance criteria was not met, then PG&E will report this to the NRC and evaluate the condition before returning the SG to service.

FIGURE 1

Example of 3" Extrapolated Tube Profile and Intersection
With Elevation of the BWT(....) Class A Expansion

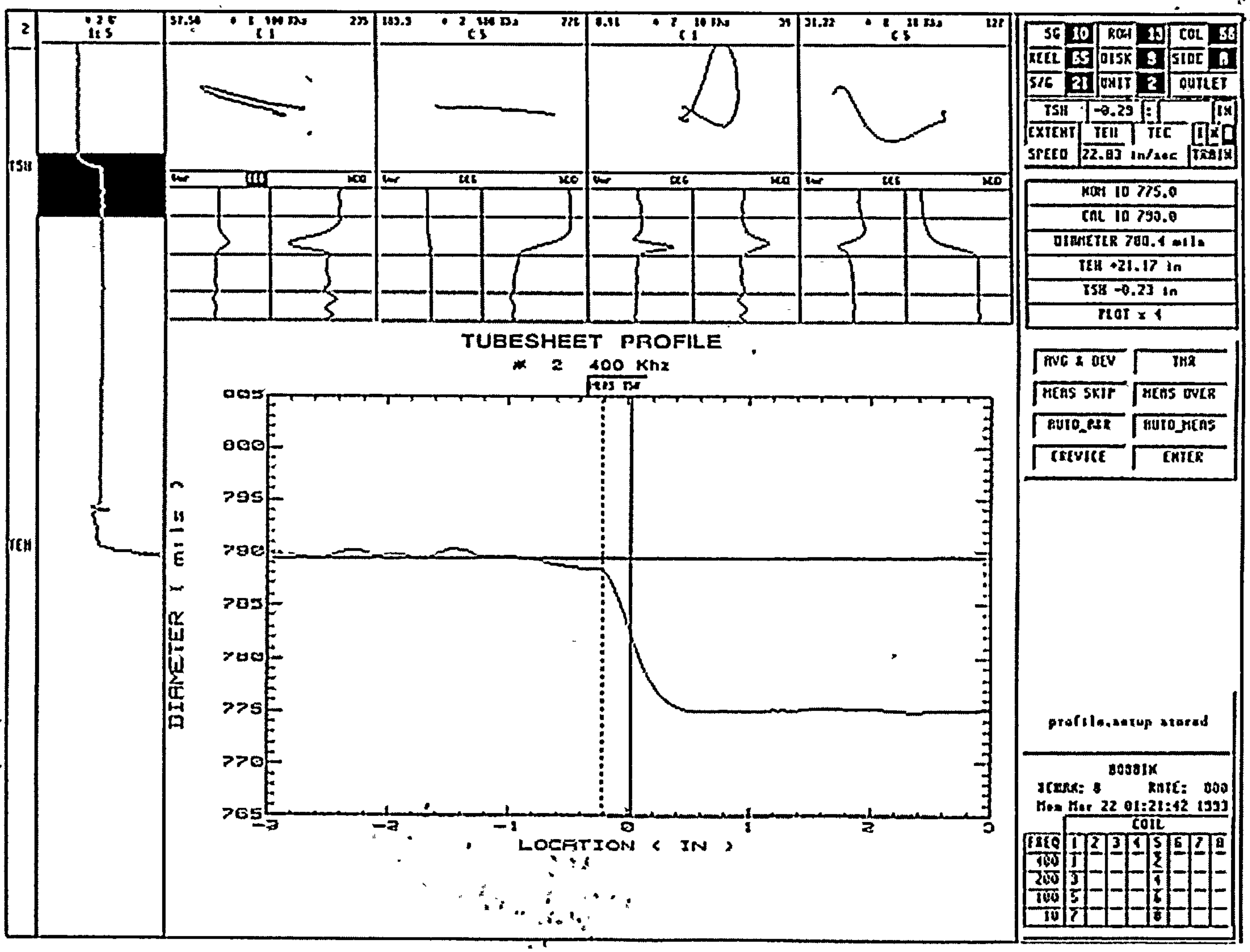
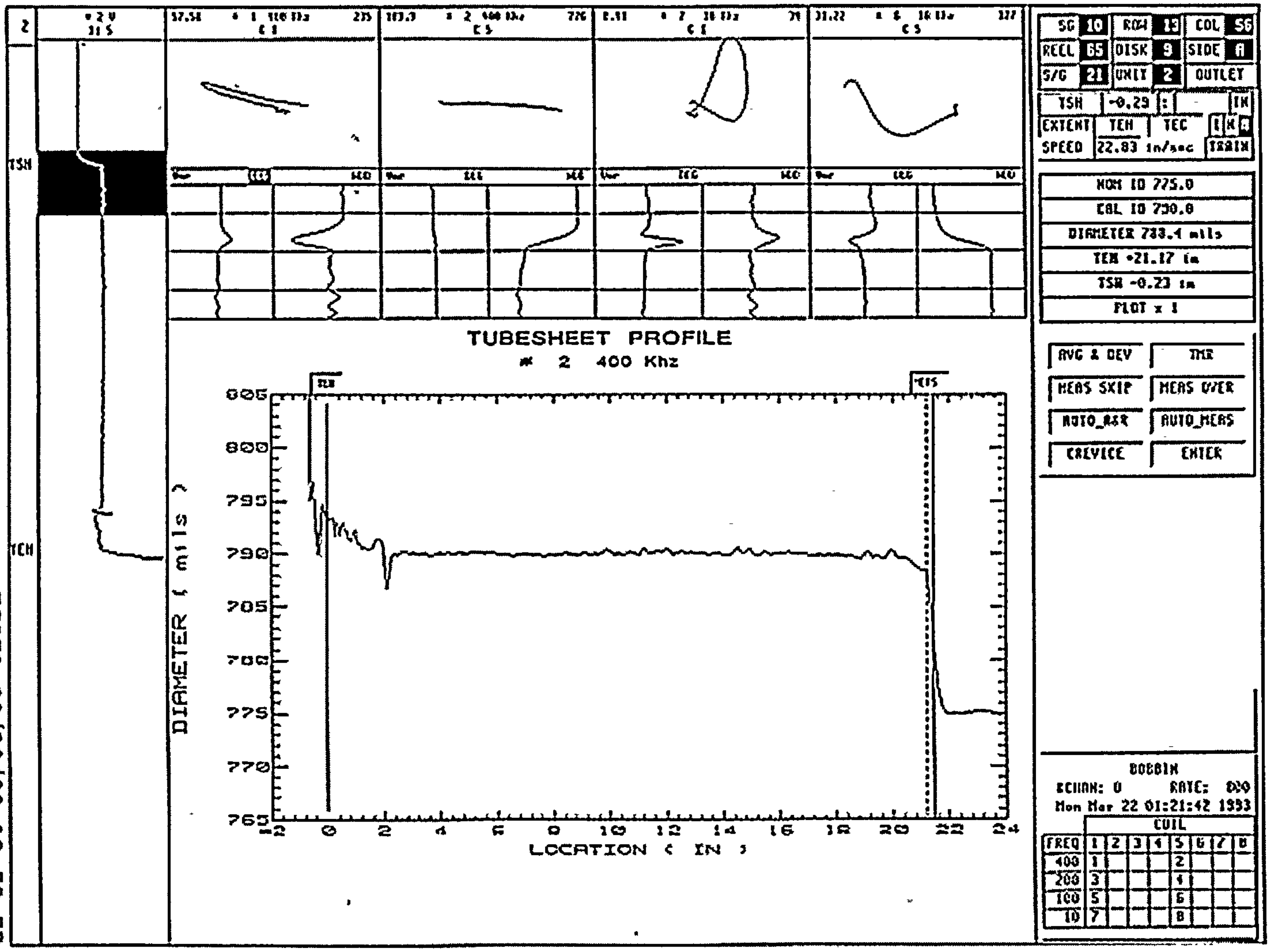


