UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SECOND TEN YEAR INTERVAL INSERVICE INSPECTION PROGRAM PLAN

REVISED REQUEST FOR RELIEF NO. ISI-07B

UNION ELECTRIC COMPANY

CALLAWAY PLANT

DOCKET NO. 50-483

1.0 INTRODUCTION

The Technical Specifications for Callaway Plant state that the inservice inspection of the American Society of Mechanical Engineers (ASME) Code Class 1, 2, and 3 components shall be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable Addenda as required by 10 CFR 50.55a(g), 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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first ten-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The applicable edition of Section XI of the ASME Code for the Callaway Plant second 10-year inservice inspection (ISI) interval is the 1989 Edition.

Pursuant to 10 CFR 50.55a(g)(5), if the licensee determines that conformance with an examination requirement of Section XI of the ASME Code is not practical for its facility, information shall be submitted to the Commission in support of that determination and a request made for relief from the ASME Code requirement. After evaluation of the determination, pursuant to 10 CFR 50.55a(g)(6)(i), the Commission may grant relief and may impose alternative requirements that are determined to be authorized by law, will not

endanger life, property, or the common defense and security, and are otherwise in the public interest, giving due consideration to the burden upon the licensee that could result if the requirements were imposed.

By letter dated August 19, 1996, as supplemented by letter dated September 13, 1996, Union Electric Company, the licensee, submitted revised Relief Request ISI-07B for the second 10-year interval inservice inspection (ISI) at the Callaway Plant. The original evaluation of this relief request (authorized with conditions) was in a safety evaluation (SE) dated December 20, 1995. The approval of Relief Request ISI-07 included a condition that would result in the removal of insulation from bolted connections during pressure tests. The licensee submitted Revised Relief Request ISI-07A to have this condition reconsidered. The staff concluded that the alternative contained in this Revised Request for Relief No. ISI-07A did not provide specific technical information and the alternative did not provide quality and safety. Revised Request for Relief No. ISI-07A was denied. The licensee revised Request for Relief No. ISI-07A to include specific components and material properties and submitted Revised Request for Relief No. ISI-07B in its letter dated August 19, 1996, as supplemented by letter dated September 13, 1996.

2.0 EVALUATION AND CONCLUSION

The information provided by the licensee in support of the relief request has been evaluated and the bases for disposition are documented below.

Relief Request ISI-07B, IWA-5242(a), System Pressure Tests for Insulated Bolted Connections

Code Requirement: IWA-5242(a) states that for systems borated for the purpose of controlling reactivity, insulation shall be removed from pressure-retaining bolted connections for a direct VT-2 visual examination.

Licensee's Code Relief Request: The licensee requested relief from the Code-required removal of insulation for VT-2 visual examinations of bolted connections in borated systems.

Licensee's Basis for Requesting Relief (as stated):

> "Authorization for a proposed alternative is requested from the requirement to remove insulation for visual VT-2 examination of bolted connections during a system pressure test on systems borated for the purpose of controlling reactivity. Union Electric believes that removal of insulation at bolted connections for the sole purpose of visual examination will result in hardship and unusual difficulty for the reasons listed below per 10CFR50.55a(a)(3)(ii).
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> "1) The visual VT-2 examination of the Reactor Coolant System (RCS) is performed following the majority of all outage maintenance activities and just prior to reactor criticality. The RCS is at a normal operating temperature and pressure (557°F and 2235 psig) during the pressure test as required by IWA-5000. Performance of

a visual VT-2 examination for the subject bolted connections, re-installation of insulation, and disassembly of scaffolding under these conditions is a personnel safety hazard.

"2) The anticipated exposure for these exams on a best base case analysis from past experience (best RCS cleanup) is 11 Person-Rem. This is approximately 9% of the total budgeted dose for Refuel 8.

"3) Differential thermal expansion occurs when insulation is removed from a bolted connection that creates a greater chance for leakage. When the insulation is removed, the flanges expand at a rate greater than the bolts causing stress on the connection. Once the bolts expand, the stress has caused the equivalent of untorquing the connection. The connection then has a higher probability of leaking.

