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

May 25, 2011

10 CFR 50.4

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

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

Subject: **WATTS BAR NUCLEAR PLANT (WBN) – UNIT 2 – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION ITEM NUMBERS 2, 3, 5 AND 15 REGARDING SEVERE ACCIDENT MANAGEMENT DESIGN ALTERNATIVE REVIEW (TAC NO. MD8203)**

References:
1. TVA to NRC letter dated May 13, 2011, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Response to Request for Additional Information Regarding Severe Accident Management Design Alternative Review (TAC No. MD8203)"
2. NRC to TVA letter dated March 30, 2011, "Watts Bar Nuclear Plant, Unit 2 - Supplemental Request for Additional Information Regarding Severe Accident Management Design Alternatives Review (TAC No. MD8203)"
3. TVA to NRC letter dated January 31, 2011, "Watts Bar Nuclear Plant (WBN) Unit 2 - Response to Request for Additional Information Regarding Severe Accident Management Alternative Review (TAC No. MD8205)"
4. NRC to TVA letter dated January 11, 2011, "Watts Bar Nuclear Plant, Unit 2 - Request for Additional Information Regarding Severe Accident Management Alternative Review (TAC No. MD8203)"

The purpose of this letter is to provide a response to the NRC requests for additional information (RAI) Item Nos. 2, 3, 5 and 15 regarding the Severe Accident Management Design Alternatives (SAMDA) analysis discussed in Reference 2. Reference 1 provided TVA's response to the majority of the requests for information

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Enclosure 1 provides TVA's response to RAI item numbers 2, 3, 5 and 15.
Enclosure 2 provides the list of commitments made in this letter.

If you have any questions, please contact Bill Crouch at (423) 365-2004.

I declare under the penalty of perjury that the foregoing is true and correct. Executed on the 25th day of May, 2011.

Respectfully,

David Stinson
Watts Bar Unit 2 Vice President

Enclosures:

1. Responses to NRC Request for Additional Information Item Numbers 2, 3, 5 and 15
2. List of Commitments

cc (Enclosures):

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ENCLOSURE 1

RESPONSES TO NRC REQUEST FOR ADDITIONAL INFORMATION ITEM NUMBERS 2, 3, 5 AND 15

By letter dated January 31, 2011, the Tennessee Valley Authority (TVA) provided a response to the Nuclear Regulatory Commission (NRC) staff regarding questions related to TVA's Updated Analysis of Severe Accident Mitigation Design Alternatives (SAMDAs) for Watts Bar Nuclear Plant (WBN), Unit 2. In its review of this information, the NRC staff requires further information and clarification on TVA's response. The information listed in the following request for additional information (RAI) refers to the RAI responses in the January 31, 2011, letter.

2. *RAI 1.f*

   The response did not address the assumptions concerning the availability of WBN Unit 1 components/systems for both dual-unit and Unit 2 initiating events. Discuss how the availability of Unit 1 systems during Unit 1 outages is accounted for in evaluating WBN Unit 2 CDF and LERF.

   TVA Response:

   The WBN model is a dual-unit model which incorporates initiating event fault tree logic for a number of support-system initiators. The relevant fault tree logic is input into both unit-specific and dual-unit initiating events. Therefore, the impact of unavailability of Unit 1 components/systems with respect both to mitigation and to initiating events (unit-specific and dual-unit) is incorporated in the model for Unit 2, and the results are included in the calculations for CDF and LERF for Unit 2. Primary systems for Unit 2 such as ECCS will not be impacted directly during Unit 1 outages, the impact will be seen in the unavailability of support systems such as service water and component cooling. Also, actual plant risk of the operating unit while the other unit is in a refueling outage will be monitored using the WBN EOOS (Equipment out of Service) model. WBN uses EPRI's EOOS program to monitor plant risk in accordance with 10 CFR 50.65a(4). As WBN has not yet completed a refueling outage on one unit while the other unit is operating, assumptions regarding these unavailabilities were made.

   The following describes the current modeling approach used in the CAFTA model. The WBN Unit 1 maintenance rule database was the primary data source used to develop estimates of system train unavailability due to testing and maintenance of modeled components; i.e., TI-119, "Maintenance Rule Performance Indicator Monitoring, Trending, and Reporting", 10 CFR 50.65. This database includes component failure and unavailability for periods when a system is required. For systems such as ERCW, Component Cooling and Compressed Air, the systems are required during power operation (Mode 1) and for some periods of time when the unit is in Modes 2-6. For dual unit operation, excessive unavailability from outage downtime would adversely impact the maintenance rule metrics. In addition, dual unit operation with controlling technical specifications from each unit will limit the outage time for common systems compared to single unit operation. As an example, two trains of ERCW must be operable during modes 1, 2, 3, and 4 (per LCO 3.7.8), or within 72 hours the unit must begin the transfer to mode 5. This LCO does not apply to single unit operation when in mode 5 or 6 already. However, when dual unit operation begins, if one unit is in an outage (i.e., Mode 5 or 6), the LCO will apply to the unit that is in Modes 1, 2, 3, or 4. Therefore, the duration of such maintenance events while one unit is in an outage will be limited by the TS requirements on the non-outage unit. This train maintenance is included in the model

Maintenance Rule data is collected on a train basis for most systems. The data for each train was used to calculate the probability of the train being unavailable due to maintenance. Each of the calculated probabilities was given a variable name which was added to the type code table in the WBN PRA CAFTA database. These variables are assigned to the applicable maintenance basic events for each train during fault tree construction.

Where maintenance rule data were not available, generic information from NUREG/CR-6928 was generally used. However, since NUREG/CR-6928 data for unavailability consider only events during critical hours from the Mitigative System Performance Index (MSPI) data, the generic experience data from plant outages are not considered. Also, unavailability was calculated or estimated in some instances where neither appropriate maintenance rule data nor NUREG/CR-6928 data were available. However, based on the maintenance rule unavailability limitations and the technical specification limits, we believe the unavailability times used in the CAFTA model are sufficient for proper decisionmaking with respect to proposed SAMA measures.

3. *RAI 1.h*

   a. *The response to the RAI states "The following peer cert findings remain open and are considered documentation related (i.e., are judged to not have the potential for significant change to model results or risk ranking): ..." Among the findings listed, the following, from the description in the IPE, do not appear to be limited to just documentation:*

      (1) 1-4 (DG [diesel generator] load sequencer) - states certain failures are missing from the logic model,

      (2) 2-11 (T-H [thermal-hydraulic] timing for HRA [human reliability analysis] cues, no simulator runs) - does this mean the runs were not performed, or that they were performed but not documented, and

      (3) 5-1 (Optimistic room heat-up times used).

      Provide further justification that each of these items is only a documentation issue and that final resolution is unlikely to impact the SAMA evaluation.

TVA Response:

a. (1) This relates to standard Supporting Requirement SY-B10. The peer reviewer's comment about this element is as follows: "Assessment: Cat 2-3 is MET. Basis: Appropriate actuation signals from RPS and ESFAS are modeled. However, the actuation signals from the DG load sequencers are not modeled for each load. This is expected to have minimal impact on the results because the sequencer dependency is modeled for the ERCW system which is required for diesel generator support."

ERCW is the only load with an individual sequencer modeled. The sequencer is modeled with the diesel generator and fails the diesel generator if failed. The supporting requirement is judged as 'met' with respect to this element; therefore, the significance of the issue is believed to be relatively minor. The peer reviewer also specifically indicated that a minimal impact on results was expected. Therefore, any final resolution is unlikely to impact the SAMA evaluation.

(2) This relates to standard Supporting Requirement HR-E4. The requirements for that element are as follows:

Category I
No requirement for using simulator observations or talk-throughs with operators to confirm response models.

Category I/II
USE simulator observations or talk-throughs with operators to confirm the response models for scenarios modeled.

The peer reviewer's comment about this element is as follows: "Assessment: Cat 1 is MET. Basis: The Process for Post initiator actions provided in MDN-000-999-2008-0144 Section 7 does not discuss use of simulators. However, timing data for post initiator actions are provided in MDN-000-999-2008-0153 section 8.0 based only on judgment of the operators, which includes some very optimistic times. Also, the operator interviews should produce some insights related to the risk model, use of procedures, etc. CAT I met for this element."

The WBN Model used walk-throughs rather than simulator runs. The peer review comment indicates that the supporting requirement was judged to be met at least at capability category I, and it is also noted that talk-throughs with operators were in fact performed. The talk-throughs were performed and were well-documented, which would appear to meet the requirements of capability category II/III. Documentation demonstrates that the talk-throughs with members of the operations staff at WBN were conducted over a significant number of hours and with several highly experienced individuals having diverse operations backgrounds. Therefore, the results are believed to be generally reasonable and appropriate. There is no information to indicate that any significant changes might result should simulator runs be performed.

(3) The peer review comment reads as follows:

The mission time used for room heat-up calculations (MDN-000-999-2008-0143, Appendix B, WBNOSG4-242, 200, and 197) was optimistically justified.

(This F&O originated from SR SC-A5.)

Basis for Significance. According to WBNOSG4-197, 200 and 242, the mission time for mitigation was verified based on simplified calculations and optimistic engineering judgment. Because the component cooling relies on HVAC, the results of room heat-up calculation affect the ability of components to function without room cooling.