FIGURE 2

Full Tubesheet Expansion of Figure 1

DIABLO CANYON ___ 03/21/93 OUTLET UNIT: 2 SG: 21 REEL: 65 PRI



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PG&E Response to NRC Question 8 - Attachment to Westinghouse Letter NSD-E-SGDA-99-006, NRC RAI on Diablo Canyon W* Loss Coefficient, Dated January 11, 1999

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Review of Loss Coefficient Test Data for WEXTEX Crevices

1. Background

Mr. Phillip Rush of the NRC staff transmitted a facsimile to Tom Pitterle of Westinghouse on September 29, 1998, with the following discussion:

> "Attached are copies of some Excel graphs I made to investigate the possibility of specimen dependence on the unusual scatter evident in Figure 6.4-2 of the W* topical report. I first separated the data into four groups by specimen ID, i.e., W4-001, W4-004, W4-008, and W4-018. Then I broke down the data in some of the groups into three subgroups (short, medium and long). Short medium and long specimens are those with crevice lengths on the order of 0.5", 1", and 2" respectively. As you can see from the attached figures, tests of W4-004 specimens and W4-018 clearly demonstrate that something unusual has cropped up in the test results. Please look at this and get back to me with your conclusions. Feel free to call me to discuss this observation."

The facsimile from Mr. Rush looks at the data base used to establish crevice loss coefficients for WEXTEX tube-to-tubesheet crevices. This data base was developed from leak tests run on simulated WEXTEX crevices and appears as Figure 6.4.2 of Reference 1. The data set is listed in Table 6.2-3 of Reference 1, but the listing does not contain the calculated loss coefficients. The complete data set including loss coefficients was intended to be provided by Reference 2.

The information plots transmitted by Mr. Rush depicted data from Reference 2, which was prepared in response to earlier RAIs and updated Table 6.2-3 of the WCAP to include calculated loss coefficients (flow resistance) for the test specimens. The essence of Mr. Rush's concern is summarized as "... tests of W4-004 specimens and W4-018 clearly demonstrate that something unusual has cropped up in the test results." The "something unusual" to which Mr. Rush refers is apparently that the loss coefficient appears to be dependent on crevice length. Physically, the loss coefficient should be independent of the length of the crevice.

2. Purpose

A review the WEXTEX leak rate data set and resulting calculated loss coefficients was conducted to determine if an unwarranted crevice length effect on loss coefficient is evident in the test data.

3. Loss Coefficient vs. Contact Pressure

Mr. Rush re-plots the data set of loss coefficient vs. contact pressure (Figure 6.4-2 of Reference 1). The loss coefficient test data used by Mr. Rush were provided via Reference 2. A review of the data set in this letter shows that most of the loss coefficients are an order of magnitude higher than those plotted on Figure 6.4-2. The

corrected data set is attached as Table 1 to this letter and supercedes the data set previously provided via Reference 2. It is noted that Table 1 represents the data analyzed in support of the conclusions of Reference 1.

Mr. Rush's plots of the data, separated by sample number and crevice length, were re-plotted using the correct data set. These plots appear as Figures 1 through 4. Except for a few of the points, the plots have the same appearance as Mr. Rush's with the loss coefficient scale an order of magnitude lower. The data scatter on Figures 1 through 4 is consistent with the scatter on Figure 6.4-2 of Reference 1. Recall that the data appear to have constant variance about the regression line of Reference 1 and do not contradict the assumption of normality for the distribution of the residuals from the regression analysis.

On the surface, Figure 2 (for Sample W4-004) and to a lesser degree, Figure 4 (for Sample W4-018) seem to indicate that loss coefficient is increasing with decreasing crevice length. Samples W4-001 and 008 do not show this pattern. Figures 5 through 8 re-plot the same loss coefficient data sets versus crevice length with operating conditions as a parameter. When viewed in this manner, the data shows no consistent trend of loss coefficient variation with length. Sample WP4-001 shows a general increase of loss coefficient with length although one set of operating conditions shows the reverse trend. The medium lengths for Sample WP4-004 have lower loss coefficients than the short lengths, but the trend is reversed for the single set operating conditions tested at the long length. Sample WP4-008 shows a general increase of loss coefficient with length. Sample WP4-018 shows a decrease of loss coefficient with length for the medium and long lengths, but the reverse trend for the single case of short and medium length tested.

4. Conclusions

The above review of the loss coefficient data for WEXTEX crevices shows no consistent length effect. The absence of a length effect is expected based on physical grounds.

Overall, it is noted that the leak rate data include considerable scatter, but do not show unacceptable bias toward the variables influencing crevice leakage. While scatter is common for leak rate data, the W* tests may include more than typical data scatter. The leak rates are small and minor variations in the crevice can influence the observed leak rates. Regardless, the spread in the loss coefficient data and associated uncertainties on the leak rates are included in the W* analyses, for both the loss coefficient and effective crack length.

5. References

1. WCAP-14797, Rev 1, Generic W* Tube Plugging Criteria for 51 Series Steam Generator Tubesheet Region WEXTEX Expansions, February 1997.
2. NSD-E-SGDA-98-0260, Rev 1, Response to NRC RAIs on Diablo Canyon W*, August 20, 1998.

