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June 29, 1990

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Reference: 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
10CFR50.46 Report of Changes or Errors in
ECCS Evaluation Models

Gentlemen:

This letter provides the required annual report of changes or errors in ECCS evaluation models. 10 CFR 50.46 requires this report to describe the nature of the change or error and its estimated effect on the limiting ECCS analysis. The following attachments provide the required information:

Attachment A - This attachment provides a list of references used in this report. These references are already on record at the NRC.

Attachment B - This provides a plant specific (BVPS-1) description of the nature of the change or error. This information was provided by Westinghouse to the NRC on a generic basis in references 2 and 3. Plant specific estimates of the effect on PCT for these changes or errors is also provided.

Attachment C - Similar in content to Attachment B, this attachment provides BVPS-2 plant specific information.

This report does not contain information related to changes in PCT due to plant modifications because these do not constitute changes or errors in the evaluation model or in the application of the model. In addition, Westinghouse has determined that input modelling corrections are not reportable under 10CFR50.46. These have not been included in this report.

Very truly yours,

J. D. Sieber
Vice President
Nuclear Group

cc: Mr. J. Beall, Sr. Resident Inspector
Mr. T. T. Martin, NRC Region I Administrator
Mr. A. W. DeAgazio, Project Manager
Mr. R. Saunders (VEPCO)

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ATTACHMENT A

REFERENCES

1. "Emergency Core Cooling Systems; Revisions to Acceptance Criteria," Federal Register, Vol. 53, No. 180, pp.35996-36005, Dated September 16, 1988

2. NS-NRC-89-3463, "10CFR50.46 Annual Notification for 1989 of Modifications in the Westinghouse ECCS Evaluation Models," Letter from W. J. Johnson (Westinghouse) to T. E. Murley (NRC), Dated October 5, 1989.

3. NS-NRC-89-3464, "Correction of Errors and Modifications to the NOTRUMP Code in the Westinghouse Small Break LOCA ECCS Evaluation Model Which Are Potentially Significant," Letter from W. J. Johnson (Westinghouse) to T. E. Murley (NRC), Dated October 5, 1989.

4. "NOTRUMP - A Nodal Transient Small Break and General Network Code," WCAP-10079-P-A (Proprietary), WCAP-10080-A (Non-Proprietary), Meyer, P. E., et. al., August 1985.

5. Beaver Valley Unit 1 Updated Final Safety Analysis Report, Revision 7 1/89.

6. Beaver Valley Unit 2 Updated Final Safety Analysis Report, Revision 1 1/89.

ATTACHMENT B

EFFECT OF WESTINGHOUSE ECCS EVALUATION MODEL MODIFICATIONS ON THE LOCA ANALYSIS RESULTS FOUND IN CHAPTER 14 OF THE BEAVER VALLEY UNIT 1 UPDATED FINAL SAFETY ANALYSIS REPORT

The October 17, 1988 revision to 10CFR50.46 required applicants and holders of operating licenses or construction permits to notify the Nuclear Regulatory Commission (NRC) of errors and changes in the ECCS Evaluation Models on an annual basis, when the errors and changes are not significant. Reference 1 defines a significant error or change as one which results in a calculated peak fuel cladding temperature different by more than 50°F from the temperature calculated for the limiting transient using the last acceptable model, or is a cumulation of changes and errors such that the sum of the absolute magnitudes of the respective temperature changes is greater than 50°F.

In References 2 and 3, information regarding modifications to the Westinghouse large break and small break LOCA ECCS Evaluation Models was submitted to the NRC. The following presents an assessment of the effect of the modifications to the Westinghouse ECCS Evaluation Models on the loss-of-coolant accident (LOCA) analysis results found in Chapter 14 of the Beaver Valley Unit 1 Updated Final Safety Analysis Report (reference 5).

LARGE BREAK LOCA

The large break LOCA analyses for Beaver Valley Unit 1 were examined to assess the effect of the applicable modifications to the Westinghouse large break LOCA ECCS Evaluation Model on peak cladding temperature (PCT) results reported in Chapter 14 of the UFSAR. The large break LOCA analyses results were calculated using the 1981 version of the Westinghouse large break LOCA ECCS Evaluation Model incorporating the BASH analysis technology. The analysis assumed the following information important to the large break LOCA analyses;

Licensed Core Power	2652 MW
Core Total Peaking Factor, FQ	2.4
Steam Generator Tube Plugging	10%
Fuel Type	17 * 17 Standard

For Beaver Valley Unit 1, the limiting break resulted from the double ended guillotine rupture of the cold leg piping with a discharge coefficient of CD = 0.4 for the Maximum Safeguards case. The calculated peak cladding temperature was 1918°F.