The resolution of this item will be that based on room heat-up calculation results, judge whether the safe and stable condition is met and the basis of the judgment should be presented explicitly.

TVA calculation MDN-000-999-2008-0143 summarized results and identified a number of areas as requiring room cooler/ HVAC support including residual heat removal pump rooms, safety injection pump rooms, containment spray pump rooms, charging pump rooms, the turbine-driven auxiliary feedwater pump room, and the emergency diesel generator rooms. Mission times of 24 hours were generally assumed. No information was identified in MDN-000-999-2008-0143 to indicate that these results are optimistic with respect to those for other Westinghouse PWR sites. The peer review report indicates that all supporting requirements for Success Criteria were met at Category II (or II/III) or above, therefore success criteria elements are indicated to be adequately met. The proposed resolution indicates that additional review, judgment, and documentation of this process may be sufficient to resolve the question. There is therefore no indication that any changes will be developed which could substantially impact the SAMA evaluation.

b. *TVA stated (p. E1-13), with reference to internal flooding, that "the current model is judged to be adequately bounding for this application," which is based on conservatisms in the flooding model described in the response. While this may be true, there are a large number of open internal flood findings from the peer review and an updated flooding analysis is to be included in the next model update. Section 3.7 (p. 70) of the WBN Unit 2 IPE submittal states that two sets of sensitivity studies were performed on the internal flooding analysis, with one set focused on evaluating alternative design/procedural changes that would significantly impact (i.e., reduce) the flood related CDF and LERF while the other was designed to address epistemic uncertainties identified in the WBN internal flooding probabilistic risk assessment (PRA). Provide a description of these studies, their results and conclusions, and how the results and conclusions support the conclusion that the current flooding model is bounding for the SAMA application.*

<u>TVA Response</u>:

b. A sensitivity study was performed to evaluate re-routing or sheathing with guard pipes certain raw cooling water piping segments in flood areas 772.0-A8, 772.0-A9, 757.0-A9 and 757.0-A17. A reduction in CDF of approximately 7.32%

and a reduction in LERF of approximately 12.98% were estimated for this configuration.

A sensitivity study was performed to examine the flooding risk contributions associated with raw cooling water and high pressure fire protection piping failures in areas 757.0-A2, -A5, -A9, -A17, -A21, and -A24, 772.0-A7, -A8, -A9 and -A10, comparing the risk associated with carbon steel piping vs. stainless steel piping. The study compared a baseline configuration of stainless steel piping with carbon steel piping. The carbon steel piping configuration CDF was approximately 45.43% greater and LERF was approximately 81.30% greater.

A sensitivity study was performed to evaluate the significance of operator actions to mitigate certain flooding scenarios. A case was run setting the failure probability of all the subject mitigating actions to 0 (certain to succeed) and then another case was run setting the failure probability to 1.0 (certain to fail). Setting the actions to 0 resulted in a reduction in CDF of approximately 2% and a reduction in LERF of approximately 1%. Setting the actions to 1.0 resulted in an increase in CDF of approximately 44% and an increase in LERF of approximately 23%.

A sensitivity study was performed to evaluate the contributions due to maintenance and human-induced flooding events. Suppressing contributions from these causes resulted in a decrease in CDF of approximately 0.3% and a decrease in LERF of approximately 0.4%.

The studies were not performed to demonstrate that the current model is bounding but rather to compare various possible plant changes or to examine the importance of certain inputs to the analysis. However they do demonstrate that the model responds as expected, showing reductions in flood risk associated with improvements, thereby providing additional confidence in its results.

TVA has previously committed to installing flood detection in WBN areas 772.0-A8 and 772.0-A9. Please see commitment 9 of Enclosure 2 of the January 31, 2011 letter from Marie Gillman (TVA) to the USNRC, "WATTS BAR NUCLEAR PLANT (WBN) – UNIT 2 – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING SEVERE ACCIDENT MANAGEMENT ALTERNATIVE REVIEW (TAC NO. MD8203)" (T02 110131 001).

TVA now numbers this as a new SAMA, 340, to install flood detection in areas 772.0-A8 and 772.0-A9.

5. *RAI 2.a.iv*

   a. *The discussion of the determination of release category characteristics (i.e. source terms) indicates that the SEQSOR methodology was used. This methodology does not calculate release fractions from first principles but uses input from other calculations and has been used in the past for Sequoyah. The WBN Unit 2 IPE submittal discusses the use of Modular Accident Analysis Program (MAAP) 4.0.7 for the LERF analysis. Clarify the origin of the source terms used for the SAMDA analysis. Note that in the July 23, 2010, TVA response to RAI 2.f, TVA took the position that results from MAAP analysis were* *more valid than those from SEQSOR. Clarify this apparent change in TVA's position.*

TVA Response:

The WBN Unit 2 IPE submittal did use the Modular Accident Analysis Program (MAAP) 4.0.7 for the LERF analysis. The use of this code, however, was specifically for the thermal hydraulic analyses needed to justify sequence success criteria, not for source term calculations. TVA has not taken the position that release fractions computed by MAAP are more or less valid than the SEQSOR approach for WBN.

In the original IPE for WBN Unit 1 (published in 1992), release fraction results from MAAP 3B were used to satisfy IPE requirements. The latest WBN Unit 2 CAFTA model, used for the SAMA analyses, results in different dominant scenarios for each Release Category than those previously assessed. Since the SEQSOR approach makes use of release fractions computed for WBN Unit 2's sister plant, Sequoyah, it was deemed prudent to use these same inputs for the SAMA evaluation.

The SEQSOR methodology itself uses release fractions originally calculated from first principles for the Sequoyah plant. The origin of the source terms used for the revised SAMA analysis is described in the previously submitted response to RAI 2.a.iv. The approach is to identify dominant scenarios for each release category specific to WBN Unit 2, note their specific release characteristics in terms of accident progression, and then follow the SEQSOR methodology to arrive at mean release fractions for each Release Category.

The SEQSOR emulator developed for use in this analysis is described in the following paragraphs.

The SEQSOR program used to calculate the source terms for Sequoyah in NUREG-1150 was not available for this analysis. SEQSOR is explained in NUREG/CR-4551 Volume 5, Chapter 3 and Appendix B of that volume. Instead, for this analysis, a spreadsheet based SEQSOR Emulator was developed and used to emulate the basic calculation of the SEQSOR program used during the NUREG-1150 analyses.

The SEQSOR code was developed because of the large number of possible sequences a plant could undergo during an accident. The complexity and time of running a phenomenological code, such as MAAP, for each of these sequences would have been impossible. Instead, the SEQSOR code was developed as a relatively simple parametric code to select from a representative set of results of detailed phenomenological codes as probability distributions. This approach allows one to estimate a large number of cases in a short time.

SEQSOR uses blocks of data containing probability distributions, by release class (the nine release classes are groups of elements with similar chemical behavior) for a variety of terms in the basic SEQSOR equations, given in equations 3.1 and 3.2 of NUREG/CR-4551, Volume 5. Equation 3.1 gives the behavior in the early phase, before the reactor vessel breach (if any). Equation 3.2 gives the behavior in the late phase, which considers the core-concrete interaction. Each of the data blocks represents a term in one or both of these equations and the data in each is a function of a probability level between 0% and 100%, and in most cases is also a function of the radionuclide group. During the Monte-Carlo process, a random variable between 0 and 1 is used to select a value (or a set of values for each radioisotope group) for the calculation. The same data blocks were used in the SEQSOR emulator, except where processes or equipment that needed to be considered for this analysis were not included in the NUREG-1150 analyses. The blocks considered in both SEQSOR and the SEQSOR emulator are shown below:

- Early releases from fuel to RCS (two oxidation states)
- Fraction of core released from RCS before vessel breach (six conditions)
- Fraction of containment contents released in the early and late phase (nine containment failure modes)
- Containment state (wet or dry)
- Sprays during early phase (three conditions)
- Number of holes in the RCS if vessel failure (one or two)
- DCH release (two conditions)
- Core-concrete interaction pool scrubbing (two conditions)
- SGTR scrubbing (three conditions)
- Ice condenser decontamination factor for early phase (three conditions)
- Ice condenser decontamination factor for late phase (four conditions)
- Fraction of core mass ejected from high pressure mass ejection (four conditions)
- Early phase ice condenser bypass (three conditions)
- Late phase ice condenser bypass (three conditions)

All of these data blocks with the exception of the SGTR scrubbing were used in the original SEQSOR analysis. Three additional containment failure modes were considered: intact containment, failure to isolate, and late unfiltered vent.

The SEQSOR Emulator was developed to use the same SEQSOR logic but in a spreadsheet format. The SEQSOR Emulator was independently reviewed prior to use for SAMA analysis. For each Release Category, the fraction of each condition for each set of data blocks is determined from the scenarios included. Then, a set of 4096 Monte-Carlo samples from the resulting probability space was selected and the resulting release fractions calculated according to the computational rules in equations 3.1 and 3.2 from the SEQSOR approach. This distribution of release fractions was used to determine the mean and other statistical measures for each radionuclide group. Finally, these release fractions and other sequence attributes (e.g., for timing and release points) were used in MACCS2 to determine the consequences for each sequence sub-category.

b. *The discussion of the source terms states that the, "The source terms for each set of accident characteristics are weighted in accordance with the % contribution for each release type in Table 2.a.iv-3." This process is valid only if the consequences of the releases are linear with respect to the source terms. This is* *not necessarily true. Provide support that this process provides a valid estimate of consequences.*

TVA Response:

The quoted statement could have been more clearly worded. The actual approach taken is as stated in the final sentence of the same paragraph describing Table 2.a.iv-3; "Each release characteristic type in Table 2.a.iv-3 are calculated separately with MACCS and then weighted by frequency to determine the averaged dose and economic consequences shown in Table 2.a.iv-6." TVA agrees that the doses and consequences used for SAMA evaluations cannot be assumed linear and must instead be calculated separately and then frequency weighted. This is what was done.

