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April 12, 2001
L-01-061

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

Subject: Beaver Valley Power Station, Unit No. 1 and No. 2
BV-1 Docket No. 50-334, License No. DPR-66
BV-2 Docket No. 50-412, License No. NPF-73
Response to Request for Additional Information
In Support of LAR Nos. 289 and 161

This letter provides the FirstEnergy Nuclear Operating Company (FENOC) response to a NRC Request for Additional Information (RAI) in support of License Amendment Requests (LAR) 289 and 161. The LARs were submitted by FENOC letter L-01-006 dated January 18, 2001. The proposed changes contained in the LARs propose a 1.4% power uprate for both Beaver Valley Power Station (BVPS) units.

The RAI was discussed during a February 28, 2001 meeting held between NRC, FENOC and Westinghouse personnel. The RAI contains four items requiring a response. Attachment A provides the FENOC response to Items 1, 3 and 4. The response to Item 2 is provided by Attachment B. The items addressed are listed below.

1. Provide written discussion why Caldon CheckPlus™ System is at least as good as the Caldon LEFM✓™ System.
2. Provide additional information regarding the entries for the mass flow uncertainty appearing in Table 3-1 of Caldon ER-80P.
3. Provide the impact of the uprate on the spent fuel pool cooling system, and how close the increase puts BVPS Unit No. 1 to its design limit.
4. Provide additional information addressing Short Term Loss of Coolant Accident Mass and Energy Release Data for BVPS Unit No. 1.

As Table 1 of Attachment B contains information proprietary to Caldon, it is supported by Affidavit CAW-01-04 signed by Caldon, the owner of the information. Accordingly, Enclosure 1 contains Affidavit CAW-01-04 and includes a Caldon Application for Withholding Proprietary Information from Public Disclosure as part of this transmittal. The affidavit sets forth the basis on which the requested information may be withheld

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from public disclosure by the Commission, and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR 2.790 of the Commission's regulations. Accordingly, FENOC requests that the information, which is proprietary to Caldon, be withheld from public disclosure in accordance with 10 CFR 2.790. Attachment C contains a non-proprietary version of Attachment B.

Correspondence regarding the proprietary aspects of the Caldon information contained in the response to Item 2, or the supporting affidavit, should reference Caldon letter CAW-01-04 and be addressed to Calvin R. Hastings, President and CEO, Caldon Incorporated, 1070 Banksville Avenue, Pittsburgh, PA 15216.

As stated in letter L-01-006, FENOC requests NRC approval of this License Amendment Request by June 1, 2001 to support implementation of the power uprate for the summer of 2001. An implementation period of up to 60 days is requested following the effective date of this amendment.

This information provided in the attached responses does not change the evaluations or conclusions presented in FENOC letter L-01-006. If there are any questions concerning this matter, please contact Mr. Thomas S. Cosgrove, Manager Regulatory Affairs at 724-682-5203.

Sincerely,

Lew W. Myers

Attachment

c: Mr. L. J. Burkhart, Project Manager
Mr. D. M. Kern, Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator
Mr. D. A. Allard, Director BRP/DEP
Mr. L. E. Ryan (BRP/DEP)

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I, Lew W. Myers, being duly sworn, state that I am Senior Vice President of FirstEnergy Nuclear Operating Company (FENOC), that I am authorized to sign and file this submittal with the Nuclear Regulatory Commission on behalf of FENOC, and that the statements made and the matters set forth herein pertaining to FENOC are true and correct to the best of my knowledge and belief.

FirstEnergy Nuclear Operating Company

Lew W. Myers
Senior Vice President - FENOC

COMMONWEALTH OF PENNSYLVANIA

COUNTY OF BEAVER

Subscribed and sworn to me, a Notary Public, in and for the County and State above named, this 12 th day of April, 2001.

My Commission Expires:

Notarial Seal
Sheila M. Fattore, Notary Public
Shippingport Boro, Beaver County
My Commission Expires Sept. 30, 2002
Member, Pennsylvania Association of Notaries

Attachment A
Responses to the February 28, 2001 meeting
Request for Additional Information
In Support of LAR Nos. 289 and 161

The NRC Request for Additional Information (RAI) made at the February 28, 2001 meeting contains four items. The items and the FirstEnergy Nuclear Operating Company (FENOC) responses are presented below.