The following modifications to the Westinghouse ECCS Evaluation Models discussed in Reference 2 would affect the large break LOCA analysis results found in Chapter 14 of the Beaver Valley Unit 1 Updated Final Safety Analysis Report.

Several improvements were made to the BASH computer code to treat special analysis cases which are related to the tracking of fluid interfaces;

1) A modification, to prevent the code from aborting, was made to the heat transfer model for the special situation when the quench front region moves to the bottom the the BASH core channel. The quench heat supplied to the fluid node below the bottom of the active fuel was set to zero.

2) A modification, to prevent the code from aborting, was made to allow negative initial movement of the liquid/two-phase and liquid-vapor interfaces. The coding these areas was generalized to prevent mass imbalance in the special case where the liquid/two-phase interface reaches the bottom of the BASH core channel.

3) Modifications, to prevent the code from aborting, were made to increase the dimensions of certain arrays for special applications.

4) A modification was made to write additional variables to the tape of information to be provided to LOCBART.

5) Typographical errors in the coding of some convective heat transfer terms were corrected, but the corrections have no effect on the BASH analysis results since the related terms are always set equal to zero.

6) A modification was made to the BASH coding to reset the cold leg conditions, in a conservative manner, when the accumulators empty. The BASH model is initialized at the bottom of core recovery with the intact cold legs, lower plenum full of liquid. Flow into the downcomer then equals the accumulator flow. The modification removed most of the intact cold leg water at the accumulator empty time by resetting the intact cold leg conditions to a high quality two phase mixture.

   In a typical BASH calculation, the downcomer is nearly full when the accumulators emptied. The delay time, prior to the intact cold leg water reaching saturation, is sufficient to allow the downcomer to fill from the addition of safety injection fluid before the water in the cold legs reaches saturation. When the intact cold leg water reached saturation it merely flowed out of the break. The cold leg water therefore, did not affect the reflood transient.

   However, in a special case, a substantial time was required to fill the downcomer after the accumulators emptied. The fluid in the intact cold legs reached saturation before the downcomer filled, which artificially perturbed the transient response by incorrectly altering the downcomer fluid conditions causing the code to abort.

For Beaver Valley Unit 1 LOCA analysis results could be affected by the modifications specified in items 1, 2, 3, 4, 5, and 6 above. While there is no adverse effect on the PCT calculation for the majority of the changes which apply to Beaver Valley Unit 1 discussed above, a conservative estimate of 10°F will be assessed and tracked for used in determining the available margin to the limits of 10CFR50.46.

As discussed above, modifications to the Westinghouse large break LOCA ECCS Evaluation Model could affect the result by altering the PCT.

A.	Analysis calculated result	1918°F
B.	Modifications to Westinghouse ECCS Evaluation Model	+ 10°F
	ECCS Evaluation Model Modifications Resultant PCT	1928°F

SMALL BREAK LOCA

The small break LOCA analyses for Beaver Valley Unit 1 were also examined to assess the effect of the applicable modifications to the Westinghouse ECCS Evaluation Models on peak cladding temperature (PCT) results reported in Chapter 14 of the UFSAR. The small break LOCA analyses results were calculated using the 1985 version of the Westinghouse small break LOCA ECCS Evaluation Model incorporating the NOTRUMP analysis technology. The analysis assumed the following information important to the small break LOCA analyses;

Licensed Core Power	2652 MW
Core Total Peaking Factor, FQ	2.4
Steam Generator Tube Plugging	10%
Fuel Type	17 * 17 Standard

For Beaver Valley Unit 1, the limiting size small break resulted from a 3-inch equivalent diameter break in the cold leg. The calculated peak cladding temperature was 1802°F.

The following modifications to the Westinghouse ECCS Evaluation Models discussed in Reference 2 would affect the small break LOCA analysis results found in Chapter 14 of the Beaver Valley Unit 1 Updated Final Safety Analysis Report.

