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ULNRC-03295

Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT
10CFR50.46 ANNUAL REPORT -
ECCS EVALUATION MODEL REVISIONS

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

Attachment 1 to this letter describes changes to Westinghouse ECCS Evaluation Models which have been implemented for Callaway for the time period from November 1994 to November 1995. Attachment 2 provides an ECCS Evaluation Model Margin Assessment which accounts for the peak cladding temperature (PCT) changes resulting from the resolution of the issues described in Attachment 1 as they apply to Callaway. References 1-8 above transmitted prior 10CFR50.46 reports.

Attachment 1 describes the resolution of those issues which have been implemented for Callaway. The margin allocations for Callaway to date are identified in Attachment 2. Since the PCT values determined in the large and small break LOCA analyses of record, when combined with all PCT margin allocations, remain well below the 2200°F regulatory limit, no reanalysis is planned by Union Electric.

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

Very truly yours,

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GGY/jdg

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ATTACHMENT ONE

CHANGES TO THE WESTINGHOUSE ECCS EVALUATION MODELS

ECCS EVALUATION MODEL CHANGES AND CORRECTIONS

1. Accumulator Water Temperature*
2. ESHAPE Axial Power Shape Sensitivity Model
3. Code Stream Improvement
4. BASH: Loop Core Interface Corrections
5. Pellet Power Radial Flux Depression Correction
6. Improvements to Flooding Rate Smoothing
7. Pressure Search Convergence Criteria in NOTRUMP
8. Friction Value Input Corrections
9. Automatic Containment Spray Actuation During SBLOCA

*Results in PCT allocation in Attachment 2

1. ACCUMULATOR WATER TEMPERATURE

The choice of accumulator water temperature can affect the calculated Peak Cladding Temperature (PCT) associated with large break LOCA analyses. Early Westinghouse Evaluation Models had assumed a generic value of 90°F for the accumulator water temperature based on a conservatively low value of containment air temperature at 100% power in fulfillment of the Appendix K requirements associated with the calculation of a low containment back-pressure. These containment initial temperature and pressure assumptions are reported in FSAR Table 6.2.1-5. The NRC had previously reviewed and approved this aspect of the LBLOCA Evaluation Model. Using these assumptions, and with the early Westinghouse models, 90°F was conservative with respect to the overall effect on large break LOCA PCT.

Newer evaluation models, including the 1981 Large Break Evaluation Model (EM) using BASH, have demonstrated that a higher containment air temperature, coupled with higher accumulator water temperatures, may result in an even more conservative calculation for PCT, even if containment pressure is slightly higher than calculated with the 90°F assumption. Sensitivity studies performed with these newer evaluation models have shown a small sensitivity to accumulator water temperature. The effect on PCT was a 1.3°F change in PCT for a 1°F change in accumulator water temperature when the accumulator water temperature varies over a range from 90°F to 120°F. Application of this sensitivity over its applicable range results in a PCT penalty of +39°F, which is below the 10 CFR 50.46 threshold for determination of a significant change (i.e., the absolute value of the cumulative changes since the last 30-day report is <50°F).

As accumulator water temperatures are expected to vary greatly during plant operation and are difficult to measure directly, the plant-specific effect of this new methodology may only be assessed if detailed accumulator water temperature data are available. There is no temperature indication installed for the accumulators. However, since there are no mechanisms that could result in the accumulator water temperature being higher than the containment atmosphere temperature, Technical Specification 3/4.6.1.5 provides the basis for the use of an initial accumulator water temperature of 120°F and the assessment of a +39°F LBLOCA penalty.

2. ESHAPE AXIAL POWER SHAPE SENSITIVITY MODEL

Large break LOCA analyses have been traditionally performed using a symmetric, chopped cosine, core axial power distribution. Under certain conditions, calculations have shown that there is a potential for top-skewed power distributions to result in PCTs greater than those calculated with chopped cosine axial power distributions. In 1991 Westinghouse developed a statistical methodology to evaluate and assure that the cosine distribution remains the limiting distribution. This methodology, Power Shape Sensitivity Model (PSSM), was submitted to the NRC via WCAP-12909, "Westinghouse ECCS Evaluation Model: Revised Large Break LOCA Power Distribution Methodology," May 1991. This methodology was implemented on a forward-fit basis as part of the Large Break LOCA EM in conducting reload safety evaluations for Callaway since Reference 5.

In March 1993 and in November 1994, the NRC requested Westinghouse to provide information on the statistical approach and the treatment of uncertainty in PSSM. After the NRC's second request for information and subsequent discussion with the NRC, it became clear that PSSM would not be approved by the NRC without significant modifications. These modifications would have likely included an additional +100°F PCT penalty to all large break LOCA analyses to account for model uncertainty and a revision to the PSSM database. As a result, Westinghouse determined that the potential penalties associated with these modifications outweighed the benefits derived from PSSM. Although Westinghouse believed that PSSM was conservative without additional modifications, Westinghouse decided to discontinue pursuing licensing of PSSM.

