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

September 16, 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 – REVISED SEVERE ACCIDENT MANAGEMENT DESIGN ALTERNATIVE REVIEW (SAMDA) RESPONSE (TAC NO. MD8203)**

References:
1. TVA to NRC letter dated June 17, 2011, "Watts Bar Nuclear Plant, Unit 2 - Response To Request For Additional Information Regarding Severe Accident Management Design Alternative Review (SAMDA) (TAC NO. MD8203)"
2. TVA to NRC letter dated May 25, 2011, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Response to Request for Additional Information Regarding Severe Accident Management Design Alternative 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. MD8203)"
4. TVA to NRC letter dated November 1, 2010, "Watts Bar Nuclear Plant (WBN) Unit 2 - Severe Accident Management Alternatives Using Latest Computer Aided Fault Tree Analysis Model - Additional Information (TAC MD8203)"

The purpose of this letter is to provide revisions to data results and conclusions contained within References 1, 2, 3, and 4 regarding the Severe Accident Management Design Alternatives (SAMDA) analysis. These revisions stem from a misinterpretation of the consequence model output for total person-rem for each of several assessed release categories and from two less significant source term errors. The Enclosure summarizes the changes, the impacts on SAMA evaluations, and the responses to RAIs. Specifically, the following tables are revised:

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NRR

Reference 1, Tables 2.a.iv-4, 2.a.iv-4a, and 2.a.iv-6.
Reference 2, Tables RAI 2.a.iv (item f, response), RAI 6 Table 15-1, and RAI 6 Table 15-2, 15-3
Reference 3, Tables 4ai-1, 2.a.iv-7, 2.a.iv-8, 2.a.iv-9, 2.a.iv-10, 2.a.iv-11, 4.d-2, and 5.c-1;
Reference 4, Tables 10b and 21.

There are no commitments in this letter. If you have any questions, please contact Gordon Arent at (423) 365-2004.

I declare under the penalty of perjury that the foregoing is true and correct. Executed on the 16th day of September, 2011.

Respectfully,

David Stinson
Watts Bar Unit 2 Vice President

Enclosure:

1. Revised Results/Conclusions to Previous Watts Bar Unit 2 SAMDA Responses

cc (Enclosure):

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Enclosure 1

Revised Results/Conclusion to Previous Watts Bar Unit 2 SAMDA Responses

ENCLOSURE 1

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION

Following the response to RAIs up to and including the TVA submittal of June 27, 2011, an error was discovered by NRC and confirmed by ABS in the interpretation of the MACCs output for total person-rem for each of the assessed release categories. This error underestimated the total person-rem computed, thereby requiring a reanalysis of the identified SAMAs with the corrected person-rem values. The total person-rem exposures are one type of input to the total consequences evaluated in units of dollars for each release category. Direct economic costs are another type of input and this other type constitutes the greatest contribution to total consequence costs. Further independent checking resulted in a change to the computed source terms for release category case, Early 1B and an insignificant reduction in the source terms for release category case, Early 2A. All of these changes have been corrected and the resulting SAMA cost-benefit analysis reevaluated. The changes in results are documented in the form of a succinct statement of changes to the SAMA analysis submittals; i.e. the original SAMA report submitted in October, 2011 and all subsequent responses to RAIs.

The following summarizes the changes, the impacts on SAMA evaluations, and the responses to RAIs. In some cases, tables presented in one submittal were reviewed in later responses to RAIs. In the summary below, only changes to the last submitted table are provided. When these revised tables were presented in earlier submittals, a cross-reference is provided to the final tables documented herein. The changes are presented in chronological order by submittal date of the past SAMAs reports, beginning with the submittal of October 2010.

Submittal of October 4, 2010

The findings of a review of the October 4, 2010 submittal of the Watts Bar Unit 2 Severe Accident Mitigation Alternatives report to account for correcting the total person-rem computed for each release category are provided below. A number of tables which initially appeared in the October 4, 2010 submittal must be updated to reflect these changes. Some of these tables have already been updated previously in response to subsequent RAIs on the October 4, 2010 submittal. The following cross-reference table directs the reader to the updated table numbers and the associated submittal date under which heading below, the final, updated table may be found.

October 4, 2010 Table Number	**Revised Table Number in RAI Responses**	**Date of Submittal when Table last changed**
8	2.a.iv-4a	June 17, 2011
10a	2.a.iv-6	June 17, 2011
16	15-1	May 25, 2011
17	2.a.iv-8	January 31, 2011
18	2.a.iv-9	January 31, 2011
19	2.a.iv-10	January 31, 2011
20	2.a.iv-11	January 31, 2011

Two additional tables appearing in the October 4, 2010 are also changed to correct the total person-rem computed for each release category. These are Tables 10b and 21 below.

Table 10b. Annual 80-Kilometer (50-mile) Population Dose and Economic Cost Risk

Release Category	Population Dose Risk (person-rem/year)	Economic Cost Risk (dollars/year)
I - LERF	3.73	7.99×10^3
II - BYPASS	0.84	1.86×10^3
III - LATE	14.14	4.14×10^4
IV- ISERF	1.24	2.25×10^3

Table 21. Evacuation Speed Sensitivity SAMA Case Results

SAMA No.	SAMA Title	Benefit/ Cost Ratio 2.2 mph	Benefit/ Cost Ratio 3.4 mph	Benefit/ Cost Ratio 1.6 mph	Change in Conclusion
4	Improve DC bus load shedding.	1.26	1.26	1.27	NO
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	0.47	0.47	0.47	NO
26	Provide an additional high pressure injection pump with independent diesel.	0.02	0.02	0.02	NO
32	Add the ability to automatically align emergency core cooling system to recirculation mode upon refueling water storage tank depletion.	0.19	0.19	0.20	NO
45	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	0.16	0.16	0.16	NO
46	Add a service water pump.	0.14	0.14	0.14	NO
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	0.15	0.15	0.15	NO
70	Install accumulators for turbine-driven auxiliary feedwater pump flow control valves.	0.39	0.39	0.40	NO
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	0.00	0.00	0.00	NO
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	0.00	0.00	0.00	NO
93	Install an unfiltered, hardened containment vent.	0.40	0.40	0.40	NO
101	Provide a reactor vessel exterior cooling system.	0.08	0.08	0.09	NO
103	Institute simulator training for severe accident scenarios.	0.18	0.17	0.18	NO
109	Install a passive hydrogen control system.	0.08	0.08	0.08	NO
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	0.09	0.09	0.09	NO
112	Add redundant and diverse limit switches to each containment isolation valve.	0.00	0.00	0.00	NO
136	Install motor generator set trip breakers in control room.	0.06	0.05	0.06	NO
156	Eliminate RCP thermal barrier dependence on CCW, such that loss of CCW does not result directly in core damage.	24.70	24.67	24.77	NO. Proposed procedure change ineffective. See Sec. 10
176	Provide a connection to alternate offsite power source.	0.09	0.09	0.09	NO
191	Provide self-cooled ECCS seals.	0.00	0.00	0.00	NO
215	Provide a means to ensure RCP seal cooling so that RCP seal LOCAs are precluded for SBO events.	0.88	0.88	0.88	NO

Table 21. Evacuation Speed Sensitivity SAMA Case Results (Continued)

SAMA No.	SAMA Title	Benefit/ Cost Ratio 2.2 mph	Benefit/ Cost Ratio 3.4 mph	Benefit/ Cost Ratio 1.6 mph	Change in Conclusion
226	Permanent, self- powered pump to backup normal charging pump.	0.49	0.49	0.49	NO
255	Permanent, Dedicated Generator for the NCP, one Motor Driven AFW Pump, and a Battery Charger.	0.26	0.26	0.26	NO
256	Install Fire Barriers Around Cables or Reroute the Cables Away from Fire Sources.	56.11	55.95	56.45	NO
276	Provide an auto start signal for AFW on loss of Standby Feedwater pump.	0.04	0.04	0.04	NO
279	Provide a permanent tie-in to the construction air compressor.	0.08	0.08	0.08	NO
280	Add new Unit 2 air compressor similar to the Unit 1 D compressor.	0.09	0.09	0.09	NO
282	Provide cross-tie to Unit 1 RWST.	0.00	0.00	0.00	NO
285	Improve training to establish feed and bleed cooling given no CCPs are running or a vital instrument board fails	3.85	3.85	3.86	NO
292	Improve training to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	14.78	14.55	15.18	NO
295	Increase frequency of containment leak rate testing	0.06	0.06	0.06	NO
299	Initiate frequent awareness training for plant operators/ maintenance/ testing staff on key human actions for plant risk	10.66	10.65	10.69	NO
300	Revise procedure FR-H.1 to eliminate or simplify complex (and/or) decision logic for establishing feed and bleed cooling and to improve operator recovery from initial mistakes	0.57	0.57	0.57	NO
303	Move indication/ operator interface for starting hydrogen igniters to front MCR panel	0.03	0.03	0.03	NO
304	Add annunciator or alarm signaling parameters to initiate hydrogen igniters to front panel on MCR	0.03	0.03	0.03	NO
305	Revise procedure E-1 to include recovery steps for failure to initiate hydrogen igniters	Not Estimated	Not Estimated	Not Estimated	NO
306	Improve operator performance by enhancing likelihood of recovery from execution errors	Not Estimated	Not Estimated	Not Estimated	NO
307	Make provisions for connecting ERCW to CCP 2B-B	0.00	0.00	0.00	NO

The list of conclusions in Section 10 of the October 4, 2010 submittal is unchanged, with one exception. SAMA 215 is now only to be considered if SAMA 58, which addresses the same RCP seal LOCA sequences, is not implemented. See the updated commitment in enclosure 2 of the submittal of May 25, 2011.

RAI Response Submittal of January 31, 2011

The findings of a review of the January 31, 2011 submittal in response to RAIs to account for correcting the total person-rem computed for each release category are provided below.

TVAs responses to items 1 through 2 of this submittal have been reviewed and concluded to be unchanged by correcting the total person-rem computed for each release category.

For item 3, a number of Tables which initially appeared in the January 31, 2011 submittal must be updated to reflect these changes. Some of these tables have subsequently been updated in response to later RAIs. These include Tables 2.a.iv-4 and 2.a.iv-6, which were last updated in the RAI response submittal of June 17, 2011; i.e. see the updated tables under that heading below.

Additionally, Tables 2.a.iv-7 through 2.a.iv-11, Table 4.d-2 and 5.c-1 are changed as a result of correcting the total person-rem computed for each release category. These updated tables are presented below.

Item 4a of this submittal concerns the identification and screening of candidate SAMAs. TVA used the basic event RRW values to CDF and to LERF to identify the key basic events for purposes of identification of candidate SAMAs. RRW cutoffs for identification were justified on the basis of the maximum averted cost risk (MACR) at that time and minimum costs applicable for training ($26,773) and for hardware fixes ($100,000). The cutoffs selected previously are modified here to reflect the changed MACR values after correcting the total person-rem computed for each release category.

Submittal date	CDF		LERF	
	Training/ HRA	Hardware	Training/ HRA	Hardware
	$26,773	$100,000	$26,773	$100,000
1/31/2011	1.007	1.026	1.0293	1.117
September 2011	1.006	1.0227	1.0437	1.1817

A revision to Table 4.a.i-1, presenting the basic events with RRW greater than 1.006 is provided below. For CDF, four additional basic events are identified as having RRW's between 1.026 and 1.022; i.e. DGGFD2GEN_0822B-B, MTM_2GEN_0822B-B, U0_ERCW_PMP_FR_CCF_IE_ALL, and HAERCW3. All of these events were already evaluated for potential SAMAs in Table 4ai-1 of the January 31, 2011 submittal. No additional SAMAs are therefore identified for hardware fixes contributing to CDF at the revised RRW screening value.

For operator training and HRA related basic events contributing to CDF, two new HRA related basic events of lower importance now just exceed the lower RRW threshold of 1.006. These events are dependent HRA combinations named HRADEP-POST-293 and HRADEP-POST-193.

Three of the human actions which are included in these two dependent action groups have already been evaluated for potential improvements; i.e. for actions HARR1, HAFR1 and AFWOP3. The remaining human action event, used in both of these two dependent action combinations was not previously evaluated for potential SAMAs; i.e. HAMU2B - Makeup to

RWST using containment spray test recirculation from the containment sump during a small LOCA. This action outside the control room has an HEP value of 5E-3. The contributors to this human error probability are both from cognitive errors (3.1E-03) and from execution errors (1.9E-03). The cues and indications for this action are good and procedure ECA-1.1, Appendix C is clear in its direction of the action. A new SAMA, number 340, is defined here to improve the error rate for action HAMU2B by additional training.

As a Phase 1 screening analysis, we note that this new SAMA is at best marginal because even if the entire benefits of eliminating this error rate were obtained, the cost-benefit would be just $26,773 considering the 2.28 multiplier and the 2.7 uncertainty on the CDF frequency. More likely the training should address both operations staff (to reduce the cognitive error rate) and those performing the action locally (execution errors). Further, the same procedure (ECA-1.1, step 10b) directs the operators to notify the TSC to evaluate transferring water to the RWST from other sources. These backup actions are not yet credited in the PRA model. Therefore, accounting for these other water sources as a means to lowering the 5E-3 error rate would further reduce the perceived benefit. New SAMA 340 is therefore considered screened on very low benefit.

For the LERF metric, the above RRW cutoff comparison table shows that the minimum RRW factors have increased from the previous evaluation. This is because the offsite exposure and offsite economic data from the October 4, 2011 used in the previous evaluation of these factors has changed. While the offsite economic costs for the early release category have gone up since the October 4, 2011 submittal, the offsite economic costs for the bypass release category have gone down by a greater amount. The latest consequence values for release categories were used in computing the revised RRW cutoffs. As a result, it now takes a greater change in LERF frequency to obtain the same benefit. Since the basic events with the lower LERF RRWs were evaluated for potential SAMAs in the January 31, 2011 submittal, no further potential SAMAs to reduce LERF need be postulated here. Table 4.a.ii-1 is unchanged and, therefore, not repeated here.

