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March 26, 2004

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
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ULNRC-04968

Ladies and Gentlemen:



**DOCKET NUMBER 50-483
CALLAWAY PLANT
UNION ELECTRIC COMPANY
10 CFR 50.46 ANNUAL REPORT
ECCS EVALUATION MODEL REVISIONS**

Attachment 1 to this letter describes changes to the Westinghouse ECCS Large Break and Small Break Loss of Coolant Accident (LOCA) Evaluation Models which have been implemented for Callaway during the time period from March 2003 to March 2004. Attachment 2 provides an ECCS Evaluation Model Margin Assessment which accounts for all peak cladding temperature (PCT) changes resulting from the resolution of prior issues as they apply to Callaway. There are no PCT changes since the last 10 CFR 50.46 report. References 1-18, listed below, include prior 10 CFR 50.46 reports.

The Large Break LOCA and Small Break LOCA tables included in Attachment 2 remain unchanged from those submitted in Reference 18 and are enclosed here for completeness only.

The PCT values determined in the Large Break and Small Break LOCA analyses of record, when combined with all PCT margin allocations, remain below the 2200°F regulatory limit. As such, no reanalysis is currently planned by AmerenUE.

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Should you have any questions regarding this letter, please contact us.

Sincerely,



Keith D. Young
Manager-Regulatory Affairs

DS/GGY/jdg

Attachments

- References:
- 1) ULNRC-2141 dated 1-19-90
 - 2) ULNRC-2373 dated 2-28-91
 - 3) ULNRC-2439 dated 7-19-91
 - 4) ULNRC-2664 dated 7-16-92
 - 5) ULNRC-2822 dated 7-15-93
 - 6) ULNRC-2892 dated 10-22-93
 - 7) ULNRC-3087 dated 10-19-94
 - 8) ULNRC-3101 dated 11-23-94
 - 9) ULNRC-3295 dated 11-22-95
 - 10) ULNRC-3499 dated 11-27-96
 - 11) ULNRC-3552 dated 3-21-97
 - 12) ULNRC-3761 dated 3-6-98
 - 13) ULNRC-3975 dated 3-5-99
 - 14) ULNRC-4146 dated 11-4-99
 - 15) ULNRC-4338 dated 11-2-00
 - 16) ULNRC-4551 dated 11-2-01
 - 17) ULNRC-4751 dated 10-14-02
 - 18) ULNRC-4834 dated 4-8-03

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ATTACHMENT ONE

CHANGES TO THE WESTINGHOUSE

ECCS EVALUATION MODEL

AND PCT PENALTY ASSESSMENTS

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1. NOTRUMP Bubble Rise / Drift Flux Model Inconsistencies

NOTRUMP was updated to resolve some inconsistencies in several drift flux models as well as the nodal bubble rise / droplet fall models. Bubble rise and droplet fall model calculations were made consistent with flow link calculations. Corrections were made to limits employed in the vertical counter-current flooding models. Checking logic was added to correct situations where drift flux model inconsistencies could result (i.e., prevent liquid flow from an all-vapor node and vapor flow from an all-liquid node). Also, a more rigorous version of the Yeh Drift Flux Model was implemented since the previous version of this model was incorrectly restricted to a 50% void fraction limit. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Plant-specific calculations using the NOTRUMP code demonstrate that the implementation of these corrections leads to a conservative estimate of 0°F PCT impact on small break LOCA for 10 CFR 50.46 purposes.

2. BART Quench Model Calculations

BART is used to perform the core reflood heat transfer calculations in BASH and LOCBART. The BART portions of BASH and LOCBART were updated to resolve some minor logic problems that led to anomalous behavior in the quench model. These changes represent Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Sample BASH and LOCBART calculations demonstrated that these changes have either no effect or a negligible effect on the core inlet flooding rate and PCT and will be assigned a 0°F PCT impact on large break LOCA for 10 CFR 50.46 reporting purposes.