[illegible]

[illegible]

Table 1: WEXTEX Loss Coefficient Re-analysis (Proprietary)

Arranged by Sample # / Crevice Length

Specimen Number	Temp (°F)	Differential Pressure (psi)	Crevice Length (inch)	Avg. Contact Pressure (psi)	Leak Rate (dpm)	Loss Coefficient	Viscosity (lbf-sec/ft^2)	Leak Rate GPM @ P_o and T_o
W4-001	70	1620	0.27	383	24.00	3.34E+13	2.04E-05	3.20E-04
W4-001	600	1620	0.43	595	15.00	2.68E+13	1.80E-06	2.94E-04
W4-001	600	2000	0.50	676	14.00	8.70E+13	1.80E-06	2.75E-04
W4-001	600	2650	0.62	1009	27.40	7.90E+13	1.80E-06	5.37E-04
W4-001	70	1620	1.02	989	8.60	2.47E+13	2.04E-05	1.15E-04
W4-001	600	1620	1.18	1392	0.80	1.83E+14	1.80E-06	1.57E-05
W4-001	600	2000	1.25	1590	5.60	8.70E+13	1.80E-06	1.10E-04
W4-001	600	2650	1.37	1864	8.90	1.10E+14	1.80E-06	1.75E-04
W4-001	70	1620	2.02	1098	23.40	4.57E+12	2.04E-05	3.12E-04
W4-001	600	1620	2.18	1587	0.10	7.92E+14	1.80E-06	1.96E-06
W4-001	600	2000	2.25	1820	0.05	5.41E+15	1.80E-06	9.80E-07
W4-001	600	2650	2.37	2169	0.10	5.66E+15	1.80E-06	1.96E-06
W4-004	70	1620	0.36	425	25.00	2.40E+13	2.04E-05	3.33E-04
W4-004	600	1620	0.47	816	3.80	9.66E+13	1.80E-06	7.45E-05
W4-004	600	2000	0.52	1004	4.60	2.55E+14	1.80E-06	9.02E-05
W4-004	600	2650	0.59	1222	8.20	2.77E+14	1.80E-06	1.61E-04
W4-004	70	1620	1.06	933	144.00	1.42E+12	2.04E-05	1.92E-03
W4-004	600	1620	1.17	1427	18.50	7.97E+12	1.80E-06	3.63E-04
W4-004	600	2000	1.22	1639	21.80	2.29E+13	1.80E-06	4.27E-04
W4-004	600	2650	1.29	1960	23.50	4.43E+13	1.80E-06	4.61E-04
W4-004	70	1620	2.06	1062	27.40	3.83E+12	2.04E-05	3.65E-04
W4-008	70	1620	0.62	759	190.00	1.84E+12	2.04E-05	2.53E-03
W4-008	600	1620	0.62	1227	74.00	3.76E+12	1.80E-06	1.45E-03
W4-008	600	2000	0.62	1447	75.00	1.31E+13	1.80E-06	1.47E-03
W4-008	600	2650	0.62	1824	84.00	2.58E+13	1.80E-06	1.65E-03
W4-008	70	1620	1.37	1009	98.00	1.61E+12	2.04E-05	1.31E-03
W4-008	600	1620	1.37	1568	18.30	6.88E+12	1.80E-06	3.59E-04
W4-008	600	2000	1.37	1822	19.30	2.30E+13	1.80E-06	3.78E-04
W4-008	600	2650	1.37	2257	6.30	1.56E+14	1.80E-06	1.24E-04
W4-008	70	1620	2.37	1092	7.00	1.30E+13	2.04E-05	9.33E-05
W4-018	70	1620	0.20	373	1740.00	6.21E+11	2.04E-05	2.32E-02
W4-018	70	1620	0.95	966	20.80	1.09E+13	2.04E-05	2.77E-04
W4-018	600	1620	1.02	1396	0.50	3.38E+14	1.80E-06	9.80E-06
W4-018	600	2000	1.06	1635	0.50	1.15E+15	1.80E-06	9.80E-06
W4-018	600	2650	1.10	1997	0.20	6.10E+15	1.80E-06	3.92E-06
W4-018	70	1620	1.95	1093	41.40	2.68E+12	2.04E-05	5.52E-04
W4-018	600	1620	2.02	1607	1.00	8.54E+13	1.80E-06	1.96E-05
W4-018	600	2000	2.06	1865	0.80	3.69E+14	1.80E-06	1.57E-05
W4-018	600	2650	2.10	2289	1.00	6.39E+14	1.80E-06	1.96E-05

Note: Underline values are corrections to those presented in Reference 1. All loss coefficient values supercede those of References 1 and 2.