The Westinghouse small break LOCA ECCS Evaluation Model analyses for Beaver Valley Unit 1 were performed with a version of the NOTRUMP computer which did not incorporate the following potentially significant modifications noted in Reference 2;

1) The modification to preclude changing the region designation (upper, lower) for a node in a stack which does not contain the mixture-vapor interface was not incorporated in the small break LOCA analyses for Beaver Valley Unit 1. The purpose of the modification was to enhance tracking of the mixture-vapor interface in a stacked series of fluid nodes and to preclude a node in a stack, which does not contain the mixture-vapor interface, from changing the region designation. The update does not affect the fluid conditions in the nodes representing the reactor coolant system, only the designation of the region of the node. The region designation does not typically affect the calculations, except for the nodes representing the core fluid volume (core nodes). In core nodes which are designated as containing vapor regions, the use of the steam cooling heat transfer correlation is forced on the calculation in compliance with the requirements of Appendix K to 10CFR50, even if the node conditions would indicate otherwise. This modification could affect the heat transfer

calculation if the region designation was improperly reflected, but is expected to result in a small decrease in the PCT if the correction were taken into account.

2) The modification to correct typographical errors in the equations which calculate the heat transfer rate derivatives for subcooled, saturated, and superheated natural convection conditions for the the upper region of interior fluid nodes were not included in the small break LOCA analyses for Beaver Valley Unit 1. The heat transfer rate derivatives for subcooled, saturated, and superheated natural convection conditions for the the upper region of interior fluid nodes used of the lower region heat transfer area instead of the upper region heat transfer area, which could in rare instances, affect the amount of heat that could be transferred to the fluid. Incorporating the modification into the small break LOCA analyses could result in an increase in the PCT of 36.7°F.

3) The modification to correct typographical errors in equations which calculate the derivatives of the natural convection mode of heat transfer in the subroutine HEAT were not included in the small break LOCA analyses for Beaver Valley Unit 1. However, incorporating the correction into the analyses would have no effect on the analysis results.

4) The modification to correct a typographical error in an equation which calculates the internal energy for nodes associated with the reactor coolant pump model when the associated reactor coolant pump flow links are found to be in critical flow was not included in the small break LOCA analyses for Beaver Valley Unit 1. Since the small break LOCA Evaluation Model calculations did not encounter critical flow in the reactor coolant pump flow links, including this modification would have no effect on the analysis results.

Modifications were made to the small break LOCTA-IV computer code used in the small break LOCA ECCS Evaluation Model. Since the small break LOCTA-IV code modifications could, at most, result in a very small benefit the effect of modification to the small break LOCTA-IV code modifications do not need to be assessed or tracked.

The effect of the potentially significant ECCS Evaluation Model modifications on the small break LOCA analyses for Beaver Valley Unit 1 could result in a penalty in the peak cladding temperature calculation if taken into account. For conservatism in estimating the available margin, a peak cladding temperature penalty of approximately 37°F should be added to the analysis calculations as a result of ECCS Evaluation Model changes when determining the available margin to the limits of 10CFR50.46.

As discussed above, modifications to the Westinghouse small break LOCA ECCS Evaluation Model could affect the small break LOCA analysis results by altering the PCT.

A.	Analysis calculated result	1802°F
B.	Modifications to Westinghouse ECCS Evaluation Model	+ 37°F
	ECCS Evaluation Model Modifications Resultant PCT	1839°F

EFFECT OF WESTINGHOUSE ECCS EVALUATION MODEL MODIFICATIONS ON THE LOCA ANALYSIS RESULTS FOUND IN CHAPTER 15 OF THE BEAVER VALLEY UNIT 2 UPDATED FINAL SAFETY ANALYSIS REPORT

The October 17, 1988 revision to 10CFR50.46 required applicants and holders of operating licenses or construction permits to notify the Nuclear Regulatory Commission (NRC) of errors and changes in the ECCS Evaluation Models on an annual basis, when the errors and changes are not significant. Reference 1 defines a significant error or change as one which results in a calculated peak fuel cladding temperature different by more than 50°F from the temperature calculated for the limiting transient using the last acceptable model, or is a cumulation of changes and errors such that the sum of the absolute magnitudes of the respective temperature changes is greater than 50°F.

In References 2 and 3, information regarding modifications to the Westinghouse large break and small break LOCA ECCS Evaluation Models was submitted to the NRC. The following presents an assessment of the effect of the modifications to the Westinghouse ECCS Evaluation Models on the loss-of-coolant accident (LOCA) analysis results found in Chapter 15 of the Beaver Valley Unit 2 Updated Final Safety Analysis Report (reference 6).

