



Westinghouse
Electric Corporation

Energy Systems

Nuclear Services Division

Box 355
Pittsburgh Pennsylvania 15230-0355

February 28, 1996
CAW-96-935

Document Control Desk
US Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. William T. Russell, Director

**APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE**

Subject: "EPRI ARC Database for 3/4" and 7/8" Diameter Tubes and Updated ARC Correlation
for 7/8" Diameter Tubes" (Proprietary)

The proprietary information for which withholding is being requested is further identified in Affidavit CAW-96-935 signed by the owner of the proprietary information, Westinghouse Electric Corporation. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Duquesne Light Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-96-935, and should be addressed to the undersigned.

Very truly yours,

N. J. Liparulo, Manager
Regulatory & Engineering Networks

JJM/bbp

Enclosures

cc: Kevin Bohrer/NRC(12H5)

CAW935/NSD093

9603140049 960307
PDR ADDCK 05000334
P PDR

Proprietary Information Notice

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

Copyright Notice

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

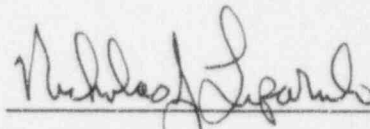
AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

SS

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Nicholas J. Liparulo, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

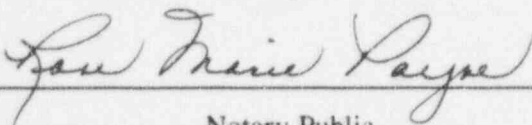


Nicholas J. Liparulo, Manager

Regulatory & Engineering Networks

Sworn to and subscribed

before me this 28 day
of February, 1996



Notary Public

Notarial Seal

Rose Marie Payne, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Nov. 4, 1996

Member, Pennsylvania Association of Notaries

- (1) I am Manager, Regulatory & Engineering Networks, in the Nuclear Services Division, of the Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.
- (2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.
- (3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.
- (4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.
 - (i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.
 - (ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

- (a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.
- (b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.
- (c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.
- (d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.
- (e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.
- (f) It contains patentable ideas, for which patent protection may be desirable.
- (g) It is not the property of Westinghouse, but must be treated as proprietary by Westinghouse according to agreements with the owner.

There are sound policy reasons behind the Westinghouse system which include the following:

- (a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

- (b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.
 - (c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.
 - (d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.
 - (e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.
 - (f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.
- (iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.
- (iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.
- (v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in letter NSD-SGD-1212, "EPRI ARC Databases for 3/4" and 7/8" Diameter Tubes and Updated ARC Correlation for 7/8" Diameter Tubes", dated February 26, 1996 (Proprietary), being transmitted by the Duquesne Light Company letter and Application for Withholding Proprietary Information from Public

Disclosure, to the Document Control Desk, Attention Mr. William T. Russell. The proprietary information as submitted for use by the Duquesne Light Company for the Beaver Valley Power Station is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of steam generator tube integrity evaluations.

This information is part of that which will enable Westinghouse to:

- (a) Perform steam generator tube integrity evaluations.

Further this information has substantial commercial value as follows:

- (a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting requirements for licensing documentation.
- (b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar methodologies and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing testing.

Further the deponent sayeth not.

Attachments : Non-Proprietary Class 3 Version

Table 1
7/8-Inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-Inch Diameter Puffed and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-Inch Diameter Pailed and Mated Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-Inch Diameter Puffed and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-Inch Diameter Puffed and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-Inch Diameter Potted and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-Inch Diameter Filled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 1
7/8-Inch Diameter Palled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

Plant Letter & Name	Specimen No. or ReneCol.	T S P	Bobbin Coil		RRC Volts	Destructive Exam		Normal Operation Leak Rate ⁽²⁾ (l/hr)	SLB Leak Rate (l/hr) ⁽³⁾			Burst Pressure (psi)	Yield Stress S_y (ksi)	Ultimate Stress S_u (ksi)	2 x Flow Stress $S_y + S_u$ (ksi)	Adjusted Burst Pressure ⁽⁴⁾ (psi)	Correlation Application ⁽⁵⁾	
			Volt ⁽¹⁾	Depth		Max Depth	Length ⁽¹⁾ (in.)		Pressure Differential								Prob of Leak	Burst Rate
									2335	psi	2560	psi	2650	psi				

NOTES:

1. All voltages normalized to the recommended values of this report.
2. Crack network length for burst crack, with through wall crack length given in parentheses.
3. N.O. leak rates are adjusted to $\Delta P = 1450$ psi per Appendix B of Reference 1. SLB leak rates are adjusted to reference ΔP 's shown.
4. Normalized to 150 ksi flow stress (sum of yield and ultimate stress).
5. Column indicates application of specimen in leak rate and/or burst correlations. 0 = No, 1 = Yes
6. Data excluded from application to correlations based on EPRI data exclusion criterion 2.
7. N.R. = Not Reliable data.
8. 98% deep for 0.22", >95% deep for 0.35".
9. N.M. = Not Measured; value of 169.8 ksi in parentheses assumed for burst pressure adjustments when measurements not available.
10. Average of multiple measurements.
11. Burst pressure not used in ARC database.
12. Inferred from destructive exam depth, leak test not performed. Corrosion depth too shallow leakage at SLB conditions.
13. Data excluded from application to correlations based on EPRI data exclusion criterion 1.

