April 1, 2002

U. S. Nuclear Regulatory Commission
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Washington, D. C. 20555-0001

Gentlemen: ULNRC-4630

DOCKET NO. 50-483
CALLAWAY PLANT
UNION ELECTRIC COMPANY

Response to NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and reactor Coolant Pressure Boundary Integrity"

Attached is the Callaway Plant response to U.S. Nuclear Regulatory Commission (NRC) Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity" dated March 18, 2002. NRC Bulletin 2002-01 requested information relative to the integrity of the reactor coolant boundary including the Reactor Pressure Vessel (RPV), previous RPV head inspections, and plans for future RPV head inspections. Callaway Plant coordinated preparation of this response with the other participants in the Strategic Teaming and Resource Sharing (STARS) group.

If you should have any questions regarding this submittal, please contact us.

Very truly yours,
Original signed by
Ronald D. Affolter

Ronald D. Affolter
Vice President - Nuclear

RDA/bfh

Attachments:
- I - Affidavit
- II - Response to NRC Bulletin 2002-01
- III - List of Commitments

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STATE OF MISSOURI)
) S S
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Ronald D. Affolter, of lawful age, being first duly sworn upon oath says that he is Vice President-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 ___________________________________

Ronald D. Affolter
Vice President-Nuclear

SUBSCRIBED and sworn to before me this ________________ day

of ______________________, 2002.

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Response to NRC Bulletin 2002-01

Reactor Pressure Vessel Degradation and Reactor Coolant Pressure Boundary Integrity

Below is the Callaway response to Nuclear Regulatory Commission (NRC) Bulletin 2002-01, Reactor Pressure Vessel Degradation and Reactor Coolant Pressure Boundary Integrity, dated March 18, 2002. The Bulletin's "Required Information" is shown in bold.

Required Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

   A. **a summary of the reactor pressure vessel head inspection and maintenance programs that have been implemented at your plant,**

Callaway Response:

Inspection

Although Callaway has not performed a 100% bare metal examination of the Reactor Pressure Vessel (RPV) Head, examination of the RPV Head has been performed periodically to satisfy ASME Section XI requirements and commitments related to Generic Letter 88-05. Callaway's boric acid leakage inspection program (GL 88-05 commitment), which includes the reactor pressure vessel head area, is performed via a reoccurring preventive maintenance document. Surveillance Task ST-17207, "VT-2 on BB RPV Head – Class 1" inspects the Reactor Pressure Vessel head (above the insulation package). A description of these inspections follows:

Boric Acid Corrosion Inspection

Boric acid corrosion (BAC) inspection walkdowns are performed each refueling outage. BAC inspection walkdowns may be performed during other outages at the discretion of plant management. Locations that are susceptible for leakage onto the reactor vessel head are specifically identified for inspection. The walkdowns are performed early in refueling outages to ensure evidence of RCS leakage, if discovered at the leakage sites, is not disturbed prior to evaluation. Evidence of leakage above the reactor vessel head insulation is documented and evaluated in accordance with Callaway work control and corrective action programs.

Surveillance Task ST-17207, "VT-2 on BB RPV Head – Class 1"

Inspections within the scope of ASME Section XI (i.e., VT-2) are performed following each refueling outage at normal operating pressure and normal operating temperature (NOP/NOT). Leakage and evidence of leakage above the reactor vessel head insulation are documented and evaluated in accordance with Callaway work control and corrective action programs.

Additional Inspections that would identify Boric Acid Corrosion on the RPV Head

Reactor vessel studs/nuts are inspected in accordance with the Callaway ASME Section XI Inservice Inspection Program Plan. The studs/nuts receive a periodic VT-1/MT examination. Boric acid corrosion would be identified during these examinations. Additionally, UT examination of the Reactor Vessel Head flange is performed in accordance with ASME Section XI Inservice Inspection (ISI) Program Plan that would identify boric acid corrosion degradation.

Maintenance

The mirror insulation outside the Control Rod Drive Mechanism (CRDM) shroud is removed during each outage to facilitate reactor disassembly. The mirror insulation inside the CRDM shroud is removable only if the CRDM shroud is removed. The CRDM shroud is not removed in order to disassemble the head for refueling. Access ports are available to visually inspect the CRDM canopy seal welds and the area above the insulation inside the CRDM shroud. The bare metal of the head, outside the CRDM shroud, can be seen during refueling outages. Leakage inside the shroud would be evident outside the shroud if sufficient leakage was present.

