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Energy Systems

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October 5, 1989
NS-NRC-89-3463

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Document Control Desk

Attention: Mr. Marvin W. Hodges, Reactor Systems Branch Chief, Division of Engineering and System Technology

Subject: 10CFR50.46 Annual Notification for 1989 of Modifications In the Westinghouse ECCS Evaluation Models

Dear Dr. Murley:

In regard to the annual reporting of errors or changes in the emergency core cooling system (ECCS) Evaluation Models, as required by the October 17, 1988 revision to 10CFR Section 50.46, the attachment to this letter provides information concerning modifications made to the Westinghouse ECCS Evaluation Models through July 1, 1989.

Westinghouse considers the ECCS Evaluation Model to consist of the calculational framework for evaluating the behavior of the reactor coolant system during a postulated loss-of-coolant accident (LOCA). The Westinghouse ECCS Evaluation Models include multiple computer programs which contain the equations representing the important physical phenomena, the numerical solution schemes for solving the equations, the method for transferring information from one computer code to another, the inputs and assumptions that are specifically associated with the model's calculational framework, and the procedures for treating the inputs and outputs which have been specifically reviewed and found acceptable by the Nuclear Regulatory Commission. The Attachment does not contain information regarding modifications to plant specific inputs altered by plant design changes under 10CFR50.59 or other means which may affect the results of LOCA analysis performed with the Westinghouse ECCS Evaluation Models.

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A copy of this letter is provided to applicants and holders of operating licenses or construction permits which utilize the results of Westinghouse ECCS Evaluation Model analyses to support plant licensing.

Please contact Mr. M. Y. Young (412-374-5081) or Mr. W. D. Tauche (412-374-5506) of my staff if you have any questions on this subject.

Very truly yours,

W. J. Johnson, Manager
Nuclear Safety Department

WDT/K

Attachment

ATTACHMENT

MODIFICATIONS TO THE WESTINGHOUSE

ECCS EVALUATION MODELS

Pursuant to the requirements of the October 17, 1988 revision to 10CFR50.46 and Appendix K to 10CFR50, previously unreported changes in the Westinghouse ECCS Evaluation Models are being reported as part of the annual notification of ECCS Evaluation Model modifications. Potentially significant modifications to the NOTRUMP and small break LOCTA-IV computer codes in the Westinghouse small break LOCA ECCS evaluation model previously reported in Reference 1 are also discussed in the following. The following changes and corrections in the Westinghouse ECCS Evaluation Models have been made through July 1, 1989:

MODIFICATIONS TO THE 1981 ECCS EVALUATION MODEL

The 1981 ECCS Evaluation Model (Reference 2) utilizes a series of computer codes to calculate the response to a large rupture of the reactor coolant system primary piping. The thermal-hydraulic response of the reactor coolant system during the blowdown depressurization phase is calculated from the initiation of the break through the end of blowdown (utilizing the SATAN-VI computer code). The vessel refilling and core reflooding hydraulics calculations determine the core flooding rates (utilizing the WREFLOOD computer code). The containment pressure and temperature response, which may be coupled to the core reflooding calculations, is calculated modeling active energy removal to the spray and fan cooler functions and passive energy removal to the containment structural (or ice bed) heat sinks (utilizing the COCO computer code for dry containments and the LOTIC2 computer code for ice condenser containments). The fuel rod thermal response throughout the transient is calculated using either the FLECHT correlation or steam cooling model (utilizing the LOCTA-IV computer code).

The following previously unreported modifications have been made to the Westinghouse 1981 ECCS Evaluation Model;

MODIFICATIONS TO THE SATAN-VI COMPUTER CODE
No modifications have been made since those outlined in Reference 2, as amended by information in Reference 3.

MODIFICATIONS TO THE COCO COMPUTER CODE (Dry Containments)
No modifications have been made since those outlined in Reference 2 as amended by information in Reference 3.

MODIFICATIONS TO THE LOTIC2 COMPUTER CODE (Ice Condenser Containments)
No modifications have been made since those outlined in Reference 2.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

<u>MODIFICATIONS TO THE 1981 ECCS EVALUATION MODEL</u> - Continued

MODIFICATIONS TO THE WREFLOOD COMPUTER CODE

<u>Modification</u>: A modification was 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.

