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August 4, 1994

U.S. Nuclear Regulatory Commission
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ULNRC-3051

Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT
BORON DILUTION REANALYSIS

Reference: ULNRC-1850 dated October 25, 1988

Union Electric Company herewith transmits an application for amendment to Facility Operating License No. NPF-30 for the Callaway Plant.

This amendment application reflects changes in the boron dilution accident analysis to address Boron Dilution Mitigation System (BDMS) time delays, the BDMS actuation setpoint uncertainty, and concerns regarding the applicability of the assumed inverse count rate ratio (ICRR) curve. These issues have been addressed by reanalysis of the Modes 3-5 boron dilution transients with a change in the actuation setpoint from one corresponding to flux doubling (2Φ) to a reduced multiplication condition (1.7Φ). Proposed changes to the Technical Specifications include:

a. Changing Bases page 2-8, note** of Table 3.3-1, and note 12 of Table 4.3-1 to reflect "flux multiplication" rather than "flux doubling";

b. Revising note 9 of Table 4.3-1 to reflect the revised 1.7Φ setpoint;

c. Revising Bases page 3/4 4-1 to reflect new analysis assumptions.

These changes are needed to reflect the reanalysis of the boron dilution transient for the shutdown modes (Modes 3-5). The boron dilution analysis in the referenced letter above was submitted in support of Cycle 4. However, after identifying non-conservatisms in the analysis for a plant with a similar flux doubling circuit

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design, Westinghouse informed us that the boron dilution event for Modes 3-5 should be reanalyzed to address time delays associated with the microprocessor algorithm and signal processing, instrument uncertainty, and concerns regarding the applicability of the assumed ICRR curve. The magnitude of these non-conservatisms, especially the instrument uncertainty, precluded obtaining acceptable results with the actuation setpoint and analysis assumptions of the referenced analysis. In order to obtain acceptable results, the boron dilution accident analysis was reanalyzed to reflect a lower actuation setpoint and an RCS mixing volume consistent with at least one reactor coolant loop in operation. The attached Technical Specification changes are needed to ensure that the analysis assumptions are properly reflected.

The Callaway Plant Onsite Review Committee and the Nuclear Safety Review Board have reviewed this amendment application. Attachments 1 through 4 provide the Safety Evaluation, Significant Hazards Evaluation, Environmental Consideration, and proposed Technical Specification revisions, respectively, in support of this amendment request. It has been determined that this amendment application does not involve an unreviewed safety question as determined per 10CFR50.59 nor a significant hazard consideration as determined per 10CFR50.92. Pursuant to 10CFR51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of this amendment.

If you have any questions on this amendment application, please contact us.

Very truly yours,

Donald F. Schnell

GGY/dls

Attachments: 1 - Safety Evaluation
2 - Significant Hazards Evaluation
3 - Environmental Consideration
4 - Proposed Technical Specification Revisions

STATE OF MISSOURI)
) S S
CITY OF ST. LOUIS)

Donald F. Schnell, of lawful age, being first duly sworn upon oath says that he is Senior Vice President-Nuclear and an officer of Union Electric Company; that he has read the foregoing document and knows the content thereof; that he has executed the same for and on behalf of said company with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By Donald F. Schnell
Donald F. Schnell
Senior Vice President
Nuclear

SUBSCRIBED and sworn to before me this 4th day of August, 1994.

Barbara J. Pfaff
BARBARA J. PFAFF
NOTARY PUBLIC – STATE OF MISSOURI
MY COMMISSION EXPIRES APRIL 22, 1997
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ATTACHMENT ONE

SAFETY EVALUATION

SAFETY EVALUATION

INTRODUCTION

This amendment application reflects changes in the boron dilution accident analysis to address Boron Dilution Mitigation System (BDMS) time delays, the BDMS actuation setpoint uncertainty, and concerns regarding the applicability of the assumed inverse count rate ratio (ICRR) curve. These issues have been addressed by reanalysis of the Modes 3-5 boron dilution transients with a change in the actuation setpoint from one corresponding to flux doubling (2Φ) to a reduced multiplication condition (1.7Φ). Proposed changes to the Technical Specifications include:

a. Changing Bases page 2-8, note** of Table 3.3-1, and note 12 of Table 4.3-1 to reflect "flux multiplication" rather than "flux doubling";

b. Revising note 9 of Table 4.3-1 to reflect the revised 1.7Φ setpoint;

c. Revising Bases page 3/4 4-1 to reflect new analysis assumptions.

