VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 24, 2001

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No. 01-232
NL&OS/GDM: R0'
Docket Nos. 50-280/281
50-338/339
License Nos. DPR-32/37
NPF-4/7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY AND NORTH ANNA POWER STATIONS UNITS 1 AND 2
ANNUAL REPORT AND 30-DAY REPORT OF EMERGENCY CORE COOLING SYSTEM (ECCS) EVALUATION MODEL CHANGES PURSUANT TO THE REQUIREMENTS OF 10CFR50.46

Pursuant to 10CFR50.46(a)(3)(ii) Virginia Electric and Power Company (Dominion) is providing information concerning changes to the ECCS Evaluation Models and their application in existing licensing analyses. Information is also provided that quantifies the effect of these changes upon reported results for North Anna and Surry Power Stations, and demonstrates continued compliance with the acceptance criteria of 10CFR50.46.

Attachment 1 contains excerpted portions of Westinghouse reports describing the changes to the Westinghouse Large Break ECCS Evaluation Model that are applicable to North Anna and Surry and have been implemented during calendar year 2000.

Attachment 2 provides a report describing plant-specific evaluation model changes associated with the application of the large break LOCA evaluation model for the Surry units (i.e., a reanalysis of the large break LOCA).

Information regarding the effect of the ECCS Evaluation Model changes upon the reported LOCA analysis of record (AOR) results is provided for North Anna and Surry Power Stations in Attachments 3 and 4, respectively. To summarize the information provided in these attachments, the calculated peak cladding temperature (PCT) for the small and large break LOCA analyses for North Anna and Surry are given below. Results that represent significant changes, based on the criterion established in 10CFR50.46(a)(3)(i), are designated with an asterisk.

North Anna Unit 1 - Small break: 1688°F
North Anna Unit 1 - Large break: 2125°F

A001

North Anna Unit 2 - Small break: 1689°F
North Anna Unit 2 - Large break: 2145°F
Surry Units 1 and 2 - Small break: 1730°F
Surry Units 1 and 2 - Large break: 2117°F(*)

Based upon our evaluation of this information and the associated changes in the applicable licensing basis PCT results, no further action is required to demonstrate compliance with 10CFR50.46 requirements.

Reporting of this information is required per 10 CFR 50.46(a)(3)(ii), which obligates each licensee to report the effect upon calculated temperature of any change or error in evaluation models or their application on an annual basis. The changes in Attachment 1 associated with the annual report are not significant, as defined in 10 CFR 50.46(a)(3)(i). The changes in Attachment 2 associated with the revised analysis of record for the Surry large break LOCA are significant, as defined in 10 CFR 50.46(a)(3)(i). This letter fulfills the commitment established in our letter dated November 18, 1999 (Serial No. 99-558) to reanalyze the Surry large break LOCA.

If you have further questions or require additional information, please contact us.

Very truly yours,

Leslie N. Hartz
Vice President – Nuclear Engineering and Services

Commitments made in this letter: None.

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Mr. M. J. Morgan
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North Anna Power Station

Mr. R. A. Musser
NRC Senior Resident Inspector
Surry Power Station

Attachments:

1) Westinghouse Report of ECCS Evaluation Model Changes - North Anna Units 1 and 2 and Surry Units 1 and 2

2) Report of Changes in Application of ECCS Evaluation Model Changes - Surry Units 1 and 2

3) Effect of ECCS Evaluation Model Changes - North Anna Units 1 and 2

4) Effect of ECCS Evaluation Model Changes - Surry Units 1 and 2

ATTACHMENT 1

WESTINGHOUSE REPORT OF ECCS EVALUATION MODEL CHANGES

NORTH ANNA UNITS 1 AND 2 AND SURRY UNITS 1 AND 2

LOCBART CLADDING EMISSIVITY ERRORS

Background

Section 2-17 of Reference 1, Section 3.2.5 of Reference 2, and Section 3-2 of Reference 3 describe expressions that are used to model radiation heat exchange between the rod, grid, and fluid during the reflood phase of the transient. It was discovered that the cladding surface emissivity values used with Equation 2-93 of Reference 1, Equation 3-47 of Reference 2, and Equation 3-8 of Reference 3 were substantially lower than the values that would be expected to exist during a large break LOCA reflood transient. A review of existing documentation was inconclusive as to the exact values that were intended for use with the equations, so a constant, representative value of 0.7 was used, based on the value used in WCOBRA/TRAC for a similar application (Reference 4). These errors were determined to be a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Representative plant calculations using the LOCBART code showed that these error corrections generally result in a small-to-moderate PCT benefit for plants with burst-node-limited PCTs occurring coincident with the onset-of-entrainment in reflood and a small PCT benefit or penalty for other plants. The generic PCT assessments for this issue were derived from the representative plant calculations as the bounding values for each of the two plant/transient categories (i.e., early-PCT, burst-node-limited plants and other plants) that were defined specifically for this purpose. For a late PCT, non-burst-node-limited plant, such as North Anna, a PCT effect (penalty) of +6°F was assigned to this change for analyses which were performed with previous code versions.

