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UNION ELECTRIC

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
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Gentlemen: ULNRC-3619

DOCKET NUMBER 50-483
CALLAWAY PLANT
RESPONSE TO GENERIC LETTER 97-01, DEGRADATION OF CONTROL ROD DRIVE MECHANISM NOZZLE AND OTHER VESSEL CLOSURE HEAD PENETRATIONS

References: 1. Generic Letter 97-01, dated April 1, 1997
2. ULNRC-3571 dated May 1, 1997

Generic Letter 97-01 (Reference 1 above) requested a written response from Union Electric concerning Callaway's program for timely inspection of PWR control rod drive mechanism and other vessel closure head penetrations. Reference 2 provided Union Electric's initial response. This letter provides Union Electric's response to Items 1 and 2 of the "Requested Information" section of the Generic Letter.

Through participation in the Westinghouse Owners Group and other industry programs, Union Electric has taken a proactive approach to addressing the cracking concern in reactor vessel head penetrations. In addition, based on WCAP 13565, which is applicable to the Callaway Plant, and the NRC SER provided to the Nuclear Energy Institute on November 19, 1993, Union Electric concludes that this is a long term aging management issue and is not a safety concern.

The Attachment to this letter contains an item by item response to specific information requested in Generic Letter 97-01. No new commitments are contained in this letter.

Sincerely,

A075 1/1

Alan C. Passwater
Manager, Licensing and Fuels

DJW/plr
Attachment

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Alan C. Passwater, of lawful age, being first duly sworn upon oath says that he is Manager, Licensing and Fuels (Nuclear) for 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 Alan C. Passwater
Alan C. Passwater
Manager, Licensing and Fuels
Nuclear

SUBSCRIBED and sworn to before me this seventeenth day of July, 1997.

Patricia L. Reynolds

PATRICIA L. REYNOLDS
NOTARY SEAL
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STATE OF MISSOURI

PATRICIA L. REYNOLDS
NOTARY PUBLIC—STATE OF MISSOURI
ST. LOUIS COUNTY
MY COMMISSION EXPIRES DEC. 22, 2000

UNION ELECTRIC RESPONSE TO NRC GENERIC LETTER 97-01

DEGRADATION OF CONTROL ROD DRIVE MECHANISM NOZZLE AND OTHER VESSEL CLOSURE HEAD PENETRATIONS

Generic Letter 97-01, Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations, was issued to request licensees to describe their program for insuring the timely inspection of PWR control rod drive mechanism (CRDM) and other closure head penetrations. This attachment provides Union Electric's response to the Generic Letter.

Prior to the issuance of Generic Letter 97-01, Union Electric has worked with the Westinghouse Owners Group (WOG), the Electric Power Research Institute (EPRI), and the Nuclear Energy Institute (NEI) to understand the operational experience, identify technical issues, cause factors, relative importance, and solutions. One of these tasks was the development of a safety evaluation that characterized the initiation of damage, propagation and consequences. The safety evaluation is contained in WCAP 13565 and is applicable to the Callaway Plant. The NRC reviewed the safety evaluation and issued a safety evaluation report (SER) to NEI on November 19, 1993. The safety evaluation and the SER provide the basis for the conclusion that this is not a safety issue.

Through participation in the WOG and U.S. industry programs, Union Electric has taken a proactive approach to address the cracking issue in reactor vessel head penetrations. This approach is based on the conclusion that the issue is not a safety concern, because (1) the PWSCC process is slow; (2) the allowable or critical flaw size is large; (3) leak-before-break (LBB) will occur to allow safe shutdown of the plant; and (4) at least six years of operation after initiation of a penetration leak is required before ASME Code structural margins would be challenged.

The following provides an item by item response for the specific information requested in Generic Letter 97-01:

REGARDING INSPECTION ACTIVITIES:

NRC Requested Information Item 1.1

A description of all inspections of CRDM nozzle and other VHPs performed to the date of this generic letter, including the results of these inspections.

Union Electric Response

Visual inspections of the top of the reactor vessel head are performed every refueling. In the spring of 1992, during Refuel 5, boron deposits were identified as a result of leakage past the seal weld on CRDM housings. The leaking welds were repaired.

