TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

January 28, 1997

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

10 CFR 50.54(f)

Gentlemen:

In the Matter of	)	Docket Nos.	50-259	50-327
Tennessee Valley Authority	)		50-260	50-328
			50-296	50-390

BROWNS FERRY NUCLEAR PLANT (BFN), SEQUOYAH NUCLEAR PLANT (SQN), AND WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 RESPONSE TO NRC GENERIC LETTER (GL) 96-06, "ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY DURING DESIGN-BASIS ACCIDENT CONDITIONS," DATED SEPTEMBER 30, 1996

This letter provides TVA's 120-day response to the subject GL. In accordance with the GL and TVA's commitment made in our October 30, 1996 letter, TVA has performed the requested actions for BFN, SQN, and WBN Unit 1. This letter summarizes the actions taken, conclusions reached, and any action(s) that will be taken.

TVA has conducted a technical evaluation to determine if containment air cooler cooling water systems are susceptible to either water hammer or two-phase flow conditions during postulated accident conditions, and if piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur. The following has been concluded for TVA's nuclear plants:

- BFN has Drywell Coolers served by the Reactor Building Closed Cooling Water (RBCCW) system. Drywell Coolers to provide cooling to the drywell are not credited for Primary Containment cooling post-accident. Therefore, loss of cooling capability is not a concern. However, the portion of the RBCCW system inside the drywell is credited for maintaining primary containment boundary during and following a Loss-of-Coolant-Accident (LOCA) and; therefore, water hammer is the concern that was analyzed.

TVA has performed an engineering evaluation which has determined that the RBCCW system is subject to water hammer upon resumption of RBCCW flow following a LOCA concurrent with a Loss-of-Offsite-Power. Calculations show that the system will remain intact with this water hammer. Therefore, the primary containment boundary will be maintained.

BFN penetrations that are isolated during an event were also analyzed. It was determined that post-accident thermal expansion will not cause a containment isolation boundary failure. A procedure change will be initiated to ensure that the demineralized water system piping is not subject to overpressurization by draining a small amount of water from the lines.

- SQN has Upper Compartment Coolers (UCCs), Lower Compartment Coolers (LCCs), Control Rod Drive Mechanism (CRDM) Coolers, and Reactor Coolant Pump (RCP) Motor Coolers served by the Essential Raw Cooling Water (ERCW) system to cool containment. The LCC (fans and ERCW) are used post-accident (and then only for a Main Steam Line Break [MSLB]). Installed relief valves on the ERCW system prevent system overpressurization due to thermal expansion and also prevents boiling and subsequent water hammer in the coils. Considering the effects of a stuck open relief valve, as required by the GL, shows that only one of the four loops of lower containment cooling (each loop contains one RCP Motor Cooler, one LCC, and one CRDM Cooler) is affected. An evaluation shows that with a stuck open relief valve, the coils will boil dry; however, water hammer will not occur. This is due to low containment temperatures when the system is returned to service and to the stuck open relief valve which provides pressure relief. Effects of a stuck open relief valve have no impact on environmental flooding.

  Other systems within containment have also been reviewed for the phenomena discussed in the GL, and no other system was determined to be affected.

- WBN has UCCs, LCCs, CRDM Coolers, and RCP Motor Coolers served by the ERCW system to cool containment. The LCC (fans only) are used post-accident (and then only for an MSLB). Installed relief valves on the ERCW system prevent system ovepressurization due to thermal expansion and also prevents boiling and subsequent water hammer in the coils. Considering the effects of a stuck open relief valve, as required by the GL, shows the coils will boil dry; however, water hammer will not occur because the ERCW system is not used post-accident. Effects of a stuck open relief valve have no impact on environmental flooding.

  Other systems within containment have also been reviewed for the phenomena discussed in the GL, and no other system was determined to be affected.

BFN, SQN, and WBN are subject to the physical phenomena described in the GL. The plants are either designed to account for the conditions described and/or will not be damaged by the conditions. There are no modifications required to the affected systems to account for the conditions in the GL. BFN Unit 1 still has an operating license, but is in a defueled condition, and this GL will be addressed prior to Unit 1 returning to service.

A more detailed discussion of the information requested in the GL is contained in the enclosures to this letter. Enclosures 1 through 3 provides the requested information for BFN, SQN, and WBN Unit 1 respectively. Enclosure 4 provides the list of commitment(s) made as a result of this letter.

If you have questions regarding this response, please contact Vic Whaley at (423) 751-7009.

