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September 3, 2004
L-04-121

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

Subject: **Beaver Valley Power Station, Unit No. 1**
Docket No. 50-334, License No. DPR-66
Response to Request for Additional Information in Support of License Amendment Request No. 328, Revised Steam Generator Inspection Scope for One Cycle of Operation

This letter provides the FirstEnergy Nuclear Operating Company (FENOC) response to an NRC request in Attachment A for additional information (RAI) dated August 23, 2004, pertaining to FENOC letter dated June 28, 2004, for an amendment request for Beaver Valley Power Station (BVPS) Unit 1 to allow a one-cycle approval of the use of the Westinghouse W* methodology.

Attachment B provides additional information supporting the application of W* to the BVPS Unit No. 1 steam generator tubes, which is proprietary to Westinghouse (Reference Westinghouse Letter FENOC-04-147 dated August 31, 2004). Attachment C provides a redacted (non-proprietary) version of the information in Attachment B (Reference Westinghouse Letter FENOC-04-149 dated August 31, 2004). Attachment D identifies the commitments made in this submittal.

Enclosed is Westinghouse authorization letter, CAW-04-1889 with accompanying affidavit, Proprietary Information Notice, and Copyright Notice.

As Attachment B contains information proprietary to Westinghouse Electric Company LLC, it is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit 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 Section 2.390 of the Commission's regulations.

Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.390 of the Commission's regulations.

A001

Correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse Affidavit should reference CAW-04-1889 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

If there are any questions concerning this submittal, please contact Mr. Larry R. Freeland, Manager, Regulatory Compliance at 724-682-5284.

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 3, 2004.

Sincerely,

L. W. Pearce

L. William Pearce

Attachments

c: Mr. T. G. Colburn, NRR Senior Project Manager
Mr. P. C. Cataldo, NRC Sr. Resident Inspector
Mr. S. J. Collins, NRC Region I Administrator
Mr. D. A. Allard, Director BRP/DEP
Mr. L. E. Ryan (BRP/DEP)

Westinghouse

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Our ref: CAW-04-1889

August 31, 2004

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Letter FENOC-04-147, "Revised W* Figure" (Proprietary)

The proprietary information for which withholding is being requested in the above-referenced letter is further identified in Affidavit CAW-04-1889 signed by the owner of the proprietary information, Westinghouse Electric Company LLC. 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 2.390 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying affidavit by FirstEnergy Nuclear Operating Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-04-1889, and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. S. Galembush, Supervisory Engineer
Regulatory Compliance and Plant Licensing

Enclosures

cc: W. Macon, NRC
E. Peyton, NRC

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared J. S. Galembush, 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 Company LLC (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:

J. S. Galembush, Supervisory Engineer
Regulatory Compliance and Plant Licensing

Sworn to and subscribed
before me this 31st day
of August, 2004

Sharon L. Fiori
Notary Public

Notarial Seal
Sharon L. Fiori, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires January 29, 2007
Member, Pennsylvania Association Of Notaries

(1) I am Supervisory Engineer, Regulatory Compliance and Plant Licensing, in Nuclear Services, Westinghouse Electric Company LLC (Westinghouse), 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 rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 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 Westinghouse 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 2.390 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.

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 that 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 10 CFR Section 2.390, 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 FENOC-04-147, "Revised W* Figure" (Proprietary), dated August 31, 2004. The information is provided in support of a submittal to the Commission, being transmitted by FirstEnergy Nuclear Operating Company letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted for use by Westinghouse for Beaver Valley Unit 1 is expected to be applicable for other licensee submittals in support of implementing the W* inspection methodology addressing service induced degradation in the tube joint region of steam generators.

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

(a) Provide documentation of the analyses, methods, and testing for the implementation of the W* tube inspection methodology.

(b) Provide evaluation of the required W* engagement lengths for Beaver Valley Unit 1.

(c) Provide a bounding W* potential steam line break leakage evaluation for Beaver Valley Unit 1.

(d) Assist the customer to respond to NRC requests for information.

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 NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of this information to its customers in the licensing process.

(c) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

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 licensing support documentation 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.

Further the deponent sayeth not.

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 2.390 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) 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 2.390(b)(1).

COPYRIGHT NOTICE

**REQUEST FOR ADDITIONAL INFORMATION
BEAVER VALLEY POWER STATION UNIT 1 (BVPS-1)
ONE-CYCLE APPROVAL TO USE W* METHODOLOGY
FOR STEAM GENERATOR (SG) TUBE INSPECTION
DOCKET NO. 50-334**

By letter dated June 28, 2004, Agencywide Documents Access and Management System (ADAMS) accession number ML041970447, FirstEnergy Nuclear Operating Company, the licensee for Beaver Valley Power Station, Unit No. 1, submitted a license amendment request, "Revised Steam Generator Inspection Scope for One Cycle of Operation." In order for the Nuclear Regulatory Commission (NRC) staff to complete its review, responses to the following questions are requested:

1. The potential leak rate for a postulated circumferential separated tube below the W* distance is estimated from a correlation of leak rate to crevice depth (refer to Figure 4.3.5). At a specific crevice depth, the mean leak rate was determined to be 0.0004 gallons per minute (gpm) and the upper 90% bound was determined to be 0.0045 gpm. Please clarify the crevice depths (e.g., 0.5 inches, 0.6 inches) associated with these leak rates since a review of Figure 4.3.5 appears to indicate that the same crevice depth may not have been used.