The following documents were used in preparing the responses to the RAI items.

1. ER-80P, Caldon, Inc. Topical Report-80P, "Improving Thermal Accuracy and Plant Safety While Increasing Operating Power Level Using the LEFM✓™ System," Revision 0, March 1997.
2. ER-160P, Caldon, Inc. Engineering Report-160P, "Supplement to Topical Report ER-80P: Basis for a Power Uprate With the LEFM✓™," Revision 0, May 2000.
3. ER-157P, Caldon, Inc. Engineering Report-157P, "Supplement to Topical Report ER-80P: Basis for a Power Uprate With the LEFM✓™ or LEFM CheckPlus™ System," Revision 3, February 2001.
4. WCAP-15264, "Westinghouse Revised Thermal Design Procedure - Instrument Uncertainty Methodology for FirstEnergy Nuclear Operating Company Beaver Valley Unit 1," Revision 3, December 2000.
5. WCAP-15265, "Westinghouse Revised Thermal Design Procedure - Instrument Uncertainty Methodology for FirstEnergy Nuclear Operating Company Beaver Valley Unit 2," Revision 2, December 2000.

Item 1.

Provide written discussion why Caldon CheckPlus™ System is at least as good as the Caldon LEFM✓™ System.

Response to Item 1.

The Caldon LEFM✓™ System has eight transducers mounted at both ends of four measurement paths arranged at different chord lengths across a single plane. The allowance of 0.6% in total power measurement uncertainty when using the Caldon LEFM✓™ System was derived by Caldon in ER-160P. ER-160P has been previously reviewed and approved by the NRC in connection with a similar LAR submitted for the Watts Bar Nuclear plant. The NRC staff approved this report by its January 19, 2001, Safety Evaluation (SE) for Watts Bar (ADAMS accession number ML010260074).

The Caldon CheckPlus™ System is similar to the LEFM✓™ System, except that it has 16 transducers on eight acoustic measurement paths grouped into two orthogonal planes with four measurement paths in each plane. The CheckPlus™ System is essentially two LEFM✓™ Systems combined. To ensure independence, each measurement plane employs its own timing clock in the LEFM CheckPlus™ System. As a result, the LEFM CheckPlus™ System provides feedwater flow measurement that is at least as accurate as that provided by a LEFM✓™ System. Superiority in measurement accuracy arises from two distinct advantages in the

CheckPlus™ System, both of which are described in Caldon Report ER-157P, Rev. 3. These advantages are listed below.

1. Because of the orthogonal geometry of the two measurement planes, any transverse components of the fluid velocity will be cancelled when the two companion measurements in each plane are averaged. The average of two numerical integrations of four pairs of axial velocity measurements in orthogonal planes is, therefore, inherently more accurate than the integration of four measurements in a single plane.
2. Because there are twice as many measurements being taken, the total statistical error due to uncertainties in both transit time measurements and path length geometry is reduced. This advantage arises due to the statistical treatment of the uncertainties, the mathematics of which are supported by NUREG-1475, Regulatory Guide 1.121, and ISA 67.01.

The individual contributions to mass flow measurement uncertainty by the two Caldon systems are tabulated for comparison in Table 1 of ER-157P. This table identifies the differences between the uncertainties associated with the two LEFM systems and provides an association with the two advantages of the CheckPlus™ System listed above. This table shows that the accuracy of the CheckPlus™ System meets, or exceeds the accuracy of the LEFM✓™ System.

Therefore, due to the design differences of the two systems (eight versus sixteen transducers and four versus eight measurement paths) and the measurement uncertainty assumptions employed, it can be seen that the CheckPlus™ System is capable of providing feedwater flow measurements that are at least as accurate as what is provided by the NRC approved Caldon LEFM✓™ System.

Item 2.

Provide additional information regarding the entries for the mass flow uncertainty appearing in Table 3-1 of Caldon ER-80P.

