NEXTera ENERGY SEABROOK

April 18, 2011

SBK-L-11067
Docket No. 50-443

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Seabrook Station
Response to Request for Additional Information
NextEra Energy Seabrook License Renewal Application

References:

1. NextEra Energy Seabrook, LLC letter SBK-L-10077, "Seabrook Station Application for Renewed Operating License," May 25, 2010. (Accession Number ML101590099)

2. NRC Letter "Request for Additional Information for the Review of the Seabrook Station License Renewal Application-SAMA Review (TAC NO. ME3959) November 16, 2010. (Accession Number ML 103090215)

3. NextEra Energy Seabrook, LLC letter SBK-L-11001, "Seabrook Station Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Application," January 13, 2011. (Accession Number ML 110140810)

4. NRC Letter "Schedule Revision and Request for Additional Information for the Review of the Seabrook Station License Renewal Application Environmental Review (TAC Number ME3959) March 4, 2011. (Accession Number ML 110590638)

In Reference 1, NextEra Energy Seabrook, LLC (NextEra) submitted an application for a renewed facility operating license for Seabrook Station Unit 1 in accordance with the Code of Federal Regulations, Title 10, Parts 50, 51, and 54.

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In Reference 2, the NRC requested additional information in order to complete its review of the License Renewal Application. In Reference 3, NextEra submitted its responses to the staff's RAIs. In reference 4 the staff identified areas where additional information is necessary to complete the SAMA review. The Enclosure contains the NextEra Energy Seabrook response to the NRC request for additional information dated March 4, 2011. There are no new or revised commitments made in this submittal.

The License Renewal Application, Appendix E, page F-6 contains a list of acronyms used in these responses. If there are any questions or additional information is needed, please contact Mr. Richard R. Cliche, License Renewal Project Manager, at (603) 773-7003.

If you have any questions regarding this correspondence, please contact Mr. Michael O'Keefe, Licensing Manager, at (603) 773-7745.

Sincerely,

NextEra Energy Seabrook, LLC.

Paul Freeman
Site Vice President

Enclosure

cc:

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NEXTera ENERGY SEABROOK

I, Paul O. Freeman, Site Vice President of NextEra Energy Seabrook, LLC hereby affirm that the information and statements contained within are based on facts and circumstances which are true and accurate to the best of my knowledge and belief.

Sworn and Subscribed

Before me this

18th day of April, 2011

Paul O. Freeman
Site Vice President

Shirley Sweeney
Notary Public

SHIRLEY SWEENEY
MY COMMISSION EXPIRES NOV. 18, 2014
NOTARY PUBLIC
NEW HAMPSHIRE

Enclosure to SBK-L-11067

NextEra Energy Seabrook
Responses to Supplementary NRC Request for Additional Information
Regarding
Severe Accident Mitigation Alternatives Analysis

SAMA Supplemental RAI 1

The responses to RAI 1.f and 2.e state that Tables F.3.1.1.1-2 and F.3.2.1-2 consider initiating events. However, Tables F.3.1.1.1-2 and F.3.2.1-2 show only basic events, and so it is not clear how initiating events are explicitly considered in the importance analysis. For example, the most dominant initiating event contributor according to the listing in Table F.3.1.1.1-1 is loss of offsite power due to weather (LOSPW), but there appears to be no corresponding event in Tables F.3.1.1.1-2 or F.3.2.1-2. Additionally, the responses to RAI 1.f and 2.e state that Attachment F.A describes a number of SAMA probabilistic risk assessment (PRA) cases that specifically addressed initiating events. While this is the case, it is unclear if all of the dominant initiating events in Table F.3.1.1.1-1 are addressed. For example, while Attachment F.A describes "NOLOSP" as the modeling case used to determine the benefit of eliminating all Loss of Off-Site Power (LOSP) events, none of the SAMAs evaluated using this case (i.e., SAMAs 13, 14, 16, 24, and 156) specifically addressed initiating event FLLP, "Flood in Turbine Building (causing LOSP)." Other examples from Attachment F.A are PRA cases "FIRE1" and "FIRE2," which are the PRA model cases used to determine the benefit of eliminating control room induced LOCA and fire in Turbine Building causing loss of power to emergency buses, respectively. Neither of these modeling cases addresses the specific scenario of a fire in Switchgear Rooms A or B and no SAMAs were identified or developed to specifically address fire in Switchgear Rooms A and B. Please provide an explanation, including a table, which correlates SAMA candidates to each of the risk-important initiating events and identifies whether there are any potentially lower cost plant-specific SAMA candidates for the specific initiating events identified. Include, as an example, a demonstration in Tables F.3.1.1.1-2 and F.3.2.1-2 of how LOSPW is considered.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 1

As noted in the Seabrook responses to RAIs 1.f and 2.e (Reference 3), the determination of basic event risk reduction worth (RRW) presented in Tables F.3.1.1.1-2 and F.3.2.1-2 (Reference 1) specifically includes consideration of all initiating events listed in Table F3.1.1.1-1 (Reference 1). For example, the initiator contributing the most to CDF in Table F.3.1.1.1-1 is LOSPW – weather-related loss of offsite power. Among the components that are important for mitigating LOSPW are the turbine-driven EFW pump and the EDGs, as demonstrated in the basic event RRW listing of Tables F.3.1.1.1-2 and F.3.2.1-2. The RRW of the basic events associated with the turbine-driven EFW pump and EDG considers all initiating events where these basic events are credited for mitigation. This includes as an example, all loss of offsite power events including; loss of offsite power due grid-related events (LOSPG, loss of offsite power due to hardware or maintenance (LOSPP) or loss of offsite power as a result of turbine building flooding (FLLP). Therefore the basic event SAMA review performed in RAI 5.b of Reference 3 specifically includes consideration of initiating events for which the basic event is credited for mitigation.

Table 1A is provided below to correlate possible SAMA candidates to the top ten risk-important initiating events and identify whether there are any potentially lower cost plant-specific SAMA candidates for these specific initiating events. Based on the Table 1A assessment, no additional cost-beneficial SAMA candidates are identified.

Table X-1 SAMA Assessment of Top 10 Initiating Events

Initiating Event	Initiator Description	CDF	Associated SAMA(s)	PRA Case(s)	Assessment	Disposition
#1 - LOSPW	Loss of offsite power due to weather-related events	10.0 %	#2 – Replace lead-acid batteries with fuel cells #9 – Provide an additional diesel generator (complete - SEPS) #10 – Bypass DG trips (complete - non-essential trips bypassed during emergency start) #13 – Install additional buried offsite power source #14 – Install gas turbine #16 – Improve uninterruptible power supplied #20 – Add new backup source of diesel cooling #24 – Bury offsite power lines #154 – Modify SEPS to accommodate auto bus alignment and loading #155 – Install swing DG (complete – SEPS) #156 – Alternate offsite source, bypass switchyard #160 – SF6 enhancements (complete) #161 – EDG alternate cooling water source #190 – Add synchronization capability to SEPS DG Basic event SAMAs addressed in Tables X-3 through X-7 also apply to this initiating event.	NOLOSP	NOLOSP $335K (nom. benefit) $638K (UB benefit) OECR Red: ~43%	The NOLOSP case conservatively maximizes the benefit by assuming that the core damage risk contribution from weather (LOSPW), grid (LOSPG) and plant (LOSPP) loss of offsite power events is eliminated.
				NOSBO	$155K (nominal benefit) $295K (UB benefit) OECR Red: ~14%	The NOSBO case conservatively maximizes the benefit by assuming that the emergency AC power supplies (EDGs) do not fail. NOSBO SAMAs are not cost beneficial based on assumed elimination of all EDG failures SAMAs #9, #10, #155 and #160 have already been addressed by Seabrook. The remaining SAMA candidates are judged to be not cost beneficial and are not sensitive to an increase in seismic risk as addressed below in RAI 4. It is noted that Seabrook Station is nearing completion of a multi-phase, multi-million dollar, comprehensive project to improve the reliability of the electrical switchyard. These switchyard upgrades will enhance the reliability of offsite power and should result in an overall reduction in loss of offsite power initiating event frequency.

Table X-1 SAMA Assessment of Top 10 Initiating Events

Initiating Event	Initiator Description	CDF	Associated SAMA(s)	PRA Case(s)	Assessment	Disposition
#2 - RXT1	Reactor trip with condenser available	6.4%	SAMA - Improve overall Seabrook Station reliability; reduce potential for plant trip initiating event frequency or reliability of mitigation systems to plant trip. Basic event SAMAs addressed in Tables X-3 through X-7 apply to this initiating event.	RXT1	$41K (nominal benefit) $77.3K (UB benefit) OECR Red: ~4% Cost: >$250K	Modifications to reduce/eliminate reactor trip risk are judged not cost beneficial based on assumed complete elimination of initiator RXT1. The cost benefit is not sensitive to the assumed increase in seismic risk evaluated below in RAI 4. It is noted that Seabrook Station is nearing completion of a multi-phase, multi-million dollar project to install a digital feedwater control system and digital electro-hydraulic control system. These upgrades will replace obsolete components and enhance the reliability of the existing control systems and should result in an overall reduction in reactor trip initiating event frequency.
#3 – E7T	Seismic 0.7g transient event	6.3%	Reduce/eliminate impact of 0.7g seismic event (PRA Case E7T). #181 – Improve relay chatter fragility #182 – Improve seismic capacity of EDGs and EFW Basic event SAMAs addressed in Tables X-3 through X-7 apply to this initiating event.	E7T SEISMIC01 SEISMIC02	$31.2K (nom. benefit) $59.3K (UB benefit) OECR Red: ~2% Cost: >$500K $102.4K (nom. benefit) $195K (UB benefit) OECR Red: ~17% <$1K (nom. benefit) <$1K (UB benefit) OECR Red: 0%	PRA Case E7T conservatively assumes complete elimination of this initiating event. E7T contributes 6.3% of the total CDF. Based on the conservative PRA case, modifications to eliminate or reduce this contribution are judged not cost beneficial. The cost benefit is not sensitive to the assumed increase in seismic risk evaluated below in RAI 4.
#4 – LOSPG	Loss of offsite power due to grid-related events	6.2%	Refer to #1	Refer to #1	Refer to #1	LOSPG included in NOLOSP, therefore refer to #1
#5 - E10T	Seismic 1.0g transient event	5.9%	Refer to #3	Refer to #3	Refer to #3	E7T bounds E10T; therefore refer to #3

Table X-1 SAMA Assessment of Top 10 Initiating Events

Initiating Event	Initiator Description	CDF	Associated SAMA(s)	PRA Case(s)	Assessment	Disposition
#6 LOSPP	Loss of offsite power due to plant hardware or maintenance	5.6%	Refer to #1	Refer to #1	Refer to #1	LOSPP included in NOLOSP, therefore refer to #1
#7 FLLP	Flood in turbine building - LOSP	4.2%	#183 – Turbine building internal flooding improvements. Protect relay room from potential impact from HELB (a) Basic event SAMAs addressed in Tables X-3 through X-7 apply to this initiating event.	F4TREL	#183 Improvements have been addressed $22K (nom. benefit) $41.8K (UB benefit) OECR Red: ~2% Cost: >$100K	Plant improvements related to SAMA #183 were identified via the Seabrook IPE (1991). As a result improvements to the turbine building flood alarms and operator response have occurred since the IPE. Procedure OS1238.02, Turbine Building Flooding, was improved to include specific operator actions and required timing to mitigate a major flood event as a result of postulated failure of a CW system expansion joint. Actions are initiated based on flood alarms: condenser pit flood hi level alarm, condenser pit flood hi-hi level alarm, and turbine building sump no. 1 level hi-hi alarm. Other indications include loss of condenser vacuum and reports of circulation water flooding conditions in the turbine building. For a major flood event, actions include tripping the reactor, opening the turbine building rollup doors, closing doors to the relay room and emergency switchgear room E5 (these doors are normally closed) and tripping CW pumps. (a) The preliminary SSPSS2010 model, which includes the latest internal flood model and insights, was reviewed as part of this RAI response. The dominant TB flood event is postulated HELB impact to the relay room. Based on PRA case F4TREL, no additional potentially cost beneficial SAMAs are identified to reduce TB flood risk and this result is not sensitive to the increase in seismic risk.
#8 LACPB	Loss of Train B essential AC power (4kV Bus E6)	4.1%	Improve Bus E6 reliability, eliminate potential for bus fault.	E6S	$39K (nom. benefit) $74.1K (UB benefit) OECR Red: ~2% Cost: >$200K	Evaluated in Reference 3, RAI 2.f, item #15 in Table RC LL3, basic event EDESWG6.FX. The E6S PRA case assumes no failures of Bus E6 that would cause an initiating event during power operation, and no failures of Bus E6 as a support system. SAMA candidate not cost beneficial based on benefit when assuming elimination of all Bus E6 faults verses SAMA estimated cost and this result is not sensitive to the increase in seismic risk.

Table X-1 SAMA Assessment of Top 10 Initiating Events

Initiating Event	Initiator Description	CDF	Associated SAMA(s)	PRA Case(s)	Assessment	Disposition
#9 SGTR	Steam Generator tube rupture	4.0%	#119 – Institute maintenance practice to perform 100% inspection of SG tubes during each refueling #121 – Increase pressure capacity of secondary side so that a SG tube rupture would not cause the relief valves to lift #125 – Route discharge from the MS safety valves through a structure where water spray would condense steam and remove fission products #126 – Install a highly reliable (closed loop) SG shell-side heat removal system #129 – Vent MS safety valves in containment Basic event SAMAs addressed in Tables X-3 through X-7 also apply to initiating events.	NOSGTR	$86.1K (nom. benefit) $164K (UB benefit) OECR Red: ~14% Cost: >$500K	SAMA candidates are not cost beneficial based on benefit when assuming elimination of all SGTR events verses SAMA estimated costs and this result is not sensitive to the increase in seismic risk as addressed below in RAI 4.
#10 FSGBE6	Fire Switchgear B – Loss of Bus E6	2.6%	Improve/reduce the core damage frequency contribution of Switchgear Room B fire events. Basic event SAMAs addressed in Tables X-3 through X-7 also apply to initiating events.	FSGBE6	$14.4K (nom. benefit) $27.6K (UB benefit) OECR Red: ~1% Cost: >$100K	SAMA PRA case eliminates fire initiator FSGBE6, fire in Switchgear B resulting in loss of electrical bus E6, to conservatively assess the benefit of possible SAMAs to reduce the fire frequency and core damage consequence. FSGBE6 is not a significant contributor to CDF. As stated in RAI 1i of reference 3, the fire ignition frequency for scenario FSGBE6 is based on the total ignition frequency for Bus E6 (21 cubicles) and other electrical cabinets (86 cabinets) located in the "B" switchgear room. Bus E6 cabinets are a fixed combustible and fire within the bus is assumed to fail the bus. Other electrical cabinets located in the switchgear room are also a fixed combustible. Fire in these other cabinets has a potential to raise the room temperature and jeopardize operation of the various electrical components within the room. Switchgear Room B is separated from Switchgear Room A with a 3 hour fire barrier. Given the safety system electrical separation, it is concluded that there are no practical, cost-beneficial SAMAs that would significantly reduce the fire risk contribution of FSGBE6. This conclusion is also relevant for initiator FSGAE5 in Switchgear Room A (Bus E5) and is not sensitive to the increase in seismic risk as addressed below in RAI 4.