   RESPONSE: The actual crevice depths for each sample vary slightly; therefore, the x-axis data will vary slightly. This data is taken from Table 6.2-3 of WCAP-14797. Samples may also be described according to the nominal flaw elevation below TTS (i.e, 1.25", 2.00", and 3.00").

   From Figure 4.3.5 of LAR 328, the upper 90% prediction of leak rate at a crevice depth of 0.625" is approximately equal to LN Leak Rate (-5.4). Review of the spreadsheet developed for the leakage prediction shows the actual value is LN Leak Rate (-5.405), or 0.0045 gpm. The mean prediction of leak rate a crevice depth of 0.625" is approximately equal to LN Leak Rate (-8.1). The actual spreadsheet value is LN Leak Rate (-8.132), or 0.0003 gpm.

2. Table 4.4-1 provides a summary of the axial and circumferential primary water stress corrosion cracking (PWSCC) for the last six outages at BVPS-1. For each indication detected below the top of the tubesheet (TTS) at BVPS-1, provide the axial or circumferential extent of the indications and the location of the indication relative to the TTS.

   RESPONSE: Figure 4.3.1 of the LAR provides the elevation distribution for all historical PWSCC. For axial PWSCC, the indication lengths from the 1R14 and 1R15 outages range from 0.13" to 0.36" with an average of 0.22".

A tabular listing of historical PWSCC indications is provided on Page 13. In the table provided, "CRLEN" represents axial flaw length, "CEG" represents circumferential flaw length. For all outages except 1995, the inspection probe was the +Point coil. The 3 coil directional probe was used for the 1995 outage.

A review of the data listed on Page 13 shows the longest axial PWSCC indication (S/G "B", R6 C11) was reported as 0.63". The longest circumferential PWSCC indication (S/G "B", R4 C38) was reported at 61° arc. Both these indications were reported during the 1995 outage.

One indication (S/G "B" R6 C11) was reported during the 1995 outage and 3 indications (S/G "C", R17 C87, R35 C41 & R35 C44) were reported during the 1996 outage that exhibited sufficient amplitude to represent 100% TW penetration.

No axial length report could be located for two indications contained within the same tube (S/G "C", R12 C14) and no arc length report could be located for one circumferential indication (S/G "B", R3 C11). The three indications were reported during the 2000 outage.

For the 1995, 1996 and 1997 inspections, the top of tubesheet RPC inspection extended from 3.00" above the TTS to 3.00" below the TTS. Starting at the 2000 outage top of tubesheet RPC inspection extended from 6.00" above the TTS to 8.00" below the TTS.

3. Figure 4.3.5 in the submittal depicts the leakage from the drilled hole specimen tests as a function of actual crevice depth. Figure 4.3.7 depicts the calculated contact pressure for the most limiting Zone A and B tubes as a function of distance below the TTS under faulted conditions. In addition, Figure 4.3.7 provides the average contact pressures for the 1.25-inch, 2-inch, and 3-inch drilled hole leak test specimens. Figure 4.3.7 relates the contact pressures for the leak test specimens to the most limiting Zone A and B tubes. Discuss the rationale for not developing a direct correlation between the drilled hole specimen leak rates and their associated contact pressures and then determining the leak rate for a Zone B tube based on the contact pressure at 8 inches and 12 inches.

RESPONSE: Leak rate data were plotted using crevice depth as crevice depth is a readily measurable parameter. The 3.00" nominal samples were selected as a conservative representation of the actual tube at the neutral axis (approximately 11.00" to 12.00" below TTS) even though the equivalent tube contact pressure is observed at approximately 8.00" for Zone B, the limiting zone. Samples with greater crevice depths are not available for comparison. Using contact pressure at 8.00" below TTS, the mean leak rate is 1.8×10^{-4} gpm while the upper 90% prediction bound is 5.2×10^{-3} gpm. At 12.00" below TTS, the mean leak rate is 8.4×10^{-7} gpm while the upper 90% prediction bound is 3.9×10^{-5} gpm. The bounding leak rate applied for assumed flawed tubes greater than 12.00" below TTS is 8.7×10^{-5} gpm; therefore, the crevice depth approach presented in the LAR is conservative compared to evaluation of leak rate as a function of contact pressure. The LAR uses a bounding leak rate allowance of 4.5×10^{-3} gpm for projected indications between 8.00" below TTS and 12.00" below TTS. This value is comparable to the contact pressure based value at 8.00" below TTS.

The above predicted leak rates are based on the calculated contact pressure excluding WEXTEX expansion pressure. The proposed application input assumptions should also be kept in context. FENOC has proposed to apply the upper 90% prediction interval leak rates for the 3.00" nominal specimens to all remaining active tubes. The conservatism in this approach is a gross overestimate.

For the assumption of all tubes flawed, which is overly conservative itself, for such a large number of occurrences, the total leak rate would be expected to migrate to the mean. As the mean is developed using the spread of the data and could include negative leak rates in the mathematics, the appropriate leak rate allowance per tube would be expected to be represented by a value between zero and the 90% prediction interval. The BVPS Unit 1 inspection history suggests a much larger percentage of the indications are axially oriented, thus the assumption that all tubes are circumferentially separated suggests the most appropriate representation would be closer to zero as opposed to the 90% prediction interval.