The RAI responses to item 4b (WBN1 IPE insights), item 4c (IPEEE seismic review screening), item 4d (FIVE related SAMAs) , item 4e (Phase I screening justifications), item 4f (internal flood prevention), item 4g (SAMA 242 screening), and item 4h (SAMA 296 screening) are all confirmed after correcting the total person-rem computed for each release category. The Phase I screening documented in Table 16 of the October 4, 2010 submittal is accurate as is and need not be updated.

For item 5, the conclusions of the Phase II cost-benefit calculations are unchanged. Tables summarizing the numerical changes caused by correcting the total person-rem computed for each release category are provided below. Table 2.a.iv-10 shows that the cost-benefit ratio for SAMA 93 went up from 0.95 to 1.08 and for SAMA 70 from 0.93 to 1.06. for the 95% CDF sensitivity case. However, these two SAMAs are already being addressed. The benefits of SAMA 70 will be reduced by TVA's commitment to implement SAMA 339. SAMA 93 will be evaluated further should SAMA 58 not prove reliable.

For item 6, the conclusions regarding the Phase I screening when considering the 95% results for

both CDF and LERF are unchanged after correcting for the total person-rem computed for each release category.

For item 7, the response is affirmed.

The list of 10 commitments in Enclosure 2 to this submittal is again affirmed. One exception is that for item 1, addressing SAMA 58. This commitment is restated as a revised commitment in enclosure 2 to the RAI response submittal of May 25, 2011. This restatement of the commitment is unrelated to correcting the total person-rem computed for each release category.

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
RCPSEAL182	2.07E-01	1.337	Reduce probability of large seal leak given loss of all RCP seal cooling	Upgrade seals or enhance procedures to cooldown RCS before leakage	50, 58, 61, 155, 242, 260	RCP SEAL 182 GPM
%0LOSP-GR	1.01E-02	1.227				Loss of Offsite Power (Grid Related)
			In training, emphasize steps in recovery of off-site power after an SBO.	Reduced human error probability during off-site power recovery.	22	
			Bury off-site power lines.	Improved off-site power reliability during severe weather.	24	
			Provide a connection to alternate offsite power source.	Increases offsite power redundancy.	176	

Table 4ai-1 - Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Onsite AC power additionally fails			Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	9	
			Revise procedure to allow bypass of diesel generator trips.	Extended diesel generator operation.	10	
			Improve 4.16-kV bus cross-tie capability.	Increased availability of on-site AC power.	11	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Onsite AC power additionally fails (Continued)			Cross-tie diesel generators within or to the other unit's	Increased availability of on-site AC power.	12, 229, 244	
			Provide for improved credit to be taken for loss of HVAC sequences, especially for the DG electric board rooms	open doors or use adjacent room's exhaust fans	160, 246	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
182 gpm RCP seal LOCA results from SBO			Implement enhanced RCP seal design.	Unit 2 has the upgraded high temperature o-rings in the Reactor Coolant Pumps. A new seal insert design has been proposed by Westinghouse which could eliminate seal LOCA sequences. Pending topical report approval, this alternate seal design may prove cost effective, however costs are unknown at this time.	58, 232	
Long term AFW fails during Station Blackout			Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.	Increased availability of feedwater.	66, 67, 75	
PAF	9.03E-01	1.226	N/A	Plant availability factor	-	PLANT AVAILABILITY FACTOR

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
%0LOSP-PC	8.12E-03	1.19	-	see %0LOSP-GR	-	Loss of Offsite Power (Plant Centered)
PTSF12PMP_003001AS	2.43E-02	1.136	Improve reliability of TD AFW pump	Upgrade unit 2 TD-AFW pump	223	PUMP FAILS TO START AND RUN FOR 1 HOUR WBN-1-3-1AS
%2CCS	1.00E+00	1.105				Total Loss of Component Cooling System Unit 2
Common cause failure of all CCS pumps			Incorporate diverse positive displacement pump for CCS	Improves reliability of CCS system.	274	
Operators fail (HCCSR4) to align ERCW to train A charging pump			Improve training to align and initiate alternate cooling to 2A-A or 2B-B CCPs when failed	Procedure (AOI-15) already provided for loss of CCS. Enhance training to improve chances of success.	51260, 299	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
182 gpm seal LOCA develops			Implement enhanced RCP seal design.	Unit 2 has the upgraded high temperature o-rings in the Reactor Coolant Pumps. A new seal insert design has been proposed by Westinghouse which could eliminate seal LOCA sequences. Pending topical report approval, this alternate seal design may prove cost effective, however costs are unknown at this time.	58, 232	
U0-CCS-PCO-FR-CCF-IE-ALL	2.75E-04	1.105	Reduce probability of core damage from seal LOCAs resulting from a loss of CCS system	can improve procedures to cope with loss of CCS (cool-down RCS or cross-tie to ERCW), add a diverse CCS pump	45, 49, 50, 53, 56, 59, 61, 64, 156, 157, 158	CCF of CCS PUMPS FAIL TO RUN, CCS HX PLUGGS, & CCS HX EXCESSIVE LEAKAGE/RUPTURE

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAFR1	3.70E-03	1.088	Improve training for loss of air after plant trip	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty	70, 73,299	Restore AFW control following initiator and loss of air
SUMMER	2.00E-01	1.082	N/A	Fraction of year	-	SUMMER SEASON
%0LOSP-WI	2.03E-03	1.067	-	see %0LOSP-GR	-	Loss of Offsite Power (Weather Induced)
%0FLRCW772A8	1.06E-06	1.066	Raw water pipe break in 5th vital battery room propagates to 480v shutdown boards causing station blackout	Eliminate flood propagation path from battery room to 480v shutdown board rooms	293	Flood event induced by rupture of RCW line in room 772.0-A8
%0FLRCW772A9	1.06E-06	1.066	Raw water pipe break in HEPA filter room propagates to 480v shutdown boards causing station blackout	Eliminate flood propagation path from HEPA filter room to 480v shutdown board rooms	294	Flood event induced by rupture of RCW line in room 772.0-A9

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
FL-BATDEP	1.00E+00	1.065	N/A	Flag event	-	Battery Depleted FLAG
HCCSR2	1.60E-02	1.06	Improve training to align and initiate alternate cooling from ERCW to 2A-A or 2B-B CCPs when CCS failed	Procedure (AOI-15) already provided for loss of CCS. Enhance training to improve chances of success.	51,260	ALIGN AND INITIATE ALTERNATE COOLING TO CCP 2A-A
%0TLERCW	1.00E+00	1.059			299,307	Total Loss of ERCW
Common cause failure of all ERCW pumps or strainers			Refurbish the ERCW pumps & upgrade the capacity of the current pumps.	Improves the reliability of the ERCW pumps.	271	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Dependence of CVCS and SI Injection on ERCW			Implement procedure to open the CVCS cross-tie valve to the opposite unit early in the accident response, or installation of a new, independently powered pump	The initiation of charging flow from the opposite unit should provide sufficient RCP seal cooling to prevent RCP seal damage. Another option is the installation of a new, independently powered pump,	154, 215	
			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.	41	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
182 gpm pump seal LOCA			Implement enhanced RCP seal design.	Unit 2 has the upgraded high temperature o-rings in the Reactor Coolant Pumps. A new seal insert design has been proposed by Westinghouse which could eliminate seal LOCA sequences. Pending topical report approval, this alternate seal design may prove cost effective, however costs are unknown at this time.	58, 232	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Dependence of AFW LCVs on compressed air			Provide a permanent tie-in to the construction air compressor, or add new Unit 2 air compressor similar to the Unit 1 D compressor, or replace the ACAS compressors and dryers.	Improve availability of air system.	279, 280, 281	
Short term AFW fails (e.g. operators fail to locally control LCVs for TD AFWP (compressed air is lost), HAFR1			Improve training for loss of air after plant trip	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty	70, 73	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Long-term AFW fails due to partial dependence on ERCW			Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.	Increased availability of feedwater.	66, 67, 75	
DGGFR2GEN_0822A-A	1.46E-02	1.048				DIESEL GENERATOR FAILS TO RUN AFTER FIRST HOUR
			Provide a 2 MW blackout diesel generator to power Charging Pumps, Igniters, Inverters, etc	Improves availability of AC power during SBO.	9	
			Revise procedure to allow bypass of diesel generator trips	extend diesel generator operation	10	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
			Improve 4.16-kv bus crosstie capability	Increased availability of on-site AC power.	11	
			Cross-tie diesel generators within or to the other unit's	Increased availability of on-site AC power.	12, 229, 244	
XSBO14	4.59E-02	1.042	-	See %0LOSP-GR	-	Recovery Sequence 7 (Common Cause of DG to Start) GR
MTM_2GEN_0822A-A	1.51E-02	1.042	-	See DGGFR2GEN_0822A-A	-	DIESEL 2A-A MAINTENANCE
DGGFR2GEN_0822B-B	1.46E-02	1.042	-	See DGGFR2GEN_0822A-A	-	DG 2B-B FAILS FAILS TO RUN (WBN-2-GEN - 082-0002B -B)
XSBO13	5.60E-02	1.042	-	See %0LOSP-GR	-	Recovery Sequence 7 (Common Cause of DG to Start) PC
%2SLOCAL	2.88E-03	1.039				Small LOCA Stuck Open Safety Relief Valve

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Failure of high pressure recirculation from the sump, HARR1			Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,**36**, 187,238, 247,299	Align high pressure recirculation, given auto swap over works
Failure to cooldown and depressurize, AFWOP3			Failure to cooldown and depressurize, AFWOP3	Improve operator performance by enhancing likelihood of recovery from execution errors	Procedure ECA-1.1, loss of RHR sump recirculation, governs this action	307
Failure to refill the RWST using containment spray pumps, HACH1			Failure to refill the RWST using containment spray pumps, HACH1	Improve operator performance by enhancing likelihood of recovery from execution errors	Procedure ES-1.3 transfer to containment sump governs this action	33, 249,282, 306

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
XSBO11	6.62E-01	1.039	-	See %0LOSP-GR	-	Recovery Sequence 4 (DG A And B Fail to Start And TDAFW Fails to Start) GR
HAFR1_FL	1.00E+00	1.038	N/A	Flag event	-	Restore AFW control following HELB scenario induced by MSS supply to AFW line break. Unit 2, 1.0
FL-ATWS	1.00E+00	1.038	N/A	Flag event	-	ATWS
FNSFD2FAN_030460	9.13E-03	1.035	Provide for improved credit to be taken for loss of HVAC sequences, especially for the DG electric board rooms	open doors or use adjacent room's exhaust fans	160, 246	BOARD ROOM EXHAUST FAN FAILS TO START OR RUN FIRST HOUR
XSBO17	6.62E-01	1.035	-	See %0LOSP-GR	-	Recovery Sequence 8 (Common Cause of DG to Start AND TDAWF Fails to Start) GR
XSBO10	7.06E-01	1.033	-	See %0LOSP-GR	-	Recovery Sequence 4 (DG A And B Fail to Start And TDAFW Fails to Start) PC

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
FNSFD2FAN_030462	9.13E-03	1.032	Provide for improved credit to be taken for loss of HVAC sequences, especially for the DG electric board rooms	open doors or use adjacent room's exhaust fans	160, 246	BOARD ROOM EXHAUST FAN FAILS TO START OR RUN FIRST HOUR
MTM_2PMP003001AS	8.52E-03	1.031	Improve reliability of TD AFW pump	Upgrade unit 2 TD-AFW pump	223	PUMP WBN-2-3-1AS IN MAINTENANCE
XSBO16	7.06E-01	1.03	-	See %0LOSP-GR	-	Recovery Sequence 8 (Common Cause of DG to Start AND TDAWF Fails to Start) PC
HRADEP-POST-221	8.60E-04	1.028				
HAOB2	1.60E-02		Goal is to reduce error rate for operator action to initiate feed and bleed cooling	Enhanced procedures already implemented, additional training could reduce error rate	79, 283,285, 300	Establish RCS Bleed and Feed cooling given no CCPS running

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAFR1	3.70E-03		Improve training for loss of air after plant trip	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty	70, 73, 299	Restore AFW control following initiator and loss of air, low dependence on HAOB2
HAERCW3			Improve training to align and initiate cooling from fire protection system to 2A-A or 2B-B CCPs when ERCW (and CCS) fails	Procedure (AOI-13) already available for loss of ERCW. Enhance training to improve chances of success.	45, 46,53, 54,56, 62,64, 155, 156	
XSBO15	1.37E-01	1.027	-	See %0LOSP-GR	-	Recovery Sequence 7 (Common Cause of DG to Start) WI
U2_0BLOCK	7.50E-01	1.027	N/A	See probability that 1 or more are blocked	-	Probability that 0 PORVs are blocked
DGGFR1GEN_0821B-B	1.46E-02	1.027	-	See DGGFR2GEN_0822A-A	-	DG 1B-B FAILS TO RUN
DGGFD2GEN_0822A-A	6.88E-03	1.026	-	See DGGFR2GEN_0822A-A	-	DIESEL GENERATOR 2A-A FAILS TO START AND RUN FIRST HOUR

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
DGGFD2GEN_0822B-B	6.88E-03	1.024	-	See DGGFR2GEN_0822A-A	-	DIESEL GENERATOR FAILS TO START AND RUN FIRST HOUR (WBN-2-GEN -082-0002B -B)
MTM_2GEN_0822B-B	1.07E-02	1.024	-	See DGGFR2GEN_0822A-A	-	DIESEL 2B-B MAINTENANCE
U0_ERCW_PMP_FR_CCF_IE_ALL	6.32E-05	1.022	Improve reliability of ERCW pumps or limit the potential for seal LOCAs given the ERCW system is lost	Pump improvements already implemented. SAMAs identified to limit dependence on ERCW	46, 53, 56, 62, 155, 158, 271	CCF OF ALL ERCW PUMPS FAILS TO RUN IE
HAERCW3	5.00E-02	1.022	Improve training to align and initiate cooling from fire protection system to 2A-A or 2B-B CCPs when ERCW (and CCS) fails	Procedure (AOI-13) already available for loss of ERCW. Enhance training to improve chances of success.	45, 46,53, 54,56, 62,64, 155, 156	OPERATOR FAILS TO ALIGN EXISTING FIRE PROTECTION PUMP TO CCP 2A-A
		1.022	For multiplier of 2.28			