In addition to the average weighted dose and economic consequences applied to the SAMA evaluations, as sensitivity, we have here instead applied the worst accident sequence dose and consequences of the sub-categories from each release category to the SAMAs to see if any of the Phase 2 SAMA results would then become cost beneficial. After applying the worst accident doses and consequences, we then reviewed the SAMAs for cost benefit using the CDF 95th percentile sensitivity. The SAMAs remain well below the cost benefit threshold except for one, SAMA 93.

This new sensitivity of cost and benefits was evaluated using the 2.70 multiplying factor for the CDF 95th percentile. Applying the 2.78 multiplying factor for the CDF 95th percentile, as suggested in NRC item 12, would not change these results developed using the worst accident doses and consequences. Again, the one exception is for SAMA 93 which is discussed further below.

SAMA 93 proposes to install an unfiltered hardened containment vent for the prevention of containment failure in late release sequences. SAMA 93 has a cost benefit of 0.96 at the CDF 95th percentile when using the average late release category dose and economic consequences for the baseline. If the worst case doses and consequences were instead used, the cost benefit ratio would exceed 1.0 for the CDF 95th percentile sensitivity. However, if implemented SAMA 93 would reduce the Level 2 release consequences of the late Release Category but would not change the core damage frequency. The mix of sequences contributing to the late release category would also not be changed by implementing SAMA 93. Therefore, we maintain that the baseline risk should use the weighted average accident dose and consequences in the baseline risk evaluation so that the cost benefit of the CDF 95th percentile would remain at 0.96 for SAMA 93. Further, using the 2.78 multiplying factor for the CDF 95th percentile for SAMA 93 and average accident doses and consequences for the baseline would result in a cost benefit of 0.99 which remains below the cost benefit threshold.

Examination of the contributors to the frequency of the Late Release Category, which would be mitigated by implementation of SAMA 93, reveals that 40% of the frequency is attributed to RCP seal LOCAs with leakages of 182 gpm per pump.

TVA's response to Item 16 (Reference 1) commits to follow the progress of the seal package design defined in SAMA 58 and to install it if proven reliable. Implementation of SAMA 58 would greatly reduce the benefits of SAMA 93. Further, in the Reference 1 response to item 16, TVA further committed to re-evaluate the benefits of SAMAs 215, 226, 50, 55, and 56 for mitigation of RCP seal LOCA scenarios if SAMA 58 is not proven reliable. TVA further commits to add SAMA 93 to this list for re-evaluation should SAMA 58 not prove reliable.

Note also that scenarios in which there is a loss of control air (e.g., during a station blackout) and failure of the operators to locally control the AFW LCVs to allow the turbine-driven AFW pump to continue steam generator cooling contribute 10% to the Late Release Category frequency. TVA has committed to implement SAMA 339 (in place of the new air accumulators called for in SAMA 70) to provide a new capability to allow the operators to transfer from the normal compressed air supply to the station nitrogen system for control of the AFW LCVs for these sequences. See the response to item 11a for RAI 5.b. Implementation of SAMA 339 will further decrease the evaluated benefit of SAMA 93, further affirming that it is not cost beneficial even for the CDF at 95^{th}% sensitivity assessment.

c. *The discussion of release category definitions and contributors in response to RAI 2.a.ii and iii indicates that early steam generator tube ruptures (SGTRs) are assigned to the BYPASS release category under the contributor LERF-SGTR (SLERF) corresponding to the SLERF CET end state. The WBN Unit 2 IPE indicates that thermally induced SGTRs make up 32 percent of the WBN Unit 2 LERF. The SLERF end state is not included in the RAI revised model dominant CET end states listed in Table 2.a.iv-2. It is noted that plant damage state (PDS) bin 4B1, which, according to Table 2.a.i-2, is made up of large SGTR sequences, is not represented in the dominant CET end states. Clarify the reason for this and describe the SGTR contribution to WBN Unit 2 consequences.*

TVA Response:

There are 2 types of SGTR sequences that contribute to LERF releases in the Containment Event Tree (CET):

1) SLERF Sequences - SGTR Initiating Events that lead to Core Damage (PDS Bin 4B1 or 4B2) and release.

2) BLERF Sequences – Non-SGTR Initiating Events that lead to Core Damage (PDS Bin 2) and Thermal-Induced SGTR (TI-SGTR) or Pressure-Induced SGTR (PI-SGTR) in the CET.

In the WBN Unit 2 IPE model, both BLERF and SLERF sequences contributed to LERF frequency. In the WBN Unit 2 SAMA model, the SGTR IE sequences are separated from the Non-SGTR IE sequences; however, both types of sequences still contribute to LERF frequency.

The sequences that contribute to LERF are shown in Table 5c-1 below. The SGTR sequences contribute negligibly. In the WBN Unit 2 SAMA Model, the Non-SGTR IE (BLERF) sequences that lead to TI-SGTR contribute 3.41E-07

(22%) of the overall LERF frequency of 1.61E-06. The difference from the WBN Unit 2 IPE Model is due to the changes made in the WBN Unit 2 SAMA model as documented in Attachment B.4 of the October 2010 SAMA submittal.

Table 5c-1 CET Sequences that Lead to large Early Release Frequency (LERF)

CET End Sate	PDS Bin	SBO Non-SBO	CET Sequence Events	CET Sequence Frequency
BLERF-01	2	Non-SBO	Not PI-SGTR, Not RCS Depressurization, TI-SGTR	3.97E-11
BLERF-02	2	Non-SBO	PI-SGTR	6.32E-09
BLERF-04	2	SBO	Not PI-SGTR, Not RCS Depressurization, TI-SGTR	2.84E-07
BLERF-05	2	SBO	PI-SGTR	5.10E-08
			(Non-SGTR Sequences) BLERF Subtotal	**3.41E-07**
SLERF-01	4B1	Non-SBO	(Containment Bypassed - No CET Events)	4.95E-10
SLERF-02	4B2	Non-SBO	(Containment Bypassed - No CET Events)	5.13E-10
SLERF-03	4B1	SBO	(Containment Bypassed - No CET Events)	<1E-14
SLERF-04	4B2	SBO	(Containment Bypassed - No CET Events)	7.69E-13
			(SGTR Sequences) SLERF Subtotal	**1.01E-09**
			BLERF and SLERF Total	**3.42E-07**

d. *The development of the RAI revised source term characteristics given in Table 2.a.iv-3 includes four contributors to the late release category, whereas Table 2.a.iv-2 identifies six dominant CET end states from three different PDS bins. Explain the development of the four late release category contributors and their weighting.*

TVA Response

There are actually 12 CET sequences rather than the 6 CET sequences listed in Table 2.a.iv-2 that contribute to the release characteristics in Table 2.a.iv-3. All 12 sequences are shown in Table 5d-1 below. The 12 CET sequences were combined into 6 for development of the source terms. Each sequence characteristic contributes a percentage to the release characteristics as shown in the table. The percentages are rounded off to the values shown in Table 2.a.iv-3.

Table 5d-1 CET Sequences that Contribute to the Late Release Category

PDS Bin	%	CET Sequence	Frequency	Level I Core Damage Sequence	Release Characteristics				
					RCS Pressure (Hi or LO)	Hi	Lo	Hi	Lo
					ARFS Success or Failed (S or F)	F	F	S	S
					Level 2 Release Sequence	6.5%	28.8%	2.4%	60.6 %
1	10%	LATE_CA-05	1.35E-06	Steam Break Outside Containment, SG isolated, SI terminated, PORV fails to reclose, SI restarted, HPR fails	RCS Depressurization, ARFS available, No containment failure early, No CHR				8.9%
1		LATE_CA-01	3.62E-07	Steam Break Outside Containment, SG isolated, SI terminated, PORV fails to reclose, SI restarted, HPR fails	No RCS Depressurization, ARFS available, No DCH, No containment failure early, No CHR			2.4%	
2	60%	LATE_CNA-28	3.64E-06	Flood IEs leading to SBO and CD Not Bypassed, High RCS Pressure and SG Dry	RCS Depressurization, LPME, ARFS failed, No containment failure early, No CHR		24.0%		
2		LATE_CNA-09	2.71E-06	Loss of ERCW or CCS leading to CD Not Bypassed Low RCS Pressure and SG Dry	RCS Depressurization, ARFS available, No containment failure early, No CHR				17.8 %
2		LATE_CNA-24	2.95E-07	LOSP leading to SBO and CD Not Bypassed, High RCS Pressure and SG Dry	RCS Depressurization, ARFS failed, No containment failure early, No CHR		1.9%		
2		LATE_CNA-20	9.15E-07	Flood IEs leading to SBO and CD Not Bypassed, High RCS Pressure and SG Dry	No RCS Depressurization, HPME, ARFS failed, No containment failure early, No CHR	6.0%			
2		LATE_CNA-11	1.41E-07	LOSP or Loss of ERCW or CCS leading to CD Not Bypassed Low RCS Pressure and SG Dry	RCS Depressurization, ARFS failed, No containment failure early, No CHR		0.9%		
2		LATE_CNA-12	1.06E-07	LOSP or Loss of ERCW or CCS leading to CD Not Bypassed Low RCS Pressure and SG Dry	RCS Depressurization, ARFS failed, No containment failure early, No CHR		0.7%		
2		LATE_CNA-16	8.34E-08	LOSP leading to SBO and CD Not Bypassed, High RCS Pressure and SG Dry	No RCS Depressurization, ARFS failed, No containment failure early, No CHR	0.5%			
3A, 3B	30%	LATE_CA-09	4.92E-06	Loss of ERCW or CCS leading to CD Not Bypassed Low RCS Pressure and SG Wet (3A) or Dry (3B)	ARFS available, No containment failure early, No CHR				32.4 %
3A, 3B		LATE_CA-36	1.98E-07	Flood IEs leading to SBO and CD Not Bypassed, High RCS Pressure and SG Dry	LPME, ARFS failed, No containment failure early, No CHR		1.3%		
3A, 3B		LATE_CA-10	2.22E-07	Loss of ERCW or CCS leading to CD Not Bypassed Low RCS Pressure and SG Wet (3A) or Dry (3B)	ARFS available, No containment failure early, No CHR				1.5%