On March 21, 1995, Westinghouse met with the NRC to discuss the large break LOCA axial power shape methodology issue. The intent of the meeting was two-fold: 1) to present the basis for safe continued operation for those plants currently using PSSM as part of their licensing basis and 2) to present an alternative axial power shape methodology which was based on explicit analysis with a set of skewed axial power shapes. The use of skewed power shapes in BASH had already been approved by the NRC as part of Westinghouse's Large Break LOCA Evaluation Model.

At the NRC meeting Westinghouse demonstrated to the NRC's satisfaction, using a previously licensed approach to determine bounding axial power shapes, that past plant operation which was based on PSSM met 10 CFR 50.46

criteria (i.e., PCT ≤2200°F). The NRC also concurred with Westinghouse that the alternative approach was similar to the approach defined in Westinghouse's approved Large Break Evaluation Model and therefore may not warrant consideration as an Evaluation Model change subject to NRC review and approval. Given the NRC's recognition of this alternative approach and the preliminary results which demonstrated that most plants would not be subject to a PCT penalty, Westinghouse decided to continue development of the alternate methodology to replace PSSM.

The alternate methodology to replace PSSM, ESHAPE (Explicit SHape Analysis for PCT Effects), is based on an explicit analysis of the large break LOCA transient with a set of skewed axial power shapes to supplement the standard analysis done with the chopped cosine. Development of this methodology was completed in June 1995. Results of multiple plant calculations have shown that the limiting core axial power distribution is related to the time of PCT and that plants with long PCT times (>100 seconds) are potentially limited by power shapes that are skewed to the top of the core. Based on on-going discussions and meetings with the NRC, Westinghouse considers the ESHAPE methodology to be an updated application of the methodology described in WCAP 10266-P-A, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code," submitted and approved in December 1987. Submittal of ESHAPE for explicit NRC review and approval is therefore not anticipated.

Westinghouse issued a letter to the NRC on August 7, 1995 (NTD-NRC-95-4518) requesting that the PSSM be withdrawn and the ESHAPE Methodology be considered the standard for the Large Break LOCA 1981 BASH Evaluation Model. Westinghouse has requested the NRC to consider October 30, 1995 as the official withdrawal date for PSSM. Westinghouse will no longer apply PSSM to future reload safety evaluations.

Using the ESHAPE methodology, Westinghouse has determined that plants with early PCT times (<100 seconds) remain cosine shape limited. As a result, Westinghouse has determined that these plants (which represent the majority of the Westinghouse NSSS plants) are not impacted by the change from PSSM to ESHAPE. The Callaway-specific LOCBART reanalysis performed as part of the Cycle 7 reload effort demonstrated a PCT time of 54.5 seconds (see Reference 6). As such, Westinghouse has determined that the Callaway Plant large break LOCA analysis of record is not impacted and the large break LOCA PCT remains unchanged.

3. CODE STREAM IMPROVEMENT

Revisions were made to the procedures used to interface the various codes that comprise the entire execution stream for performing a large break LOCA analysis with the BASH Evaluation Model. The previous use of the coupled WREFLOOD/COCO code for calculating containment pressure response, which was then transferred as a boundary condition to the BASH code, has been replaced with direct coupling of the BASH and COCO codes such that the same code used to calculate the RCS conditions during reflood also supplies the boundary conditions for the containment pressure calculation. In conjunction with this, the portion of the WREFLOOD code which calculated the refill phase of the transient has been reprogrammed into a separate, but identical, code called REFILL which is also coupled with COCO.

This methodology revision was made only as a process improvement for conducting analyses and involved no changes to the approved physical models, nor basic solution techniques governing the solutions provided by the individual computer codes. The NRC was advised of the implementation of this methodology on a forward-fit basis via NTD-NRC-94-4143 dated May 23, 1994.

Due to small perturbations in the boundary conditions resulting from this revised methodology for interfacing the codes, small differences in predicted results were observed. The effects were minor, with no observed bias. Since this methodology is a process improvement which is to be implemented on a forward-fit basis, there are no effects on existing licensing analyses, and any small effects on results will be implicitly accounted for in future analyses.

4. BASH: LOOP/CORE INTERFACE CORRECTIONS

Two corrections were made to the logic for interfacing the loop model and BART code model. One correction prevents the possibility of an occasional inconsistency in how the core time step was limited by the loop time step. Another corrects the fluid density used in the interface calculation when the inlet flow rate is negative.

Results from sensitivity studies for the corrections demonstrated negligible perturbations in the trends of the system parameters with a very minor net effect on large break LOCA PCT predictions relative to results from the previous version. Since this is an extremely small effect, with no apparent bias, the net effect on existing analyses is estimated to be 0°F for margin tracking purposes. The change has been implemented on a forward fit basis only and will be incorporated implicitly in any future analyses.

5. PELLET POWER RADIAL FLUX DEPRESSION CORRECTION

A coding error (an incorrect sign) was discovered and corrected in a subroutine that calculates radial power distribution factors in the fuel pellet for the LOCBART code.

Sensitivity studies found the error correction to result in less than a ±0.1°F effect on predicted large break LOCA PCT. The net effect on existing analyses is therefore 0°F for margin tracking purposes. This change will be implicitly included in future analyses.