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
U2_RPS_RT__RTB_FO_CCF_1_2	3.33E-06	1.021	Reduce probability of reactor trip failure	Reduce challenges to plant trip or provide alternate means to trip reactor	136, 137, 218	CCF of two components: RTBFO2RTB_0990000A & RTBFO2RTB_0990000B
HAOSBF	2.00E-01	1.021	Improve training for manual steam generator level control	Provide procedure for local control when control power is lost for station blackout and non station blackout sequences	73, 299	Blind Feed DGs Recovery
U1_250BATTDEP	1.00E+00	1.021	-	Flag event	-	
HRADEP-POST-128	9.90E-05	1.02				
HACH1			Improve operator performance by enhancing likelihood of recovery from execution errors	Goal is to reduce error rate to transfer containment spray pumps to sump, (HACH1) given successful RHR swap over to the sump	35, 91, 92,105, 106,107,306	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HARR1			Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,36, 187,238, 247,299	
AFWOP3			Improve operator performance by enhancing likelihood of recovery from execution errors	Sequence involves need to depressurize and cooldown the RCS for LPI following a small LOCA with failure of high pressure recirculation. Numerous critical steps with limited recovery of slips or omissions	299	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
CMPSR0COMP03200060	6.29E-02	1.02	Improve availability of air system.	Provide a permanent tie-in to the construction air compressor, or add new Unit 2 air compressor similar to the Unit 1 D compressor, or replace the ACAS compressors and dryers.	86, 188,279, 280, 281	COMPRESSOR A-A FAILS TO RUN WBN-0-32-60
FLAB4F	1.30E-01	1.019	Improve reliability of high stress action to isolate the HPFP break in the auxiliary building.	Improve recovery from failure of execution step (4 hours available after alarm 167-D) which dominates error rate.	330	Isolate break in HPFP line (supplied by RCW - HPFP diesel pump does not start
%0FLHPFPABF	5.49E-04	1.019	-	See FLAB4F	330	Flood event induced by HPFP in the common areas of the Auxiliary Building
CMPSR0COMP03200086	6.29E-02	1.019	-	see CMPSR0COMP03200060	-	COMPRESSOR B-B FAILS TO RUN WBN-0-32-86
HRADEP-POST-180	9.70E-05	1.019				

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAAEIE	1.80E-03		Reduce execution error of failure to start standby ERCW pump	Add recovery step for execution error in starting ERCW pump (HAAEIE=1.8E-3) in response to 2 ERCW pumps failing to run	331	Start standby ERCW pump - operating pump fails - normal ops
HAFR1	3.70E-03		Improve training for loss of air after plant trip	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty	70, 73, 299	Restore AFW control following initiator and loss of air, (when ERCW failed), low dependence with HAAEIE
%2TTIE	2.32E-01	1.018	Reduce frequency of turbine trip	Improve reliability of power supplies.	218	Turbine Trip
MTM_1GEN_0821B-B	1.22E-02	1.018	-	See DGGFR2GEN_0822 A-A	-	DIESEL 1B-B MAINTENANCE
FNSFD1FAN_030461	9.13E-03	1.017	Provide for improved credit to be taken for loss of HVAC sequences, especially for the DG electric board rooms	open doors or use adjacent room's exhaust fans	160, 246	BOARD ROOM EXHAUST FAN FAILS TO START OR RUN FIRST HOUR, on DG 1B-B

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
SSIOP	6.70E-03	1.017	Improve training and annunciating to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	Training already conducted on inadvertent Safety Injection (SI),	8,292, 299, 306	Terminate Safety Injection to prevent PORV water challenge

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HRADEP-POST-309	2.50E-05	1.016				
SSIOP	6.70E-03		Improve training and annunciating to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	Training already conducted on inadvertent Safety Injection (SI),	8,292, 299, 306	Terminate Safety Injection to prevent PORV water challenge
HARR1	3.80E-03		Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,36, 187,238, 247,299	Align high pressure recirculation, given auto swap over works, medium dependence on SSIOP

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
FL_SPARE_250_CHGR_NOT_A	1.00E+00	1.016	-	Flag event	-	SPARE CHARGER NOT ALIGNED FOR A TRAIN
MTM_2PMP_0620108A	3.78E-03	1.015	Reduce fraction of time charging pump in maintenance while plant is at power	Reschedule CCP maintenance to shutdown conditions	328	WBN-2-PMP-062-0108-A CCP 1A-A IN MAINTENANCE
%2SSBO-1	2.50E-03	1.014				SECONDARY BREAK OUTSIDE CONTAINMENT SG 1
Failure to terminate SI			Improve training and annunciating to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	Training already conducted on inadvertent Safety Injection (SI),	8, 292,299	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Failure to align for high pressure recirculation from the sump, HARR1			Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,**36**, 187,238, 247,299	
%2SSBO-4	2.50E-03	1.014	-	see %2SSBO-1		SECONDARY BREAK OUTSIDE CONTAINMENT SG 4
%2SSBO-2	2.50E-03	1.014	-	see %2SSBO-1		SECONDARY BREAK OUTSIDE CONTAINMENT SG 2
%2SSBO-3	2.50E-03	1.014	-	see %2SSBO-1		SECONDARY BREAK OUTSIDE CONTAINMENT SG 3
U2-AFW-TOT-PMA-FD-CCF_1_2	4.04E-04	1.014	Reduce CCF failure probability of MD AFW pump	CCF pump failure probability not measurably affected by procedures, training, nor indications	None	CCF of two components: PMAF12PMP_0030011 8 & PMAF12PMP_0030012 8

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
DGGFR1GEN_0821A-A	1.46E-02	1.014	-	See DGGFR2GEN_0822 A-A	-	DG 1A-A FAILS TO RUN
PTSFR2PMP_003001AS	1.76E-03	1.013	-	Random pump failure not measurably affected by procedures, training, nor indications	None	PUMP FAILS AFTER 1 HOUR WBN-2-3-1AS
%0FLTBMF	8.58E-03	1.013	Reduce operator action error to recover from turbine building flood with independent failure of ACAS.	Recovery actions addresses with action group HRADEP-POST-221	None	Major flood in the Turbine Building
DGGFD1GEN_0821B-B	6.88E-03	1.013	-	See DGGFR2GEN_0822 A-A	-	DG 1B-B FAILS TO START AND RUN FIRST HOUR

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
FNSFD2FAN_03000214	9.13E-03	1.012	Reduce frequency of losing all AFW caused when all room cooling is lost to TD AFW pump. Operator action to open room containing AFW pump should suffice.	Action is called for in procedures and PRA model already considers action to restore AFW under Station blackout conditions (HAAF1) when local manual control is required. However, only credit for offsite power recovery is conservatively modeled when this fan also fails.	Already implemented	DC EMERG EXHAUST FAN FAILS TO START AND RUN FOR 1ST HOUR WBN-2-30-214, for TD AFW pump room
PRAI2	1.70E-01	1.012	Reduce time fraction that pressure relief requires 3 SVs and 2 PORVs during an ATWS	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	Interval 2 for PRA (pres relief requires 3 SVs & 2 PORVs)
SEQFD2A-A	3.33E-03	1.012	-	See DGGFR2GEN_0822 A-A	-	SEQUENCER 2A-A FAILS (Unknown UNID)
%2RTIE	2.85E-01	1.012	Reduce frequency of reactor trip	Improve reliability of power supplies.	218	Reactor Trip

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAOB2	1.60E-02	1.012	Improve training or revise procedure to establish feed and bleed cooling given no CCPs are running	Enhanced procedures already implemented, additional training could reduce error rate	283, 285, 299, 300	Establish RCS Bleed and Feed cooling given no CCPS running
U0_ERCW_TS_PL_CCF_IE_ALL	6.73E-04	1.011	Refurbish the ERCW pumps & upgrade the capacity of the current pumps.	Improves the reliability of the ERCW pumps.	271	CCF of all components in group 'U0_ERCW_TS_PL_CCF_IE', 2 MD AFW pumps
%2LVBB4	1.00E+00	1.011				Loss of Battery Board 4
Loss of AFW given battery board fails			Improve training for MD AFW pump trains A and B and for TD AFW pump isolation tests	Additional training may reduce isolation error rate	284,286	
Feed and bleed cooling fails given battery board fails			Improve training to establish feed and bleed cooling given battery board lost	Enhanced procedures already implemented, additional training could reduce error rate	285, 283	

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
Failure of high pressure recirculation during feed and bleed with battery board lost			Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32,34,36, 187,238,247	
SEQFD2B-B	3.33E-03	1.011	-	See DGGFR2GEN_0822 A-A	-	SEQUENCER 2B-B FAILS (Unknown UNID)
%2PLMFW	1.46E-01	1.011	-	Random pump and valve failures not measurably affected by procedures, training, nor indications	None	Partial Loss of Main Feedwater

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
U0_EPS_VDG_FAN_FD2_CCF_ALL	1.62E-04	1.011	-	See DGGFR2GEN_0822 A-A, opening room doors is not sufficient to adequately cool the DG room	None	CCF of all components in group 'U0_EPS_VDG_FAN_FD2_CCF'
FNSFR2FAN_03000183	2.66E-03	1.011	Add procedures and perform analysis to justify that CCP room may be adequately cooled by just opening doors when room cooling is lost.	PRA assumes room cooler is required (cooled by ERCW) for pump operation. Opening door to CCP room is not included in the PRA nor yet verified to be effective at keeping temperatures acceptable	337	CCP A ROOM COOLER FAN FAILS DURING OPERATION
MTM_0CAD03204900	3.30E-02	1.011	Reduce fraction of time CAS compressor D in maintenance while plant is at power	Reschedule CAS compressor D maintenance to shutdown conditions	329	CAS COMPRESSOR D IN MAINTENANCE WBN-0-32-COMP-4900
XSBO12	9.31E-01	1.011	-	See %0LOSP-GR	-	Recovery Sequence 4 (DG A And B Fail to Start And TDAFW Fails to Start) WI

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
%0FLRCWABMF	3.94E-05	1.01	Improve training for loss of air after plant trip	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty. Current PRA model gives no credit for action to cope with loss of air, but procedures apply equally well to flood induced losses.	70, 73,299	Major flood event induced by RCW in the common areas of the Auxiliary Building (
POEFR0PMP_06700028IE	2.97E-02	1.01	-	Secondary contributor to loss of ERCW initiating event; see responses for %0TLERCW, HAAEIE, and HAERCW3	-	ERCW PUMP A-A FAILS TO RUNINITIATING EVENT WBN-0-67-28
POEFR0PMP_06700036IE	2.97E-02	1.01	-	Secondary contributor to loss of ERCW initiating event; see responses for %0TLERCW, HAAEIE, and HAERCW3	-	ERCW PUMP C-A FAILS TO RUN INITIATING EVENT WBN-0-67-36

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
POEFR0PMP_06700047IE	2.97E-02	1.01	-	Secondary contributor to loss of ERCW initiating event; see responses for %0TLERCW, HAAEIE, and HAERCW3	-	ERCW PUMP E-B FAILS TO RUN CC 1/4 INITIATING EVENT WBN-0-67-E-B
POEFR0PMP_06700055IE	2.97E-02	1.01	-	Secondary contributor to loss of ERCW initiating event; see responses for %0TLERCW, HAAEIE, and HAERCW3	-	ERCW PUMP G-B FAILS TO RUNINITIATING EVENT WBN-0-67-55
FNSFD2FAN_030448	9.13E-03	1.01	-	See DGGFR2GEN_0822 A-A, opening room doors is not sufficient to adequately cool the DG room	None	EXHAUST FAN FAILS TO START OR RUN FIRST HOUR
FNSFD2FAN_030452	9.13E-03	1.01	-	See DGGFR2GEN_0822 A-A, opening room doors is not sufficient to adequately cool the DG room	None	EXHAUST FAN FAILS TO START OR RUN FIRST HOUR

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
XSBO18	9.31E-01	1.01	-	See %0LOSP-GR	-	Recovery Sequence 8 (Common Cause of DG to Start AND TDAWF Fails to Start) WI
PRAI3	1.50E-01	1.01	Reduce time fraction that pressure relief requires 3 SVs and 1 PORV during an ATWS	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	Interval 3 for PRA (pres relief requires 3 SVs & 1 PORV)
CBKFO2BKR_2111816/16-A	2.55E-03	1.009	Improve reliability of 6.9kv circuit breaker to SD BD to open on demand	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	6.9kV SDBD BREAKER 1816 FAILS TO OPEN, required for power from EDG
RLVFO2RFV_0620636	2.47E-03	1.009	Reduce potential for failing to open on demand the common relief valve on seal return	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications. Local action to open breaker would be too late to achieve success.	None	WBN-1-RFV-062-0636-S RELIEF VALVE FAILS TO OPEN on common seal injection return line
HRADEP-POST-289	1.10E-02	1.009				

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
AFWOP1	2.10E-02		Improve operator performance by improving procedures and training for completing RCS depressurization during a medium LOCA to allow low pressure injection	Action error rate dominated by execution steps which are already well documented in ES-1.2, though high stress is postulated for the medium LOCA. High dependence assumed between execution steps and occurrence of feedback to operators for recovery.	338	Depressurize/cooldown to low pressure injection following MLOCA

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HARR1	3.80E-03		Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,**36**, 187,238, 247,299	Align high pressure recirculation, given auto swap over works; high dependence on AFWOP1
U2_ESF_SGD_CF_517_CCF_1_2	9.32E-05	1.009	Reduce CCF probability of multiple safeguard driver cards resulting in loss of actuation signals	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	CCF of two components: SGDCF2SGD_099A517A & SGDCF2SGD_099A517B
MTM_1GEN_0821A-A	1.10E-02	1.009	-	See DGGFR2GEN_0822A-A	-	DIESEL 1A-A MAINTENANCE