e. *Table 2.a.iv-6 gives the October 2010 RAI offsite population dose for release category III as 8.19E06 person-rem. This is a significant increase over the original October 2010 result of 1.13E06 person-rem, and when multiplied by the release category frequency of 1.3E-05 per year gives an annual population dose of 107 person-rem. This is a factor of 10 higher than that given in Table 5.c-1. Confirm that the value in Table 2.a.iv-6 should be 8.19E05 person-rem.*

TVA Response

The value should be 8.19E+05 person-rem.

f. *Provide the revised Off-Site Exposure Cost and Off-Site Economic Cost used to develop the maximum averted cost risk (MACR) as given in Section 5.1 and 5.2 of the October 14, 2010, RAI response submittal (and On-Site Exposure Cost in Section 5.3 and On-Site Cleanup and Decontamination Cost and Replacement Power Cost in Section 5.4 if these have changed for any reason) of the October 14, 2010, submittal.*

TVA Response

Below are the revised costs for the SAMA MACR. The table shows the October 2010 costs as compared to the Revised RAI MACR costs.

Cost Category	October 2010, SAMA Report	Revised (RAI) SAMA Results
Off-Site Exposure Cost $	$514,379	$369,019
Off-Site Economic Cost $	$466,032	$718,959
On-Site Exposure Cost $	$8,153	$8,153
On-Site Economic Cost $	$666,023	$666,023
Total Base Cost $	$1,654,587	$1,762,154
Base Cost with External Event Multiplier 2.0	**$3,309,174**	**$3,524,309**
Base Cost with External Event Multiplier 2.28	**$3,772,461**	**$4,017,712**

15. RAI 6

This RAI requested an assessment of the impact of uncertainty on the Phase I screening of SAMDAs due to either excessive cost or very low benefit similar to that given in response to the original RAI 7.a. The response to this new RAI does not provide this assessment. While Table 19 of the October 14, 2010, SAMDA submittal is cited, this table addresses the impact of uncertainty on the Phase II cost benefit analysis not the Phase 1 screening. The current marginal MACR is a factor of 2.6 times that on which the original screening was performed, while the risk profile of the current PRA is considerably different from that used in the original screening. These changes could impact the judgments made in the Phase I screening without requiring a Phase II cost evaluation. Provide the requested assessment.

TVA Response:

This response provides an assessment of the impact of uncertainty on the Phase I screening of SAMAs due to either excessive cost or very low benefit. A comparison of the Maximum Averted Cost of Risk (MACR) for the Revised RAI SAMA results are shown in Table 15-1. The Revised RAI sensitivity results show the 95% uncertainty (multiplier of 2.7) MACR for an External Event multiplier of 2.28 is $10,847,822. This $10,847,822 MACR value can be used to screen the Phase I SAMAs for either Excessive Cost or Very Low Benefit.

Table 15-1 - Revised RAI SAMA Maximum Averted Cost of Risk (MACR) Results

Cost Description	Revised (RAI) SAMA Results				
	Total MACR	MACR Onsite Costs (Function of Core Damage without Release Costs)		MACR Offsite Costs (Function of Core Damage and Release Costs)	
Base Cost with External Event Multiplier 2.0	$3,524,309	$1,348,352	38%	$2,175,957	62%
Base Cost with External Event Multiplier 2.28	$4,017,712	$1,526,731	38%	$2,490,981	62%
95% Cost with External Multiplier 2.0 (95% Multiplier 2.70)	$9,515,634	$3,615,941	38%	$5,899,693	62%
95% Cost with External Multiplier 2.28 (95% Multiplier 2.70)	$10,847,822	$4,122,173	38%	$6,725,650	62%

If we assume 100% Core Damage Frequency (CDF) reduction is worth $10,847,822, we can estimate the potential change in MACR of various impacts from proposed SAMAs. Table 15-2 shows the potential change of MACR of 7 cases of risk reduction according to what aspects of the CDF and Release category frequencies the proposed change impacts.

Table 15-2. 95% MACR Risk Reduction Case Types

SAMA Case	CDF	LERF (Early & Bypass)	LATE	SERF	% Contribution to MACR	Potential Change in MACR
1	Changed	Linear	Linear	Linear	100.0%	$10,847,823
2	Fixed	Changed	Fixed	Fixed	10.6%	$1,150,720
3	Fixed	Fixed	Changed	Fixed	47.9%	$5,201,087
4	Fixed	Fixed	Fixed	Changed	3.2%	$345,785
5	Changed	Changed	Fixed	Fixed	14.2%	$1,538,656
6	Changed	Fixed	Changed	Fixed	77.0%	$8,348,905
7	Changed	Fixed	Fixed	Changed	11.7%	$1,272,159

Case 1 is calculated as a linear function of the total MACR based on the fractional change in CDF. For Cases 2 through 4, the values are calculated by zeroing the release category frequency contribution and subtracting the result from the total MACR. For Cases 5 through 7, the values are calculated by zeroing the release category frequency contribution, subtracting the release frequency from the CDF, and then subtracting the changes from the total MACR.

For SAMA Case 1 in Table 15-2, if the risk reduction changed the CDF and the LERF, LATE and SERF Release categories are changed linearly, the MACR available for reduction would be the full $10,847,823. A 1% reduction in CDF would be worth $108,478, a 10% reduction in CDF would be worth $1,084,782 and so forth.

For SAMA Cases 2 through 7, if the risk reduction change affected the LERF, LATE, SERF or combination of CDF and LERF, CDF and LATE, or CDF and SERF, and the other contributors to MACR were fixed, the table shows the potential change in MACR available for reduction. Based on comparing the SAMA change to one of these SAMA cases, we can screen for excessive costs based on the maximum potential change in MACR.

In addition to the potential maximum MACR available for reduction ($10,847,823), we can screen based on the potential benefit using the 7 case values in Table 15-2. Costs would have to be equal to or less than the corresponding maximum potential change in MACR to be cost beneficial.

Using the above cost benefit screening guidelines we have reviewed the Phase I SAMAs for Excessive Costs, Very Low Benefit, or low cost benefit (cost greater than potential benefit). All of the Phase I SAMAs that were screened for Excessive Cost or Very Low Benefit were rescreened and the results provided in Table 15-3. In estimating the potential benefits of each SAMA, often the estimated percentage reduction in MACR was based on observations of RRWs for basic events in the model that would be affected by implementing the associated SAMA. Table 15-3 is sorted first by disposition and then by SAMA number. For others, knowledge of the implementation cost was used to qualitatively bound the anticipated benefit. All of the Phase I SAMAs remain screened out. This conclusion is unchanged if instead of using frequency weighted average consequences for each Release Category to compute MACR, the worst sub-category doses and consequences are conservatively used.

Some of the Phase I SAMAs pertaining to mitigation of Seal LOCA events may be retained for consideration along with the other Seal LOCA SAMAs being considered in Phase II. See the TVA response to item 16 (Reference 1).