Table 2

[illegible]

Table 2
3/4-Inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 2
3/4-Inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 2
3/4-Inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 2
3/4-Inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 2
3/4-Inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 2
3/4-Inch Diameter Pulled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

[illegible]

Table 2
3/4-Inch Diameter Palled and Model Boiler Tube Leak Rate
and Burst Pressure Measurements

Plant Letter & Name	Specimen No. or Rev'd Col.	T S P			Bolted Coll		RPC Volts		Destructive Exam			Normal Operation Leak Rate ⁽²⁾ (lb/hr)		SLB Leak Rate (lb/hr) ⁽²⁾				Burst Pressure (psi)	Yield Stress S_y (ksi)	Ultimate Stress S_u (ksi)	$2 \times$ Flow Stress $S_y + S_u$ (ksi)	Adjusted Burst Pressure ⁽⁴⁾ (ksi)	Corrosion Application ⁽³⁾	

NOTES:

1. All voltages normalized to the recommended values of this report.
2. Crack network length for burst crack, with through wall crack length given in parentheses.
3. N.O. leak rates are adjusted to $\Delta P = 1300$ psi per Appendix B of NP-7480-L, Volume 2. SLB leak rates are adjusted to reference ΔP 's shown.
4. Normalized to 150 ksi flow stress (sum of yield and ultimate stress).
5. Column indicates application of specimen in leak rate and/or burst correlations. 0 = No, 1 = Yes
6. Leak rate inferred from destructive examination crack morphology. Corrosion depth too shallow for leakage at SLB conditions.
7. N.R. = Not Reliable data.
8. Burst tests performed with TSP constraint; data not used in ARC burst correlation.
9. Conservatively calculated with CRACKFLO code; included per NRC directive.
10. Data excluded from application to correlations based on EPRI data exclusion criterion 2.
11. Burst test showed insignificant extension at the corrosion crack tips. Therefore, burst pressure is a minimum value since burst is defined to include crack extension.
12. Data excluded from application to correlations based on EPRI data exclusion criterion 1.
13. Data meets EPRI data exclusion criterion 3.
14. Second throughwall crack 30 degrees from burst crack.

1.0 Updated ARC Correlations for 7/8" Tubes

This section reports on the evaluations performed which utilized the results of leak rate and burst testing of tube sections removed from SGs at utility sites in the United States after the publication of the original EPRI database for 7/8" diameter SG tubes (NP-7480-L, Volume 1). The results of the destructive examinations of the tube sections were reported in utility specific reports, and will be summarized in the complete data update report to follow. The additional pulled tube data germane to the APC correlations, and the bobbin amplitudes for APC applications, will be contained in a table in the complete update report to be issued at a later date. The additional data consist of results from pulled tube sections from Beaver Valley 1 (SG-95-06-006, May 1995), Farley 2 (SG-95-07-010, July 1995), Sequoyah 1 (SG-96-01-007, January 1996), and Farley 1 (SG-96-01-003, January 1996).

The results of the leak and burst tests are compared herein to the database of similar test results for 7/8" outside diameter SG tubes, and the effect of including the new test data in the reference database is evaluated. In summary, the applicable test data are consistent with the database relative to the burst pressure, the probability of leak, and the leak rate as function of bobbin amplitude correlations for 7/8" diameter tubes. The comparisons and evaluations follow.

Suitability for Inclusion in the Database

The morphology of the degradation of each indication considered herein was reviewed relative to the EPRI guidelines for inclusion/exclusion of tube specimen data in the alternate plugging criteria (APC) database. The findings of the reviews were recorded in documents prepared for each utility as the data were obtained. The details of the reviews will be included in a comprehensive report to be issued at a later date dealing with multiple tube sizes. None of the reviews revealed information that would lead to a conclusion that the data considered in this section should not be included in the database. Therefore, the correlations reported herein should be considered applicable to the use of APC for indications in 7/8" diameter tubes in Westinghouse SGs and constitute the analyses of the updated database.

1.1 Free Span Burst Correlation

The burst pressure database used in this report for 7/8" tubes consists of the EPRI recommended database, plus test results from tube R11C60-1 removed from D.C. Cook Unit 1. The results for this tube section were abnormally high, but the degradation morphology did not meet all of the exclusion criteria developed for degradation with abnormally high burst pressures, hence it was retained in the correlation database. The results from ten (10) burst tests, performed on tube specimens which exhibited a non-zero bobbin amplitude at a TSP elevation location, were considered for evaluation. A plot of the burst pressures of the additional specimens is depicted on Figure 1-1 relative to the burst pressure correlation devel-

oped using the reference database and relative to a 95% confidence band to contain 90% of the population of burst pressures.

