

February 15, 2000

Mr. J. A. Scalice
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY UNITS 1, 2 & 3, COMPLETION OF LICENSING ACTION FOR GENERIC LETTER 96-06 CONCERNING WATERHAMMER, TWO-PHASE FLOW, AND EXPANSION OF ENTRAPPED WATER IN PIPING (TAC NOS. M96784, M96785 AND M96786)

Dear Mr. Scalice;

On September 30, 1996, the U.S. Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," to holders of operating licenses for nuclear power reactors, except those that have been amended for a possession-only status.

The purpose of the GL was to: (1) notify addressees about safety-significant issues that could affect containment integrity and equipment operability during accident conditions, (2) request that all addressees submit certain information relative to the issues that have been identified and implement actions as appropriate to address these issues, and (3) require that all addressees submit a written response to the NRC relative to implementation of the requested actions.

The following issues were identified as being of concern:

(1) Cooling water systems serving the containment air coolers may be exposed to the hydrodynamic effects of waterhammer during either a loss-of-coolant accident (LOCA) or a main steamline break (MSLB). These cooling water systems were not designed to withstand the hydrodynamic effects of waterhammer and corrective actions may be needed to satisfy system design and operability requirements; and

(2) Cooling water systems serving the containment air coolers may experience two-phase flow conditions during postulated LOCA and MSLB scenarios. The heat removal assumptions for design-basis accident scenarios were based on single-phase flow conditions. Corrective actions may be needed to satisfy system design and operability requirements.

(3) Thermally induced overpressurization of isolated water-filled piping sections in containment could jeopardize the ability of accident-mitigating systems to perform their safety functions and could also lead to a breach of containment integrity via bypass leakage. Corrective actions may be needed to satisfy system operability requirements.

Licensees were requested to determine: (1) if containment air cooler cooling water systems are susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions; and (2) if piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur. The GL requested the licensees provide (A) a 30-day response identifying (1) whether or not the requested actions will be completed, (2) whether or not the requested information will be submitted and (3) whether or not the requested information will be submitted within the requested time period and, (B) a 120-day response providing a written summary report stating (1) actions taken in response to the requested actions noted above, (2) conclusions that were reached relative to susceptibility for waterhammer and two-phase flow in the containment air cooler cooling water system and overpressurization of piping that penetrates containment, (3) the basis for continued operability of affected systems and components as applicable, (4) corrective actions that were implemented or are planned to be implemented, and (5) if systems were found to be susceptible to the conditions that are discussed in this GL, the systems affected and specific circumstances involved.

Mr. Raul Baron provided Tennessee Valley Authority's (TVA's) 30-day response by letter dated October 30, 1996. Mr. Pedro Salas provided TVA's 120-day response by letter dated January 28, 1997. These letters applied to Browns Ferry Nuclear Plant (BFN), Watts Bar Nuclear Plant and Sequoyah Nuclear Plant. Additional information specific to BFN was provided in a §50.72 notification dated February 3, 1997, and letters dated October 23, 1997, April 15, 1998, and August 12, 1998.

TVA's January 28, 1997, letter provided a discussion of the findings of a system-by-system review of the potential for thermal overpressurization. Three systems were identified as being subject to pressure increase due to entrapped fluid. These systems were the Main Steam System, Sampling System and Demineralized Water System. These systems were evaluated for operability and the Main Steam System and Sampling System were determined to be operable based on criteria in Appendix F of Section III of the American Society of Mechanical Engineers Code. The Demineralized Water System was found to be operable, on a short-term basis, by reliance on air retained in the system following Appendix J testing. As a permanent corrective action, plant procedures would be modified to assure that the system cannot be overpressurized. The findings for the demineralized water system were also reported in the §50.72 notification. With respect to waterhammer and two-phase flow, the reactor building closed-cooling water (RBCCW) system was identified as being susceptible to waterhammer, but such waterhammer was considered to be insufficient to damage the coils or threaten containment integrity. The letter also stated that this system is not credited for accident mitigation.

The October 23, 1997 letter revised the BFN portion of the January 28, 1997 letter. It presented the following new findings:

- (1) that the Sampling System lines and Main Steam Drain lines, which had previously been analyzed using American Society of Mechanical Engineers Appendix F methodology, had been reanalyzed for actual plant conditions and it was found that the design pressure would not be exceeded. The new Sampling System analysis considered that pressure would be relieved due to unseating of a valve. The new Main Steam Drain Lines analysis found that the piping has sufficient volume to accommodate post-accident thermal expansion, and is thus not susceptible to thermal overpressurization,

(2) while the drywell floor and equipment drain sump discharge lines were originally found acceptable on the basis of assumed valve leakage, since valve leakage is not a design basis assumption, this system would be modified, and

(3) two additional systems had been found to be potentially vulnerable to thermal overpressurization of entrapped water. These include the Drywell Floor Drain Sump Discharge lines and Drywell Equipment Drain Sump Discharge lines. The lines were found to be operable based on potential leakage through packing, bonnet gaskets and valve seats.

The April 15, 1998, letter responded to a staff request for additional information (RAI) dated February 27, 1998. It provided clarifying information, including the basis for the finding that sampling system overpressure is precluded by valve unseating. The staff has found that this finding is reasonable and acceptable. The April 15, 1998 letter also described the Drywell Floor Drain Sump Discharge line commitment of the October 23, 1997 letter, stating that pressure relief orifices would be drilled in check valve disks.

The August 12, 1998, letter was a reply to a staff RAI dated May 14, 1998. This letter described the results of a reanalysis of the RBCCW System using a GOTHIC model. The GOTHIC analysis demonstrated that boiling will not occur in the RBCCW system under MSLB or LOCA conditions. Based on the results of this more recent analysis, we are satisfied with your response and resolution of the waterhammer and two-phase flow issues. Your GOTHIC analysis was not included within the scope of our GL 96-06 review, and this element of the licensee's evaluation may be examined more closely during a future NRC inspection activity.

All requested information has been provided. The staff has reviewed the information and concluded that GL 96-06 requirements are met. We consider GL-96-06 closed for BFN, Units 1, 2 and 3. Your Refueling Outage Summaries dated October 23, 1998 (Unit 3, Cycle 8) and June 1, 1999 (Unit 2, Cycle 10) report that the drywell floor and equipment drain sump discharge line modifications have been performed for Units 2 and 3. For Unit 1, GL-96-06 will be revisited in the event of restart.

If you have any questions regarding this matter, please contact me at 301-415-3026.

Sincerely,

/RA/

William O. Long, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management

Docket Nos. 50-259, 50-260 and 50-296

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