Table 15-3. Phase I SAMA Candidates

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
2	Replace lead-acid batteries with fuel cells.	Extended DC power availability during an SBO.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the cost of implementation caused by replacing all batteries with fuel cells, including structural, electrical, and HVAC changes required, including a fuel supply which does not currently exist on site, would exceed $2M and the bounding benefit would be less than 13% reduction in CDF. More complex technology with alternate fuel source requirements. Combine with SAMA 174.	Excessive Implementation Cost. (Table 15-2 Case 1)
9	Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the cost of implementation ($8,500,000 to $22,800,000, representative of similar nuclear power plants, WBN specific cost estimate $5,000,000) and benefit would be less than 28% reduction in CDF. WBN in process of updating cost estimate for non-SAMA reasons but expected to not be SAMA cost beneficial. Combine with SAMA 233.	Excessive Implementation Cost. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
13	Install an additional, buried off-site power source.	Reduced probability of loss of off-site power.	NEI 05-01 (Rev A)	Basis for Screening: There are two existing 161 kV connections to a nearby dam switchyard above ground. The estimated cost of burying them would exceed $5M and the benefit would be much less than 28% reduction in CDF. Pricing of above ground 161 kV line from hydro to construction yard was excessive. Buried would be even more.	Excessive Implementation Cost. (Table 15-2 Case 1)
14	Install a gas turbine generator.	Increased availability of on-site AC power.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation ($3,350,000 to $30,000,000, representative of similar nuclear power plants) would be much less than 28% reduction in CDF. Based on cost of completion of 5th Diesel Generator, addition of turbine/gen with extra fuel source and building would be even more expensive.	Excessive Implementation Cost. (Table 15-2 Case 1)
15	Install tornado protection on gas turbine generator.	Increased availability of on-site AC power.	NEI 05-01 (Rev A)	Basis for Screening: A gas turbine generator is not available at the Watts Bar site. Based on cost of completion of 5th Diesel Generator, addition of turbine/gen with extra fuel source and building would be even more expensive.	Excessive Implementation Cost. (Table 15-2 Case 1)
24	Bury off-site power lines.	Improved off-site power reliability during severe weather.	NEI 05-01 (Rev A)	Basis for Screening: The distance that would be necessary to bury offsite power lines would be significant since severe weather to which transmission lines are susceptible typically affects a broad area. For a plant with significant construction already completed, the estimated cost of	Excessive Implementation Cost. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				implementation would exceed the potential benefit. Similar to #13 except two lines buried. Approx 2 miles underground duct bank and 161 underground cable. Benefit would be much less than 40% of CDF.	
25	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	NEI 05-01 (Rev A)	Basis for Screening: The previous passive UHI system was removed from the WBN design. For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. Design basis safety reanalysis would be around $3M. Engineering, construction, hardware, and testing costs would be in addition to that. Total costs would greatly exceed $3M and bounding risk reduction benefit would be less than 25% reduction in CDF.	Excessive Implementation Cost. (Table 15-2 Case 1)
34	Provide an in-containment reactor water storage tank.	Continuous source of water to the safety injection pumps during a LOCA event, since water released from a breach of the primary system collects in the in-containment reactor water storage tank, and thereby eliminates the need to realign the safety injection pumps for long-term post-LOCA recirculation.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. There is limited room in containment to install an in-containment RWST. Complex engineering problem. Ice condenser currently acts as in-containment water source approx equal to the RWST after melt. Additional tank would reduce containment available volume for pressure suppression and raise post accident water level with additional post accident water level flooding issues.	Not Feasible to implement inside containment due to limited space available. Will also screen on Excessive Cost. (Table 15-2 Case 1)
37	Upgrade the	For a plant like the	NEI 05-01	Basis for Screening: For a plant with	Excessive

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	chemical and volume control system to mitigate small LOCAs.	Westinghouse AP600, where the chemical and volume control system cannot mitigate a small LOCA, an upgrade would decrease the frequency of core damage.	(Rev A)	significant construction already completed, the estimated cost of implementation to increase CVCS flow capacity would exceed the bounding benefit. WBN currently has 2 trains of high head charging pumps. Additional charging pump would require additional power source and water supply. Recirculation from the sump would still be required. Cost would exceed $2M and benefit would be much less than 10% reduction in CDF.	Implementation Cost. (Table 15-2 Case 1)
39	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high- and low-pressure safety injection systems.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation to replace the SI pumps would exceed the bounding benefit. Current SI pumps are Diesel backed. Diesel driven pumps would require a separate building along with appropriate protection (tornado, seismic, etc., and ASME piping into containment).	Excessive Implementation Cost. (Table 15-2 Case 1)
41	Create a reactor coolant depressurization system.	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation to install larger PORVs would exceed the bounding benefit. Would require ASME connections to the RCS and appropriately qualified valves and control circuits. Safety analysis update including seismic RCS loop reanalysis would be required.	Excessive Implementation Cost. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				Cost would exceed $2M and benefit would be much less than 10% reduction in CDF.	
55	Install an independent reactor coolant pump seal injection system, with dedicated diesel.	Reduced frequency of core damage from loss of component cooling water, service water, or station blackout.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. Hardware, building, facilities support would be high cost. ASME, safety grade interface to CVCS. SAMA 56 (reactor coolant pump seal injection system without dedicated diesel) was screened out in Phase II evaluation. Would be considered with other Seal LOCA SAMAs.	Excessive Implementation Cost. (Table 15-2 Case 1)
77	Provide a passive, secondary-side heat-rejection loop consisting of a condenser and heat sink.	Reduced potential for core damage due to loss-of-feedwater events.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. Potential change is less than 50% of CDF. A passive heat removal system using air as the ultimate heat sink would be extremely large and expensive to install.	Excessive Implementation Cost. (Table 15-2 Case 1)
78	Modify the startup feedwater pump so that it can be used as a backup to the emergency feedwater system, including during a station blackout scenario.	Increased reliability of decay heat removal.	NEI 05-01 (Rev A)	Basis for Screening: Implementation of this SAMA requires a flow path around the isolation valves. Also for use during a station blackout the Standby Feedwater pump would have to be powered from a diesel generator. For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. Would require flowpath from condenser through hotwell pumps, through condensate system and around safety	Excessive Implementation Cost. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				grade isolation valves (or alternate power source to reopen valves and power pumps). Potential change is less than 50% of CDF.	
90	Create a reactor cavity flooding system.	Enhanced debris cool ability, reduced core concrete interaction, and increased fission product scrubbing.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation ($8,750,000, representative of similar nuclear power plants) would yield a benefit of much less than 20% reduction in LERF.	Excessive Implementation Cost. (Table 15-2 Case 2)
91	Install a passive containment spray system.	Improved containment spray capability.	NEI 05-01 (Rev A)	Basis for Screening: The source of this SAMA is the AP600 Design Certification Review submittal. For a plant with significant construction already completed, the cost of implementation ($20,000,000, representative of similar nuclear power plants) would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Cases 2 and 3)
94	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter Option 2: Multiple Venturi Scrubber	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation ($5,700,000, representative of similar nuclear power plants) would not reduce all of the LATE consequences and would result in a benefit of less than 50% reduction in LATE.	Excessive Implementation Cost. (Table 15-2 Case 3)
95	Enhance fire protection system and standby gas treatment system hardware and procedures.	Improved fission product scrubbing in severe accidents.	NEI 05-01 (Rev A)	Basis for Screening: Enhancements to the EGTS and ABGTS filters to provide scrubbing for ISLOCA source terms would exceed the bounding benefit. This system is not currently credited in the PSA and has limited capability for beyond design basis events due to filter loading concerns. Upgrading the system for severe accidents	Excessive Implementation Cost. (Table 15-2 Case 2)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				would require a redesign with more capable equipment. EPSIL already contains instructions for spraying release points with fire water, which would provide fission product scrubbing. Costs would exceed expected benefit.	
97	Create a large concrete crucible with heat removal potential to contain molten core debris.	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation ($90,000,000 to $108,000,000, representative of similar nuclear power plants) would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Cases 2 and 3)
98	Create a core melt source reduction system.	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation ($90,000,000, representative of similar nuclear power plants) would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Cases 2 and 3)
99	Strengthen primary/secondary containment (e.g.,	Reduced probability of containment over-pressurization.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the cost of implementation would exceed	Excessive Implementation Cost. (Table

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	add ribbing to containment shell).			the bounding benefit.	15-2 Cases 2 and 3)
100	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	Reduced probability of base mat melt-through.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the cost of implementation caused by reconstruction of the containment building would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Cases 2 and 3)
102	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	Reduced probability of containment over-pressurization.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the cost of implementation ($10,000,000 and up, representative of similar nuclear power plants) would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Cases 2 and 3)
105	Delay containment spray actuation after a large LOCA.	Extended reactor water storage tank availability.	NEI 05-01 (Rev A)	Basis for Screening: Delay of containment spray actuation would require reanalysis of safety analysis. Current safety analysis does not allow actuation delay. Cost of re-analysis and implementation would exceed the maximum benefit (<.0008 CDF)	Excessive Implementation Cost. Would require development and NRC approval of new gothic containment model and revised mass/energy release model. Costs are excessive unless done through an

