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January 14, 2011

10 CFR 50.4
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ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 1
Facility Operating License No. NPF-90
NRC Docket No. 50-390

Subject: **Response to Request for Additional Information Regarding Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems"**

Reference: Letter from NRC to TVA, "Watts Bar Nuclear Plant, Unit 1 - Request for Additional Information Regarding Generic Letter 2008-01, 'Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems,' (TAC No. MD7895)," dated December 1, 2010

By letters dated May 9, 2008, June 6, 2008, July 11, 2008, October 11, 2008, and January 19, 2010, the Tennessee Valley Authority (TVA) provided responses to Generic Letter (GL) 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," for Watts Bar Nuclear Plant (WBN), Unit 1. By letter dated December 1, 2010 (Reference), the NRC requested additional information regarding GL 2008-01. In the Referenced letter, the NRC documented that TVA's response be provided by January 12, 2011. By letter dated January 12, 2011, TVA stated that it would provide the response by January 14, 2011.

The enclosure to this letter provides the TVA response for WBN, Unit 1 to the NRC's request for additional information as contained in the Referenced letter.

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There are no new regulatory commitments contained in this letter. If you have any questions concerning this issue, please contact Josh Perrel at (423) 751-7737.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on the 14th day of January, 2011.

Respectfully,

R. M. Krich

Enclosure:

Response to Request for Additional Information Regarding NRC Generic Letter 2008-01

cc (Enclosure):

NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Watts Bar Nuclear Plant

ENCLOSURE

Tennessee Valley Authority
Watts Bar Nuclear Plant, Unit 1

Response to Request for Additional Information Regarding NRC Generic Letter 2008-01

NRC Question 1

Please clarify the specific systems reviewed as part of the GL 2008-01 review.

TVA Response

TVA's Generic Letter (GL) 2008-01 Review evaluated the following systems:

1. Chemical Volume and Control System (CVCS): The CVCS performs inventory and chemical addition during normal operation and includes the centrifugal charging (CC) pumps that serve as the high-head pumps in the Emergency Core Cooling (ECC) System (ECCS).

2. Safety Injection (SI) System: The SI System (SIS) includes the safety injection pumps (SIPs) that serve as the intermediate head pumps in the ECCS.

3. Residual Heat Removal (RHR) System: The RHR System (RHRS) performs normal shutdown cooling and includes the residual heat removal pumps that serve as the low head pumps in the ECCS. The RHR pumps can also be aligned to containment spray headers to augment containment heat removal.

   (Note: GL 2008-01 refers to the Decay Heat Removal (DHR) System and, in its October 2008 response, TVA used the GL 2008-01 DHR terminology when describing the Watts Bar Nuclear Plant (WBN) RHRS. In this present response, TVA refers to the system by the RHRS nomenclature used in the WBN Updated Final Safety Analysis Report).

4. Containment Spray (CS) System: The CS System (CSS) is the system that, in conjunction with the ECCS, performs containment heat removal.

NRC Question 2

Void acceptance criteria has been updated since TVA's submittal of its 9-month response. How has WBN Unit 1 addressed the updated information? Note: mechanical integrity only is not considered adequate to ensure pump operability.

TVA Response

The Pressurized Water Reactor Owner's Group (PWROG) developed pump suction void acceptance criteria to support the industry's evaluations for the GL 2008-01 required 9-month responses. These pump suction void acceptance criteria ensure the CC, SI, RHR, and CS pumps will not be mechanically damaged by air ingestion. It was recognized at the time these criteria were developed that pump head also decreases when the CC, SI, RHR, and CS pumps ingest air. In order to maintain the CCS, SIS, RHRS, and CSS flow rates as modeled in the safety analyses, the total degradation in pump head from all phenomena (including normal wear) needs to be less than the head degradation allowed by the safety analyses. Limiting head degradation results in more restrictive suction void acceptance criteria than the mechanical damage suction void acceptance criteria. Limiting head degradation is the updated criteria referred to in this question (see row 5 of Table 2 in Revision 2 to *NRC Staff Criteria for Gas Movement in the Suction Lines and Pump Response to Gas*, dated March 26, 2009).