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
FNSFD1FAN_030459	9.13E-03	1.009		FNSFD1FAN_030461		BOARD ROOM EXHAUST FAN FAILS TO START OR RUN FIRST HOUR, DG 1A-A
BUSFR0BD__2364G_IE	3.80E-03	1.009	Improve reliability of DC bus to operate	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	125V DC VITAL BATTERY BOARD IV FAILS DURING OPERATION
%2CCS2A	1.00E+00	-		See %2CCS	-	Loss of Component Cooling System Train 2A
HRADEP-POST-220	2.40E-03	1.009				
HACD1			Improve manual actions to re-establish secondary heat removal or initiate bleed and feed cooling when automatic actuation of AFW fails	Can provide alternate means to establish secondary heat removal or improve training and procedures to respond to loss of actuation signal	66,68, 276, 296, 299	Perform cooldown with main feedwater, following AFW failure
HAOS3						Start AFW (Reactor trip, no SI), medium dependence on HACD1

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAOB2			Goal is to reduce error rate for operator action to initiate feed and bleed cooling	Enhanced procedures already implemented, additional training could reduce error rate	79, 283,285, 300	Establish RCS Bleed and Feed cooling given no CCPS running, high dependence on HAOS3
HRADEP-POST-218	5.40E-03	1.009				
HACD1	3.24E-02		Improve manual actions to re-establish secondary heat removal or initiate bleed and feed cooling when automatic actuation of AFW fails	Can provide alternate means to establish secondary heat removal or improve training and procedures to respond to loss of actuation signal	66,68, 276, 296, 299	Perform cooldown with main feedwater, following AFW failure
HAOB2	1.60E-02		Goal is to reduce error rate for operator action to initiate feed and bleed cooling	Enhanced procedures already implemented, additional training could reduce error rate	79, 283,285, 300	Establish RCS Bleed and Feed cooling given no CCPS running, medium dependence on HACD1

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HARR1	3.80E-03	1.009	Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,**36**, 187,238, 247,299	Align high pressure recirculation, given auto swap over works
CBKFO2BKR_2111828/16-B	2.55E-03	1.009	Improve reliability of 6.9kv circuit breaker to SD BD to open on demand	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	6.9kV SDBD BREAKER 1828 FAILS TO OPEN, required for power from EDG

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
%0FLHPFPAB757A2	1.44E-07	1.008	Flood event induced by break of HPFP line in room 757.0-A2 propagates to all 4 6.9kv shutdown boards causing station blackout	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	Flood event induced by break of HPFP line in room 757.0-A2
HRADEP-POST-305	1.30E-05	1.008				
HCRL1	3.80E-03		Reduce likelihood that operators reset SI signal failing sump auto-swap over by including execution recovery step in procedures	Sequence involves %SSBO-1,2,3,4 with failure to terminate SI prior to PZR PORV water challenge; Modify procedures to ensure that operators confirm that no RCS leakage occurs once PORV is challenged to minimize chance of inadvertently resetting SI signal.	333	Inadvertently Reset SI Signal, Failure of Auto Sump Swap over

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
SSIOP	6.60E-03		Improve training and annunciating to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	Training already conducted on inadvertent Safety Injection (SI),	8,292, 299, 306	Terminate Safety Injection to prevent PORV water challenge, high dependence on HCRL1
HARL1	2.30E-03		Improve procedures to include recovery from execution errors	Human error rate conservatively evaluated assuming timing for a large LOCA. Much greater time available for secondary side breaks with stuck open PZR PORV	334	Recover from auto swap over failure, medium dependence on SSIOP
U0_EPS_GA_GEN_FR_CCF_2_3	3.59E-04	1.008	-	See DGGFR2GEN_0822A-A	-	CCF of two components: DGGFR1GEN_0821B-B & DGGFR2GEN_0822A-A

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
FNSFD2FAN_030450	9.13E-03	1.008	Provide for improved credit to be taken for loss of HVAC sequences, especially for the DG electric board rooms	open doors or use adjacent room's exhaust fans; already implemented at Watts Bar	160, 246	EXHAUST FAN FAILS TO START OR RUN FIRST HOUR
FNSFD2FAN_030454	9.13E-03	1.008	Provide for improved credit to be taken for loss of HVAC sequences, especially for the DG electric board rooms	open doors or use adjacent room's exhaust fans; already implemented at Watts Bar	160, 246	EXHAUST FAN FAILS TO START OR RUN FIRST HOUR
%0TLPCA	9.81E-03	1.008	-	See HAFR1	-	Total Loss of Plant Compressed Air
HRADEP-POST-171	2.10E-04	1.008				
DHAERCWS	3.80E-03		Reduce execution error rate by adding recovery step to procedures	Action is to start selected pump to allow traveling screen to rotate at least one full revolution, for 20 minutes or until no longer needed	332	Operators fail to clear ERCW screens before plant trip

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAFR1	3.70E-03		Improve training for loss of air after plant trip	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty	70, 73,299	Restore AFW control following initiator and loss of air, low dependence on DHAERCWS
FNSFR2FAN_030460	2.66E-03	1.008	Provide for improved credit to be taken for loss of HVAC sequences, especially for the DG electric board rooms	open doors or use adjacent room's exhaust fans; already implemented at Watts Bar	160, 246	EXHAUST FAN 2-FAN-30-460 FAILS TO RUN
MTM_2FAN_03000183	2.00E-03	1.008	Add procedures and perform analysis to justify that CCP room may be adequately cooled by just opening doors when room cooling is lost.	PRA assumes room cooler is required (cooled by ERCW) for pump operation. Opening door to CCP room is not included in the PRA nor yet verified to be effective at keeping temperatures acceptable	337	CCP A ROOM COOLER FAN IN MAINTENANCE

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
TTM_2FAN_03000183	2.00E-03	1.008	Add procedures and perform analysis to justify that CCP room may be adequately cooled by just opening doors when room cooling is lost.	PRA assumes room cooler is required (cooled by ERCW) for pump operation. Opening door to CCP room is not included in the PRA nor yet verified to be effective at keeping temperatures acceptable	337	CCP A ROOM COOLER FAN IN TEST
CMPSR0COMP03200025	6.29E-02	1.008	-	See CMPSR0COMP03200060 and HAFR1	-	CAS COMPRESSOR A FAILS TO RUN WBN-0-32-25
CMPSR0COMP03200026	6.29E-02	1.008	-	See CMPSR0COMP03200060 and HAFR1	-	COMPRESSOR B FAILS TO RUN WBN-0-32-26
HART1	1.40E-03	1.008	Reduce probability of reactor trip failure	Reduce challenges to plant trip or provide alternate means to trip reactor	136, 137,218	Manually trip reactor, given SSPS fails

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
%0FLRCW757A17	1.27E-07	1.007	Flood event induced by rupture of RCW line in room 757.0-A17 propagates to all 4, 6.9kv shutdown boards causing station blackout	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	Flood event induced by rupture of RCW line in room 757.0-A17
%0FLRCW757A9	1.27E-07	1.007	Flood event induced by rupture of RCW line in room 757.0-A9 propagates to all 4, 6.9kv shutdown boards causing station blackout	Basic plant design cannot be changed by revising procedures, additional training, nor additional indications.	None	Flood event induced by rupture of RCW line in room 757.0-A9
XSBO25	5.00E-01	1.007	-	See %0LOSP-GR	-	ALIGN PORTABLE DIESEL GENERATOR TO SHUTDOWN BOARD 2B-B

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
U0_ERCW_PMP_FR_CCF_ALL	3.88E-06	1.007	-	See %0TLERCW	-	CCF of all components in group 'U0_ERCW_PMP_FR_CCF'
FNSFD2FAN_03000182	9.13E-03	1.007	-	See FNSFR2FAN_03000183	-	CCP 1B-B ROOM COOLING FAN FAILS TO START AND RUN FOR FIRST HOUR
DHARR3	1.00E-03	1.007	Reduce error rate for operators failing to restart an Residual Heat Removal (RHR) pump for HP recirculation from the sump after previously securing SI.	Revise procedures and training to address this human action (DHARR3 = 1E-3).	336	OPERATOR FAILS TO RESTART RHR PUMP FOR HP RECIRCULATION
U0_032_ACAS_CMP_FR_CCF_1_2	3.25E-03	1.007	-	See CMPSR0COMP03200060	-	CCF of two components: CMPSR0COMP03200060 & CMPSR0COMP03200086
FNSFR2FAN_030462	2.66E-03	1.007	-	See FNSFR2FAN_030460	-	EXHAUST FAN 2-FAN-30-462 FAILS TO RUN

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
SMPPL2STN_SUMP1	1.00E-03	1.007	Reduce probability of sump strainers plugging precluding recirculation from the sump	Biggest contributors from steam line breaks leading to stuck open PZR PORVs' i.e., smaller LOCAs. Basic plant design cannot be changed by revising procedures, additional training, nor additional indications. Local action to open breaker would be too late to achieve success.	None	SUMP SUCTION STRAINERS PLUGGED (LLOCA OR MLOCA)
DGGFD1GEN_0821A-A	6.88E-03	1.007	-	See DGGFR2GEN_0822A-A	-	DG 1A-A FAILS TO START AND RUN FIRST HOUR
HXRPL2HTX_07000185IET	5.65E-03	1.007		Sequence leads to loss of CCS with seal LOCA and fails recirculation from sump due to multiple operator actions (HRADEP-POST-A1). Consider improvements to associated human actions below	Hardware fixes not cost effective	WBN-2-HTX-070-0185 CCS HEAT EXCHANGER A PLUGGING

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HCCSR2	1.60E-02		-	See HCCSR2	-	ALIGN AND INITIATE ALTERNATE COOLING TO CCP 2A-A
HACH1	1.10E-02		-	See %2SLOCAL	-	Transfer Containment Spray to Sump (RHR Swap Successful)
AFWOP3	1.10E-02		-	See %2SLOCAL	-	Depressurize/cooldown to low pressure injection following small LOCA with failure
HRADEP-POST-B7	7.61E-03	1.007				
HAERCW2	7.80E-02		Improve training and procedures to cross-connect fire protection pump flow to ERCW in the event ERCW pumps all fail as initiating event with power from shutdown boards available	Procedure MA-1, Rev 3, Appendix C details the steps to follow.	335	OPERATOR FAILS TO ALIGN FIRE PROTECTION PUMP TO ERCW HEADER

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAERCW3	5.00E-02		Improve training to align and initiate cooling from fire protection system to 2A-A or 2B-B CCPs when ERCW (and CCS) fails	Procedure (AOI-13) already available for loss of ERCW. Enhance training to improve chances of success.	45, 46,53, 54,56, 62,64, 155, 156	OPERATOR FAILS TO ALIGN EXISTING FIRE PROTECTION PUMP TO CCP 2A-A, low dependence on HAERCW2 performed within minutes
AOCFC0PCV_03300004	7.39E-04	1.006	N/A	Not Training or HRA related		AOV FAILS TO CLOSE ON DEMAND WBN-0-33-4
CRI	1.20E-06	1.006	N/A	Not Training or HRA related		CONTROL RODS FAIL TO INSERT
FNSFR2FAN_03000214	2.66E-03	1.006	N/A	Not Training or HRA related		DC EMERGENCY EXHAUST FAN FAILS TO RUN AFTER 1ST HOUR WBN-2-30-214
%0FLHPFPAB757A24	1.07E-07	1.006	N/A	Not Training or HRA related		Flood event induced by break of HPFP line in room 757.0-A24

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HRADEP-POST-293	2.10E-04	1.006				
Failure of high pressure recirculation from the sump, HARR1			Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in license operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,**36**, 187,238, 247,299	Align high pressure recirculation, given auto swap over works
HAFR1	3.70E-03		Improve training for loss of air after plant trip	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty	70, 73, 299	Restore AFW control following initiator and loss of air, low dependence on HAOB2

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HRADEP-POST-193	3.1E-05	1.006				
Failure of high pressure recirculation from the sump, HARR1			Improve operator performance and minimize need for manual action to complete high pressure recirculation alignment	Existing EOPs provide directions for monitoring and conserving water in the containment recirculation sump. These procedures are already used extensively in licensed operator initial training and license operator continuing training programs, and are practiced in the plant simulator.	31,32, 34,**36**, 187,238, 247,299	Align high pressure recirculation, given auto swap over works
AFWOP3	1.10E-02		-	See %2SLOCAL	-	Depressurize/cooldown to low pressure injection following small LOCA with failure

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
HAMU2B	5E-03		Improve operator performance via training	Cognitive contribution is 3.1E-03, Execution is 1.9E-03. Procedure ECA-1.1 governs	340 (New)	Makeup to RWST using containment spray test recirculation from the containment sump during a small LOCA
XPORV1	5.29E-02	1.006	N/A	Not Training or HRA related		BLOCK VALVE CLOSED TO ISOLATE LEAKING PORV
U0_EPS_GA_GEN_FD_CCF_ALL	9.01E-05	1.006	N/A	Not Training or HRA related		CCF of all components in group 'U0_EPS_GA_GEN_FD_CCF'
SRVSR2SRV_06800563	7.95E-04	1.006	N/A	Not Training or HRA related		SAFETY VALVE FAILS TO RESEAT AFTER STEAM RELIEF WBN-2-68-563
SRVSR2SRV_06800564	7.95E-04	1.006	N/A	Not Training or HRA related		SAFETY VALVE FAILS TO RESEAT AFTER STEAM RELIEF WBN-2-68-564
SRVSR2SRV_06800565	7.95E-04	1.006	N/A	Not Training or HRA related		SAFETY VALVE FAILS TO RESEAT AFTER STEAM RELIEF WBN-2-68-565

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
FLTB1C	1.00E-02	1.006	N/A	Not Training or HRA related		Isolate CCW following major break in Turbine Building
%2TLMFW	7.01E-02	1.006	N/A	Not Training or HRA related		Total Loss of Main Feedwater
SEQFD1B-B	3.33E-03	1.006	N/A	Not Training or HRA related		SEQUENCER 1B-B FAILS (Unknown UNID)
%2EX	1.00E-07	1.006	N/A	Not Training or HRA related		EXCESSIVE LOCA (VESSEL RUPTURE)
CMPSR0COMP03200027	6.29E-02	1.006	N/A	Not Training or HRA related		COMPRESSOR C FAILS TO RUN WBN-0-32-27
%2LOCV	6.53E-02	1.006	N/A	Not Training or HRA related		Loss of Condenser Vacuum

Table 4ai-1 Review of Basic Events with RRW Greater than 1.006 to CDF for Potential New RAI SAMAs (Continued)

Event Name	Probability	Red W	SAMA Title	SAMA Discussion	SAMA #	Description
MTM_2PMP00300128	4.22E-03	1.006	N/A	Not Training or HRA related		PUMP WBN-2-3-128-B IN MAINTENANCE
PMAF12PMP_00300118	2.89E-03	1.006	N/A	Not Training or HRA related		PUMP FAILS TO START AND RUN FOR 1 HOUR WBN-2-3-118-A
MTM_2PMP00300118	3.84E-03	1.006	N/A	Not Training or HRA related		PUMP WBN-2-3-118-A IN MAINTENANCE
		1.006	for Multiplier of 2.28			

Table 2.a.iv-7.

