May 19, 2004

Mr. Garry L. Randolph
Vice President and Chief Nuclear Officer
Union Electric Company
Post Office Box 620
Fulton, MO 65251

SUBJECT: CALLAWAY PLANT, UNIT 1 - REQUEST FOR RELIEF FROM ASME CODE REQUIREMENTS ON THE USE OF WELD OVERLAY REINFORCEMENT TO RESTORE WALL THICKNESS OF ASME CLASS 2 CARBON STEEL MAIN FEEDWATER PIPING (TAC NO. MC3086)

Dear Mr. Randolph:

By the application dated May 7, 2004 (ULNRC-04993), you requested relief from the requirements in Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) to repair or replace ASME Class 2 carbon steel piping sections associated with the main feedwater (MFW) system at the Callaway Plant, Unit 1. Pursuant to 10 CFR 50.55a(a)(3)(i), you have proposed to perform a temporary weld repair of the affected piping sections using weld overlay. This relief request is a revision of the request submitted in your letters dated July 22, 2003 (ULNRC-04875), and January 22, 2004 (ULNRC-04942), that the NRC approved in its letter dated April 7, 2004. The revision adds an additional MFW pipe section to the previous relief request.

Based on the enclosed safety evaluation, the staff concludes that compliance with ASME Code Section XI requirements to permanently repair or replace ASME Code Class 2 carbon steel piping sections would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) for the second 10-year inservice inspection interval at the Callaway Plant, Unit 1. All other ASME Code, Section XI requirements, for which relief was not specifically requested and approved in this relief request, remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Sincerely,

/RA/

Stephen Dembek, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosure: Safety Evaluation

cc w/encl: See next page

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Project Directorate IV
Division of Licensing Project Management
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cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF FROM ASME CODE SECTION XI REQUIREMENTS

USE OF WELD OVERLAY REINFORCEMENT TO RESTORE WALL THICKNESS

OF ASME CLASS 2 CARBON STEEL MAIN FEEDWATER PIPING

UNION ELECTRIC COMPANY

CALLAWAY PLANT, UNIT 1

DOCKET NO. 50-483

1.0 INTRODUCTION

By letter dated May 7, 2004, Union Electric Company (the licensee) submitted, pursuant to 10 CFR 50.55a(a)(3)(i), a request for relief from the American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code (Code), Section XI requirements to repair or replace ASME Code Class 2 carbon steel piping sections associated with the main feedwater system at Callaway Plant, Unit 1 (Callaway). The licensee proposed to perform a temporary weld repair of the affected piping sections using weld overlay.

The licensee stated that the request for relief is limited to specific areas where the projected pipe wall thickness monitored under Callaway's flow accelerated corrosion (FAC) program may be found to be less than the minimum ASME Code-specified wall thickness when inspections are completed during refueling outage (RF) 13, which began on April 10, 2004. The licensee also stated that the affected piping sections are already scheduled for replacement during RF-14 (scheduled for the Fall of 2005) because of the planned replacement of the steam generators at Callaway. Application of the weld overlay in RF-13 would restore pipe wall thickness and thus ensure that the repaired pipe segments would perform as designed during the period of plant operation between RF-13 and RF-14. This action would eliminate the need for consecutive replacement of the same piping sections (i.e., once in RF-13 and then again in RF-14) and the service life of the weld overlay(s) would be limited to one operating cycle. Callaway is currently in the second 10-year inservice inspection interval and the 1989 Edition of ASME Code, Section XI with no Addenda governs the current repair/replacement activities at the Callaway plant.