Sincerely,

Pedro Salas
Manager
Licensing and Industry Affairs

Subscribed to and sworn to before me
this 28th day of January 1997

Carol L. Hamill
Notary Public

My Commission Expires 9-8-99

Enclosure
cc (Enclosure):
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Mr. R. W. Hernan, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852

cc: Continued on page 4

cc (Enclosure):

NRC Senior Resident Inspector
Browns Ferry Nuclear Plant
10833 Shaw Road
Athens, Alabama 35611

NRC Resident Inspector
Sequoyah Nuclear Plant
U.S. Nuclear Regulatory Commission
2600 Igou Ferry Road
Soddy Daisy, Tennessee 37379

NRC Resident Inspector
Watts Bar Nuclear Plant
U.S. Nuclear Regulatory Commission
1260 Nuclear Plant Road
Spring City, Tennessee 37381

PS:DVW:LYM
cc (Enclosure):
T. E. Abney, PAB 1G-BFN
R. J. Adney, OPS 4A-SQN
M. Bajestani, POB 2C-BFN
J. E. Blackburn, OSA 1E-BLN
M. J. Burzynski, DSE 1A-SQN
E. S. Christenbury, ET 10A-K
C. Crane, PAB 1E-BFN
R. L. George, BR 5C-C
D. J. Green, LP 4J-C
K. N. Harris, LP 6A-C
O. D. Kingsley, Jr., LP 6A-C
J. E. Maddox, OIB 1A-WBN
T. J. McGrath, LP 3B-C
P. L. Pace, ADM 1L-WBN
R. T. Purcell, MOB 2R-WBN
J. R. Rupert, OPS 4A-SQN
J. A. Scalice, ADM 1V-WBN
R. H. Shell, OPS 4C-SQN
E. J. Vigluicci, ET 10A-K
H. L. Williams, EDB 1A-BFN
O. J. Zeringue, LP 6A-C
RIMS, WR 4Q-C

s:\corplic\nrc\gl9606final.doc

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

NRC GENERIC LETTER (GL) 96-06
ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY
DURING A DESIGN-BASIS ACCIDENT

The following provides the response for BFN on the subject GL. Pursuant to Section 182a, Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f), all holders of operating licenses for nuclear power reactors, except for those licenses that have been amended to possession-only status, are requested to submit the following written information.

NRC Requested Information

Within 120 days of the date of this GL, addressees are requested to submit a written summary report stating actions taken in response to the requested actions noted below, conclusions that were reached relative to susceptibility for water hammer and two-phase flow in the containment air cooler cooling water system and overpressurization of piping that penetrates containment, the basis for continued operability of affected systems and components as applicable, and corrective actions that were implemented or are planned to be implemented. If systems were found to be susceptible to the conditions that are discussed in this GL, identify the systems affected and describe the specific circumstances involved.

- **Requested Action(s)**

  Addressees are requested to determine:

  (1) if containment air cooler cooling water systems are susceptible to either water hammer or two-phase flow conditions during postulated accident conditions;

  (2) if piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur.

  In addition to the individual addressee's postulated accident conditions, these items should be reviewed with respect to the scenarios referenced in the GL.

  If systems are found to be susceptible to the conditions discussed in this GL, addressees are expected to assess the operability of affected systems and take corrective action as appropriate in accordance with the requirements stated in 10 CFR Part 50 Appendix B and as required by the plant Technical Specifications.

TVA Response

Background

On September 30, 1996, NRC issued GL 96-06 which notified the licensees of a potential issue with cooling water system serving the containment air cooler systems. That is, these systems may be exposed to the hydrodynamic effects of water hammer during a loss-of-coolant accident (LOCA). These cooling water systems may not be able to withstand the hydrodynamic effects of water hammer. Cooling water systems serving the containment air coolers may experience two-phase flow conditions during a postulated LOCA scenario. The heat removal assumptions for design-basis accident scenarios were based on single-phase flow conditions. Also, thermally induced overpressurization of isolated water-filled piping sections in containment could jeopardize the ability of accident-mitigating systems of performing their safety functions and could lead to a breach of containment integrity bypass leakage.

Evaluation Summary

TVA performed an evaluation of each water filled system penetrating primary containment. The Reactor Building Closed Cooling Water (RBCCW) system is the only closed cooling loop inside the containment. Each penetration was reviewed for the potential to compromise the containment integrity from thermal expansion of water because of elevated containment temperatures in isolated sections of piping during and following a LOCA. The evaluation determined the maximum pressure that an isolated section of piping would encounter due to elevated temperatures during and following a LOCA would not cause piping failure and thus not compromise containment integrity.

TVA's evaluation determined that, with the exception of the demineralized water system, the penetrations were acceptable with no further actions.

Sampling System: This system has piping inside primary containment. The sampling system is normally isolated, and the concern is the containment penetration. The penetration has been analyzed in accordance with Appendix F of ASME Section III and found acceptable for the postulated LOCA.

Main Steam Drain Lines: The main steam drain lines penetration may be closed during normal operation and remain closed for the postulated accidents. The main steam drain line penetrations were in accordance with Appendix F of ASME Section III and found acceptable for the postulated LOCA.

Demineralized Water: This system has the potential to be affected by overpressurization during a postulated LOCA if the piping inside containment is completely filled with water. TVA performed an evaluation which has determined that water is normally drained between the outboard isolation valves and blocking valve during Appendix J testing. This air in the system prevents the primary containment penetration from being overpressurized. Therefore, because of the as-left configuration of the system, it will not be affected by conditions described by the GL. However, plant procedures will be revised, adding actions that assure, the system is partially drained following use.