Modeling of the leak rate as a function of crevice depth was selected as the most appropriate model as crevice depth can be readily measured during normal NDE practice. Subsequent evaluation of correlation statistics indicate that the fit of crevice depth and leak rate has a better *p-value* and R-squared than does correlation of contact pressure and leak rate. Additionally, the calculation of contact pressures in the tube includes conservative assumptions that suggest that the contact pressures are much higher than indicated for deeper depths within the tubesheet, particularly if flashing is assumed in the crevice for a leakage condition. The constrained crack leak rate data of WCAP-14797 suggests that the leak rate varies little for contact pressures up to 2000 psi. However, at greater than 2000 psi, the leak rates drop dramatically with increasing contact pressure. With a driving pressure of 2650 during the test, contact pressures greater than this value should result in a no leak condition. Further conservatism is provided in that the BVPS SLB pressure differential is limited to 2407 psi due to PORV availability. This would also suggest that below the neutral axis no leakage would be postulated due to the high contact pressures.

The largest contribution to postulated leakage arises from the indications at greater than 12.00" below the TTS. A very conservative assumption was applied that all tubes were degraded at greater than 12.00" below the TTS. Using the crevice depth versus the leak rate model, this contribution is approximately 0.25 gpm. At a crevice depth of 12.00" the correlation of contact pressure versus leak rate yields a value of 0.11 gpm for the same assumption.

At 8.00" below the TTS, the contact pressure is 1436 psi (Table 4.3-9 of WCAP-14797). If this value is applied to the correlation of contact pressure versus leak rate, the predicted value is 0.0046 gpm, which is essentially equal to the value of 0.0045 applied in the LAR.

The conservatism applied involving the projection of indications capable of providing a leak rate equal to the test specimens far outweighs difference of 0.0001 gpm per tube.

Slide 19 of the June 8, 2004 presentation (ADAMS No. ML042010038) presented a linear 1st order regression curve of the common logarithm of the leak rate as a function of the actual crevice depth. The regression analysis included only the data obtained at an intended differential pressure of 2650 psi; however, the last bullet of slide 18 noted that the regression lines for intended differential pressures of 1620, 2000, and 2650 were not statistically different, thus, all of the data could have been included in the regression analysis. Moreover, the actual contact pressure for each specimen was calculated. Thus, a model of the leak rate as a function of crevice length could be expanded to include the contact pressure as,

$$Q = b_0 + b_1 L + b_2 P_c$$

whereas the contact pressure was not included in the regression results presented at the June 8 meeting. It was noted during the meeting that a significant reduction in the predicted leak rate would be realized if the pressure term were added. The figure from the meeting presentation is included herein as Figure 1. The results from the preliminary analysis of the grouped data are presented in Figure 2. A significant reduction of the predicted leak rate is readily apparent relative to the Figure 1 regression results.

Review of the specimen contact pressure calculation indicates that WEXTEX pressure was not included. However, the corresponding tube depths for application of the leak rates based on sample contact pressure remain bounded by the elevation application in the LAR. The calculation of tube contact pressures in Table 4.3-9 of WCAP-14797 include a crevice secondary side pressure of 800 psi. The calculation of leakage specimen contact pressures do not include crevice secondary side pressure.

During the discussion with representatives of the NRC staff on August 26, 2004, it was noted that the contact pressures used for the presented correlation did not include any reduction for the fluid pressure in the crevice. Moreover, the contact pressures noted for the SG do include a reduction of the contact pressure to account for a postulated 800 psi fluid pressure in the crevice. This means that for a given leak rate, a higher contact pressure is deemed to be needed using the analysis results. Conversely, for a given calculated contact pressure the associated predicted leak rate will be higher than indicated by the test data. In summary, the exclusion of the crevice pressure for the test data and the inclusion of the crevice pressure for leak rate prediction purposes is conservative.