SAMA Supplemental RAI 2a

Concerning the NextEra response to staff RAI 3.b:

a. Relative to the FIVE fire risk analysis methodology, clarify if fire-induced failures of components or human actions credited for mitigating the initiator are assessed, given that the initiator is now fire-induced (including identifying either new components or actions to be modeled or requantifying the random failure probabilities of previously modeled ones). In addition, clarify if hot shorts are considered and, if so, what probabilities are assigned to these. If the assigned probabilities are not bounded by currently accepted values (e.g., best estimates of 0.3 and 0.6, respectively, for intra-cable hot shorts for circuits protected vs. not protected by control power transformers in Tables 10-1 through 10-5 of NUREG/CR-6850 [2005], which are based on Electric Power Research Institute (EPRI) 1006961 [2002]), either provide a technical basis for the values assumed (such as circuit analysis) or perform a sensitivity evaluation using the currently accepted values to determine the effect on the potential cost-benefit of the SAMAs.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 2a

Fire initiators that are not screened are evaluated in detail to determine fire sequences and to quantify associated core damage. The quantification of fire-induced events considers the following:

- Fire ignition frequency (events/year)
- Fire severity factor for the specific source
- Conditional probability of target damage given a fire, depending on the presence of the combustible in the critical location and on the success of suppression
- Probability of additional failures needed for core damage; this includes unavailability of redundant systems/components, failure of operator actions and recovery actions.

Components that are not impacted by the fire are modeled as random, subsequent failures. For example, fire initiating event FSGBE6 is a fire in SWGR-B, which causes an assumed guaranteed loss of Emergency Bus 6 (Train B). Subsequent random failures, which must also occur to achieve core damage include failures of Train A support system components, such as AC power, service water, PCCW. No new components or actions are identified for re-quantification.

As mentioned in the RAI 3b response, fire initiating events are reviewed in detail and some were screened based on their total fire event frequency compared to the frequency of modeled internal events having similar consequence. The total fire event frequency considers the event ignition frequency, severity factor and probability for hot short initiation (for example, a hot short that would cause inadvertent opening of a PORV causing a small LOCA event). A hot short probability of 0.1 was assigned in the Seabrook screening evaluation for important valves and components. An evaluation using a hot short probability of 0.6 was performed to assess the sensitivity of a change in hot short potential on the quantitative screening of fire events. Based on this evaluation, screening of fire events is relatively insensitive to a hot short probability in the range of 0.1 to 0.6. Although the

total frequency for each applicable fire event increases due to the increase in hot short potential, their contribution compared to the frequency of similarly modeled internal events is still relatively low. For example, the frequency of a specific fire event in the East Main Steam Feedwater Pipe Chase resulting in an inadvertent ASDV opening contributes less than 20% of the modeled internal events frequency of steam line break which has the same plant impacts.

A total of 18 fire events were evaluated for sensitivity to the increase in hot short potential. The results of the sensitivity evaluation are summarized below. Based on the sensitivity evaluation, the increase in hot short potential is judged not to have a significant effect on the cost-benefit of other SAMAs.

Number of Fire Events That Include Hot Shorts	**Contribution to Modeled Internal Events**	**SAMA Disposition**
3 of 18	10% to 20%	The 3 fire events that increase are related to inadvertent opening of an ASDV (steam line break). SAMA case NOSLB evaluated the benefit of complete elimination of steam line break contribution to risk. The result of this case are: $3.1K (nom. benefit) $6.0K (UB benefit) OECR Red: ~0% Based on the conservative assessment, the benefit of complete elimination of SLB risk is very low. Therefore, no new SAMAs are identified relative to fire events and the increase in hot short potential is judged not to have a significant effect on the cost-benefit of other SAMAs. This result is not sensitive to the assumed increase in seismic risk evaluated in RAI 4.
15 of 18	<10%	These events would continue to contribute only a small fraction (less than 10%) to the frequency of initiating events already modeled in the PRA. These initiators would not have a significant impact on the SAMA results. Therefore, the increase in hot short potential is judged not to have a significant effect on the cost-benefit of other SAMAs.

SAMA Supplemental RAI 2b

Concerning the NextEra response to staff RAI 3.b:

b. Relative to the Fire-induced interfacing system loss-of-coolant accident (ISLOCA) & Containment Impact section. For the "only area where isolation valves both inside and outside containment could be affected," clarify how "important isolation valves [that] could be controlled locally at the valve" would be so controlled for valves inside containment during operation. For the letdown system and its "several; fail closed air-operated valves (AOVs)," clarify the basis for the statement "it is not credible for all three valves to hot short." For "isolation failure of one or more valves of a single train," clarify the statement "the ability to remove power from fail closed valves to provide isolation" and the case for failed open valves due to hot shorting (which could not be de-powered?).

NextEra Energy Seabrook Response to SAMA Supplemental RAI 2b

RAI regarding:

> *For the "only area where isolation valves both inside and outside containment could be affected," clarify how "important isolation valves [that] could be controlled locally at the valve" would be so controlled for valves inside containment during operation.*

Seabrook Response: Local control of valves applies to isolation valves located outside containment; these valves could be controlled locally or from the Remote Shutdown Panel. Valves located inside containment could be controlled at the Remote Shutdown Panel. No credit is taken for local control of valves inside containment.

RAI regarding:

> *For the letdown system and its "several; fail closed air-operated valves (AOVs)," clarify the basis for the statement "it is not credible for all three valves to hot short."*

Seabrook Response: It is judged not credible for all of the letdown isolation valves to hot short <u>and remain open</u> for an extended time. Letdown isolation capability is provided by several redundant valves including one AOV outside containment and three AOVs inside containment. All four AOVs fail to the closed position upon loss of air or loss of control power. Shorts to ground of control cables for AOVs or SOVs will move the valve to its failed position just as loss of control power to the circuit. There are also two MOVs inside containment, which could be available for isolation.

RAI regarding:

> *For "isolation failure of one or more valves of a single train," clarify the statement "the ability to remove power from fail closed valves to provide isolation" and the case for failed open valves due to hot shorting (which could not be de-powered?).*

Seabrook Response: The assessment of fire-induced impact on containment isolation concluded that, for isolation failure of one or more valves of a single train, either redundant isolation would be available or the ability to remove power from fail closed valves to provide isolation is available. The ability to remove power from failed closed valves is based on the consideration that, for the subset of control power hot short events that maintain control power to the AOV/SOV, the AOV/SOV can be de-energized by removal of its divisional power supply. This is a reasonable consideration given the plant's divisional cable separation design. Thus, the overall conclusion reached in the review of fire-induced impact on containment is that the frequency of fires that could cause sufficient damage to fail containment isolation is low enough, compared to hardware failures, to not contribute significantly to loss of containment isolation.

SAMA Supplemental RAI 3

The response to RAI 3.c.a states that "[h]owever, the present PRA model has been updated to the more recent EPRI hazards," and that "[t]his was done because, while the methodology and experts used in developing the EPRI hazard are essentially the same as the Seabrook Station Probabilistic Safety Assessment (SSPSA), the EPRI hazard is more recent and the EPRI uniform hazard spectrum (UHS) developed for the Seabrook Station site is more realistic than that used in the SSPSA." Since the EPRI hazard curve was assessed in the individual plant examination external events (IPEEE) as a sensitivity case, and the SSPSA curves were considered the baseline, please clarify the basis for considering the SSPSA curves as the baseline and the EPRI curves as the sensitivity case, and why replacing the SSPSA hazard curves with the EPRI hazard curves is now more appropriate as the baseline representation for Seabrook Station.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 3

As stated in the RAI 3.c.a response, the EPRI hazard is more recent than the original seismic hazard developed in 1983. In the 2005 PRA update, the more recent EPRI hazard and the related uniform hazard spectrum (UHS) developed for the Seabrook Station site were judged more realistic and representative of the best estimate hazard because of overall general improvement in seismic technology since the early 1980's. The more recent seismic hazard and UHS for Seabrook were developed in EPRI NP-6395-D, "Probabilistic Seismic Hazard Evaluations to Nuclear Plant Sites in the Central and Eastern United States: Resolution of the Charleston Earthquake Issue," April 1989.

SAMA Supplemental RAI 4

A seismic core damage frequency (CDF) of 2.2E-05 per year, based on the updated 2008 United States Geologic Survey (USGS) seismic hazard curves (as determined from GI-199 information), was used to develop a factor of 2.6 multiplier on the maximum attainable benefit (MAB). The potential effect of this factor is three-fold: (1) for those Phase II SAMAs that were previously screened on high cost or low benefit, the use of this factor could result in some of these SAMAs being reconsidered for a quantitative Phase II evaluation, (2) for those Phase II SAMAs previously evaluated quantitatively and dismissed as non-cost-beneficial, the use of this factor could now render some of these potentially cost-beneficial, and (3) for those Phase II SAMAs previously evaluated and

determined to be cost-beneficial, the use of this factor could increase the degree of cost-benefit. The revised MAB based on the 2.6 factor was used to re-assess only those Phase II SAMAs that were qualitatively screened based on high cost or low benefit (Item 1). Phase II SAMAs that were quantitatively evaluated in the original analysis were not re-assessed in the RAI response (items 2 and 3). Based on a scoping assessment by the NRC staff, applying the 2.6 multiplier to the estimated benefit for these non-re-assessed SAMAs will result in many SAMAs becoming potentially cost-beneficial, based on the current cost estimates. Please provide an assessment of the impact of the higher seismic CDF on all SAMAs, including those identified and evaluated in response to the staff's original RAIs. Note that this re-evaluation applies to all SAMAs, whether or not they result from internal or external event considerations. Specifically, please discuss whether random failures are included in the seismic analysis and, if not, use the 2.6 factor to assess the impact of the higher seismic CDF on the SAMA evaluation.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 4

The Seabrook seismic risk analysis considers both seismic-induced component failures and non-seismic-induced component failures. Non-seismic-induced failures consider random, non-mechanistic, component failures, for example, pump fails to start and pump fails to run. These random component failures are assessed in seismic sequences where the seismic event's ground motion acceleration does not challenge the seismic capacity of the component.

In NextEra Energy's response to RAI 3g, Reference 3, a conservative multiplier of 2.6 was used to assess the possible increase in seismic CDF on the SAMA evaluation. The 2.6 multiplier was determined using the 2.2E-05/yr seismic CDF upper bound contribution as suggested by NRC using the earlier Seabrook IPEEE seismic results. The IPEEE seismic evaluation was submitted in 1992 before the Supplemental Emergency Power Supply (SEPS) was installed. Therefore the IPEEE risk results did not consider the seismic benefit of the SEPS. A more realistic multiplier of 2.1 is used, as documented below, based on crediting the seismic benefit of SEPS.

The Supplemental Emergency Power System (SEPS) was installed at Seabrook Station in 2004. The SEPS diesels are a backup to the two emergency diesels. The SEPS automatically start on loss of offsite power and can be closed onto either emergency bus (E5 or E6, based on local alignment) from the main control room. If the emergency diesels failed (e.g., non-seismic failures) and a diesel could not be immediately recovered, plant operators would close the load breaker to align the SEPS to an emergency bus. SEPS is a seismically rugged component and has been evaluated by an independent consultant to have a median seismic fragility of 1.23g.

Credit for the SEPS function, including its seismic fragility, was modeled in the seismic PRA in 2005. Crediting SEPS in seismic sequences reduces the seismic CDF by approximately 26% by avoiding station blackout sequences. Applying this same factor to the IPEEE results, the IPEEE seismic CDF contribution when SEPS is credited can effectively be reduced by 26%, thus reducing the NRC suggested GI-199 seismic CDF contribution from 2.2E-05 to 1.6E-05. This seismic CDF contribution is used to refine the seismic multiplier used in RAI 3g from 2.6 to 2.1 based on the following approach:

Seabrook baseline CDF from (at power) internal and external events: 1.17E-05/yr (SSPSS-2009)

Seismic contribution to baseline CDF: 3.11E-06/yr

Estimated maximum seismic contribution from GI-199 (crediting the SEPS diesels):

2.2E-05/yr * (1.0 - 0.26) = 1.6E-05/yr

Overall seismic increase factor:

(1.17E-05/yr – 3.11E-06/yr + 1.6E-05/yr) / 1.17E-05/yr = 2.1 factor increase in CDF

As the NRC staff indicated in this RAI, applying the multiplier to the estimated benefit for the non-re-assessed SAMAs would result in many SAMAs becoming potentially cost-beneficial based on the current cost estimates. As discussed in the ER, Reference 1, the SAMA phase II screening process was performed using a conservative approach to compare the SAMA potential benefit (conservative maximum benefit) against the SAMA potential cost (conservative minimum cost estimate).

As part of NextEra's response to this RAI, the assessment of the seismic risk multiplier impact on the SAMA evaluation included both a review of the PRA Case used to determine the SAMA benefit and a review of the SAMA's original cost estimate. This was done to understand conservatisms and to ensure that the SAMA risk benefit and cost estimate continue to reflect meaningful estimates. Where NextEra judged the SAMA's original PRA Case to provide an overly conservative risk benefit, a more realistic, (but still conservative) PRA Case is used to provide the SAMA risk benefit. Where NextEra judged the SAMA's original cost estimate to be overly conservative, the original cost estimate is revised to provide a more realistic (but still conservative) SAMA cost estimate based on an assessment of costs.

Table X-2 (Attachment A) provides the sensitivity evaluation of the potential seismic risk increase for SAMA candidates in Table F.8-1 of the Seabrook ER (Reference 1). Tables X-3 through X-8 (Attachment A) provides the sensitivity evaluation of the SAMA candidates that were evaluated in Seabrook's response to RAIs (Reference 3).

Changes to the SAMA cost estimate are provided in the Cost Estimate column of Tables X-2 thru X-8 with the change highlighted by strikethroughs for deleted cost and bolded italics for revised cost. The basis for the change in cost is provided in the SAMA evaluation column. Any changes to the selected PRA Case are also shown similarly in Tables X-2 thru X-8, PRA Case column, and are also discussed in the SAMA evaluation column. Based on the assessment performed, the SAMA evaluation is insensitive to the assumed increase in seismic risk. As a result, no new SAMA candidates are identified as being potentially cost beneficial. It is also noted that SAMA cases using previous Cost Estimates would only have been justified by the extremely conservative "upper bound" benefit results. The upper bound benefit sensitivity is included only as a flag to consider more realistic costs and benefits, as was done above.

In addition to Tables X-2 through X-8, NextEra's response to RAI 51 (reference 3) is revised below based on the assumed increase in seismic risk:

When considering the seismic risk factor of 2.1, the maximum dollar benefit of a SAMA that eliminates 100% of the risk of a basic event having an RRW value of 1.005 is approximately $5.25K (nominal benefit at 7% discount rate) and approximately $10.1K (upper bound benefit).

SAMA Supplemental RAI 5

The response to staff's RAI 5.b states that all top ranked basic events related to large early release frequency (LERF) have been addressed in response to RAI 2.f. This appears to be the case with the exception of basic event FWP161.FS, which has a LERF risk reduction worth (RRW) of 1.0886 (see Environmental Report Table F.3.2.1-2). Please provide an assessment of this basic event for SAMAs, including an identification of the specific basic events that bound this basic event and the associated SAMAs.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 5

Basic event FWP161.FS models failure to start of the Pre-lube Oil Pump (FW-P-161). Operation of this pump is needed for success of the Startup Feedwater Pump (FW-P-113). The potential SAMA candidate would be to improve the reliability of the pre-lube pump via installation of a redundant pump. PRA Case SUFPS is used to conservatively estimate the SAMA benefit. This case is conservative because it assumes guaranteed success of the entire Startup Feedwater system. Basic event FW-P-161 contributes approximately 17.5% to the unreliability of the SUFP system. Therefore, the maximum benefit associated with reliability improvements to the pre-lube pump is approximately 17.5% of the SUFPS PRA case results.

<u>FW-P-161 benefit results</u>
7.4K (nominal benefit)
$14.2K (UB benefit)
OECR Red: <1%
Min. Cost: >100K

Conclusion: Not cost beneficial based on assumed guaranteed success of the pre-lube oil pump and estimated cost. This cost benefit result is not sensitive to the assumed increase in seismic risk evaluated in RAI 4.