3. BASHER Calculation of BASH Metal Heat Inputs

BASHER is used to generate the plant-specific input models for BASH. Some minor errors were discovered in the calculation of geometric terms used with the BASH metal heat model. As discussed below, it was determined that correcting these errors would have a negligible effect on results, so BASHER updates will be deferred to a future code release. When corrected, these changes will represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

The changes described above are small and are considered to have a negligible effect on BASH results. These changes will be deferred to a future code release and are assigned a 0°F PCT impact on large break LOCA for 10 CFR 50.46 reporting purposes.

4. Inconsistencies in Vessel Geometric Input Data

Several inconsistencies were identified in the specification of vessel geometric data for plant-specific input models. These changes were evaluated for impacts on current licensing-basis analyses, and will be incorporated into the corresponding input databases on a forward-fit basis. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

A combination of sensitivity calculations and engineering evaluation led to the conclusion that the identified changes have a negligible effect on large and small break LOCA analysis results. These changes will therefore be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

5. LOCBART Fuel Rod Plenum Modeling

A LOCBART calculation performed under non-standard conditions predicted burst to occur in the fuel rod plenum node. This situation does not occur for standard PWR licensing calculations, and is now precluded for all calculations by bypassing the burst calculations for the fuel rod plenum node. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

This situation does not occur for standard PWR licensing calculations and is assigned a 0°F PCT impact on large break LOCA for 10 CFR 50.46 reporting purposes.

6. LOCBART Grid Mass Balance

In the LOCBART spacer grid heat transfer model, a mass balance is applied to ensure that the available liquid can support the predicted wetting. Three discrepancies related to the grid mass balance in LOCBART were discovered and corrected, with a tendency for improved grid wetting in some instances. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Sample LOCBART calculations demonstrated that these changes have a negligible effect on PCT that will be assigned a 0°F PCT impact on large break LOCA for 10 CFR 50.46 reporting purposes.

7. NOTRUMP Drift Flux Model Inconsistencies

NOTRUMP was updated to resolve some inconsistencies in the resetting of certain parameters in the drift flux models when single phase conditions are determined to exist. The previous coding had inadvertently omitted certain conditions on drift velocity and void fraction which are now included. Also, in the node boundary mixture level crossing logic, several partial derivatives for liquid and vapor volumetric fluxes with respect to mass flux in the void fraction model were erroneously set to zero. The correct partial derivative calculations were added to the code. In addition, several

instances (stacking logic, accumulator empty logic and pump critical flow logic) where flow link specific volumes were incorrectly always based on saturated conditions were corrected. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

The subject changes involve logic that is seldom used in standard Evaluation Model calculations. As such, the estimated effect on small break LOCA PCT calculations is 0°F for 10 CFR 50.46 reporting purposes.

8. NOTRUMP Inverted T-Node Sign Convention

This change deals with the correction of the sign convention for inverted T-nodes, which was incorrectly applied via input into the Evaluation Model. It can potentially impact the reactor vessel lower plenum node and the lower reactor coolant pump node in the standard Evaluation Model. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

This error affected the mixture/vapor interfacial area within a fluid node. Because these conditions only exist momentarily within the pump stack node and never in the reactor vessel lower plenum, it is judged that the impact of this error correction is insignificant. Based on this judgment, coupled with the fact that plant model calculations show this to be the case, the correction of this error will be assigned a 0°F PCT impact on small break LOCA for 10 CFR 50.46 reporting purposes.

9. NOTRUMP Vapor Region Formation Logic

The logic governing formation of a vapor region within a fluid node in NOTRUMP was corrected to allow superheated conditions where appropriate, instead of saturated conditions which may not exist at that instant. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Typically, region formation conditions in standard Evaluation Model calculations occur at saturation. If a region is formed at superheat conditions, the amount of superheat is usually small and the region quickly reaches saturated conditions. As such, the nature of these changes leads to an estimated small break LOCA PCT impact of 0°F.