RAI Revised Base Cost Comparison

	October 2010, SAMA Report	Revised (RAI) Sept 2011 SAMA Results	% Change
Base Cost with External Event Muliplier 2.0	$3,309,176	$3,860,606	+ 17%
Base Cost with External Event Multiplier 2.28	$3,772,461	$4,401,090	+ 17%

Table 2.a.iv-8 - RAI Revised SAMA Phase II Analysis Results

		Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.0)				Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.28)			
SAMA No.	SAMA Title	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion
4	Improve DC bus load shedding.	$35,111	$31,675	1.11	Already committed to do, see Jan.,2009t SAMA submittal	$40,026	$31,675	1.26	Already committed to do, see January, 2009SAMA submittal
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	$10,949	$26,773	0.41	Already committed to do, see January, 2009 SAMA submittal	$12,482	$26,773	0.47	Already committed to do, see January, 2009 SAMA submittal
26	Provide an additional high pressure injection pump with independent diesel.	$57,181	$3,571,000	0.02	Not cost beneficial	$65,186	$3,571,000	0.02	Not cost beneficial
32	Add the ability to automatically align emergency core cooling system to recirculation mode upon refueling water storage tank depletion.	$351,587	$2,100,000	0.17	Not cost beneficial	$400,809	$2,100,000	0.19	Not cost beneficial
45	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	$4,562	$31,675	0.14	Not cost beneficial	$5,201	$31,675	0.16	Not cost beneficial
46	Add a service water pump.	$129,763	$1,042,511	0.12	Not cost beneficial	$147,930	$1,042,511	0.14	Not cost beneficial
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	$1,080,157	$8,233,000	0.13	Not cost beneficial	$1,231,379	$8,233,000	0.15	Not cost beneficial
70	Install accumulators for turbine-driven auxiliary feedwater pump flow control valves.	$88,566	$256,204	0.35	Not cost beneficial	$100,966	$256,204	0.39	Not cost beneficial
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	$0	$1,706,586	0.00	Not cost beneficial	$0	$1,706,586	0.00	Not cost beneficial

Table 2.a.iv-8 - RAI Revised SAMA Phase II Analysis Results (Continued)

		Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.0)				Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.28)			
SAMA No.	SAMA Title	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	$1,908	$886,205	0.00	Not cost beneficial	$2,175	$886,205	0.00	Not cost beneficial
93(See Note 1)	Install an unfiltered, hardened containment vent.	$1,089,701	$3,100,000	0.35	Not cost beneficial	$1,242,259	$3,100,000	0.40	Not cost beneficial
101	Provide a reactor vessel exterior cooling system.	$182,392	$2,500,000	0.07	Not cost beneficial	$207,927	$2,500,000	0.08	Not cost beneficial
103	Institute simulator training for severe accident scenarios.	$1,229,070	$8,000,000	0.15	Not cost beneficial, Cost includes new software and hardware upgrade	$1,401,139	$8,000,000	0.18	Not cost beneficial, Cost includes new software and hardware upgrade
109	Install a passive hydrogen control system.	$265,139	$3,736,000	0.07	Not cost beneficial	$302,259	$3,736,000	0.08	Not cost beneficial
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	$90,783	$1,151,000	0.08	Not cost beneficial	$103,493	$1,151,000	0.09	Not cost beneficial
112	Add redundant and diverse limit switches to each containment isolation valve.	$2,815	$691,524	0.00	Not cost beneficial	$3,210	$691,524	0.00	Not cost beneficial
136	Install motor generator set trip breakers in control room.	$11,679	$241,795	0.05	Not cost beneficial	$13,315	$241,795	0.06	Not cost beneficial
156	Eliminate RCP thermal barrier dependence on CCW, such that loss of CCW does not result directly in core damage.	$686,176	$31,675	21.66	Proposed procedure change ineffective. See Section 10 of Oct., 2010 SAMA report	$782,241	$31,675	24.70	Proposed procedure change ineffective. See Section 10 of Oct., 2010 SAMA report

Table 2.a.iv-8 - RAI Revised SAMA Phase II Analysis Results (Continued)

		Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.0)				Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.28)			
SAMA No.	SAMA Title	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion
176	Provide a connection to alternate offsite power source.	$686,153	$9,126,460	0.08	Not cost beneficial	$782,214	$9,126,460	0.09	Not cost beneficial
191	Provide self-cooled ECCS seals.	$0	$1,000,000	0.00	Not cost beneficial	$0	$1,000,000	0.00	Not cost beneficial
215	Provide a means to ensure RCP seal cooling so that RCP seal LOCAs are precluded for SBO events.	$1,153,970	$1,500,000	0.77	Not cost beneficial; first of a kind installation; downside impacts on risk impact not assessed	$1,315,525	$1,500,000	0.88	Not cost beneficial; first of a kind installation; downside impacts on risk impact not assessed
226	Permanent, self- powered pump to backup normal charging pump.	$1,153,970	$2,700,000	0.43	Not cost beneficial	$1,315,525	$2,700,000	0.49	Not cost beneficial
255	Permanent, Dedicated Generator for the NCP, one Motor Driven AFW Pump, and a Battery Charger.	$737,229	$3,225,000	0.23	Not cost beneficial	$840,441	$3,225,000	0.26	Not cost beneficial
256	Install Fire Barriers Around Cables or Reroute the Cables Away from Fire Sources.	$965,083	$19,608	49.22	Already committed to do, see January, 2009 SAMA submittal	$1,100,195	$19,608	56.11	Already committed to do, see January, 2009 SAMA submittal
276	Provide an auto start signal for AFW on loss of Standby Feedwater pump.	$22,114	$615,605	0.04	Not cost beneficial	$25,210	$615,605	0.04	Not cost beneficial
279	Provide a permanent tie-in to the construction air	$63,064	$909,893	0.07	Not cost beneficial	$71,893	$909,893	0.08	Not cost beneficial

Table 2.a.iv-8 - RAI Revised SAMA Phase II Analysis Results (Continued)

		Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.0)				Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.28)			
SAMA No.	SAMA Title	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion
	compressor.								
280	Add new Unit 2 air compressor similar to the Unit 1 D compressor.	$63,064	$814,546	0.08	Not cost beneficial	$71,893	$814,546	0.09	Not cost beneficial
282	Provide cross-tie to Unit 1 RWST.	$18,319	$10,215,000	0.00	Not cost beneficial	$20,883	$10,215,000	0.00	Not cost beneficial
285	Improve training to establish feed and bleed cooling given no CCPs are running or a vital instrument board fails	$90,528	$26,773	3.38	Potentially cost beneficial	$103,202	$26,773	3.85	Potentially cost beneficial
292	Improve training to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	$347,048	$26,773	12.96	Potentially cost beneficial	$395,634	$26,773	14.78	Potentially cost beneficial
295	Increase frequency of containment leak rate testing	$126,291	$2,500,000	0.05	Not cost beneficial	$143,972	$2,500,000	0.06	Not cost beneficial
299	Initiate frequent awareness training for plant operators/ maintenance/ testing staff on key human actions for plant risk	$250,281	$26,773	9.35	Potentially cost beneficial	$285,320	$26,773	10.66	Potentially cost beneficial
300(See Note 1)(See Note 1)	Revise procedure FR-H.1 to eliminate or simplify complex (and/or) decision logic for establishing feed and bleed cooling and to improve operator recovery from initial mistakes	$50,156	$100,000	0.50	Not cost beneficial; Requires PWROG approval	$57,178	$100,000	0.57	Not cost beneficial; Requires PWROG approval

Table 2.a.iv-8 - RAI Revised SAMA Phase II Analysis Results (Continued)

		Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.0)				Revised September, 2011 SAMA RAI Results (External Events Multiplier = 2.28)			
SAMA No.	SAMA Title	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion	Estimated Benefit	Estimated Cost	Benefit/ Cost Ratio	Change in Conclusion
303	Move indication/ operator interface for starting hydrogen igniters to front MCR panel	$1,515	$50,000	0.03	Not cost beneficial	$1,727	$50,000	0.03	Not cost beneficial
304	Add annunciator or alarm signaling parameters to initiate hydrogen igniters to front panel on MCR	$1,515	$50,000	0.03	Not cost beneficial; HRA analysis considered procedure E-1 but not SAG-6, already implemented	$1,727	$50,000	0.03	Not cost beneficial; HRA analysis considered procedure E-1 but not SAG-6, already implemented
305	Revise procedure E-1 to include recovery steps for failure to initiate hydrogen igniters	$133,980	Not Estimated	NA	HRA analysis considered procedure E-1 but not SAG-6, already implemented	$152,737	Not Estimated	NA	HRA analysis considered procedure E-1 but not SAG-6, already implemented
306	Improve operator performance by enhancing likelihood of recovery from execution errors	$149,539	Not Estimated	NA	HRA analysis considered procedures ES-1.3 and FR-Z.1 but not SAG-6, already implemented	$170,474	Not Estimated	NA	HRA analysis considered procedures ES-1.3 and FR-Z.1 but not SAG-6, already implemented
307	Make provisions for connecting ERCW to CCP 2B-B	$531	$98,600	0.01	Not cost beneficial	$605	$98,600	0.01	Not cost beneficial

Note 1 – SAMA 93 was revised (see RAI Response to Question 5.f). SAMA 300 was revised (see RAI Response to Question 5.i).

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	**SAMA Title**	**Benefit/ Cost Ratio 7% RDR**	**Benefit/ Cost Ratio 3% RDR**	**Change in Conclusion**	**Benefit/ Cost Ratio 7% RDR**	**Benefit/ Cost Ratio 3% RDR**	**Change in Conclusion**
4	Improve DC bus load shedding.	1.11	1.96	Already committed to do, see January, 2009 SAMA submittal	1.26	2.24	Already committed to do, see January,2009 SAMA submittal
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	0.41	0.74	Already committed to do, see January, 2009 SAMA submittal	0.47	0.85	Already committed to do, see January, 2009 SAMA submittal
26	Provide an additional high pressure injection pump with independent diesel.	0.02	0.03	NO	0.02	0.03	NO

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
32	Add the ability to automatically align emergency core cooling system to recirculation mode upon refueling water storage tank depletion.	0.17	0.29	NO	0.19	0.34	NO
45	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	0.14	0.26	NO	0.16	0.30	NO
46	Add a service water pump.	0.12	0.22	NO	0.14	0.25	NO
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	0.13	0.23	NO	0.15	0.26	NO
70	Install accumulators for turbine-driven auxiliary feedwater pump flow control valves.	0.35	0.61	NO	0.39	0.70	NO

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	0.00	0.00	NO	0.00	0.00	NO
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	0.00	0.00	NO	0.00	0.00	NO
93	Install an unfiltered, hardened containment vent.	0.35	0.61	NO	0.40	0.70	NO
101	Provide a reactor vessel exterior cooling system.	0.07	0.13	NO	0.08	0.14	NO
103	Institute simulator training for severe accident scenarios.	0.15	0.27	NO	0.18	0.31	NO

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion
109	Install a passive hydrogen control system.	0.07	0.12	NO	0.08	0.14	NO
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	0.08	0.14	NO	0.09	0.16	NO
112	Add redundant and diverse limit switches to each containment isolation valve.	0.00	0.01	NO	0.00	0.01	NO
136	Install motor generator set trip breakers in control room.	0.05	0.09	NO	0.06	0.10	NO

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion
156	Eliminate RCP thermal barrier dependence on CCW, such that loss of CCW does not result directly in core damage.	21.66	38.10	NO. Proposed procedure change ineffective. See Section 10 of Oct., 2010 SAMA report	24.70	43.44	NO. Proposed procedure change ineffective. See Section 10 of Oct., 2010 SAMA report
176	Provide a connection to alternate offsite power source.	0.08	0.13	NO	0.09	0.15	NO
191	Provide self-cooled ECCS seals.	0.00	0.00	NO	0.00	0.00	NO
215	Provide a means to ensure RCP seal cooling so that RCP seal LOCAs are precluded for SBO events.	0.77	1.36	YES; first of a kind installation; downside impacts on risk impact not assessed	0.88	1.55	YES; first of a kind installation; downside impacts on risk impact not assessed
226	Permanent, self-powered pump to backup normal charging pump.	0.43	0.75	NO	0.49	0.86	NO