More recently, inspection and repairs were performed on the inside of the reactor vessel head in response to NRC Information Notice 94-40. Inspection of the CRDM Thermal Sleeve Guide Funnels was performed during Refuel 7 in the spring of 1995. The visual inspection was performed with cameras, and all funnels were verified intact. During Refuel 8 in the fall of 1996, a weld overlay was performed on all the guide funnels to ensure the conical guide would not separate from the thermal sleeve.

During these work evolutions, while no special inspection instructions were given, no abnormal conditions were noted with the remaining portion of the penetration assemblies.

Inservice inspections in accordance with ASME Section XI requirements are performed on the reactor vessel head. Exam category B-E requires a VT-2 (visual) of 25% of the CRDM assemblies. This was performed in Refuel 2, and is scheduled again for Refuel 9. Exam category B-O requires 10% of the dissimilar metal welds to receive either a volumetric or a surface exam. This was completed during Refuel 7, and is again scheduled for either Refuel 13 or 14. Due to the difficult access, these inspections are typically performed on the CRDM housings located on the periphery. These peripheral locations that are inspected are the ones with the highest residual stresses in the CRDM penetration. Again, while no special instructions were given, no abnormal conditions were noted with the remaining portion of the penetration assemblies.

A summary of the vessel head volumetric inspections performed to date worldwide is provided in WCAP 14901, Background and Methodology for Evaluation of Reactor Vessel Closure Head Penetration Integrity for the Westinghouse Owners Group. This WCAP is being submitted to the NRC directly by the Westinghouse Owners Group.

<u>NRC Requested Information Items 1.2, 1.3, 1.4</u>

1.2 If a plan has been developed to periodically inspect the CRDM nozzle and other VHPs:

a. Provide the schedule for first, and subsequent, inspections of the CRDM nozzle and other VHPs, including the technical basis for this schedule.

b. Provide the scope for the CRDM nozzle and other VHP inspections, including the total number of penetrations (and how many will be inspected), which penetrations have thermal sleeves, which are spares, and which are instrument or other penetrations.

1.3 If a plan has <u>not</u> been developed to periodically inspect the CRDM nozzle and other VHPs, provide the analysis that supports why no augmented inspection is necessary.

1.4 In light of the degradation of CRDM nozzle and other VHPs described above, provide the analysis that supports the selected course of action as listed in either 1.2 or 1.3, above. In particular, provide a description of all relevant data and/or tests used to develop crack initiation and crack growth models, the methods and

data used to validate these models, the plant-specific inputs to these models, and how these models substantiate the susceptibility evaluation. Also, if an integrated industry inspection program is being relied on, provide a detailed description of this program.

Union Electric Response

Union Electric plans to continue performing visual inspections of the Callaway Plant reactor vessel head every refueling. Additionally, the inservice inspections in accordance with ASME Section XI will continue to be performed.

Westinghouse, for the WOG, has calculated failure probabilities for all vessel head penetrations. A technical description of the probabilistic model is provided in section 4 of WCAP 14901. This model calculates the probability of failure of the Alloy 600 head penetrations as a function of operating time. The model has been validated against plant inspections performed to date.

The Alloy 600 head penetrations at Callaway have several positive factors. Most importantly, the temperature of the head is at T-cold. The time at temperature for the Callaway plant is less than many other plants. The Alloy 600 material features a high mill annealing temperature, and lower yield strength which indicates a microstructure more resistant to PWSCC.

Using the WOG model, after 20 years of operation, the probability of a 75% through wall flaw of the most limiting Alloy 600 head penetration at the Callaway Plant is essentially 0%, and after 40 years it is only 1.4%. The probability of a 75% through wall flaw of at least one of the 78 Alloy 600 head penetration is 0.5% after 20 years of operation, and 11.3% after 40 years. Considering these low probabilities for the Callaway plant, Union Electric has not scheduled a volumetric inspection for the CRDM nozzles or other VHPs.