Figure 1

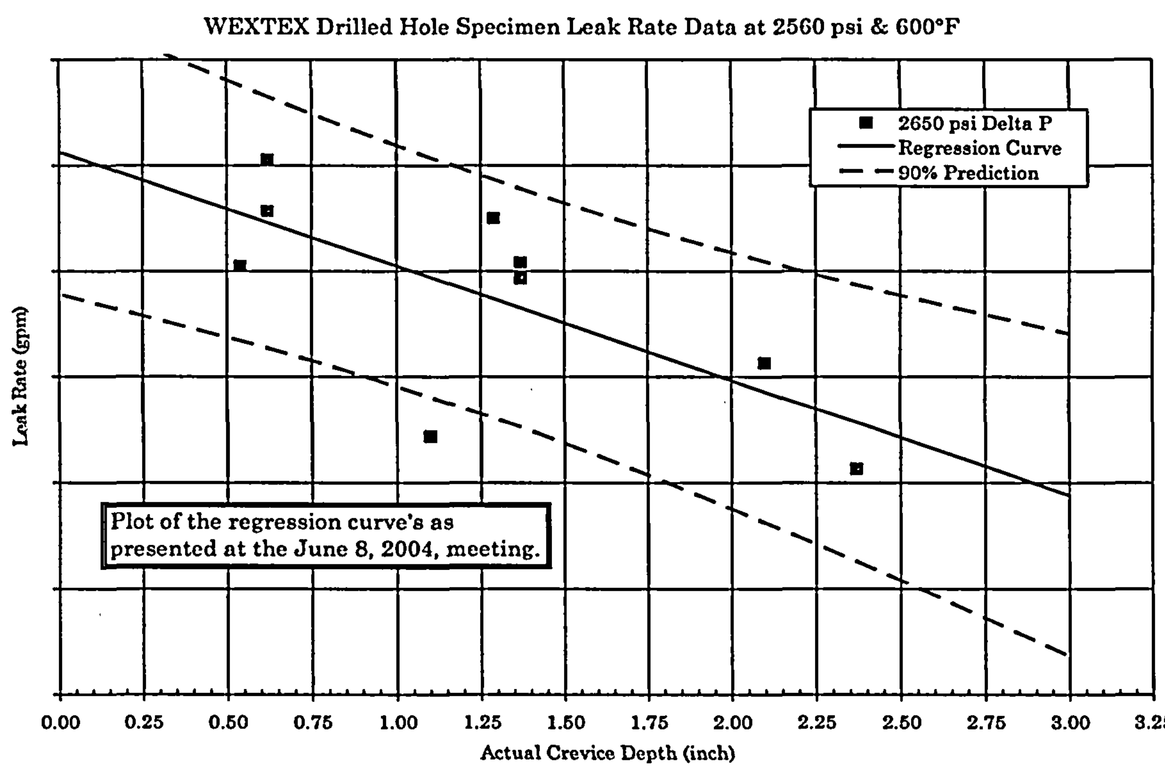
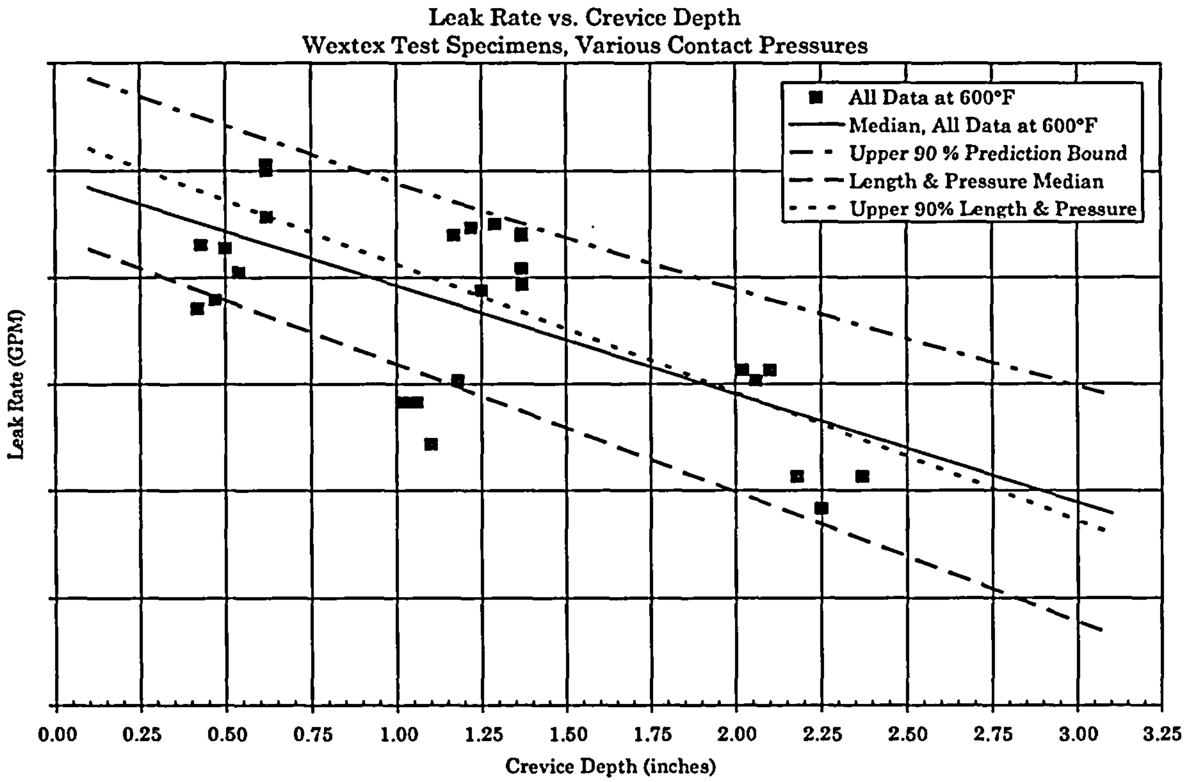


Figure 2



4. On page 6-4 of WCAP-14797-P, Revision 2, "Generic W* Tube Plugging Criteria for 51 Series Steam Generator Tubesheet Region WEXTEX Expansion", dated March 2003, enclosed with the June 28, 2004 application, it was indicated that the average contact pressure for the drilled-hole leak rate specimens provided in Table 6.2-3 includes the contact pressure due to differential thermal expansion and primary to secondary differential pressure. It is further indicated that the contact pressure due to the WEXTEX expansion is not included in the average contact pressure since it is inherent in both the test samples and in steam generator tubes in the plant. Describe how the average contact pressures shown in Table 6.2-3 were calculated and clarify the assumptions made in these calculations. If the average contact pressures presented in Table 6.2-3 (and included in Figure 4.3.7 of the license amendment request) do not include a contribution from the WEXTEX expansion process, discuss the relative conservatism of comparing these average contact pressures to those plotted in Figure 4.3.7 of the license amendment request.

   For each leak test specimen, provide a summary table which shows the actual contact pressure at various elevations along the specimen. Provide similar information for the most limiting tube in Zone A and Zone B. What would be the highest contact pressure if the expansion and staking process did not result in changes in the diameter of the leak test specimens (i.e., in an "ideal" leak test specimen, please clarify the contribution to the contact pressure from pressure, temperature, and the WEXTEX expansion process, which presumably would be constant throughout the length of the expansion). Please clarify whether the average contact pressure would be identical for all the specimens if they were all tested under the same pressure and temperature conditions and the diametral expansions of all the specimens were the same.

