1901 Chouteau Avenue
Post Office Box 149
St. Louis, Missouri 63166
314-554-2650

UNION ELECTRIC

January 28, 1997

Donald F. Schnell
Senior Vice President
Nuclear

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, D.C. 20555-0001

ULNRC-3526

Gentlemen:

**CALLAWAY PLANT**
**DOCKET NUMBER 50-483**
**ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY DURING DESIGN-BASIS ACCIDENT CONDITIONS**

References:
1) NRC Generic Letter 96-06 dated September 30, 1996
2) ULNRC-3483 dated October 30, 1996
3) NRC Memorandum, "Summary of December 19, 1996 Meeting With the Nuclear Energy Institute (NEI) Regarding Industry Responses to Generic Letter 96-06," dated December 26, 1996

Union Electric herewith transmits the 120-day response to NRC Generic Letter 96-06 (Reference 1). Reference 2 provided our 30-day response.

Generic Letter 96-06 identified three issues requiring evaluation and resolution by each nuclear power plant licensee:

1. Water hammer in containment air cooler systems during a Loss-of-Coolant Accident (LOCA) or Main Steamline Break (MSLB) which could result in piping loads exceeding design limits.

2. Two-phase flow in containment air cooling systems during a LOCA or MSLB such that heat removal capability of the system does not meet the design bases.

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3. Thermally induced over-pressurization of isolated portions of piping in containment which could jeopardize the ability of systems to perform their safety functions.

We have completed our review of the three issues and determined that there are no operability concerns. Our preliminary evaluation of Issue 3, however, showed that piping stresses resulting from thermal expansion may exceed the stress levels specified in the ASME Boiler and Pressure Vessel Code for primary stresses. It is the NRC's position that thermally-induced stresses must be treated as primary stresses (Reference 3). Union Electric will therefore perform a specific evaluation for each affected pipe section. For those areas in which primary stress criteria are exceeded, modifications will be performed. Our evaluations and any required modifications will be complete consistent with the end of Refuel 9 (Spring 1998) and Refuel 10 (Fall 1999).

The specific information requested by Generic Letter 96-06 is provided in Attachments 1 and 2. I would point out that conclusions reached in these attachments involved a considerable amount of study. Details and supporting information are available at Callaway.

If you have any questions concerning this information, please contact us.

Very truly yours,

Donald F. Schnell

WBM/plr

STATE OF MISSOURI )
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CITY OF ST. LOUIS )

Donald F. Schnell, of lawful age, being first duly sworn upon oath says that he 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 28th day of January, 1997.

Barbara J. Pfaff
BARBARA J. PFAFF
NOTARY PUBLIC — STATE OF MISSOURI
MY COMMISSION EXPIRES APRIL 22, 1997
ST. LOUIS COUNTY

cc: M. H. Fletcher
Professional Nuclear Consulting, Inc.
19041 Raines Drive
Derwood, MD 20855-2432

Regional Administrator
U.S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive
Suite 400
Arlington, TX 76011-8064

Senior Resident Inspector
Callaway Resident Office
U.S. Nuclear Regulatory Commission
8201 NRC Road
Steedman, MO 65077

Kristine M. Thomas (2)
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
1 White Flint, North, Mail Stop 13E16
11555 Rockville Pike
Rockville, MD 20852-2738

Manager, Electric Department
Missouri Public Service Commission
P.O. Box 360
Jefferson City, MO 65102

**UNION ELECTRIC**
**120-DAY RESPONSE TO NRC GENERIC LETTER 96-06**

References: 1) NRC Generic Letter 96-06 dated September 30, 1996
2) NRC Memorandum, "Summary of December 19, 1996 Meeting With The Nuclear Energy Institute (NEI) Regarding Industry Responses to Generic Letter 96-06," dated December 26, 1996

Reference 1 requested nuclear power plant licensees to determine if their plants are susceptible to any of the following conditions:

1. Water hammer in the containment air cooler cooling water system,

2. Two-phase flow in the containment air cooler cooling water system, or

3. Over pressurization of piping due to thermal expansion of fluid for piping systems penetrating containment.

Reference 1 also instructed licensees to assess the operability of affected systems and to take corrective action as appropriate for systems found to be susceptible to any of the above conditions.

Union Electric has evaluated these issues and has determined that Callaway Plant is susceptible to each of the conditions identified in NRC Generic Letter 96-06. Union Electric has evaluated the operability of affected systems and has found that all remain capable of performing their respective design-basis functions and, therefore, remain operable. Details of the evaluations and their findings are provided below for each of the three conditions

Containment Cooling System General Description

The containment cooling system provides cooling by recirculation of the containment atmosphere across air-to-water heat exchangers. During normal operation, the system functions to maintain a suitable atmosphere for equipment located within the containment. The four containment coolers operate after a Design Basis Accident (DBA) to reduce the temperature and pressure of the containment

atmosphere and thus reduce the potential for containment leakage of airborne and gaseous radioactivity to the environment. Cooling water to the containment coolers is supplied by the non-safety-related Service Water System (SWS) during normal operations. During post-accident operations, the safety-related Essential Service Water System (ESWS) supplies the coolers. Two of the coolers are supplied by the "A" train of ESW and two are supplied by the "B" train. Each train of ESW is served by one safety grade pump.