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Figure 1. Loss Coefficient vs Contact Pressure - Sample W4-001

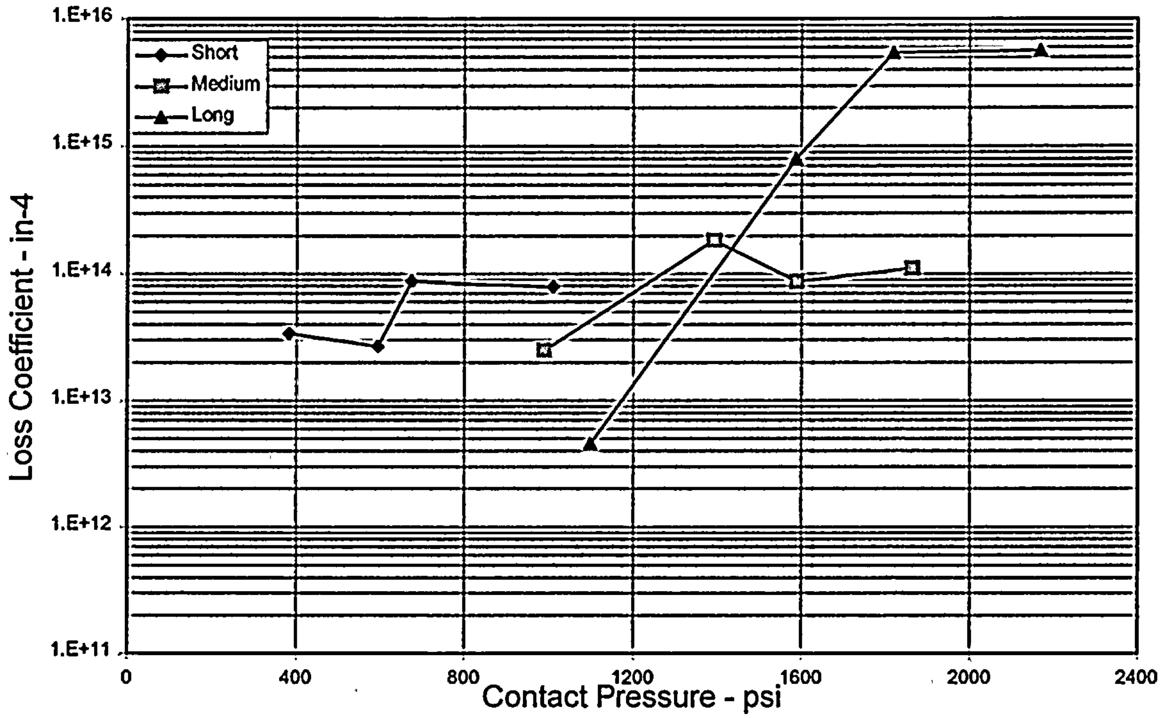

Figure 2. Loss Coefficient vs Contact Pressure - Sample W4-004