These revisions are needed to reflect the reanalysis of the boron dilution transient for the shutdown modes (Modes 3-5). The boron dilution analysis reflected in ULNRC-1850 was performed by Westinghouse in support of Cycle 4 and reflected a density compensation methodology to account for the density differences between the dilution source and the reactor coolant system. However, after identifying non-conservatisms in the analysis for a plant with a similar flux doubling circuit design, Westinghouse informed us that the boron dilution event for Modes 3-5 should be reanalyzed to address time delays associated with the microprocessor algorithm and signal processing, instrument uncertainty, and concerns regarding the applicability of the assumed ICRR curve which was based on data from plants operating in the late 1970's. The magnitude of these non-conservatisms, especially the instrument uncertainty, precluded obtaining acceptable results with the actuation setpoint and analysis assumptions used in the ULNRC-1850 analysis. In order to obtain acceptable results, the boron dilution accident was reanalyzed to reflect a lower actuation setpoint and an RCS mixing volume consistent with at least one reactor coolant loop in operation. The Technical Specification changes in Attachment 4 are needed to ensure that the analysis assumptions are properly reflected.

BACKGROUND

Technical Specification 3/4.3.1, "Reactor Trip System Instrumentation," imposes surveillances on the BDMS circuitry in Modes 3, 4, and 5 and discusses the blocking of the flux doubling signal. The BDMS was developed to detect and mitigate an

inadvertent boron dilution event in Modes 3, 4, and 5 before a complete loss of shutdown margin occurs. The microprocessor-based system monitors the output of the source range neutron flux detectors in discrete one-minute intervals and retains the averaged flux data for up to 10 of those intervals. Using a flux multiplication setpoint, the microprocessor compares the average flux value in the most recent interval to each of the prior 9 intervals. The BDMS actuates an alarm and automatic mitigation functions when the flux multiplication setpoint is reached. When a dilution event is detected, the BDMS automatically aligns the suction of the charging pumps to the Refueling Water Storage Tank (RWST), and isolates the suction path from the Volume Control Tank (VCT), in order to reborate the reactor coolant system.

The purpose of this safety evaluation is to incorporate the Callaway plant-specific Cycle 5 ICRR data, a reduced flux multiplication setpoint, and revised initial and critical boron concentration values in a revised boron dilution analysis. The analysis methods utilized in the ULNRC-1850 boron dilution event calculations assume no uncertainty on the BDMS flux multiplication setpoint. They also used the H.B. Robinson Cycle 3 ICRR data as the limiting ICRR versus RCS boron concentration curve. Although it has been shown that the H.B. Robinson Cycle 3 ICRR data bounds the Callaway Cycle 5 data, it has been decided to use the Callaway-specific curve to obtain plant operating margin. The Callaway Cycle 5 ICRR data has been found to be applicable for the current Cycle 7.

BORON DILUTION ACCIDENT REANALYSIS

The ULNRC-1850 boron dilution analysis credits the automatic BDMS in Modes 3-5 but assumes no uncertainty exists on the flux multiplication setpoint. A review and evaluation of all available information on the BDMS flux multiplication setpoint has resulted in reasonable estimates for the instrument uncertainties (assuming the uncertainty parameters are random and two-sided). An uncertainty has been determined for source range count rates greater than 10 counts per second (cps) and for count rates less than 10 cps. For each estimate of the uncertainty, a safety analysis limit (SAL) has been determined presuming a nominal plant setpoint of 1.70 times the reference flux. The reanalysis of the boron dilution transient accounts for the BDMS instrument uncertainty; it also assumes Callaway-specific ICRR data from Cycle 5, with a requirement to verify that this ICRR curve is bounding for future cycles in each cycle-specific reload safety evaluation. A discussion of other analysis assumptions and results is provided in the following paragraphs.

The response time acceptance criterion was recalculated for each of the 3 modes for which the automatic BDMS is utilized. The shutdown mode analyses account for the following delay times:

Delay from the microprocessor to mitigation actuation (10 second signal delay)

Opening of CVCS isolation valves from the RWST (BN-LCV-112D and E, 15 seconds)

Closure of CVCS outlet isolation valves from the VCT (BG-LCV-112B and C, 10 seconds)

Purge of the CVCS piping from the RWST to the RCS (dependent on the assumed dilution flow rate - 212 seconds for Mode 5 and 131 seconds for Modes 3&4).