For maximum safety injection scenarios, the reflooding models in the Westinghouse 1981 ECCS Evaluation Model, the Westinghouse 1981 ECCS Evaluation Model incorporating the BART analysis technology, and the Westinghouse 1981 ECCS Evaluation Model incorporating the BASH analysis technology use WREFLOOD code versions which predict the downcomer to overfill. Flow through the vessel side of the break is computed based upon the available head of water in the downcomer in WREFLOOD using an incompressible flow in an open channel method. A modification to the WREFLOOD computer code was made to consider the cold leg inventory which would be present in conjunction with the enhanced downcomer level in the non-faulted loops.

WREFLOOD code logic was altered to consider the filling of the cold legs together with downcomer overfilling. Under this coding update, when the downcomer level exceeds its maximum value as input to WREFLOOD, liquid flow into the intact cold leg, as as well as spillage out the break, is considered. This logic modification stabilizes the overfilling of the vessel downcomer as it approaches it equilibrium level. The appropriate WREFLOOD code versions associated with the 1981 Westinghouse ECCS Evaluation Model and the 1981 Westinghouse ECCS Evaluation Model incorporating the BART and BASH technology have been modified to incorporate the downcomer overfill logic update.

<u>Effect of Modification on PCT:</u> This change represents a model enhancement in terms of the consistency of the approach in the WREFLOOD code and the actual response of the downcomer level. In some cases this change could delay the overfilling process, which could result in a peak cladding temperature (PCT) penalty. The magnitude of the possible PCT penalty was assessed by reanalyzing the plant which is maximum safeguards limited (CD=0.6 DECLG case) and which is most sensitive to the changes in the WREFLOOD code. The PCT penalty of $16^{o}F$ which resulted for this case represents the maximum PCT penalty which could be exhibited for any plant due to the WREFLOOD logic change.

MODIFICATIONS TO THE LOCTA-IV COMPUTER CODE

No modifications have been made since those outlined in Reference 2 as amended by information in Reference 3.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

MODIFICATIONS TO THE UHI ECCS EVALUATION MODEL

The emergency core cooling system (ECCS) for some Westinghouse designed plants includes the upper head injection (UHI) system. Special UHI ECCS Evaluation Models were developed to evaluate ECCS performance in plants equipped with the UHI system (reference 4). The UHI ECCS Evaluation Model dates from 1978 and received NRC approval in NUREG-0297 (reference 5). The thermal-hydraulic response of the reactor coolant system during the blowdown depressurization phase is calculated from the initiation of the break through the bottom of core recovery (utilizing the UHI-SATAN computer code). The continued vessel refilling and core reflooding hydraulics calculations determine the core flooding rates (utilizing the UHI-WREFLOOD computer code). The containment pressure and temperature response is calculated modeling active energy removal through the spray and fan cooler capabilities and passive energy removal through the containment structural heat sinks and ice beds (utilizing the LOTIC2 computer code for ice condenser containments). The fuel rod thermal response throughout the transient is calculated using either the FLECHT correlation or steam cooling model (utilizing the LOCTA-UHI and LOCTA-POWERREGIONS computer codes).

The following modifications were made to the UHI ECCS Evaluation Model;

> No modifications have been made since those outlined in Reference 4 except for implementation of the required burst and blockage model from NUREG-0630 as outlined in Reference 2 and docketed in the Sequoyah Updated FSAR, Amendment 6.

TWO-LOOP PLANT-SPECIFIC MODIFICATION

In the 1981 version of the Westinghouse ECCS Evaluation Model, the pressurizer is modeled as being attached to the broken (faulted) loop in the SATAN-VI code for calculating large break blowdown behavior. Sensitivity studies were performed to determine if this pressurizer location in the noding scheme was the most limiting position. The results indicated that two-loop Westinghouse PWRs are sensitive to the pressurizer nodal location and that in some cases modeling the pressurizer in the intact (non-faulted) loop resulted in a slight increase in the calculated Peak Cladding Temperature (PCT). For a two loop plant, core cooling is provided by negative core flow and the negative core flow period lasts through most of the remaining blowdown period. The concern regarding pressurizer location relates to the negative core flow period which is crucial for core cooling in a two-loop plant. With the pressurizer on the broken loop, pressurizer flow is a large contributor to break flow (pump side), lessening the contribution from the upper plenum and leaving a large upper plenum inventory for negative core flow later in blowdown. An appropriate penalty for this effect is added to the calculated PCT for each affected two-loop plant. The magnitude of this penalty is less than $10^{o}F$.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

MODIFICATIONS TO THE BART ECCS EVALUATION MODEL

The BART ECCS Evaluation Model (reference 6) couples the 1981 ECCS Evaluation Model computer codes with the BART LOCA Analysis Technology methodology by including the BARTA1 computer code in the analysis sequence. The BARTA1 computer code calculates thermohydraulic conditions in the fuel assembly during reflood utilizing mechanistic models to describe two-phase flow and heat transfer, axial conduction, grid rewetting, and fuel clad convective and radiative heat transfer to drops and vapor in the flow.