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion
255	Permanent, Dedicated Generator for the NCP, one Motor Driven AFW Pump, and a Battery Charger.	0.23	0.40	NO	0.26	0.46	NO
256	Install Fire Barriers Around Cables or Reroute the Cables Away from Fire Sources.	49.22	87.01	Already committed to do, see January, 2009 SAMA submittal	56.11	99.19	Already committed to do, see January, 2009 SAMA submittal
276	Provide an auto start signal for AFW on loss of Standby Feedwater pump.	0.04	0.06	NO	0.04	0.07	NO
279	Provide a permanent tie-in to the construction air compressor.	0.07	.12	NO	0.08	0.14	NO
280	Add new Unit 2 air compressor similar to the Unit 1 D compressor.	0.08	0.14	NO	0.09	0.16	NO
282	Provide cross-tie to Unit 1 RWST.	0.00	0.00	NO	0.00	0.00	NO

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion
285	Improve training to establish feed and bleed cooling given no CCPs are running or a vital instrument board fails	3.38	6.16	No (Remains Potentially cost beneficial)	3.85	7.02	No (Remains Potentially cost beneficial)
292	Improve training to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	12.96	22.69	No (Remains Potentially cost beneficial)	14.78	25.87	No (Remains Potentially cost beneficial)
295	Increase frequency of containment leak rate testing	0.05	0.09	NO	0.06	0.10	NO
299	Initiate frequent awareness training for plant operators/ maintenance/ testing staff on key human actions for plant risk	9.35	16.51	No (Remains Potentially cost beneficial)	10.66	18.82	No (Remains Potentially cost beneficial)

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion
300	Revise procedure FR-H.1 to eliminate or simplify complex (and/or) decision logic for establishing feed and bleed cooling and to improve operator recovery from initial mistake	0.50	0.91	YES; Requires PWROG approval	0.57	1.04	YES; Requires PWROG approval
303	Move indication/ operator interface for starting hydrogen igniters to front MCR panel	0.03	0.05	NO	0.03	0.06	NO
304	Add annunciator or alarm signaling parameters to initiate hydrogen igniters to front panel on MCR	0.03	0.05	NO	0.03	0.06	NO

Table 2.a.iv-9 - SAMA RAI 3% RDR Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion	Benefit/ Cost Ratio 7% RDR	Benefit/ Cost Ratio 3% RDR	Change in Conclusion
305	Revise procedure E-1 to include recovery steps for failure to initiate hydrogen igniters	Not Estimated	NA	NO	Not Estimated	NA	NO
306	Improve operator performance by enhancing likelihood of recovery from execution errors	Not Estimated	NA	NO	Not Estimated	NA	NO
307	Make provisions for connecting ERCW to CCP 2B-B	0.01	0.01	NO	0.01	0.01	NO

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
4	Improve DC bus load shedding.	1.11	2.99	Already committed to do, see January, 2009 SAMA submittal	1.26	3.41	Already committed to do, see January, 2009 SAMA submittal
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	0.41	1.10	Already committed to do, see January, 2009 SAMA submittal	0.47	1.26	Already committed to do, see January, 2009 SAMA submittal
26	Provide an additional high pressure injection pump with independent diesel.	0.02	0.04	NO	0.02	0.05	NO

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
32	Add the ability to automatically align emergency core cooling system to recirculation mode upon refueling water storage tank depletion.	0.17	0.45	NO	0.19	0.52	NO
45	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	0.14	0.39	NO	0.16	0.44	NO
46	Add a service water pump.	0.12	0.34	NO	0.14	0.38	NO
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	0.13	0.35	NO	0.15	0.40	NO
70	Install accumulators for turbine-driven auxiliary feedwater pump flow control valves.	0.35	0.93	NO	0.39	1.06	NO
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	0.00	0.00	NO	0.00	0.00	NO

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	0.00	0.01	NO	0.00	0.01	NO
93	Install an unfiltered, hardened containment vent.	0.35	0.95	NO	0.40	1.08	NO
101	Provide a reactor vessel exterior cooling system.	0.07	0.20	NO	0.08	0.22	NO
103	Institute simulator training for severe accident scenarios.	0.15	0.41	NO	0.18	0.47	NO
109	Install a passive hydrogen control system.	0.07	0.19	NO	0.08	0.22	NO

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	0.08	0.21	NO	0.09	0.24	NO
112	Add redundant and diverse limit switches to each containment isolation valve.	0.00	0.01	NO	0.00	0.01	NO
136	Install motor generator set trip breakers in control room.	0.05	0.13	NO	0.06	0.15	NO
156	Eliminate RCP thermal barrier dependence on CCW, such that loss of CCW does not result directly in core damage.	21.66	58.49	NO. Proposed procedure change ineffective. See Section 10 of Oct., 2010 SAMA	24.70	66.68	NO. Proposed procedure change ineffective. See Section 10 of Oct., 2010 SAMA

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
				report			report
176	Provide a connection to alternate offsite power source.	0.08	0.20	NO	0.09	0.23	NO
191	Provide self-cooled ECCS seals.	0.00	0.00	NO	0.00	0.00	NO
215	Provide a means to ensure RCP seal cooling so that RCP seal LOCAs are precluded for SBO events.	0.77	2.08	YES; first of a kind installation; downside impacts on risk impact not assessed	0.88	2.37	YES; first of a kind installation; downside impacts on risk impact not assessed
226	Permanent, self-powered pump to backup normal charging pump.	0.43	1.15	Yes Potentially cost beneficial	0.49	1.32	Yes Potentially cost beneficial

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
255	Permanent, Dedicated Generator for the NCP, one Motor Driven AFW Pump, and a Battery Charger.	0.23	0.62	NO	0.26	0.70	NO
256	Install Fire Barriers Around Cables or Reroute the Cables Away from Fire Sources.	49.22	132.89	Already committed to do, see January, 2009 SAMA submittal	56.11	151.50	Already committed to do, see January, 2009 SAMA submittal
276	Provide an auto start signal for AFW on loss of Standby Feedwater pump.	0.04	0.10	NO	0.04	0.11	NO
279	Provide a permanent tie-in to the construction air compressor.	0.07	0.19	NO	0.08	0.21	NO
280	Add new Unit 2 air compressor similar to the Unit 1 D compressor.	0.08	0.21	NO	0.09	0.24	NO
282	Provide cross-tie to Unit 1 RWST.	0.00	0.00	NO	0.00	0.01	NO

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
285	Improve training to establish feed and bleed cooling given no CCPs are running or a vital instrument board fails	3.38	9.13	No (Remains Potentially cost beneficial)	3.85	10.41	No (Remains Potentially cost beneficial)
292	Improve training to reduce failure probability to terminate inadvertent safety injections prior to water challenge to PORVs	12.96	35.00	No (Remains Potentially cost beneficial)	14.78	39.90	No (Remains Potentially cost beneficial)
295	Increase frequency of containment leak rate testing	0.05	0.14	NO	0.06	0.16	NO
299	Initiate frequent awareness training for plant operators/ maintenance/ testing staff on key human actions for plant risk	9.35	25.24	No (Remains Potentially cost beneficial)	10.66	28.77	No (Remains Potentially cost beneficial)

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
300	Revise procedure FR-H.1 to eliminate or simplify complex (and/or) decision logic for establishing feed and bleed cooling and to improve operator recovery from initial mistakes	0.50	1.35	YES; Requires PWROG approval	0.57	1.54	YES; Requires PWROG approval
303	Move indication/ operator interface for starting hydrogen igniters to front MCR panel	0.03	0.08	NO	0.03	0.09	NO
304	Add annunciator or alarm signaling parameters to initiate hydrogen igniters to front panel on MCR	0.03	0.08	NO	0.03	0.09	NO
305	Revise procedure E-1 to include recovery steps for failure to initiate hydrogen igniters	Not Estimated	NA	NO	Not Estimated	NA	NO

Table 2.a.iv-10 - SAMA RAI 95% CDF Sensitivity Results (Continued)

		SAMA Revised September 2011 Results (External Events Multiplier = 2.0)			SAMA Revised September 2011 Results (External Events Multiplier = 2.28)		
SAMA No.	SAMA Title	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion	Benefit/ Cost Ratio Mean CDF (Base Case)	Benefit/ Cost Ratio 95th%CDF	Change in Conclusion
306	Improve operator performance by enhancing likelihood of recovery from execution errors	Not Estimated	NA	NO	Not Estimated	NA	NO
307	Make provisions for connecting ERCW to CCP 2B-B	0.01	0.01	NO	0.01	0.02	NO

Table 2.a.iv-11 - RAI Revised Evacuation Speed Sensitivity Results

	Base Case (2.2m/s)		Faster Evacuation (3.4m/s)		Slower Evacuation (1.6m/s)	
Case	Total Person-Rem	Economic Cost ($)	Total Person-Rem	Economic Cost ($)	Total Person-Rem	Economic Cost ($)
I. Early	2.96E+06	6.34E+09	2.83E+06	6.34E+09	3.19E+06	6.34E+09
II. Bypass	2.39E+06	5.31E+09	2.35E+06	5.31E+09	2.46E+06	5.31E+09
III. Late	1.09E+06	3.19E+09	1.09E+06	3.19E+09	1.09E+06	3.19E+09
IV. SERF	3.22E+05	5.85E+08	3.16E+05	5.85E+08	3.34E+05	5.85E+08

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
308	Install automatic fire suppression in AB 757-A13 (refueling room)	Reduces frequency of fire scenarios in this room with or without manual suppression success	FIVE contributors	Maximum reduction in CDF is 7.46E-7 corresponding to about $84,000 benefit.	Excessive Implementation Cost
309	Install automatic fire suppression in AB 757-A22 (125v vital battery board room)	Reduces frequency of fire scenarios in this room with or without manual suppression success	FIVE contributors	Maximum reduction in CDF is 8.35E-7 corresponding to about $94,000 benefit.	Excessive Implementation Cost
310	Install automatic fire suppression in AB 786-AR (auxiliary building roof)	Reduces frequency of fire scenarios in this room with or without manual suppression success	FIVE contributors	Maximum reduction in CDF is 3.1E-7 corresponding to about $35,000 benefit.	Excessive Implementation Cost
311	Install automatic fire suppression for the main panels of the main control room CB 755-C12	Reduces frequency of fire scenarios in this room with or without manual suppression success	FIVE contributors	Maximum reduction in CDF is 9.65E-7 corresponding to about $108,000 benefit.	Excessive Implementation Cost

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
312	Install automatic fire suppression in areas of small ignition sources in the turbine building	Reduces frequency of fire scenarios in this room with or without manual suppression success	FIVE contributors	Maximum reduction in CDF is 2.20E-7 corresponding to about $25,000 benefit.	Excessive Implementation Cost
313	Enhance fire department training and carry out drills for the 9 key rooms contributing the most to the sum of the FIVE CDF screening frequencies.	Reduces frequency of fire scenarios with or without manual suppression success	FIVE contributors	Maximum reduction in CDF is the sum of all sequence 4 contributions or 4.59E-6 corresponding to about $516,000 benefit. See note (1)	Already Implemented
314	Enhance training for local control of AFW given station blackout, loss of control air, or fires affecting AFW LCVs.	Reduce probability of losing all secondary heat removal during station blackout.	FIVE contributors	Per Table 15f, SAMAs previously identified are: 70, 73, 79, 282, 285, 299, and 300. SAMAs 285 and 299 previously committed to. Maximum reduction in CDF is the sum of all sequence 4 contributions or 3.89E-6 corresponding to about $437,000 benefit.	Already Implemented

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
315	Upgrade seals or enhance procedures to cooldown RCS before leakage	Reduce probability of significant RCP seal leakage in event of losing all seal cooling and seal injection.	FIVE contributors	Per Table 15e, applicable SAMAs previously identified are: 50, 58, 61, 155, 242, and 260. SAMAs 61 and 155 are already implemented. Maximum reduction in CDF is the sum of all sequence 4 contributions or 2.28E-6 corresponding to about $256,000 benefit.	Already Implemented
316	Reroute offsite power cables away from fire area 737-A1A	Reduce demands on onsite AC power system	FIVE contributors	8kv power cables are expensive and difficult to locate. Maximum reduction in CDF is the sum of all sequence 4 contributions or 4.24e-7 corresponding to about $48,000 benefit.	Excessive Implementation Cost
317	Reroute offsite power cables away from fire area 737-A1B	Reduce demands on onsite AC power system	FIVE contributors	8kv power cables are expensive and difficult to locate. Maximum reduction in CDF is the sum of all sequence 4 contributions or 5.05e-7 corresponding to about $57,000 benefit.	Excessive Implementation Cost

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
318	Reroute offsite power cables away from fire area 737-A1C	Reduce demands on onsite AC power system	FIVE contributors	8kv power cables are expensive and difficult to locate. Maximum reduction in CDF is the sum of all sequence 4 contributions or 2.89e-7 corresponding to about $33,000 benefit.	Excessive Implementation Cost
319	Reroute onsite power cables to either SD BD 2A-A or 2B-B away from fire area 737-A1B	Limit fire impact to just one train of SD BDs when also fail offsite power.	FIVE contributors	2PL6510A & 2PL6512A are the only 6-9kv SDBD 2A-A cables in 737-A1B and they are to be protected with fire wrap for Appendix R. Maximum reduction in CDF is the sum of all sequence 4 contributions or 5.05e-7 corresponding to about $57,000 benefit.	TVA implementation in process
320	Providing nitrogen bottles as accumulators for selected valves would reduce action difficulty. Enhance procedures already implemented, additional training could reduce error rate	Reduce joint human error probability between recovery of AFW given loss of control air (HAFR1) and action to initiate feed and bleed cooling (HAOB2)	FIVE contributors	Per Table 15f, SAMAs previously identified are: 70, 73, 79, 282, 285, 299, and 300. SAMAs 285 and 299 previously committed to. Maximum reduction in CDF is the sum of all sequence 4 contributions or 8.75e-7 corresponding to about $98,000 benefit.	Already Implemented