Standby Liquid Control System: This system has piping in primary containment. The penetrations were evaluated and found to be acceptable. The system is open to the Reactor Pressure Vessel (RPV) and would relieve any pressure increases to the RPV. Therefore, the conditions described in the GL do not pertain to this system.

Waste System: The primary containment isolation valves, are both located outside of primary containment. Therefore, the piping between the two valves (and water in the piping) is not subject to the high temperature environment inside containment following a LOCA. The piping that penetrates the primary containment boundary will not see excessive pressures due to the inherent tendency of non-isolation valves located inside the containment boundary to leak and relieve pressure. Therefore, the system is not susceptible to conditions described in the GL.

Reactor Water Cleanup System: The system will be operating normally at the time of the postulated event. The system temperature will be approximately 500°F during normal operation. There is no concern for heat gain and pressure increases resulting from temperature increases, as the line will actually cool. Therefore, the system is not susceptible to conditions described in the GL.

Residual Heat Removal (RHR) Shutdown Cooling: The RHR shutdown cooling supply line isolation valves will close on an accident signal. The isolated pipe section is provided with a pressure relief line back into the upstream process piping inside primary containment which will prevent overpressuration. Therefore, the system is not susceptible to conditions described in the GL.

Reactor Building Closed Cooling Water (RBCCW) System: This system serves the Primary Containment Drywell Coolers. The coolers are used for normal operation to cool primary containment. The RBCCW system continues to operate post-LOCA as the plant procedures allow the coolers to be used if available for Drywell cooling post-accident. However, accident analyses do not take credit for the coolers.

The RBCCW is a closed loop system with a surge/head tank outside containment. The RBCCW isolation is remote manual from the control room for the discharge line and an in-line check valve for the supply side. RBCCW is not isolated automatically following a LOCA. The RBCCW system piping is considered part of the containment boundary. As such, there are no primary containment isolation valves that automatically respond to a LOCA or a concurrent Loss-of-Offsite-Power (LOOP).

The coils are assumed to void (boil dry) at the onset of a LOCA concurrent with a LOOP. The voiding that occurs in the tubes is postulated to result in a water hammer in the system. Evaluation of the postulated water hammer concludes the water hammer pressure wave and resulting dynamic loads are acceptable and, therefore, do not violate the design-basis of the system. Thermal expansion of the water following the LOCA is accommodated by the system vented surge tank and will have no affect on the RBCCW system. Two-phase flow is not a consideration at BFN, as the coolers are not credited with accident mitigation. Therefore, containment heat removal is unaffected.

Conclusion

The condition stated within GL 96-06 exists at BFN. The condition poses no threat to safe shutdown of the reactor following an event or during the mitigation of that event. The RBCCW system can sustain the postulated water hammer during a LOCA concurrent with a LOOP and maintain containment integrity.

Specifically the following is concluded:

- The RBCCW system is susceptible to water hammer during postulated accident conditions; however, the intensity of the water hammer is within the design-basis of the system and is insufficient to damage the coils and violate primary containment.
- Two-phase flow is not a consideration for the system post-LOCA. BFN accident analysis does not credit heat removal by RBCCW.
- Piping systems that penetrate the primary containment have been evaluated/analyzed and will remain intact during a postulated event.
- Both operability and containment integrity are unaffected as the design-basis for affected systems encompass the conditions of the GL, and these systems will not be damaged by the described conditions.

Based on the above discussion, no modifications to the plant are recommended as the system is capable of handling the consequences of the exposure to the containment environment. Plant procedures will be revised to add actions that ensure water is drained from portions of the demineralized water system inside the drywell, such that the system will not be overpressurized as a result of the conditions described in the GL. This will be completed for Unit 3 prior to close-out of the Unit 3 cycle 7 outage. Unit 2 effected procedures will be changed prior to close-out of the Unit 2 cycle 9 outage.

BFN Unit 1 is shutdown, defueled, and under administrative hold. The conditions described by this GL will be addressed prior to Unit 1 return to service.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

NRC GENERIC LETTER (GL) 96-06
ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY
DURING A DESIGN-BASIS ACCIDENT

The following provides the response for SQN on the subject GL. Pursuant to Section 182a, Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f), all holders of operating licenses for nuclear power reactors, except for those licenses that have been amended to possession-only status, are requested to submit the following written information.

NRC Requested Information

Within 120 days of the date of this GL, addressees are requested to submit a written summary report stating actions taken in response to the requested actions noted below, conclusions that were reached relative to susceptibility for water hammer and two-phase flow in the containment air cooler cooling water system and overpressurization of piping that penetrates containment, the basis for continued operability of affected systems and components as applicable, and corrective actions that were implemented or are planned to be implemented. If systems were found to be susceptible to the conditions that are discussed in this GL, identify the systems affected and describe the specific circumstances involved.