Modifications to the BART ECCS Evaluation Model include the modifications made to the 1981 ECCS Evaluation Model and the following previously unreported modifications;

MODIFICATIONS TO THE BART-INTERIM COMPUTER CODE

No modifications have been made since those outlined in Reference 6.

MODIFICATIONS TO THE INTERIM-REFLOOD COMPUTER CODE

Modification: The modifications made to the WREFLOOD computer code, described for the Westinghouse 1981 ECCS Evaluation Model were carried into the Interim-Reflood computer code.

Effect OF Modification On PCT: The effect on the PCT in the INTERIM-REFLOOD model would be smaller than that assessed previously for the WREFLOOD modification in the 1981 ECCS Evaluation Model.

MODIFICATIONS TO THE INTERIM-LOCTA COMPUTER CODE

No modifications have been made since those outlined in Reference 6.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

MODIFICATIONS TO THE BASH ECCS EVALUATION MODEL

In the BASH ECCS Evaluation Model (reference 7), the BART core model is coupled with equilibrium-NOTRUMP computer code to calculate the dynamic interaction between the core thermohydraulics and system behavior in the reactor coolant system during core reflood. The BASH code reflood model replaces the WREFLOOD calculation to produce a more dynamic flooding transient which reflects the close coupling between core thermohydraulic and loop behavior. Special treatment of the BASH computer code outputs is used to provide the core flooding rate for use in the LOCBART computer code. The LOCBART computer code results from the direct coupling of the BART computer code and the LOCTA computer code to directly calculate the peak cladding temperature.

Modifications to the BASH ECCS Evaluation Model include the modifications made to the 1981 ECCS Evaluation Model, discussed previously, and the following previously unreported modifications;

MODIFICATIONS TO THE BASH COMPUTER CODE

Modification: 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.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

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.

Effect OF Modification On PCT: For typical calculations, there is no effect on the PCT calculation for the majority of the changes discussed above. A conservative estimate of the effect of the modifications on the calculations was determined to be less than 10^{o}F, singly or in combination.

MODIFICATIONS TO THE WREFLOOD COMPUTER CODE

Modification: The modifications made to the WREFLOOD computer code, described for the Westinghouse 1981 ECCS Evaluation Model were carried into the WREFLOOD computer code used for BASH analyses.

Effect OF Modification On PCT: In the BASH methodology, the WREFLOOD code is only used to calculate the bottom of core recovery time. Therefore this modification has no effect on the BASH ECCS Evaluation Model calculations.

MODIFICATIONS TO THE LOCBART COMPUTER CODE

No modifications have been made since those outlined in Reference 7.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

MODIFICATIONS TO THE TWO-LOOP UPI BEST ESTIMATE ECCS EVALUATION MODEL

Westinghouse developed a best-estimate LOCA analysis methodology specifically for plants with Upper Plenum Injection (reference 8). This methodology was responsive to the NRC's proposed best-estimate method for performing LOCA analysis (SECY-83-472) utilizing realistic models to calculate the plant response to a LOCA at the most realistic or most probable level (50% probability) and at a more conservative 95% probability level. The calculation at the 95% probability level includes uncertainties code and plant specific uncertainties such as power level, fuel initial temperature, nuclear parameters, and computer code uncertainties. A separate calculation is then performed using a plant-specific realistic best-estimate model including the required Appendix K features, such as 1971 ANS decay heat + 20% maximum stored energy, no rewet during blowdown, etc. This would be the new Appendix K calculation. The best-estimate methodology is based on the WCOBRA/TRAC computer code. The following modifications have been made to the best estimate WCOBRA/TRAC computer code.

MODIFICATIONS TO THE WCOBRA/TRAC COMPUTER CODE

Modification: An error in the prompt K data in the ANSI/ANS 5.1-1979 decay heat model was corrected. It was also found that the same calculation used a 2-sigma value for the hot rod decay heat 95/95 uncertainty. The true 95/95 uncertainty value should be 1.645-sigma. Both findings are related to the best estimate decay heat model in the WCOBRA/TRAC computer program.