2.0 REGULATORY EVALUATION

In the Commission's regulations, 10 CFR 50.55a(g) specifies that inservice inspection (ISI) of nuclear power plant components shall be performed in accordance with the requirements of the ASME Code, Section XI, except where specific written relief has been granted by the

Commission pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(a)(3) states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Section 50.55a(g)(5)(iii) states that if the licensee has determined that conformance with certain code requirements is impractical for its facility, the licensee shall notify the Commission and submit, as specified in 10 CFR 50.4, information to support the determination.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Evaluation

Background (as stated in the licensee's letter dated May 7, 2004):

> As an alternative to piping replacement in accordance with ASME Section XI IWC-4000, and pursuant to the provisions of 10 CFR 50.55a(a)(3)(i), Callaway Plant requests permission to restore the wall thickness of high energy ASME Class 2 feedwater piping by weld overlay. Requested service life of the weld overlay reinforcement is one operating cycle from Refuel 13 to Refuel 14. Piping reinforced by weld overlay will be cut out and replaced during installation of new steam generators in Refuel 14.
>
> The 1989 Edition with no Addenda of ASME Section XI currently governs repair/replacement activities at the Callaway Nuclear Plant. Callaway Plant is currently in the second 10-year inservice inspection interval, which began on August 1, 1995. The 1974 Edition with Summer 1975 Addenda of ASME Section III is the Construction Code for the main feedwater piping system.

Areas Identified that may Require Weld Overlay Reinforcement (as stated in the licensee's letter dated May 7, 2004):

> The Callaway Flow Accelerated Corrosion (FAC) program is used to monitor and evaluate the remaining life of ASME Class 2 feedwater piping at the Callaway plant. Evaluation and ultrasonic wall thickness examinations have revealed a small number of locations where repair and/or piping replacement will be necessary in the future. Table 1 [an attachment to this safety evaluation] lists feedwater piping areas where repair by overlay reinforcement is requested. The piping/part description, Callaway location identifier, nominal pipe size, pipe schedule, and base material type are listed for each location. Table 2 [an attachment to this safety evaluation] provides wall thickness data for these locations. The design minimum wall thickness, measured wall thickness, projected wall thickness, and expected margin are provided for each location. The maximum projected axial length requiring overlay reinforcement (L dimension in Figure 1 [in the letter]) is expected to be 8 inches or less.

Justification for Weld Overlay Reinforcement (as stated in the licensee's letter dated May 7, 2004):

> Projections based on calculated wear rates and ultrasonic examination data obtained during Refuel 11 and Refuel 12 indicate weld overlay reinforcement may be necessary to maintain the required structural integrity until Refuel 14 when new steam generators will be installed. Piping reinforced by weld overlay will be cut out and replaced during installation of the new steam generators.
>
> The piping areas that may require weld overlay reinforcement are relatively small localized areas. Adjacent areas have been inspected and verified to have wall thickness that meets design requirements. Weld overlay reinforcement will restore wall thickness of the piping to a value greater than or equal to design minimum wall thickness with adequate margin, considering predicted wear rates, to provide a service life of one operating cycle. In addition, the weld overlay material is not predicted to become exposed to feedwater during the cycle. The weld overlay will have a uniform width and extend 360 degrees circumferentially around the piping. The proposed overlay reinforcement will ensure a sufficient level of safety and provide adequate structural integrity for one operating cycle.
>
> The weld overlay reinforcement alternative will result in a significant reduction in personnel radiation exposure during refueling outage maintenance work. In addition, by avoiding replacement of the piping during Refuel 13 and again in Refuel 14, outage duration and costs are reduced by decreasing the overall scope of work.

Requirements for Restoration of Internal Wall Thinning by Weld Overlay (as stated in the licensee's letter dated May 7, 2004):

> Weld overlay reinforcement on the outside surface of the piping shall be installed in accordance with the following requirements and rules:
>
> 1. General Requirements
>
> 1.1 The weld overlay(s) installed to restore wall thickness shall be performed in accordance with the Callaway Repair/Replacement Program[1] [footnote in letter is not included in this safety evaluation].
>
> 1.2 The wall thickness restoration shall meet all requirements of the Callaway Repair/Replacement Program except as permitted in this relief request.
>
> 2. Initial Evaluation
>
> 2.1 The piping base material where the weld overlay is to be installed shall be evaluated to establish the existing average wall thickness and the extent and configuration of degradation to be reinforced by the weld overlay.

