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10 CFR 50.46(a)(3)(ii)

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

SUBJECT:
Beaver Valley Power Station, Unit Nos. 1 and 2
Docket No. 50-334, License No. DPR-66
Docket No. 50-412, License No. NPF-73
<u>10 CFR 50.46 Report of Changes to or Errors in Emergency Core Cooling System Evaluation Models</u>

In accordance with Title 10 of the *Code of Federal Regulations*, Part 50, Section 50.46(a)(3)(ii), FirstEnergy Nuclear Operating Company (FENOC) provides the attached report as annual notification of changes or errors in emergency core cooling system evaluation models or the application of the models for the Beaver Valley Power Station, Unit Nos. 1 (BVPS-1) and 2 (BVPS-2). Current information for both large and small break loss-of-coolant accident (LOCA) transients is provided to satisfy 10 CFR 50.46 reporting requirements.

The attachments provide a summary list and description of each change or error in the acceptable evaluation models or the application of the models that affects the peak fuel cladding temperature (PCT) calculation for various LOCA transients, as well as the estimated PCT effects of the change or error.

The changes or errors communicated to FENOC since the previous annual report are listed in the attachment and result in PCTs for the large and small break LOCA transients as follows:

BVPS-1 large break LOCA – 1840 degrees Fahrenheit (°F)
BVPS-1 small break LOCA – 1895°F
BVPS-2 large break LOCA – 1839°F
BVPS-2 small break LOCA – 1917°F

There are no regulatory commitments contained in this submittal. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager – Fleet Licensing, at (330) 315-6810.

Sincerely,

Eric A. Larson

Attachments:

1. Summary of Peak Fuel Cladding Temperature (PCT) Effects for Beaver Valley Power Station (BVPS) Loss-of-Coolant Accident (LOCA) Transients
2. Descriptions of Emergency Core Cooling System (ECCS) Evaluation Model Changes or Errors

cc: NRC Region I Administrator
NRC Resident Inspector
NRC Project Manager
Director BRP/DEP
Site BRP/DEP Representative

Summary of Peak Fuel Cladding Temperature (PCT) Effects for Beaver Valley Power Station (BVPS) Loss-of-Coolant Accident (LOCA) Transients

Beaver Valley Power Station Unit No. 1 (BVPS-1) Large Break LOCA

Description	PCT Effect (°F)	Attachment 2 Description (page)
General Computer Code Maintenance	0	1
Errors in Decay Group Uncertainty Factors	0	3
Beaver Valley Units 1 and 2 Change of Modeled Pressurizer Level Program	0	5

BVPS-1 Small Break LOCA

Description	PCT Effect (°F)	Attachment 2 Description (page)
General Computer Code Maintenance	0	1
Fuel Rod Gap Conductance Error	0	6
Radiation Heat Transfer Model Error	0	7
SBLOCTA Pre-DNB Cladding Surface Heat Transfer Coefficient Calculation	0	8

Beaver Valley Power Station Unit No. 2 (BVPS-2) Large Break LOCA

Description	PCT Effect (°F)	Attachment 2 Description (page)
General Computer Code Maintenance	0	1
Revised Total Computer Code Uncertainty in Best Estimate Large Break LOCA Monte Carlo Simulations	0	2
Containment Model Input Error Corrections	7	4
Beaver Valley Units 1 and 2 Change of Modeled Pressurizer Level Program	0	5

BVPS-2 Small Break LOCA

Description	PCT Effect (°F)	Attachment 2 Description (page)
General Computer Code Maintenance	0	1
Fuel Rod Gap Conductance Error	0	6
Radiation Heat Transfer Model Error	0	7
SBLOCTA Pre-DNB Cladding Surface Heat Transfer Coefficient Calculation	0	8

GENERAL COMPUTER CODE MAINTENANCE

Background

Various changes have been made to enhance the usability of computer codes and to streamline future analyses. Examples of these changes include: modifying input variable definitions, units and defaults; improving the input diagnostic checks; enhancing the computer code output; optimizing active coding; and eliminating inactive coding. These changes represent discretionary changes that will be implemented on a forward-fit basis in accordance with Section 4.1.1 of WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