The delay time from when the core flux reaches the flux multiplication setpoint until the BDMS indicates that the setpoint has been reached is accounted for by the algorithm built into the solution technique used to analyze the boron dilution transient for plants that detect a positive reactivity insertion via a flux multiplication signal. This algorithm conservatively models the cycling of the circuitry of the Westinghouse Source Range Flux Multiplication Boron Dilution Mitigation System.

Thus, the total delay time from when the BDMS indicates that the setpoint has been reached until reboration of the RCS commences defines the acceptance criterion, i.e., 247 seconds for Mode 5 and 166 seconds for Modes 3 and 4.

The reanalysis also contains the following Callaway plant-specific assumptions:

1. A minimum mixing volume of 8995 ft^3 in the RCS is used for Modes 3, 4, and 5. This volume corresponds to the active volume of the RCS with one reactor coolant pump in operation, and does not include any volume in the pressurizer or its surge or spray lines, the vessel head, the CVCS, or the RHR system. The volume specified here is conservative in that no consideration is given to mixing in the upper head region. One reactor coolant pump can provide sufficient driving force to ensure adequate mixing of all four reactor coolant loops. Administrative controls will ensure that dilution sources are isolated if no reactor coolant loop is in operation.

2. Dilution flow rates assumed for each mode are based on the dilution source fluid conditions for reactor makeup water at 37°F and 14.7 psia. The analysis results presented are based on calculations which account for density compensation between these dilution source conditions and the mode-specific RCS conditions listed on Table 1.

3. Initial and critical boron concentrations are noted on Table 1. These values are bounding with respect to the maximum values used in the reload design process.

4. The Callaway plant-specific Cycle 5 ICRR data was used.

5. Assuming a nominal flux multiplication setpoint of 1.70, a safety analysis limit (SAL) of 2.14 was calculated for source

range count rates greater than 10 counts per seconds (cps); this accounts for a 25.5% instrument uncertainty. Similarly, an SAL of 2.65 was used for count rates less than 10 cps; this accounts for a 55.5% instrument uncertainty.

6. The boron concentrations used in the Mode 5 analysis are based on a plant shutdown margin of 1.0% $\Delta k/k$. For Modes 3 and 4, the boron concentrations used are based on a plant shutdown margin of 1.3% $\Delta k/k$.

The results of the boron dilution reanalysis for Callaway Modes 3, 4, and 5 are presented in Table 1. The more limiting results, those with the least margin to the response time acceptance criterion, are presented in the updated FSAR Section 15.4.6 and Table 15.4-1 (Revision OL-7 submitted via ULNRC-3024 dated 5-20-94).

DETERMINATION OF NO UNREVIEWED SAFETY QUESTION

The proposed changes do not involve an unreviewed safety question because operation of Callaway Plant in accordance with these changes would not:

(1) Involve an increase in the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the FSAR.

The actuation setpoint decrease and administrative controls to isolate dilution sources if no reactor coolant loop is in operation during Modes 3-5 reflect the new analysis assumptions. The initiating events are presented in FSAR Section 15.4.6. The proposed changes affect only the time required for BDMS to mitigate the event and do not affect the probability of any event initiators.

Overall protection system performance will remain within the bounds of the accident analyses documented in FSAR Chapter 15, WCAP-10961-P, and WCAP-11883 since no hardware changes are proposed.

The BDMS will continue to function in a manner consistent with the above analysis assumptions and the plant design basis. As such, there will be no degradation in the performance of nor an increase in the number of challenges to equipment assumed to function during an accident situation.

These Technical Specification revisions do not involve any hardware changes nor do they affect the probability of any event initiators. There will be no change to normal plant operating parameters or accident mitigation capabilities.

Therefore, there will be no increase in the probability of any accident of safety-related equipment malfunction occurring due to the revised analysis.

The results of this new analysis indicate that there is sufficient time for BDMS action to prevent a loss of plant shutdown margin. Since plant shutdown margin is not lost, the minimum DNBR remains well above the safety analysis limit values, no overpressurization occurs and, therefore, there are no fuel failures. The Technical Specification limits on shutdown margin in Modes 3-5 will be met. The conclusions of NRC Generic Letter 85-05 and NSAC-183 remain valid (i.e., that gradual boron dilution events are self-limiting due to inherent reactivity feedback mechanisms). Given the above, there will be no increase in the consequences of any accident or equipment malfunction.

(2) Create the possibility for an accident or malfunction of a different type than any previously evaluated in the FSAR.