2.2 Areas of piping, parts, or components, adjacent to the identified overlay area shall be examined to verify that the entire defect area will be encompassed as necessary by the weld overlay and to validate any design assumptions relative to the structural integrity of the piping.

3. Weld Overlay Design

3.1 The thickness of the weld overlay reinforcement shall not exceed 1/4 inch. See thickness dimension W in Figure 1 [of the letter].

3.2 Evaluation of areas that require restoration by weld overlay shall consider the design life of the piping, future internal wall thinning in the weld overlay area, and shall be based on the design thickness as prescribed by ASME Section III.

3.3 The weld overlay shall have a uniform width and extend 360 degrees circumferentially around the piping.

3.4 Unless otherwise established by design analysis, the weld overlay shall extend axially a distance of at least s in each direction beyond the area that requires restoration, where s is defined as:

$$s \geq \frac{3}{4}\sqrt{Rt_{nom}}$$

[R] = average outer radius of the component
t_{nom} = nominal wall thickness of the component

3.5 Edges of the weld overlay shall be tapered to the existing piping surface to a maximum angle of 45°. See angle a shown in Figure 1 [of the letter].

3.6 Final configuration of the weld overlay reinforcement shall permit nondestructive examination as required in 5.1 and 5.2.

3.7 Except for the tapered edges, the weld overlay reinforcement shall have a uniform thickness.

3.8 Tensile strength of the weld filler metal used for the overlay shall be at least that specified for the piping base material.

3.9 Design shall be in accordance with ASME Section III and shall consider the weld overlay as an integral portion of the piping upon which it is applied (not as a weld).

3.10 The allowable stress values of the base metal shall apply to the design of the deposited weld metal.

3.11 The following factors shall be considered in design of the weld overlay reinforcement:

3.11.1 The effects on the piping system of radial and longitudinal shrinkage caused by application of the overlay;

3.11.2 The effects on flexibility, stress concentration, and section properties of the added section thickness;

3.11.3 Stress concentrations resulting from existing and predicted piping internal surface configuration;

3.11.4 The effects of different coefficients of thermal expansion between the weld overlay filler metal and the base metal.

3.12 The effect of the weld overlay shall be reconciled with the original flexibility analysis required by ASME Section III. Unless a lower stress intensification factor (SIF or i) is established, an SIF(i) of 2.1 shall be applied for overlays on straight pipe and adjacent welds; a stress multiplier of 1.7 shall be applied to the SIF(i) for standard elbows; and an SIF(i) of 2.1 shall be applied for tees and branch connections when the toe of the overlay is not less than $2.5\sqrt{7[R]t_{nom}}$ from any branch reinforcement.

4. Installation

4.1 The entire surface area to which the weld overlay is to be installed shall be examined using either the liquid penetrant (PT) or magnetic particle (MT) test method. Acceptance criteria shall be in accordance with NC-2500/5300 for the specific product form that was examined (e.g., base material or weld metal).

4.2 The weld overlay reinforcement shall be installed in accordance with the Callaway Repair/Replacement Program.

4.3 The overlay weld metal shall be installed using a groove weld procedure qualified in accordance with ASME Section IX and Section III.

4.4 The surface of the final overlay reinforcement shall be prepared by machining or grinding as necessary to permit performance of surface and wall thickness examination.

5. Examination

5.1 The completed weld overlay reinforcement shall be examined using liquid penetrant (PT) or magnetic particle (MT) test method. The acceptance criteria shall be in accordance with ASME Section III, NC-5300.

5.2 The weld overlay reinforcement and the base material below the reinforcement shall be examined by ultrasonic examination to verify acceptable wall thickness.

6. Documentation

Use of this relief request shall be documented as specified in the Callaway Repair/Replacement Program.