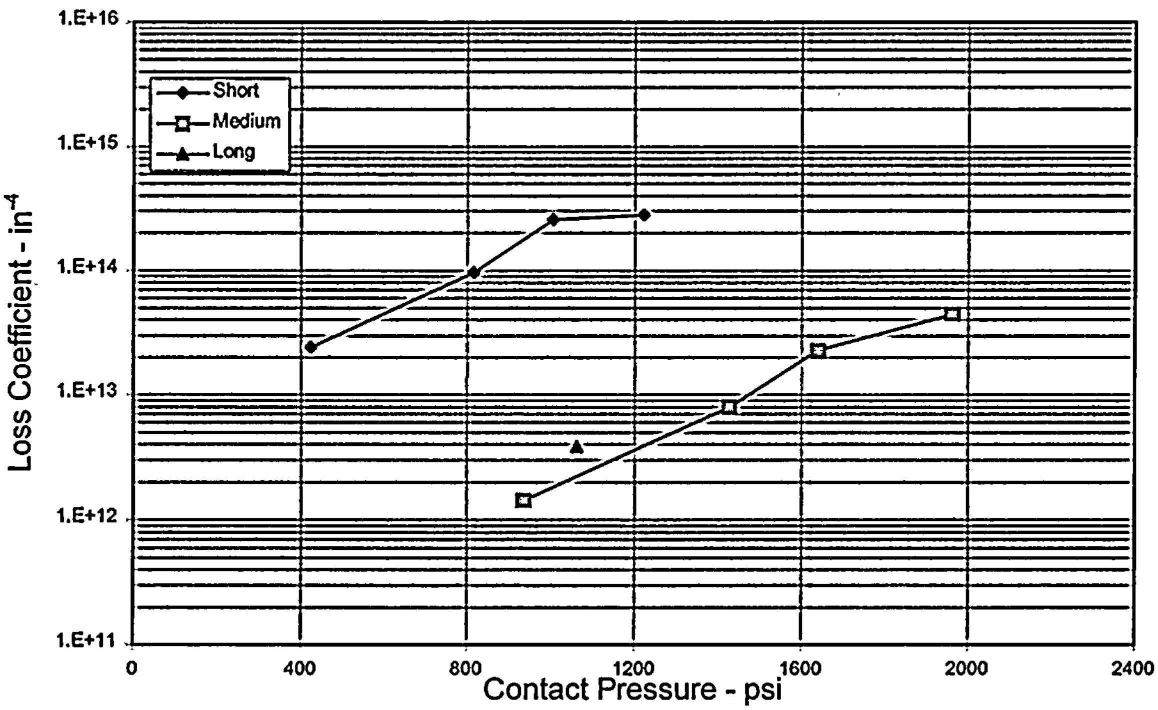

Figure 3. Loss Coefficient vs. Contact Pressure - Sample W4-008

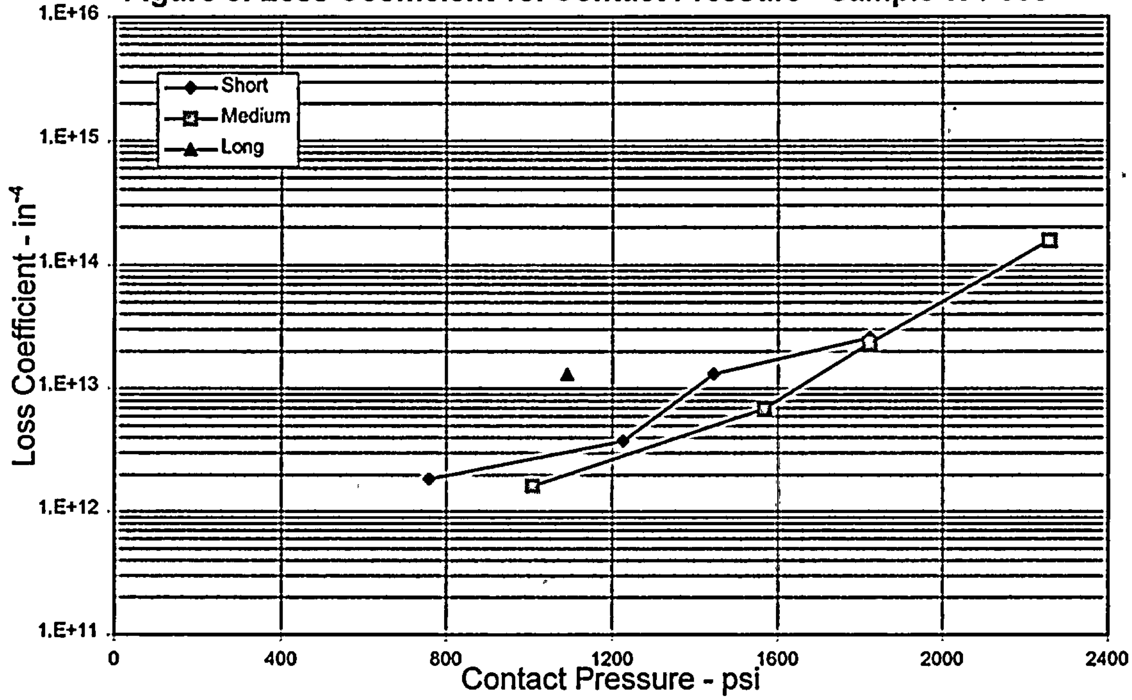

Figure 4. Loss Coefficient vs. Contact Pressure - Sample W4-018