1. A visual examination of the data relative to the EPRI database indicates that the burst pressures measured fall within the scatter band of the reference data.
2. Nine, i.e., 90%, of the data points fall within a 95%/90% tolerance interval (approximate) about the regression line (95% confident to contain 90% of the underlying normal population).
3. One, i.e., 10%, of the data points falls outside of the 95%/90% tolerance band about the regression line.

In summary, the visual examination doesn't indicate any significant departures from the reference database. Although the burst pressure is less than would have been expected for one of the indications, the appearance of one such indication in the additional ten data points is not significantly improbable. Moreover, the bobbin amplitude for this indication increased from 4 volts before removal to 12 volts after, thus, the burst pressure could have been reduced as a consequence of mechanical deformation from the tube removal activities. Since the regression line for this analysis represents the mean and median burst pressure to be expected from the parent population, it would be expected that additional data should fall about half above and half below the line. For the additional data analyzed, six (6) values were above the line and four (4) values below the line. For ten values drawn at random from the population of bursts, the probability that the split would be five above and five below is about 25%, and the probability that the results would be split six/four in either direction is 41%. Thus, distribution relative to above or below the regression line is not unusual. In addition, the average difference in the observed burst pressure relative to the predicted burst pressures is only 1.1%. Finally, although the tube data are from SGs at multiple plant sites, an examination of the normalized residuals relative to the predictions of the reference correlation equation was performed. The results of this analysis are shown on Figure 1-2 where the distribution of observed deviates is compared to those expected from a normal distribution. There doesn't appear to be any significant systematic departure from normality.

Since the additional burst pressure data were not indicated to be from a separate population from the reference data, the regression analysis of the burst pressure on the common logarithm of the bobbin amplitude was repeated with the additional data included. A comparison of the regression results obtained by including these data in the regression analysis is provided in Table 1-1. Regression predictions ob-

tained by including these data in the regression analysis are shown on Figure 1-3. The appropriate regression equation for future ARC analyses is,

$$P_B = 7.592 - 2.370 \log(\text{Volts}), \quad (1-1)$$

with a SLB structural limit of 8.6 volts. The changes to the correlation are:

1. The intercept of the burst pressure, P_B , as a linear function of the common logarithm of the bobbin amplitude regression line is increased by 0.48%. This has the effect of increasing the predicted burst pressure as a function of the bobbin amplitude.
2. The absolute slope of the regression line is increased by 2.19%, i.e., the slope is more steep. This has the effect of decreasing the burst pressure as a function of bobbin amplitude for indications greater than about 3 volts.
3. There is an increase in the standard error of the residuals of 1.38%. The effect of this change would be reflected in a slightly larger deviation of the 95% prediction line from the regression line.

The net effect of the changes on the SLB structural limit ($1.43 \cdot \Delta P_{\text{SLB}}$), using 95%/95% lower tolerance limit material properties, is to decrease it by 0.2 volts, i.e., from 8.8 volts to 8.6 volts. The increase in the slope relative to the increase in the intercept, and the increase in the standard error coupled with the fact that the structural limit is also decreased indicates that the probability of burst would also increase for bobbin indications over the structural range of interest. Based on the relatively small change in the structural limit, the change in the probability of burst would also be expected to be small.

1.2 Probability of Leak Correlation

As for the burst pressure correlation, there are ten (10) additional data pairs that were considered relative to the reference database and the probability of leak (POL) correlation to the common logarithm of the bobbin amplitude. Figure 1-4 illustrates the additional data relative to the reference correlation. All of the specimens except one exhibited POL behavior commensurate with expectations indicated by the reference database and regression curve. The single exception was an indication with a bobbin amplitude of 4.03 volts that exhibited leakage, thus becoming the indication with the second lowest voltage of the indications that leaked in the database.

Based on the reference curve, the POL for the leaking indication is 0.133, thus, roughly 1 in 7 indications with an amplitude of 4.03 volts would be expected to leak. Had the expectation been 1 in 20, statistically anomalous behavior could have been suspected. The indication that leaked was the same indication that

exhibited a lower than expected burst pressure. It is strongly suspected that this indication experienced ligament tearing during the tube pull as indicated by the maximum 96% corrosion depth resulting in post-pull Argon leakage at 200 psid and the increase in bobbin amplitude from 4.03 to 12.2 volts. However, since it is difficult to prove that the wall thickness ligament would not have torn during postulated SLB conditions, the indication is to be retained in the EPRI database. In conclusion, data examinations revealed no significant evidence of irregular results, i.e., outlying behavior is not indicated.