10. SBLOCTA Burst Logic

The burst logic in SBLOCTA was updated to preclude burst from occurring at more than one axial elevation on a given rod. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Most SBLOCTA calculations predict burst at no more than one axial elevation per rod and are therefore unaffected by this discrepancy. For the affected cases, SBLOCTA calculations and/or engineering evaluation led to the conclusion that resolving the

discrepancy would not produce an increase in the limiting PCT. This change is therefore assigned a 0°F PCT impact on small break LOCA for 10 CFR 50.46 reporting purposes.

11. SBLOCTA ZIRLO™ Cladding Creep Constants

SBLOCTA was updated to correct two of the constants in the high-temperature creep model for ZIRLO™ cladding, which were found to disagree with the basis documentation. These changes represent a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

The changes identified above lead to a small change in the creep rate over a limited range of temperatures, which is considered to have a negligible effect on results and will be assigned a 0°F PCT impact on small break LOCA for 10 CFR 50.46 reporting purposes.

12. SATIMP/SPADES Updates

SATIMP and SPADES are used to generate the plant-specific input models for SATAN-VI and NOTRUMP, respectively. Some minor improvements were made to SATIMP and SPADES, primarily to provide more rigorous calculations of certain SATAN-VI and NOTRUMP inputs. An example of these changes is to replace linear interpolation with parabolic interpolation in the SATIMP calculation of the reactor coolant pump head at steady-state operating conditions. These changes represent Discretionary Changes that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

The nature of these changes leads to an estimated PCT effect of 0°F for both large and small break LOCA.

13. SBLOCTA Oxide-to-Metal Ratio

An option has been added to SBLOCTA to allow conversion of the user-specified zirconium-oxide thickness into equivalent cladding reacted. This adjustment is made during problem initialization, and the cladding outside diameter is modified accordingly. This change represents a Discretionary Change that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

A sample SBLOCTA calculation showed that this change has a minimal effect on PCT. This change will be implemented on a forward-fit basis and will be assigned a 0°F PCT impact on small break LOCA for 10 CFR 50.46 reporting purposes.

14. SBLOCTA Gap Conductance Model

The convective term in the SBLOCTA pellet-to-cladding gap conductance model was updated for consistency with the corresponding model in LOCBART. Included in this change is the implementation of a PAD-version-specific value of the gap reduction factor, which is specified by the user in the SBLOCTA input file. This change represents a Discretionary Change that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Sample SBLOCTA calculations showed that this change has a negligible effect on PCT. This change will be implemented on a forward-fit basis and will be assigned a 0°F PCT impact on small break LOCA for 10 CFR 50.46 reporting purposes.

15. General Code Maintenance (Appendix K)

Various changes in code input and output format have been made to enhance usability and help preclude errors in analyses. This includes both input changes (e.g., more relevant input variables defined and more common input values used as defaults) and input diagnostics designed to preclude unreasonable values from being used, as well as various changes to code output which have no effect on calculated results. In addition, various blocks of coding were rewritten to eliminate inactive coding, optimize the active coding, and improve commenting, both for enhanced usability and to facilitate code debugging when necessary. These changes represent Discretionary Changes that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

The nature of these changes leads to an estimated PCT impact of 0°F on large break and small break LOCA.