SAMA Supplemental RAI 6

The response to staff's RAI 5.b provides the same disposition (not beneficial based on eliminating all supplemental electric power system (SEPS) failures), same associated SAMAs (#9 and #14), and same two pairs of case studies (PRA cases SEPS for #s 8-9 and OSEP1 for #s 10-11) for basic events #8, #9, #10, and #11, yet the estimated benefits are different between the pairs #s 8-9 and #s 10-11. Clarify the differences in the treatment of these four SAMAs, including the two different case studies and provide additional details on the modeling assumptions for each.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 6

Basic events SEPSDG2A.FR3 and SEPSDG2B.FR3 (items #8 and #9) model the fail-to-run failure mode of the supplemental electric power supply (SEPS) diesel generators A/B. PRA case SEPES is used to estimate the potential benefit of improving SEPS reliability (e.g. add an additional SEPS diesel). The SEPES PRA case assumes guaranteed success of all SEPS DG hardware (successful start and run). Manual actions to align and connect SEPS to the desired electrical bus are assumed to remain at their baseline HEP values. The SAMA disposition for these basic events is not cost beneficial based on assumed elimination of all SEPS hardware failures which, even with an additional DG, is not practical to achieve. As provided in SAMA#189 of Reference 1, the estimated cost of modifying or analyzing SEPS DG success criteria capability such that 1 of 2 SEPS DGs has capacity to provide LOSP non-SI loads and 2 of 2 SEPS DGs have capacity to provide LOSP SI loads exceeds $300K.

It is noted that the basic event description for item #11, HH.OHPR3.FA, was incorrect in RAI 5.b; this operator action is not related to SEPS. A SAMA evaluation for HH.OHPR3.FA is provided in Table X- 7.

Basic event HH.OSEP1.FA (item #10) models the human action to manually close the SEPS breaker without a safety injection signal. The action to manually close the SEPS breaker is required to connect SEPS to the desired emergency bus. PRA case OSEP1 assumes guaranteed success of operator action OSEP1 and is used to estimate the potential benefit of improving the reliability of connecting SEPS to the desired bus (e.g. add a SEPS automatic start and load feature). In this case, the SEPS hardware is assumed to remain at its baseline failure probability. The SAMA disposition in the RAI 5.b table of top 15 RRW basic events stated; not cost beneficial based on assumed elimination of all SEPS failures. This was a carry-over from earlier SEPS basic events and is not accurate for the OSEP1 case. The more correct disposition for basic event OSEP1 is; not cost beneficial based on assumed elimination of the OSEP1 action. It is noted that an additional PRA case related to human action HH.OSEP2Q.FA (Case OSEPALL) is provided in NextEra response to RAI 2.f. This case modeled elimination of all manual actions associated with SEPS. The SAMA disposition for providing automatic control of the SEPS breaker is not cost beneficial. As provided in SAMA#154 of Reference 1, the estimated cost to modify the SEPS design to accommodate automatic bus loading and alignment is >$750K.

SAMA Supplemental RAI 7

Clarify why NextEra believes the uncertainty distribution represents the uncertainty in the fire and seismic portions of the PRA model. Include a discussion of whether probability distributions were assigned for external events (such as for fire ignition frequencies, non-suppression probabilities, hot short probabilities, seismic frequencies, other seismic parameters) and, if not or only done so partially, how this impacts the SAMA analysis, including any specific examples of where probability distributions were applied in the fire and seismic models.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 7

The NextEra Seabrook PRA fire and seismic results consider uncertainty. Specifically, uncertainty is considered for fire initiating events, seismic initiating events, component seismic fragilities, operator actions and component non-seismic/random failures. Hot short probabilities are accounted for in the fire events screening evaluation, which does not apply uncertainties. Uncertainties in non-suppression probabilities were not specifically addressed in the quantification. However, non-suppression uncertainty is addressed in fire events sensitivity evaluations. A number of sensitivity evaluations were performed to support the fire events and seismic events models to ensure the reasonableness of the key inputs. The results of the sensitivity studies indicate that the baseline fire and seismic results are relatively insensitive to reasonable variations in key inputs. Based on the level of uncertainty applied in the fire events and seismic events analyses, and the associated sensitivity studies performed, the calculated model uncertainty distribution adequately reflects the uncertainty for both internal and external events and is judged reasonable for the SAMA evaluation.

SAMA Supplemental RAI 8

In the response to RAI 5.f for Essential Switchgear Rooms, clarify if electrical raceway fire barriers are also considered for fire areas where cables for redundant trains may be co-located.

NextEra Energy Seabrook Response to SAMA Supplemental RAI 8

As discussed in the response to RAI 5.f, the switchgear rooms are safety train separated. The review of fire impact scenarios on the individual switchgear room components and cables performed as part of the fire risk analysis, did not identify redundant safety train cables/impacts. The switchgear room scenarios involve fires in a single switchgear room/division, with subsequent fire-independent hardware failures of redundant components. Therefore, additional fire barriers were not considered.

Attachment A to SBK-L-11067

Tables X-2 through X-8

NextEra Energy Seabrook

Responses to Supplementary NRC Request for Additional Information

Regarding

Severe Accident Mitigation Alternatives Analysis

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
2	Replace lead-acid batteries with fuel cells	Extended DC power availability during an SBO	NOSBO	$326K	$629K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events. The cost of replacing batteries is expected to significantly exceed benefit.
13	Install an additional, buried off-site power source	Reduced probability of loss of off-site power	NOLOSP	$704K	$1.34M	>$2.4M ~~>$1M~~	Not cost beneficial. PRA case NOLOSP conservatively assumes elimination of all LOSP events. Cost of installing buried, alternate power source expected to significantly exceed benefit. Reduction in seismic risk not significant unless offsite power source is seismically rugged. This improvement was previously estimated at $2.485M dollars in the Cooper License Renewal application. Estimate far exceeds the upper bound benefit of $1.34M, and no more refined estimate is warranted.
14	Install a gas turbine generator	Increased availability of on-site AC power	NOSBO ~~NOLOSP~~	$326K	$620K	$>1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Cost of installing an alternate power gas turbine expected to significantly exceed benefit. Reduction in seismic risk not significant unless gas turbine is seismically rugged. PRA case NOSBO is judged more representative than original PRA case NOLOSP. This is because the gas turbine would not eliminate the LOSP event, but rather would help avoid station blackout subsequent to the LOSP event.
16	Improve uninterruptible power supplies	Increased availability of power supplies supporting front-line equipment	NOSBO ~~NOLOSP~~	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Cost of installing additional power supplies expected to significantly exceed benefit. Reduction in seismic risk not significant unless power supplies are seismically rugged. PRA case NOSBO judged more representative than original PRA case NOLOSP. This is because additional uninterruptible power supplies would not eliminate the LOSP event, but rather would help avoid station blackout subsequent to the LOSP event.
20	Add a new backup source of diesel cooling	Increased diesel generator availability	NOSBO	$326K	$629K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events. The cost of installing backup cooling source is expected to significantly exceed benefit.
21	Develop procedures to repair or replace failed 4 KV breakers	Increased probability of recovery from failure of breakers that transfer 4.16 kV non-emergency buses from unit station service transformers	BREAKER	$17K	$32K	—	Intent of this SAMA is met and further development is not cost beneficial. Detailed procedures exist for inspection and repair of 4kV breakers. These procedures are applied to both safety related and non-safety related breakers to ensure that these breakers are proper maintained and highly reliable. The PRA case BREAKER conservatively assumes guaranteed success of all 4kV safety and non-safety bus feeder breakers. Thus, the benefit of implementing additional measures for repair and replacement of non-safety breakers is conservatively high. Given that inspection and repair procedures exist, no further actions are judged needed for this SAMA. Ref Procedures: LS0558.04, 4.16KV Circuit Breaker Refurbishment LX0558.01, 4.16KV Breaker Inspection, Testing and PM