6. IMPROVEMENTS TO FLOODING RATE SMOOTHING

Part of the approved methodology for performing large break LOCA analyses with the BASH Evaluation Model is the requirement that the core inlet flooding rate calculated by the BASH code be linearized in a piece-wise manner to remove oscillations prior to use in the hot channel fuel rod calculation. This operation is termed "smoothing," and guidelines are provided to the analysts describing how to linearize the curve by observing inflections in the overall flooding rate. To facilitate consistency in performing this operation, the logic has been coded into a program named SMUUTH. A new version of the SMUUTH program has been implemented which incorporates improved logic for determining the inflection points gained through experience in utilizing the program for a broad range of plant transients.

There are no changes to the approved Evaluation Model methodology from this revision. The SMUUTH program merely represents a convenient way of automating the approved methodology and does not explicitly introduce any effects on the results. This revision is being reported only as a change to the code stream used for standard analyses. There are no effects on predicted results from using the new program version.

7. PRESSURE SEARCH CONVERGENCE CRITERIA IN NOTRUMP

The convergence criteria used during the pressure search in NOTRUMP have been found to not be adequately restrictive to ensure a sufficiently accurate value for fluid node pressure when conditions approach the boundary between subcooled and saturated in some cases. The resulting effects on predicted pressure were more pronounced at pressures below those normally seen during standard Evaluation Model calculations. The previously hardwired convergence criteria values are now considered to be user-defined input, appropriate values have been determined, and these values will be implemented in all future analyses.

This was determined to be non-discretionary change as described in Section 4.1.2 of WCAP-13451 and was corrected in accordance with Section 4.1.3 of WCAP-13451.

The nature of this error led to an estimated generic small break LOCA PCT effect of 0°F for existing analyses.

8. FRICTION VALUE INPUT CORRECTIONS

The SPADES code is used to generate input decks for the small break LOCA analysis code, NOTRUMP. An error was found in the SPADES code which involved the values assigned to some of the friction factor input. The erroneous values had no impact on transient calculations and were corrected in order to maintain the consistency of the SPADES code with the relevant documentation.

The errors are considered to be discretionary changes as described in Section 4.1.1 of WCAP-13451 and were corrected in accordance with Section 4.1.3 of WCAP-13451.

Representative plant calculations indicate no effect on PCT analyses.

9. AUTOMATIC CONTAINMENT SPRAY ACTUATION DURING SBLOCA

Automatic containment spray actuation during a small break LOCA had not previously been addressed in the Westinghouse small break LOCA Evaluation Model. The containment pressure transient is not modeled because the small break PCT is not directly sensitive to this effect. While investigating this issue, however, Westinghouse concluded that containment spray actuation early in the small break transient is possible for a variety of containment types. Containment spray actuation could result in draindown of the RWST prior to conclusion of the small break LOCA transient. Switching to cold leg recirculation during the transient may reduce or briefly interrupt the modeled ECCS injection flow in some plants and elevate the enthalpy of ECCS injection water. Furthermore, an alternate single failure scenario (loss of a single CCP or SI pump rather than the current assumption of the loss of one diesel generator) could result in earlier draindown of the RWST (with both containment spray pumps running) and subsequent switchover to cold leg recirculation.

The concern with Safety Injection interruption or reduction as a result of switchover from cold leg injection to recirculation does not apply to Callaway. Regarding the increase in ECCS water enthalpy following switchover to ECCS recirculation, Westinghouse has determined that Callaway is not affected by this issue in terms of PCT, through the use of engineering analysis including the above assumption of an alternate single failure which would more rapidly drain the RWST. There is no PCT effect assessed for this issue for Callaway.

ULNRC- 03295

ATTACHMENT TWO

ECCS EVALUATION MODEL

MARGIN ASSESSMENT FOR CALLAWAY

LARGE BREAK LOCA

A. ANALYSIS OF RECORD	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. CURRENT LOCA MODEL ASSESSMENTS - NOVEMBER 1995	
1. ACCUMULATOR WATER TEMPERATURE (see Item 1 of Attachment 1)	+ 39°F
2. ESHAPE AXIAL POWER SHAPE SENSITIVITY MODEL (see Item 2 of Attachment 1)	+ 0°F

LICENSING BASIS PCT + MARGIN ALLOCATIONS	=	2031°F
ABSOLUTE MAGNITUDE OF MARGIN ALLOCATIONS SINCE LAST 30-DAY REPORT (ULNRC-2892)	=	45°F

SMALL BREAK LOCA

A.	ANALYSIS OF RECORD	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 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)	+ 4°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.	CURRENT LOCA MODEL ASSESSMENTS - NOVEMBER 1995	+ 0°F

LICENSING BASIS PCT + MARGIN ALLOCATIONS	=	1466°F
ABSOLUTE MAGNITUDE OF MARGIN ALLOCATIONS SINCE LAST 30-DAY REPORT (ULNRC-3101)	=	0°F

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.

4. Based on the limiting case clad heatup reanalysis with axial offset reduced from 30% to 20%, as discussed in ULNRC-3101.