Since Refuel 3 (1989) Callaway has had a maintenance inspection of the canopy seal welds for all upper head penetrations. This inspection is performed each refueling on the first day access to the reactor cavity is granted. This canopy seal weld inspection is performed above the insulation that covers the head penetrations that are the subject of this bulletin, but this inspection would identify leakage or evidence of leakage from above the insulation that may intrude below the insulation to the reactor head surface.

Required Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

   B. **an evaluation of the ability of your inspection and maintenance programs to identify degradation of the reactor pressure vessel head including, thinning, pitting, or other forms of degradation such as the degradation of the reactor pressure vessel head observed at Davis-Besse,**

Callaway Response:

Callaway has access to all surfaces of components above the insulation that could potentially leak borated water onto the head. All joints (mechanical or welded) above the J-groove welds of RPV penetrations are visible above the head insulation. These include all control rod drive mechanisms (CRDM), core exit thermocouple (CET) columns, reactor vessel level indicating system (RVLIS) columns, and reactor vessel head vent piping and components. Visual inspection inside the CRDM cooling shroud and on the seismic platform would reveal leakage from any of the aforementioned penetration joints without requiring the removal of any insulation. Therefore boric acid residue and/or leakage from any joint above the RPV penetrations' J-groove weld, including the resultant flow path, would be readily evident.

Also, the insulation that covers the portion of the reactor head below the CRDM cooling shroud is removed during each refueling outage. This provides direct visual access to the lower area of the reactor head and to the reactor vessel studs, nuts and washers. Significant borated water leakage onto the RPV head above or below the insulation would be identified as visible deposits in this region.

Any boric acid deposits identified during inspections are evaluated in accordance with the programs identified in 1.A.

Any leakage of such a magnitude that would have led to the thinning, pitting or wastage experienced by Davis—Besse would have been identified by the above listed inspections. Identification of Class 1 pressure boundary leakage from below the insulation would be designated as a Nonconforming Material Condition (NMR) requiring disposition and corrective action. The NMR investigation would lead to inspection below the insulation.

Required Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    C. **a description of any conditions identified (chemical deposits, head degradation) through the inspection and maintenance programs described in 1.A that could have led to degradation and the corrective actions taken to address such conditions,**

Callaway Response:

A review of plant history since commercial operation was performed to identify any potential borated water leaks onto the reactor pressure vessel head. The results of this review are described below.

Refuel 2 (Fall 1987) - Leaks were observed on TVBB05 and TVBB07 (Core Exit Thermocouple Nozzle Assemblies, commonly referred to as Conoseals). The leak area was above the CRDM shroud, however it can be assumed that some of the fluid migrated to the surface of the reactor vessel head. This leak was observed following vessel re-assembly during pressure increase to NOP/NOT. The plant was depressurized and the leaks repaired prior to power operation. The area above the insulation was cleaned, however insulation was not removed. Therefore, this short-term leakage may have resulted in minor boron deposits in the plant north area of the head. These potential minor boron deposits would not have resulted in wastage of the type seen at Davis-Besse.

Refuel 5 (Spring 1992) - The inspection performed as described in 1.A identified leaking canopy seal welds. The leaking canopy seal welds were repaired with a weld overlay. The affected penetrations were numbers 3, 4, 7, 14, 28 and 35. The leaking canopy seal welds were successfully repaired prior to restart from Refuel 5. Since Refuel 5 there have been no indications of leaking canopy seal welds.

During Refuel 5, Engineering prepared an inspection procedure to identify the locations of canopy seal weld cracks as indicated by boron deposits. A review of the inspection results revealed the boron was generally limited to the area of the canopy seal weld (above the insulation). The inspection also looked at adjacent canopies to determine if fluid had sprayed on them. The results of the inspection found mostly dust-like boron deposits on the affected canopies with the exception of penetrations 7 & 14 that had some crystalline boron present. No indications of spraying were identified in the inspections. Additionally, the inspections only found boron near the affected canopy seal welds. It was concluded that no fluid leaked onto the reactor vessel head from these leaks. Penetration 7 was noted as having "water tracks - clean" present, but there was no indication that this was from borated water.

Refuel 11 (Spring 2001) – At the beginning of the refueling outage, the reactor head vent valves, (located approximately 20' above the plant northeast quadrant of the reactor head), were identified as leaking. The majority of the RCS fluid fell outside the CRDM shroud, while some portion did enter the shroud. During Refuel 11 extensive decontamination was performed to remove the borated water from the exposed portion of the head, removed mirror insulation, reactor studs, and any reasonably accessible areas inside the CRDM shroud. There was no degradation of the exposed portion of the reactor vessel head from this leak. Because no degradation was noted on exposed portions and because of ALARA concerns, no cleaning was done under the insulation inside the CRDM shroud.