- **Requested Action(s)**

  Addressees are requested to determine:

  (1) if containment air cooler cooling water systems are susceptible to either water hammer or two-phase flow conditions during postulated accident conditions;

  (2) if piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur.

  In addition to the individual addressee's postulated accident conditions, these items should be reviewed with respect to the scenarios referenced in the GL.

  If systems are found to be susceptible to the conditions discussed in this GL, addressees are expected to assess the operability of affected systems and take corrective action as appropriate in accordance with the requirements stated in 10 CFR Part 50 Appendix B and as required by the plant Technical Specifications.

TVA Response

Background

On September 30, 1996, NRC issued GL 96-06 which notified the licensees of a potential issue with cooling water system serving the containment air cooler systems. That is, these systems may be exposed to the hydrodynamic effects of water hammer during a loss-of-coolant accident (LOCA). These cooling water systems may not be able to withstand the hydrodynamic effects of water hammer. Cooling water systems serving the containment air coolers may experience two-phase flow conditions during a postulated LOCA scenario. The heat removal assumptions for design-basis accident scenarios were based on single-phase flow conditions. Also, thermally induced overpressurization of isolated water-filled piping sections in containment could jeopardize the ability of accident-mitigating systems of performing their safety functions and could lead to a breach of containment integrity bypass leakage.

Evaluation Summary

The postulated design-basis accidents in question are the LOCA and main steam line break (MSLB). Systems penetrating containment were analyzed. The analysis determined that the penetrations were acceptable for the LOCA and MSLB accidents.

The maximum containment temperatures reached for these two events are encompassed by the MSLB temperature of 327°F. The maximum temperature exists for a relatively short period of time (temperatures return to 120°F after approximately one hour). The specifics on each system evaluated follow.

Component Cooling System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is isolated inside containment post-accident. The portions of the system located inside containment are not required for accident mitigation. The system contains thermal overpressurization relief valves on the piping inside containment, plus the containment penetrations have relief lines back into containment with check valves for containment isolation. No voiding occurs and any hydraulic pressures created can be accommodated by the system relief valves. The conditions described in the GL do not pertain to this system.

Waste Disposal System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. This penetration has an outboard containment isolation valve with significant portions of piping located in the auxiliary building (AB) that alleviates any overpressurization following a MSLB (i.e., the piping and valve body located in the AB acts as a fin or radiator and continue to cool the internal penetration fluid convectively). In addition, no heat transfer mechanism associated with steam induced condensation exists for piping in the auxiliary building when coupled with a LOCA, steam line, or feed line break inside containment. Therefore, little or no heat-up and subsequent pressurization of the total penetration is considered credible. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency diaphragm valves inside to relieve the pressure created by the thermal expansion of the water. Based on the previous discussion, the conditions described in the GL do not pertain to this system.

Air Conditioning System - Chilled Water Portion: This portion (incore instrument room, inside containment) of the system is isolated post-accident and is not used for accident mitigation. The chilled water portion has relief valves installed on the piping inside containment. Penetrations are designed with a thermal overpressurization relief line back into containment with an in-line check valve for containment isolation on the relief line. No voiding occurs and any hydraulic pressures created can be accommodated by the system relief valve. The conditions described in the GL do not pertain to this portion of the air conditioning system.

Demineralized Water System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is nonsafety-related, and is not used post-accident. The system has a relief valve on the piping located inside containment and a check valve is utilized as the inboard containment isolation valve, thereby precluding penetration and piping overpressuration. No voiding occurs and any hydraulic pressures created can be accommodated by the system relief valve. The conditions described in the GL do not pertain to this system.

Chemical and Volume Control System (CVCS): This system has piping in containment, but no air-to-water heat exchangers located inside containment. The CVCS is used post-accident, and the system is designed for high temperatures and pressures for the portion used post-accident. The portions of the system that are susceptible to the phenomena are the seal water return lines. A relief valve is installed on the common seal water return line. No voiding occurs, and any hydraulic pressures created can be accommodated by the system relief valve. The penetration is protected by a thermal relief line on the penetration. The conditions described in the GL do not pertain to this system.

Residual Heat Removal (RHR) System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The RHR system is used post-accident and has relief valves installed on the piping located inside containment. No voiding occurs, and any hydraulic pressures created can be accommodated by the system relief valve. The conditions described in the GL do not pertain to this system.

Safety Injection System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The safety injection system is used post-accident and is open to the Reactor coolant system (RCS) (it is isolated from the RCS via check valves). Any pressure increases on this system following a MSLB will relieve to the RCS. No voiding occurs in the system. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of valves inside containment to relieve the pressure created by the thermal expansion of the water. The conditions described in the GL do not pertain to this system.

Containment Spray System: Piping inside containment is open to containment atmosphere and, therefore, cannot be overpressurized or experience water hammer for the conditions described in the GL. This also includes the containment spray portion of the RHR system. The conditions described in the GL do not pertain to this system.

