**Enclosure 1 is to be withheld from public disclosure under 10 CFR 2.390. When separated from this submittal, this letter is decontrolled.**

**Tennessee Valley Authority,** 1101 Market Street, Chattanooga, Tennessee 37402

October 30, 2012

10 CFR 50.4

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

Sequoyah Nuclear Plant, Units 1 and 2
NRC Docket Nos. 50-327 and 50-328
Facility License Nos. DPR-77 and DPR-79

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

Subject: **Impact of Potential Breaches of HESCO Modular Flood Barriers and Earthen Embankments on the Updated Hydrologic Analysis Results for Sequoyah Nuclear Plant, Units 1 and 2, and Watts Bar Nuclear Plant, Unit 1**

References:

1. Tennessee Valley Authority (TVA) Submittal to NRC Document Control Desk, "Commitments Related to Updated Hydrologic Analysis Results for Sequoyah Nuclear Plant, Units 1 and 2, and Watts Bar Nuclear Plant, Unit 1," dated June 13, 2012 (ADAMS Accession No. ML12171A053)

2. Eric J. Leeds, NRC, to Joseph W. Shea, TVA, "Confirmatory Action Letter - Watts Bar Nuclear Plant, Unit 1, and Sequoyah Nuclear Plant, Units 1 and 2, Commitments to Address External Flooding Concerns (TAC Nos. ME8805, ME8806, and ME8807)," dated June 25, 2012 (ADAMS Accession No. ML12165A527)

As committed to in the Reference 1 letter, Tennessee Valley Authority (TVA) has completed an analysis of the Design Basis Flood for Sequoyah Nuclear Plant (SQN), Units 1 and 2, and Watts Bar Nuclear Plant (WBN), Unit 1, that assumes a failure of a section of the HESCO modular flood barriers (sand baskets) and earthen embankments at Fort Loudon, Cherokee, Tellico, and Watts Bar Dams. This study was completed on August 31, 2012. As required by the Reference 2 letter, TVA is providing a summary of the results of this analysis in Enclosure 1 within 60 days after its completion.

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Enclosure 1 contains security-related information identified by the designation "Security-Related Information - Withhold Under 10 CFR 2.390." TVA hereby requests this information be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390(d)(1). Enclosure 2 provides a public version of the information suitable for public disclosure.

Enclosure 3 contains a list of new regulatory commitments. Please address any questions regarding this request to Terry Cribbe at (423) 751-3850.

Respectfully,

J.W. Shea
Vice President, Nuclear Licensing

Enclosures:
1. Summary of Impact of Breaches of the HESCO Modular Flood Barriers and Earthen Embankments on Design Basis Flood Levels (Proprietary Version)
2. Summary of Impact of Breaches of the HESCO Modular Flood Barriers and Earthen Embankments on Design Basis Flood Levels (Public Version)
3. List of New Regulatory Commitments

cc (Enclosures):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector – Watts Bar Nuclear Plant, Unit 1
NRC Senior Resident Inspector – Sequoyah Nuclear Plant

## ENCLOSURE 2

## SUMMARY OF IMPACT OF BREACHES OF THE HESCO MODULAR FLOOD BARRIERS AND EARTHEN EMBANKMENTS ON DESIGN BASIS FLOOD LEVELS (PUBLIC VERSION)

On May 31, 2012, Tennessee Valley Authority (TVA) met with the NRC staff to discuss issues regarding the updated hydrologic analysis for Sequoyah Nuclear Plant (SQN), Units 1 and 2, and Watts Bar Nuclear Plant (WBN), Unit 1 (Reference 1). As part of the presentation, TVA described the circumstances under which, in 2009, it had placed temporary barriers atop portions of four dams upstream of the SQN and WBN sites. In previous correspondence regarding the barriers (References 2 through 6), TVA had described the barriers as temporary measures which were adequate to prevent overtopping of the specific upstream dams under certain hydrologic conditions. In a letter dated January 25, 2012 (Reference 7), the NRC discussed the review of this previous correspondence, and indicated the following:

> "(T)he NRC staff finds that the sand baskets are not capable of resisting debris impact. These documents neither discuss the ability of sand baskets to withstand debris impact, or mention whether the baskets are designed for impact of debris loads. The NRC staff is unable to conclude that these sand baskets were designed to withstand impacts from large debris during a flood. If a design flood were to occur, there is a high likelihood that significant debris would accompany the flood waters which could impact the baskets. There is the potential for this debris to damage the baskets or push the individual baskets apart causing a breach. There would be no time to repair the baskets because the flood would already be in progress. Therefore, sand baskets that are not designed and constructed to withstand impacts from large debris are not acceptable as a long-term solution."

During the May 31, 2012, meeting, TVA confirmed that the modular flood barriers were intended to be temporary structures and that TVA intends to replace the modular flood barriers with permanent modifications by October 2015. To support the conclusion that the modular flood barriers represent an acceptable interim compensatory measure, TVA presented the results of the range of impact tests that were previously presented in the Reference 3 letter. In addition, TVA presented the results of a qualitative assessment of the potential for barges on the Tennessee River to impact the modular flood barriers at each of the four affected dams. Finally, TVA committed to perform a hydrologic analysis assuming such a failure in an initiative to gain additional insight as to the potential impact on flood level at SQN and WBN from a failure of a portion of the modular flood barriers at the upstream dam prior to the completion of the permanent dam modifications. In a letter dated June 13, 2012 (Reference 8), TVA provided the following written commitment (numbered as Commitment No. 6):

> "By August 31, 2012, TVA will perform an analysis of the Design Basis Flood for SQN, Units 1 and 2 and WBN, Unit 1 that assumes a failure of a section of the HESCO flood barriers and earthen embankments at Fort Loudoun, Cherokee, Tellico, and Watts Bar dams."

By letter dated June 25, 2012 (Reference 9), the NRC confirmed the commitments made by TVA in the Reference 8 letter. In the Reference 9 letter, the NRC further directed:

> "With regard to Commitment No.6, please provide a summary of the results of TVA's analysis to the NRC within 60 days after its completion."

TVA completed the analysis associated with Commitment No. 6 of the Reference 8 letter on August 31, 2012. A summary of the results of that analysis during high river flow conditions is hereby presented.

## ENCLOSURE 2

## SUMMARY OF IMPACT OF BREACHES OF THE HESCO MODULAR FLOOD BARRIERS AND EARTHEN EMBANKMENTS ON DESIGN BASIS FLOOD LEVELS (PUBLIC VERSION)

### Purpose

In a letter dated June 13, 2012 (Reference 8), TVA committed to perform an analysis of the Design Basis Flood for SQN Units 1 and 2 and WBN Unit 1 that assumes a failure of a section of the HESCO flood barriers and earthen embankments at Fort Loudoun, Cherokee, Tellico, and Watts Bar Dams. The study evaluates changes to the Probable Maximum Flood (PMF) elevations at SQN Units 1 and 2 and WBN Unit 1 resulting from non-mechanistic postulated breaches of the HESCO modular flood barriers and a subsequent failure of the earthen embankments of the dam. A report on the results of this study was completed and accepted by TVA on August 31, 2012.

The HESCO modular flood barriers are installed on the earthen embankments of four dams (Cherokee, Fort Loudoun, Tellico, and Watts Bar Reservoirs) to increase the height of the embankments and to prevent embankment overflow and failure of the embankment. As described in the License Amendment Requests related to the updated hydrologic analysis submitted for SQN Units 1 and 2 (Reference 10) and WBN Unit 1 (Reference 11), the HESCO modular flood barriers are credited in the hydrologic analysis for determining the PMF. The analysis described below does not revise the proposed changes to the hydrologic analysis described in the License Amendment Requests. Instead, this analysis is a sensitivity study that assesses the impact of a postulated failure of the HESCO modular flood barriers if such a failure were to occur prior to implementation of the TVA commitment to replace the flood barriers with permanent modifications by October 2015. TVA is not proposing that a failure of the HESCO modular flood barriers be considered an assumption of the design and licensing basis for either SQN Units 1 and 2 or WBN Unit 1.

### Discussion of Analysis

The simulations performed for this study used the TVA Simulated Open Channel Hydraulics (SOCH) software code. TVA developed the SOCH model for flood routing calculations for the Tennessee River and selected tributaries. The SOCH computer model is the hydraulic model used to determine flood elevations at each TVA operating nuclear plant site. The SOCH model has been calibrated for main stem reservoirs, and Melton Hill and Tellico tributary reservoirs, to reasonably replicate observed river discharges and elevations for known historic events. Once calibrated, the SOCH model can be used to reliably predict flood elevations and discharges for events of other magnitudes.

To model the effects of a potential breach of the modular flood barriers, modified dam rating curves that take into account the effects of the postulated breach were used as inputs to the SOCH model. The configuration of the postulated breach is based upon a number of factors including the following:

a. The breach configurations are based on review of different methods discussed in the *Prediction of Embankment Dam Breach Parameters* paper prepared by Tony Wahl with the U.S. Department of the Interior.

b. The breach configuration proposed for each dam is based on the approach used by the Federal Energy Regulatory Commission (FERC). The breach size using this approach

produces the largest size of three of the four methods discussed in the U.S. Department of the Interior paper, but is not the most conservative. The most conservative breach size would approach a complete failure of the embankment.

c. For each dam a single embankment was postulated to fail. The embankment selected to fail provides the greatest breach size allowing the largest volume of water downstream.

d. The size of the breach was a function of the breach depth which assumed failure down to bedrock.

e. The location of the postulated breach is the main earthen embankment next to the spillways where bedrock elevations are known.

Two basic storm situations have the potential to produce a PMF at SQN Units 1 and 2 and WBN Unit 1. These are (1) a sequence of March storms producing maximum rainfall on the 21,400-square-mile watershed above Chattanooga, hereafter called the 21,400-square-mile storm, and (2) a sequence of March storms centered and producing maximum rains in the basin to the west of the Appalachian Divide and above Chattanooga, hereafter called the 7,980-square-mile storm.

Two simulations were performed.

Case 1 is the 21,400 square-mile event which does not overtop the permanent dam structure at Cherokee Dam (i.e., maximum headwater elevation is below the top of the permanent dam structure and the HESCO modular flood barriers (sand baskets) at Cherokee Dam). However, this storm is assumed to breach Fort Loudoun Dam and Tellico Dam HESCO modular flood barriers and underlying earthen embankments.

Case 2 is the 7,980 square-mile event which is postulated to arbitrarily breach the HESCO modular flood barriers and earthen embankments at Cherokee Dam. This arbitrary breach is postulated to occur at the maximum headwater elevation which is below the top of the HESCO modular flood barriers (i.e., flood barriers do not fail by overtopping).

Additional details of each simulation are as follows:

Case 1 (21,400 square-mile event)

a. Postulated non-mechanistic breaches of Fort Loudoun Dam and Tellico Dam earthen embankments are chosen to occur simultaneously at the peak PMF elevation of 835.61 ft.

b. Watts Bar Dam East Earth Embankment fails by overtopping upon the Fort Loudoun/Tellico flood wave reaching Watts Bar Dam and raising headwater to elevation 768.0 ft. Failure of the earthen embankment is initiated when the East Earth Embankment wall is overtopped by more than one foot from the flood wave.

c. Chickamauga and Nickajack Dams downstream of Watts Bar Dam are conservatively postulated not to fail.

**ENCLOSURE 2**

**SUMMARY OF IMPACT OF BREACHES OF THE HESCO MODULAR FLOOD BARRIERS AND EARTHEN EMBANKMENTS ON DESIGN BASIS FLOOD LEVELS (PUBLIC VERSION)**

Case 2 (7,980 square-mile event)

a. Arbitrarily postulated (non-overtopping) failure of Cherokee Dam South Embankment is assumed.

b. Fort Loudoun Dam South Embankment fails by overtopping (barrier fails at the moment of overtopping) upon the Cherokee flood wave reaching Fort Loudoun and raising headwater to elevation 837.0 ft.

c. Tellico Dam Main Works Embankment fails arbitrarily at the same time the Fort Loudoun barrier is overtopped and failed.

d. Watts Bar Dam East Earth Embankment fails by overtopping (barrier fails at the moment of overtopping) upon the Cherokee/Fort Loudoun/Tellico flood wave reaching Watts Bar Dam and raising headwater to elevation 768.0 ft.

e. Chickamauga and Nickajack Dams downstream of Watts Bar Dam are conservatively assumed not to fail.

Each simulation provided a flood water elevation at SQN and WBN. Those elevations are shown below in Table 1.

Table 1 - Results of Simulations

Case 1 (Cherokee not breached, Fort Loudoun and Tellico breached)

| Site | Current Calculated PMF (ft) | Study Result (ft) | [ ] |
|---|---|---|---|
| SQN | 722.0 | [ ] | [ ] |
| WBN | 739.2 | [ ] | [ ] |

Case 2 (Cherokee breached)

| Site | Current Calculated PMF (ft) | Study Result (ft) | [ ] |
|---|---|---|---|
| SQN | 722.0 | [ ] | [ ] |
| WBN | 739.2 | [ ] | [ ] |

**Conclusion**

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**ENCLOSURE 2**

**SUMMARY OF IMPACT OF BREACHES OF THE HESCO MODULAR FLOOD BARRIERS AND EARTHEN EMBANKMENTS ON DESIGN BASIS FLOOD LEVELS (PUBLIC VERSION)**

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**Discussion of Potential Failures of the HESCO Modular Flood Barriers**

The simulations discussed above postulate non-mechanistic failures of the HESCO modular flood barriers resulting in a breach of the earthen embankment. TVA will evaluate possible breach initiators to determine their credibility. These potential breach initiators include uncontrolled commercial river traffic (including assessment of the operational controls of commercial river traffic) and waterborne debris (organic and man-made). TVA will submit a report summarizing the results of these evaluations by January 18, 2013.

These evaluations will include consideration of additional specific factors that could ameliorate the potential for impact failures during flooding. These additional factors include the following:

1. HESCO Modular Flood Barrier Locations - Locations of the HESCO modular flood barriers in relation to the edges of the reservoirs, and the topography of the reservoirs and earthen embankments underlying the modular flood barriers, influences the potential for impact by commercial barges or other waterborne objects during a PMF event. Additional details regarding the influence of the locations of the HESCO modular flood barriers on the potential for impact by commercial barges or other waterborne objects during a PMF event will be included in the summary of the results of the evaluations to be submitted to the NRC by January 18, 2013.

2. Commercial River Traffic – The amount of commercial river traffic in each reservoir influences the likelihood that commercial barges would be located in each reservoir during a PMF event, and then available to impact the modular flood barriers if they become uncontrolled. Commercial river traffic on the Tennessee River primarily consists of commercial barges and towboats. Cherokee Dam is located above the navigable channel, and Cherokee Reservoir has no commercial river traffic. Tellico Reservoir no longer has commercial harbors and no commercial river traffic, so all commercial river traffic through that stretch of the Tennessee River will be restricted to the Fort Loudoun and Watts Bar channels. Additional details regarding the influence of the amount of commercial river traffic on the potential for impact by commercial barges during a PMF event will be included in the summary of the results of the evaluations to be submitted to the NRC by January 18, 2013

3. River Traffic Management – The control of commercial transportation during high river levels and flows influences the likelihood that commercial barges would become uncontrolled during a PMF event and then possibly impact the modular flood barriers. Commercial transportation on the Tennessee River is managed through regulations by the United States Coast Guard (USCG). Operation of the dams and locks is managed by TVA River Operations (RO) and the United States Army Corps of Engineers (USACE). The roles and responsibilities of these organizations, including responsibilities for managing commercial river traffic during high river levels and flows, are described in the Tennessee River Waterway Management Plan co-authored and implemented by TVA RO, USACE, and USCG. The Marine Transportation Emergency Response Cycle is described in the plan, which includes the four phases of the response cycle - Watch, Action, Emergency, and

Recovery. Additional details on the roles and responsibilities described in the Tennessee River Waterway Management Plan, including an assessment of the affect on minimizing the potential for uncontrolled barges and impacts to the HESCO modular flood barriers, will be included in the summary of the results of the evaluations to be submitted to the NRC by January 18, 2013.

4. Computational Fluid Dynamics (CFD) Model for Fort Loudoun Reservoir – The actual flow profile through the reservoirs during high river levels and flows influences the likelihood that commercial barges would be directed towards or away from the modular flood barriers during a PMF event. Fort Loudoun Dam is located at TRM 602.30 (Tennessee River Mile). Commercial harbors or docks are located upstream at approximately TRM 646.10, almost 44 miles upstream of the dam and lock. Assuming that a barge could break loose from this location and navigate its way downstream, a CFD model for the Fort Loudoun and Tellico Reservoirs is being developed to determine the likely movement of an uncontrolled barge during a PMF event. A portion of this study has been completed, and the CFD simulations completed demonstrate that the major stream flows are towards the spillway portions of both dams with stream flow from the Tennessee River to the Little Tennessee River through the interconnecting channel. A summary of the complete study, including use of different release points, velocity vectors, and masses of the simulated debris field released, will be included in the summary of the results of the evaluations to be submitted to the NRC by January 18, 2013.

5. Waterborne Debris – The ability of the HESCO modular flood barriers to withstand impacts from waterborne debris influences the likelihood of a failure of the modular flood barriers during a PMF event. A detailed description of the bases for concluding that failure of the flood barriers is unlikely due to these impacts will be included in the summary of the results of the evaluations to be submitted to the NRC by January 18, 2013.

**References**

1. Carl F. Lyon, NRC, to NRC Document Control Desk, "Summary of May 31, 2012, Senior Management Meeting With Tennessee Valley Authority on the Licensing Basis for Flooding/Hydrology," dated June 6, 2012 (ADAMS Accession No. ML12157A457).

2. TVA Submittal to NRC Document Control Desk, "Responses to Hydrology Action Items," dated January 14, 2011 (ADAMS Accession No. ML12136A439).

3. TVA Submittal to NRC Document Control Desk, "Re-submittal of Attachments for Responses to Hydrology Action Items," dated March 21, 2011 (ADAMS Accession No. ML110831044).

4. TVA Submittal to NRC Document Control Desk, "Response to Request for Additional Information Regarding Final Safety Analysis Report Section 2.4 (TAC No. ME3945)," dated April 20, 2011 (ADAMS Accession No. ML11112A137).

5. TVA Submittal to NRC Document Control Desk, "Revised Response to Request for Additional Information Question 3 Regarding Final Safety Analysis Report Section 2.4 (TAC No. ME3945)," dated May 20, 2011 (ADAMS Accession No. ML11145A163).

6. TVA Submittal to NRC Document Control Desk, "Information Presented in the May 11-12, 2011 TVA/NRC Meeting Regarding Final Safety Analysis Report Section 2.4," dated June 1, 2011 (ADAMS Accession No. ML11154A139).

7. Siva P. Lingam, NRC, to Joseph W. Shea, TVA, "Tennessee Valley Authority (TVA) Long-Term Hydrology Issues for Operating Nuclear Plants - Browns Ferry Nuclear Plant, Units 1,2, and 3 (TAC Nos. ME5026, ME5027, and ME5028); Sequoyah Nuclear Plant, Units 1 and 2 (TAC Nos. ME5029 and ME5030); and Watts Bar Nuclear Plant, Unit 1 (TAC No. ME5031)," dated January 25, 2012 (ADAMS Accession No. ML11241A166).

8. TVA Submittal to NRC Document Control Desk, "Commitments Related to Updated Hydrologic Analysis Results for Sequoyah Nuclear Plant, Units 1 and 2, and Watts Bar Nuclear Plant, Unit 1," dated June 13, 2012 (ADAMS Accession No. ML12171A053).

9. Eric J. Leeds, NRC, to Joseph W. Shea, TVA, "Confirmatory Action Letter - Watts Bar Nuclear Plant, Unit 1, and Sequoyah Nuclear Plant, Units 1 and 2, Commitments to Address External Flooding Concerns (TAC Nos. ME8805, ME8806, and ME8807)," dated June 25, 2012 (ADAMS Accession No. ML12165A527).

10. TVA Submittal to NRC Document Control Desk, "Application to Revise Sequoyah Nuclear Plant Units 1 and 2 Updated Final Safety Analysis Report Regarding Changes to Hydrologic Analysis, (SQN-TS-12-02)," dated August 10, 2012 (ADAMS Accession No. ML12226A561).

11. TVA Submittal to NRC Document Control Desk, "Application to Revise Watts Bar Nuclear Plant Unit 1 Updated Final Safety Analysis Report Regarding Changes to Hydrologic Analysis, TAC No. ME8200 (WBN-UFSAR-12-01)," dated July 19, 2012 (ADAMS Accession No. ML12236A167).

## ENCLOSURE 3

## LIST OF NEW COMMITMENTS

1. TVA will evaluate possible breach initiators to determine their credibility. These potential breach initiators include uncontrolled commercial river traffic (including assessment of the operational controls of commercial river traffic) and waterborne debris (organic and man-made). TVA will submit a report summarizing the results of these evaluations by January 18, 2013.