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
321	Reroute cables in fire area Aux Bldg 757-A22 to preclude failure of both trains of SD BDs (6.9kv SD BD 2B-B and 480v SD BDs on A train)	Limit fire impact to just one train of SD BDs	FIVE contributors	Maximum reduction in CDF is 8.35E-7 corresponding to about $94,000 benefit.	Excessive Implementation Cost
322	Reroute offsite power cables away from Aux Bldg 786-AR - auxiliary building roof	Reduce demands on onsite AC power system	FIVE contributors	8kv power cables are expensive and difficult to locate. Maximum reduction in CDF is 3.1E-7 corresponding to about $35,000 benefit.	Excessive Implementation Cost
323	Enhance procedures for control room fire evacuation and associated procedures to achieve safe shutdown from shutdown panel	Limit potential for operator error following evacuation	FIVE contributors	Plant abnormal operating instructions exits for fires in each room. AOI-30.2C.69 applies to these rooms. Maximum reduction in CDF is 1.23E-6 corresponding to about $138,000 benefit.	Already Implemented
324	Reroute offsite power cables away from turbine building	Reduce demands on onsite AC power system	FIVE contributors	8kv power cables are expensive and difficult to locate. Maximum reduction in CDF is 5.92E-7 corresponding to about $67,000 benefit.	Excessive Implementation Cost

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
325	*Provide an additional diesel generator - 2 MW blackout diesel generators to power charging pumps, igniters, Inverters, etc. SAMA 9 *Revise procedure to allow bypass of DG trips. SAMA 10 *Improve 6.9 kV bus crosstie capability. SAMA 11,229,244 *Cross-tie diesel generators within or to the other units.	Improved reliability of onsite AC power sources. Procedures already modified to add manual cross-tie capabilities	FIVE contributors	Per Table 15e, previously identified SAMAs are: 9, 10, 11, 12, 229, and 244. WBN is purchasing a 2MW blackout diesel generator for Unit 2. SAMAs 10, 11, and 12 are already implemented. Procedures for cross-tying 6.9 kV buses are available but conservatively not credited in the FIVE analyses. It is credited in the SAMA model for internal events. Maximum reduction in CDF is 3.82E-7 corresponding to about $43,000 benefit.	Already Implemented

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
326	*Modify procedure to provide ability to align diesel power to more air compressors. SAMA 86 *Improve reliability of ACAS compressors when AC power is available. SAMA 188 *Provide a permanent tie-in to the construction air compressor. SAMA 279 *Add a new Unit 2 air compressor similar to Unit 1 D compressor. SAMA 280 *Replace the ACAS dryers and compressors. SAMA 281	Improve availability of air system	FIVE contributors	Per Table 15e, SAMAs previously identified include 86, 188, 279, 280, and 281. SAMAs 86, 188, 279 and 280 are not cost effective. Maximum reduction in CDF is 7.22E-7 corresponding to about $81,000 benefit.	Already Implemented. A study has been initiated to see if it is practical to improve ACAS availability (SAMA 281).

Table 4.d-2 RAI SAMAs Identified for 18 Key Fire Scenarios from the FIVE Screening Analysis (Continued)

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
327	Improve reliability of ERCW system failure in response to plant trip or limit the potential for seal leak given loss of all RCP seal cooling.	Pump improvements already implemented. SAMAs identified to limit dependence on ERCW	FIVE contributors	Per Table 15a, SAMAs previously identified are: 46, 53, 56, 62, 155, 158, and 271. SAMAs 46 and 53 are not cost effective. SAMAs 62,155, 158 and 278 are already implemented. Action HAERCW2 has been added to the SAMA model to allow for crosstie of the fire protection water to a failed ERCW system. The action can be accomplished within the 4 hours available for most seal leakage rates. For 480 gpm leak rates no credit is taken for the crosstie. The analysis to extend the time to CCS failure and to implement and refine the analysis is not cost effective. Maximum reduction in CDF is 6.39E-8 corresponding to about $7,000 benefit.	Already Implemented

Note (1)

The fire department at Watts Bar is a dedicated organization that responds to fires on site and maintains the majority of the fire protection equipment. The fire response organization is staffed and equipped for firefighting activities. The fire brigade is comprised of a fire brigade leader and four fire brigade members (minimum). The fire brigade shall not include the Shift Manager or the other members of the minimum shift crew necessary for safe shutdown of the unit, nor any personnel required for other essential functions during a fire emergency. Additional support is available when needed through an agreement with a local fire department (s). The fire brigade composition may be less than the minimum requirements for a period of time not to exceed two hours, in order to accommodate unexpected absence, provided immediate action is taken to fill the required positions.

The fire department already schedules quarterly fire drills for each rotating shift crew in specific fire areas. Each drill includes a formal critique to evaluate the effectiveness of the fire brigade in responding to a simulated fire emergency. The drills conducted have already included 8 of the 9 areas with relatively high screening values in the final FIVE screening analysis. The one area for which no drills have been conducted is AB 786 RA, which has minimal combustibles; i.e., less than 5 minute fire. Both announced and unannounced drills are conduced to fulfill NRC, OSHA, and NEIL training requirements. Abnormal operating instruction series AOI-30.2 is to direct the actions to be carried out for all Appendix R cooldowns. The steps required are listed as a function of the room in which the fire occurs. Further, fire pre-plans are developed for each fire area to facilitate fire fighting. These pre-plans contain the following types of information laid out on an easy to read room diagram; primary and secondary access routes, stairs and fire related barriers, safe shutdown equipment locations, hose stations, installed fire suppression systems, and locked access locations.

Table 5.c-1. October 2010, SAMA Model Release Categories, Frequencies, Doses, and Economic Costs

	Release Category 1 - LERF			Release Category 2 - BYPASS			Release Category 3 - LATE			Release Category 5 - SERF		
SAMA	Freq (per yr)	Dose Risk (man-rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man-rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man-rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man-rem/yr)	Economic Risk ($/yr)
Base	1.26E-06	3.72E+00	$7,971	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,614	3.84E-06	1.23E+00	$2,243
4	1.25E-06	3.70E+00	$7,929	3.45E-07	8.25E-01	$1,832	1.29E-05	1.40E+01	$41,231	3.81E-06	1.23E+00	$2,231
8	1.25E-06	3.71E+00	$7,963	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,608	3.82E-06	1.23E+00	$2,235
26	1.23E-06	3.65E+00	$7,827	3.50E-07	8.37E-01	$1,859	1.28E-05	1.40E+01	$40,944	3.81E-06	1.23E+00	$2,228
32	6.51E-07	1.93E+00	$4,134	3.50E-07	8.37E-01	$1,859	1.30E-05	1.41E+01	$41,506	2.36E-06	7.60E-01	$1,380
45	1.26E-06	3.72E+00	$7,970	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,586	3.83E-06	1.23E+00	$2,241
46	1.25E-06	3.70E+00	$7,924	3.49E-07	8.35E-01	$1,855	8.11E-06	1.36E+01	$39,797	3.77E-06	1.21E+00	$2,203
56	1.18E-06	3.48E+00	$7,459	3.50E-07	8.37E-01	$1,859	1.27E-05	8.82E+00	$25,891	3.21E-06	1.03E+00	$1,880
70	1.25E-06	3.70E+00	$7,936	3.48E-07	8.33E-01	$1,850	1.30E-05	1.38E+01	$40,449	3.79E-06	1.22E+00	$2,214
71	1.26E-06	3.72E+00	$7,971	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,614	3.84E-06	1.23E+00	$2,243
87	1.26E-06	3.72E+00	$7,971	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,592	3.83E-06	1.23E+00	$2,242
93	1.26E-06	3.72E+00	$7,971	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,614	3.84E-06	1.23E+00	$2,243
101	6.14E-07	1.82E+00	$3,896	3.50E-07	8.37E-01	$1,859	1.32E-05	1.44E+01	$42,256	3.84E-06	1.23E+00	$2,243

Table 5.c-1. October 2010, SAMA Model Release Categories, Frequencies, Doses, and Economic Costs (Continued)

SAMA	Release Category 1 - LERF			Release Category 2 - BYPASS			Release Category 3 - LATE			Release Category 5 - SERF		
	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)
103	5.20E-07	1.54E+00	$3,299	3.42E-07	8.17E-01	$1,816	9.85E-06	1.07E+01	$31,464	1.49E-06	4.79E-01	$871
109	6.43E-07	1.90E+00	$4,078	3.50E-07	8.37E-01	$1,859	1.26E-05	1.37E+01	$40,212	3.84E-06	1.23E+00	$2,243
110	9.51E-07	2.82E+00	$6,037	3.50E-07	8.37E-01	$1,859	1.31E-05	1.43E+01	$41,825	3.84E-06	1.23E+00	$2,243
112	1.26E-06	3.72E+00	$7,971	3.42E-07	8.18E-01	$1,816	1.30E-05	1.42E+01	$41,614	3.84E-06	1.23E+00	$2,243
136	1.25E-06	3.71E+00	$7,954	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,611	3.82E-06	1.23E+00	$2,234
156	1.19E-06	3.53E+00	$7,568	3.50E-07	8.37E-01	$1,859	9.70E-06	1.06E+01	$30,988	3.44E-06	1.11E+00	$2,011
176	1.14E-06	3.37E+00	$7,227	2.72E-07	6.50E-01	$1,445	1.05E-05	1.14E+01	$33,523	3.46E-06	1.11E+00	$2,025

Table 5.c-1. October 2010, SAMA Model Release Categories, Frequencies, Doses, and Economic Costs (Continued)

	Release Category 1 - LERF			Release Category 2 - BYPASS			Release Category 3 - LATE			Release Category 5 - SERF		
SAMA	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)
191	1.26E-06	3.72E+00	$7,971	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,614	3.84E-06	1.23E+00	$2,243
215	1.16E-06	3.44E+00	$7,369	3.50E-07	8.37E-01	$1,859	7.78E-06	8.47E+00	$24,856	3.18E-06	1.02E+00	$1,860
226	1.16E-06	3.44E+00	$7,369	3.50E-07	8.37E-01	$1,859	7.78E-06	8.47E+00	$24,856	3.18E-06	1.02E+00	$1,860
255	1.05E-06	3.10E+00	$6,651	1.88E-07	4.50E-01	$1,001	1.05E-05	1.14E+01	$33,373	3.47E-06	1.12E+00	$2,026
256	9.42E-07	2.79E+00	$5,978	2.63E-07	6.28E-01	$1,396	9.77E-06	1.06E+01	$31,211	2.88E-06	9.26E-01	$1,682
276	1.25E-06	3.70E+00	$7,926	3.48E-07	8.32E-01	$1,849	1.30E-05	1.41E+01	$41,368	3.81E-06	1.23E+00	$2,231
279	1.25E-06	3.71E+00	$7,954	3.50E-07	8.35E-01	$1,856	1.28E-05	1.39E+01	$40,768	3.80E-06	1.22E+00	$2,223
280	1.25E-06	3.71E+00	$7,954	3.50E-07	8.35E-01	$1,856	1.28E-05	1.39E+01	$40,768	3.80E-06	1.22E+00	$2,223
282	1.25E-06	3.71E+00	$7,965	3.42E-07	8.18E-01	$1,816	1.30E-05	1.42E+01	$41,614	3.83E-06	1.23E+00	$2,238
285	1.25E-06	3.70E+00	$7,936	3.49E-07	8.34E-01	$1,852	1.30E-05	1.42E+01	$41,605	3.74E-06	1.20E+00	$2,186
292	5.97E-07	1.77E+00	$3,788	3.50E-07	8.37E-01	$1,859	1.29E-05	1.41E+01	$41,266	2.03E-06	6.54E-01	$1,189
295	1.26E-06	3.72E+00	$7,971	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,614	3.89E-09	1.25E-03	$2
299	1.23E-06	3.64E+00	$7,803	3.50E-07	8.37E-01	$1,859	1.19E-05	1.30E+01	$38,156	3.71E-06	1.19E+00	$2,169
300	1.25E-06	3.70E+00	$7,936	3.49E-07	8.34E-01	$1,852	1.30E-05	1.42E+01	$41,604	3.78E-06	1.22E+00	$2,209
303	1.25E-	3.71E+0	$7,964	3.50E-	8.37E-	$1,859	1.30E-	1.42E+0	$41,589	3.84E-	1.23E+0	$2,243

Table 5.c-1. October 2010, SAMA Model Release Categories, Frequencies, Doses, and Economic Costs (Continued)

SAMA	Release Category 1 - LERF			Release Category 2 - BYPASS			Release Category 3 - LATE			Release Category 5 - SERF		
	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)	Freq (per yr)	Dose Risk (man - rem/yr)	Economic Risk ($/yr)
	06	0		07	01		05	1		06	0	
304	1.25E-06	3.71E+00	$7,964	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,589	3.84E-06	1.23E+00	$2,243
305	9.06E-07	2.68E+00	$5,749	3.50E-07	8.37E-01	$1,859	1.29E-05	1.40E+01	$41,199	3.84E-06	1.23E+00	$2,243
306	9.07E-07	2.68E+00	$5,755	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,563	3.79E-06	1.22E+00	$2,218
307	1.26E-06	3.72E+00	$7,969	3.50E-07	8.37E-01	$1,859	1.30E-05	1.42E+01	$41,605	3.84E-06	1.23E+00	$2,243

RAI Response Submittal of May 13, 2011

TVA's responses to items 1 through 16 have been reviewed and concluded to be unchanged by correcting the total person-rem computed for each release category. With regard to item 12 (RAI 5.e), the previous response recognized that SAMA 70 would exceed a cost-benefit ratio of 1.0 if an uncertainty multiplier of 2.78 were assumed. This exceedance is now slightly greater because of the change correcting the total person-rem computed for each release category. This SAMA 70 has, however, been superseded by TVA's commitment to implement SAMA 339.

The list of commitments in enclosure 2 is also unchanged.

RAI Response Submittal of May 25, 2011

TVA's responses to items 2 through 3 have been reviewed and concluded to be unchanged by correcting the total person-rem computed for each release category.