References

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients," M. Y. Young, et. al., March, 1984.
2. WCAP-7437-L, "LOCTA-R2 Program: Loss of Coolant Transient Analysis," W. A. Bezella, et. al., January, 1970.
3. WCAP-10484-P-A, "Spacer Grid Heat Transfer Effects During Reflood," M. Young, et. al., March, 1991.
4. WCAP-12945-P-A, Volume 1 (Revision 2) and Volumes II-V (Revision 1), "Westinghouse Code Qualification for Best Estimate Loss of Coolant Accident Analysis," S. M. Bajorek, et. al., March, 1998.

LOCBART VAPOR FILM FLOW REGIME HEAT TRANSFER ERROR

Background

As discussed in Reference 1, the Berenson model for film boiling is used in LOCBART to compute the cladding-to-fluid heat transfer coefficient for conduction across the vapor film in the vapor film flow regime, which occurs near the quench front and is assumed to consist of a conduction component and a radiation component. An error was discovered in LOCBART whereby the multiplier on this correlation was programmed incorrectly, resulting in a relatively minor underprediction of the cladding-to-fluid heat transfer coefficient. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Representative plant calculations using the LOCBART code showed that this error correction generally results in a small-to-moderate PCT benefit for plants with burst-node-limited PCTs occurring coincident with the onset-of-entrainment in reflood and a small PCT benefit or penalty for other plants. The generic PCT assessments for this issue were derived from the representative plant calculations as the bounding values for each of the two plant/transient categories (i.e., early-PCT, burst-node-limited plants and other plants) that were defined specifically for this purpose. For a late PCT, non-burst-node-limited plant, such as North Anna, a PCT effect (penalty) of +9°F was assigned to this change for analyses which were performed with previous code versions.

Reference

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients," M. Y. Young, et. al., March, 1984.

LOCBART DISPERSED FLOW REGIME WALL EMISSIVITY ERROR

Background

As discussed in Section 2-18 of Reference 1, the Sun, Gonzalez, and Tien model is used in LOCBART to predict radiant heat exchange between the fuel rod, vapor, and droplets in the dispersed flow regime. An error was discovered in LOCBART whereby the wall emissivity in the dispersed flow regime was substantially lower than the corresponding value identified in Section 2-18 of Reference 1. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Representative plant calculations using the LOCBART code showed that this error correction generally results in a small-to-moderate PCT benefit for plants with PCTs occurring early in reflood and a small-to-moderate PCT benefit for plants with PCTs occurring late in reflood. The generic PCT assessments for this issue were derived from the representative plant calculations as the bounding values for each of the two plant/transient categories (i.e., early-reflood-PCT plants and late-reflood-PCT plants) that were defined specifically for this purpose. For a late PCT, non-burst-node-limited plant, such as North Anna, a PCT effect (benefit) of –12°F was assigned to this change for analyses which were performed with previous code versions.

Reference

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients," M. Y. Young, et. al., March, 1984.

NOTRUMP – MIXTURE LEVEL TRACKING/REGION DEPLETION ERRORS

Background

Several closely related errors have been discovered in how NOTRUMP deals with the stack mixture level transition across a node boundary in a stack of fluid nodes. Firstly, when the mixture level attempts to transition a node boundary in a stack of fluid nodes, it can occasionally have difficulty crossing the interface (i.e., level hang). When a mixture level hang occurs at a node boundary, this leads to situations where the flow for a given time step is reset and becomes inconsistent with the matrix solution of the momentum equation for an excessive period of time. This results in local mass/energy errors being generated. In addition, it was discovered that the code was not properly updating metal node temperatures as a result of the implementation of the nodal region depletion logic which can be incurred when a fluid node empties or fills. It is noted that several aspects of these errors, namely mixture level tracking and flow resets, are not directly tied to erroneous coding; rather, they are a direct result of modeling choices made and documented in the original code development/licensing. These errors affect all code versions up to and including NOTRUMP Version 37.0. These error corrections were determined to contain both Discretionary and Non-Discretionary Change aspects in accordance with Sections 4.1.1 and 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of this error leads to a bounding 13°F increase of the calculated PCT for all standard EM applications.