Response to Item 2.

See Attachment B.

Item 3.

LAR 289/161 Enclosure 1, Section 3.5.5 discusses the impact of uprate on the spent fuel pool cooling system. For BVPS Unit No. 1, it is noted that for all analyzed conditions, the increase in maximum fuel pool temperature is less than 2°F. The BVPS Unit No. 2 results are not affected since the existing analysis considered core power levels which bound the uprated power level. The reviewer asked what the actual results are, and how close the increase puts BVPS Unit No. 1 to its design limit.

Response to Item 3.

The current analysis of record for the BVPS Unit No. 1 spent fuel cooling system performance was performed in conjunction with the re-racking project in 1994; i.e., License Amendment 178. The following cases were analyzed and discussed in the SER for License Amendment 178.

Case (1a)	Normal refueling load of spent fuel assemblies discharged, one train of Spent Fuel Pool (SFP) cooling system operating.
Case (1b)	Same as Case (1a) with both SFP cooling trains operating.
Case (2)	Full core (157 spent fuel assemblies) discharged, both SFP cooling trains operating.
Case (3)	Refueling load (72 fuel assemblies) discharged, then full core offload approximately 60 days later, both SFP cooling trains operating.

This analysis was based on a thermal power of 2660 MWth and the results for maximum pool bulk temperature were as follows.

Case (1a)	161.2 °F
Case (1b)	133.0 °F
Case (2)	153.4 °F
Case (3)	153.4 °F

A new calculation was performed to support the uprate project and to evaluate the effect of the higher core power levels on the spent fuel pool cooling system performance. The results are shown below based on power levels at the current operating level and also at the 1.4% uprate level.

	2660 MWth	2705 MWth
Case (1a)	159.6 °F	160.6 °F
Case (1b)	132.1 °F	132.7 °F
Case (2)	153.0 °F	153.9 °F
Case (3)	154.5 °F	155.5 °F

Several changes in assumptions and methodology account for the small differences in the results of the new analysis versus the previous analysis. These include such things as the decay heat calculations, pool volume, cooling system flow rates, and heat exchanger performance. The results indicate that the maximum predicted pool bulk temperature is within the cooling system and fuel pool design temperature limits. All components have a design temperature of 200°F and thermal analyses have been performed to bound the maximum temperatures expected.

Item 4.

In Section 3.11.1.1, Short Term Loss of Coolant Accident (LOCA) Mass and Energy Release Data, of LAR 289/161 Enclosure 1, the only statement which seems to address BVPS Unit No. 1 appears at the end of the section and states "For Unit 1, an evaluation has been completed that demonstrates sufficient margin exists within the compartment structural design to accommodate the small increase in releases due to the uprate." The reviewer requested that FENOC expound on what was done to address BVPS Unit No. 1 for this subject.

Response to Item 4.

The last statement in the last paragraph concerning the BVPS Unit No. 1 evaluation only pertains to the subject of the paragraph; i.e., upper pressurizer cubicle pressure analysis. For this analysis of a spray line rupture, which is the only break not eliminated or bounded by the larger breaks eliminated by application of Leak Before Break (LBB), an evaluation was performed for BVPS Unit No.1 due to some changes in the mass and energy release rates associated with the uprate.

The preceding paragraphs in the section apply to both BVPS units with the exception that the WCAP 8264-P-A methodology is noted as being in the licensing basis for BVPS Unit No. 2 only. BVPS Unit No. 1 uses a similar methodology for generation of mass and energy release data; however, WCAP-8264-P-A is not part of the licensing basis for BVPS Unit No. 1. The discussions on the Reactor Cavity, Loop Compartments, and surge line relative to the application of LBB are applicable to both units.

Attachment C

LEFM Interface and Reconciliation Document
Calorimetric Uncertainties with the LEFM Check and Check Plus
April 5, 2001

I. Purpose

It is the purpose of this document to define precisely the uncertainties that Caldon will calculate and justify for a specific Appendix K uprate project. The uncertainties that are outside Caldon's scope are also defined, as well as the method for combining all uncertainties to obtain a power uncertainty. This document also breaks down the relationship between the uncertainties tabulated in Caldon reports covering the operation of the LEFM Check and LEFM CheckPlus instruments and the data that Caldon will provide for a specific uprate project.