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
					Owners Group cost share with other ice condenser plants. (Table 15-2 Case 1)
106	Install automatic containment spray pump header throttle valves.	Extended time over which water remains in the reactor water storage tank, when full containment spray flow is not needed.	NEI 05-01 (Rev A)	Basis for Screening: The estimated cost of implementing a design change including reanalysis of the safety analysis is considered excessive cost compared to the risk benefit. Would require development and NRC approval of new gothic containment model and revised mass/energy release model. Benefit is less than 1% of CDF. Costs are excessive unless done through an Owners Group cost share with other ice condenser plants. (proposal in progress)	Excessive Implementation Cost. (Table 15-2 Case 1)
115	Locate residual heat removal (RHR) inside containment.	Reduced frequency of ISLOCA outside containment.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation ($28,000,000, representative of similar nuclear power plants) would exceed the bounding benefit. Combine with SAMA 178.	Excessive Implementation Cost. (Table 15-2 Case 5)
119	Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage.	Reduced frequency of steam generator tube ruptures.	NEI 05-01 (Rev A)	Basis for Screening: The current cost of steam generator eddy current inspection is approximately $1million per steam generator. The cost of performing 100% inspection including the cost of the added outage time would exceed the bounding benefit. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. (Table 15-2 Case 5)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
120	Replace steam generators with a new design.	Reduced frequency of steam generator tube ruptures.	NEI 05-01 (Rev A)	Basis for Screening: The cost of replacing the steam generators at Watts Bar Unit 1 was $221,760,000. This exceeds the bounding benefit. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. (Table 15-2 Case 5)
121	Increase the pressure capacity of the secondary side so that a steam generator tube rupture would not cause the relief valves to lift.	Eliminates release pathway to the environment following a steam generator tube rupture.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. (Table 15-2 Case 5)
122	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture.	Enhanced depressurization capabilities during steam generator tube rupture.	NEI 05-01 (Rev A)	Basis for Screening: Normal and auxiliary pressurizer spray capability is available in the current design. The estimated cost of implementation of a new pressurizer spray system would exceed the potential benefit. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. ASME safety grade connections to RCS and civil/DBA reanalysis would drive costs high. (Table 15-2 Case 5)
125	Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove	Reduced consequences of a steam generator tube rupture.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation of a new structure would exceed the bounding benefit. Installation of another structure, additional SRV tailpipe, and new SRVs, larger Steam Gen connections to accommodate additional piping pressure	Excessive Implementation Cost. (Table 15-2 Case 5)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	most of the fission products.			drops and remain inside the current safety analysis would be costly. SGTR IE reduction in CDF is very small.	
126	Install a highly reliable (closed loop) steam generator shell-side heat removal system that relies on natural circulation and stored water sources	Increased reliability of decay heat removal.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation of a water cooled isolation condenser would exceed the bounding benefit. Potential change is less than 50% of CDF. A passive heat removal system using water as the ultimate heat sink would be extremely large and expensive to install.	Excessive Implementation Cost. (Table 15-2 Case 5)
129	Vent main steam safety valves in containment.	Reduced consequences of a steam generator tube rupture.	NEI 05-01 (Rev A)	Basis for Screening: The estimated cost of design reanalysis and implementation of hardware changes would exceed bounding benefit. Implementation would also have negative consequences since the increase in containment pressure would result in containment isolation phase B which would empty the RWST. This would convert the event into a LOCA with consequential challenges. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. (Table 15-2 Case 5)
133	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the potential benefit; i.e. <.04 of CDF.	Excessive Implementation Cost. (Table 15-2 Case 1)
143	Upgrade fire compartment barriers.	Decreased consequences of a fire.	NEI 05-01 (Rev A)	Basis for Screening: Two and three hour regulatory required fire protection barriers are installed and maintained. Non regulatory required two hour fire barriers	Excessive Implementation Cost. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				are also credited in IPEEE. For a plant with significant construction already completed, the estimated cost of upgrading to 4 hour fire barriers would exceed the potential benefit. Potential SAMAs for FIVE contributors were described in the response to RAI 4d.	
166	Create a water-cooled rubble bed on the pedestal.	This rubble bed would contain a molten core dropping onto the pedestal, and would allow the debris to be cooled.	Cook	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation ($18,000,000, representative of similar nuclear power plants) would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Cases 2 and 3)
172	Increase containment design pressure.	Reduces chance of containment overpressure failures.	Cook	Basis for Screening: For a plant with significant construction already completed, the cost of implementation caused by reconstruction of the containment building would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Cases 2 and 3)
211	Replace reactor vessel with stronger vessel.	Reduces core damage contribution due to vessel failure.	Cook	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Case 1)
214	Reinforce the seismic capacity of the steel structure supporting the auxiliary building.	Seismic failure of the steel structure supporting the auxiliary building would lead to collapse of the building. Reinforcing the building potentially precludes or lessens this failure mode.	Cook	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation to reinforce the auxiliary building to withstand beyond-design-basis earthquake levels would exceed the potential benefit.	Excessive Implementation Cost. (Table 15-2 Case 1)
233	Implement alternate AC power source.	The implementation of an alternate AC power source would most likely take the	Vogtle	Basis for Screening: The cost of installing an additional EDG has been estimated to be greater than $20 million in the Calvert	Excessive Implementation Cost. (Table

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
		form of an additional EDG. This SAMA would help mitigate LOSP events and would reduce the risk during time frames of on-line EDG maintenance. The benefit would be increased if the additional DG could 1) be substituted for any current diesel that is in maintenance, and 2) if the diesel was of a diverse design such that CCF dependence was minimized.		Cliffs Application for License Renewal. It was similarly estimated to be about $26.09M for both units at Vogtle. As the per unit cost of approximately $10M to $13M is greater than the Watts Bar maximum benefit, it has been screened from further analysis.	15-2 Case 1)
242	Permanent, Dedicated Generator for the NCP with Local Operation of TD AFW after 125V Battery Depletion.	This SAMA provides a means of limiting the size of a seal LOCA and providing primary side makeup through the installation of a diesel generator that can be rapidly aligned to the NCP from the MCR. Long term secondary side cooling can be provided through the operation of the turbine driven AFW pump using existing Wolf Creek procedures. This arrangement would make it possible to provide adequate core cooling in	Wolf Creek	Basis for Screening: Local operation of the TDAFWP is currently proceduralized. This requires a dedicated DG with auto start capability and auto transfer to meet the 13 minute criteria to prevent seal LOCA. Additionally the DG and Charging Pump lube oil cooling and seal cooling would require CCS and ERCW. The estimated cost of implementation of a dedicated DG would exceed the potential benefit. This SAMA will be considered with other Seal LOCA SAMAs under consideration if SAMA 58 is shown unreliable. See also SAMA 226.	Excessive Implementation Cost. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
		extended SBO evolutions.			
253	Install SG Isolation Valves on the Primary Loop Side.	Installation of primary side isolation valves provides an additional means of isolating and controlling an SGTR event. These valves would also eliminate the need for local action to complete a steam generator isolation after a tube rupture has occurred.	Wolf Creek	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. Would require ASME safety related piping and valves in additional to verification by analysis and testing of the increased flow resistance. Also seismic reanalysis of the RCS system. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. (Table 15-2 Case 5)
261	Guidance to align the C-S diesel generator.	In the event of a loss of offsite power followed by the failure of both shutdown boards on one unit, the procedures would be enhanced by adding the guidance to align the C-S diesel generator (i.e., the fifth diesel generator) to one of the shutdown buses not powered in the accident sequence due to the loss of a normally aligned diesel generator. This alignment could be accommodated by including a reference to the spare diesel generator in AOI 35, "Loss of Offsite Power."	IPE	Basis for Screening: The cost to refurbish, complete and license the spare 5th DG was estimated at ~2 to 3 million in 1996. The potential benefit is much less than 20% reduction in CDF. Procedures to align the portable DG have already been implemented.	Excessive Implementation Cost. See #9. (Table 15-2 Case 1)
270	Delay containment spray operation	From a severe accident point of view, one potential	IPE	Basis for Screening: The current Watts Bar design basis calculations require sprays to	Excessive Implementation

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	relative to phase B conditions.	change, for consideration, would be the delaying of spray operations relative to the Phase B condition. Currently, containment sprays actuate immediately in response to a Phase B condition, and air return fans (ARF) actuate after a 10 minute delay. This is currently a requirement of the design basis LOCA where switchover to containment spray recirculation occurs prior to ice melt; thereby limiting pressure increases below containment design pressure. Modular Accident Analysis Program analyses of representative core damage sequences indicate that actuation of the containment sprays while ice remains in the ice condenser has little impact on severe accident containment performance and may be detrimental in that operation of the sprays rapidly depletes the inventory of the RWST, making its contents		initiate at containment phase B conditions. This SAMA would require reanalysis of Safety analysis; and the benefit is less than 1% of CDF. Therefore it is considered cost prohibitive.	Cost. See #105. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
		unavailable for vessel injection. Since many scenarios have successful injection but failure at recirculation, the rapid depletion of the RWST due to spray operation accelerates the time to core damage. Therefore, an evaluation balancing the severe accident versus design basis requirements could be made.			
274	Replace CCS pumps with positive displacement pumps.	Improves reliability of CCS system.	RRW Review	Basis for Screening: PD pump removed from CVCS due to problems during initial testing on U1. WBN preference to avoid PD pumps on other systems. For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Case 1)
287	Increase 0.232 probability of hot leg failure prior to Vessel breach given no temperature induced SGTR	Probability taken from analysis of Sequoyah in NUREG/CR-4551	CAFTA IPE	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. A fundamental change in RCS piping design would be needed to materially change this probability, plus new safety analysis including civil analysis would be required. Since this change would not reduce the core damage frequency, the expected benefit is limited.	Excessive Implementation Cost. (Table 15-2 Case 5)
288	Reduce 5.14E-2	Probabilities taken from	CAFTA	Basis for Screening: For a plant with	Excessive