Affected Evaluation Models

1. 1996 Westinghouse Best Estimate Large Break loss-of-coolant accident (LOCA) Evaluation Model
   (Applicable to BVPS Unit No. 2 [BVPS-2])
2. 2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using Automated Statistical Treatment of Uncertainty Method (ASTRUM)
   (Applicable to BVPS Unit No. 1 [BVPS-1])
3. 1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP (a nodal transient small break and general network computer code)
   (Applicable to BVPS-1 and BVPS-2)

Estimated Effect

The nature of these changes leads to an estimated peak fuel cladding temperature (PCT) impact of 0 degrees Fahrenheit (°F) for both BVPS-1 and BVPS-2.

REVISED TOTAL COMPUTER CODE UNCERTAINTY IN BEST ESTIMATE LARGE BREAK LOCA MONTE CARLO SIMULATIONS

Background

As part of the WCOBRA/TRAC validation basis for use in Best-Estimate (BE) Large-Break Loss-of-Coolant Accident (LBLOCA) analyses, simulations of many separate effects tests and integral effects tests were performed. In the Westinghouse 1996 BE LBLOCA evaluation model (the code qualification document evaluation model), the simulations of the test data that included core heat transfer measurements were used in the uncertainty methodology in two ways:

1. To develop heat transfer multiplier distributions that are used in the HOTSPOT computer code for local hot fuel rod calculations.
2. To determine the minimum code uncertainties for blowdown and reflood that are used in the MONTECF computer code for the Monte Carlo uncertainty calculations.

The effects of several changes and error corrections to the WCOBRA/TRAC computer code were previously reported in 2013, including effects of revised heat transfer multiplier distributions. As a result of previously reported changes and error corrections made to WCOBRA/TRAC, the total code uncertainty values utilized in the MONTECF computer code for both blowdown and reflood were recalculated. The recalculated total code uncertainty values are lower than the previous values. Resolution of this issue represents a non-discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1. 1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model (Applicable to BVPS-2)

Estimated Effect

The total code uncertainty value is essentially a minimum limit for the superposition correction in the Monte Carlo simulations performed with the MONTECF computer code. As a result, a reduction in the minimum superposition correction would be expected to produce a small benefit, and will thus be conservatively assigned an estimated PCT impact of 0°F for BVPS-2.

ERRORS IN DECAY GROUP UNCERTAINTY FACTORS

Background

Errors in the calculation of decay heat were discovered in the WCOBRA/TRAC computer code. The decay group uncertainty factors for each fissile isotope are provided in Table 8-14 of WCAP-16009-P-A, "Realistic Large Break LOCA Evaluation Methodology Using Automated Statistical Treatment of Uncertainty Method (ASTRUM)," January 2005. The uncertainty factors for ^{239}Pu were applied to ^{238}U, and those for ^{238}U were applied to ^{239}Pu. This error causes an over-prediction of the uncertainty in decay power from ^{239}Pu and an under-prediction of the uncertainty in decay power from ^{238}U. Further, the decay group uncertainty factor for decay group 6 of ^{235}U was erroneously coded as 2.5 percent instead of 2.25 percent. Correction of these errors impacts the application of the sampled decay heat uncertainty, which may result in small changes to the decay heat power. These issues have been evaluated to estimate the impact on ASTRUM LBLOCA analysis results. The resolution of these issues represents a closely-related group of non-discretionary changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1. 2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM (Applicable to BVPS-1)

Estimated Effect

Based on inspection of the limiting cases, it was concluded that the decay heat power was conservatively modeled for the limiting case, resulting in an estimated PCT impact of 0°F for BVPS-1.