In order to assess the quantitative effect of the new data on the correlation curve, the database was expanded to include the additional data points and a *Generalized Linear Model* regression of the POL on the common logarithm of the bobbin amplitude was repeated. A comparison of the correlation parameters with those for the reference database is shown in Table 1-2. These results indicate:

1. A 9.7% increase (smaller negative value) in the *logistic* intercept parameter.
2. A 6.2% decrease in the *logistic* slope parameter.
3. The absolute values of the parameters' covariance matrix changed by 26.5% to 34.5%. These changes may have a significant impact on the POL values used during the Monte Carlo Simulations, but may not have a significant impact on the 95% confidence bound on the total estimated leak rate from a single SG.
4. The Pearson standard error decreased by 7.2% from 0.640 to 0.594. This is a negative indicator since the ideal value would be 1.0, but is not judged to be significant.

An additional evaluation was performed which demonstrated that most of the changes in the distribution parameters are a result of including the 4.03 V indication that leaked. In order to assess whether or not these changes are significant, the reference correlation and the new correlation were also plotted on Figure 1-4. An examination of Figure 1-4 reveals a moderate change in the correlation up to about 5 V, with a 31% increase at 4.03 V. A tabular summary of POL predictions before and after including the additional data point is provided as Table 1-3. For indications with amplitudes less than 1.0 volt, the POL increases by a factor of 2 to 4. The POL for indications of 3 volts increases by about 50%, while the change in the POL is not significant for indications of 8 volts and greater.

When the total leak rate is determined using the leak rate to bobbin volts correlation, the resulting value can be quite insensitive to the form of the POL function. So, the effect of the changes in the parameter values and variances would be expected to be small or insignificant relative to the calculation of the 95% confidence bound of the total leak rate from a SG. However, when the leak rate is

considered as independent of the voltage, as for the current APC database, the increase in POL will more directly affect the estimated total leak rate.

1.3 Free Span SLB Leak Rate Correlation for 7/8" Tubes

As previously noted, only one of the specimens exhibited leakage at SLB operating conditions. The test leak rate value corresponded to 2.19 lph at the SLB temperature and pressure difference conditions. The correlation of leak rate to bobbin voltage exhibits a p -value of 6.5% for the slope parameter using the reference database, and a value of 6.4% with the additional data point. Based on the requirements stipulated in NRC Generic Letter 95-05 for voltage based plugging criteria, the use of the correlation in performing Monte Carlo simulations to estimate the total leak rate from a SG is not considered to be justified. Figure 1-5 illustrates the new data point relative to the distribution predicted mean using the reference database and relative to a lower 95% confidence limit for a predicted leak rate from the distribution. Also illustrated on Figure 1-5, is the relation of the data point to the regression fit (median of the log-normal distribution) and to the expected leak rate (mean of the log-normal distribution) based on the regression analysis of the leak rate on the bobbin amplitude.

The common logarithm (log) of the test leak rate, 0.340, is lower than the mean log leak rate for the reference database, 0.576, but is well within one standard deviation of that value. The effects of including the data point in the database on the estimated parameters of the leak rate distribution are tabulated in Table 1-4. The estimated mean and standard deviation of the population of leak rates are decreased, hence, predicted leak rates from Monte Carlo simulations and the 95% confidence bound on the total leak rate from a single SG will be reduced. For clarification, the values listed in Table 1-4 for the mean, μ , and standard deviation, σ , of the population of leak rates are derived from the sample values of the log leak rate. These are the expected leak rate parameters to result from a simulation of the log leak rates using the NRC accepted leak rate simulation method as described in WCAP-14277.

1.4 Summary/Conclusions

The review of the effect of the additional data indicates that the SLB structural limit burst pressure will not be significantly changed by the inclusion of the data. Therefore, it is likely that the conclusions relative to EOC probability of burst and based on the correlation obtained using the reference database would not be significantly affected.

The probability of leak correlation to the common logarithm of the bobbin amplitude is moderately changed by the inclusion of the data, leading to the expectation of predicting slightly larger 95% confidence bound leak rates. At the same time, the mean and standard deviation of the leak rate distribution are decreased, leading to the expectation of lower 95% confidence bound leak rates. It may be

expected that the increase in the POL will be at least partially offset by the decrease in the predicted leak rates.

Table 1-1: Effect of Additional Data on the 7/8" Tube Burst Pressure vs. Bobbin Amplitude Correlation

$$P_B = \alpha_1 + \alpha_2 \log(\text{Volts})$$

Parameter	Reference Database Value	Database with additional	New / Old Ratio
α_1	7.5557	7.5920	1.0048
α_2	-2.3194	-2.3700	1.0219
r^2	82.7%	81.84%	0.9900
σ_{Error}	0.817	0.828	1.0138
N (data pairs)	70	80	
p Value for α_2	$5 \cdot 10^{-27}$	$1 \cdot 10^{-30}$	$9 \cdot 10^{-4}$
Reference σ_f	68.78 ksi ⁽¹⁾		

Notes: (1) This is the flow stress value to which all data was normalized prior to performing the regression analysis. This affects the coefficient and standard error values. The corresponding values for a flow stress of 75.0 ksi can be obtained from the above values by multiplying by 1.0904.