RESPONSE: The calculated contact pressures for the samples listed in Table 6.2-3 of WCAP-14797 do not include the residual WEXTEX contact pressure. The listed contact pressure for the 3.00" nominal samples intersects the contact pressure calculation line with no WEXTEX pressure included at 10.20" for Zone B. Therefore, the assumption that the upper 90% prediction bound leakage for 3.00" nominal samples remains conservative for the proposed FENOC application as the results of these samples are applied to postulated degradation at >12.00" below TTS.

Contact pressures for the samples are provided in Table 6.2-3 of WCAP-14797. Figure 4.3.7 of the LAR was developed by adding 693 psi to the calculated contact pressure for each respective elevation.

Tube contact pressures excluding WEXTEX expansion pressure can be developed by reducing each point on the plot by 693 psi, or by using the analysis model calculated values in Table 4.3-9 of WCAP-14797.

Specimen contact pressure is calculated by including positive allowances for thermal expansion and pressure expansion. End effects due to the expansion transition and displacement of the tube from the tubesheet stimulant due to staking are subtracted from the positive effects. The total contact pressure is divided by the effective contact length to develop an average value over the length of contact. The calculation of the average contact pressure was based on the results of inside diameter profile measurements of the leak rate test specimens. The profile of the inside is not uniform along the length of the expansion, departing from the average at the upper end, but not so much in the vicinity of the staking operation.

The length of the expansion was considered in 0.18" increments and a numerical integration of the contact pressures was performed to determine the average contact pressure over the contact length using the inside diameter profile measurements. The theory of elasticity equations for coaxial cylinders were used to establish the contact pressure associated with a 1 mil diametral initial interference of the tube with the collar, i.e., a free tube OD of 1 mil greater than free collar ID. The elasticity equations were also used to demonstrate that the reduction in initial interference can be calculated from the ID measurements of the installed tube. Thus, the reduction in contact pressure at locations away from where the ID is uniform was calculated using the reduction in inside diameter.

For example, if the interference stiffness is 3000 psi per mil of initial interference, a reduction of the diameter of 0.4 mil relative to the uniformly expanded section indicates the contact pressure is reduced by about 1200 psi at that location. The inside profile at the top of the expanded region was used to estimate the location where the contact pressure was reduced to zero relative to the residual preload from the WEXTEX expansion. Recall that all calculations with regard to W* are based on the preload above that from the installation process. The location of the zero-load point was subtracted from the overall length of the installed joint to arrive at an effective length.

The loss of contact associated with the staking operation extended for about 0.23" from the end of the staking. Thus, a nominal expansion length of 2.00" in a specimen is immediately considered to be reduced to 1.77". The above adjustment for the profile at the top of the expansion could reduce the length further by as much as 0.4", to, following the example, 1.23". Once the loss of contact location has been identified, the average diameter reduction values over the 0.18" increments are then calculated until the profile is uniform, typically one increment, but may be two. The overall average was then calculated using the individual contact pressure values.

As the specimen contact pressure did not include allowance for the WEXTEX residual contact pressure contribution, the individual y-axis points of Figure 4.3.7 of the LAR should be reduced by 693 psi. This would then be consistent with the data of Table 4.3-9 with regard to contact pressure as a function of depth below the TTS. As stated in the response to Question 3, the average contact pressures for the specimens at the corresponding elevations of equal contact pressure in the tube are conservative for the elevation assumption applied in the LAR with regard to leak rate applied to the 8.00" to 12.00" below the TTS and greater than 12.00" below the TTS depths. A revised Figure 4.3.7 is provided in Attachment B (Attachment C provides the non-proprietary Figure 4.3.7). The contact pressures in this revised plot are taken from Table 4.3-9 of WCAP-14797.

It should be further noted that the assumption applied that all tubes are flawed (and separated) at greater than 12.00" below TTS, that for such a large sample of leakage sources, the application of an upper bound leak rate is an extreme conservatism. For such a large number of leakage sources the "true" aggregate leakage will migrate towards the mean correlation. For comparison purposes, a 90% confidence applied to the mean leakage correlation for a contact pressure of 2916 psi (at 12.00" below TTS) is 8×10^{-6} gpm, nearly one order of magnitude less than the leakage contribution applied in the LAR.

The request for contact pressure for an "ideal" leak specimen is unclear in that it is not understood exactly what information is desired. Measurements of specimens indicate a taper at the top that results in a less than uniform expansion. Individual measurements for each sample were input to the calculation of contact pressure. The staking process affected contact pressure by producing an end effect. To consider specimen leak rates as a function of contact pressure without these reducing effects is not recommended. Without end effects (i.e., away from the end taper and the staked, drilled holes), the total contact pressure due to WEXTEX, pressure, and temperature is approximately 3209 psi at 600°F with a 2560 psi pressure differential. The WEXTEX contribution is 693 psi; therefore, internal pressure and temperature contribution is 2516 psi. The value of 3209 is developed assuming no secondary pressure acting within the tube to tubesheet crevice. This value is reduced for a condition of secondary pressure within the crevice. For an assumed pressure of 800 psi in the crevice, the total temperature and pressure contribution is reduced to 1514 psi. Note that if the crevice pressure does not exceed the secondary fluid pressure at the tube expansion transition, no leakage will occur.

It should be noted that the contact pressure numbers reported for the test specimens did not include the estimated annulus pressure while leak was taking place, which would have reduced the estimate of the contact pressure. However, the operating plant calculated values do include 800 psi secondary pressure in the crevice. This combination assures a conservative estimate of the leak rate in the plant.

5. Discuss the differences between the inputs (e.g., temperature, pressure, location of BWT, tube hole dilation, etc) used to develop Figure 4.3.7 in the license amendment request and Figure 6.5-1 in WCAP-14797.