Ice Condenser System - Glycol Portion: This portion of the system has an expansion tank and relief valve located inside containment. This tank accommodates any pressure increases of the system. The piping is insulated inside containment, except at the ice condenser air handling units. These units are located at the top of the ice condenser and the temperatures at this location are less than the boiling point for glycol. Therefore, no voiding occurs and any hydraulic pressures created can be accommodated by the expansion tank and relief valve. Penetrations are designed with a thermal overpressurization relief line that relieves into containment with a check valve for containment isolation. The conditions described in the GL do not pertain to this system.

Fire Protection System: The fire protection piping inside containment is a dry system (i.e., the piping contains no water). The system would have to be manually flooded to allow water in the piping. The conditions described in the GL do not pertain to this system.

Primary Makeup Water System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is isolated post-accident and is not used for accident mitigation. This penetration has an outboard containment isolation valve with significant portions of piping located in the auxiliary building (AB) that alleviates any overpressurization following a MSLB (i.e., the piping and valve body located in the AB acts as a fin or radiator and continue to cool the internal penetration fluid convectively). In addition, no heat transfer mechanism associated with steam induced condensation exists for piping in the auxiliary building when coupled with a LOCA, steam line or feed line break inside containment. Therefore, little or no heat-up and subsequent pressurization of the total penetration is considered credible. The piping (and water within the piping) internal to containment was determined not to affect the penetration. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of diaphragm valves inside containment to relieve the pressure created by the thermal expansion of the water. No voiding occurs in the system. The conditions described in the GL do not pertain to this system.

Spent Fuel Pool Cooling and Cleaning: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is isolated except during refueling operations and; therefore, not used for accident mitigation. This penetration has an outboard containment isolation valve with significant portions of piping located in the auxiliary building (AB) that alleviates any overpressurization following a MSLB (i.e., the piping and valve body located in the AB acts as a fin or radiator and continue to cool the internal penetration fluid convectively). In addition, no heat transfer mechanism associated with steam induced condensation exists for piping in the auxiliary building when coupled with a LOCA, steam line, or feed line break inside containment. Therefore, little or no heat-up and subsequent pressurization of the total penetration is considered credible. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of non-isolation valves (inside containment) to relieve the pressure created by the thermal expansion of the water. Based on the previous discussion, the conditions described in the GL do not pertain to this system.

Essential Raw Cooling Water (ERCW) System: The ERCW system serves the lower compartment coolers (LCC), upper compartment coolers, the control rod drive mechanism (CRDM) coolers, and the reactor coolant pump (RCP) motor coolers. This system is initially isolated post-accident. It is later used post-MSLB to feed the LCCs for long-term cooling. The LCCs are analyzed to start at four hours following the initiation of the event. Procedural direction can have the system start as soon as one hour after the event. The containment temperature at the earliest possible start of the system is less than 120°F. Consequently, at this temperature two-phase flow or waterhammer would not occur.

Relief valves are installed on piping located inside containment. Penetrations are designed with a thermal overpressurization relief line that relieves into containment with an in-line check valve for containment isolation on the relief line. Consequently, no voiding occurs, and any hydraulic pressures created can be accommodated by the system relief valve.

Note that SQN and WBN differ on the use of ERCW to LCCs for post-MSLB mitigation. This difference is due to the design-basis of the system. WBN has parallel suction from its RCS and can achieve cold shutdown. Therefore, the WBN LCC fans are required to circulate air in lower containment and the containment spray actually performs the containment heat removal function. SQN is not designed with parallel suction line connections from the RCS. Following a MSLB, SQN must remain in mode 3 (hot standby) and the LCCs are used to perform the containment heat removal function.

Specifically for the components served by ERCW:

<u>Upper Compartment Coolers:</u> The system has relief valves installed on the ERCW lines inside containment. No voiding occurs, and any h 'raulic pressures created is accommodated by the system relief valve. No impact on the plant due to the conditions described in the GL.

<u>CRDM Coolers, RCP Motor Coolers, Lower Compartment Coolers:</u> This system has relief valves installed on the ERCW lines inside containment. The boiling temperature is determined by the pressure maintained on the system by the relief valve. Therefore, no boiling or voiding occurs, and any hydraulic pressures created is accommodated by the system relief valve. No impact on the plant due to the conditions described in the GL.

GL 96-06 requires consideration of a stuck open relief valve on the ERCW system. The relief valve failure is also considered as the single active failure. The ERCW system has relief valves installed on the lines inside containment. There are four ERCW loops in lower containment, each loop having two relief valves. One relief valve is considered to be stuck open, and the most conservative valve chosen is on one loop of containment lower compartment cooling. One loop of cooling affects cooling to one RCP, one CRDM cooler, and one lower compartment cooler. With a stuck open relief valve, the system cannot prevent the coils from boiling dry (i.e., the pressure on the coils is reduced resulting in boiling at a lower temperature).

The stuck open relief valve is located in the fan rooms and would dump water to the containment raceway. For conservatism, the water from the coils is considered added to the sump water in containment. Following a LOCA, the total amount of potential water added to the sump is negligible (i.e., the volume contained within one loop's piping). It is estimated that 400 gallons would enter the sump which is less than one percent of the total sump volume. The containment sump will be capable of performing its design function.