Table 1-2: Effect of Additional Data on the
7/8" Tube Probability of Leak Correlation

$$\Pr(Leak) = \left\{ 1 + e^{-[\beta_1 + \beta_2 \log(V)]} \right\}^{-1}$$

Parameter	Reference Database	Database with additional	Change
β_1	-6.8974	-6.2269	-9.7%
β_2	8.3507	7.7739	-6.9%
$V_{11}^{(1)}$	3.4998	2.2911	-34.5%
V_{12}	-3.8456	-2.6004	-32.4%
V_{22}	4.5821	3.2955	-26.1%
DoF ⁽²⁾	97	107	
Deviance	25.09	28.90	15.2%
Pearson SD	64.0%	59.4%	-7.2%

Notes: (1) Parameters V_{ij} are elements of the covariance matrix of the coefficients, β_i , of the regression equation.

(2) Degrees of freedom.

Table 1-3: Effect of Additional Data on
7/8" Tube Probability of Leak Predictions

Bobbin Amplitude (Volts)	EPRI/NRC Database POL	w/ additional Database POL	New / Old Ratio
0.100	$2.39 \cdot 10^{-7}$	$8.31 \cdot 10^{-7}$	3.48
0.200	$2.95 \cdot 10^{-6}$	$8.63 \cdot 10^{-6}$	2.93
0.300	$1.28 \cdot 10^{-5}$	$3.39 \cdot 10^{-5}$	2.64
0.500	$8.18 \cdot 10^{-5}$	$1.90 \cdot 10^{-4}$	2.33
0.600	$1.58 \cdot 10^{-4}$	$3.52 \cdot 10^{-4}$	2.22
0.800	$4.50 \cdot 10^{-4}$	$9.29 \cdot 10^{-4}$	2.07
1.000	$1.01 \cdot 10^{-4}$	$1.97 \cdot 10^{-3}$	1.95
2.000	0.0123	0.0201	1.63
3.000	0.0515	0.0746	1.45
4.030	0.1367	0.1793	1.31
5.000	0.2572	0.3115	1.21
8.000	0.6557	0.6886	1.05
10.000	0.8105	0.8245	1.02
15.000	0.9490	0.9486	1.00
20.000	0.9814	0.9799	1.00
30.000	0.9957	0.9948	1.00
40.000	0.9985	0.9980	1.00
50.000	0.9993	0.9991	1.00

**Table 1-4: Effect of Inclusion of Additional Data
on the Reference Leak Rate Database
for 7/8" Tube APC Applications**

Parameter	Leak Rate (lph)		Log(Leak Rate) ¹	
	Reference Database	w/ additional Database	Reference Database	w/ additional Database
Sample Size	26	27	26	27
Sample μ	13.74	13.32	0.5764	0.5696
Sample σ	21.13	20.84	0.8338	0.8188
<i>p</i> Value			6.5%	6.4%
The following are based on the lognormal distribution sample parameters.				
Population μ	23.9 lph	22.0 lph	These values are biased to be higher than expected.	
Population σ	149.1 lph	128.0 lph		
Upper 95% Pred.	100.6 lph	92.5 lph	These ranges are biased to be wider than expected.	
Lower 95% Pred.	0.143 lph	0.149 lph		
Notes: 1. It has been previously shown that a log-normal distribution can be used to describe the population of leak rates.				

Figure 1-1: Burst Pressure vs Volts for 7/8" Alloy 600 SG Tubes
Additional Data, Reference $\sigma_f = 68.8$ ksi @ 650°F