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	probability of temperature induced SGTRs for SBO sequences with no secondary heat sink	NUREG-1570	IPE	significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. A fundamental change in RCS/SGTTR piping design would be needed to materially change this probability, likely including new steam generators. SGTR IE reduction in CDF is very small.	Implementation Cost. (Table 15-2 Case 5)
289	Reduce 3.81E-2 probability of temperature induced SGTRs for non-SBO sequences with no secondary heat sink	Probabilities taken from NUREG-1570	CAFTA IPE	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. A fundamental change in RCS/SGTTR piping design would be needed to materially change this probability, likely including new steam generators. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. (Table 15-2 Case 5)
290	Reduce probability of rocket mode and ex-vessel steam explosions causing early containment failure	Probabilities taken from NUREG/CR-6427	CAFTA IPE	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit. A fundamental change in Reactor vessel cavity design would be needed to materially change this probability.	Excessive Implementation Cost. (Table 15-2 Case 2)
5	Provide DC bus cross-ties.	Improved availability of DC power system.	NEI 05-01 (Rev A)	Basis for Screening: Since cross-ties are available at the 480V supplies, and the #5 spare battery can be aligned to and supply any of the 4 buses, this SAMA has very little risk benefit (<2% CDF) Combine with SAMA 258.	Very Low Benefit. (Table 15-2 Case 1)
16	Improve uninterruptible power supplies.	Increased availability of power supplies supporting front-line equipment.	NEI 05-01 (Rev A)	Basis for Screening: Four new inverters have been incorporated and a spare is already available. PRA modeling changes	Very Low Benefit. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				to realistically reduce the loss of 120V AC initiating event frequencies has greatly reduced the importance of these supplies. Benefit is less than 0.1% of CDF.	
28	Add a diverse low pressure injection system.	Improved injection capability.	NEI 05-01 (Rev A)	Basis for Screening: See response to item 10, RAI 4.e.ii regarding the feasibility of a similar diverse low pressure injection system. For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit.	Very Low Benefit. (Table 15-2 Case 1)
29	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.	NEI 05-01 (Rev A)	Basis for Screening: See response to item 10, RAI 4.e.ii regarding the feasibility of a similar diverse low pressure injection system. There is a minimal benefit from this SAMA since it does not provide a recirculation path. Therefore it is not considered further. This SAMA is considered cost prohibitive relative to the potential benefit.	Very Low Benefit. (Table 15-2 Case 1)
47	Enhance the screen wash system.	Reduced potential for loss of SW due to clogging of screens.	NEI 05-01 (Rev A)	Basis for Screening: The location of the intake on the river is protected from debris therefore there is minimal benefit of this SAMA (i.e. <1.6% CDF). Combine with SAMA 202	Very Low Benefit. (Table 15-2 Case 1)
50	Enhance loss of component cooling water procedure to underscore the desirability of cooling down the reactor coolant system prior to	Reduced probability of reactor coolant pump seal failure.	NEI 05-01 (Rev A)	Basis for Screening: Upon receipt of any RCP seal no. 1 outlet temperature high alarm, AOI-15 & 24 require an RCS cooldown after isolation of the CCS path to the RCP thermal barrier and isolation of RCP seal injection. This order of actions is deemed appropriate for overall plant stabilization following a loss of CCS.	Very Low Benefit. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	seal LOCA.			Enhanced procedure will not affect the risk because of the rapid progression of the seal leak. Therefore, the intent of this SAMA is minimal benefit. This SAMA may be considered with other Seal LOCA SAMAs in Phase II.	
53	On loss of essential raw cooling water, proceduralize shedding component cooling water loads to extend the component cooling water heat-up time.	Increased time before loss of component cooling water (and reactor coolant pump seal failure) during loss of essential raw cooling water sequences.	NEI 05-01 (Rev A)	Basis for Screening: AOI-13 for ERCW system loss or rupture does not provide directions to quickly implement loss of CCS procedure AOI-15 if ERCW cannot be restored. AOI-13, however, does provide directions to trip all of the RCPs, isolate thermal barrier cooling, cooldown the plant and cross-tie ERCW if available. There is minimal risk reduction for CCS load shedding since this is a timing issue for recovery of ERCW. The PRA model credits manual alignment of fire protection water to ERCW as a backup... Therefore this SAMA has very low risk improvement benefit.	Very Low Benefit. (Table 15-2 Case 1)
79	Replace existing pilot-operated relief valves with larger ones, such that only one is required for successful feed and bleed.	Increased probability of successful feed and bleed.	NEI 05-01 (Rev A)	Basis for Screening: The Watts Bar success criteria for bleed and feed is two PORVs only if charging is not available. Otherwise one PORV is sufficient. Larger valves would require piping changes, block valve changes, and analysis changes. There is a larger probability of leakage with larger valves. Based on this, this SAMA provides little benefit for the estimated cost.	Very Low Benefit. (Table 15-2 Case 1)
80	Provide a redundant train or	Increased availability of components dependent on	NEI 05-01 (Rev A)	Basis for Screening: Provisions for compensatory ventilation is in place for the	Very Low Benefit. (Table

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	means of ventilation.	room cooling.		480V electric board rooms and margin to room heatup limits exists in the 480V transformer room. Plant chillers are being upgraded based on Freon considerations. TVA has committed to purchasing new temporary ventilation equipment. See the response to item 11, RAI 4.e.v. This SAMA is considered not cost beneficial due to low risk benefit.	15-2 Case 1)
81	Add a diesel building high temperature alarm or redundant louver and thermostat.	Improved diagnosis of a loss of diesel building HVAC.	NEI 05-01 (Rev A)	Basis for Screening: The diesel generator building is manned during DG starts, and shiftly operator rounds take temperature measurements per SI-2. Therefore this SAMA is considered very low benefit.	Very Low Benefit. (Table 15-2 Case 1)
92	Use the fire water system as a backup source for the containment spray system.	Improved containment spray capability.	NEI 05-01 (Rev A)	Basis for Screening: Although there are two 2-inch test connections (72-545 & 544) that could be used to connect fire water to containment spray, this lineup bypasses the containment spray heat exchangers and would not remove containment heat. It also cannot recirculate water from the containment sump. The low flow rate would be ineffective for fission product removal. Therefore this SAMA is considered very low benefit. Combine with SAMA 170.	Very Low Benefit. (Table 15-2 Case 1)
116	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that	Scrubbed ISLOCA releases.	NEI 05-01 (Rev A)	Basis for Screening: The cost of implementation of this SAMA has not been estimated in detail. A minimum value of $100K for a hardware change is assumed for screening purposes. Auxiliary building releases are scrubbed by the Aux Building	Very Low Benefit. (Table 15-2 Case 2)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	break point will be covered with water.			Gas Treatment System (ABGTS); however the ABGTS may not be sized for ISLOCA releases. RHR suction and discharge lines are in the overhead and therefore would not be submerged. Contributes <0.1 % to LERF). Therefore this SAMA is considered very low benefit. Combine with SAMA 237.	
124	Provide improved instrumentation to detect steam generator tube ruptures, such as Nitrogen-16 monitors.	Improved mitigation of steam generator tube ruptures.	NEI 05-01 (Rev A)	Basis for Screening: In the latest model, the contribution of steam generator tube ruptures to the core damage frequency is only .0001. For a plant with significant construction already completed, the estimated cost of implementation of rad monitors for each steam generator would exceed the bounding benefit.	Very Low Benefit. (Table 15-2 Case 5)
131	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed, the estimated cost of installing a relief valve system (likely well over $1million) is judged to be excessive relative to the risk benefit since ATWS accounts for only 3.8 % of the total internal event CDF.	Very Low Benefit. (Table 15-2 Case 1)
137	Provide capability to remove power from the bus powering the control rods.	Decreased time required to insert control rods if the reactor trip breakers fail (during a loss of feedwater ATWS which has rapid pressure excursion).	NEI 05-01 (Rev A)	Basis for Screening: Implementation of this SAMA would require reevaluation of the loss of the loads on the unit boards. Training and procedure changes is estimated to cost more than the potential benefit. The contribution of ATWS to CDF is 3.8%. Of this fraction roughly 95% is attributable to RCS overpressurization events resulting from inadequate pressure relief within the first couple of minutes.	Very Low Benefit. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				The ability to remove holding power from the control rods would have to be under a time constraint of 1-2 minutes in order to affect the resulting peak pressures. This response time is not feasible and later response times would have minimal benefit; i.e. about 0.2% of CDF. Therefore this SAMA is considered very low benefit.	
147	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	NEI 05-01 (Rev A)	Basis for Screening: The FVI of large break LOCAs to the core damage frequency is less than .0008. For a plant with significant construction already completed, the estimated cost of implementation would exceed the bounding benefit.	Very Low Benefit. (Table 15-2 Case 1)
152	Develop procedures for transportation and nearby facility accidents.	Reduced consequences of transportation and nearby facility accidents.	NEI 05-01 (Rev A)	Basis for Screening: An anti barge boom is installed at the intake structure to reduce transportation accidents. There are no identified hazardous barge shipments near the Watts Bar site. Therefore this SAMA is considered very low benefit.	Very Low Benefit. (Table 15-2 Case 1)
153	Install secondary side guard pipes up to the main steam isolation valves.	Prevents secondary side depressurization should a steam line break occur upstream of the main steam isolation valves. Also guards against or prevents consequential multiple steam generator tube ruptures following a main steam line break event.	NEI 05-01 (Rev A)	Basis for Screening: The FVI of all secondary side breaks, both inside and outside containment, in the current model is just .06. For a plant with significant construction already completed, the estimated cost of implementation (i.e. greater than $700k) would exceed the bounding benefit.	Very Low Benefit. (Table 15-2 Case 1)
167	Enhance air return	Provide an independent	Cook	Basis for Screening: 10 CFR 50.44	Very Low