Union Electric is a participant in the Westinghouse Owners Group/NEI RPV head penetration integrated inspection program. This integrated program includes volumetric inspection of head penetrations that have been performed and additional volumetric inspections scheduled to be performed. Present plans call for two Combustion Engineering designed plants and two Babcock and Wilcox designed plant to be inspected over the next three years.

Union Electric believes that the number of plants that have, or will be inspected is sufficient to demonstrate the adequacy of the WOG/NEI integrated inspection program.

The need and schedule for initial as well as re-inspections will be based on an evaluation of the inspection results from the integrated inspection program.

For additional information, please refer to WCAP 14901. A description of the data and tests used to develop crack initiation and crack growth models is provided. Additionally, the plant specific inputs, and methods and data used to validate the models are provided. As mentioned above, Union Electric is part of the integrated industry inspection program.

A description of the program, including a table summarizing the results of inspections to date is included in WCAP 14901 as well.

In addition to the WOG integrated inspection plan previously discussed, all three PWR owners groups, EPRI, and NEI are cooperatively working to compile information on the estimated operating time from January 1, 1997, needed to initiate and propagate a crack 75% through wall in a vessel penetration. This information will be evaluated to determine if an adequate number of plants have, or are planning to inspect. This evaluation is scheduled to be completed by the end of 1997, and will be provided to the NRC.

REGARDING PWR PRIMARY WATER CHEMISTRY:

In item 2 the NRC has requested, "*Provide a description of any resin bead intrusions, as described in IN 96-11, that exceeded the current EPRI PWR Primary Water Chemistry Guidelines recommendations for primary water sulfate levels, including the following information:*" For this section of Generic Letter 97-01, Union Electric's response is based on a review of primary plant records dating back to January, 1986.

The NEI and the WOG, through discussions with the NRC have defined a 'significant' resin intrusion event to be an intrusion into the primary coolant system with a magnitude greater than 1 ft^3. This volume of 1 ft^3 was chosen as a conservative lower bound since it represents less than 15% of the estimated volume of resin released into the reactor coolant system during the two events at Jose Cabrera.

Prior to the above discussions, Union Electric directly contacted the NRC (Mr. James Medoff), requesting additional guidance on reporting this chemistry information. As a result of that conversation, Union Electric reviewed, and is reporting for the Callaway plant, **any** excursion for parameters that have exceeded Technical Specification or FSAR limits. For all other parameters listed, **any** excursion above the current EPRI guidelines is reported. As is detailed in the following responses, Callaway has never exceeded a Technical Specification or FSAR chemistry limit, for the parameters requested.

NRC Requested Information Item 2.1

2.1 Were the intrusions cation, anion, or mixed bed?

Union Electric Response

A resin intrusion event with a magnitude of 1 ft^3 or greater has not occurred at Callaway. However, as noted above, Union Electric reviewed and is reporting all excursions above Technical Specification and FSAR limits, as well as those exceeding current EPRI guidelines.

Callaway's Reactor Coolant System (RCS) has experienced one resin intrusion that exceeded EPRI's PWR Action Levels for sulfates. The event occurred on November 23, 1990 and was caused by the failure of a retention element for a Cation Resin Demineralizer used to remove lithium from the RCS. The volume of resin that entered the

RCS was estimated to be 0.05 ft^3, or about 1.4 liters. The intrusion and subsequent breakdown of cation resin caused the RCS sulfate concentration to reach a maximum of 510 ppb at 100% power. Using EPRI's current guidelines stated in ***Revision 3*** of ***PWR Primary Water Chemistry Guidelines,*** the highest sulfate level reached during this event would have placed the plant in Action Level 2.

Note: EPRI did not have recommended actions for high sulfates in 1990.