The potential for water hammer exists on the cooler with a stuck open relief valve. The coils will be voided while returning the cooler to service post-MSLB. Procedurally, the coolers may be returned to service when containment temperature reaches approximately 120°F. The fans are started first (starting the fans cools any water in the coils and condenses any remaining steam). The stuck open relief valve acts as a vent while the coils refill and would prevent water hammer. Starting the lower compartment cooler fans also prevent flashing of hot water on loops without a stuck open relief valve. This would minimize any water hammer from flashing of the water as it moves through the system. The stuck open relief valve acts as a vent if located on the downstream side of the coils. The valve on the upstream side would allow air into the system (when the steam condenses), and this cushions the flow of water into the coils such that water hammer does not occur. Therefore, the system will not experience water hammer and will continue to provide its intended function of long-term cooling following a MSLB.

The LCCs are capable of cooling with a stuck open relief valve. This is due to the flow rate through the coils being greater than or equal to 200 gpm and the leakage rate of the relief valve at 5 gpm (less than 3 percent of total flow). Therefore, the coolers will provide cooling on the affected loop.

Conclusion

Specifically the following has been concluded for SQN:

1. The containment air cooler cooling water system (ERCW) is not susceptible to water hammer during postulated accident conditions. The ERCW system is not susceptible to two-phase flow, as the containment temperatures are well below the boiling temperature of water during the timeframe the LCCs are required to be operated.

2. Piping systems that penetrate the containment are not susceptible to overpressurization due to thermal expansion of fluid. The penetrations have been designed or analyzed for thermal expansion of fluid.

3. Operability of the ERCW system is unaffected, as the system has been designed to account for the effects of high temperatures in containment post-accident.

4. The containment sump water is still capable of performing its function as required and is within design-basis with a stuck open relief valve on the ERCW system following a LOCA or MSLB. The total amount of potential water added to the sump is negligible for a LOCA and a MSLB.

Based on the above evaluation, there are no operability issues associated with the systems reviewed.

ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

NRC GENERIC LETTER (GL) 96-06
ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY
DURING A DESIGN-BASIS ACCIDENT

The following provides the response for WBN on the subject GL. Pursuant to Section 182a, Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f), all holders of operating licenses for nuclear power reactors, except for those licenses that have been amended to possession-only status, are requested to submit the following written information.

NRC Requested Information

Within 120 days of the date of this GL, addressees are requested to submit a written summary report stating actions taken in response to the requested actions noted below, conclusions that were reached relative to susceptibility for water hammer and two-phase flow in the containment air cooler cooling water system and overpressurization of piping that penetrates containment, the basis for continued operability of affected systems and components as applicable, and corrective actions that were implemented or are planned to be implemented. If systems were found to be susceptible to the conditions that are discussed in this GL, identify the systems affected and describe the specific circumstances involved.

- **Requested Action(s)**

  Addressees are requested to determine:

  (1) if containment air cooler cooling water systems are susceptible to either water hammer or two-phase flow conditions during postulated accident conditions;

  (2) if piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur.

  In addition to the individual addressee's postulated accident conditions, these items should be reviewed with respect to the scenarios referenced in the GL.

  If systems are found to be susceptible to the conditions discussed in this GL, addressees are expected to assess the operability of affected systems and take corrective action as appropriate in accordance with the requirements stated in 10 CFR Part 50 Appendix B and as required by the plant Technical Specifications.

TVA Response

Background

On September 30, 1996, NRC issued GL 96-06 which notified the licensees of a potential issue with cooling water system serving the containment air cooler systems. That is, these systems may be exposed to the hydrodynamic effects of water hammer during a loss-of-coolant accident (LOCA). These cooling water systems may not be able to withstand the hydrodynamic effects of water hammer. Cooling water systems serving the containment air coolers may experience two-phase flow conditions during a postulated LOCA scenario. The heat removal assumptions for design-basis accident scenarios were based on single-phase flow conditions. Also, thermally induced overpressurization of isolated water-filled piping sections in containment could jeopardize the ability of accident-mitigating systems of performing their safety functions and could lead to a breach of containment integrity bypass leakage.

Evaluation Summary

The postulated design-basis accidents in question are the LOCA and main steam line break (MSLB). Systems penetrating containment were analyzed. The analysis determined that the penetrations were acceptable for the LOCA and MSLB accidents.

The maximum temperatures reached for these two events is encompassed by the MSLB temperature of 327°F. Event (LOCA and MSLB) maximum and high temperatures exist for a relatively short period of time (approximately one hour duration). The specifics on each system evaluated follow.

<u>Component Cooling System:</u> This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is isolated inside containment post-accident. The portions of the system located inside containment are not credited for accident mitigation. The system contains relief valves on the piping inside containment plus the containment penetrations, with inboard and outboard isolation valves, and the system has thermal overpressurization relief lines back into containment with check valves for containment isolation. No voiding occurs and any hydraulic pressures created can be accommodated by the system relief valves. The conditions described in the GL do not pertain to this system.