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
24	Bury off-site power lines	Improved off-site power reliability during severe weather	NOLOSP	$704K	$1.34M	>$3M ~~>$1M~~	Not cost beneficial. PRA case NOLOSP conservatively assumes elimination of all loss of offsite power events. Burying offsite power lines to the station is judged not practical and cost is expected to significantly exceed benefit. This improvement was previously estimated at $1.14B dollars in the Cooper License Renewal application. Estimate far exceeds the upper bound benefit of $1.34M, and no more refined estimate is warranted.
25	Install an independent active or passive high pressure injection system	Improved prevention of core melt sequences	LOCA02	$978K	$1.9M	>$2M ~~>$1M~~	Not cost beneficial. PRA case LOCA02 conservatively assumes guaranteed success of all high head and intermediate head injection pumps (charging and SI pumps.) Therefore, the benefit of installing a single, independent, backup injection system is judged conservatively high. Installation of an independent, active or passive injection system is judged not practical and cost is expected to significantly exceed the conservative benefit. Given the seismic ruggedness of the existing injection system(s), any new/additional system would need to be equally rugged to significantly reduce plant risk. Including seismic ruggedness in the design would further increase cost. This improvement was previously estimated at greater than $2 million dollars in the Pilgrim License Renewal application. In the Duane Arnold License Renewal application, the Pilgrim estimate was judged to be low and used a $20 million estimate based on similar modification experience. Both estimates exceed the upper bound benefit of $1.9M, and no more refined estimate is warranted.
26	Provide an additional high pressure injection pump with independent diesel	Reduced frequency of core melt from small LOCA and SBO sequences	LOCA02	$978K	$1.9M	>$2M ~~>$1M~~	Not cost beneficial. PRA case LOCA02 conservatively assumes guaranteed success of all high head and intermediate head injection pumps (charging and SI pumps.) Therefore, the benefit of installing a single, independent, backup injection system is conservatively high. Installation of an additional injection system is judged not practical and cost is expected to significantly exceed the conservative benefit. Given the seismic ruggedness of the existing injection system, any new/additional system would need to be equally rugged to significantly reduce plant risk. Including seismic ruggedness in the design would further increase cost. This modification was assumed to be the equivalent of adding one new high pressure injection pump powered by a diesel rather than an electric motor with a suitable injection path and suction source. In the Duane Arnold License Renewal application, the cost of this was one half the cost of replacing pumps discussed in SAMA 25 above, the cost would be $10 million. This estimate far exceeds the upper bound benefit of $1.9M and no more refined cost estimate is warranted.
28	Add diverse low pressure injection system	Improve injection capability	LOCA03	$336K	$639M	>$1M	Not cost beneficial. PRA case LOCA03 conservatively assumes elimination all low pressure injection failures. The cost of installing an additional low pressure injection system is expected to significantly exceed benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
35	Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory	Extended reactor water storage tank capacity	LOCA04	$332K	$630K	***>$1M*** ~~>$500K~~	Not cost beneficial. PRA case LOCA04 conservatively assumes guaranteed success of the RWST volume as a continuous source of water for ECCS. Therefore, the benefit of throttling low pressure injection to extend the time to RWST depletion for medium or large break LOCA events is conservatively high. The current system valves and controls do not allow throttling. The cost of engineering analysis, installation of the proper valves, control systems, etc. to accomplish this SAMA is expected to significantly exceed the conservative benefit. Given the seismic ruggedness of the existing injection system, any system changes would need to be equally rugged so as to not impact the current seismic design basis. Including seismic ruggedness in the design would further increase cost. Implementation would require both LOCA and Containment Mass Energy calculations to be performed. Additional analysis would be required to verify ECCS flow balance and NPSH for low, intermediate and high head SI pumps. The implementing modification would address design and licensing basis changes as well as post mod testing to validate required flow balance is achieved. Pending review of the throttling capability of existing system valves, hardware changes may be necessary to achieve the desired results. The expected cost to implement SAMA 35 will exceed the upper bound benefit of $630K.
39	Replace two of the four electric safety injection pumps with diesel-powered pumps	Reduced common cause failure of the safety injection system. The intent of this SAMA is to provide diversity within the high- and low-pressure safety injections systems	LOCA02	$978K	$1.9M	***>$2M*** ~~>$1M~~	Not cost beneficial. PRA case LOCA02 conservatively assumes guaranteed success of all high head and intermediate head injection pumps (charging and SI pumps.) Therefore, the benefit of replacing two electric motor pumps with diesel-driven pumps is conservatively high. Installation of diesel-driven pumps in place of the existing motor-driven pumps is judged not practical and cost is expected to significantly exceed the conservative benefit. Given the seismic ruggedness of the existing injection system, any new/additional equipment would need to be equally rugged so as to not impact the current seismic design basis. Including seismic ruggedness in the design would further increase cost. Changes to how safety related pumps are powered would require substantial changes to the foot print of the system and re-analysis of safety related piping in addition to the procurement and installation of the diesel power device. Due to complexity of this modification, the Duane Arnold License Renewal application estimates the cost to be similar in nature to replacement of pumps mentioned in SAMA 25 above ($20 million). As this value substantially exceeds the upper bound benefit of $1.9M, no more refined estimate is warranted.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
41	Create a reactor coolant depress system	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure	LOCA01	$70K	$132K	>$1M	Not cost beneficial. PRA case LOCA01 conservatively assumes elimination small LOCA events. The cost of installing an RCS depressurization system is expected to significantly exceed benefit.
43	Add redundant DC control power for SW pumps	Increased availability of SW	SW01	$20.6K	$40K	>$100K	Not cost beneficial. PRA case SW01 conservatively assumes that the SW pumps are not dependent on DC power. The cost of installing an independent DC power system for the SW pumps is expected to significantly exceed benefit.
44	Replace ECCS pump motors with air-cooled motors	Elimination of ECCS dependency on component cooling system	CCW01	$384K	$731K	>$4M ~~>$500K~~	Not cost beneficial. PRA case CCW01 conservatively assumes guaranteed success of the component cooling water (CCW) systems to provide heat removal. Because CCW is needed for success of the ECCS divisions (including room cooling), the benefit of installing ECCS pump motors that are independent of CCW is conservatively high. Installation of air cooled pumps would still rely on room cooling/CCW. Therefore, this SAMA would provide negligible benefit and its cost for replacing eight large motors would be expected to significantly exceed even the conservative benefit. Given the seismic ruggedness of the existing injection system, any new equipment would need to be equally rugged so as to not impact the current seismic design basis. Including seismic ruggedness in the design would further increase cost. Since all ECCS pumps are dependant on component cooling, the cost of this improvement was assumed to be the cost of eight large safety related pumps, engineering design support and installation for a total of at least $4 million. Similar to SAMA 170, replacement of a single large safety related pump independent of cooling water is estimated to cost in excess of $500K. No allowance in the cost estimate was given to account for the possibility that complex support or fit changes were needed. As this value substantially exceeds the upper bound benefit of $731K, no more refined estimate is warranted.
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	RCPLOCA	$173K	$370K	>$1M	Not cost beneficial. PRA case RCPLOCA conservatively assumes that RCP seal LOCA events are eliminated. The cost of installing an independent seal injection system with or without a dedicated diesel is expected to significantly exceed benefit.
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel	Reduced frequency of core damage from loss of component cooling water or service water, but not a station blackout	RCPLOCA	$173K	$370K	>$3M	Not cost beneficial. PRA case RCPLOCA conservatively assumes that RCP seal LOCA events are eliminated. The cost of installing an independent seal injection system with or without a dedicated diesel is expected to significantly exceed benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
59	Install an additional component cooling water pump	Reduced likelihood of loss of component cooling water leading to a reactor coolant pump seal LOCA	CCW01	$384K	$731K	*>$1M* ~~>$500K~~	Not cost beneficial. PRA case CCW01 conservatively assumes guaranteed success of the component cooling water (CCW) systems to provide heat removal. Thus, the benefit of installing an additional CCW pump is conservatively high. Seabrook has four CCW pumps. Adding an additional pump will not significantly reduce plant risk due to common-cause failure considerations and limitations in divisional power. Installation of an additional pump would still rely on the same power supplies as the existing pumps. The cost of installing an additional CCW pump is expected to significantly exceed the conservative benefit. Given the seismic ruggedness of the existing injection system, any new equipment would need to be equally rugged so as to not impact the current seismic design basis. Including seismic ruggedness in the design would further increase cost. It is also noted that Seabrook has an alternate cooling configuration for the charging pumps should there be a loss of CCW. This alternate cooling configuration reduces the likelihood of loss of RCP seal injection/cooling and associated seal LOCA sequences. This improvement was previously estimated at greater than $1.2 million dollars in the Kewaunee License Renewal application. As this value substantially exceeds the upper bound benefit of $731K, no more refined estimate is warranted.
65	Install a digital feed water upgrade	Reduced chance of loss of main feed water following a plant trip	—	—	—	>$30M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. The cost of installing the digital feedwater control upgrade is expected to significantly exceed benefit.
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	—	—	—	>$10M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. As stated in Reference 3, RAI response 3g, the installation of such a system is judged not practical at an existing nuclear power plant such as Seabrook Station. The cost of this SAMA would be in excess of $10M significantly exceeding the MAB 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	FW01	$154K	$294K	*>$1M* ~~>$250K~~	This SAMA is from Reference 3, RAI 5g and is evaluated for sensitivity to the 2.1x risk increase. Not cost beneficial. PRA case FW01 conservatively assumes elimination of loss of feedwater events. The cost of replacing the PORVs to increase capacity and improve feed and bleed performance is expected to significantly exceed benefit. This SAMA was previously estimated at $2.7M in the Calvert Cliffs License Renewal application (SAMA 77). Estimate far exceeds the upper bound benefit of $294K and no more refined estimate is warranted.
80	Provide a redundant train or means of ventilation	Increased availability of components dependent on room cooling	HVAC2	$67.2K	$128K	>$500K	Not cost beneficial. PRA case HVAC2 conservatively assumes no HVAC dependency for CS, SI, RHR and CBS pumps. The cost of installing a redundant or independent HVAC system is expected to significantly exceed benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
84	Create ability to switch emergency feedwater room fan power supply to station batteries in a station blackout	Continued fan operation in a station blackout	OEFWVS	<$1K	<$2K	>$250K	This SAMA is from Reference 3, RAI 5g and is evaluated for sensitivity to the 2.1x risk increase. Not cost beneficial. PRA case OEFWVS conservatively assumes no HVAC dependency for EFW pumps. The cost of modifying the HVAC system to allow for DC power supplies is expected to significantly exceed benefit.
90	Create a reactor cavity flooding system	Enhanced debris cool ability, reduced core concrete interaction, and increased fission product scrubbing	—	—	—	>$4M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. As stated in Reference 3, RAI response 3g, the installation of a cavity flooding system is judged not practical at an existing nuclear power plant such as Seabrook Station. The cost of installing a reactor cavity flooding system is expected to significantly exceed benefit.
91	Install a passive containment spray system	Improved containment spray capability	CONT01	$342K	$651K	>$6M	Not cost beneficial. PRA case CONT01 conservatively assumes the containment does not fail due to overpressure. As stated in Reference 3, RAI response 3g, the installation of a passive containment spray system is judged not practical at Seabrook Station. Design and implementation costs are judged to realistically exceed $3M to $6M The cost of installing a passive containment spray system is expected to significantly exceed benefit.
93	Install an unfiltered, hardened containment vent	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products	CONT01	$342K	$651K	>$3M	Not cost beneficial. PRA case CONT01 conservatively assumes the containment does not fail due to overpressure. As stated in Reference 3, RAI response 3g, the cost of installing a unfiltered hardened containment vent system is expected to significantly exceed benefit.
94	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter; Option 2: Multiple Venturi Scrubber	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products	CONT01	$342K	$651K	>$5M ~~>$500K~~	Not cost beneficial. The conservative PRA case CONT01 assumes elimination of containment failure events due to overpressure. The context of this SAMA is to eliminate containment overpressure failure events by removing decay heat from containment via a filtered vent which would retain fission products. Based on the high level concept for this SAMA, installation of a filtered vent system is expected to be in the range of $5M to $6M. This SAMA was previously estimated at $5.7M in the Calvert Cliffs License Renewal application (SAMA 12). Estimate far exceeds the upper bound benefit of $651K and no more refined estimate is warranted.
96	Provide post-accident containment inerting capability	Reduced likelihood of hydrogen and carbon monoxide gas combustion	H2BURN	<$1K	<$1K	>$100K	Not cost beneficial. PRA case H2BURN conservatively assumes that hydrogen burns and detonations do not occur. The cost of installing a containment inerting system is expected to significantly exceed benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
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	—	—	—	>$50M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. As stated in Reference 3, RAI response 3g, the cost of installing a core catcher and cooling system in the reactor cavity is expected to significantly exceed benefit and is not practical at Seabrook Station.
`98	Create a core melt source reduction system	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur	—	—	—	>$50M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. As stated in Reference 3, RAI response 3g, the cost of installing refractory material in the reactor cavity is expected to significantly exceed benefit and is not practical at Seabrook Station.
99	Strengthen primary/secondary containment (e.g., add ribbing to containment shell)	Reduced probability of containment over-pressurization	CONT01	$342K	$651K	>$10M	Not cost beneficial. The conservative PRA case CONT01 assumes elimination of containment failure events due to overpressure. The context of this SAMA is to eliminate containment overpressure failure events by adding reinforcement to containment. As stated in Reference 3, RAI response 3g,, based on the high level concept for this SAMA, installation of reinforcement steel is expected to significantly exceed the benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
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	—	—	—	>$5M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. As stated in Reference 3, RAI response 3g, the cost of installing additional base mat concrete material in the reactor cavity is expected to significantly exceed benefit and is not practical at Seabrook Station.
101	Provide a reactor vessel exterior cooling system	Increased potential to cool a molten core before it causes vessel failure, by submerging the lower head in water	—	—	—	>$5M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. The cost of installing an RPV external cooling system is expected to significantly exceed benefit and is not practical at Seabrook Station. As stated in Reference 3, RAI response 3g, Seabrook Station currently has several proceduralized methods to ensure that the reactor cavity can be flooded to provide a means of external vessel cooling. These methods include containment injection of the RWST contents and containment injection via the fire protection system through an ILRT flange (refer to SAMA #188). Therefore, it is judged that the current Seabrook Station design meets the intent of SAMA #101.
102	Construct a building to be connected to primary/sec. containment and maintained at a vacuum	Reduced probability of containment over-pressurization	CONT01	$342K	$651K	>$10M	Not cost beneficial. The conservative PRA case CONT01 assumes elimination of containment failure events due to overpressure. The context of this SAMA is to eliminate containment overpressure failure events by adding a system to evacuate containment. As stated in Reference 3, RAI response 3g, based on the concept of this SAMA, installation of a containment evacuation building/system is expected to significantly exceed the benefit.
105	Delay containment spray actuation after a large LOCA	Extended reactor water storage tank availability	OLPRS	$15.1K	$29K	>$100K	This SAMA is from Reference 3, RAI 5n and is evaluated for sensitivity to the 2.1x risk increase. Not cost beneficial. PRA Case OLPRS conservatively assumed guaranteed success of the operator action to complete/ensure the RHR/LHSI transfer to long term recirculation during large LOCA events. The results of this case study show that the operator action does not contribute significantly to core damage frequency. The estimated cost is expected to significantly exceed benefit.
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	LOCA04	$332K	$630K	*>$1M* ~~>$500K~~	Not cost beneficial. PRA case LOCA04 conservatively assumes guaranteed success of the RWST volume as a continuous source of water for ECCS. Therefore, the benefit of throttling containment spray flow to extend the time to RWST depletion is conservatively high. The cost of engineering analysis, installation of the proper valves, control systems, etc. to accomplish this SAMA is expected to significantly exceed the conservative benefit. Implementation would require both LOCA and Containment Mass Energy calculations to be performed. Additional analysis would be required to verify ECCS flow balance and NPSH for low, intermediate and high head SI pumps. The implementing modification would address design and licensing basis changes as well as post mod testing to validate required flow balance is achieved. Pending review of the throttling capability of existing system valves, hardware changes may be necessary to achieve the desired results. The expected cost to implement SAMA 35 will exceed the upper bound benefit of $630K.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
107	Install a redundant containment spray system	Increased containment heat removal ability	CONT01	$342K	$651K	>$4M	Not cost beneficial. The conservative PRA case CONT01 assumes elimination of containment failure events due to overpressure. The context of this SAMA is to eliminate containment overpressure failure events by adding a redundant containment spray system. As stated in Reference 3, RAI response 3g, based on the high level concept for this SAMA, installation of a containment spray system is expected to significantly exceed the benefit.
108	Install an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel	Reduced hydrogen detonation potential	H2BURN	<$1K	<$1K	>$100K	Not cost beneficial. PRA case H2BURN conservatively assumes that hydrogen burns and detonations do not occur. The cost of installing an independent power supply to the H2 control system is expected to significantly exceed benefit. It is noted that SAMA #108 would benefit from SAMA #157, portable AC generator, which was shown to be potentially cost beneficial.
109	Install a passive hydrogen control system	Reduced hydrogen detonation potential	H2BURN	<$1K	<$1K	>$100K	Not cost beneficial. PRA case H2BURN conservatively assumes that hydrogen burns and detonations do not occur. The cost of installing a passive hydrogen control system is expected to significantly exceed benefit.
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	Reduced probability of containment failure	—	—	—	>$5M	Not cost beneficial based on an upper bound maximum attainable benefit (MAB) of $1.56M * 2.1 = $3.3M. As stated in Reference 3, RAI response 3g, the cost of installing additional concrete barrier material in the reactor cavity is expected to significantly exceed benefit and is not practical at Seabrook Station.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
112	Add redundant and diverse limit switches to each containment isolation valve	Reduced frequency of containment isolation failure and ISLOCAs	CONT02	*$220K* ~~$439K~~	*$417K* ~~$834K~~	>$500K	Not cost beneficial. PRA case CONT02 conservatively assumes guaranteed be success of all containment isolation valves. At Seabrook, containment isolation valves are already equipped with limit switches. The limit switch function is primarily for valve position indication/verification and judged not to contribute significantly to the overall reliability of the containment isolation valves themselves. Adding an additional limit switch would not provide significant improvement in the reliability of the isolation function. For SAMA purposes, the limit switches are conservatively assumed to contribute 50% to the containment isolation function. Thus, the PRA case upper bound benefit is less than $834K * 0.5 = $417K and is judged not cost beneficial.
113	Increase leak testing of valves in ISLOCA paths	Reduced ISLOCA frequency	LOCA06	*$30K* ~~$59K~~	*$56K* ~~$111K~~	>$100K	Not cost beneficial. PRA case LOCA06 conservatively assumes complete elimination of all ISLOCA risk contribution. Performing increased testing of PIVs would not significantly reduce the ISLOCA event frequency. Nor is it practical to perform more frequent tests. This is because PIV testing cannot be safely performed during power operation and would require a plant shutdown. Plant transition to shutdown introduces risk and additional costs due to lost generation. For SAMA purposes, increased PIV testing is conservatively assumed to reduce the ISLOCA frequency by 50%. Thus, the PRA case upper bound benefit is less than $111K * 0.5 = $56K and is judged not cost beneficial.
114	Install self-actuating containment isolation valves	Reduced frequency of isolation failure	CONT02	*$220K* ~~$439K~~	*$417K* ~~$834K~~	>$500K	Not cost beneficial. PRA case CONT02 conservatively assumes guaranteed success of all containment isolation valves. At Seabrook, isolation of containment penetrations is typically performed using motor operated valves (MOV), air operated valves (AOV) and check valves (CV), and combinations of these valves, depending on the operational function and isolation requirements of the specific penetration. Check valves are considered to be self-actuated valves. MOVs and AOVs automatically close upon receipt of Engineered Safety Actuation Signals. Containment penetrations are either closed (isolated) or if open, automatically close upon receipt of reliable Engineered Safety Actuation Signals. Self-actuated valves are judged to not significantly improve the reliability of the containment isolation function. For SAMA purposes, the benefit of a self-actuating valve(s) is assumed to contribute 50% to the containment isolation function. Thus, the PRA case upper bound benefit is less than $834K * 0.5 = $417K and is judged not cost beneficial. Refer to SAMA# 193, CS-V-167.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
115	Locate residual heat removal (RHR) inside containment	Reduced frequency of ISLOCA outside containment	LOCA06	$59K	$112K	>$1M	Not cost beneficial. PRA case LOCA06 conservatively assumes that ISLOCA events do not occur. The cost of relocating the RHR system function to inside containment is expected to significantly exceed benefit and is judged not practical.
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	NOSGTR	$181K	$345K	>$500K	Not cost beneficial. PRA case NOSGTR conservatively assumes that SGTR events do not occur. The cost of 100% inspection each refueling outage is expected to significantly exceed benefit. Costs for this item were estimated to be >$3M in Kewaunee, Beaver Valley and Calvert Cliffs License Renewal submittals.
121	Increase the pressure capacity of the secondary side so that a steam generator tube rupture would not cause the relief valves to lift	Eliminates release pathway to the environment following a steam generator tube rupture	NOSGTR	$181K	$345K	>$500K	Not cost beneficial. PRA case NOSGTR conservatively assumes that SGTR events do not occur. The cost of analysis and design to increase the SG secondary side pressure is expected to significantly exceed benefit and is judged not practical.
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	NOSGTR	$181K	$345K	>$500K	Not cost beneficial. PRA case NOSGTR conservatively assumes that SGTR events do not occur. The cost of a main steam safety valve spray system to reduce fission product release during SGTR is expected to significantly exceed the benefit. It is noted that Severe Accident Management Guideline SAG-5, Reduce Fission Product Release, includes guidance and procedure steps for use of external spraying sources for fission product plume reduction including possible reduction of SG releases. Reference: SAG-5, Reduce Fission Product Releases, Section B and Table 7.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
126	Install a highly reliable (closed loop) steam generator shell-side heat removal system that relies on natural circulation and stored water sources	Reduced consequences of a steam generator tube rupture	NOSGTR	$181K	$345K	>$500K	Not cost beneficial. PRA case NOSGTR conservatively assumes that SGTR events do not occur. The cost of installing a passive, closed loop SG heat removal system is expected to significantly exceed the benefit and is judged not practical.
129	Vent main steam safety valves in containment	Reduced consequences of a steam generator tube rupture	NOSGTR	$181K	$345K	>$500K	Not cost beneficial. PRA case NOSGTR conservatively assumes that SGTR events do not occur. The cost of analysis and design to locate main steam safety valves in containment or route existing Safety valve discharge to containment is expected to significantly exceed the benefit and is judged not practical.
130	Add an independent boron injection system	Improved availability of boron injection during ATWS	NOATWS	$148K	$282K	>$500K	Not cost beneficial. PRA case NOATWS conservatively assumes that ATWS events do not occur. The cost of installation of an independent boron injection system is expected to significantly exceed the benefit.
131	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS	Improved equipment availability after an ATWS	NOATWS	$148K	$282K	>$500K	Not cost beneficial. PRA case NOATWS conservatively assumes that ATWS events do not occur. The cost of installing additional relief capacity is expected to significantly exceed the benefit.
133	Install an ATWS sized filtered containment vent to remove decay heat	Increased ability to remove reactor heat from ATWS events	NOATWS	$148K	$282K	>$500K	Not cost beneficial. PRA case NOATWS conservatively assumes that ATWS events do not occur. The cost of installing a filtered vent sized for ATWS heat removal is expected to significantly exceed the benefit and is not practical.
147	Install digital large break LOCA protection system	Reduced probability of a large break LOCA (a leak before break)	LOCA05	$217K	$412K	>$500K	Not cost beneficial. PRA case LOCA05 conservatively assumes that LOCA events, as a result of pipe failures, do not occur. The cost of installing a digital break detection system is expected to significantly exceed the benefit. It is noted that a benchmarked plant estimated the cost of this type of modification to be ~$2M.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
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	NOSLB	$6.6K	$12.6K	>$500K	Not cost beneficial. PRA case NOSLB conservatively assumes that steam line break events do not occur. The cost of installing secondary side pipe guards is expected to significantly exceed the benefit.
154	Modify SEPS design to accommodate automatic bus loading and automatic bus alignment	Improve reliability of onsite power; reduce SBO CDF contribution; remove dependence on operator action	*OSEPALL* ~~NOSBO~~	$68K	$130K	>$750k	Not cost beneficial. The PRA case OSEPALL conservatively assumes guaranteed success of all manual actions to align and load the SEPS diesel generators. The current design requires the operator to manually align SEPS to the desired bus and to manually load SEPS to ensure power is available to needed components. The proposed SAMA is to install a control system to perform these actions automatically. The cost of the automatic control system is estimated to exceed the benefit. PRA case OSEPALL is judged to be more representative of this proposed SAMA than the original PRA case NOSBO. This is because OSEPALL more accurately models elimination of the SEPS manual actions compared to NOSBO, which credits success of the EDGs.
156	Install alternate offsite power source that bypasses the switchyard. For example, use campus power source to energize Bus E5 or E6	Improve offsite power reliability and independence of switchyard and SF6 bus duct; allow restoration of offsite power within a few hours	NOLOSP	$704K	$1.34M	*>$7M* ~~>$1M~~	Not cost beneficial. PRA case NOLOSP conservatively assumes elimination of all LOSP events. Cost of installing alternate offsite power source that bypasses the current switchyard power source is expected to significantly exceed benefit. Implementation cost was assumed similar to an estimate performed at Seabrook Station which would supply campus power directly to plant buses 1 & 2. A study performed to implement this change determined it necessary to replace and/or install new transformers and switchgear at an estimated cost >$7M. As this value substantially exceeds the upper bound benefit of $1.34M, no more refined estimate is warranted.
157	Provide independent AC power source for battery chargers. For example, provide portable generator to charge station battery	Reduce CDF of long term SBO sequences; extend battery life to allow additional time for recovery	INDEPAC	$48K	$95K	$30K	SAMA #157 was shown to be potentially cost beneficial in the original study. The 2.1x sensitivity evaluation furthers the degree to which this SAMA is beneficial.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
159	Install additional batteries	Reduce CDF of long term SBO sequences; extend battery life to allow additional time for recovery	INDEPAC	$48.3K	$94.5K	>$1M	Not cost beneficial. PRA case INDEPAC conservatively assumes that station batteries have AC power available for battery charging. The cost of installing additional batteries is expected to significantly exceed the benefit.
161	Modify EDG jacket heat exchanger service water supply and return to allow timely alignment of alternate cooling water source (supply & drain) from firewater, RMW, DW, etc.	Alternate cooling to both EDGs would reduce CDF long term sequences involving LOOP and loss of SW /cooling tower. A loss of service water / cooling tower with a LOOP could result in EDG failure and non-recovery	NOSBO	$326K	$620K	***>$1M*** ~~>$500K~~	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the DG cooling system is conservatively high because loss of cooling does not contribute significantly to DG failure. The cost of installing a backup diesel cooling water system is expected to significantly exceed the conservative benefit. Backup diesel cooling water system was also addressed in original SAMA #20 with estimate of >$1M. A reduction in seismic risk would not be significant unless the backup cooling water system is also seismically rugged, which would further increase cost. Approximately 1800 GPM of water to the existing EDG jacket water heat exchangers would be required to support full load operation. Existing firewater system capacity is limited to 1500 GPM with limited water availability. Other alternate water sources limited to much less. A pump with flexibility of suction source, such as that used in SAG-1, but with higher capacity would be needed to achieve the benefit of this SAMA. The lower capacity SAG-1 pump with associated hose, fittings and connections cost was $759K. The expected cost to implement SAMA 161 will exceed the upper bound benefit of $620K.
162	Increase the capacity margin of the CST	Extend long term operation of EFW without operator action for CST makeup for sequences that do not go to cold shutdown. Enhance CST margin for design-basis seismic event with cooldown via SG and transition to RHR	CST01	18.1K	$33.6K	>$100K	Not cost beneficial. PRA case CST01conservatively assumes a continuous, successful CST suction source for EFW. Cost of expanding capacity of the CST is expected to significantly exceed benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
163	Install third EFW pump (steam-driven)	Reduce CDF of SBO sequences by improving overall reliability of EFW system independent of AC power. An additional pump might also have a Level 2 benefit by maintaining coverage of SG tubes thus reducing the release potential for induced SGTR given high pressure core melt sequence	TDAFW	$210K	$400K	*>$2M* ~~>$250K~~	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost. This modification was assumed to be the equivalent of adding one new high pressure injection pump described in SAMA 26. A discharge path, suction source and supply from the Main Steam header would have to be routed, analyzed and supported. Changes to how the safety related EFW pumps are configured would require substantial changes to the foot print of the system and flow analysis in addition to procurement and installation of the pump, piping and control valves. A detailed estimate would far exceed the upper bound benefit of $400K and no more refined cost estimate is warranted.
164	Modify 10" Condensate Filter Flange to have a 2½-inch female fire hose adapter with isolation valve	Possible enhancement of long term core damage sequences that credit CST makeup	CST01	18.1K	$33.6K	>$40K	Not cost beneficial. PRA case CST01conservatively assumes a continuous, successful CST suction source for EFW. Cost of modifying the condensate flange is expected to exceed benefit.
165	RWST fill from firewater during containment injection - Modify 6" RWST Flush Flange to have a 2½-inch female fire hose adapter with isolation valve	Could enhance long term containment injection sequences that would benefit from RWST makeup	NORMW	$158	$298K	$50K	SAMA #165 was shown to be potentially cost beneficial in the original study. The 2.1x sensitivity evaluation furthers the degree to which this SAMA is beneficial.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
167	Install independent seal injection pump (low volume pump) with automatic start	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures	RCPLOCA	$173K	$370K	>$1M	Not cost beneficial. PRA case RCPLOCA conservatively assumes that RCP seal LOCA events are eliminated. The cost of installing an independent seal injection pump/system with automatic start is expected to significantly exceed benefit.
168	Install independent seal injection pump (low volume pump) with manual start	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures	RCPLOCA	$173K	$370K	>$1M	Not cost beneficial. PRA case RCPLOCA conservatively assumes that RCP seal LOCA events are eliminated. The cost of installing an independent seal injection pump/system with manual start is expected to significantly exceed benefit.
169	Install independent charging pump (high volume pump) with manual start	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures; improve decay heat removal using feed & bleed	RCPLOCA	$173K	$370K	>$500K	Not cost beneficial. PRA case RCPLOCA conservatively assumes that RCP seal LOCA events are eliminated. The cost of installing an independent charging pump with manual start is expected to significantly exceed benefit.
170	Replace the Positive Displacement Pump (PDP) with a 3rd centrifugal charging pump. Consider low volume and cooling water independence	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures	RCPLOCA	$173K	$370K	>$500K	Not cost beneficial. PRA case RCPLOCA conservatively assumes that RCP seal LOCA events are eliminated. The cost of installing a centrifugal pump, independent of cooling water, in place of the PDP start is expected to significantly exceed benefit.
172	Evaluate installation of a "shutdown seal" in the RCPs being developed by Westinghouse	Reduce CDF contribution from transients with seal cooling hardware failures resulting in RCP seal LOCA events	RCPLOCA	$173K	$370K	>$1M	Not cost beneficial. PRA case RCPLOCA conservatively assumes that RCP seal LOCA events are eliminated. The cost of the RCP shutdown seals is expected to significantly exceed benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
174	Provide alternate scram button to remove power from MG sets to CR drives	Improve reliability of reactor scram by providing remote-manual capability to remove rod drive power should the reactor trip breakers fail; reduce ATWS contribution	NOATWS	$147.4K	$281.4K	>$500K	Not cost beneficial. PRA case NOATWS conservatively assumes elimination of all ATWS risk. Cost of modifying the scram system to provide an alternate scram button is expected to exceed benefit.
175	Install fire detection in turbine building relay room	Improve fire detection and manual suppression actions	FIRE2	—	—	—	Complete. Fire detection is installed in the Turbine Building Relay Room. Reference: IS1642.919 and 93DCR021
179	Fire induced LOCA response procedure from Alternate Shutdown Panel	Possible reduction in CDF if mitigating fire-induced LOCA	FIRE1	$8.1K	$15.3K	***>$20K*** ~~>$10K~~	Not cost beneficial. PRA case FIRE1 conservatively assumes complete elimination of the control room fire initiating event that results in a PORV challenge. The proposed SAMA is to improve operator procedures for coping with a small LOCA due to fire and opening of a PORV. The procedure change would not eliminate, but potentially reduce the significance of this event. Therefore, the estimated benefit is conservative for this SAMA. This SAMA is judged to have marginal benefit due to existing design and guidance to minimize potential for inadvertent PORV interaction. Also, the likelihood of LOCA with control room uninhabitable for a long period of time is judged low. Anticipate additional remote indication and controls will need to be installed to achieve the benefit of procedural enhancements. The major Abnormal Procedure change alone has an estimated implementation cost of $15K. Total cost expected to significantly exceed the upper bound benefit of $15.3K.
181	Improve relay chatter fragility	Reduce CDF contribution from relay chatter	SEISMIC01	$214K	$409K	***>$600K*** ~~>$300K~~	PRA case SEISMIC01 conservatively assumes complete elimination of relay chatter. As stated in the ER SAMA report, there is significant uncertainty in relay fragility and this is not necessarily addressed by component replacement and is beyond state-of-the-art. The scope of this proposed SAMA would include approximately 34 relays associated with the EDGs and load sequencers. The expected average cost of a relay replacement is $20K each. As the implementation cost of replacing 34 relays (>$600K) exceeds the upper bound benefit of $409K, no more refined estimate is warranted. It is noted that a SAMA related to the seismic upgrade of relays for Diablo Canyon was estimated at >$4M.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
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Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
182	Improve seismic capacity of EDGs and steam-driven EFW pump	Improve component fragility and reduce seismic event contribution to CDF	SEISMIC02	<$1K	<$1K	>$500K	Not cost beneficial. PRA case SEISMIC02 conservatively assumes no seismic failures of the EDGs and turbine-driven EFW pump occur. The cost of upgrading the EDGs or the TD-EFW pump is expected to significantly exceed benefit.
184	Control/reduce time that the containment purge valves are in open position	Purge path is large opening. Reduce exposure time of open path, improve reliability/availabilit y of CI, reduce CI failure contribution to large release	PURGE	<$1K	<$1K	>$20K	Not cost beneficial. PRA case PURGE conservatively assumes that the containment purge valves are continuously in the closed position and are not opened periodically. The cost of procedural changes is expected to significantly exceed benefit. In addition, it is noted that historically, the exposure fraction of the containment online purge (COP) supply and exhaust paths is less than 10%, which is judged not significant.
186	Install containment leakage monitoring system	Improve containment reliability by reducing the potential for pre-existing containment leakage	*CISPRE* ~~CONT01~~	$23K	$43K	>$500K	Not cost beneficial. PRA case CISPRE conservatively assumes complete elimination of pre-existing containment leakage. The proposed SAMA is to install a leakage detection system having the proper sensitivity to detect leakage. Thus, upon detection of a leak, actions would be taken to identify the leakage source and take actions to reduce leakage. PRA case CISPRE is judged more representative than original PRA case CONT01. This is because CISPRE more accurately models the benefit of a leakage monitoring system compared to CONT01, which assumes elimination of containment failure events due to overpressure.
187	Install RHR isolation valve leakage monitoring system	Reduce ISLOCA challenge to RHR by identification of upstream valve failure	LOCA06	$59K	$112K	*>$190K* ~~>$100K~~	Not cost beneficial. PRA case LOCA06 conservatively assumes that ISLOCA events do not occur. The cost of installing a leakage monitoring system at the RHR isolation valves is expected to significantly exceed the benefit. Will require pressure and/or temperature transmitters installed between isolation valves. Alerts operator that lower pressure piping is being challenged by RCS leakage. This enhancement is similar to SAMA 111 contained in the Kewaunee License Renewal application. In that application $190K, the lowest of three estimates assessed was used for an implementing cost basis. The expected cost to implement SAMA 187 of $190K will exceed the upper bound benefit of $112K.
189	Modify or analyze SEPS capability: 1 of 2 SEPS for LOSP non-SI loads, 2 of 2 for LOSP SI loads	Allow all equipment to be run following LOSP with EDG failure but successful start and load of SEPS	1of2SEPS	$63K	$120K	>$300K	Not cost beneficial. PRA case 1of2SEPS models the change in SEPS success criteria from 2 of 2 DGs to 1 fo 2 DGs. The cost of analysis, hardware modifications and testing is expected to significantly exceed the benefit.
190	Add synchronization capability to SEPS Diesel	Eliminate current requirement for dead bus transfer from SEPS to normal power	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events. The cost of installing synchronization capability to the SEPS diesel is expected to significantly exceed benefit.