Following a Main Steamline Break (MSLB) or Loss of Coolant Accident (LOCA), each train of the ESW system is automatically isolated from the SWS system by motor-operated butterfly valves. Both ESW pumps are started by the emergency diesel load sequencer. Pump A starts 30 seconds after receipt of the Safety Injection Signal (SIS) or loss of offsite power signal (LOOP). Pump B starts 35 seconds after receipt of the SIS or LOOP. Each ESW pump supplies the containment coolers through normally open motor-operated containment isolation valves. Cooling flow splits to supply the two coolers per train and rejoins prior to exiting containment. Motor-operated butterfly valves are installed at the containment exit of each train to throttle flow and maintain system flow balance. The containment cooler effluent is then mixed with flow from other ESW loads and returned through a 30-inch back pressure orifice to the Ultimate Heat Sink (UHS).

<u>Water Hammer in Containment Air Cooling System</u>

Callaway Plant's containment air coolers are normally supplied by the non-safety-related SWS. During emergency conditions, the coolers are supplied by the safety-related ESWS. A LOCA or MSLB would cause the realignment of the ESW cross-connect valves to isolate the SWS and allow flow from the ESWS. Since Callaway has an "open system" design for both the SWS and the ESWS, the system will drain down from the containment coolers until the ESW pumps are able to repressurize the system. Initial experience with this system alerted us to the potential for water hammer during the switchover from SWS to ESWS. Callaway's original design was evaluated and redesigned to accommodate the water hammer associated with water column rejoining prior to the issuance of Reference 1.

The scenario presented in Reference 1 involves a Loss of Offsite Power (LOOP) concurrent with a LOCA or MSLB which causes interruption of cooling water flow soon after initiation of the event (within approximately 2 seconds)

while the associated fans would coast down for a much longer time (approximately 45 seconds). Continuation of air flow over the coils would cause the water in the cooler tubes to boil until cooling water flow resumes. At Callaway, the cross-connect isolation valves would not receive a signal to realign until approximately 10 seconds into the event. The realignment to the ESWS takes approximately 30 additional seconds to complete (time to full-close the SWS valves and achieve full ESW flow). During this time, the system would be draining. Boiling would occur in the containment cooler coils until the cooler coils are voided.

In our previous water hammer analysis, we did not consider the effects of steam generation in the coils which could allow steam to enter horizontal sections of cooling water piping in containment. Under this scenario, water hammers would occur due to collapsing of steam inside the piping (condensation induced water hammer).

In our current investigation of this issue, the condensation induced water hammer and water column closure water hammer were evaluated. Both cases were found to result in piping stresses that remained within the ASME Code. Therefore, the containment air cooling system was found to be adequately designed to withstand the effects of water hammers associated with a concurrent LOCA or MSLB concurrent with LOOP.

Two-phase Flow in the Containment Air Cooling System

The issue of two-phase flow in containment air cooling systems was also evaluated by Union Electric. The concern raised by GL 96-06 is related to a potential reduction in containment cooling capacity due to reduced flow caused by the increased friction of two-phase flow. Our review of the various causes of this problem allows us to conclude that the Callaway design essentially prevents two-phase flow in the coolers and associated piping.

While interruption of ESW flow to the coolers will cause some steam to form in the tubes, our evaluation has concluded that this steam will be quickly pushed from the cooler tubes and condensed. The difference in system refill time due to the presence of steam is 0.4 seconds, which is not significant. Once ESW flow is restored, steam in the coolers and associated piping will be condensed and temperatures at all locations in the system will remain below saturation temperature.

Based on the evaluations discussed above, Union Electric has determined that Callaway does not have a problem with two-phase flow inhibiting full design heat removal capability of the containment coolers.

Thermal Over Pressurization of Isolated Piping Sections

The third concern identified in GL 96-06 involves the potential over pressurization of piping resulting from thermal expansion of trapped fluid in isolated portions of piping systems exposed to the containment atmosphere. After a postulated accident, the containment atmosphere could heat exposed piping and their contents. If the fluid is isolated and restricted from expansion, the associated piping could become over pressurized and potentially jeopardize the ability of the affected systems to perform their safety functions.