The error affected only the superbounded and nominal UPI analyses, not the Appendix K calculations, which used the ANSI/ANS 5.1-1971 decay heat model.

Effect OF Modification On PCT: Sensitivity studies were performed to determine the effect of the corrections. The total impact on the superbounded PCT calculation was found to be less than 20°F. The overall transient results between the two cases were very similar. Since there is at least 80°F margin between the superbounded (95% conservative estimate) and the Appendix K calculation, the UPI licensing basis remains valid, and the modifications have no effect on the licensing results which used the ANSI/ANS 5.1-1971 decay heat model.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

MODIFICATIONS TO THE NOTRUMP SMALL BREAK LOCA EVALUATION MODEL

The NOTRUMP small break LOCA ECCS Evaluation Model (reference 9) was developed by Westinghouse in cooperation with the Westinghouse Owners Group to address technical issues expressed in NUREG-0611, "Small Break LOCA and Feedwater Transients in W PWRs," in compliance with the requirements of NUREG-0737, "Implementation of the TMI Action Plan," Section II.K.3.30. In the NOTRUMP small break LOCA ECCS Evaluation Model, the NOTRUMP code is used to calculate the thermal-hydraulic response of the reactor coolant system during a small break LOCA and the SBLOCTA-IV computer program is used to calculated the performance of fuel rods in the hot assembly.

The following provides information regarding potentially significant modifications which have been made to the NOTRUMP small break LOCA ECCS Evaluation Model as reported in reference 1;

MODIFICATIONS TO THE NOTRUMP COMPUTER CODE

Several modifications have been made to the NOTRUMP computer (Reference 2) to correct erroneous coding or improve the coding logic to preclude erroneous calculations. The modifications indicated in A through I below have been incorporated into the production version of the code. Remaining corrections and modifications are not significant and will be incorporated during the next code update in accordance with the Westinghouse quality assurance procedures for computer code maintenance. The following modifications to the NOTRUMP small break LOCA ECCS Evaluation Model have been made;

A <u>Modification</u>: A modification was made to preclude changing the region designation (upper, lower) for a node in a stack which does not contain the mixture-vapor interface. 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 node, 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. The use of the steam cooling heat transfer regime above the mixture level is documented on page 3-1 of reference 2.

<u>Effect of Modification On PCT</u>: In rare instances, an incorrect heat transfer correlation could be selected if the region designation was improperly reflected. An analysis calculation was performed for a three-loop plant which resulted in a decrease in the PCT of 6.5°F when the corrections were made for a calculation which would be affected by the change.

B <u>Modification</u>: 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 corrected. The heat transfer rate derivatives for subcooled, saturated, and superheated natural convection conditions for the the upper region of interior fluid nodes are given by equations 6-55, 6-56, and 6-57 of reference 2. A typographical error led to the use of the lower region heat transfer area instead of the upper region heat transfer area in the calculation of derivatives. The error affected only the upper region heat transfer derivatives which are used by the code to characterize the implicit coupling of the heat rates to changes in the independent nodal variables.

<u>Effect of Modification On Peak Cladding Temperature</u>: In rare instances, the amount of heat that could be transferred to the fluid could be improperly calculated. The effect of the errors was expected to be small since the error would only affect the derivatives of the heat rates for vapor regions that are in natural convection. An analysis calculation was performed for a three-loop plant which resulted in a larger than expected increase in the PCT of 36.7^{O}F when the correction was made on a calculation which would be affected by the change.

C <u>Modification</u>: Typographical errors in equations which calculate the derivatives of the natural convection mode of heat transfer in the subroutine HEAT were corrected. A conductivity term used in the equations which calculate the derivatives of the natural convection mode of heat transfer was incorrectly typed as CK (to be used for the Thom or McBeth correlations, instead of CKNC (to be used for the desired McAdams correlation.

<u>Effect of Modification On PCT</u>: A review of the code logic was performed to assess the effect of the error. In all equations that contain the typographical error, the incorrect variable is multiplied by zero. Therefore the typographical errors have no effect on the PCT results of the calculations.

D <u>Modification</u>: A typographical error was corrected 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. An incorrect value for the mixture region internal energy in the fluid node downstream of a pump flow link would be calculated if the pump flow link were in critical flow.