Reference

1. NSBU-NRC-00-5972, "NRC Report for NOTRUMP Version 38.0 Changes," (Non-Proprietary), June 30, 2000.

BASH ISOTHERM INITIALIZATION ERROR

Background

As discussed in Section 3-6 of Reference 1, the quench front progression in BART is computed using the isotherm migration method. An error was discovered in BASH whereby a variable was not being initialized for cases where a user entered the initial isotherm temperatures and elevations into the BASH input file, instead of letting the code calculate the initial isotherms internally. This error existed in BASH Version 18.0 and 19.0. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

A survey of BASH-EM analyses under Westinghouse Pittsburgh LBLOCA analysis cognizance found no usage of the erroneous option which is not accessed for standard production applications. This is also the case for the North Anna and Surry applications which are under Dominion cognizance. As a result, the correction of this error is treated as having a 0°F PCT effect for 10CFR50.46 reporting purposes.

Reference

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients," M. Y. Young, et. al., March, 1984.

BASH IMPLEMENTATION OF LOCBART CORRECTIONS

Background

Since BART coding is used in both LOCBART and BASH, the following changes described elsewhere in this report (the Westinghouse write-ups) have also been implemented into BASH for consistency:

- LOCBART Cladding Emissivity Errors
- LOCBART Vapor Film Flow Regime Heat Transfer Error
- LOCBART Dispersed Flow Regime Wall Emissivity Error

These changes were determined to be a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Representative plant calculations using the BASH code showed that these error corrections had a relatively minor effect on the core inlet flooding rate during reflood, which in turn would be expected to have a negligible effect on PCT. As a result, these corrections are being treated as having a 0°F PCT effect for 10CFR50.46 reporting purposes.

INADEQUATELY DIMENSIONED CORE REFLUX FLOW LINK ERROR IN NOTRUMP

Background

An error has been discovered in NOTRUMP which results in the termination of the NOTRUMP code when attempting to model more than 12 active core nodes. The problem results from an inadequately defined maximum number of core reflux flow links in the code externals. The nature of the error is such that code execution can not be performed when attempting to model more than 12 core nodes due to compiler options selected. This problem only exists in the NOTRUMP Version 37.0 code. This was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of this error leads to no PCT impact for all EM applications due to the core modeling assumed in these models (i.e., <= 12 nodes).

LOCBART ROD-TO-ROD RADIATION ERROR

Background

An error has been discovered in LOCBART whereby a variable was not being defined for the rod-to-rod radiation calculations. This error caused the radiation heat flux for the hot rod to be calculated incorrectly and caused the radiation heat flux for the adjacent rod to be zero. This error is present only in LOCBART Version 20.0. This was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Representative plant calculations using the LOCBART code showed that this error correction had a negligible effect on results. As a result, this correction is being treated as having a 0°F PCT effect for 10CFR50.46 reporting purposes.

LOCBART NUREG-0630 CODING ERRORS

Background

The following errors were discovered in the LOCBART code related to the programming of the NUREG-0630 (Reference 1) burst and blockage models for Zircaloy-4 cladding:

1. In Subroutine FBLOK, the assembly blockage corresponding to a burst temperature of 700°C (1292°F) and a temperature ramp rate of 25°C/s (45°F/s) was programmed as 13.6%, instead of the correct value of 13.8% from page 112 of Reference 1.
2. In Subroutine XPAND, the burst temperature corresponding to a burst strain of 48% (for a temperature ramp rate of 10°C/s or 18°F/s) or 45% (for a temperature ramp rate of 25°C/s or 45°F/s) was programmed as 1675°F, instead of the correct value of 1652°F (900°C) from pages 111 and 112 of Reference 1.

As discussed below, it was determined that correcting these errors would either have no effect on results or would be expected to result in a small PCT benefit, so LOCBART updates will be deferred to a future code release. When corrected, these corrections will represent Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

The error in Subroutine GBLOK affects the calculation of assembly blockage for Zircaloy-4 cladding over the burst temperature range of 1247-1337°F, which is substantially lower than the burst temperatures that are encountered in typical licensing calculations. For a hypothetical case with a burst temperature in the affected range, the difference in assembly blockage is very small and would be expected to have a negligible effect on results.

The error in subroutine XPAND affects the calculation of burst strain for Zircaloy-4 cladding over the burst temperature range of 1607-1697°F. It was determined that correcting the error would either have no effect on results or would result in a small reduction in burst strain, which would be expected to result in a small decrease in PCT with all other things being equal.