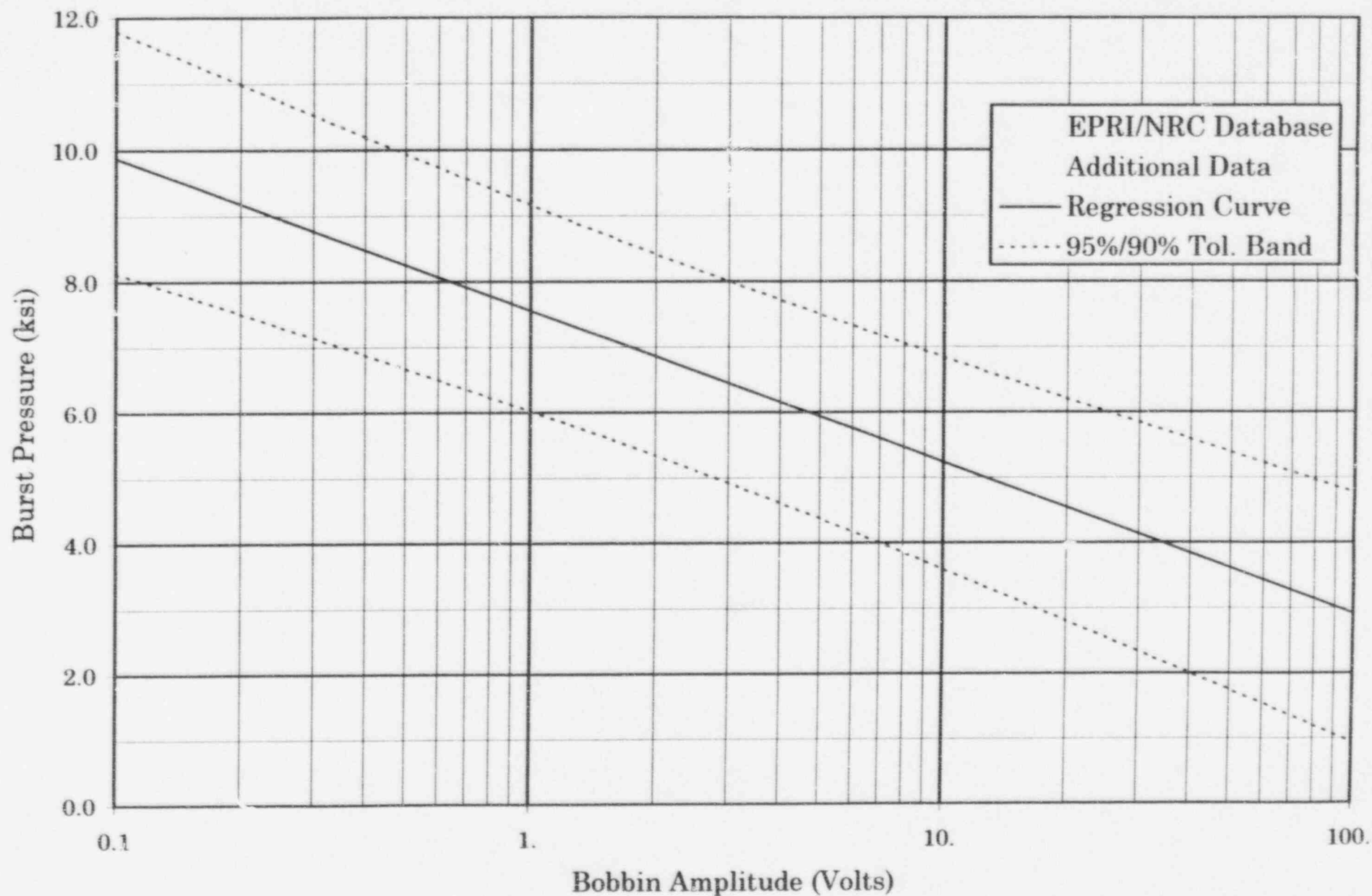


Figure 1-2: Burst Pressure for 7/8" Diameter Tubes
Deviates Analysis of Additional Data