The proposed Technical Specification changes do not involve any design changes nor are there any changes in the method by which any safety-related plant system performs its safety function. The normal manner of plant operation is unaffected. The revised actuation setpoint of 1.7Φ was implemented during Refuel 6. Implementation of the lower setpoint met all Technical Specification requirements on the BDMS.

The initiating events for this reanalysis are discussed in FSAR Section 15.4.6. No new accident scenarios, transient precursors, failure mechanisms, or limiting single failures are introduced as a result of these changes. There will be no adverse effect or challenges imposed on any safety-related system as a result of these changes. Therefore, the possibility of a new or different kind of accident is not created.

There are no changes which would cause the malfunction of safety-related equipment, assumed to be operable in the accident analyses, as a result of the proposed Technical Specification changes. No new mode of failure has been created and no new equipment performance burdens are imposed. Therefore, this amendment will not create the possibility of a new or different malfunction of safety-related equipment.

Procedures were implemented during Refuel 6 to ensure that dilution sources are isolated during Modes 3-5 if no reactor coolant loop is in operation.

(3) Involve a reduction in the margin of safety as defined in the basis for any Technical Specification.

The results of the new analysis show that there is sufficient time for BDMS action to prevent a loss of plant shutdown margin. Since plant shutdown margin is not lost, the minimum DNBR remains well above the safety analysis limit values.

The Technical Specification limits on shutdown margin in Modes 3-5 will be met. There will be no effect on the manner in which safety limits or limiting safety system settings are determined nor will there be any effect on those plant systems necessary to assure the accomplishment of protection functions. There will be no impact on DNBR limits, F_Q, F-delta-H, LOCA PCT, peak local power density, or any other margin of safety.

Based on the information presented above, the proposed amendment does not involve an unreviewed safety question and will not adversely affect or endanger the health or safety of the general public.

Table 1

Callaway Boron Dilution Analysis Assumptions and Results for Modes 3, 4 and 5

Mode	Temp.	Pressure	Dilution Flowrate (Density Compensated)	Initial Boron Conc.	Critical Boron Conc.	Time from Initiation to Flux-Multiplication Alarm	Time from Flux-Multiplication Alarm to Loss of SDM	Acceptance Criterion
3	350°F	saturation	292 gpm	1550 ppm	1423 ppm	13.48 min	6.22 min	2.77 min
3*	557°F	2250 psia	350 gpm	1490 ppm	1335 ppm	15.12 min	6.00 min	2.77 min
4	200°F	14.7 psia	271 gpm	1528 ppm	1412 ppm	13.23 min	6.37 min	2.77 min
4*	350°F	saturation	292 gpm	1550 ppm	1423 ppm	13.48 min	6.22 min	2.77 min
5*	68°F	14.7 psia	150.3 gpm	1476 ppm	1390 ppm	22.72 min	4.16 min	4.12 min
5	200°F	14.7 psia	156 gpm	1501 ppm	1412 ppm	19.70 min	6.66 min	4.12 min

* Limiting cases reported in FSAR Section 15.4.6 and Table 15.4-1.
The limiting end of the temperature range for each mode bounds the temperature at the other end as well as all temperatures in between.

ATTACHMENT TWO

SIGNIFICANT HAZARDS EVALUATION

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This amendment application reflects changes in the boron dilution accident analysis to address Boron Dilution Mitigation System (BDMS) time delays, the BDMS actuation setpoint uncertainty, and concerns regarding the applicability of the assumed inverse count rate ratio (ICRR) curve. These issues have been addressed by reanalysis of the Modes 3-5 boron dilution transients with a change in the actuation setpoint from one corresponding to flux doubling (2Φ) to a reduced multiplication condition (1.7Φ). Proposed changes to the Technical Specifications include:

a. Changing Bases page 2-8, note** of Table 3.3-1, and note 12 of Table 4.3-1 to reflect "flux multiplication" rather than "flux doubling";

b. Revising note 9 of Table 4.3-1 to reflect the revised 1.7Φ setpoint;

c. Revising Bases page 3/4 4-1 to reflect new analysis assumptions.

The attached Technical Specification changes are needed to reflect the reanalysis of the boron dilution transient for the shutdown modes (Modes 3-5) and ensure that the analysis assumptions are properly reflected.

The proposed changes to the Technical Specifications do not involve a significant hazards consideration because operation of Callaway Plant in accordance with these changes would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated.