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	fans (ice condenser containment).	power supply for the air return fans, potentially reducing containment failure probability during SBO sequences.		analysis shows these fans are a negligible contribution to the containment's ability to handle a hydrogen burn. Therefore this SAMA is considered very low benefit.	Benefit. (Table 15-2 Cases 2 and 3)
183	Implement internal flood prevention and mitigation enhancements.	Options considered include 1) use of submersible MOV operators, and 2) back flow prevention in drain lines.	Cook	Basis for Screening: The current modeling of flooding concerns in the WBN PRA does not indicate a vulnerability to this item. Therefore this SAMA is considered very low benefit.	Very Low Benefit. (Table 15-2 Case 1)
184	Implement internal flooding improvements identified at Fort Calhoun Station.	Implement improvements to prevent or mitigate 1) a rupture in the RCP seal cooler of the CCW system, 2) an ISLOCA in a shutdown cooling line, and 3) an AFW flood involving the need to possibly remove a watertight door. For a plant where any of these apply, potentially reduces flooding risk.	Cook	Basis for Screening: The current modeling of flooding concerns in the WBN PRA does not indicate a vulnerability to this item. Therefore this SAMA is considered very low benefit.	Very Low Benefit. (Table 15-2 Case 1)
199	Provide auxiliary building vent/seal structure.	Enhances ventilation in auxiliary building.	Cook	Basis for Screening: Normal auxiliary building ventilation is not risk significant at Watts Bar unit 2. Therefore this SAMA is considered very low benefit.	Very Low Benefit. (Table 15-2 Case 1)
222	Establish a preventive maintenance program for expansion joints, bellows, and boots.	Potentially reduces flooding initiating event frequency and the failure probability of plant components.	Cook	Basis for Screening: There is a limited use of expansion joints at Watts Bar and no indication of a vulnerability. Therefore this SAMA is considered very low benefit.	Very Low Benefit. (Table 15-2 Case 1)
225	Upgrade main	Potentially reduces turbine	Cook	Basis for Screening: Since the turbine trip	Very Low

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	turbine controls.	trip frequency.		initiator contributes less than 2% CDF and most turbine trips are not related to control problems, the estimated cost of implementation would exceed the minimal risk benefit from this SAMA. Therefore this SAMA is considered very low benefit.	Benefit. (Table 15-2 Case 1)
234	Implement automatic initiation of HPI on low RCS level (after AC power recovery).	The implementation of an automatic HPI initiation system would reduce the potential for core damage from occurring following events where ac power is recovered, but where a seal LOCA has already occurred. In these cases, RCS level must be restored to avoid core damage from occurring.	Vogtle	Basis for Screening: The WBN design initiates HPSI on low RCS pressure which would result from an RCP seal LOCA. The PRA model does not explicitly include operator actions to restore the pumps after AC power recovery since this sequence is dominated by non-recovery of AC power sources. Manual start of the pumps after AC power recovery is already proceduralized. Including this operator action would result in limited risk benefit and therefore is not analyzed further.	Very Low Benefit. (Table 15-2 Case 1)
254	Alternate Fuel Oil Tank with Gravity Feed Capability.	EDG failures related to failure of the fuel oil transfer pumps are currently considered to be unrecoverable in the PSA model. The installation of a large volume tank at an elevation greater than the EDG fuel oil day tanks would allow for emergency refill of the day tanks in the event of fuel oil transfer pump failure.	Wolf Creek	Basis for Screening: Failure of the fuel oil transfer pumps contributes less than 1% the internal event CDF based on RRW review. Improvements in the fuel oil transfer system are judged to be a minimal risk benefit. The cost of this enhancement has been previously estimated to be $150,000 by Wolf Creek.	Very Low Benefit. (Table 15-2 Case 1)
262	Provide connections for	A potential improvement that could be evaluated is	IPE	Basis for Screening: The potential improvement was evaluated and there is	Very Low Benefit. (Table

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	centrifugal charging pumps to the ERCW system.	a plant change to provide connections for both centrifugal charging pumps, on both units, to the ERCW system for lube oil cooling in the event of a loss of CCS cooling to the associated pump. Currently, this capability is only available for centrifugal charging pump A on Unit 1.		low benefit to aligning a second charging pump to ERCW.	15-2 Case 1)
273	Provide a redundant path for ECCS suction from the RWST around check valve 62-504.	Eliminates single failure potential of RWST check valve failure to open.	RRW Review	Check valve 62-504 is a single failure point for ECCS injection but it contributes <.00001 to CDF in the SAMA model. The cost of a design change, new hardware and analysis greatly exceeds the potential risk reduction benefit.	Very Low Benefit. (Table 15-2 Case 1)
277	Replace shutdown board chillers.	Improved reliability of shutdown board HVAC.	RRW Review	Basis for Screening: The potential improvement was evaluated by reviewing the risk reduction worth (RRW) of the 6.9 kV board room ventilation and ventilation recovery. There is low benefit to these ventilation systems. However, these chillers are being upgraded and replaced for other reasons.	Very Low Benefit. (Table 15-2 Case 1)
284	Improve training for MD AFW pump train A or B isolation tests	Additional training may reduce assigned error rate	CAFTA IPE	MD and TD AFW pump isolation test restoration errors (WHEMDA_1, WHEDA_2, and WHEAFW) can impact AFW system reliability, especially under conditions of loss of a vital instrument bus or vital battery board. Human failure rate was re-evaluated substantially lower after	Very Low Benefit. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
				initial identification of this SAMA to recognize that the error must occur on at least two steam generators rather than just the flow path to just 1 steam generator. Revised contribution is much less than 0.1% of CDF. Estimated cost is $26,773 for enhanced training.	
286	Improve training to avoid a TD AFW isolation test error	Additional training may reduce assigned error rate	CAFTA IPE	Human failure rate was re-evaluated substantially lower after initial identification of this SAMA to recognize that the error must occur on at least two steam generators rather than just the flow path to just 1 steam generator. Revised contribution is much less than 0.1% of CDF. Estimated cost is $26,773 for enhanced training.	Very Low Benefit. (Table 15-2 Case 1)
296	Improve training and procedures to respond to loss of both trains of AFW actuation signal	Needed to address failure combinations of DC buses, vital instrument buses, and failures of SSPS.	CAFTA IPE	Leading cutset involves common cause failure of safeguards actuation signal in a sequences where there is a plant trip without an SI condition (action HAOS3). Event importance markedly reduced to less than 1% now that initiating event frequencies for loss of inverters and battery boards have been lowered.	Very Low Benefit. (Table 15-2 Case 1)
297	Improve remote valve position indication in the MCR for MD AFW pump isolation valves	Valve indication in MCR allows operators to check realignment	CAFTA IPE	Difficulty to inspect valves are more likely to be checked if indicated in MCR. Human failure rate was re-evaluated substantially lower after initial identification of this SAMA to recognize that the error must occur on at least two steam generators rather than just the flow path to just 1 steam generator. Revised contribution is much less than 0.1% of CDF	Very Low Benefit. (Table 15-2 Case 1)

Table 15-3. Phase I SAMA Candidates (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
298	Require added supervisory check to MD AFW pump train isolation valve test procedure	Check is to be performed separately from (not concurrent to) the initial checks	CAFTA IPE	Human failure rate was re-evaluated substantially lower after initial identification of this SAMA to recognize that the error must occur on at least two steam generators rather than just the flow path to just 1 steam generator. Revised contribution is much less than 0.1% of CDF	Very Low Benefit. (Table 15-2 Case 1)
301	Require added supervisory check to TD AFW pump train isolation valve test procedure	Check is to be performed separately from (not concurrent to) the initial checks	CAFTA IPE	Human failure rate was re-evaluated substantially lower after initial identification of this SAMA to recognize that the error must occur on at least two steam generators rather than just the flow path to just 1 steam generator. Revised contribution is much less than 0.1% of CDF	Very Low Benefit. (Table 15-2 Case 1)
302	Improve remote valve position indication in the MCR for TD AFW pump isolation valves	Valve indication in MCR allows operators to check realignment	CAFTA IPE	Difficult to inspect valves are more likely to be checked if indicated in MCR. Human failure rate was re-evaluated substantially lower after initial identification of this SAMA to recognize that the error must occur on at least two steam generators rather than just the flow path to just 1 steam generator. Revised contribution is much less than 0.1% of CDF	Very Low Benefit. (Table 15-2 Case 1)

ENCLOSURE 2

LIST OF COMMITMENTS

1. RAI 16 of the March 30, 2011, NRC to TVA letter requested the process TVA would use to evaluate SAMAs 215 and 226 if the seal package design is not proven reliable. In our response of May 13, 2011, TVA committed to re-evaluate the benefits of SAMAs 215, 226, 50, 55, and 56 for mitigation of RCP seal LOCA scenarios if SAMA 58 is not implemented. In response to RAI 5b of the March 30, 2011, letter, TVA further commits to add SAMAs 93 and 242 to this list for re-evaluation should SAMA 58 not prove reliable.