   RESPONSE: Figure 4.3.7 of the LAR evaluates contact pressure at 4200 seconds into the SLB event. The minimum WEXTEX contact pressure of 693 psi is added to each data point. Figure 6.5-1 of WCAP-14797 evaluates contact pressure at normal operating conditions excluding WEXTEX contribution.

6. Provide the DENTFLO predicted leak rate for indications at 8, 10, and 12 inches below the TTS for the most limiting tube in Zone B. Compare these values to the proposed values using the BVPS-1 bounding leakage methodology.

   RESPONSE: DENTFLO is modeled to simulate leakage from axial flaws and includes allowance for restrained crack opening due to tubesheet proximity. It is not comparable with the bounding approach applied in the BVPS LAR.

At 6.00" below TTS, the limiting Zone B leak rate for axial flaws is approximately 1 x 10^{-3} gpm. The LAR applies a leak rate of 4.5 x 10^{-3} for indications at 8.00" below TTS. Therefore, application of DENTFLO type calculations would dramatically reduce predicted leak rates.

7. Confirm that the steam generator tubesheet bore roughness used to develop WCAP-14797 is applicable to the BVPS-1 SG tubesheets.

   RESPONSE: The WEXTEX samples were prepared using the tubesheet hole bore roughness of the manufacturing drawing as well as samples with smoother bores, which are conservative. Using a variety of surface roughness bounds the condition of the BVPS Unit #1 S/G's.

8. Given the sequence of the drilled hole leak tests, please clarify why the leak rate at 600°F and 2650 pounds per square inch for specimen W4-004 would be lower when the crevice length was 0.59 inch than when it was 1.29 inch.

   RESPONSE: Variability in samples could be introduced by the staking process. All drilled hole locations included drilling the tubesheet to a slightly larger diameter than the hole drilled in the tube. The tube was then staked to pull the tube away from the tubesheet. The staking process for the 1.29" crevice location may have been severe. Note also that Sample W4-004 had zero leakage at the 2.29" crevice depth location.

9. On page 9 of Enclosure 1 of the license amendment request, there is a statement that indicates that critical regions are based on a degradation assessment where potential and active degradation is expected in SG tubes that could challenge structural and/or leakage integrity if the tubes are not taken out of service by repair. The NRC staff understands the role of the degradation assessment to identify locations susceptible to degradation and then to select the appropriate technique for inspecting these locations. This intent is consistent with the regulations (technical specifications (TSs) in conjunction with Title 10 of the Code of Federal Regulations (10 CFR), Part 50, Appendix B). Please clarify whether there are locations (other than in the tubesheet or where permitted by a previously approved TS amendment) where you are not using techniques capable of finding potential flaws based on your conclusion that flaws in this region will not challenge the structural and/or leakage integrity of the SG tubes.

   RESPONSE: EPRI Appendix H qualified techniques are used for all other S/G locations. The discussion of pages 9 and 10 of the LAR specifically address the tubesheet region inspection distance and the basis for past inspections performed to 8.00" below TTS using the +Point coil.

10. On page 11 of Enclosure 1 of the license amendment request, there is a discussion regarding a lateral contraction in the axial direction. Please clarify this discussion.

RESPONSE: The discussion provided simply implies that for some assumed amount of lateral displacement of the tube above the TTS, that the amount of end displacement, assuming both ends are unrestrained is small compared to the absolute lateral displacement, and this end displacement will not affect the integrity of the joint.

11. Please discuss your plans to include in the 90-Day Report following your SG tube inspection the following information: the number of indications, the location of the indication (relative to TTS and BWT), the orientation (axial, circumferential, skewed), and an assessment of whether the results were consistent with expectations with respect to the number of flaws and flaw severity (and if not consistent a description of proposed corrective actions).

RESPONSE: Within 90 days of returning the S/G's to service (MODE 4), the total number of indications identified during 1R16 from the W* inspections, their location relative to the BWT and TTS, the indication orientation and an assessment of the number and severity of the indications will be reported. This will most likely be submitted as a supplement to the 90 Day Report required for implementation of Generic Letter (G.L.) 95-05.

Also included will be the aggregate calculated steam line break leakage from the application of G.L. 95-05, the application of W* methodology and any other sources of postulated leakage (i.e., Alloy 800 sleeves).

If the results from application of the W* methodology are inconsistent with the expected results, an evaluation as to the cause of the discrepancy shall be performed and corrective actions will be implemented as deemed necessary.

12. On page 6 of Enclosure 1 of the license amendment request, there is a statement that indicates that compliance with the TS SG tube repair limits and normal operating and accident-induced primary-to-secondary leakage limits provides reasonable assurance that SG tubing remains capable of fulfilling its specific safety function of maintaining the reactor coolant pressure boundary. This statement is incomplete since actions beyond those required by the TSs may be needed (and required by Criterion XVI of 10 CFR Part 50, Appendix B) in some instances to ensure tube integrity. This is supported by operating experience and the industry's commitment to the voluntary SG initiative referred to as NEI 97-06. Please clarify this statement.

RESPONSE: It was not the intent of this statement to imply compliance with the technical specifications alone would ensure the structural and leakage integrity of the S/G tubing. Beaver Valley has and will continue to be committed to meeting the expectations required to maintain S/G structural and leakage integrity through implementation of the guidance set forth in NEI 97-06. Qualified inspection techniques and personnel are utilized for all S/G examinations.