In conclusion, these conditions would not have resulted in degradation of the reactor pressure vessel head including, thinning, pitting, or other forms of degradation such as the degradation of the reactor pressure vessel head observed at Davis-Besse. Callaway Plant's corrective action program has removed boric acid deposits from all accessible locations such that any future leakages can be identified.

Required Information

1. **Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:**

    D. **your schedule, plans, and basis for future inspections of the reactor pressure vessel head and penetration nozzles. This should include the inspection method(s), scope, frequency, qualification requirements, and acceptance criteria, and**

Callaway Response:

Using the PWSCC susceptibility model described in Appendix B to the MRP-44, Part 2 report (as referenced in NRC Bulletin 2001-01), Callaway Plant is considered to have low susceptibility to circumferential cracking of the reactor pressure vessel head penetration nozzles. The evaluation based upon these criteria indicated it would take approximately 114 Effective Full Power Years (EFPYs) of additional operation to reach the same time-at-temperature as Oconee Nuclear Station Unit 3 (ONS3). The 114 EFPY is based from March 1, 2001. March 2001 is when leaking nozzles were discovered at ONS3. As described in Reference 2, the evaluation used the same time-at-temperature model as described in Appendix B to MRP-44, Part 2. Because of this, in the response to NRC Bulletin 2001-01, Callaway Plant made no commitment to perform a bare metal visual examination of the RPV Head.

However, due to the significance of the Davis-Besse reactor pressure vessel head degradation issue, Callaway Plant is committing to perform an inspection of the RPV head and nozzles to supplement the inspections describe in 1A above.

Scope:

Callaway will perform a bare metal inspection of 100% of the RPV head to identify degradation of the reactor pressure vessel head, including thinning, pitting, or other forms of degradation, such as the degradation of the reactor pressure vessel head identified at Davis-Besse. The inspection will be performed prior to startup from Refuel 12, which is currently scheduled for October 2002.

Method:

The visual inspections under the mirror insulation will be performed using remote examination equipment.

Personnel qualification requirements:

Personnel performing the remote examination of the bare metal reactor head will be certified at a minimum as VT 2 level II visual examiners in accordance with the requirements of ASME Section XI, 1989 Edition or later approved code editions.

Personnel performing the final evaluation of examination findings will be certified VT-2 level II or III.

<u>Examination system qualification requirements</u>:

The remote examination system will provide visual resolution equivalent to a direct VT-2 visual as specified in the 1992 Edition of ASME Section XI Article IWA-2212 and ASME Section V Article 9 paragraph T-942. The remote examination system and procedure will be demonstrated to resolve a near vision test chart meeting the requirements of ASME Section XI Article IWA table 2210-1 for VT-2 examination.

<u>Acceptance criteria:</u>

All accumulations of boric acid residue on the reactor head will be investigated sufficiently to determine the origin of the deposit. Consistent with the ASME Code, discolored surfaces or areas with boric acid buildup will be given particular attention to determine if the surface below the residue is sound, to the extent possible with visual examination equipment. If necessary, supplemental investigation aids such as scrapers/brushes, compressed air and water washing will be applied to suspect areas to assist in the resolution of these areas.

If head penetration leakage is found in the course of the visual inspections, the remaining penetrations will be examined using appropriate nondestructive examination methods (e.g., volumetric examination). Defects will be repaired or evaluated using a qualified ASME Section XI plan or approved alternative.

Boric acid residue, whose source is other than from a penetration tube juncture, will be evaluated as noted above. Additional corrective measures regarding the termination of the leak source and the arrest of any corrosive attack of the head will be employed.

<u>Frequency:</u>

In addition to the inspections described in 1A above, the frequency of future bare metal inspections beyond the one committed to in Refuel 12 will be based on Callaway Plant inspection results, the Davis-Besse root cause analysis, industry inspection results, and industry initiatives.

E. your conclusion regarding whether there is reasonable assurance that regulatory requirements are currently being met (see the Applicable Regulatory Requirements, above). This discussion should also explain your basis for concluding that the inspections discussed in response to Item 1.D will provide reasonable assurance that these regulatory requirements will continue to be met. Include the following specific information in this discussion:

(1) If your evaluation does not support the conclusion that there is reasonable assurance that regulatory requirements are being met, discuss your plans for plant shutdown and inspection.