3.2 Technical Evaluation

The staff reviewed the information provided by the licensee in support of its request for relief from ASME Code, Section XI requirements to permanently repair or replace ASME Code Class 2 carbon steel piping sections at its Callaway plant. This relief request is a revision of the relief request submitted by the licensee in its letters dated July 22, 2003, and January 22, 2004, in that additional locations are being submitted for relief from the ASME Code requirements. In RF-13 which began April 10, 2004, the licensee conducted inspections of the MFW piping in which greater-then-expected pipe wall thinning in a pipe section not identified in the request submitted July 22, 2003 and January 22, 2004, was discovered. The relief request submitted May 7, 2004, is including this additional pipe section, FAC Identification (ID) No. AE05-E690, which is the last pipe section listed in the tables attached to this safety evaluation. This safety evaluation follows the staff's safety evaluation issued April 7, 2004, for the previous relief request.

The weld overlay(s) to be installed to restore wall thickness will be performed in accordance with the Callaway Repair/Replacement Program. The program meets the requirements of the 1989 Edition of ASME Code, Section XI with no Addenda. The licensee determined that the piping areas that may require weld overlay reinforcement are relatively small and localized areas. Adjacent areas have been inspected and found to have wall thickness that meets design requirements. The proposed weld overlay will have a uniform width and extend 360 degrees circumferentially around the piping and the weld overlay material is not predicted to become exposed to feedwater during the period of plant operation between RF-13 and RF-14. The thickness of the weld overlay reinforcement will not exceed 1/4 inch. The surface of the final overlay reinforcement shall be prepared by machining or grinding in order to permit performance of surface and wall thickness examination. The entire surface area to which the weld overlay is to be installed will be examined using either the PT or MT test method. Acceptance criteria shall be in accordance with ASME Code, Section III paragraph(s) NC-2500/5300 for the specific product form that was examined (e.g., base material or weld metal). The effect of the weld overlay will be reconciled with the original flexibility analysis required by ASME Code, Section III using conservative stress intensification factors. The staff finds this process acceptable because it meets the design, fabrication and examination requirements of ASME Code, Section III.

The attached Table 2, from the licensee's submittal, identifies the location of the pipe segments that will require weld overlay in order to provide additional pipe thickness during the period of planned operation between RF-13 and RF-14. A total of thirteen piping locations are listed in the table. In the table, six locations (the margin shown in **bold** in the table) are projected by RF-14 to fall below minimum wall thickness required by ASME Code, Section III. In addition,

three locations are projected by RF-14 to be within 1 to 3 mils above the minimum wall thickness required by ASME Code, Section III. The remaining four locations are projected to be between 15 and 90 mils above the minimum wall thickness. The review of the data presented in Table 1 and Table 2 established that the proposed weld overlay of 1/4 inch maximum is adequate to provide additional pipe thickness during plant operation in the period between RF-13 and RF-14, because the addition of the weld overlay will place the affected piping segments above the minimum design wall thickness required by the ASME Code, Section III.

Because the staff finds that the licensee has provided an acceptable alternative method to increase the required wall thickness above the minimum design wall thickness specified by the ASME Code, Section III for the pipe segments listed in Table 2, the staff concludes that the proposed overlay reinforcement will provide adequate structural integrity for one operating cycle. Because the permanent ASME Code repair would result in a significant increase in personnel radiation exposure and would require double replacement of the piping, during RF-13 and again in RF-14, the staff also concludes that imposing the ASME Code requirements at this time would place a significant burden upon the licensee without a compensating increase in the level of quality and safety.

4.0 CONCLUSIONS

Based on the above evaluation, the staff concludes that the proposed alternative as discussed in the licensee's request for relief is acceptable because the proposed overlay reinforcement will provide adequate structural integrity for one operating cycle and imposing the ASME Code requirements at this time would place a significant burden upon the licensee without a compensating increase in the level of quality and safety. Therefore, the proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) for the second 10-year ISI interval at Callaway. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Attachments:
1. Table 1 – Feedwater Piping Areas That May Require Weld Overlay Reinforcement
2. Table 2 – Feedwater Piping Wall Thickness Data

Principal Contributor: George Georgiev

Date: May 19, 2004

Table 1: Feedwater Piping Areas That May Require Weld Overlay Reinforcement

The following table, which lists feedwater piping areas where repair by overlay reinforcement is requested by the licensee, is taken from the attachment to the licensee's letter dated May 7, 2004:

Area Description	FAC ID No. [1&2]	NPS[3]	Sch.	Mat.
Downstream area of A S/G 14" by 16" expander	AE04-DE7E	16	80	CS
Downstream area of C S/G 14" by 16" expander	AE05-B5E	16	80	CS
Downstream area of D S/G 14" by 16" expander	AE05-CD7E	16	80	CS
Upstream area of 45^0 elbow upstream of AEV0122	AE05-E645	14	80	CS
Upstream area of 90^0 elbow downstream of AEV0123	AE05-AB590	14	80	CS
Midspan area of A S/G 5D bend	AE04-E890	14	80	CS
Midspan area of B S/G 5D bend	AE04-C4590	14	80	CS
Midspan area of C S/G 5D bend	AE05-B590	14	80	CS
Midspan area of D S/G 5D bend	AE05-D890	14	80	CS
Upstream area of 90° elbow upstream of AEVO122	AE05-E690	14	80	CS

Notes:

1. Listed FAC ID Numbers are those currently identified in the Callaway FAC Program.
2. Figures 2 and 3 in the licensee's letter show location of areas by FAC ID No.
3. NPS is pipe size of area for weld overlay reinforcement.

Table 2: Feedwater Piping Wall Thickness Data[1]

The following table, which lists the wall thickness data for the locations in Table 1, is taken from the attachment to the licensee's letter dated May 7, 2004.

FAC ID No.	Location	Design[2] Min	Ware Rate (Mils/yr)	RF11[3] measured	RF12[3] measured	RF13[4] Projected	RF13[4] margin	RF14[4] Projected	RF14[4] margin
AE04-DE7E	Upstream	0.489	8.203	0.549	0.514	0.502	0.013	0.490	0.001
AE04-DE7E	Downstream	0.680	7.590	0.687	0.687	0.676	**-0.004**	0.665	**-0.015**
AE04-E890	General	0.614	11.122	0.700	0.676	0.659	0.045	0.642	0.028
AE04-C4590	General	0.643	8.347	0.671	0.684	0.671	0.028	0.658	0.015
AE05-B5E	Upstream	0.489	9.421	0.544	0.519	0.505	0.016	0.491	0.002
AE05-B5E	Downstream	0.559	8.513	0.649	0.644	0.631	0.072	0.618	0.059
AE05-B590	General	0.643	12.603	0.650	0.663	0.644	0.001	0.625	**-0.018**
AE05-AB590	General	0.489	12.522	0.535	0.510	0.491	0.002	0.472	**-0.017**
AE05-CD7E	Upstream	0.489	8.185	0.609	0.603	0.591	0.102	0.579	0.090
AE05-CD7E	Downstream	0.680	7.434	0.693	0.685	0.674	**-0.006**	0.663	**-0.017**
AE05-D890	General	0.614	10.950	0.655	0.649	0.633	0.019	0.617	0.003
AE05-E645	General	0.489	9.776	0.535	0.516	0.501	0.012	0.486	**-0.003**
AE05-E690	General	0.403	44.000[5]	0.577	no data	0.459[6]	0.056	0.393	**-0.010**

Notes:

1. Wall thickness values are in inches.

2. General design minimum wall was determined by analysis at each location. Structural integrity was verified by additional detailed analysis at specific locations where the measured wall thickness encroached on design minimum wall thickness.

3. Anomalous ultrasonic test readings are attributed to changes in inspection personnel and test equipment and are considered within acceptable tolerances. These variances do not adversely impact the model for calculating projected wear.

4. Projected wall thickness margin is based on average wear rates determined by the Callaway FAC program. Wall thickness margin is the difference between the projected thickness and the design minimum.

5. This wear rate is based on the difference of minimum measured wall thickness from Refuel 11 and Refuel 13 divided by the operating time. This results in a highly conservative ware rate estimate.

6. Measured wall thickness taken during Refuel 13.

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