ATTACHMENT TWO

ECCS EVALUATION MODEL

MARGIN ASSESSMENT FOR CALLAWAY

LARGE BREAK LOCA

A.	ANALYSIS OF RECORD (AOR)	PCT = 2014°F
B.	1989 LOCA MODEL ASSESSMENTS (refer to ULNRC-2141 dated 1-19-90)	+ 10°F
C.	1990 LOCA MODEL ASSESSMENTS (refer to ULNRC-2373 dated 2-28-91)	+ 0°F
D.	1991 LOCA MODEL ASSESSMENTS (refer to ULNRC-2439 dated 7-19-91)	+ 10°F
E.	1992 LOCA MODEL ASSESSMENTS, MARGIN ALLOCATIONS, AND SAFETY EVALUATIONS (refer to ULNRC-2664 dated 7-16-92 and ULNRC-2892 dated 10-22-93)	+ 29°F
F.	1993 LOCA MODEL ASSESSMENTS (refer to ULNRC-2822 dated 7-15-93 and ULNRC-2892 dated 10-22-93)	- 65°F
G.	1994 LOCA MODEL ASSESSMENTS (refer to ULNRC-3087 dated 10-19-94 and ULNRC-3101 dated 11-23-94)	- 6°F
H.	1995 LOCA MODEL ASSESSMENTS (refer to ULNRC-3295 dated 11-22-95)	+ 39°F
I.	1996 LOCA MODEL ASSESSMENTS (refer to ULNRC-3499 dated 11-27-96)	+ 0°F
J.	1997 LOCA MODEL ASSESSMENTS (refer to ULNRC-3552 dated 3-21-97)	+ 15°F
K.	1998 LOCA MODEL ASSESSMENTS (refer to ULNRC-3761 dated 3-6-98)	+ 0°F
L.	1999 SAFETY EVALUATIONS (refer to ULNRC-3975 dated 3-5-99)	+ 30°F ⁵

LARGE BREAK LOCA (cont.)

M.	1999 LOCA MODEL ASSESSMENTS, MARGIN ALLOCATIONS, AND SAFETY EVALUATIONS	
1.	LOCBART ZIRC-WATER OXIDATION ERROR (This PCT assessment is tracked separately since it will change depending on future margin allocations.)	+197°F
2.	NET CHANGE OF OTHER ALLOCATIONS (refer to ULNRC-4146 dated 11-4-99)	-139°F ⁸
N.	2000 LOCA MODEL ASSESSMENTS AND MARGIN ALLOCATIONS (refer to ULNRC-4338 dated 11-2-00)	- 14°F
O.	2001 LOCA MODEL ASSESSMENTS (refer to ULNRC-4551 dated 11-2-01)	- 10°F
P.	2002 LOCA MODEL ASSESSMENTS (refer to ULNRC-4751 dated 10-14-02)	+ 0°F
Q.	2003 LOCA MODEL ASSESSMENTS (refer to ULNRC-4834 dated 4-8-03)	+ 0°F
R.	CURRENT LOCA MODEL ASSESSMENTS - March 2004	+ 0°F
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	LICENSING BASIS PCT + MARGIN ALLOCATIONS	2110°F
	ABSOLUTE MAGNITUDE OF MARGIN ALLOCATIONS SINCE LAST LBLOCA 30-DAY REPORT (ULNRC-04834)	0°F

SMALL BREAK LOCA

A.	ANALYSIS OF RECORD (AOR)	PCT = 1528°F
B.	1989 LOCA MODEL ASSESSMENTS (refer to ULNRC -2141 dated 1-19-90)	+229°F
C.	1990 LOCA MODEL ASSESSMENTS (refer to ULNRC-2373 dated 2-28-91)	+ 0°F
D.	1991 LOCA MODEL ASSESSMENTS (refer to ULNRC-2439 dated 7-19-91)	+ 0°F ¹
E.	1992 LOCA MODEL ASSESSMENTS AND SAFETY EVALUATIONS (refer to ULNRC-2664 dated 7-16-92)	+ 0°F
F.	1993 LOCA MODEL ASSESSMENTS (refer to ULNRC-2892 dated 10-22-93)	- 13°F ²
G.	1993 SAFETY EVALUATIONS (refer to ULNRC-2822 dated 7-15-93)	+ 0°F ³
H.	BURST AND BLOCKAGE/TIME IN LIFE (This PCT assessment is tracked separately since it will change depending on future margin allocations.)	+ 0°F ¹
I.	1994 LOCA MODEL ASSESSMENTS (refer to ULNRC-3087 dated 10-19-94 and ULNRC-3101 dated 11-23-94)	-282°F ⁴
J.	1995 LOCA MODEL ASSESSMENTS (refer to ULNRC-3295 dated 11-22-95)	+ 0°F

SMALL BREAK LOCA (cont.)