NRC Requested Information Item 2.2

2.2 What were the durations of these intrusions?

Union Electric Response

The intrusion event described in Question 2.1 exceeded EPRI Action Level 2 limits for sulfates (>150, ≤ 1500 ppb SO_4). The reactor was placed in a Hot Shutdown condition approximately 4 hours following the failure of the retention element. RCS sulfates were reduced to the Action Level 1 range with ion exchange using a mixed bed demineralizer operating at full-flow capacity. Action Level 2 concentrations returned for a short time following reactor startup and a return to power operations. Callaway did not enter a Cold Shutdown condition as recommended by current guidelines, but did follow the manufacturer's recommendations (at the time) to shutdown, maintain the plant >350° F, and reduce the sulfate concentration. The following table summarizes the duration of the event:

1990 RESIN INTRUSION EVENT		
Action Level 2	Duration at power (150 < ppb SO_4 ≤ 1500)	8.5 hrs.
Action Level 2	Duration shutdown (150 < ppb SO_4 ≤ 1500)	9.1 hrs.
Action Level 2	Total duration (150 < ppb SO_4 ≤ 1500)	17.6 hrs.
Action Level 1	Total duration (50 < ppb SO_4 ≤ 150)	90.0 hrs.

NRC Requested Information Item 2.3

2.3 Does the plant's RCS water chemistry Technical Specifications follow the EPRI guidelines?

Union Electric Response

Reactor Coolant System contaminant concentrations for Chloride, Fluoride, and Oxygen are restricted by Callaway's Final Safety and Analysis Report (FSAR), originally Technical

Specifications. Callaway has administrative controls placed on other PWR chemical contaminants not addressed by the FSAR or Technical Specifications. The procedures containing the administrative controls are based on EPRI guidelines and follow the recommended limits.

NRC Requested Information Item 2.4

2.4 *Identify any RCS chemistry excursions that exceeded the plant administrative limits for the following species: sulfates, chlorides or fluorides, oxygen, boron, and lithium.*

Union Electric Response

Chlorides, Fluorides, and Oxygen - Callaway has never exceeded a Technical Specification/FSAR limit for these parameters.

Sulfates - *See Question 2.2 for a sulfate summary of the 1990 resin intrusion event.* A review of records indicates EPRI limits for sulfates during Cold Shutdown conditions were exceeded on two separate occasions during refueling outages. The following table summarizes the sulfate conditions:

COLD SHUTDOWN SULFATE EXCURSIONS		
REFUEL 2 (10/87)	Action Level 2 duration	33.6 hrs.
REFUEL 4 (9/90)	Action Level 2 duration	10.3 hrs.
	TOTAL	43.9 hrs.

Boron and Lithium- EPRI's recommended PWR pH_t low limit of 6.9 and Callaway's FSAR upper Lithium limit of 3.75 ppm served as the basis for this review. Reactor Coolant System chemistry was reviewed to determine if system parameters exceeded the defined regions. Callaway has never exceeded a Technical Specification/FSAR limit for these parameters.

NRC Requested Information Item 2.5

2.5 *Identify any conductivity excursions which may be indicative of resin intrusions. Provide a technical assessment of each excursion and any follow-up actions.*

Union Electric Response

EPRI chemWORKS™ software was used to calculate theoretical Reactor Coolant System specific conductivities based on boron and lithium levels. Theoretical values were compared to actual measured values to determine if any mismatches existed, pointing to a possible resin intrusion. No unexplained conductivity mismatches were found during the review.

NRC Requested Information Item 2.6

2.6 *Provide an assessment of the potential for any of these intrusions to result in a significant increase in the probability for IGA of VHPs and any associated plan for inspections.*

Union Electric Response

As noted previously, the intrusion that occurred in 1990 had a magnitude of much less than 1 ft^3 and is not defined as significant. As such, a formal assessment evaluating any increase in the probability for IGA is not warranted.

Studies conducted for the WOG have investigated the effect of environmental factors on stress corrosion cracking. Primary water chemistry is considered a second order factor influencing PWSCC of Alloy 600. Temperature is considered the most significant environmental factor (PWSCC varies exponentially with temperature).

In review of Callaway's 1990 resin intrusion, the steps taken by plant management to mitigate long-term effects from sulfates were far more conservative than the EPRI Action Level guidelines at that time. The 1990 event has been evaluated to have caused no significant effect on plant materials since prompt action, consistent with the latest industry information, was taken. Callaway continues to take the conservative approach in managing sulfate levels in the RCS and uses EPRI's recommendations for controlling the parameter.