Table X-2 Seabrook Station Sensitivity Evaluation using Seismic Risk Multiplier of 2.1
(SAMA Candidates are from Seabrook ER Table F.8-1)

Seabrook SAMA Number	Potential Improvement	Discussion	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
191	Remove the 135F temperature trip of the PCCW pumps	Potential for some improvement in PCCW reliability by eliminating consideration of spurious trip	PCTES	<$1K	<$1K	>$100K	This SAMA is from Reference 3, RAI 5n and is evaluated for sensitivity to the 2.1x risk increase. Not cost beneficial. PRA Case PCTES assumed elimination of 100% of the inadvertent failure of the redundant temperature element/logic as a failure mode of the associated PCC division for both loss of PCCW (A/B) initiating events (during the year) and loss of PCCW (A/B) mitigative function (mission time). The results of this case study show that inadvertent actuation of the temperature/element logic does not contribute significantly to the system unreliability.
192	Install flow orifice in fire protection system	Reduce CDF contribution of CB flooding due to fire protection pipe break	NOCBFLD	$338K	$644K	$200K	SAMA #192 was shown to be potentially cost beneficial in the RAI submittal, reference 3. The 2.1x sensitivity evaluation furthers the degree to which this SAMA is beneficial. SAMA #192 was identified in RAI 1a (Reference 3)
193	Eliminate CSV167 AC power dependence	Reduce containment isolation failure contribution of CSV167	V167AC	$403K	$766K	$300K	SAMA #193 was shown to be potentially cost beneficial in the RAI submittal, reference 3. The 2.1x sensitivity evaluation furthers the degree to which this SAMA is beneficial. SAMA #193 was identified in RAI 2f (Reference 3)
194	Purchase or manufacture of a "gagging device" that could be used to close a stuck-open steam generator safety valve	Improve release mitigation for a SGTR event prior to core damage	MSSVRS	<$1K	<$1K	>$30K	This SAMA is from Reference 3, RAI 7, item c and is evaluated for sensitivity to the 2.1x risk increase. Not cost beneficial based on conservative PRA case and estimated cost.