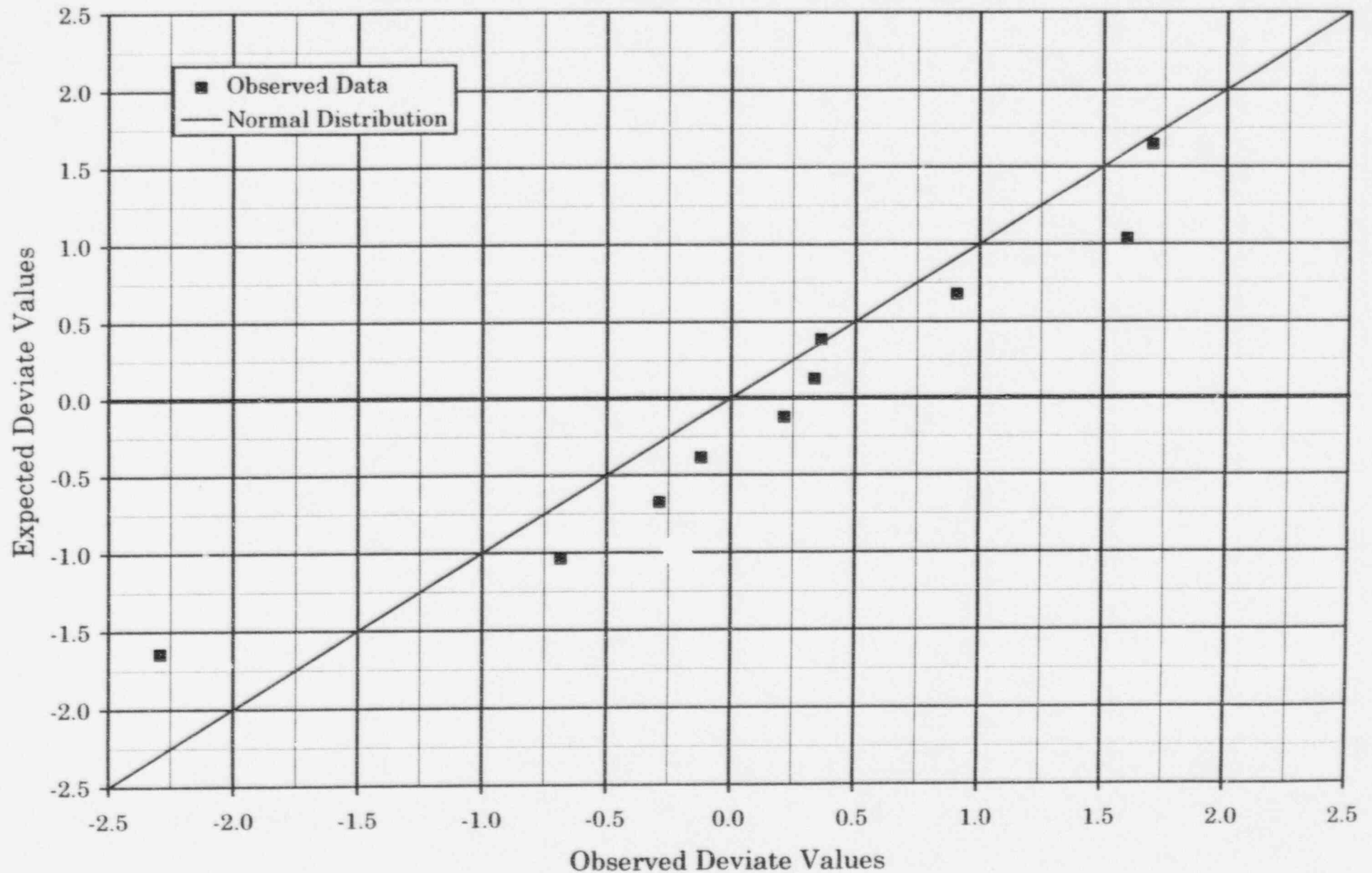


Figure 1-3: Burst Pressure vs Volts for 7/8" OD Alloy 600 SG Tubes
 NRC/EPRI Database, Reference $\sigma_f = 68.8$ ksi @ 650°F