When considering the effect of head degradation due to air ingestion, the CC, SI, RHR, and CS pumps remain capable of providing the flows used in the safety analyses due to the design of these systems:

- There are no continuous sources of gas in the CC, SI, RHR or CS pump suction pipe; no air entraining vortexes form in the Refueling Water Storage Tank (RWST) and containment sump during ECC and CS injection or recirculation.

- The CC, SI, RHR, and CS pumps are located below their suction sources and the suction pipe self vents to the RWST. The ECCS suction piping contains no inverted pipe "U"s or gas traps that need to be vented. However, subsequent to the previous responses to NRC GL 2008-01, TVA has recognized that the last horizontal run in the CS Pump 1A-A suction piping to the pump is actually an intermediate high point between the pump and the RWST due to the configuration of the piping in the Auxiliary Building pipe chase. A similar condition does not exist for the CS Pump 1B-B.

  This condition does not adversely affect the performance of the CSS Pump 1A-A. An analysis performed by Westinghouse (CN-SEE-IV-09-22, Revision 0) in support of GL 2008-01 determined that the suction header could contain an allowable void fraction of 5% without adversely affecting the CS pumps. The CS pumps are periodically tested at a flow rate of approximately 4,000 gpm in the quarterly pump surveillance tests. This flow rate would disperse and transport any potential voids in their suction pipe and part of their discharge piping to the RWST. In addition, TVA conducted ultrasonic (UT) examination of this portion of piping in support of the 9-month response to GL 2008-01 and confirmed that the suction lines were free of voids. Therefore, voids that could damage the CS pumps have not occurred and are not expected to occur in this piping.

  Additionally, because of the recent identification of the intermediate high point in the CS Pump 1A-A suction piping, TVA initiated action to have the piping ultrasonically examined again. Suction piping for both CS pumps was re-examined in January 2011 and determined to be free of voids. TVA also has an open action in the Corrective Action Program (CAP) (PER 245024) to determine if periodic UT examinations should be performed at these locations.

This means that the only potential for head degradation is from latent voids in the slopes and bows of nominally horizontal pipe.

The suction pipe in the CCS, SIS, RHRS, and CSS contains horizontal headers upstream of the last vertical pipe to the inlet of the pumps. Any latent voids in the suction pipe accumulate at the down elbow in this pipe where the turbulence induced by the elbow breaks up the voids into small bubbles before being drawn down the vertical pipe to the inlet of the pump. As a result, the void fraction in the flow stream that enters the pump will be ~1% by volume and not result in a significant pump head loss. In addition, the pump head loss that does occur will be of short duration due to the small potential void volumes in the slopes and bows of the CC, SI, RHR, and CS pump suctions.

Therefore, there was no need to re-evaluate the CCS, SIS, RHRS, or CSS as a result of the *new void acceptance criteria*.

NRC Question 3

In light of updated acceptance criteria, are any piping segments susceptible to unacceptable void limits since the piping systems were previously evaluated against other criteria?

TVA Response

As discussed in the response to Question 2 of this Request for Additional Information, including the discussion of the CS 1A-A pump suction when lined up to the RWST, the evaluations of the suction of the WBN pumps determined that the design, construction, and operation of the CC, SI, RHR, and CS pump suction piping prevents:

- A continuous source of voids of any size being transported to the CC, SI, RHR, or CS pump suctions; and,
- A latent void in the CC, SI, RHR, or CS pump suction piping that could result in a limiting void being transported to these pumps.

Therefore, there are no pipe segments that could contain a void that would cause pump mechanical damage or a measurable degradation in the head developed by the CC, SI, RHR, or CS pumps.