Table X-3 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-SE3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 21)

Basic Event	Basic Event Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#1 DGDG1A.FR3	DG-1A fails to run for 24 hours	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#2 DGDG1B.FR3	DG-1B fails to run for 24 hours	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#3 ZZ.CIS.PRE.EXIST	Small pre-existing unidentified containment leakage	#186 Hardware or procedural change to eliminate or reduce likelihood of small pre-existing unidentified leakage	CISPRE	$23.1K	$42.6K	$50 to $100K	Not cost beneficial. PRA case CISPRE conservatively assumes complete elimination of pre-existing containment leakage. The proposed SAMA is to install a leakage detection system having the proper sensitivity to detect leakage. Thus, upon detection of a leak, actions would be taken to identify the leakage source and take actions to reduce leakage. Note that the cost of installing a hardware system for leakage detection is expected to exceed $500K (SAMA #186)
#4 HH.OSEP2Q.FA	Operator fails to close SEPS breaker from MCB, given SI Signal Top Event OSEP	#154 Hardware change for auto closure of SEPS breaker to eliminate operator action	OSEPALL	$68.3	$130.2	>$750K	Not cost beneficial. The PRA case OSEPALL conservatively assumes guaranteed success of all manual actions to align and load the SEPS diesel generators. The current design requires the operator to manually align SEPS to the desired bus and to manually load SEPS to ensure power is available to needed components. The proposed SAMA is to install a control system to perform these actions automatically. The cost of the automatic control system is estimated to exceed the benefit.
#5 FWP37A.FR	Turbine Driven Pump FW-P-37A fails to run	#163	TDAFW	$210K	$399K	>$2M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost.
#6 CSV167.FO	Top Event CIS, Pen. X-37 isolation valve CS-V-167	#193 Hardware change to eliminate MOV AC power dependence	V167AC	$403K	$766K	>$300K	Potentially cost beneficial based on assumed replacement of MOV with FC AOV. SAMA #193 was shown to be potentially cost beneficial in the RAI submittal, reference 3. The 2.1x sensitivity evaluation furthers the degree to which this SAMA is beneficial.

Table X-3 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-SE3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 21)

Basic Event	Basic Event Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#7 HH.OSEP1Q.FA	Operator fails to close SEPS breaker from MCB given seismic event	#154 Hardware change for auto closure of SEPS breaker to eliminate operator action	OSEPALL	$68.3K	$130.2K	>$750K	Not cost beneficial. The PRA case OSEPALL conservatively assumes guaranteed success of all manual actions to align and load the SEPS diesel generators. The current design requires the operator to manually align SEPS to the desired bus and to manually load SEPS to ensure power is available to needed components. The proposed SAMA is to install a control system to perform these actions automatically. The cost of the automatic control system is estimated to exceed the benefit.
#8 SEPSDG2A.FR3	1-SEPS-DG-2-A fails to run within 24 hours	#9, #14, #189, Elimination of all potential for SEPS failure	SEPES	$83.6K	$159.2K	>$300K	Not cost beneficial. PRA case SEPES conservatively assumes elimination of all SEPS DG hardware failures (assumes guaranteed success of SEPS DGs). Thus, the benefit of modifying the SEPS electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost to analyze existing SEPS DGs, or installation of an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#9 SEPSDG2B.FR3	1-SEPS-DG-2-B fails to run within 24 hours	#9, #14, #189, Elimination of all potential for SEPS failure	SEPES	$83.6K	$159.2K	>$300K	Not cost beneficial. PRA case SEPES conservatively assumes elimination of all SEPS DG hardware failures (assumes guaranteed success of SEPS DGs). Thus, the benefit of modifying the SEPS electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost to analyze existing SEPS DGs, or installation of an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#10 HH.OCI2Q.FL	Operator fails to close containment isolation valve CSV-167 locally given medium seismic event	Provide a hardware modification (additional signals or remote capability) to automatically close V-167.	OCI2S	$5.5K	$10.5K	N/A	This SAMA basic event candidate is related to basic event CSV167.FO and SAMA #193, which has been shown to be potentially cost beneficial based on assumed replacement of MOV with FC AOV.
#11 DGP115A.FS	DG-1A Engine Driven Lube Oil Pump fails to run	Provide hardware modification to improve lube oil pump reliability	DGP115A/B	$19K	$35.7K	>$100K	Not cost beneficial based on assumed elimination of DGP115A/B basic event RRW SE3, LL3, SE1, LL4 failure contribution and estimated cost to add hardware (additional pump) needed to improve reliability.
#12 DGDG1A.FS	DG-1A fails to start on demand	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.

Table X-3 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-SE3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Basic Event Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#13 DGDG1A.FR1	DG-1A fails to run for first hour	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#14 DGP115B.FS	DG-1A Engine Driven Lube Oil Pump fails to run	Provide hardware modification to improve lube oil pump reliability	DGP115A/B	$19K	$35.7K	>$100K	Not cost beneficial based on assumed elimination of DGP115A/B basic event RRW SE3, LL3, SE1, LL4 failure contribution and estimated cost to add hardware (additional pump) needed to improve reliability.
#15 DGDG1B.FS	DG-1B fails to start on demand	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.

Table X-4 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#1 XX.EDESWG5.FX	4KV Bus E5 fault (IE)	Improve Bus E5 reliability, eliminate potential for bus fault	E6S	$82K	$156K	***>$500K*** ~~>$100K~~	Not cost beneficial. PRA case E6S is representative of 4Kv Bus E5. The PRA case conservatively assumes elimination of Bus E5 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#2 XX.EDESWG6.FX	4KV Bus E6 fault (IE)	Improve Bus E6 reliability, eliminate all potential for bus fault	E6S	$82K	$156K	***>$500K*** ~~>$100K~~	Not cost beneficial. The PRA case conservatively assumes elimination of Bus E6 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-4 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#3 CCTE2271.FZ	PCC Train B Temperature Element CC-TE-2271 transmits false low	Improve PCC TE reliability, eliminate potential for temp. element failure	PCCTS	$61K	$116K	>$250K ~~>$100K~~	Not cost beneficial based on assumed elimination of all risk associated with TE-2171 and TE-2271 failures. PRA case PCCTS conservatively assumes guaranteed success of the TE function for PCC Trains A and B that could cause an initiating event (IE model) and/or fail PCCW during mission time (support system model). Hardware changes that would significantly improve temperature control reliability, for example adding additional redundant instrumentation and controls, is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 186,which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#4 CCTE2171.FZ	PCC Train A Temperature Element CC-TE-2171 transmits false low	Improve PCC TE reliability, eliminate potential for temp. element failure	PCCTS	$61K	$116K	>$250K ~~>$100K~~	Not cost beneficial based on assumed elimination of all risk associated with TE-2171 and TE-2271 failures. PRA case PCCTS conservatively assumes guaranteed success of the TE function for PCC Trains A and B that could cause an initiating event (IE model) and/or fail PCCW during mission time (support system model). Hardware changes that would significantly improve temperature control reliability, for example adding additional redundant instrumentation and controls, is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#5 FWP37A.FR	Turbine Driven Pump FW-P-37A fails to run	#163	TDAFW	$210K	$399K	>$2M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost.
#6 ZZ.SY1.FX	Loss of Offsite Power subsequent to Plant Trip	#13, #156, #160	NOLOSP	$704K	$1.34M	>$2M	Not cost beneficial based on assumed elimination of all risk associated with loss of offsite power. PRA case NOLOSP assumes elimination of all LOSP events and provides a conservative benefit for ZZ.SY1.FX, which models consequential loss of offsite power following a plant trip event. The cost of power system upgrades that would significantly reduce or eliminate consequential loss of offsite power events is expected to significantly exceed the conservative benefit.

Table X-4 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#7 HH.XOSMP1.FA	Operator aligns containment sump recirculation after core melt	Provide a hardware modification for auto-control, eliminate operator action to align sump after core melt.	XOSMPS	$44.1K	$83.4K	>$100K	Not cost beneficial based on assumed elimination of human action. PRA case XOSMPS conservatively assumes guaranteed success of the operator action to align containment sump recirculation after core melt. The cost to modify the recirculation system to provide automatic control of the transfer to sump recirculation is expected to significantly exceed the conservative benefit. Procedures directing this action are sufficiently detailed and evaluated in the PRA human reliability analysis. Any changes to procedures are judged not to have a significant beneficial impact on release risk.
#8 CCE17B.GL	Train B HX E-17B Excessive Leakage During Operation	Improve PCC Ht Ex reliability, eliminate potential for heat exchanger leakage	PCCLS	$46K	$87.4K	>$100K	Not cost beneficial based on assumed elimination of all risk associated with heat exchanger E17A and E17B leakage. A hardware modification to improve reliability, and/or eliminate the potential for PCCW heat exchanger leakage is expected to significantly exceed the conservative benefit.
#9 ZZ.SY2.FX	Loss of Offsite Power subsequent to LOCA initiator	#13, #156, #160	NOLOSP	$704K	$1.34M	>$2M	Not cost beneficial based on assumed elimination of all risk associated with loss of offsite power. PRA case NOLOSP assumes elimination of all LOSP events and provides a conservative benefit for ZZ.SY2.FX, which models consequential loss of offsite power following a LOCA event. The cost of power system upgrades that would significantly reduce or eliminate consequential loss of offsite power events is expected to significantly exceed the conservative benefit.
#10 CCE17A.GL	Train A HX E-17A Excessive Leakage During Operation	Improve PCC Ht Ex reliability, eliminate potential for heat exchanger leakage	PCCLS	$46K	$87.4K	>$100K	Not cost beneficial based on assumed elimination of all risk associated with heat exchanger E17A and E17B leakage. A hardware modification to improve reliability, and/or eliminate the potential for PCCW heat exchanger leakage is expected to significantly exceed the conservative benefit.

Table X-4 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#11 EDESWG11B.FX	DC Power Panel 11B fails to operate Top Event DCP, CCF Group BUSFL	Improve Bus E11B reliability, eliminate bus failure	E6S	$82K	$156K	***>$500K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of SWG11A/B basic event, case E6S is representative of Bus E11B. The PRA case conservatively assumes elimination of bus faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, dc buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#12 EDESWG11A.FX	DC Power Panel 11A fails to operate Top Event DCP, CCF Group BUSFL	Improve Bus E11A reliability, eliminate bus failure	E6S	$82K	$156K	***>$500K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of SWG11A/B basic event, case E6S is representative of Bus E11A. The PRA case conservatively assumes elimination of bus faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, dc buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#13 SWV5.FO	SW Secondary Isolation MOV SW-V-5 fails to close on demand	Improve SWV-5 reliability, eliminate valve failure	SWV5	$17K	$34K	>$100K	Not cost beneficial based on assumed elimination of SWV5 basic event RRW LL3, LL4, SE1 failure contribution. A hardware change that would significantly improve isolation valve reliability, for example adding redundant valves for isolation of SW to Turbine Building SW loads, is expected to significantly exceed the conservative benefit.
#14 DGDG1A.FR3	DG-1A fails to run for 24 hours	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG

Table X-4 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL3 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
							failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#15 EDESWG6.FX	4KV Bus E6 Fault	Improve Bus E6 reliability, eliminate potential for bus fault	E6S	$82K	$156K	*>$500K* ~~>$100K~~	Not cost beneficial. The PRA case conservatively assumes elimination of Bus E6 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies).. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-5 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#1 FWP37A.FR	Turbine Driven Pump FW-P-37A fails to run	#163	TDAFW	$210K	$399K	>$2M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost.
#2 HH.XOEFW1.FA	Operator establishes feed flow to faulted SG	Hardware for automatic feed flow, eliminate potential for operator failure to feed SG	XOEFW	$8.6K	$16.4K	>$100K	Not cost beneficial based on assumed elimination of operator failure to feed SG. A hardware change to provide automatic feed flow to the faulted SG is expected to significantly exceed the conservative benefit. Procedures directing this action are sufficiently detailed and evaluated in the PRA human reliability analysis. Any changes to procedures are judged not to have a significant beneficial impact on release risk.
#3 ZZ.SY2.FX	Loss of Offsite Power subsequent to LOCA initiator	#13, #156, #160	NOLOSP	$704K	$1.34M	>$2M	Not cost beneficial based on assumed elimination of all risk associated with loss of offsite power. PRA case NOLOSP assumes elimination of all LOSP events and provides a conservative benefit for ZZ.SY2.FX, which models consequential loss of offsite power following a LOCA event. The cost of power system upgrades that would significantly reduce or eliminate consequential loss of offsite power events is expected to significantly exceed the conservative benefit.
#4 FWV156.FC	SUFP to EFW Header MOV FW-V-156 fails to open on demand	Improve reliability of SUFP, eliminate potential for SUFP failures	SUFPS	*$20.5K* ~~$89K~~	*$39.1K* ~~$170K~~	>$100K	Not cost beneficial based on assumed elimination of all risk associated with the startup feedwater pump hardware. A hardware change to improve SUFP system reliability, e.g., install a parallel valve, is expected to significantly exceed the conservative benefit. PRA Case SUFPS is used to conservatively estimate the SAMA benefit. This case is conservative because it assumes guaranteed success of the entire Startup Feedwater system. Basic event FWV156.FC contributes approximately 23% to the total unreliability of the SUFP system. Therefore, the maximum benefit associated with reliability improvements to valve FW-V-156 is approximately 23% of the SUFPS PRA case results. Thus, the adjusted benefits are: Nominal Benefit: $89K * 0.23 = $20.5K Upper Bound Benefit: $170K * 0.23 = $39.1K

Table X-5 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#5 FWV163.FC	SUFP to EFW Header MOV FW-V-163 fails to open on demand	Improve reliability of SUFP, eliminate potential for SUFP failures	SUFPS	*$20.5K* ~~$89K~~	*$39.1K* ~~$170K~~	>$100K	Not cost beneficial based on assumed elimination of all risk associated with the startup feedwater pump hardware. A hardware change to improve SUFP system reliability, e.g., install a parallel valve, is expected to significantly exceed the conservative benefit. PRA Case SUFPS is used to conservatively estimate the SAMA benefit. This case is conservative because it assumes guaranteed success of the entire Startup Feedwater system. Basic event FWV163.FC also contributes approximately 23% to the total unreliability of the SUFP system. Therefore, the maximum benefit associated with reliability improvements to valve FW-V-163 is approximately 23% of the SUFPS PRA case results. Thus, the adjusted benefits are: Nominal Benefit: $89K * 0.23 = $20.5K Upper Bound Benefit: $170K * 0.23 = $39.1K
#6 FWP37B.FS	EFW motor-driven pump FW-P-37-B fails to start on demand	Hardware change to eliminate or reduce mechanical failures of MD EFW pump (installation of additional motor-driven pump)	MEFWS	$81K	$154.1K	*>$200K* ~~>$100K~~	Not cost beneficial based on assumed elimination of all risk associated with MD EFW pump failures. A hardware change to reduce/eliminate mechanical failures of the motor-driven EFW pump is expected to significantly exceed the conservative benefit. SAMA 25, 26 and 28 evaluated installation of a similar redundant pump, this improvement was previously estimated at greater than $2 million dollars in the Pilgrim License Renewal application. In the Duane Arnold License Renewal application, the Pilgrim estimate was judged to be low and used a $20 million estimate based on similar modification experience.
#7 HH.OTSI3.FA	Operator action for SI termination given successful cooldown and depressurization for SGTR.	Implement hardware change to improve reliability of SGTR control, eliminate or reduce operator failure to terminate SI	OTSIS	$59.4K	$113K	*>$300K* ~~>$100K~~	Not cost beneficial based on assumed elimination of the human failure risk including actions OTSI3, OTSI4 and OTSI5 for SI termination during SGTR. A hardware change to improve reliability of SGTR control is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#8 FWP37A.FS1	Turbine Driven Pump TURBINE FW-P-37A fails to start on demand	#163	TDAFW	$210K	$399K	>$2M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase

Table X-5 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
							cost.
#9 HH.ORWMZ1.FA	Operator minimizes ECCS flow w/recirculation failure	Implement hardware change for automatic ECC control, eliminate or reduce operator failure to min. ECC flow	ORWS	$66.8K	$127.3K	***>$300K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of the human failure risk. A hardware change to improve reliability of ECC control is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#10 ZZ.2PORV.NOCRI	ATWS - Unfavorable Exposure Time (UET) Probability, given 2 PORVs & 3 SVs available, w/o Control rod insertion (CRI)	Improve hardware and procedures to reduce or eliminate unfavorable exposure probability, improve CRI availability	UET	$6.3K	$12.6K	>$50K	Not cost beneficial based on assumed elimination of UET basic event RRW LE1, LL4 probability contribution. A hardware or procedure change to improve CRI availability is expected to significantly exceed the conservative benefit.
#11 HH.OSUFP2.FA	Operator fails to start SUFP given SI initiator	Provide auto-start of SUFP, eliminate potential for operator failure to start SUFP	OSUFPS	$13.9K	$26.7K	>$100K	Not cost beneficial based on assumed elimination of all risk associated with manual action to start the SUFP. A hardware change to provide an auto-start feature to the startup feedwater pump is expected to significantly exceed the conservative benefit.
#12 FWP113.FS	Startup Feed Pump FW-P113 fails to start on demand	Improve SUFP reliability, eliminate potential for SUFP mechanical failures	SUFPS	***$20.5K*** ~~$89K~~	***$39.1K*** ~~$170K~~	>$100K	Not cost beneficial based on assumed elimination of all risk associated with the startup feedwater pump hardware. A hardware change to improve SUFP reliability is expected to significantly exceed the conservative benefit. PRA Case SUFPS is used to conservatively estimate the SAMA benefit. This case is conservative because it assumes guaranteed success of the entire Startup Feedwater system. The startup feed pump itself contributes approximately 15% to the total unreliability of the SUFP system. Therefore, the maximum benefit associated with reliability improvements to the startup feed pump is approximately 15% of the SUFPS PRA case results. Thus, the adjusted benefits are: Nominal Benefit: $89K * 0.15 = $13.3K Upper Bound Benefit: $170K * 0.15 = $25.5K

Table X-5 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA(s)	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#13 FWP37B.FR	EFW motor-driven pump FW-P-37-B fails to run	Hardware change to improve pump reliability, eliminate or reduce mechanical failures of MD EFW pump (installation of additional motor-driven pump)	MEFWS	$80.9K	$154.1K	***>$200K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of all risk associated with MD EFW pump failures. A hardware change to reduce/eliminate mechanical failures of the motor-driven EFW pump is expected to significantly exceed the conservative benefit. SAMA 25, 26 and 28 evaluated installation of a similar redundant pump, this improvement was previously estimated at greater than $2 million dollars in the Pilgrim License Renewal application. In the Duane Arnold License Renewal application, the Pilgrim estimate was judged to be low and used a $20 million estimate based on similar modification experience.
#14 FWPCV4326.FC	1-FW-PCV-4326 SUFP recirculation fails to open on demand	Hardware change to improve SUFP reliability, eliminate or reduce potential for SUFP/valve failures	SUFPS	***$8.0K*** ~~$89K~~	***$15.3K*** ~~$170.1K~~	>$100K	Not cost beneficial based on assumed elimination of all risk associated with the startup feedwater pump hardware. A hardware change to improve SUFP reliability is expected to significantly exceed the conservative benefit. PRA Case SUFPS is used to conservatively estimate the SAMA benefit. This case is conservative because it assumes guaranteed success of the entire Startup Feedwater system. The SUFP recirculation valve FW-PCV-4326 contributes approximately 9.0% to the total unreliability of the SUFP system. Therefore, the maximum benefit associated with reliability improvements to valve FW-PCV-4326 is approximately 9.0% of the SUFPS PRA case results. Thus, the adjusted benefits are: Nominal Benefit: $89K * 0.09 = $8.0K Upper Bound Benefit: $170K * 0.09 = $15.3K
#15 FWV347.OP	EFW P-37B recirculation MOV FW-V-347 transfers open (flow diversion)	Hardware change to improve reliability, eliminate or reduce mechanical failures of MD EFW pump/valves	MEFWS	***$7.6K*** ~~$80.9K~~	***$14.5K*** ~~$154.1K~~	>$100K	Not cost beneficial based on assumed elimination of all risk associated with MD EFW pump failures. A hardware change to reduce/eliminate mechanical failures of the motor-driven EFW pump/valves is expected to significantly exceed the conservative benefit. Valve FW-V-347 contributes approximately 8.5% to the total unreliability of the motor-driven EFW pump. Therefore, the maximum benefit associated with reliability improvements to valve FW-V-347 is approximately 8.5% of the MEFWS PRA case results. Thus, the adjusted benefits are: Nominal Benefit: $89K * 0.085 = $7.6K Upper Bound Benefit: $170K * 0.085 = $14.5K

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-SE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#1 HH.OTSI3.FA	Operator action for SI termination given successful cooldown and depressurization for SGTR.	Provide automatic control, eliminate or reduce operator failure to terminate SI	OTSIS	$59.4K	$113K	***>$300K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of the human failure risk including actions OTSI3, OTSI4 and OTSI5 for SI termination during SGTR. A hardware change to improve reliability of SGTR control is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#2 HH.ORWMZ1.FA	Operator minimizes ECCS flow w/recirculation failure	Implement hardware change for automatic ECC control, eliminate or reduce operator failure to min. ECC flow	ORWS	$66.8K	$127.3K	***>$300K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of the human failure risk. A hardware change to improve reliability of ECC control is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#3 ZZ.SY2.FX	Loss of Offsite Power subsequent to LOCA initiator	#13, #156, #160	NOLOSP	$704K	$1.34M	>$2M	Not cost beneficial based on assumed elimination of all risk associated with loss of offsite power. PRA case NOLOSP assumes elimination of all LOSP events and provides a conservative benefit for ZZ.SY2.FX, which models consequential loss of offsite power following a LOCA event. The cost of power system upgrades that would significantly reduce or eliminate consequential loss of offsite power events is expected to significantly exceed the conservative benefit.
#4 HH.ODDSG1.FA	Operator fails to diagnose SG Tube Rupture Event	Implement hardware change to eliminate or reduce operator failure to terminate SI	OTSIS	$59.4K	$113K	***>$300K*** ~~>$100K~~	OTSIS is representative case for HH.ODDSG1.FA. Not cost beneficial based on assumed elimination of the human action to diagnose SGTR event. A hardware change to improve reliability of SGTR control is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#5 HH.OSGRD1.FA	Operator depressurizes RCS to Stop Break Flow to Ruptured SG (SGTR)	Implement hardware change to improve reliability of SGTR control, eliminate operator action to depressurize	OSGRDS	$9.5K	$17.9K	>$100K	Not cost beneficial based on assumed elimination of operator action to depressurize RCS. A hardware change to improve reliability of SGTR control including depressurization is expected to significantly exceed the conservative benefit.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-SE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#6 HH.ORWCD1.FA	Operator fails to Cooldown/Depressurize RCS to Minimize Leak w/Recirculation Failure (VSEQ)	Implement hardware change to improve reliability, eliminate operator action to depressurize	ORWCDS	$9.3K	$17.5K	>$100K	Not cost beneficial based on assumed elimination of operator action to cooldown and depressurize RCS. A hardware change to improve reliability of VSEQ control including depressurization is expected to significantly exceed the conservative benefit.
#7 FWP37A.FR	Turbine Driven Pump FW-P-37A fails to run	#163	TDAFW	$210K	$399K	>$2M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump to improve reliability is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost.
#8 HH.ORWIN1.FA	Operator fails to initiate makeup to RWST given LOCA w/ recirculation failure	Hardware change to provide auto-makeup to RWST, eliminate operator action	ORWS	$66.8K	$127.3K	***>$300K*** ~~>$100K~~	ORWS is representative case for HH.ORWIN1.FA. Not cost beneficial based on assumed elimination of the human action to perform RWST makeup. A hardware change to improve reliability of RWST makeup (automatic control system) is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#9 HH.OTEFW3.FA	Operator fails to terminate EFW flow to ruptured SG - SGTR	Hardware change to eliminate operator action to depressurize	OSGRDS	$9.5K	$17.9K	***>$300K*** ~~>$100K~~	OSGRDS is representative case for HH.OTEF3.FA. Not cost beneficial based on assumed elimination of operator action to terminate EFW flow for SGTR. A hardware change to improve reliability of SGTR control including control of EFW to the ruptured SG is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-SE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#10 HH.ORWLT1.FA	Operator fails to maintain stable plant conditions w/ long term makeup	Hardware change for automatic control or eliminate operator action to maintain stable conditions	ORWS	$66.8K	$127.3K	***>$300K*** ~~>$100K~~	ORWS is representative case for HH.ORWLT1.FA. Not cost beneficial based on assumed elimination of the human failure risk A hardware change to improve reliability of RWST makeup (automatic control system) is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#11 HH.OSGRC1.FA	Operator fails to cooldown RCS to allow isolation of ruptured SG (SGTR)	Hardware change for automatic control or eliminate operator action to cooldown RCS	OSGRDS	$9.5K	$17.9K	***>$300K*** ~~>$100K~~	OSGRDS is representative case for HH.OSGRC1.FA. Not cost beneficial based on assumed elimination of operator action to cooldown RCS. A hardware change to improve reliability of SGTR control including RCS cooldown is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#12 HH.ORHCD8.FA	Operator fails to cool/depressurize RCS for RHR S/D cooling for SGTR w/ failure of OSGRD	Hardware change for automatic control or eliminate operator action to cooldown RCS	ORHCDS	$25.8K	$49.4K	>$100K	Not cost beneficial based on assumed elimination of all ORHCD related operator actions to cooldown RCS. A hardware change to improve reliability of SGTR control including RCS cooldown is expected to significantly exceed the conservative benefit.
#13 CBSV17.FC	Containment Building Spray Pump P-9B discharge MOV CBS-V-17 fail to open on demand	Hardware change to improve valve reliability, eliminate CBS discharge MOV failures	CBSDVS	$<2K	$<2K	>$100K	Not cost beneficial based on assumed elimination of both CBS-V-11 and CBS-V-17 failure to open on demand. A hardware change to improve reliability of CBS discharge valves is expected to significantly exceed the conservative benefit.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-SE1 using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#14 CBSV11.FC	Containment Building Spray Pump P-9A discharge MOV CBS-V-11 fail to open on demand	Hardware change to improve valve reliability, eliminate CBS discharge MOV failures	CBSDVS	$<2K	$<2K	>$100K	Not cost beneficial based on assumed elimination of both CBS-V-11 and CBS-V-17 failure to open on demand. A hardware change to improve reliability of CBS discharge valves is expected to significantly exceed the conservative benefit.
#15 HH.OSEP2.FA	Operator fails to close SEPS breaker from the MCB given SI signal	#154 Hardware change for auto closure of SEPS breaker to eliminate operator action	OSEPALL	$68.3K	$130.2K	>$750K	Not cost beneficial. The PRA case OSEPALL conservatively assumes guaranteed success of all manual actions to align and load the SEPS diesel generators. The current design requires the operator to manually align SEPS to the desired bus and to manually load SEPS to ensure power is available to needed components. The proposed SAMA is to install a control system to perform these actions automatically. The cost of the automatic control system is estimated to exceed the benefit.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL4 using Seismic Risk Multiplier of 2.1 (Basic Events are from RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#1 HH.XOVNT1.FA	Operator fails to vent containment late	Hardware change for automatic venting control, eliminate need to perform late containment venting	XOVNTS	$63.8K	$122K	*>$300K* ~~>$100K~~	Not cost beneficial based on assumed elimination of operator action to vent containment. A hardware change to for automatic venting control is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#2 HH.XOSMP1.FA	Operator aligns containment sump recirculation after core melt	Provide a hardware modification for auto-control, eliminate operator action to align sump after core melt.	XOSMPS	$44.1K	$83.4K	>$100K	Not cost beneficial based on assumed elimination of human action. PRA case XOSMPS conservatively assumes guaranteed success of the operator action to align containment sump recirculation after core melt. The cost to modify the recirculation system to provide automatic control of the transfer to sump recirculation is expected to significantly exceed the conservative benefit.
#3 FWP37A.FR	Turbine Driven Pump FW-P-37A fails to run	#163	TDAFW	$210K	$399K	>$2M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump to improve reliability is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost.
#4 DGDG1A.FR3	DG-1A fails to run for 24 hours	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL4 using Seismic Risk Multiplier of 2.1 (Basic Events are from RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#5 XX.EDESWG5.FX	4KV BUS E5 fault (IE)	Improve Bus E5 reliability, eliminate all potential for bus fault	E6S	$82K	$156K	***>$500K*** ~~>$100K~~	Not cost beneficial. PRA case E6S is representative of 4Kv Bus E5. The PRA case conservatively assumes elimination of Bus E5 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#6 DGDG1B.FR3	DG-1B fails to run for 24 hours	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#7 XX.EDESWG6.FX	4KV BUS E6 fault (IE)	Improve Bus E6 reliability, eliminate all potential for bus fault	E6S	$82K	$156K	***>$500K*** ~~>$100K~~	Not cost beneficial. The PRA case conservatively assumes elimination of Bus E6 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL4 using Seismic Risk Multiplier of 2.1 (Basic Events are from RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#8 ZZ.SY1.FX	Loss of Offsite Power subsequent to plant trip	#13, #156, #160	NOLOSP	$704K	$1.34M	>$2M	Not cost beneficial based on assumed elimination of all risk associated with loss of offsite power. PRA case NOLOSP assumes elimination of all LOSP events and provides a conservative benefit for ZZ.SY1.FX, which models consequential loss of offsite power following a plant trip event. The cost of power system upgrades that would significantly reduce or eliminate consequential loss of offsite power events is expected to significantly exceed the conservative benefit.
#9 EDESWG6.FX	4KV BUS E6 fault	Improve Bus E6 reliability, eliminate all potential for bus fault	E6S	$82K	$156K	>$500K ~~>$100K~~	Not cost beneficial. The PRA case conservatively assumes elimination of Bus E6 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#10 SEPSDG2A.FR3	1-SEPS-DG-2-A fails to run within 24 hours	#9, #14, #189, Improve reliability of SEPS DG, eliminate potential for SEPS failure	SEPES	$83.6K	$159.2K	>$300K	Not cost beneficial. PRA case SEPES conservatively assumes elimination of all SEPS DG hardware failures (assumes guaranteed success of SEPS DGs). Thus, the benefit of modifying the SEPS electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost to analyze existing SEPS DGs or installation of an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit
#11 SEPSDG2B.FR3	1-SEPS-DG-2-B fails to run within 24 hours	#9, #14, Improve reliability of SEPS DG, eliminate potential for SEPS failure	SEPES	$83.6K	$159.2K	>$300K	Not cost beneficial. PRA case SEPES conservatively assumes elimination of all SEPS DG hardware failures (assumes guaranteed success of SEPS DGs). Thus, the benefit of modifying the SEPS electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost to analyze existing SEPS DGs or installation of an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL4 using Seismic Risk Multiplier of 2.1 (Basic Events are from RAI 2f)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#12 CCTE2271.FZ	PCC Train B Temperature Element CC-TE-2271 transmits false low	Improve PCC TE reliability, eliminate potential for temp. element failure	PCCTS	$61K	$116.1K	***>$250K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of all risk associated with TE-2171 and TE-2271 failures. PRA case PCCTS conservatively assumes guaranteed success of the TE function for PCC Trains A and B that could cause an initiating event (IE model) and/or fail PCCW during mission time (support system model). Hardware changes that would significantly improve temperature control reliability, for example adding additional redundant instrumentation and controls, is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted..
#13 CCTE2171.FZ	PCC Train A Temperature Element CC-TE-2171 transmits false low	Improve PCC TE reliability, eliminate potential for temp. element failure	PCCTS	$61K	$116.1K	***>$250K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of all risk associated with TE-2171 and TE-2271 failures. PRA case PCCTS conservatively assumes guaranteed success of the TE function for PCC Trains A and B that could cause an initiating event (IE model) and/or fail PCCW during mission time (support system model). Hardware changes that would significantly improve temperature control reliability, for example adding additional redundant instrumentation and controls, is expected to significantly exceed the conservative benefit. Design changes to implement this type of action would be similar in nature to SAMAs 147, 174, 186 and 187, which were estimated to exceed $500K. As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.
#14 HH.OINE3.FA	Operator fails to start containment injection early without AC power (gravity drain of RWST)	Hardware change for automatic initiation of containment injection gravity drain, eliminate operator action	XOINES	$8.6K	$16.2K	>$100	Not cost beneficial based on assumed elimination of all operator actions to initiate containment injection (XOINE1, XOINE2, & OINE3). A hardware change to improve containment injection reliability is expected to significantly exceed the conservative benefit.