Based on the preceding information, these error corrections will be deferred to a future code release and are treated as having a 0°F PCT effect for 10CFR50.46 reporting purposes.

Reference

1. NUREG-0630, "Cladding Swelling and Rupture Models for LOCA Analysis," R. O. Meyer and D. A. Powers, April, 1980.

NOTRUMP CORE HEAT TRANSFER ERROR

Background

An error has been discovered in NOTRUMP which results in either a code abort or the usage of invalid steam table properties and/or heat transfer correlations in the core region under certain conditions. The problem results from the steam cooling core heat transfer correlation attempting to pass sub-cooled properties to steam property routines. Since the property routines do not perform input validity checking, this can result in erroneous properties being returned/utilized by the correlation. This error can only occur when complete subcooling of the core cladding occurs in conjunction with core uncovery. This error affects all code versions up to and including NOTRUMP Version 37.0. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of this error leads to no PCT impact for all standard EM applications due to the lack of this type of core uncovery process.

SATAN6 MOMENTUM FLUX LOGIC ERROR

Background

An error was discovered in the SATAN6 momentum flux logic whereby the sonic velocity limit was being applied incorrectly. In some instances, this caused the break flow to hang near the end of the blowdown transient, instead of allowing the calculation to proceed normally to the end of blowdown. The erroneous logic was corrected to ensure proper application of the sonic velocity limit. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Representative plant calculations using the SATAN6 code showed that this error correction had a very minor effect on blowdown results for typical cases, which in turn would be expected to have a negligible effect on PCT. Even for a case with a more substantial effect on SATAN6 results, the effect on PCT was found to be small, due mainly to the fact that the core heatup near end-of-blowdown is essentially adiabatic. As a result, this correction is being treated as having a 0°F PCT effect for 10CFR50.46 reporting purposes.

SATAN6 REACTOR COOLANT PUMP LOGIC ERROR

Background

An error was discovered in the SATAN6 reactor coolant pump logic where, during a time step in which the pump critical flow iteration failed to converge, the pump discharge mass flow rate was incorrectly reset to the value corresponding to the last iteration. This problem was resolved by removing the pump critical flow iteration from the code, since the corresponding logic was found to be of little use for standard licensing applications. This change was determined to contain both Discretionary and Non-Discretionary Change aspects in accordance with Sections 4.1.1 and 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Representative plant calculations using the SATAN6 code showed that these changes had either no effect or a negligible effect on blowdown results, which would be expected to have either no effect or a negligible effect on PCT. As a result, this correction is being treated as having a 0°F PCT effect for 10CFR50.46 reporting purposes.

LARGE BREAK LOCA SINGLE FAILURE ASSUMPTION

Background

A concern was raised by a licensee whereby a single failure in the Solid State Protection system (or Relay Protection system for older plants) could cause the loss of an entire train of safety injection pumps, without causing the loss of the corresponding train of containment heat removal equipment. This situation is contrary to section 3.6 of Reference 1, which defines the limiting single failure for Appendix K LBLOCA analysis as the loss of a low pressure injection pump. To address this concern, the analysis guidance has been modified to direct the analyst to assume the loss of an entire train of safety injection pumps, unless a less conservative single failure assumption can be justified. This was determined to represent a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Recent LBLOCA analyses have generally assumed the loss of an entire train of safety injection pumps as the limiting single failure, since the additional conservatism introduced by this simplification is typically small. A survey of BART-EM and BASH-EM analyses under Westinghouse Pittsburgh LBLOCA analysis cognizance found no domestic applications in which the analyst assumed the loss of a low pressure injection pump as the limiting single failure. This is also the case for the North Anna and Surry applications which are under Dominion cognizance. As a result, this change is being treated as having a 0°F PCT effect for 10CFR50.46 reporting purposes.

Reference

1. WCAP-8471-P-A, "The Westinghouse ECCS Evaluation Model: Supplementary Information," F. M. Bordelon et. al., April, 1975.

ATTACHMENT 2

REPORT OF CHANGES IN APPLICATION

OF ECCS EVALUATION MODEL CHANGES

SURRY UNITS 1 AND 2

Revised Large Break LOCA Analysis

Surry Units 1 and 2

1.0 Background

This report provides a summary of changes in LOCA analysis results from those last reported for Surry Units 1 and 2 (1). These changes are described in Section 2.0 below. It has been concluded that these changes are significant, as defined in 10 CFR 50.46(a)(3)(i).