NRC Question 4

In TVA's discussion of pressure pulsations, TVA states, "These criteria are usually met when the discharge pipe has been filled to the isolation valve as this prevents an abrupt stopping of flow." What is meant by "usually"? What are the criteria and are there instances when the criteria are not met?

TVA Response

This question relates to pump discharge void volume acceptance criteria and the impact of pressure pulsations as discussed on page E3-4 of TVA's October 11, 2008 response. The intent of the discussion in the October 11, 2008 response was to express that by ensuring that the discharge piping was filled to the isolation valve, there would be no pressure pulsations from gas voids that could affect system operation. The fill criteria include venting until a steady stream of water is coming out of the vent. This will ensure the system is full.

The October 11, 2008 discussion also intended to allow for circumstances where gas is found when venting the discharge pipe indicates the pipe is not completely filled. When gas is found, it does not meet the acceptance criteria, but additional quantitative analysis is undertaken to determine whether the amount of gas could create concerns related to excessive pressure pulsation.

The drawing review and survey data taken for the GL 2008-01 evaluation verified that after being filled and vented, the discharge pipe is full except for latent voids that could exist due to adverse slope or bow in nominally horizontal pipe. The detailed slope and bow measurements taken for the nominally horizontal pipe were evaluated to determine if any potential latent voids could exceed 5% of the pipe cross sectional area. Pipe segments that could contain latent voids exceeding the 5% screening criteria received further evaluation, where the total gas volume in the pipe segment was compared to a 0.5 cubic feet acceptance criteria for pipes larger than 3 inches in diameter. Pipes smaller than 3 inches in diameter did not receive further review due to the very small amount of void that could be present. The evaluations determined that there are no instances when the stated *criteria are not met*.

NRC Question 5

How were the system primary gas limits determined? Did the evaluation include the possibility that all gas is sent to the pump in one slug?

TVA Response

As stated in TVA's 9-month response to GL 2008-01 for WBN, the PWROG qualitatively evaluated the impact of gases entering the Reactor Coolant System (RCS) on the ability of the post-accident core cooling functions of the ECCS. This evaluation assumed that:

- 5 cubic feet of gas at 400 psig would be injected to the RCS from the CC pumps and SI pumps; and,
- 5 cubic feet of gas at 100 psig would be injected to the RCS from the RHR pumps.

The evaluation concluded that these quantities of gas do not prevent the ECCS from performing its core cooling function. As discussed in the October 11, 2008 submittal, the quantity of gas determined to be acceptable based on the above described limits is very large compared to the total volume of the ECCS. Thus the effect on the ECCS core cooling function of gas entering the primary system was found not to be limiting with respect to allowable void volume.

A void of the size allowed by the primary system gas limits was not evaluated as potentially reaching the pump suction as a slug of air because the primary system gas limits were not used as an allowable void size in evaluating the acceptability of voids in the ECCS suction pipe. A void size based on primary system gas limits is much too large to be acceptable in the suction pipe. Instead, as discussed in the response to Question 2, the acceptability of potential voids in the suction pipe is based on:

- Suction pipe voids existing only in the slopes and bows of nominally horizontal pipe (with the additional information provided in the response to Question 2 regarding TVA's basis for concluding that unacceptable gas voids cannot form in the last horizontal run in the CS Pump 1A-A suction piping); and,

- The location of the horizontal header upstream of the last vertical pipe to the suctions of the CC, SI, RHR, and CS pumps.

NRC Question 6

In Testing Evaluation Section 2, TVA stated that procedures are being updated to include entry into the corrective actions program (CAP) if extended gas releases are found. What defines an extended gas release and why aren't all found voids entered into the CAP?

TVA Response

The venting procedures used to meet the requirements of SR 3.5.2.3 and 3.5.3.1 currently require that any gas release during venting be timed and entered into the CAP for evaluation. The ECCS and RHRS discharge pipe is expected to be full of water at all times so any bubbles discharged subsequent to the purging of the vent pipe would indicate a condition requiring further evaluation via the CAP regardless of the duration of the gas release.