13. On page 8 of Enclosure 1 of the license amendment request there is a statement that indicates that there is no need for the "leak-before-break leakage limit". Although the full statement appears to imply that no changes are needed in the operational leak rate limit as a result of this amendment request, the statement also seems to imply that the leakage limit in the Beaver Valley Unit 1 TS's will ensure the plant will be shut down prior to "burst" for all mechanisms; this conclusion is not supported by operating experience (i.e., a tube can burst even if the leakage prior to the burst is below the TS leakage limit). Please clarify this statement.

RESPONSE: This statement was only made to accentuate the fact that constraint provided by the tubesheet precludes the potential for tube burst from primary water stress corrosion cracking occurring within the thickness of the tubesheet. Therefore, from a tube burst perspective, it is not necessary to monitor S/G tube primary-to-secondary leakage for this degradation mechanism occurring at this location.

It is recognized on Page 56 of the license amendment request that leakage from primary water stress corrosion cracking is limited by the tube-to-tubesheet crevice and the limited crack opening permitted by the tubesheet constraint. Thus, negligible normal operating leakage is expected from cracks in the tubesheet. In addition, no credit is taken in the implementation of the W* methodology for the technical specification leakage limit helping to ensure the maintenance of S/G tube integrity consistent with the latest revision of NEI 97-06 performance criteria during plant operation. FENOC understands that compliance with the technical specifications, does not, by itself, ensure tube integrity or eliminate the possibility of tube leakage.

BVPS Unit 1 PWSCC Indication Listing

Outage	SG	ROW	COL	VOLTS	DEG	IND	CHN	LOCN	INCH1	CRLEN	CEG	PTYPE
1995	B	4	38	0.83	22	SCI	4	TSH	-0.33		61	720- B
1995	B	6	11	19.3	30	SAI	4	TSH	-0.51	0.63		720- B
1996	A	2	13	2.39	17	SAI	10	TSH	-0.88	0.39		720-ZP
1996	A	5	74	1.56	15	SAI	9	TSH	-2.12	0.31		720-ZP
1996	A	5	75	2.4	7	SAI	9	TSH	-1.03	0.35		720-ZP
1996	A	5	76	0.35	41	SAI	2	TSH	0.02	0.19		720-ZP
1996	B	9	18	2.02	11	SAI	2	TSH	-1.46	0.24		720-ZP
1996	C	17	87	7.72	13	SAI	9	TSH	-2.01	0.54		720-ZP
1996	A	28	18	1.22	17	SAI	9	TSH	-0.41	0.21		720-ZP
1996	C	31	17	3.57	11	SAI	9	TSH	-0.51	0.43		720-ZP
1996	C	35	41	16.85	10	SAI	9	TSH	-3.51	0.42		720-ZP
1996	C	35	41	3.74	11	SAI	2	TSH	-2.98	0.24		720-ZP
1996	C	35	44	7.03	19	SAI	9	TSH	-3.96	0.54		720-ZP
1996	B	38	43	2.97	18	SAI	10	TSH	-0.74	0.35		720-ZP
1997	B	5	83	1.54	9	SAI	2	TSH	-0.35	0.21		7203P
1997	B	10	61	0.36	10	SAI	2	TSH	-0.18	0.35		7203P
1997	A	10	85	0.6	3	SAI	2	TSH	-0.99	0.27		7203P
1997	A	14	80	0.31	48	SAI	2	TSH	-0.44	0.32		7203P
1997	A	27	28	1.25	13	SAI	2	TSH	-3.15	0.22		7203P
1997	C	27	31	0.95	12	SAI	2	TSH	-0.6	0.18		7203P
1997	B	31	80	0.42	10	SAI	2	TSH	5.5	0.2		7203P
1997	C	33	44	0.71	13	SAI	2	TSH	-2.88	0.2		7203P
1997	A	34	16	0.73	13	SAI	2	TSH	-0.9	0.24		7203P
1997	A	34	16	0.52	14	SAI	2	TSH	0.41	0.22		7203P
1997	C	35	52	0.73	15	SAI	2	TSH	-0.2	0.19		7203P
1997	A	38	41	0.84	6	SAI	2	TSH	-0.16	0.13		7203P
2000	B	3	11	0.89	15	SCI	P1	TSH	-2.76			ZPSHF
2000	B	3	47	0.5	7	SAI	3	TSH	-0.31	0.14		ZPSHF
2000	A	5	17	1.28	9	SAI	3	TSH	-9.66	0.15		ZPSHF
2000	A	5	17	2.17	15	SAI	3	TSH	-8.83	0.34		ZPSHF
2000	C	12	14	2.24	15	SAI	3	TSH	-7.47			ZPSHF
2000	C	12	14	2.38	12	SAI	3	TSH	-8.51			ZPSHF
2000	C	21	81	1.74	22	SAI	3	TSH	-4.78	0.44		ZPSHF
2000	C	24	61	0.77	15	SAI	3	TSH	-0.64	0.12		ZPSHF
2000	C	30	59	0.95	10	SAI	3	TSH	-6.91	0.09		ZPSHF
2000	C	35	59	3.13	19	SAI	3	TSH	-7.98	0.23		ZPSHF
2001	A	2	20	1.64	12	SAI	3	TSH	-1.29	0.18		ZPSHF
2001	A	2	28	0.87	9	SAI	3	TSH	-1.7	0.18		ZPSHF
2001	C	3	62	1.73	27	SCI	P1	TSH	-7.66		27	ZPSHF
2001	C	3	73	0.77	29	SCI	P1	TSH	-2.27		38	ZPSHF
2001	A	4	51	0.28	29	SAI	3	TSH	-0.19	0.19		ZPSHF
2001	A	5	15	0.88	6	SAI	3	TSH	-2	0.21		ZPSHF
2001	A	5	55	2.01	11	SAI	3	TSH	-2.35	0.19		ZPSHF
2001	A	7	59	1.98	12	SAI	3	TSH	-1.86	0.2		ZPSHF
2001	A	10	53	0.51	30	SAI	3	TSH	-0.35	0.19		ZPSHF
2001	B	15	79	0.95	9	SAI	3	TSH	-8.3	0.2		ZPSHF
2001	C	24	58	0.52	9	SAI	3	TSH	-5.64	0.2		ZPSHF
2001	C	25	19	0.24	36	SAI	3	TSH	-2.12	0.18		ZPSHF
2001	C	30	52	0.57	14	SAI	3	TSH	-1.8	0.2		ZPSHF
2001	B	35	22	1.3	17	SAI	3	TSH	-1.51	0.18		ZPSHF
2001	B	35	72	1.15	11	SAI	3	TSH	-10.55	0.13		ZPSHF
2001	B	35	72	1.02	13	SAI	3	TSH	-8.41	0.21		ZPSHF
2003	C	1	73	0.53	14	SAI	6	TSH	-0.31	0.3		ZPSHF
2003	A	2	61	1.04	9	SAI	6	TSH	-1.68	0.19		ZPSHF
2003	B	5	78	1.56	23	SAI	6	TSH	-1.62	0.29		ZPSHF
2003	B	5	86	1.22	19	SAI	6	TSH	-9.79	0.26		ZPSHF
2003	C	7	29	0.53	23	SAI	6	TSH	-0.28	0.24		ZPSHF
2003	B	16	22	0.47	11	SAI	6	TSH	-0.59	0.27		ZPSHF
2003	A	17	56	0.79	15	SAI	6	TSH	-0.18	0.2		ZPSHF
2003	B	20	14	0.72	16	SAI	6	TSH	-4.68	0.25		ZPSHF
2003	A	20	36	2.19	32	SAI	6	TSH	-0.43	0.26		ZPSHF
2003	C	23	49	0.56	17	SAI	6	TSH	-0.49	0.2		ZPSHF
2003	C	27	60	0.58	14	SAI	6	TSH	-0.5	0.24		ZPSHF
2003	C	28	70	0.6	13	SAI	6	TSH	-2.16	0.19		ZPSHF
2003	C	30	33	0.75	12	SAI	6	TSH	-3.14	0.14		ZPSHF
2003	C	31	57	0.53	16	SAI	6	TSH	-3.63	0.21		ZPSHF
2003	C	35	66	0.74	14	SAI	6	TSH	-7.72	0.29		ZPSHF
2003	B	38	45	0.83	15	SAI	6	TSH	-0.25	0.36		ZPSHF
2003	C	43	46	0.69	18	SAI	6	TSH	-0.37	0.19		ZPSHF
2003	C	44	52	0.57	8	SAI	6	TSH	-0.24	0.16		ZPSHF