The TVA response to item 5 has been reviewed and some discussion is offered to the response for part b. Correcting the total person-rem computed for each release category required a change to the maximum averted cost risk (MACR). The changes offered caused the SAMA 93 cost benefit ratio to go from just below 1.0 to slightly greater than 1.0 for the CDF 95th percentile sensitivity case. However, the potential benefits of implementing SAMA 93 are also addressed by SAMA 58. Hence, the existing commitment in enclosure 2 to the May 25, 2011 submittal adequately addresses this potentially cost beneficial SAMA.

Furthermore, the next highest benefit-cost ratio SAMA in the revised Table 2.a.iv-10, is SAMA 255 with a 95th percentile ratio of 0.70. If the 2.78 95th percentile multiplier is used instead of the 2.7, then SAMA 255 would have a benefit-cost ratio of 0.72. Therefore, all remaining SAMAs are well below the 1.0 benefit-cost ratio using the 2.78 95th percentile multiplier and no other SAMA conclusions would change.

Part f of item 5 gives a breakdown of contributions to the MACR. This table is updated and presented below as Table 2.a.iv.f.

The response to item 15 (RAI 6) also involves changes to Tables 15-1 and 15-2. The updated tables are presented below. Table 15-3 summarizes a Phase 1 rescreening of the SAMAs which were screened because of Excessive Cost of Very Low Benefit. Table 15-3 has been reviewed in light of correcting the total person-rem computed for each release category and the conclusions found to be unchanged.

The list of commitments in enclosure 2 is also unchanged.

Table 2.a.iv-f from May 25, 2011 Submittal

Cost Category	October 2010, SAMA Report	Revised September, 2011 (RAI) SAMA Results
Off-Site Exposure Cost $	$514,379	$535,803
Off-Site Economic Cost $	$466,032	$720,324
On-Site Exposure Cost $	$8,153	$8,153
On-Site Economic Cost $	$666,023	$666,023
Total Base Cost $	$1,654,587	$1,930,303
Base Cost with External Event Multiplier 2.0	**$3,309,174**	**$3,860,606**
Base Cost with External Event Multiplier 2.28	**$3,772,461**	**$4,401,090**

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

Cost Description	Revised September, 2011 (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	$ 3,860,606	$1,347,351	34.9%	$2,513,254	65.1%
Base Cost with External Event Multiplier 2.28	$4,401,090	$1,535,981	34.9%	$2,865,110	65.1%
95% Cost with External Multiplier 2.0 (95% Multiplier 2.70)	$10,423,635	$3,637,849	34.9%	$6,785,786	65.1%
95% Cost with External Multiplier 2.28 (95% Multiplier 2.70)	$11,882,944	$4,147,147	34.9%	$7,735,796	65.1%

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%	$11,882,944
2	Fixed	Changed	Fixed	Fixed	13.2%	$1,564,242
3	Fixed	Fixed	Changed	Fixed	48.6%	$5,779,353
4	Fixed	Fixed	Fixed	Changed	3.3%	$389,118
5	Changed	Changed	Fixed	Fixed	16.4%	$1,952,178
6	Changed	Fixed	Changed	Fixed	75.1%	$8,927,170
7	Changed	Fixed	Fixed	Changed	11.1%	$1,315,493

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.	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
				For a plant with significant construction already completed, the estimated cost of 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-	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	Not Feasible to implement inside containment due to limited space available. Will also screen on Excessive 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
		term post-LOCA recirculation.		suppression and raise post accident water level with additional post accident water level flooding issues.	
37	Upgrade the chemical and volume control system to mitigate small LOCAs.	For a plant like the Westinghouse AP600, where the chemical and volume control system cannot mitigate a small LOCA, an upgrade would decrease the frequency of core damage.	NEI 05-01 (Rev A)	Basis for Screening: For a plant with 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.	Excessive 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	Allows low pressure emergency core cooling	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed,	Excessive Implementation

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	depressurization system.	system injection in the event of small LOCA and high-pressure safety injection failure.		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. Cost would exceed $2M and benefit would be much less than 10% reduction in CDF.	Cost. (Table 15-2 Case 1)
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	Increased reliability of decay heat removal.	NEI 05-01 (Rev A)	Basis for Screening: Implementation of this SAMA requires a flow path around the	Excessive Implementation

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	that it can be used as a backup to the emergency feedwater system, including during a station blackout scenario.			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 grade isolation valves (or alternate power source to reopen valves and power pumps). Potential change is less than 50% of CDF.	Cost. (Table 15-2 Case 1)
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:	Increased decay heat removal capability for non-ATWS events, with scrubbing of released	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	Excessive Implementation Cost. (Table 15-2 Case 3)

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	Gravel Bed Filter Option 2: Multiple Venturi Scrubber	fission products.		nuclear power plants) would not reduce all of the LATE consequences and would result in a benefit of less than 50% reduction in LATE.	
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 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.	Excessive Implementation Cost. (Table 15-2 Case 2)
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	Increased cooling and containment of molten core	NEI 05-01 (Rev A)	Basis for Screening: For a plant with significant construction already completed,	Excessive Implementation

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	system.	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.		the estimated cost of implementation ($90,000,000, representative of similar nuclear power plants) would exceed the bounding benefit.	Cost. (Table 15-2 Cases 2 and 3)
99	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	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 the bounding benefit.	Excessive Implementation Cost. (Table 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	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)

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	vacuum.				
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 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	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
				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)	
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)
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	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)

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	rupture would not cause the relief valves to lift.				
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 most of the fission products.	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 drops and remain inside the current safety analysis would be costly. SGTR IE reduction in CDF is very small.	Excessive Implementation Cost. (Table 15-2 Case 5)
126	Install a highly reliable (closed loop) steam generator shell-side	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	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
	heat removal system that relies on natural circulation and stored water sources			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.	
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 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	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
				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 form of an additional EDG.	Vogtle	Basis for Screening: The cost of installing an additional EDG has been estimated to be greater than $20 million in the Calvert Cliffs Application for License Renewal. It	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
		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.		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.	
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	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
		possible to provide adequate core cooling in 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	IPE	Basis for Screening: The cost to refurbish, complete and license the spare 5th DG was estimated at ~2 to 3 million in 1996. Currently the cost is estimated at $7 million plus labor. 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)

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
		AOI 35, "Loss of Offsite Power."			
270	Delay containment spray operation relative to phase B conditions.	From a severe accident point of view, one potential 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	IPE	Basis for Screening: The current Watts Bar design basis calculations require sprays to 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.	Excessive Implementation 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
		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 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	Probability taken from analysis of Sequoyah in	CAFTA IPE	Basis for Screening: For a plant with significant construction already completed,	Excessive Implementation

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	leg failure prior to Vessel breach given no temperature induced SGTR	NUREG/CR-4551		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.	Cost. (Table 15-2 Case 5)
288	Reduce 5.14E-2 probability of temperature induced SGTRs for 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)
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	Probabilities taken from NUREG/CR-6427	CAFTA IPE	Basis for Screening: For a plant with significant construction already completed, the estimated cost of implementation	Excessive Implementation Cost. (Table

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	explosions causing early containment failure			would exceed the bounding benefit. A fundamental change in Reactor vessel cavity design would be needed to materially change this probability.	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 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.	Very Low Benefit. (Table 15-2 Case 1)
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	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
				considered further. This SAMA is considered cost prohibitive relative to the potential benefit.	
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 seal LOCA.	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. 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.	Very Low Benefit. (Table 15-2 Case 1)
53	On loss of essential raw cooling water, proceduralize shedding component cooling water loads to extend the component cooling	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.	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
	water heat-up time.			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.	
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 means of ventilation.	Increased availability of components dependent on room cooling.	NEI 05-01 (Rev A)	Basis for Screening: Provisions for compensatory ventilation is in place for the 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.	Very Low Benefit. (Table 15-2 Case 1)
81	Add a diesel building high	Improved diagnosis of a loss of diesel building	NEI 05-01 (Rev A)	Basis for Screening: The diesel generator building is manned during DG starts, and	Very Low Benefit. (Table

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	temperature alarm or redundant louver and thermostat.	HVAC.		shiftly operator rounds take temperature measurements per SI-2. Therefore this SAMA is considered very low benefit.	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 break point will be covered with water.	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 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.	Very Low Benefit. (Table 15-2 Case 2)
124	Provide improved	Improved mitigation of	NEI 05-01	Basis for Screening: In the latest model,	Very Low

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	instrumentation to detect steam generator tube ruptures, such as Nitrogen-16 monitors.	steam generator tube ruptures.	(Rev A)	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.	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. 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	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
				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. much greater than $700k) would exceed the bounding benefit.	Excessive Implementation Cost. (Table 15-2 Case 1)
167	Enhance air return fans (ice condenser containment).	Provide an independent power supply for the air return fans, potentially reducing containment	Cook	Basis for Screening: 10 CFR 50.44 analysis shows these fans are a negligible contribution to the containment's ability to handle a hydrogen burn. Therefore this	Very Low Benefit. (Table 15-2 Cases 2 and 3)

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
		failure probability during SBO sequences.		SAMA is considered very low benefit.	
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	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)

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
		pump failure.			
262	Provide connections for centrifugal charging pumps to the ERCW system.	A potential improvement that could be evaluated is 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.	IPE	Basis for Screening: The potential improvement was evaluated and there is low benefit to aligning a second charging pump to ERCW.	Very Low Benefit. (Table 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	Additional training may	CAFTA	MD and TD AFW pump isolation test	Very Low

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
	for MD AFW pump train A or B isolation tests	reduce assigned error rate	IPE	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 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.	Benefit. (Table 15-2 Case 1)
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)

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

SAMA Number	SAMA Title	SAMA Discussion	Source	Phase I Comments	Disposition
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)
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	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	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
	pump isolation valves			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	

RAI Response Submittal of June 17, 2011

TVAs responses in this submittal to items 1,2, 3 and 5 have been reviewed and concluded to be unchanged by correcting the total person-rem computed for each release category.
The response to item 4 is updated below in the form of revised tables to account for correcting the total person-rem computed for each release category. The methodology confirmed in the response is again confirmed here. However, the changed total person-rem computed for each release category does affect the tables provided in this response. Changes to Tables 2.a.iv-4, 2.a.iv-6 and 2.a.iv-4a are provided below. The updated tables account for the corrected person-rem values, a correction to the source term consequences for case Early 1B and a very minor change to the consequence results for Early case 1A.

Table 2.a.iv-4 - RAI Revised Source Terms for Eleven Release Category Cases

Case	Noble	I	Cs	Te	Ba	Sr	Ru	La	Ce	Frequency
Early 1A	8.5E-01	2.2E-02	1.5E-02	1.7E-02	9.1E-03	1.4E-02	9.5E-03	8.4E-03	9.2E-03	35.0%
Early 1B	8.5E-01	1.0E-02	9.0E-03	1.3E-02	8.1E-03	1.4E-02	9.3E-03	8.1E-03	8.1E-03	30.0%
Early 2A	8.5E-01	1.3E-01	7.1E-02	5.5E-02	1.8E-02	1.6E-02	1.0E-02	1.1E-02	1.9E-02	20.0%
Early 2B	8.5E-01	3.2E-01	1.7E-01	1.3E-01	3.4E-02	1.9E-02	1.1E-02	1.6E-02	3.7E-02	15.0%
Bypass	8.5E-01	9.0E-02	4.9E-02	3.6E-02	1.1E-02	1.1E-02	7.2E-03	7.5E-03	1.2E-02	100.0%
Late 1A	8.5E-01	1.1E-02	6.7E-03	7.1E-03	2.7E-03	4.6E-03	2.5E-03	2.3E-03	2.8E-03	6.6%
Late 1B	8.5E-01	5.3E-03	3.7E-03	5.5E-03	2.6E-03	4.7E-03	2.5E-03	2.3E-03	2.6E-03	30.0%
Late 2A	8.5E-01	7.4E-03	4.8E-03	6.0E-03	2.5E-03	4.6E-03	2.5E-03	2.2E-03	2.6E-03	3.4%
Late 2B	8.5E-01	1.7E-02	9.2E-03	9.3E-03	3.3E-03	4.8E-03	2.5E-03	2.5E-03	3.4E-03	60.0%
SERF 1	8.5E-03	2.4E-04	2.6E-04	2.9E-04	3.0E-04	3.4E-04	3.2E-04	3.1E-04	3.0E-04	80.0%
SERF 2	8.5E-03	2.7E-03	2.1E-03	1.8E-03	1.6E-03	1.5E-03	1.5E-03	1.5E-03	1.6E-03	20.0%

Table 2.a.iv-6 - RAI Revised Doses and Economic Consequences for Eleven Release Category Cases

Case	Total Person-Rem	Economic Cost, $
Early 1A	2.20E+06	4.66E+09
Early 1B	1.96E+06	4.23E+09
Early 2A	3.74E+06	7.97E+09
Early 2B	5.68E+06	1.23E+10
Bypass	2.39E+06	5.31E+09
Late 1A	1.09E+06	2.97E+09
Late 1B	8.99E+05	2.77E+09
Late 2A	9.52E+05	2.83E+09
Late 2B	1.19E+06	3.45E+09
SERF 1	2.47E+05	2.96E+08
SERF 2	6.21E+05	1.74E+09

Table 2.a.iv-4a - RAI Revised Weighted Source Terms for Four Release Category Cases

Case	Noble	I	Cs	Te	Ba	Sr	Ru	La	Ce
Early	8.5E-01	8.4E-02	4.7E-02	4.0E-02	1.4E-02	1.5E-02	9.9E-03	1.0E-02	1.5E-02
Bypass	8.5E-01	9.0E-02	4.9E-02	3.6E-02	1.1E-02	1.1E-02	7.2E-03	7.5E-03	1.2E-02
Late	8.5E-01	1.3E-02	7.2E-03	7.9E-03	3.0E-03	4.7E-03	2.5E-03	2.4E-03	3.1E-03
SERF	8.5E-03	7.3E-04	6.3E-04	6.0E-04	5.6E-04	5.8E-04	5.5E-04	5.5E-04	5.6E-04

RAI Response Submittal of June 27, 2011
The answer provided in this submittal is unchanged by correcting the total person-rem computed for each release category.