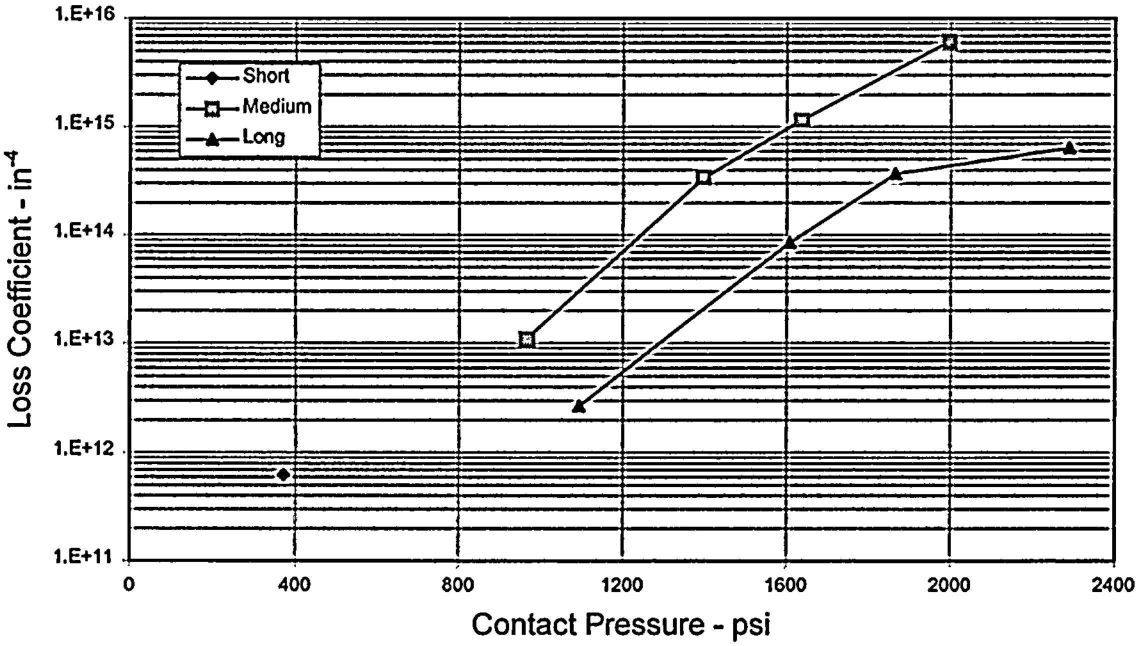

Figure 5. Loss Coefficient vs Crevice Length
Sample WP4-001

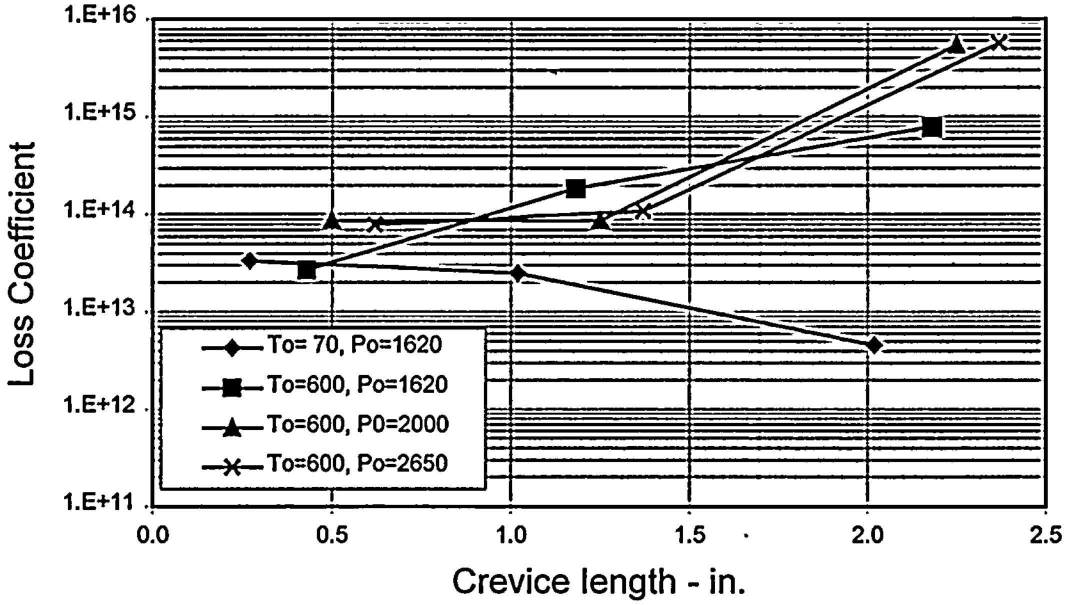

Figure 6. Loss Coefficient vs Crevice Length
Sample WP4-004