<u>Waste Disposal System:</u> This system has piping in containment, but no air-to-water heat exchangers located inside containment. The waste disposal system is isolated post-accident. The system is nonsafety-related and is not used post-accident. The process fluid between the isolation valves is nitrogen or water. Calculations have been performed to demonstrate that the post-accident pressure increase in the isolated containment boundary is negligible for the nitrogen filled lines. The water filled lines have either relief valves or have been analyzed for the resultant pressure increases and found to be within the pressure limitations of the system. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of diaphragm valves inside containment to relieve the pressure created by the thermal expansion of the water. The conditions described in the GL do not pertain to this system.

<u>Air Conditioning System - Chilled Water Portion:</u> This portion (incore instrument room, inside containment) of the system is isolated post-accident, and is not used for accident mitigation. The chilled water portion has relief

valves installed on the piping inside containment. Penetrations are designed with a thermal overpressurization relief line back into containment with a check valve for containment isolation on the relief line. No voiding occurs, and any hydraulic pressures created can be accommodated by the system relief valve. The conditions described in the GL do not pertain to this portion of the air conditioning system.

Demineralized Water System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is nonsafety-related and is not credited post-accident. The piping between the containment isolation valves is drained after each use to prevent overpressurization due to thermal expansion. No voiding occurs and the potential for hydraulic pressures is eliminated by draining the containment boundary. This system is not credited for post-accident mitigation. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of valves inside containment to relieve the pressure created by the thermal expansion of the water. The conditions described in the GL do not pertain to this system.

Chemical and Volume Control System (CVCS): This system has piping in containment but no air-to-water heat exchangers located inside containment. The CVCS is used post-accident and the system is designed for high temperatures and pressures for the portion used post-accident. The portions of the system that are susceptible to the phenomena are the seal water return lines. A relief valve is installed on the common seal water return line. No voiding occurs and any hydraulic pressures created can be accommodated by the system relief valve. The penetration is protected by a thermal relief line on the penetration. The conditions described in the GL do not pertain to this system.

Residual Heat Removal (RHR) System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The RHR system is used post-accident and has relief valves installed on the piping located inside containment. No voiding occurs, and any hydraulic pressures created can be accommodated by the system relief valve. The conditions described in the GL do not pertain to this system.

Safety Injection System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The safety injection system is used post-accident and is open to the reactor coolant system (RCS) (it is isolated from the RCS via check valves). Any pressure increases on this system following a MSLB will relieve to the RCS. No voiding occurs in the system. The safety injection system accumulator fill line is isolated by containment isolation valves post-accident. However, the piping between the containment isolation valves is drained after each use to prevent overpressurization of the penetration due to thermal expansion. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of valves inside containment to relieve the pressure created by the thermal expansion of the water. The conditions described in the GL do not pertain to this system.

Containment Spray System: Piping inside containment is open to containment atmosphere and, therefore, cannot be overpressurized or experience water hammer for the conditions described in the GL. This also includes the containment spray portion of the RHR system. The conditions described in the GL do not pertain to this system.

Ice Condenser System - Glycol Portion: This portion of the system has an expansion tank located inside containment. This tank accommodates any volume increases due to thermal expansion of the glycol. The piping is insulated inside containment, except at the ice condenser air handling units. These units are located at the top of the ice condenser and the temperature at this location is less than the boiling point for glycol. The system is isolated post-accident and is not used for accident mitigation. Penetrations are designed with a thermal overpressurization relief line that relieves into containment with a check valve for containment isolation. No voiding occurs, and any hydraulic pressures created can be accommodated by the expansion tank. The conditions described in the GL do not pertain to this system.

Fire Protection System: The fire protection piping inside containment, is a dry system (i.e., the piping contains no water). The system would have to be manually flooded to allow water in the piping. The conditions described in the GL do not pertain to this system.

Primary Makeup Water System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is isolated post-accident and is not used for accident mitigation. Penetrations are designed with a thermal overpressurization relief line back into containment with a check valve for containment isolation. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of diaphragm valves inside containment to relieve the pressure created by the thermal expansion of the water. No voiding occurs in the system. The conditions described in the GL do not pertain to this system.

Spent Fuel Pool Cooling and Cleaning System: This system has piping in containment, but no air-to-water heat exchangers located inside containment. The system is isolated except during refueling operations and is, therefore, not used for accident mitigation. The piping between the containment isolation valves is drained after each use. The piping (and water within the piping) internal to containment was determined not to affect the penetration. This is due to the inherent tendency of diaphragm valves (inside containment) to relieve the pressure created by the thermal expansion of the water. The conditions described in the GL do not pertain to this system.

Essential Raw Cooling Water (ERCW) System: This system is isolated post-accident. The ERCW system serves the lower compartment coolers (LCCs), upper compartment coolers (UCCs), the control rod drive motor (CRDM) coolers, and the reactor coolant pump (RCP) motor coolers. Relief valves are installed on piping located inside containment. Penetrations are designed with a thermal overpressurization relief line that relieves into containment with a check valve for containment isolation on the relief line. The portion of the ERCW system inside containment is not credited for post-accident mitigation.