Attachment C

Beaver Valley Power Station, Unit No. 1
License Amendment Request No. 328

Redacted Version of Westinghouse Proprietary Information
Provided in Attachment F

Westinghouse Letter FENOC-04-149, dated August 31, 2004
"Additional Information Supporting the Application of W* to the
Beaver Valley Unit 1 Steam Generator Tubes"
[Non-Proprietary]

Note: The attached information is not proprietary.

Westinghouse

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Nuclear Services
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Beaver Valley Power Station
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W Sales Order: 3264
FENOC P.O. No.: 7024829

Our ref: FENOC-04-149

August 31, 2004

FirstEnergy Nuclear Operating Company
Beaver Valley Unit 1
Revised Steam Generator W* Figure

Dear Mr. Alberti:

Per telecon with FENOC and NRC on August 26, 2004, a revised figure 4.3.7 of the FENOC LAR is to be provided to the NRC. This letter presents that figure.

If you have any questions regarding this information, please contact Bill Cullen at 724-722-5314 or Gary Brassart at 412-374-5216.

Regards,

WESTINGHOUSE ELECTRIC COMPANY

G. A. Brassart
Customer Project Manager

cc: BVRC Central File, SEB-1
G. Kammerdeiner - (FENOC)
R. Fedin - (FENOC)
B. Sepelak - (FENOC)

Official Record Electronically Approved in EDMS 2000

Revised Figure 4.3.7 of BVPS LAR #328

a, c

Attachment D

Beaver Valley Power Station, Unit No. 1
License Amendment Request No. 328

Commitment Summary

The following list identifies those actions committed to by FirstEnergy Nuclear Operating Company (FENOC) for Beaver Valley Power Station (BVPS) Unit No. 1 in this document. These commitments are applicable only to Cycle 17. Any other actions discussed in the submittal represent intended or planned actions by Beaver Valley. These other actions are described only as information and are not regulatory commitments. Please notify Mr. Larry R. Freeland, Manager, Regulatory Compliance, at Beaver Valley on (724) 682-5284 of any questions regarding this document or associated regulatory commitments.

Commitment	Due Date
Within 90 days of returning the S/G's to service (MODE 4), the total number of indications identified during 1R16 from the W* inspections, their location relative to the BWT and TTS, the indication orientation and an assessment of the number and severity of the indications will be reported. Also included will be the aggregate calculated steam line break leakage from the application of G.L. 95-05, the application of W* methodology and any other sources of postulated leakage (i.e., Alloy 800 sleeves).	90 days from entering Mode 4 during start-up from 1R16..