2.0 Evaluation Model Changes

2.1 Revised Large Break LOCA Analysis

Since our previous 10CFR50.46 report (1), a revised analysis of the large break LOCA transient has been performed for Surry Units 1 and 2. This revised analysis has been implemented as the analysis of record via a station 10CFR50.59 evaluation (2), consistent with the provisions of Surry Technical Specification 6.9.1.7 (relating to the Core Operating Limits Report). This discussion summarizes the changes incorporated in this analysis in addition to changes in other key analysis inputs.

The key analysis inputs are listed below and discussed further in the following paragraphs as necessary.

- 1981 Evaluation Mode with BASH
- Improved BASH Evaluation Model codestream
- Incorporation of skewed axial power distribution evaluation methodology
- Uprated Core Power of 2546 MWt
- Assumption of 15% uniform steam generator tube plugging (current limit)
- Peak Heat Flux Hot Channel Factor, F(Q), of 2.32 (changed from 2.20)
- Peak Enthalpy Hot Channel Factor, $F\Delta h$ of 1.62 (current limit)
- Hot Assembly Relative Power Factor of 1.465 (current limit)
- Safety Injection, 1 HHSI + 1 LHSI, spilling to 0 psig containment pressure
- Safety Injection Accumulator Water Temperature of 105°F.
- Safety Injection Accumulator Water Volume of 1000 ft^3 per Accumulator
- Improved Spacer Grid Heat Transfer Model
- Surry Improved Fuel (SIF) with ZIRLO™ cladding and PERFORMANCE+ design features

This analysis was performed using the Westinghouse 1981 large break LOCA evaluation model with BASH (3). Technical Specification 6.9.1.7 lists this as an

acceptable reference methodology for determination of relevant power distribution limits in the Core Operating Limits Report.

An improvement to the BASH Evaluation Model codestream is described in Reference (4). The improved codestream provides for an interactive calculation between the BASH and COCO codes. The containment pressure methodology during the blowdown phase of the transient has not been changed. The refill transient portion of the WREFLOOD code, which calculates RCS behavior during vessel lower plenum refill following the end of blowdown, has been reprogrammed as a separate, but identical code (REFILL), which also runs interactively with the COCO code.

A further improvement in the BASH Evaluation Model codestream is described in Reference (5). With the improved codestream, the REFILL and LOCTA codes have been incorporated directly into the BASH code as subroutine modules. This eliminates all external transfer of data between these codes. In conjunction with this merging of codes, efforts were made to minimize any remaining code-to-code data transfer and to streamline and optimize some internal operations in the coding. The newly combined codes are configured as a single code which is identified as a new version of BASH.

With the improvements to the BASH codestream in References (4) and (5), no changes have been made to any of the approved physical models or basic techniques which form the basis of the methodology. However, these revisions to the BASH codestream can produce small changes to the results calculated by the improved codestream.

Large Break LOCA analyses have been traditionally performed using a symmetric, chopped cosine, core axial power distribution. In Reference (6), Westinghouse informed the NRC of the withdrawal of the Westinghouse Power Shape Sensitivity Model (PSSM) topical (Reference 7) effective October 30, 1995. This power shape methodology had been employed to support Reload Safety Evaluations (RSEs). Westinghouse further indicated that future large break LOCA analysis with the 1981 model with BASH would incorporate the explicit analysis approach to skewed power shapes as described in Reference (8). The analysis described herein employs the Reference (8) explicit analysis methodology.

The analysis assumed a peak Heat Flux Hot Channel Factor, FQ(z), value of 2.32 and a peak Nuclear Enthalpy Hot Channel Factor, $F\Delta h$, value of 1.62. As required by Technical Specification 6.9.1.7, the Core Operating Limits Report (COLR) documents the applicable limit values of key core-related parameters for each reload core. These values bound the limits in the current cycle specific COLR's. For future reload cycles, the COLR will specify the appropriate limits which account for all design considerations, particularly large and small break LOCA effects.

The analysis assumes a full core of Surry Improved Fuel (SIF) with ZIRLO™ cladding and PERFORMANCE+ design features.

Employing these assumptions in the current version of the 1981 ECCS Evaluation Model with BASH, it has been demonstrated that operation at an assumed core thermal power of 2546 MWt with steam generator tube plugging (SGTP) up to 15% in any SG

will comply with all of the acceptance criteria specified in 10 CFR 50.46. Attachment 4 provides the PCT result for the revised analysis of record, in conjunction with appropriate margin assessments which address BASH evaluation model issues.