CONTAINMENT MODEL INPUT ERROR CORRECTIONS

Background

Several input errors were discovered in the containment model for the BVPS-2 BE LBLOCA analysis. The input errors included an incorrect specification of the number of ECCS spill table entries, a typo in the heat transfer surface area of one heat sink, and an incorrect thickness input for one of the heat sinks. These input errors have been evaluated to estimate the impact on the BE LBLOCA analysis results. The resolution of these issues represents a non-discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1. 1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model (Applicable to BVPS-2)

Estimated Effect

The correction of these errors resulted in a lower calculated containment pressure, and the plant-specific evaluation resulted in an estimated PCT increase of 7°F for BVPS-2.

BEAVER VALLEY UNITS 1 AND 2 CHANGE OF MODELED PRESSURIZER LEVEL PROGRAM

Background

It was discovered that the pressurizer level program modeled in the LBLOCA analyses of record for BVPS-1 and BVPS-2 was changed when implemented at the plant. Modeling the as-implemented program results in a change to the assumed pressurizer water volume range in the LBLOCA analyses. The change in pressurizer water volume range resulting from the as-implemented program has been evaluated. This change represents a non-discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1. 1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model (Applicable to BVPS-2)
2. 2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM (Applicable to BVPS-1)

Estimated Effect

The plant-specific evaluation determined that the change in pressurizer water volume range was insignificant, leading to an estimated PCT impact of 0°F for both BVPS-1 and BVPS-2.

FUEL ROD GAP CONDUCTANCE ERROR

Background

An error was identified in the fuel rod gap conductance model in the NOTRUMP computer code. The error is associated with the use of an incorrect temperature in the calculation of the cladding emissivity term. This error corresponds to a non-discretionary change as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1. 1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP (Applicable to BVPS-1 and BVPS-2)

Estimated Effect

The estimated effect was determined based on a combination of engineering judgment of the phenomena and physics of a small break LOCA and sensitivity calculations performed with the advanced plant version of NOTRUMP. It was concluded that this error has a negligible effect on small break LOCA analysis results, leading to an estimated PCT impact of 0°F for both BVPS-1 and BVPS-2.

RADIATION HEAT TRANSFER MODEL ERROR

Background

Two errors were discovered in the calculation of the radiation heat transfer coefficient within the fuel rod model of the NOTRUMP computer code. First, existing logic did not preclude non-physical negative or large (negative or positive) radiation heat transfer coefficients from being calculated. These erroneous calculations occurred when the vapor temperature exceeded the cladding surface temperature or when the predicted temperature difference was less than 1°F. Second, a temperature term incorrectly used degrees Fahrenheit instead of Rankine. These errors represent a closely related group of non-discretionary changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1. 1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP (Applicable to BVPS-1 and BVPS-2)

Estimated Effect

The estimated effect was determined based on a combination of engineering judgment of the phenomena and physics of a small break LOCA and sensitivity calculations performed with the advanced plant version of NOTRUMP. It was concluded that this error has a negligible effect on small break LOCA analysis results, leading to an estimated PCT impact of 0°F for both BVPS-1 and BVPS-2.

SBLOCTA PRE-DNB CLADDING SURFACE HEAT TRANSFER COEFFICIENT CALCULATION

Background

Two errors were discovered in the pre-departure from nucleate boiling (pre-DNB) cladding surface heat transfer coefficient calculation in the SBLOCTA computer code (cladding heat-up calculations). The first error is a result of inconsistent time units (hours versus seconds) in the parameters used for the calculation of the Reynolds and Prandtl numbers, and the second error relates to an incorrect diameter used to develop the area term in the cladding surface heat flux calculation. Both of these issues impact the calculation of the pre-DNB convective heat transfer coefficient, representing a closely related group of non-discretionary changes to the evaluation model as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1. 1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP (Applicable to BVPS-1 and BVPS-2)

Estimated Effect

These errors have been corrected in the SBLOCTA computer code. Because this condition occurred prior to DNB, it was judged that these errors had no direct impact on the cladding heat-up related to the core uncover period. A series of validation tests confirmed that these errors have a negligible effect on small break LOCA analysis results, leading to an estimated PCT impact of 0°F for both BVPS-1 and BVPS-2.