LARGE BREAK LOCA

The large break LOCA analyses for Beaver Valley Unit 2 were examined to assess the effect of the applicable modifications to the Westinghouse large break LOCA ECCS Evaluation Model on peak cladding temperature (PCT) results reported in Chapter 15 of the UFSAR. The large break LOCA analyses results were calculated using the 1981 version of the Westinghouse large break LOCA ECCS Evaluation Model incorporating the BART analysis technology. The analysis assumed the following information important to the large break LOCA analyses;

Licensed Core Power	2652 MW
Core Total Peaking Factor, FQ	2.32
Steam Generator Tube Plugging	5%
Fuel Type	17 * 17 Standard

For Beaver Valley Unit 2, the limiting break resulted from the double ended guillotine rupture of the cold leg piping with a discharge coefficient of CD = 0.4 for the Minimum Safeguards case. No Maximum Safeguards case was performed in this analysis. The calculated peak cladding temperature was 2120°F.

The following modifications to the Westinghouse ECCS Evaluation Models discussed in Reference 2 would affect the large break LOCA analysis results found in Chapter 15 of the Beaver Valley Unit 2 Updated Final Safety Analysis Report;

Modifications to the WREFLOOD code in the 1981 version of the Westinghouse ECCS Evaluation Model incorporating the BART analysis technology were made to delay downcomer overfilling. The delay corresponds to backfilling of the intact cold legs. Data from tests simulating cold leg injection during the post-large break LOCA reflood phase which have adequate safety injection flow to condense all of the available steam flow show a significant amount of subcooled liquid to be present in the cold leg pipe test section. This situation corresponds to the so-called maximum safety injection scenario of ECCS Evaluation Model analyses.

The Beaver Valley Unit 2 LOCA analyses performed with the Westinghouse 1981 large break LOCA ECCS Evaluation Model incorporating the BART analysis technology are not affected by the WREFLOOD code modifications since the maximum safeguards safety injection flow assumption case is not applicable.

As discussed above, modifications to the Westinghouse large break LOCA ECCS Evaluation Model do not affect the PCT result.

A.	Analysis calculated result	2120°F
B.	Modifications to Westinghouse ECCS Evaluation Model	+ 0°F
	ECCS Evaluation Model Modifications Resultant PCT	2120°F

SMALL BREAK LOCA

The small break LOCA analyses for Beaver Valley Unit 2 were also examined to assess the effect of the applicable modifications to the Westinghouse ECCS Evaluation Models on peak cladding temperature (PCT) results reported in Chapter 15 of the UFSAR. The small break LOCA analyses results were calculated using the 1985 version of the Westinghouse small break LOCA ECCS Evaluation Model incorporating the NOTRUMP analysis technology. The analysis assumed the following information important to the small break LOCA analyses;

Licensed Core Power	2652 MW
Core Total Peaking Factor, FQ	2.32
Steam Generator Tube Plugging	5.34%
Fuel Type	17 * 17 Standard

For Beaver Valley Unit 2, the limiting size small break resulted from a 4-inch equivalent diameter break in the cold leg. The calculated peak cladding temperature was 1399°F.

The following modifications to the Westinghouse ECCS Evaluation Models discussed in Reference 2 would affect the small break LOCA analysis results found in Chapter 15 of the Beaver Valley Unit 2 Updated Final Safety Analysis Report.

The Westinghouse small break LOCA ECCS Evaluation Model analyses for Beaver Valley Unit 2 were performed with a version of the NOTRUMP computer which did not incorporate the following potentially significant modifications noted in Reference 2;

1) The modification to preclude changing the region designation (upper, lower) for a node in a stack which does not contain the mixture-vapor interface was not incorporated in the small break LOCA analyses for Beaver Valley Unit 2. The purpose of the modification was to enhance tracking of the mixture-vapor interface in a stacked series of fluid nodes and to preclude a node in a stack, which does not contain the mixture-vapor interface, from changing the region designation. The update does not affect the fluid conditions in the nodes representing the reactor coolant system, only the designation of the region of the node. The region designation does not typically affect the calculations, except for the nodes representing the core fluid volume (core nodes). In core nodes which are designated as containing vapor regions, the use of the steam cooling heat transfer correlation is forced on the calculation in compliance with the requirements of Appendix K to 10CFR50, even if the node conditions would indicate otherwise. This modification could affect the heat transfer calculation if the region designation was improperly reflected, but is expected to result in a small decrease in the PCT if the correction were taken into account.