II. Background

Reports covering the operation of the LEFM Check and LEFM CheckPlus instruments describe how the use of these instruments reduces the uncertainties in feedwater mass flow and feedwater enthalpy.[2] In combination with the uncertainties in the determination of other variables (steam enthalpy, for example), the uncertainties in feedwater mass flow and enthalpy establish the uncertainty in the core thermal power. The amount of a power increase allowable under an Appendix K uprate is directly dependent on achieving a thermal power uncertainty within bounds defined by the reports cited above.

The uncertainties in the variables measured by an LEFM, either mass flow or derived from its outputs (feedwater temperature and pressure, which are converted to enthalpy) are made up of several elements. These elements relate to the LEFM's measurements of time, to its dimensions, to the hydraulics of the installation and to correlations relating fluid temperature and density to sound velocity and pressure. With respect to the correlations and the measurements of time and dimensions, some of the uncertainties in mass flow are systematically related to the uncertainties in feedwater enthalpy while others are not. The structure and combination methods for power uncertainties are described further below.

III. Structure of the Thermal Power Uncertainties

The core thermal power as determined by a heat balance around the steam supply is given by:

(1) $Q_{RX} = W_{FW} (h_S - h_{FW}) + Q_{LOSS\ NET}$

Where Q_{RX} is the core thermal power

W_{FW} is the mass flow rate of the feed to the steam supply, the product of feedwater volumetric flow rate and feedwater density,

h_S is the enthalpy of the steam delivered by the steam supply, a function of its pressure and moisture content for saturated steam supplies and its pressure and temperature for superheated steam supplies,

h_{FW} is the enthalpy of the feedwater, a function of its temperature and pressure, and

$Q_{LOSS\ NET}$ is the net loss or gain in power from coolant pump heating, blowdown and/or reactor water purification, convective and radiant losses, etc.

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[2] Caldon Engineering Reports ER-80P, ER-160P and ER-157P

The contributing uncertainties to the thermal power computation are defined by differentiating equation (1):

(2) $dQ_{RX} = dW_{FW} (h_S - h_{FW}) + W_{FW}\, dh_S - W_{FW}\, dh_{FW} + dQ_{LOSS\ NET}$

The contributors can be expressed per unit by dividing equation (2) by Q_{RX}.

(3) $dQ_{RX}/Q_{RX} = dW_{FW}/W_{FW} [1 - (Q_{LOSS\ NET}/Q_{RX})] + [dh_S/ (h_S - h_{FW})] [1 - (Q_{LOSS\ NET}/Q_{RX})] - [dh_{FW} / (h_S - h_{FW})] [1 - (Q_{LOSS\ NET}/Q_{RX})] + dQ_{LOSS\ NET}/ Q_{RX}$

Since the net gains and losses term is typically less than 1% of the reactor thermal power, the term $[1 - (Q_{LOSS\ NET}/Q_{RX})]$ may be taken as approximately 1.0. Hence,

(4) $dQ_{RX}/Q_{RX} = dW_{FW}/W_{FW} + [dh_S/ (h_S - h_{FW})] - [dh_{FW}/ (h_S - h_{FW})] + dQ_{LOSS\ NET}/ Q_{RX}$

It should be pointed out that equation (4) applies algebraically only if all error contributors are systematically related to each other. Most of these components are *not* systematically related. If all of the components were random errors or biases the power uncertainty of equation (4) would be the square root of the sum of the squares of the individual terms on the right hand side of the equation. In fact, a combination of the two procedures is appropriate as described below.