(2) If your evaluation supports the conclusion that there is reasonable assurance that regulatory requirements are being met, provide your basis for concluding that all regulatory requirements discussed in the Applicable Regulatory Requirements section will continue to be met until the inspections are performed.

Callaway Response:

Based on the following, Callaway Plant has reasonable assurance that the reactor pressure vessel head, head penetrations and reactor coolant pressure boundary are capable of fulfilling all license and design basis requirements and will continue to be met. Specific licensing basis requirements are addressed below.

The NRC Bulletin 2002-01 section entitled Applicable Regulatory Requirements cites the following regulatory requirements as providing the basis for the bulletin assessment:

- Appendix A to 10 CFR Part 50, General Design Criteria for Nuclear Power Plants
- Criteria 14 – Reactor Coolant Pressure Boundary
- Criteria 31 – Fracture Prevention of Reactor Coolant Pressure Boundary, and
- Criteria 32 - Inspection of Reactor Coolant Pressure Boundary
- Plant Technical Specifications
- 10 CFR 50.55a, Codes and Standards, which incorporates by reference Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, of the ASME Boiler and Pressure Vessel Code
- Appendix B of 10 CFR Part 50, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, Criteria V, IX, and XVI
- NRC Generic Letter 88-05

General Design Criteria (GDC):

The Bulletin states that the applicable GDC include GDC 14, GDC 31, and GDC 32. GDC 14 specifies that the reactor coolant pressure boundary be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. GDC 31 specifies that the reactor coolant pressure boundary be designed with sufficient margin to assure that the probability of rapidly propagating fracture is minimized. GDC 32 specifies that components that are part of the reactor coolant pressure boundary be designed to permit periodic inspection and testing of important areas and features to assess their structural and leaktight integrity.

As part of the original design and licensing, Callaway Plant demonstrated that the design of the reactor coolant pressure boundary meets these requirements. Callaway Plant complied with these criteria in part by: 1) selecting corrosion resistant materials with high fracture toughness for reactor coolant pressure boundary materials; and 2) following ASME Codes and Standards for fabrication, erection, and testing of the pressure boundary parts. As described above, the requirements established for design, fracture toughness, and inspectability in GDC 14, 31, and 32, respectively, were satisfied during the initial design and licensing, and continue to be satisfied during operation.

It is recognized that stress corrosion cracking has been identified in some reactor pressure vessel heads in the industry. However, Callaway Plant is in the low susceptibility range for stress corrosion cracking based upon the MRP-44, Part 2 susceptibility rankings. To date, industry penetration cracking inspection results have been very consistent with the susceptibility ranking. Plants that are comparable to Callaway Plant have performed both visual inspections and non-visual NDE and have not identified indications of cracking.

D.C. Cook Unit 2 is a Westinghouse 4-loop plant that is higher in the susceptibility ranking than Callaway Plant, and is similar in design to Callaway Plant. The reactor pressure vessel head at D.C. Cook Unit 2 was inspected with both visual and non-visual NDE in the spring of 2002. No flaws or leakage were identified in any penetrations.

Millstone Unit 2 is a CE plant that is higher in the susceptibility ranking than Callaway Plant. During the current refueling outage, non-visual NDE was performed, and identified non-through-wall flaws below the weld. While flaws like these would require evaluation or repair, the flaws would have to propagate through the reactor coolant pressure boundary before degradation could begin.

The probable cause summary from Davis-Besse states that the head penetration crack was through-wall for approximately 2-4 cycles. Reactor pressure vessel head degradation occurred over the course of several years. The probable cause summary also notes that there were indications of borated water leakage for some time. The Davis-Besse estimated corrosion rates were noted as being compatible with the EPRI Boric Acid Corrosion Guidebook.

Based upon the agreement between industry susceptibility ranking and industry inspection results to date, Callaway Plant is extremely unlikely to have any leakage from head penetration cracking. Callaway Plant has aggressively pursued all identified leakage sources, correcting the source and cleaning the accessible resultant boric acid residue. Therefore, if there is leakage, Callaway Plant expects the results to be typical of plants like Oconee, Crystal River, and others that have found a small popcorn-like deposit on the head near the penetration tube, and not leakage that would cause the degradation observed at Davis-Besse.