Union Electric has evaluated this issue for all piping systems penetrating containment for Callaway Plant and has found 23 areas susceptible to this problem. A short description of the affected areas is provided in Attachment 2. For all of the associated systems, the only safety-related function after isolation is to maintain the containment barrier. None of the affected systems is required to mitigate the consequences of an accident beyond pressure boundary integrity. Union Electric performed a bounding analysis to assure that affected piping would not rupture and would maintain its pressure boundary. This analysis consisted of a strain evaluation of the worst case piping configuration. For Callaway Plant, the worst case configuration involves a temperature rise from 40 °F (Component Cooling Water System minimum operating temperature) to 290 °F (containment penetration temperature per FSAR Figure 6.2.1-85). For this case, the piping was found to experience a strain of approximately 3 percent. The ultimate strain is approximately 14.5 percent. Consequently, the piping will maintain its structural integrity throughout the event. This evaluation takes no credit for isolation valve leakby, potential packing leaks, or other mechanisms of pressure relief. Based on the evaluation discussed above, the affected systems remain capable of performing their design basis functions and, therefore, remain operable.

Despite the fact that the affected systems remain capable of performing their design basis functions, the analyses show that the secondary piping stresses will exceed the stress levels specified in ASME for primary stresses. The NRC has

stated that these stresses are to be treated as primary stresses (Reference 2). Therefore, to bring the affected areas in compliance with the NRC position, Union Electric will perform more specific evaluations for each area to verify the primary stress criteria are met. For those areas in which the primary stress criteria are not met, modifications will be performed consistent with the end of Refuel 9 (Spring 1998) and Refuel 10 (Fall 1999).

# Areas Affected By Potential Over Pressurization Due to Thermal Expansion of Trapped Fluid

| PENETRATION | DESCRIPTION OF PIPING AREA | NORMAL CONDITION | ISOLATED BY | REMARKS |
|---|---|---|---|---|
| P-23 | Chemical and Volume Control Letdown | OPEN | CIS-A | |
| P-25 | Reactor Makeup Water Supply | OPEN | CIS-A | |
| P-26 | Reactor Coolant Drain Tank Discharge | OPEN | CIS-A | |
| P-32 | Containment Normal Sump Discharge | ISOLATED | CIS-A | Periodically opened to drain sump. |
| P-52 | RHR Pump Suction | ISOLATED | N/A | Section between isolation valves is isolated per Technical Specifications. |
| P-53 | Fuel Pool Cooling and Cleanup | ISOLATED | N/A | |
| P-54 | Fuel Pool Cooling and Cleanup | ISOLATED | N/A | |
| P-55 | Fuel Pool Cooling and Cleanup | ISOLATED | N/A | |
| P-58 | Accumulator Safety Injection Fill Line | ISOLATED | CIS-A | Periodically opened to fill accumulators. |
| P-64 | Reactor Coolant System Sample Line | OPEN | CIS-A | Periodically opened for sampling. |
| P-69 | Pressurizer Vapor Space Sample Line | ISOLATED | CIS-A | Periodically opened for sampling. |
| P-74 | Component Cooling Water | OPEN | CIS-B | |
| P-75 | Component Cooling Water | OPEN | CIS-B | |
| P-76 | Component Cooling Water | OPEN | CIS-B | |
| P-78 | Steam Generator Drain Line | ISOLATED | N/A | |
| P-79 | RHR Pump Suction | ISOLATED | N/A | Section between isolation valves is isolated per Technical Specifications. |
| P-83 | Steam Generator Blowdown Sample Line | OPEN | SGBSIS | Periodically opened for sampling. |
| P-84 | Steam Generator Blowdown Sample Line | OPEN | SGBSIS | Periodically opened for sampling. |

CIS-A = CONTAINMENT ISOLATION SIGNAL, PHASE A
CIS-B = CONTAINMENT ISOLATION SIGNAL, PHASE B
SGBSIS = STEAM GENERATOR BLOWDOWN SYSTEM ISOLATION SIGNAL

# Areas Affected By
# Potential Over Pressurization
# Due to Thermal Expansion of Trapped Fluid

| PENETRATION | DESCRIPTION OF PIPING AREA | NORMAL CONDITION | ISOLATED BY | REMARKS |
|---|---|---|---|---|
| P-85 | Steam Generator Blowdown Sample Line | OPEN | SGBSIS | Periodically opened for sampling. |
| P-86 | Steam Generator Blowdown Sample Line | OPEN | SGBSIS | Periodically opened for sampling. |
| P-92 | Safety Injection Test Line | ISOLATED | CIS-A | Periodically opened for ECCS testing. |
| P-93 | Reactor Coolant System Sample Line | OPEN | CIS-A | Periodically opened for sampling. |
| P-95 | Accumulator Liquid Sample Line | ISOLATED | CIS-A | Periodically opened for sampling. |

CIS-A = CONTAINMENT ISOLATION SIGNAL, PHASE A
CIS-B = CONTAINMENT ISOLATION SIGNAL, PHASE B
SGBSIS = STEAM GENERATOR BLOWDOWN SYSTEM ISOLATION SIGNAL