The actuation setpoint decrease and administrative controls to isolate dilution sources if no reactor coolant loop is in operation during Modes 3-5 reflect the new analysis assumptions. The initiating events are presented in FSAR Section 15.4.6. The proposed changes affect only the time required for BDMS to mitigate the event and do not affect the probability of any event initiators.

Overall protection system performance will remain within the bounds of the accident analyses documented in FSAR Chapter 15, WCAP-10961-P, and WCAP-11883 since no hardware changes are proposed.

The BDMS will continue to function in a manner consistent with the above analysis assumptions and the plant design basis. As such, there will be no degradation in the performance of nor an increase in the number of challenges to equipment assumed to function during an accident situation.

These Technical Specification revisions do not involve any hardware changes nor do they affect the probability of any event initiators. There will be no change to normal plant operating parameters or accident mitigation capabilities. Therefore, there will be no increase in the probability of any accident occurring due to the revised analysis.

The results of this new analysis indicate that there is sufficient time for BDMS action to prevent a loss of plant shutdown margin. Since plant shutdown margin is not lost, the minimum DNBR remains well above the safety analysis limit values, no overpressurization occurs and, therefore, there are no fuel failures. The Technical Specification limits on shutdown margin in Modes 3-5 will be met. The conclusions of NRC Generic Letter 85-05 and NSAC-183 remain valid (i.e., that gradual boron dilution events are self-limiting due to inherent reactivity feedback mechanisms). Given the above, there will be no increase in the consequences of any accident.

(2) Create the possibility of a new or different kind of accident from any previously evaluated.

As discussed above, there are no hardware changes associated with these Technical Specification revisions nor are there any changes in the method by which any safety-related plant system performs its safety function. The normal manner of plant operation is unaffected.

No new accident scenarios, transient precursors, failure mechanisms, or limiting single failures are introduced as a result of these changes. There will be no adverse effect or challenges imposed on any safety-related system as a result of these changes. Therefore, the possibility of a new or different type of accident is not created.

(3) Involve a significant reduction in a margin of safety.

The results of the new analysis show that there is sufficient time for BDMS action to prevent a loss of plant shutdown margin. Since plant shutdown margin is not lost, the minimum DNBR remains well above the safety analysis limit values. The Technical Specification limits on shutdown margin in Modes 3-5 will be met. There will be no effect on the manner in which safety limits or limiting safety system settings are determined nor will there be any effect on those plant systems necessary to assure the accomplishment of protection functions. There will be no impact on DNBR limits, F_Q, F-delta-H, LOCA PCT, peak local power density, or any other margin of safety.

Based upon the preceding information, it has been determined that the proposed changes to the Technical Specifications do not involve a significant increase in the probability or consequences

of an accident previously evaluated, create the possibility of a new or different kind of accident from any accident previously evaluated, or involve a significant reduction in a margin of safety. Therefore, it is concluded that the proposed changes meet the requirements of 10CFR50.92(c) and does not involve a significant hazards consideration.

ATTACHMENT THREE

ENVIRONMENTAL CONSIDERATION

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This amendment application reflects changes in the boron dilution accident analysis to address Boron Dilution Mitigation System (BDMS) time delays, the BDMS actuation setpoint uncertainty, and concerns regarding the applicability of the assumed inverse count rate ratio (ICRR) curve. These issues have been addressed by reanalysis of the Modes 3-5 boron dilution transients with a change in the actuation setpoint from one corresponding to flux doubling (2Φ) to a reduced multiplication condition (1.7Φ). Proposed changes to the Technical Specifications include:

a. Changing Bases page 2-8, note** of Table 3.3-1, and note 12 of Table 4.3-1 to reflect "flux multiplication" rather than "flux doubling";

b. Revising note 9 of Table 4.3-1 to reflect the revised 1.7Φ setpoint;

c. Revising Bases page 3/4 4-1 to reflect new analysis assumptions.

The proposed amendment involves changes with respect to the use of facility components located within the restricted area, as defined in 10CFR20, and changes surveillance requirements. Union Electric has determined that the proposed amendment does not involve:

1) A significant hazards consideration, as discussed in Attachment 2 of this amendment application;

2) A significant change in the types or significant increase in the amounts of any effluents that may be released offsite;

3) A significant increase in individual or cumulative occupational radiation exposure.

Accordingly, the proposed amendment meets the eligibility criteria for categorical exclusion set forth in 10CFR51.22(c)(9). Pursuant to 10CFR51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of this amendment.