"4) Code Class 1 and 2 systems borated for the purpose of controlling reactivity are extensive and are located in many areas inside and outside of containment on multiple elevations. Scaffolding will be required to access many of the bolted connections. In addition, many of the bolted connections are located in difficult to access areas and in medium to high radiation areas. Insulation removal combined with scaffolding requirements will increase outage costs. Approximately 590 insulator manhours and 428 scaffolder manhours will be required to be added to Refuel 8 to support the performance of these VT-2 exams. Based on craft hourly labor rates as of June, 1995 for outage work, this equates to $38,495. The VT-2 is performed between modes 3 and 2 ascending, which normally has a duration of six to eight hours. Under the new requirements, critical path time will be extended several hours to accommodate the insulation installation and scaffold removal inside the bio-shield wall and throughout the containment after the examination is complete. Outage cost is currently estimated at $400,000 per day.

"Union Electric believes that the Callaway programs and alternative examination proposed below, provide an acceptable level of safety and quality for bolted connections in systems borated for the purpose of controlling reactivity.

"1) In response to NRC Generic Letter 88-05, Union Electric has established a program to inspect all boric acid leaks discovered in the containment building and to evaluate the impact of those leaks on carbon steel or low alloy steel components. All evidence of leaks, including boric acid crystals or residue, is inspected and evaluated regardless of whether the leak was discovered at power or during an outage. Issues such as the following are considered in the inspection and evaluation: 1) evidence of corrosion or metal degradation, 2) effect the leak may have on the pressure boundary, 3) possibility of boric acid traveling along the inside of insulation on piping, and 4) possibility of dripping

or spraying on other components. Based on this evaluation, appropriate corrective actions are initiated to prevent reoccurrence of the leak and to repair, if necessary, any degraded materials or components.

"2) In addition to the nondestructive examinations required by ASME Section XI, Union Electric has committed to the bolting examination requirements of NRC Bulletin 82-02. In accordance with this Bulletin, at least two nondestructive examination techniques (e.g., ultrasonic, liquid penetrant, magnetic particle, or visual VT-1) are performed on bolted connections of the following components: Steam Generator primary manways, Pressurizer primary manway, Pressurizer safety valves, and a total of 22 Reactor Coolant System isolation valves that are greater than 6 inch NPS. As a minimum, two nondestructive examination techniques are used whenever the bolted connection of one of the subject components is dissembled for maintenance or other inspection. These examinations ensure that degradation mechanisms such as Stress Corrosion Cracking or corrosion do not go undetected in bolted connections critical to reactor safety.

"3) All bolted connections on Callaway's Class 1 and 2 borated systems are either stainless materials SA-564 Grade 630 studs with SA-194 Grade 6 nuts or superalloy SA-453 Grade 660 studs with SA-194 Grade 6 or SA-453 Grade 660 nuts. The stainless steels were designed to be resident in corrosive applications. This is substantiated for the 410 stainless steels (SA-194) and the 17-4 PH stainless steel (SA-564) by EPRI Report NP-5769 which attests to the resistance of stainless steels to boric acid corrosion.

EPRI Report TR-102748 further confirms in section 7.2.1 that the 410 stainless steels and 17-4 PH stainless steel are superior to low alloy and carbon steel bolting materials. Materials test reports from Armco Steel Corporation and Republic Steel delineate superior corrosion resistance in the 17-4 PH stainless steel over standard hardenable chromium stainless steels and equivalence TYPE 304. The 410 stainless steel is an acceptable nut material because the nuts only experience compressive stress and tensile stresses are required for initiation of stress corrosion cracking. Therefore, only studs comprised of 410 stainless steel are potentially susceptible to stress corrosion cracking.

EPRI Report TR-102748 also includes the A-286 (SA-453) as a superior fastening material. The superalloy was designed for resistivity to acid corrosion environments due to its high nickel and chrome content and the inclusion of molybdenum specifically to inhibit inorganic acids such boric acid. These materials have been further evaluated by material selection expert C.P. Dillon who was subcontracted for Union Electric by Nickel Laboratories. His evaluation concludes that "the development of intermediate concentrations of boric acid solution in the flange area (due to

minor leaks and evaporation of the water) would not attack the bolting significantly and would be a marked improvement over low-alloy steel assemblies."