<u>Effect of Modification On PCT</u>: This section of coding is not expected to be executed for small break LOCA Evaluation Model calculations since critical flow in the reactor coolant pump flow links does not occur. Therefore this modification has no effect on the calculations. This was confirmed in an analysis calculation for a three-loop plant which demonstrated no change to the PCT.

E <u>Modification</u>: A modification was made to properly call some doubly dimensioned variables in subroutines INIT and TRANSNT. Some variables are doubly dimensioned (X,Y) but were being used as if they were singly dimensioned.

<u>Effect of Modification On PCT</u>: A detailed review of the code logic indicated that all of the doubly dimensioned variables had 1 as the second dimension in any of the erroneous calls. The computer inferred a 1 for the second dimension in the improper subroutine calls. Therefore, there is no effect of this modification on the PCT.

F <u>Modification</u>: A modification was made to prevent code aborts resulting from implementation of a new FORTRAN compiler. Due to the different treatments of the precision of numbers between the FORTRAN compilers, the subtraction of two large, but close numbers resulted in exactly zero. The zero value was used in the denominator of a derivative equation, which resulted in the code aborts. This situation only occurred when the mass of a region in a node approached, but was not equal to zero.

<u>Effect of Modification On PCT</u>: An analysis calculation was performed for a four-loop plant which resulted in a larger than expected increase in the PCT of 4.8^{o}F when the modification was implemented.

G <u>Modification</u>: An error in the implementation of equation 5-33 of reference 2 was corrected. Equations 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. For the case where the flow quality is zero, equation 5-34 is similar in form to equation 5-33 since the two-phase friction multipliers are exactly unity when the flow quality is zero and the donor cell and flow link fluids are saturated, equations 5-33 and 5-34 are equivalent. However, for subcooled flow the flow link specific volume v_k in equation 5-33 is not equivalent to the saturated fluid donor cell specific volume (v_k,donor(k)) in equation 5-34.

<u>Effect of Modification On PCT</u>: 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^{o}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 10CFR50.59 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. Evaluations of the effect of this change will be examined as part of the investigation of the larger than expected sensitivity results.

H Modification: A test was added in the rod-to-steam radiation heat transfer coefficient calculation to preclude the use of the correlation when the wall-to-steam temperature differential dropped below the useful range of the correlation. This limit was derived based upon the physical limitations of the radiation phenomena.

Effect of Modification On PCT: There is no effect of the modification on reported PCTs since the erroneous use of the correlation forced the calculations into aborted conditions.

I Modification: A modification was made to correct an error in implementing equations L-28, L-52 and L-29, L-53 of reference 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 2. In each pair the lower equation number is for the subcooled condition, and the higher equation number is for the superheated condition. The denominator of each equation contains the differences between h^k and h^{k-1} where h^k is defined by equations L-21, L-45 and h^{k-1} is defined by equations L-22, L-46 of reference 2. Although the expression defining h^k and h^{k-1} were correctly calculated in NOTRUMP, they were not used in equations L-28, L-52 and L-29, L-53 as they should have been.

Effect of Modification On PCT: An analysis calculation was performed for a four-loop plant which resulted in a decrease in the PCT of 12.8°F when the modification was made for a calculation which would be affected.

Several modifications will be made to the NOTRUMP computer (Reference 2) to correct erroneous coding or printed information. The modifications indicated in J through L below will be incorporated into the production version of the code during the next maintenance upgrade to the computer code in accordance with Westinghouse quality assurance procedures. The corrections and modifications do not affect the results of small break LOCA ECCS Evaluation Model analyses.

J Modification: An error in the printed value for the break flow link specific volume in the Moody break flow model has been identified. Only the printed output value of the specific volume is incorrect.

Effect of Modification On ·PCT: The small break LOCA ECCS Evaluation Model calculations do not use the printed value of the break flow link specific volume for any purpose, therefore this error does not affect the calculational result for the PCT.

K Modification: An error in the fuel pellet to cladding contact pressure (used in the fuel rod gap conductance model) has been identified. The erroneous coding is called only when no gap between the fuel pellet and the cladding exists.

Effect of Modification On PCT: For small break LOCA ECCS Evaluation Model calculations fuel data pertaining to the time of highest fuel temperatures is used. At this time in life, a gap exists between the pellet and the cladding. Therefore this error does not affect the calculational result for the PCT.