The revised analysis of record PCT is 2117°F for the limiting axial power shape (chopped-cosine). Although the revised analysis of record licensing basis PCT is not more than 50°F different from the existing licensing basis PCT, implementation of this analysis represents a significant change, as defined in 10CFR50.46(a)(3)(i). The resulting licensing basis PCT demonstrates that operation at the rated thermal power of 2546 MWt will comply with all of the acceptance criteria specified in 10CFR50.46. Attachment 4 provides the PCT result for the revised analysis of record, in conjunction with appropriate margin assessments which address BASH evaluation model issues.

3.0 References

(1) Letter from L. N. Hartz (Va. Electric & Power Co.) to USNRC, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1 and 2, Report of Emergency Core Cooling System (ECCS) Evaluation Model Changes Pursuant to the Requirements of 10CFR50.46" Serial No. 00-271, June 2, 2000.

(2) Surry Power Station 10CFR50.59 Safety Evaluation #01-021, "Surry Power Station Units 1 and 2 - Safety Evaluation for Revised Large Break Loss of Coolant Analysis (LBLOCA)," April 5, 2001.

(3) WCAP-10266-P-A, Rev. 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model using the BASH Code," March 1987.

(4) Letter from N. J. Liparulo (Westinghouse) to USNRC, "Change in Methodology for Execution of BASH Evaluation Model," NTD-NRC-94-4143, May 23, 1994.

(5) Letter from N. J. Liparulo (Westinghouse) to USNRC, "Change in Methodology for Execution of BASH Evaluation Model," NTD-NRC-95-4540, August 29, 1995.

(6) Letter from N. J. Liparulo (Westinghouse) to USNRC, "Withdrawal of WCAP-12909-P on Power Shape Sensitivity Model (PSSM)," NTD-NRC-95-4518, August 7, 1995.

(7) WCAP-12909-P, "Westinghouse ECCS Evaluation Model: Revised Large Break LOCA Power Distribution Methodology," June 1991.

(8) WCAP-10266-P-A, Addendum 1, Revision 2-P-A, "The 1981 Version of Westinghouse ECCS Evaluation Model Using the BASH Code, Addendum 1; Power Shape Sensitivity Studies," March, 1987.

ATTACHMENT 3

EFFECT OF ECCS EVALUATION MODEL CHANGES

NORTH ANNA UNITS 1 AND 2

Effect of ECCS Evaluation Model Changes - North Anna Unit 1

The information provided herein is applicable to North Anna Power Station, Unit 1. It is based upon reports from Westinghouse Electric Corporation for issues involving the ECCS evaluation models and plant-specific application of the models in the existing analyses. Peak cladding temperature (PCT) values and margin allocations represent issues for which permanent resolutions have been implemented. The assessments for small break and large break LOCA are presented in Sections A and B, respectively.

Section A - Small Break LOCA Margin Utilization - North Anna Unit 1

A. PCT for Analysis of Record (AOR)	1704°F	(1)
B. Prior PCT Assessments Allocated to AOR	**-29°F**	
1. NOTRUMP Specific Enthalpy Error	+20°F	(2)
2. SALIBRARY Double Precision Errors	-15°F	(2)
3. Fuel Rod Initialization Error	+10°F	(3)
4. Loop Seal Elevation Error	-44°F	(3)
SBLOCA Augmented PCT for AOR	1675°F	
C. PCT Assessments for 10CFR50.46(a)(3)(i) Accumulation {1}	**13°F**	
1. NOTRUMP – Mixture Level Tracking Errors {2} {3}	+13°F	
SBLOCA Licensing Basis PCT (AOR PCT + PCT Assessments)	1688°F	

Section B - Large Break LOCA Margin Utilization - North Anna Unit 1

A. PCT for Analysis of Record (AOR)	2013°F	(1)
B. Prior PCT Assessments Allocated to AOR	**109°F**	
1. LBLOCA/Seismic SG Tube Collapse	+30°F	(1)
2. BASH Accumulator Empty Flag	+10°F	(1)
3. Translation of Fluid Conditions from SATAN to LOCTA	+15°F	(4)
4. LOCBART Spacer Grid Single-Phase Heat Transfer	+15°F	(6)
5. LOCBART Zirc-Water Oxidation Error	+39°F	(6)
LBLOCA Augmented PCT for AOR	2122°F	
C. PCT Assessments for 10CFR50.46(a)(3)(i) Accumulation {1}	**27°F**	
1. LOCBART Cladding Emissivity Errors {2} {3}	+6°F	
2. LOCBART Vapor Film Flow Regime Heat Transfer Error {2} {3}	+9°F	
3. LOCBART Dispersed Flow Regime Wall Emissivity Error {2} {3}	-12°F	
LBLOCA Licensing Basis PCT (AOR PCT + PCT Assessments)	2125°F	

Notes { } and References ( ) are provided below.