To ensure that degradation mechanisms in these metals are mitigated, Union Electric maintains a program at the Callaway Plant that controls materials (insulation, thread lubricant, boron, hydrogen sulfide, molybdenum disulfide etc.) that may come in contact with safety related component, including bolting. This program ensures that impurities are not present in concentrations that would promote development of Stress Corrosion Cracking in stainless steel bolted connections. Additionally, Union Electric places a very high emphasis on leak prevention, which is the root cause of boric acid corrosion concerns in bolted joints. Callaway's leak reduction program is outlined in EPRI Report TR-102748. At Callaway, bolted connections utilizing these fasteners are only preloaded 35% to 50% of their yield stress. This is below the threshold values that causes stress correction cracking for these materials. Additionally, the UNC bolting thread form that was evaluated by NUREG CR-3604 is deeper than the code required bolting thread form. Thread form 8 TPI or finer is utilized at Callaway as required by ANSI B1.1 and the ASTM specifications of each material. This finer thread form further minimizes the potential for stress corrosion cracking.

The only carbon steel bolted connections at the Callaway Plant is systems borated for the purpose of controlling reactivity are Steam Generators Manways, Reactor Coolant Pump Bolting and Pressurizer Manways. These areas will be inspected for leakage programs with the insulation removed."

Licensee's Proposed Alternative (As stated):

"Bolted connections fabricated from materials resistant to boric acid corrosion in systems borated for the purpose of controlling reactivity shall receive a visual VT-2 examination during the system pressure tests of IWB-5000 and IWC-5000 with the insulation installed. If evidence of leakage is detected, either by discovery of active leakage or evidence of boric acid crystals, the insulation shall be removed and the bolted connection shall be re-examined and, if necessary, evaluated in accordance with the corrective measures of Subarticle IWA-5250.

"Carbon steel bolted connections within the Inservice Inspection boundaries will receive an inspection for boric acid residue with the insulation removed. In addition, a VT-2 examination will be performed in accordance with ASME Section XI requirements with the insulation installed at normal operating pressure and temperature.

"If insulation is removed for planned maintenance, repair, or other inspection at a bolted connection in a system borated for the purpose of controlling reactivity, a visual examination shall be performed on the

bolted connection prior to disassembly and, if evidence of leakage is discovered, evaluated in accordance with the corrective measures of Subarticle IWA-5250."

Although Code Case N-533, *Alternative Requirements for VT-2 Visual Examination of Class 1 Insulated Pressure-Retaining Bolted Connections*, is not referenced in Regulatory Guide 1.147, it has been found by the NRC staff to be an acceptable alternative for use by other licensees. This Case provides for the insulation to be removed during each refueling outage and the connection examined when the system is not pressurized. The licensee does not propose to follow Code Case N-533. The licensee proposed as an alternative to Code requirements to eliminate most of the bolting from the Code required examinations based on the material used in the joint. The staff's review of the licensee's proposed bolting material finds that SA-453 Gr660 (A-286) bolt material, although resistant to boric acid corrosion, is susceptible to stress corrosion cracking. Limited data available appears to show that when bolt preload is below 100 ksi, no stress corrosion cracking occurs in A-286 material. However, this conclusion has not been adequately proven at this time. For SA-564 Gr630 (17-4 PH) bolt material, the staff finds that with a tempering of 1100°F or less, the Rockwell C hardness value is required by the ASME Code to be a minimum of 31. The staff is concerned that stress corrosion cracking might occur when the Rockwell C hardness value is greater than 30.

The staff finds that although the stainless steel bolting material selected for Callaway is resistant to boric acid corrosion, there is some concern about the susceptibility of the selected bolting material to stress corrosion cracking that has not been adequately addressed. Because current Code requirements and Code Case N-533 require insulation removal each refueling outage in order to perform a visual examination for leakage (VT-2), some degree of protection exists to identify leakage caused by stress corrosion cracking. The licensee's proposal to perform a VT-2 examination with no insulation removal does not ensure that leakage caused by bolt degradation as a result of stress corrosion cracking will be identified in a timely manner.

The staff concludes that the proposed alternative is unacceptable because the licensee's proposed alternative does not provide an acceptable level of quality and safety to ensure that component degradation, as a result of stress corrosion cracking, would be readily identified and corrected. Therefore, Revised Relief Request ISI-07B is denied.

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Date: October 3, 1996