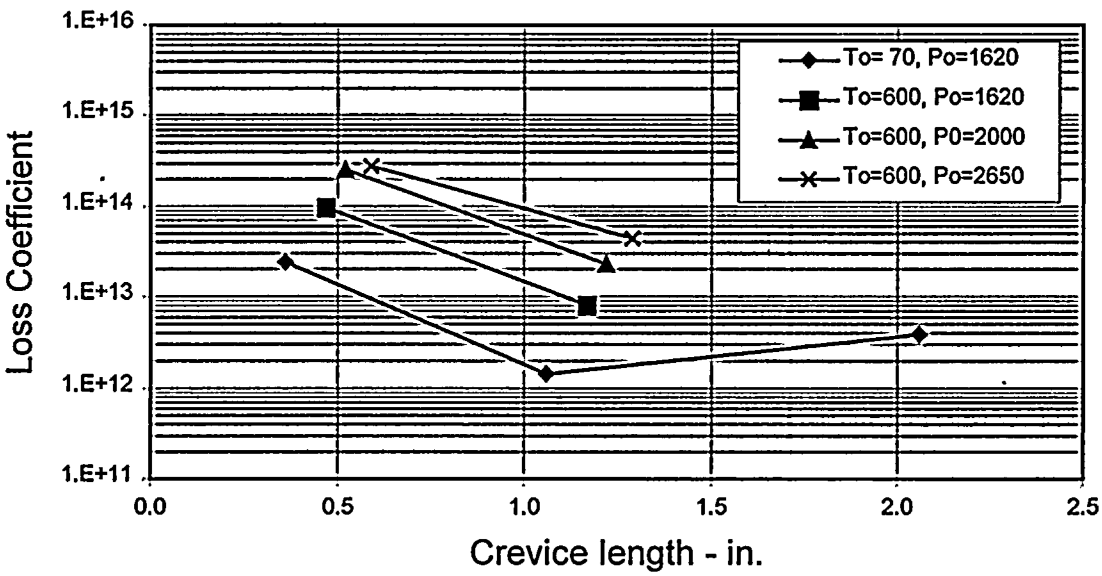

Figure 7. Loss Coefficient vs Crevice Length
Sample WP4-008

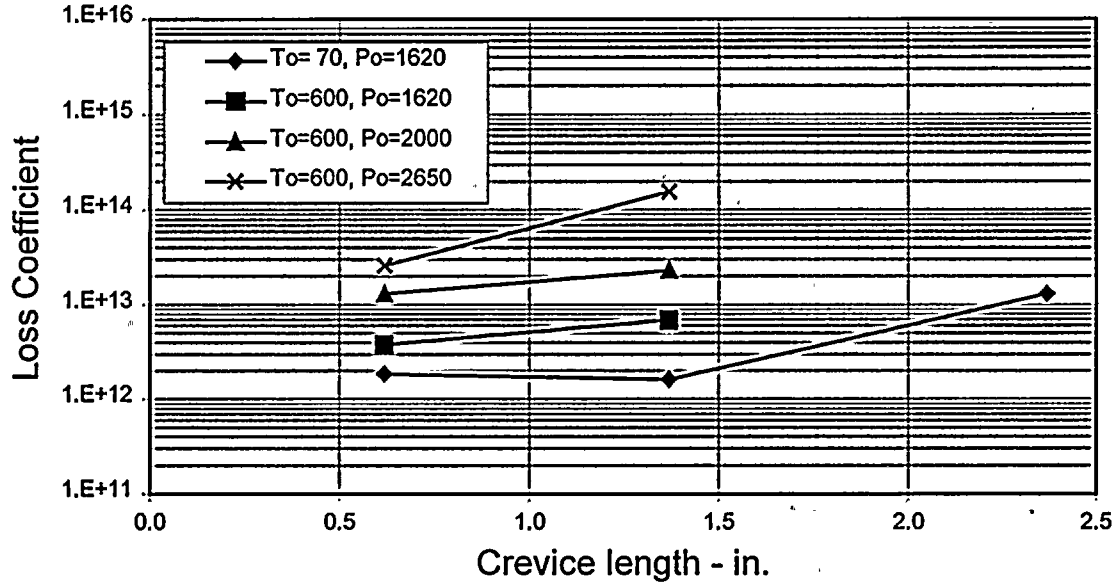

Figure 8. Loss Coefficient vs Crevice Length
Sample WP4-018