L Modification: An error in the calculation of the saturated or subcooled boiling critical heat fluxes using the McBeth correlation has been identified. In the correlation, the effective equivalent diameter is expected to be specified in the units of inches. However, the NOTRUMP code this diameter is input by the user in the units of feet and is not converted prior to being used in the critical heat flux equation.

Effect of Modification On PCT: A review of the coding and the output from analyses using NOTRUMP indicates that this error will not affect any small break LOCA Evaluation Model analysis results. For heat link calculations, the heat flux is computed for subcooled or saturated nucleate boiling is always less than both the erroneous and correct values for the critical heat flux. In the core nodes where the critical heat flux could be exceeded, the core heat links correctly convert the equivalent diameter to the proper dimension. Therefore this error does not affect the calculational results for the PCT.

MODIFICATIONS TO THE SMALL BREAK LOCTA-IV COMPUTER CODE

The following modifications to the LOCTA-IV computer code in the small break LOCA ECCS Evaluation Model have been made;

M Modification: A test was added in the rod-to-steam radiation heat transfer coefficient calculation to preclude the use of the correlation when the wall-to-steam temperature differential dropped below the useful range of the correlation. This limit was derived based upon the physical limitations of the radiation phenomena.

Effect of Modification On PCT: There is no effect of the modification on reported PCTs since the erroneous use of the correlation forced the calculations into aborted conditions.

N Modification: An update was performed to allow the use of fuel rod performance data from the revised Westinghouse (PAD 3.3) model.

Effect of Modification On PCT: An evaluation indicated that there is an insignificant effect of the modification on reported PCTs.

O Modification: Modifications supporting a general upgrade of the computer program were implemented as follows;
1) the removal of unused or redundant coding,
2) better coding organization to increase the efficiency of calculations, and
3) improvements in user friendliness
   a) through defaulting of some input variables,
   b) simplification of input,
   c) input diagnostic checks, and
   d) clarification of the output.

Effect of Modification On PCT: Verification analyses calculations demonstrated that there was no effect on the calculated output resulting from these changes.

P Modification: Two modifications improving the consistency between the Westinghouse fuel rod performance data (PAD) and the small break LOCTA-IV fuel rod models were implemented;
1) The form of the equation for the density of Uranium-dioxide in the specific heat correlation, which modelled three dimensional expansion was corrected to account for only two-dimensional thermal expansion due to the way the fuel rod is modeled.
2) An error in the equation for the pellet/clad contact pressure was corrected. The contact resistance is never used in licensing calculations.

Effect of Modification On PCT: The Uranium-dioxide density correction is estimated to have a maximum PCT benefit of less than 2°F, while the contact resistance modification has no PCT effect since it is not used.

CONCLUSIONS

The effect of changes and errors in the Westinghouse small break LOCA ECCS Evaluation Model have been assessed in accordance with the requirements of 10CFR50.46(a)(3)(i). Appropriate modifications to the NOTRUMP and small break LOCTA-IV computer codes in the Westinghouse small break LOCA ECCS Evaluation Model could be significant, but would not result in the small break LOCA analyses becoming the limiting transient for any plants which support plant licensing with the Westinghouse large break and small break LOCA ECCS Evaluation Models.

In all cases, the effect of incorporating the modifications in those analyses which have been performed with versions of the NOTRUMP and small break LOCTA-IV computer codes which did not incorporate the modifications would not result in violation of the limits of 10CFR50.46. Consequently, no immediate actions are needed to show compliance with 10CFR50.46 requirements.

Furthermore, the effect of the modifications, as indicated to date would result in a net reduction in the peak cladding temperature for those plants analyses which would be affected by the modifications to the NOTRUMP and small break LOCTA-IV computer codes. Therefore, a schedule for reanalysis or other actions is unnecessary.

MODIFICATIONS TO THE WESTINGHOUSE ECCS EVALUATION MODELS

REFERENCES

1. 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.

2. WCAP-9220-P-A, Revision 1 (Proprietary), WCAP-9221-A, Revision 1 (Non-Proprietary), "Westinghouse ECCS Evaluation Model - 1981 Version," 1981, Eicheldinger, C.

3. NS-EPR-2952, "1981 ECCS Evaluation Model Computer Code Versions," Letter from E. P. Rahe (Westinghouse) to C. O. Thomas (NRC), Dated August 14, 1984.

4. WCAP-8480, Revision 2, M. Y. Young et.al., "Westinghouse Emergency Core Cooling System Evaluation Model Application to Plants Equipped with Upper Head Injection," January 1975.

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