K.	1996 LOCA MODEL ASSESSMENTS - (refer to ULNRC-3499 dated 11-27-96)	+30°F ⁶
L.	1997 LOCA MODEL ASSESSMENTS - (refer to ULNRC-3552 dated 3-21-97)	+ 0°F
M.	1998 LOCA MODEL ASSESSMENTS - (refer to ULNRC-3761 dated 3-6-98)	+ 0°F
N.	1999 SAFETY EVALUATIONS* (refer to ULNRC-3975 dated 3-5-99)	+120°F ⁷ + 22°F ⁶ + 40°F ⁵
O.	1999 LOCA MODEL ASSESSMENTS (refer to ULNRC-4146 dated 11-4-99)	+ 0°F
P.	2000 LOCA MODEL ASSESSMENTS - (refer to ULNRC-4338 dated 11-2-00)	+ 13°F
Q.	2001 LOCA MODEL ASSESSMENTS - (refer to ULNRC-4551 dated 11-2-01)	+ 0°F
R.	2002 LOCA MODEL ASSESSMENTS - (refer to ULNRC-4751 dated 10-14-02)	+ 0°F
S.	2003 LOCA MODEL ASSESSMENTS - (refer to ULNRC-4834 dated 4-8-03)	+ 0°F
T.	CURRENT LOCA MODEL ASSESSMENTS - March 2004	
	1. NOTRUMP Bubble Rise / Drift Flux Model Inconsistencies	+ 0°F

LICENSING BASIS PCT + MARGIN ALLOCATIONS	1687°F
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ABSOLUTE MAGNITUDE OF MARGIN ALLOCATIONS SINCE LAST SBLOCA 30-DAY REPORT (ULNRC-3101)	43°F*
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* Prior changes to plant input parameters evaluated per 10 CFR 50.59 (such as the March 1999 safety evaluations) are not tracked against the 10 CFR 50.46 reporting requirements related to a significant change (i.e., > 50°F). As a result of the 10 CFR 50.59 rule change, future changes of this type will be reportable under 10 CFR 50.46.

NOTES:

1. See Attachment 1 to ULNRC-3101. The 1991 assessments have been eliminated as a result of the new SBLOCTA calculation. The Small Break Burst and Blockage penalty is a function of the base PCT plus margin allocations and has been reduced to 0°F since the total PCT has been reduced to a value below that at which burst would occur.
2. Addendum 2 to WCAP-10054 has been submitted to NRC. It references the improved condensation model (COSI) described in WCAP-11767 and provides justification for application of this model to small break LOCA calculations. Union Electric tracks the Peak Cladding Temperature (PCT) change reported in ULNRC-2892 (+150°F/-150°F) as a permanent change to Callaway's calculated PCT. See WCAP-10054, Addendum 2, "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code: Safety Injection into the Broken Loop and COSI Condensation Model," August 1994.
3. +4.0°F Cycle 6 crud deposition penalty has been deleted. A PCT penalty of 0°F has been assessed for 4 mils of crud, provided BOL conditions remain limiting. In the event that the SBLOCA cumulative PCT becomes $\geq 1700^\circ\text{F}$, this issue must be reassessed.
4. Based on the limiting case clad heatup reanalysis with axial offset reduced from 30% to 20%, as discussed in ULNRC-3101.
5. Based on a safety evaluation for a 5°F reduction in full-power T_{avg} (from 588.4°F to 583.4°F), a +30°F PCT penalty is established for LBLOCA and a +40°F PCT penalty is established for SBLOCA.
6. The 1996 safety evaluation reported a +10°F PCT penalty for a feedwater temperature reduction from 446°F to 410°F. This is replaced by a new safety evaluation. The 1996 assessment is reduced from +40°F to +30°F and a new +22°F PCT penalty is established for SBLOCA associated with a feedwater temperature reduction from 446°F to 390°F.
7. See Amendment No. 128 dated October 2, 1998.
8. Included in this value is an estimated PCT benefit of 100°F associated with reducing the F_Q limit from the AOR value of 2.5 to a value of 2.45 for core average burnups between 0 and 8000 MWd/MTU. After a burnup of 8000 MWd/MTU, the F_Q limit returns to 2.5 with no PCT penalty. This applies for the current operating cycle.