Plant Technical Specifications:

The limits for Callaway Plant reactor coolant pressure boundary leakage are provided in Technical Specification (TS) 3.4.13, and are stated in terms of the amount of leakage (i.e., 1 gallon per minute for unidentified leakage; 10 gpm for identified leakage; and no pressure boundary leakage). Routine surveillance testing is performed to ensure these requirements are met. Based on industry experience, leaks from reactor coolant system Alloy 600 penetrations have been well below the sensitivity of on-line leakage detection systems. If measurable leakage is detected by the on-line leak detection systems, the leak will be evaluated per the TS, and the plant will be shut down if required. Upon detection and identification of a leak, corrective actions will be taken to restore reactor coolant pressure boundary integrity. Callaway Plant continues to meet the requirements of this TS.

Inspection Requirements (10 CFR 50.55a and ASME Section XI):

The Bulletin describes the requirements for inspection in accordance with the ASME Code, detection of leakage from insulated components, and the acceptance standards if through wall leakage is detected. Callaway Plant has complied with the inspection requirements for insulated components as part of the Callaway Plant ISI program.

Since the head is insulated, and the CRDM nozzles do not represent a bolted flange, the Code permits these inspections to be performed with the insulation left in place. Callaway Plant also complies with the requirements of Generic Letter 88-05 by performing walkdowns during refueling outages and other shutdowns. If conditions are identified in the course of these inspections, corrective actions are performed, including supplemental examinations, repairs and/or evaluations, and inspections for consequential degradation of carbon steel or low alloy steel.

Quality Assurance Requirements (10 CFR 50, Appendix B):

The Bulletin states that special processes, including nondestructive testing, shall be controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements, as required by Appendix B, Criteria V (Instructions, Procedures, and Drawings) and Appendix B, Criteria IX (Control of Special Processes). Callaway Plant programs comply with these standards.

Criterion XVI (Corrective Action) of Appendix B states that measures shall be established to assure that conditions adverse to quality are promptly identified and corrected. For significant conditions adverse to quality, the measures taken shall include root cause determination and corrective action to preclude repetition of the adverse conditions.

If any cracking, leakage or degradation in Class 1 systems is detected during the reactor head and head penetration inspections described above, corrective actions will be taken in accordance with the Callaway Plant corrective action program and plant procedures. Any reactor coolant pressure boundary leakage or degradation would be considered a significant condition adverse to quality and appropriate actions, including a cause analysis, will be taken.

In consideration of potential conditions adverse to quality, Callaway Plant has been actively participating in industry organizations (Westinghouse Owners Group and Material Reliability Program) and continues to be aware of industry experience.

NRC Generic Letter 88-05:

As discussed above, Callaway Plant has implemented the inspection and walkdown requirements of Generic Letter 88-05.

Based upon the evaluation provided above, Callaway Plant continues to comply with the regulatory requirements described in NRC Bulletin 2002-01.

2. **Within 30 days after plant restart following the next inspection of the reactor pressure vessel head to identify any degradation, all PWR addressees are required to submit to the NRC the following information:**

   A. **the inspection scope (if different than that provided in response to Item 1.D.) and results, including the location, size, and nature of any degradation detected,**

   B. **the corrective actions taken and the root cause of the degradation.**

Callaway Response:

Callaway Plant will submit the information as requested within 30 days after plant restart following the next refueling outage. Based on current outage schedule for Callaway Plant the submittals will be provided in December 2002.

3. **Within 60 days of the date of this bulletin, all PWR addressees are required to submit to the NRC the following information related to the remainder of the reactor coolant pressure boundary:**

   A. **the basis for concluding that your boric acid inspection program is providing reasonable assurance of compliance with the applicable regulatory requirements discussed in Generic Letter 88-05 and this bulletin. If a documented basis does not exist, provide your plans, if any, for a review of your programs.**

Callaway Response:

Callaway Plant will submit the information as requested by May 17, 2002.

LIST OF COMMITMENTS

The following table identifies those actions committed to by Callaway Plant in this document. Any other statements in this submittal are provided for information purposes and are not considered to be commitments. Please direct questions regarding these commitments to Mr. Dave E. Shafer, Superintendent Licensing (314) 554-3104.

COMMITMENT	Due Date/Event
Submit 60 day response to NRC Bulletin 2002-01 item 3A	May 17, 2002
Bare metal inspection of 100% of the Reactor Pressure Vessel (RPV) head to identify degradation of the RPV head, including thinning, pitting, or other forms of degradation,	Refuel 12
Provide the information requested by NRC Bulletin 2002-01 items 2A and 2B.	Within 30 days after plant restart following Refuel 12. (December 2002)