The feedwater enthalpy is a function of its temperature and pressure. Likewise, the density of the feedwater, which the LEFM combines with the volumetric flow to compute mass flow, is a function of temperature and pressure. Because of this and other factors, certain elements of the uncertainty in feedwater enthalpy are combined systematically with the mass flow uncertainty, while other elements, unrelated to the mass flow measurement, are combined randomly. For convenience in defining the combination of terms, the feedwater enthalpy will be related to its temperature and pressure by the following:

(5) $h_{FW} = \delta h/\delta p\,|_T (p_{FW} - p_0) + \delta h/\delta T\,|_p (T_{FW} - T_0) + h_0$

The computation of feedwater enthalpy from temperature and pressure by the plant computer—part of the thermal power computation—may be carried out by a more complex algorithm than that of equation (5), or the enthalpy may be determined from a look up table. Equation (5) is used here simply as a convenience for developing the elements of the error contributors to feedwater enthalpy. Using equation (5), the uncertainty in feedwater enthalpy is:

(6) $dh_{FW} = \delta h/\delta p\,|_T\, dp_{FW} + \delta h/\delta T\,|_p\, dT_{FW} + dh_0$

Here dh_0 represents the potential bias in the enthalpy algorithm of the plant computer.

Rewriting equation (4) to incorporate equation (6), and rearranging terms:

$$(7)\qquad dQ_{RX}/Q_{RX} = \overset{\mathbf{A}}{\{dW_{FW}/W_{FW}\}} - \overset{\mathbf{B}}{\{[1/(h_S - h_{FW})]\,[\delta h/\delta p\,|_T\, dp_{FW} + \delta h/\delta T\,|_p\, dT_{FW}]\}}$$

$$+ \overset{\boldsymbol{C}}{\{[1/(h_S - h_{FW})]\, dh_0\}} + \overset{\boldsymbol{D}}{\{[1/(h_S - h_{FW})]\, dh_S\}} + \overset{\boldsymbol{E}}{\{dQ_{LOSS\,NET}/Q_{RX}\}}$$

In the determination of overall thermal power uncertainty, terms **A** and **B** will be provided by Caldon, based in part on a feedwater pressure uncertainty provided by the utility. This uncertainty is generally assumed to be within 11 psi.

Terms **C**, **D**, and **E** are outside of Caldon's scope, are based on other plant instruments, and are to be provided by others.

Caldon will provide a single uncertainty, **AB**, expressed as a percentage of the rated thermal power, that encompasses terms **A** and **B**. Under normal circumstances, there will not be a systematic relationship between term **AB**, on the one hand, and terms **C**, **D**, and **E**, on the other. Likewise, there will normally not be systematic relationships among terms **C**, **D**, and **E.** Therefore, the utility will normally compute the total thermal power uncertainty from the following.

$$(8)\qquad dQ_{RX}/Q_{RX} = [(\mathbf{AB})^2 + (\mathbf{C})^2 + (\mathbf{D})^2 + (\mathbf{E})^2]^{1/2}$$

IV. Reconciliation of Uncertainties for Beaver Valley 1 and 2 With the Uncertainties Quoted in Caldon Engineering Reports

Table 1 below compares the expected site-specific bounding uncertainties for Beaver Valley Units 1 and 2 to the following Caldon Engineering Reports:

- ER-80P, Rev. 0, the original Caldon topical report from 1997 that requests a 1% power uprate based on an accuracy of the LEFM Check system bounded by 0.6% thermal power accuracy.
- ER-160P, Rev. 0, which presents instrument uncertainties exactly the same as those in ER-80P. ER-160P recognizes that, in accordance with NRC Rulemaking in June 2000, a power uprate up to and including 1.4% power can be requested for the LEFM Check System (since ER-80P demonstrates that its accuracy supports a thermal power uncertainty of ± 0.6%).
- ER-157P, Rev. 3, which describes Caldon's next generation LEFM CheckPlus. ER-157P revises the uncertainty analyses of ER-80P to reflect actual LEFM Check data as applied to a typical single flow measurement application (similar to Beaver Valley). It also shows that the LEFM Check system can achieve power uncertainties as low as ± 0.5% thermal power accuracy. Additionally, ER-157P demonstrates that the LEFM CheckPlus can support power uncertainties as small as ± 0.3%.

Table 1. Reconciliation of Beaver Valley Uncertainties With Caldon Reports

Notes: