Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

January 31, 2011

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

Watts Bar Nuclear Plant, Unit 2
NRC Docket No. 50-391

Subject: **Watts Bar Nuclear Plant (WBN) Unit 2 – Request For Additional Information (RAI) Regarding Individual Plant Examination (TAC No. ME3334)**

References:

1. NRC to TVA letter dated June 23, 2010, "Watts Bar Nuclear Plant, Unit 2 – Supplemental Request for Additional Information Regarding Individual Plant Examination (TAC NO. ME 3334)" [ML101680072]

2. TVA to NRC letter dated August 12, 2010, "Watts Bar Nuclear Plant (WBN) Unit 2 – Request for Additional Information (RAI) Regarding Individual Plant Examination (TAC NO. ME 3334)" [ML101680072]

TVA to NRC letter dated August 12, 2010 (Reference 2) provided response to RAIs contained in NRC to TVA letter dated June 23, 2010 (Reference 1). The TVA letter committed to providing a response to RAI 14. Enclosure 1 to this letter provides the response to RAI 14.

There are no new commitments associated with this submittal. If you have any questions, please contact Bill Crouch at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 31st day of January, 2011.

Respectfully,

Marie Gillman
Acting Watts Bar Unit 2 Vice President

Enclosure:

1. Response to IPE RAI 14

D030
NRR

cc (Enclosure):

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IPE RAI 14

Inappropriate truncation can result in significant accident sequences being erroneously eliminated; SRs QU-B3/LE-E4 provide the requirements for acceptable truncation. Provide the technical bases for using the same truncation limit for LERF; that is, provide the change in LERF if a lower truncation limit was issued. If the change in LERF is greater than 5 percent, identify what sequences were eliminated (Reference F&O 3-1).

TVA Response:

As noted in the peer review report documentation, a WBN LERF truncation evaluation was not provided to the Peer Review Team. Subsequent to the peer review, a truncation study of the WBN LERF model was performed by quantifying at different truncation levels, and the results are shown in Table 1. The quantification was performed for a range of truncation values to demonstrate the impact on the LERF value with decreasing truncation levels. Demonstration of Level 2 model convergence to meet QU-B3 of RA-Sa-2009 (final change is less than 5%) could not be achieved. The percent difference between truncation levels 1E-12 /r-yr and 1.0E -13/r-yr was 37%.

Table 1: WBN U2 Results of Truncation Evaluation for LERF – Base Model

Truncation Limit	U2-LERF (r-yr)	% difference
1.00E-08	3.27E-07	-
1.00E-09	4.88E-07	49%
1.00E-10	1.30E-06	166%
1.00E-11	1.93E-06	48%
1.00E-12	2.62E-06	36%
1.00E-13	3.58E-06	37%

When comparing the differences between the 1.0E-12, 1.0E-13, and 1.0E-14 cutsets, several HRA dependency factors were identified as driving the increase in results. Since the original LERF truncation was performed at 1.0E-12, these HRA dependency combinations were not adequately reviewed, and the default values from the HRA calculator were used in the quantification. Several of these values were overly conservative. As a result, several LERF HRA dependency combinations were reviewed and updated as noted in Table 3. Table 2 displays the truncation study performed on the WBN model with the updated LERF HRA dependency values. Quantification with a 1E-14 truncation value had to be performed in parts by IE group and then the cutset files were merged to generate the total LERF frequency. Quantification at 1.0E-15 was not possible due to computing limitations.

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Table 2: WBN U2 Results of Truncation Evaluation for LERF – Updated HRA Dependency

Truncation Limit	U2-LERF (r-yr)	% difference
1.00E-08	3.27E-07	-
1.00E-09	4.88E-07	49%
1.00E-10	1.30E-06	166%
1.00E-11	1.94E-06	49%
1.00E-12	2.24E-06	15%
1.00E-13	2.46E-06	10%
1.00E-14	2.64E-06	7%

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Figure 1: WBN U2 Results of Truncation Evaluation for LERF – Updated HRA Dependency

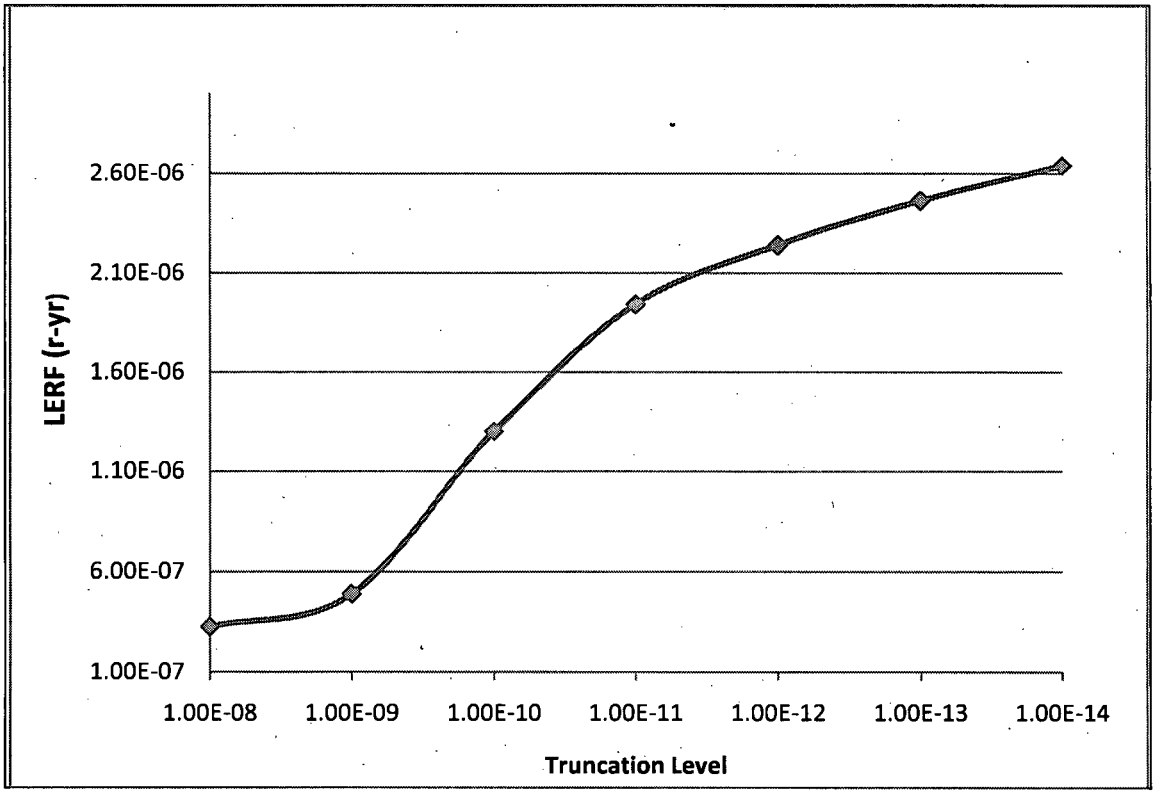

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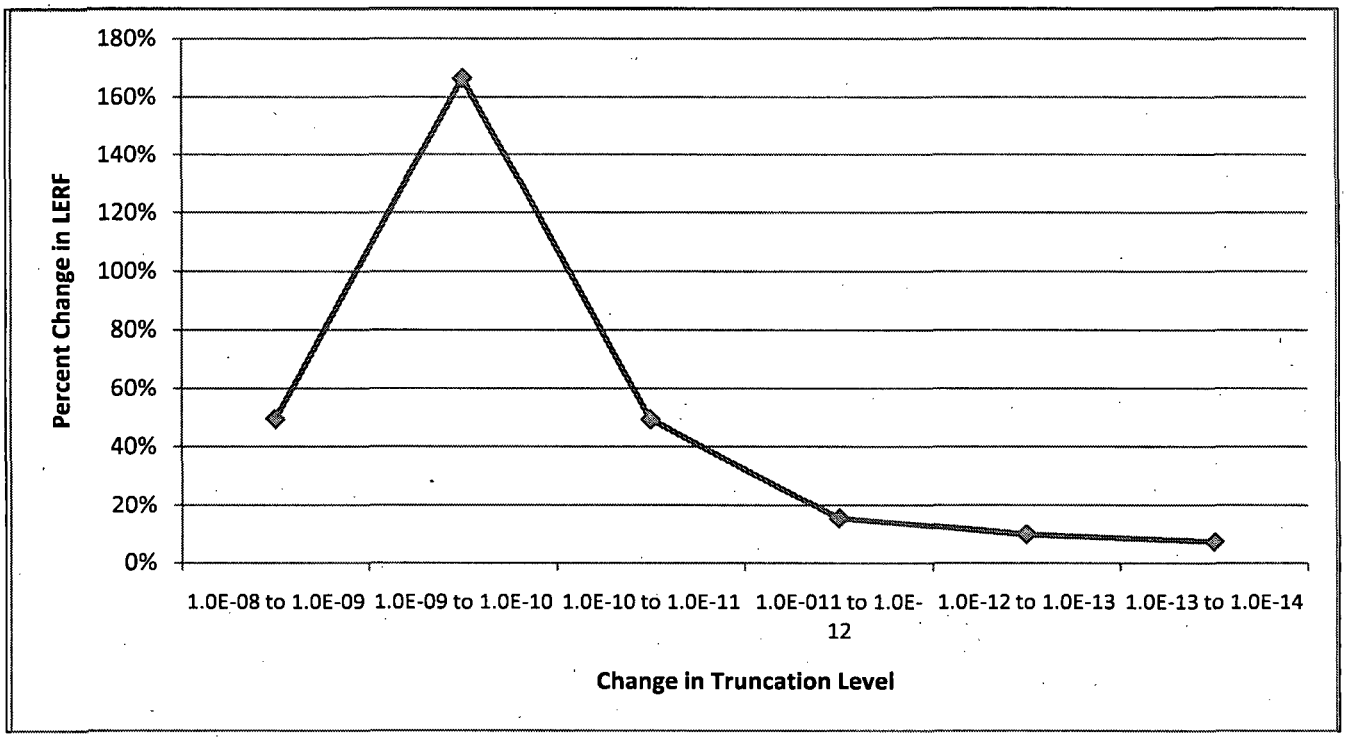
Figure 2: Percent Change in LERF vs. Change in Truncation Level – Updated HRA Dependency



HRA Dependency Impact on Convergence

HRA dependencies are addressed in a recovery file. The LERF recovery file (RecruleLERF.caf) is run after the fault tree file is quantified using the defined truncation level set in the PRAQuant file. The recovery file reviews each cutset for combinations of independent HEP basic events that are replaced with the applicable HRA dependency combination event and its associated probability. This method of applying HRA dependency can impact convergence.

The following example cutset is a WBN LERF cutset that contains HRA dependency combination 1295. Also provided is the text from the recovery file that replaces the independent operator actions with the dependency combination value. This is a Small Loss of Coolant Accident (%2SLOCAL) followed by a common cause failure of the ESFAS (*U2_ESF_SGD_CF_517_CCF_1_2)* to start AFW automatically. Operator failure to start AFW manually (HAOS3) and operator failure to cooldown the RCS with MFW (HACD1) are the two actions contained in HRA dependency combination 1295 (HRADEP-LERF-POST-1295). All remaining basic events in this cutset are branch probabilities from the level 2 event tree for its corresponding level 1 plant damage state.

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Example Text from RecruleLERF.caf

***CHANGEEVENTS** +HRADEP-LERF-POST-1295 -HACD1 -HAOS3*
HACD1 HAOS3

SET EVENT PROBS
HRADEP-LERF-POST-1295 1.70E-03

Example Cutset

1.73E-11 %2SLOCAL U2_ESF_SGD_CF_517_CCF_1_2 U2_L2_NOTPISGTRNOSBO U2_L2_NOTRCSDEPNOSBO U2_L2_TISGTRNOSBO U2_L2FBLERF001 HRADEP-LERF-POST-1295

The joint probability of the two operator actions (HAOS3 * HACD1) prior to the dependency analysis was 6.5E-06. Using the joint probability, the cutset frequency would be 6.63E-14 r-yr. This would only contribute to LERF when the model is quantified with a truncation value less than 1.0E-13. Using the updated joint probability from the dependency analysis of 1.7E-03 results in a cutset frequency of 1.73E-11 r-yr. This increase in LERF due to cutsets involving multiple operator actions impacts the demonstration of convergence.

A sensitivity of the WBN LERF model was performed by quantifying without accounting for any HRA dependency between human actions. The LERF recovery file was updated to remove all text associated with HRA dependency. The following results were obtained:

Table 3: WBN U2 Results of Truncation Evaluation for LERF – No HRA Dependency

	Unit 2	
Truncation	LERF(r-yr)	% Difference
1.00E-12	1.86E-06	-
1.00E-13	1.95E-06	4.9%
1.00E-14	1.98E-06	1.7%

As expected, the corresponding LERF values are lower than the values presented in Tables 1 and 2. Comparison of the results from Table 3 to Tables 1 and 2 clearly shows the impact that HRA dependency has on convergence.

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Summary of the HRA Dependency Review and Update

Table 4 summarizes the results of the HRA dependency combinations review and update. Please note that other HRA dependency combinations may have also been updated since they may share a subset of HEP events contained within these combinations. The dependency levels assigned for several combinations were reviewed and updated based on several different reasons. If two actions were occurring in the same time window, the default dependency assigned was completed based on the availability of the crew. These actions were reviewed to ensure adequate resources, and the level of dependency was assigned based on the locations of the action and the stress level. Dependency levels were also adjusted to more realistically match the timing and recovery time available to support the actions. For example, the timing for RWST to sump swap over was based on a Large LOCA event for the independent HEP evaluation. For sequences going to bleed and feed, the time to cue and the time until core damage after injection are longer than the time windows based on a Large LOCA event. For these cases dependency was assigned based on the more realistic timing for that given initiating event and sequence.

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Table 4: Reviewed and Updated HRA Dependency Probabilities

Event Name	HEPs in Combinations Event	Joint Probability (prior to dependency assessment)	Joint Probability (after initial dependency assessment)	Joint Probability (after review and update of initial dependency assessment)
HRADEP-LERF-POST-837	HACD1: Cooldown with MFW HAOB2: Establish RCS Bleed and Feed Cooling HACI1: Backup Containment Isolation	9.20E-08	3.40E-02	1.70E-03
HRADEP-LERF-POST-853	HACD1: Cooldown with MFW HARR1: Align High Pressure Recirculation HACI1: Backup Containment Isolation	2.20E-08	3.40E-02	8.50E-04
HRADEP-LERF-POST-840	HACD1: Cooldown with MFW HAOS2: Start ECCS HACI1: Backup Containment Isolation	2.50E-09	3.40E-02	8.50E-04
HRADEP-LERF-POST-851	HACD1: Cooldown with MFW HARL1: Recover from Auto Swapover Failure HACI1: Backup Containment Isolation	1.30E-08	3.40E-02	8.50E-04
HRADEP-LERF-POST-839	HACD1: Cooldown with MFW HAOS3: Start AFW HAOB2: Establish RCS Bleed and Feed Cooling HACI1: Backup Containment Isolation	1.80E-11	8.70E-04	3.80E-05

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Table 4: Reviewed and Updated HRA Dependency Probabilities

Event Name	HEPs in Combinations Event	Joint Probability (prior to dependency assessment)	Joint Probability (after initial dependency assessment)	Joint Probability (after review and update of initial dependency assessment)
HRADEP-LERF-POST-1389	SSIOP: Terminate Safety Injection to Prevent PORV Water Challenge HARR1: Align High Pressure Recirculation HAHH1: Place Hydrogen Igniters in Service	5.90E-08	5.00E-04	1.00E-05
HRADEP-LERF-POST-1415	SSIOP: Terminate Safety Injection to Prevent PORV Water Challenge HARR1: Align High Pressure Recirculation	2.50E-05	1.00E-03	1.00E-03
HRADEP-LERF-POST-838	HACD1: Cooldown with MFW HAOS2: Start ECCS HAOB2: Establish RCS Bleed and Feed Cooling HACI1 : Backup Containment Isolation	4.00E-11	1.70E-02	1.20E-04
HRADEP-LERF-POST-843	HACD1: Cooldown with MFW HAOS2: Start ECCS HCRL1: Inadvertently Reset SI Signal, Failure of Auto Sump Swapover HARL1: Recover from Auto Swapover Failure HACI1: Backup Containment Isolation	2.20E-14	1.70E-02	6.00E-05
HRADEP-LERF-POST-1295	HAOS3: Start AFW HACD1: Cooldown with MFW	6.50E-06	3.40E-02	1.7E-03

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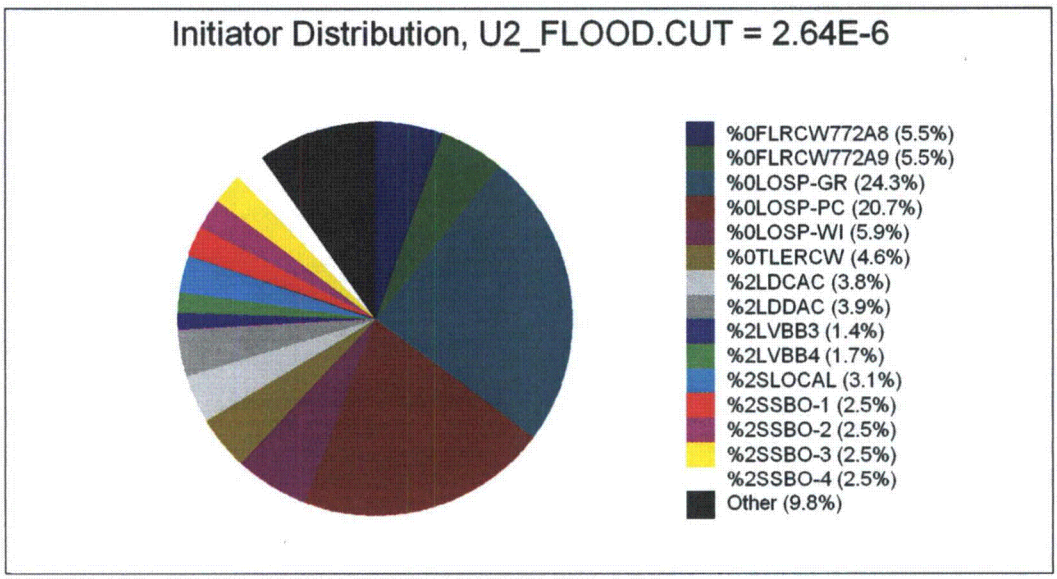
Summary of the Updated Initiating Event LERF Contributions

The Initiating Event LERF contribution pie chart was updated based on the results with the updated HRA dependency combinations failure probabilities and is displayed in Figure 3. When compared to the results of the 1.0E-12 quantification using the original HRA dependency combinations probabilities (LERF = 2.62E-06/r-yr), the LERF contribution due to a Secondary Side Break Outside Containment decreased from 6% to 3%. The LERF contribution due to Grid and Plant Centered Loss of Offsite Power increased from 22% to 24% and from 19% to 21%, respectively. All remaining IE LERF contributions were within a 1% change.

Figure 3: Updated Unit 2 LERF IE Pie Chart



Conclusion

Figures 1 and 2 clearly illustrate decreasing changes in LERF following successive reductions in the truncation value. These results demonstrate convergence of the model with the updated recovery file and that no significant cutsets have been inadvertently eliminated. As an independent perspective, we also received feedback from EPRI on the WBN LERF result, and they recommended quantifying the WBN LERF results at 1E-13/r-yr based on the small relative change in LERF. A representative from EPRI also noted that, at this truncation level, the Level 2 model uncertainty is likely to dominate the results.