Effect of ECCS Evaluation Model Changes - North Anna Unit 2

The information provided herein is applicable to North Anna Power Station, Unit 2. It is based upon reports from Westinghouse Electric Corporation for issues involving the ECCS evaluation models and plant-specific application of the models in the existing analyses. Peak cladding temperature (PCT) values and margin allocations represent issues for which permanent resolutions have been implemented. The assessments for small break and large break LOCA are presented in Sections A and B, respectively.

Section A - Small Break LOCA Margin Utilization - North Anna Unit 2

A. PCT for Analysis of Record (AOR)	1704°F	(1)
B. Prior PCT Assessments Allocated to AOR	**-29°F**	
1. NOTRUMP Specific Enthalpy Error	+20°F	(2)
2. SALIBRARY Double Precision Errors	-15°F	(2)
3. Fuel Rod Initialization Error	+10°F	(3)
4. Loop Seal Elevation Error	-44°F	(3)
SBLOCA Augmented PCT for AOR	1675°F	
C. PCT Assessments for 10CFR50.46(a)(3)(i) Accumulation {1}	**14°F**	
1. Removal of Part-Length CRDMs	+1°F	(5)
2. NOTRUMP – Mixture Level Tracking Errors {2} {3}	+13°F	
SBLOCA Licensing Basis PCT (AOR PCT + PCT Assessments)	1689°F	

Section B - Large Break LOCA Margin Utilization - North Anna Unit 2

A. PCT for Analysis of Record (AOR)	2013°F	(1)
B. Prior PCT Assessments Allocated to AOR	**129°F**	
1. LBLOCA/Seismic SG Tube Collapse	+30°F	(1)
2. BASH Accumulator Empty Flag	+10°F	(1)
3. Translation of Fluid Conditions from SATAN to LOCTA	+15°F	(4)
4. Removal of Part-Length CRDMs	+18°F	(5)
5. LOCBART Spacer Grid Single-Phase Heat Transfer	+15°F	(6)
6. LOCBART Zirc-Water Oxidation Error	+41°F	(6)
LBLOCA Augmented PCT for AOR	2142°F	
C. PCT Assessments for 10CFR50.46(a)(3)(i) Accumulation {1}	**27°F**	
1. LOCBART Cladding Emissivity Errors {2} {3}	+6°F	
2. LOCBART Vapor Film Flow Regime Heat Transfer Error {2} {3}	+9°F	
3. LOCBART Dispersed Flow Regime Wall Emissivity Error {2} {3}	-12°F	
LBLOCA Licensing Basis PCT (AOR PCT + PCT Assessments)	2145°F	

Notes { } and References ( ) are provided below.

Effect of ECCS Evaluation Model Changes - North Anna

Notes:

{1} The accumulation of changes (sum of absolute magnitudes) is less than 50°F and is not significant, as defined in 10CFR50.46(a)(3)(i).

{2} The current report is the initial quantification of effects for this issue.

{3} Refer to the Westinghouse Report of ECCS Evaluation Model Changes provided in Attachment 1.

References:

(1) Letter from J. P. O'Hanlon (VEPCO) to Document Control Desk (USNRC), "Virginia Electric and Power Company, North Anna Power Station Units 1 and 2, 30-Day Report of ECCS Evaluation Model Changes Per Requirements of 10CFR50.46," Serial No. 95-608, November 29, 1995.

(2) Letter from J. P. O'Hanlon (Va. Electric & Power Co.) to USNRC, "Virginia Electric and Power Company, North Anna and Surry Power Station Units 1 and 2, Report of ECCS Evaluation Model Changes and 30-Day Report of ECCS Evaluation Model Changes Per Requirements of 10CFR50.46," Serial No. 96-111, March 14, 1996.

(3) Letter from J. P. O'Hanlon (Va. Electric & Power Co.) to USNRC, "Virginia Electric and Power Company, North Anna Power and Surry Power Station Units 1 and 2, Report of ECCS Evaluation Model Changes and 30-Day Report of ECCS Evaluation Model Changes Per Requirements of 10CFR50.46," Serial No. 96-390, August 1, 1996.

(4) Letter from J. P. O'Hanlon (Va. Electric & Power Co.) to USNRC, "Virginia Electric and Power Company, Surry and North Anna Power Stations Units 1 and 2, Report of Emergency Core Cooling System (ECCS) Evaluation Changes Pursuant to the Requirements of 10CFR50.46," Serial No. 97-174, March 27, 1997.