2) The modification to correct typographical errors in the equations which calculate the heat transfer rate derivatives for subcooled, saturated, and superheated natural convection conditions for the the upper region of interior fluid nodes were not included in the small break LOCA analyses for Beaver Valley Unit 2. The heat transfer rate derivatives for subcooled, saturated, and superheated natural convection conditions for the the upper region of interior fluid nodes used of the lower region heat transfer area instead of the upper region heat transfer area, which could in rare instances, affect the amount of heat that could be transferred to the fluid. Incorporating the modification into the small break LOCA analyses could result in an increase in the PCT of 36.7°F.

3) The modification to correct typographical errors in equations which calculate the derivatives of the natural convection mode of heat transfer in the subroutine HEAT were not included in the small break LOCA analyses for Beaver Valley Unit 2. However, incorporating the correction into the analyses would have no effect on the analysis results.

4) The modification to correct a typographical error in an equation which calculates the internal energy for nodes associated with the reactor coolant pump model when the associated reactor coolant pump flow links are found to be in critical flow was not included in the small break LOCA analyses for Beaver Valley Unit 2. Since the small break LOCA Evaluation Model calculations did not encounter critical flow in the reactor coolant pump flow links, including this modification would have no effect on the analysis results.

5) The modification to correct an error in the implementation of equation 5-33 of reference 4 was not included in the small break LOCA analyses for Beaver Valley Unit 2. Equation 5-33 describes the calculation of the flow link friction parameter c_k for single phase flow in a non critical flow link k. In the erroneous implementation, equation 5-33

was replaced by equation 5-34 which is used for all flow conditions. This modification was expected to have only a small beneficial effect on the analysis. However, an analysis calculation was performed for a three-loop plant to quantify the effect and a larger than expected decrease in the peak cladding temperature of 217°F resulted. Larger than expected peak cladding temperature sensitivities, in some instances, have been observed when analyses to support safety evaluations of the effect of plant design changes under 10CFR50.46 were performed using the NOTRUMP computer code. The unexpected sensitivity results are under investigation at Westinghouse and may be due to the artificial restrictions on loop seal steam venting placed on the model for conservatism. Evaluation of the effect of this change will be examined as part of the investigation of the larger than expected sensitivity results.

6) The modification made to prevent code aborts resulting from implementation of a new FORTRAN compiler on the Westinghouse CRAY computer system was not included in the small break LOCA analyses for Beaver Valley Unit 2. Due to the different treatments of the precision of numbers between the FORTRAN compilers, the subtraction of two large, but close numbers resulted in zero. The zero value was used in the denominator of a derivative equation, which resulted in the code aborts. Implementing this modification for cases which did not abort has the potential to result in an increase in the PCT of approximately 4.8°F.

7) The modification to properly call some doubly dimensioned variables in subroutines INIT and TRANSNT was not included in the small break LOCA analyses for Beaver Valley Unit 2. However, all of the doubly dimensioned variables used a 1 as the second dimension in all of the erroneous calls, and therefore this modification would have no effect on the PCT.

8) The modification to correct an error in implementing equations L-28, L-52 and L-29, L-53 of reference 4 was not included in the small break LOCA analyses for Beaver Valley Unit 2. The two pairs of equations respectively describe the partial derivatives of F^K with respect to pressure and specific enthalpy. F^K is an interpolation parameter that is defined by equations L-27, L-51 of reference 4. This modification could affect the small break LOCA calculation, but is expected to result in a decrease in the PCT if the correction were taken into account through a new analysis.

Modifications were also made to the small break LOCTA-IV computer code used in the small break LOCA ECCS Evaluation Model. Since the small break LOCTA-IV code modifications could, at most, result in a very small benefit the effect of modification to the small break LOCTA-IV code modifications do not need to be assessed or tracked.

The effect of the potentially significant ECCS Evaluation Model modifications on the small break LOCA analyses for Beaver Valley Unit 2 could result in a penalty in the peak cladding temperature calculation if taken into account. For conservatism in estimating the available margin, a peak cladding

temperature penalty of approximately 42°F should be added to the analysis calculations as a result of ECCS Evaluation Model changes when determining the available margin to the limits of 10CFR50.46.

As discussed above, modifications to the Westinghouse small break LOCA ECCS Evaluation Model could affect the small break LOCA analysis results by altering the PCT.

A.	Analysis calculated result	1399°F
B.	Modifications to Westinghouse ECCS Evaluation Model	+ 42°F
	ECCS Evaluation Model Modifications Resultant PCT	1441°F