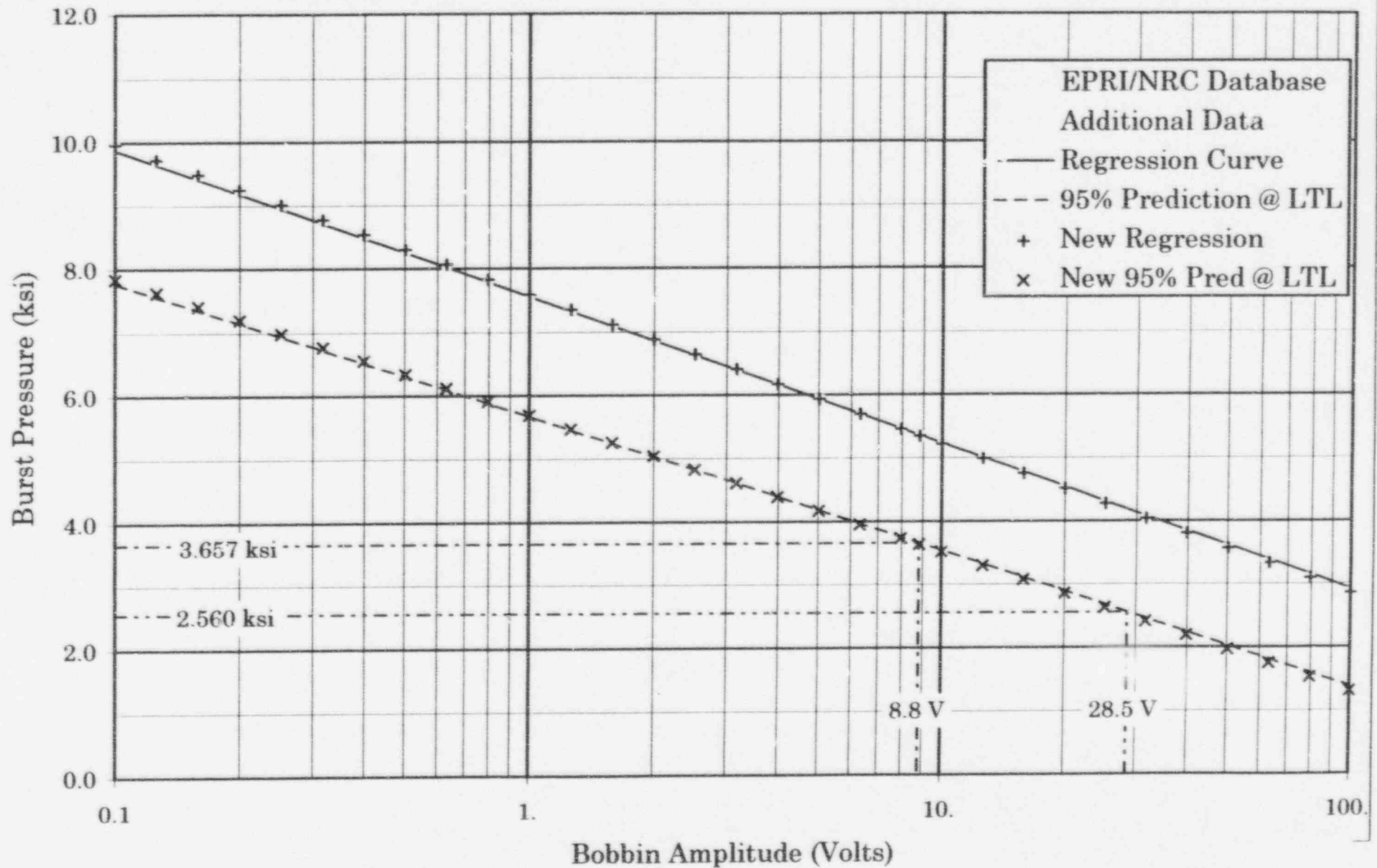


Figure 1-4: Probability of Leak for 7/8" SG Tubes
Effect of Inclusion of Additional Data

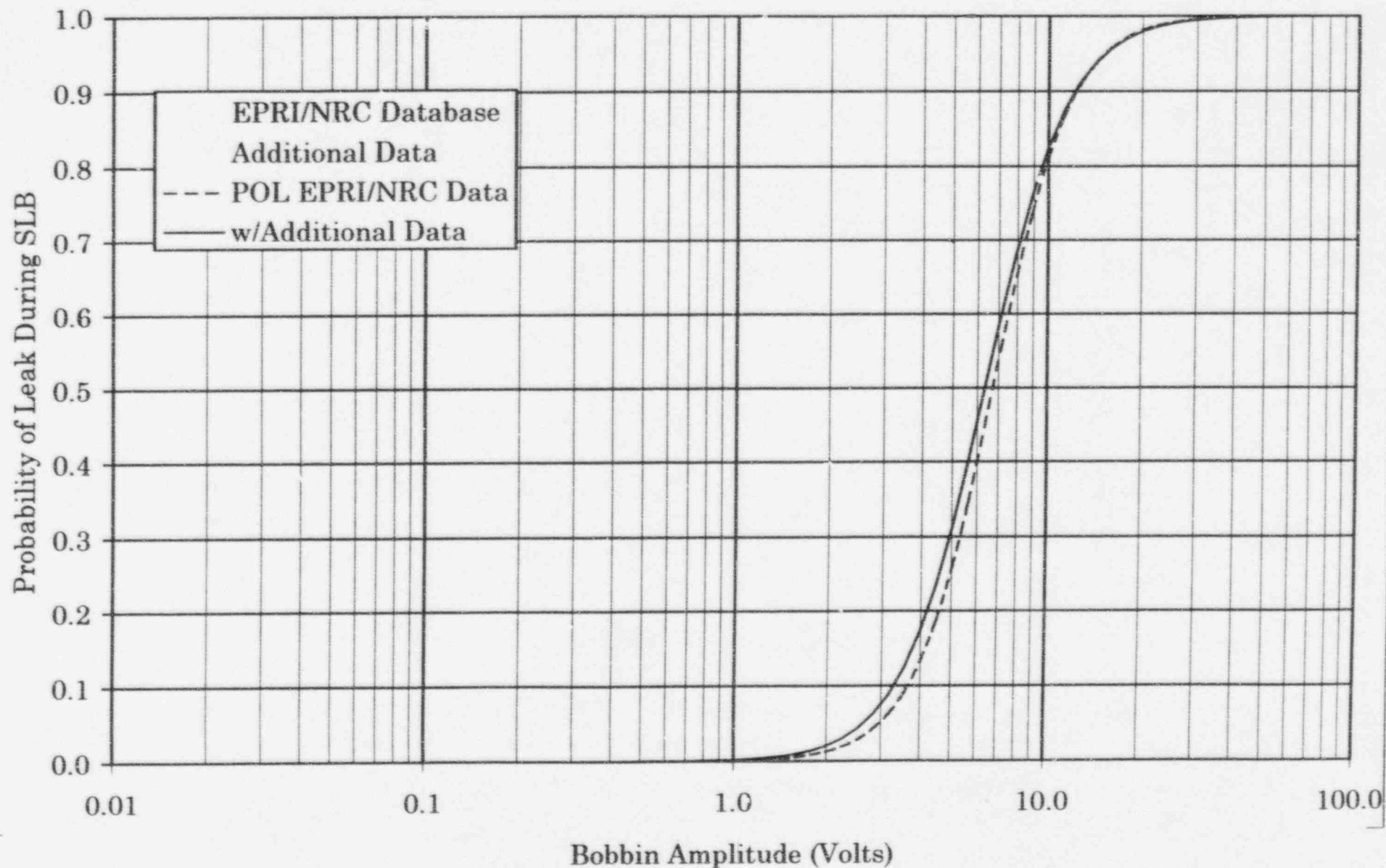


Figure 1-5: Leak Rate vs Bobbin Amplitude
 7/8" Tube Data, All Data, NRC Correlation