The systems of most concern at WBN (associated with the ERCW system) are the LCCs, UCCs, the CRDM coolers, and the RCP motor coolers. These systems have air-to-water cooling coils that would be rapidly heated following an accident. The UCCs are on an ERCW header separate from the remaining coolers. The LCCs, CRDM coolers, and the RCP motor coolers are on the same ERCW header (which contains a relief valve). The only component that would be required for accident mitigation is the LCCs (which are required to circulate air only following a MSLB).

Note that SQN and WBN differ on the use of ERCW to LCCs for post-MSLB mitigation. This difference is due to the design-basis of the system. SQN is not designed with parallel suction line connections from the RCS. Following a MSLB, SQN must remain in mode 3 (hot standby) and the LCCs are used to perform the containment heat removal function. WBN has parallel suction from its RCS and can achieve cold shutdown. Therefore, the WBN LCC fans are only required to circulate air in lower containment, and the containment sprays actually perform containment heat removal function.

Specifically:

<u>Upper Compartment Coolers:</u> These coolers see a maximum temperature which is below the saturated steam temperature. The system has relief valves installed on the ERCW lines inside containment. Therefore, no voiding occurs and any hydraulic pressures created is accommodated by the system relief valve. No impact on the plant due to the conditions described in the GL.

<u>CRDM Coolers, RCP Motor Coolers, Lower Compartment Coolers:</u> The system has relief valves installed on the ERCW lines inside containment. The boiling temperature is determined by the pressure maintained on the system by the relief valve. Therefore, no boiling or voiding occurs and any hydraulic pressures created is accommodated by the system relief valve. There is no impact on the plant due to the conditions described in the GL.

GL 96-06 requires consideration of a stuck open relief valve on the ERCW system. The relief valves are located in the fan rooms and would dump water to the containment raceway if they become stuck open. This is outside the area in which the containment sump draws. For conservatism, the water from the coils is considered added to the sump water in containment. The total amount of potential water added to the sump during a LOCA is negligible (i.e., less than a few hundred gallons compared to the sump total volume of several thousands of gallons, less than one percent). With the system designed for the effects of the conditions described in the GL and that the effects of a stuck open relief valve is negligible, there is no impact on the plant due to the conditions described in the GL.

Conclusion

The condition stated within GL 96-06 exists at WBN. The condition poses no threat to the capability of the plant to safety shutdown following an event or the mitigation of that event. This is due primarily to the ERCW system inside containment not being required for accident mitigation, that other systems inside containment remain intact if needed for accident mitigation, containment cooling is available (only LCC fans are used post-accident), and that containment integrity is maintained. Offsite doses are unaffected as containment integrity is assured.

Specifically the following has been concluded for WBN:

1. The containment air cooler cooling water systems (UCCs, LCCs, CRDM coolers, and RCP motor coolers) are not susceptible to either water hammer or two-phase flow conditions during postulated accident conditions. This is due to the systems not being required for post-accident mitigation and due to the systems being designed to account for the conditions described in the GL.

2. Piping systems that penetrate the containment are not susceptible to thermal expansion of fluid. This is due to the penetrations being designed or analyzed for thermal expansion of fluid with thermal overpressurization relief lines relieving back to containment from the penetrations. Systems that cannot handle the thermal expansion of fluid have the penetrations drained between the isolation valves after each use.

3. Operability of the WBN syst re unaffected by the conditions described in the GL, as the systems signed to account for the effects of MSLB and LOCA.

4. The containment sump water is still capable of performing its function as required and is within design-basis with a stuck open relief valve on the ERCW system following a LOCA or MSLB. The total amount of potential water added to the sump is negligible for a LOCA and a MSLB.

No corrective actions have been taken for WBN, as the plant is already designed for the effects of a LOCA and MSLB as described in the GL.

ENCLOSURE 4

TENNESSEE VALLEY AUTHORITY

RESPONSE TO NRC GENERIC LETTER (GL) 96-06,
"ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY
DURING DESIGN-BASIS ACCIDENT CONDITIONS," DATED SEPTEMBER 30, 1996

BROWNS FERRY NUCLEAR PLANT (BFN)

Commitment(s)

1. BFN Unit 1 is shutdown, defueled, and under administrative hold. The conditions described by this GL will be addressed prior to Unit 1 return to service.

2. Plant procedures will be revised to add actions that ensure water is drained from portions of the demineralized water system inside the drywell. This will be completed for Unit 3 prior to close-out of the Unit 3 cycle 7 outage. Unit 2 effected procedures will be changed prior to close-out of the Unit 2 cycle 9 outage.

SEQUOYAH NUCLEAR PLANT (SQN)

Commitment(s)

None

WATTS BAR NUCLEAR PLANT (WBN)

Commitment(s)

None