(5) Letter from J. P. O'Hanlon (Va. Electric & Power Co.) to USNRC, "Virginia Electric and Power Company, Surry and North Anna Power Stations Units 1 and 2, Report of Emergency Core Cooling System (ECCS) Evaluation Changes Pursuant to the Requirements of 10CFR50.46," Serial No. 98-303, May 28, 1998.

(6) Letter from L. N. Hartz (Va. Electric & Power Co.) to USNRC, "Virginia Electric and Power Company, Surry and North Anna Power Station Units 1 and 2, 30-Day Report – Emergency Core Cooling System (ECCS) Evaluation Model Changes Pursuant to the Requirements of 10CFR50.46," Serial No. 99-558, November 18, 1999.

ATTACHMENT 4

EFFECT OF ECCS EVALUATION MODEL CHANGES

SURRY UNITS 1 AND 2

Effect of Westinghouse ECCS Evaluation Model Changes - Surry

The information provided herein is applicable to Surry Power Station, Units 1 and 2. It is based upon reports from Westinghouse Electric Corporation for issues involving the ECCS evaluation models and plant-specific application of the models in the existing analyses. Peak cladding temperature (PCT) values and margin allocations represent issues for which permanent resolutions have been implemented. The assessments for small break and large break LOCA are presented in Sections A and B, respectively.

Section A - Small Break LOCA Margin Utilization - Surry Units 1 and 2

A. PCT for Analysis of Record (AOR)	1717°F	(1)
B. Prior PCT Assessments Allocated to AOR	**0°F**	
SBLOCA Augmented PCT for AOR	1717°F	
C. PCT Assessments for 10CFR50.46(a)(3)(i) Accumulation {1}	**13°F**	
1. NOTRUMP – Mixture Level Tracking Errors {2} {3}	+13°F	
SBLOCA Licensing Basis PCT (AOR PCT + PCT Assessments)	1730°F	

Section B - Large Break LOCA Margin Utilization - Surry Units 1 and 2

A. PCT for Analysis of Record (AOR)	2117°F	(2)
B. Prior PCT Assessments Allocated to AOR	**0°F**	
1. LBLOCA/Seismic SG Tube Collapse {2} {3} {4}	0°F	
LBLOCA Augmented PCT for AOR	2117°F	
C. PCT Assessments for 10CFR50.46(a)(3)(i) Accumulation {5}	**0°F**	
LBLOCA Licensing Basis PCT (AOR PCT + PCT Assessments)	2117°F	

Notes { } and References ( ) are provided on the following page.

Effect of Westinghouse ECCS Evaluation Model Changes - Surry

Notes:

{1} The accumulation of changes (sum of absolute magnitudes) is less than 50°F and is not significant, as defined in 10CFR50.46(a)(3)(i).

{2} The current report is the initial quantification of effects for this issue.

{3} Refer to the Westinghouse Report of ECCS Evaluation Model Changes provided in Attachment 1.

{4} A generic steam generator LOCA/seismic load evaluation was performed by Westinghouse to quantify the potential steam generator tube collapse which may occur at the time of a LOCA due to combined LOCA and seismic loads. Based on this analysis, a steam generator tube reduction of 5% was allocated as a permanent assessment (References 2 and 3) for Surry which does not have a detailed analysis.

{5} Although the revised analysis of record licensing basis PCT is not more than 50°F different from the existing licensing basis PCT, implementation of this analysis represents a significant change, as defined in 10CFR50.46(a)(3)(i).

References:

(1) Letter from J. P. O'Hanlon (Va. Electric & Power Co.) to USNRC, "Virginia Electric and Power Company, Surry Power Station Units 1 and 2, 30-Day Report of ECCS Evaluation Changes Pursuant to the Requirements of 10CFR50.46," Serial No. 96-635, January 9, 1997.

(2) Surry Power Station 10CFR50.59 Safety Evaluation #01-021, "Surry Power Station Units 1 and 2 – Safety Evaluation for Revised Analysis of Large Break Loss of Coolant Accident (LBLOCA)," April 5, 2001.

(3) Letter from W. L. Stewart (VEPCO) to Document Control Desk (USNRC), "Virginia Electric and Power Company, Surry Power Station Units 1 and 2, North Anna Power Station Units 1 and 2, Report of ECCS Evaluation Model Changes Per Requirements of 10 CFR50.46," Serial No. 91-428, August 23, 1991.