Table X-6 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RC-LL4 using Seismic Risk Multiplier of 2.1 (Basic Events are from RAI 2f)							
Basic Event	**Description**	**Associated SAMA**	**PRA Case**	**Nominal Benefit at 2.1x**	**Upper Bound Benefit at 2.1x**	**Cost Estimate**	**Evaluation**
#15 EDESWG5.FX	4KV BUS E5 fault	Improve Bus E5 reliability, eliminate all potential for bus fault	E6S	$82K	$155.6K	*>$500K* ~~>$100K~~	Not cost beneficial. PRA case E6S is representative of 4Kv Bus E5. The PRA case conservatively assumes elimination of Bus E5 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-7 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RRW using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 5b)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#1 FWP37A.FR	Turbine Driven PUMP FW-P-37A fails to run	#163	TDAFW	$210K	$399K	>$1M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost.
#2 DGDG1A.FR3	DG-1A fails to run for 24 hours	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#3 DGDG1B.FR3	DG-1B fails to run for 24 hours	#9, #10, #14, #155	NOSBO	$326K	$620K	>$1M	Not cost beneficial. PRA case NOSBO conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite diesel generators. Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost of installing an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#4 EDESWG6.FX	4KV BUS E6 fault	Improve Bus E6 reliability, eliminate / reduce potential for bus fault	E6S	$82K	$156K	***>$500K*** ~~>$100K~~	Not cost beneficial. The PRA case conservatively assumes elimination of Bus E6 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-7 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RRW using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 5b)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#5 ZZ.SY1.FX	Loss of Offsite Power subsequent to plant trip	#13, #156, #160	NOLOSP	$704K	$1.34M	>$2M	Not cost beneficial based on assumed elimination of all risk associated with loss of offsite power. PRA case NOLOSP assumes elimination of all LOSP events and provides a conservative benefit for ZZ.SY1.FX, which models consequential loss of offsite power following a plant trip event. The cost of power system upgrades that would significantly reduce or eliminate consequential loss of offsite power events is expected to significantly exceed the conservative benefit.
#6 ZZ.SY2.FX	Loss of Offsite Power subsequent to LOCA initiator	#13, #156, #160	NOLOSP	$704K	$1.34M	>$2M	Not cost beneficial based on assumed elimination of all risk associated with loss of offsite power. PRA case NOLOSP assumes elimination of all LOSP events and provides a conservative benefit for ZZ.SY2.FX, which models consequential loss of offsite power following a LOCA event. The cost of power system upgrades that would significantly reduce or eliminate consequential loss of offsite power events is expected to significantly exceed the conservative benefit.
#7 FWP37A.FS1	Turbine Driven Pump TURBINE FW-P-37A fails to start on demand	#163	TDAFW	$210K	$399K	>$2M	Not cost beneficial. PRA case TDAFW conservatively assumes guaranteed success of the turbine-driven EFW pump. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Installation of an additional turbine-driven EFW pump is not practical and the cost would be expected to significantly exceed the conservative benefit. The reduction in seismic risk would not be significant unless the new equipment is also seismically rugged, which would further increase cost.
#8 SEPSDG2A.FR3	1-SEPS-DG-2-A fails to run within 24 hours	#9, #14, #189, Improve reliability of SEPS DG, eliminate potential for SEPS failure	SEPES	$83.6K	$159.2K	>$300K	Not cost beneficial. PRA case SEPES conservatively assumes elimination of all SEPS DG hardware failures (assumes guaranteed success of SEPS DGs). Thus, the benefit of modifying the SEPS electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost to analyze existing SEPS DGs or installation of an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.
#9 SEPSDG2B.FR3	1-SEPS-DG-2-B fails to run within 24 hours	#9, #14, #189, Improve reliability of SEPS DG, eliminate potential for SEPS failure	SEPES	$83.6K	$159.2K	>$300K	Not cost beneficial. PRA case SEPES conservatively assumes elimination of all SEPS DG hardware failures (assumes guaranteed success of SEPS DGs). Thus, the benefit of modifying the SEPS electrical power system to add or modify a DG to improve/eliminate DG failures is conservatively high. The cost to analyze existing SEPS DGs or installation of an additional DG to improve electrical system reliability is expected to significantly exceed the conservative benefit.

Table X-7 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RRW using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 5b)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#10 HH.OSEP1.FA	OPERATOR fails to close SEPS breaker from MCB	#9, #14, #154, Provide auto-start and load for SEPS DG	OSEPALL	$68.3	$130.2	>$750K	Not cost beneficial. The PRA case OSEPALL conservatively assumes guaranteed success of all manual actions to align and load the SEPS diesel generators. The current design requires the operator to manually align SEPS to the desired bus and to manually load SEPS to ensure power is available to needed components. The proposed SAMA is to install a control system to perform these actions automatically. The cost of the automatic control system is estimated to exceed the benefit. PRA case OSEPALL models elimination of all SEPS operator actions and is used here for operator action HH.OSEP1.FA in place of PRA case OSEP1.
#11 HH.OHPR3.FA	OPERATOR fails to align ECCS for HP Cold Leg Recirculation for Feed & Bleed Cooling with CBS	Provide hardware change for automatic alignment of recirculation, eliminate operator action	LOCA04	$332K	$630K	>$1M	Not cost beneficial. PRA case LOCA04 conservatively assumes guaranteed success of the RWST volume as a continuous source of water for ECCS. Included in this conservative PRA case is the assumption that all operator actions for the various high and low pressure seequences and hardware to initiate the ECCS swap-over to the sump are successful. Therefore, the benefit of an automatic swap-over control system is conservatively high. The cost of implementing a swap-over control system is expected to significantly exceed the conservative benefit. The implementation cost is consistent with the implementation cost estimated for other plants, for example Indian Point and McGuire estimated >$1M and Diablo Canyon estimated >$6M.
#12 RCPCV456B.RS	PORV RC-PCV-456B fails to reseat	Improve reliability of PORV reseat function, eliminate PORV re-seat failure	PORVRS	$48K	$91.1K	>$100K	Not cost beneficial based on assumed elimination of all PORV reclose failure potential. A hardware change to improve reseat reliability is expected to significantly exceed the conservative benefit.
#13 EDESWG5.FX	4KV BUS E5 fault	Improve Bus E5 reliability, eliminate / reduce potential for bus fault	E6S	$82K	$156K	*>$500K* ~~>$100K~~	Not cost beneficial. PRA case E6S is representative of 4Kv Bus E5. The PRA case conservatively assumes elimination of Bus E5 faults that could cause an initiating event (IE model) and/or fail the associated power division during mission time (support system model) by assuming guaranteed success of the bus. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. A hardware change that would significantly improve bus reliability, for example adding a redundant bus within a division, is judged impractical and is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-7 Seabrook Station Sensitivity Evaluation of Top Basic Events Contributing to RRW using Seismic Risk Multiplier of 2.1
(Basic Events are from Seabrook Response to RAI 5b)

Basic Event	Description	Associated SAMA	PRA Case	Nominal Benefit at 2.1x	Upper Bound Benefit at 2.1x	Cost Estimate	Evaluation
#14 RCPCV456A.RS	PORV RC-PCV-456A fails to reseat	Improve reliability of PORV reseat function, eliminate PORV re-seat failure	PORVRS	$48K	$91.1K	>$100K	Not cost beneficial based on assumed elimination of all PORV reclose failure potential. A hardware change to improve reseat reliability is expected to significantly exceed the conservative benefit.
#15 HH.ORWMZ1.FA	OPERATOR minimizes ECCS flow w/ recirc. failure	Provide hardware change for automatic ECCS flow control.	ORWS	$66.8K	$127.3K	***>$300K*** ~~>$100K~~	Not cost beneficial based on assumed elimination of the human failure risk. A hardware change to improve reliability of ECC control is expected to significantly exceed the conservative benefit. Implementation assumed to involve design of additional bus to achieve improvement in bus reliability with a cost of >$1M. This scope is assumed similar to SAMA #16 (improved uninterruptible power supplies). As this value substantially exceeds the upper bound benefit no more refined estimate is warranted.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1 (Other Plant SAMAs are from Seabrook Response to RAI 5k)			
SAMA	**SAMA Description**	**Seabrook Original Evaluation (RAI 5k)**	**Sensitivity Evaluation to Seismic Risk Increase of 2.1x**
Salem Station Proposed SAMA Candidates			
SAMA #1	Enhance Procedures and Provide Additional Equipment to Respond to Loss of Control Area Ventilation.	Screened Phase 1, Criterion B – Intent Met. Seabrook currently has a specific abnormal procedure for implementing compensatory actions for loss of control room ventilation or air conditioning. A compensatory procedure for loss of Essential Switchgear Room ventilation also exists (as addressed in Seabrook SAMA #82).	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #2	Re-configure Salem 3 to Provide a More Expedient Backup AC Power Source for Salem 1 and 2.	Screened Phase 2, Not Cost-Beneficial. Seabrook Station is a single unit site with no other onsite power generation capability (except for onsite emergency and supplemental diesel generators). Installation of additional onsite power generation capability was evaluated in Seabrook SAMA #13 (buried offsite power source), SAMA #14 (gas turbine), and SAMA #156 (install alternate offsite power source). These SAMA candidates were judged not cost-beneficial in Phase 2.	Seabrook SAMAs #13, #14 and #156 have been evaluated for sensitivity to seismic risk increase and have been shown not to be cost beneficial. Refer to Table X-2.
SAMA #3	Install Limited EDG Cross-tie Capability Between Salem 1 and 2.	Screened Phase 1, Criterion A – Not Applicable. Seabrook Station is a single unit site with no other onsite power generation capability (except for onsite emergency and supplemental diesel generators). Phase 1 screening is consistent with Seabrook SAMA# 12, Create AC Cross-tie Capability with Other Unit (multi-unit site).	SAMA not applicable, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #4	Install Fuel Oil Transfer Pump on "C" EDG & Provide Procedural Guidance for Using "C" EDG to Power Selected "A" and "B" Loads.	Screened Phase 1, Criterion B – Intent Met. This SAMA is similar to Seabrook SAMA #11 and SAMA #17. Seabrook currently has 2 EDGs that are dedicated to their respective emergency bus. In addition, Seabrook has a third diesel generator unit - supplemental emergency power supply (SEPS), which can be aligned to either emergency power division. In addition, Seabrook has the capability to cross-tie the divisional EDG fuel oil tanks.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1
(Other Plant SAMAs are from Seabrook Response to RAI 5k)

SAMA	SAMA Description	Seabrook Original Evaluation (RAI 5k)	Sensitivity Evaluation to Seismic Risk Increase of 2.1x
SAMA #5	Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries & Replace PDP with Air-Cooled Pump.	PDP Replacement - Screened Phase 2, Not Cost-Beneficial Replacement of PDP and installing a diesel generator for motive power is similar to Seabrook SAMA #26 (install additional high pressure injection pump with independent diesel). This SAMA was shown to be not cost-beneficial. Portable Battery Charger – Not screened – Potentially Cost-Beneficial – however, similar to Seabrook SAMA #157 Installing portable diesel generator for charging batteries is similar to Seabrook SAMA #157 (provide independent AC power source for battery chargers). This SAMA was shown to be potential cost beneficial to extend main station battery life during long term SBO sequences. Regarding switchyard DC control power, Seabrook has an 8 hour switchyard battery system, independent of the main station batteries. If switchyard batteries become depleted, Seabrook switchyard breakers can be operated locally/manually without DC control power. This local/manual action is accounted for in the PRA by assuming an additional hour is needed to recover offsite power during long term SBO sequences. Removal of the additional hour for local action is judged to have a negligible positive impact on SBO core damage risk.	PDP Replacement - Seabrook SAMA #26 has been evaluated for sensitivity to seismic risk increase and shown not to be cost beneficial. Refer to Table X-2. Portable Battery Charger – Seabrook SAMA #157 (provide independent AC power source for battery chargers) has been evaluated for sensitivity to seismic risk increase. This SAMA is potentially cost beneficial. Refer to Table X-2. Switchyard DC Control Power - SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #5A	Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries.	Not screened – Potentially Cost-Beneficial – however, similar to Seabrook SAMA #157 Installing portable diesel generator for charging batteries is similar to Seabrook SAMA #157 (provide independent AC power source for battery chargers). This SAMA was shown to be potential cost beneficial to extend main station battery life during long term SBO sequences. Regarding switchyard DC control power, Seabrook has an 8 hour switchyard battery system, independent of the main station batteries. If switchyard batteries become depleted, Seabrook switchyard breakers can be operated locally/manually without DC control power. This local/manual action is accounted for in the PRA by assuming an additional hour is needed to recover offsite power during long term SBO sequences. Removal of the additional hour for local action is judged to have a negligible positive impact on SBO core damage risk.	Portable Battery Charger – Seabrook SAMA #157 (provide independent AC power source for battery chargers) has been evaluated for sensitivity to seismic risk increase. This SAMA is potentially cost beneficial. Refer to Table X-2. Switchyard DC Control Power - SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #6	Enhance Flood Detection for 84' Aux Building and Enhance Procedural Guidance for Responding to Service Water Flooding.	Screened Phase 1, Criterion B – Intent Met. Flood alarms, sump alarms, response procedures and associated operator actions were reviewed as part of updated internal flooding assessment. Current alarm response procedures judged adequate and are reflected in assessment.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1
(Other Plant SAMAs are from Seabrook Response to RAI 5k)

SAMA	SAMA Description	Seabrook Original Evaluation (RAI 5k)	Sensitivity Evaluation to Seismic Risk Increase of 2.1x
SAMA #7	Install "B" Train AFWST Makeup Including Alternate Water Source.	Screened Phase 2, Not Cost-Beneficial This SAMA involving long term makeup to the CST is similar to Seabrook SAMA #162 (increase capacity of the CST) and SAMA #164 (modify 10" condensate filter flange to have 2-1/2-inch female fire hose adapter with isolation valve). These SAMAs were shown to be not cost-beneficial. In addition, it is noted that the time to empty the CST is approximately 17 hours. Seabrook currently has several means of making-up water inventory to the CST. These include alignment of the Demineralized Water (DW) system pumps or alignment of the gravity drain of the Demineralized Water Storage Tanks to the CST, makeup from the condenser hot well spill or by use of the cooling tower portable pump. Therefore, the intent of the Salem SAMA is judged to be met regardless of cost-benefit.	Seabrook SAMAs #162 and #164 have been evaluated for sensitivity to seismic risk increase and have been shown not to be cost beneficial. Refer to Table X-2.
SAMA #8	Install High Pressure Pump Powered with Portable Diesel Generator and Long-term Suction Source to Supply the AFW Header.	Screened Phase 1, Criterion B – Intent Met. This SAMA is similar to Seabrook SAMA #66 and SAMA #75. Seabrook currently has the capability to connect several water sources to supply the EFW suction header. These include: the fire system using a diesel-driven fire pump; the portable diesel-driven pump with suction connected to the fire main; and the cooling tower portable makeup pump using either the cooling tower basin or Browns River. In addition, the water contents in the DWST can be gravity drained to the CST.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #9	Connect Hope Creek Cooling Tower Basin to Salem Service Water System as Alternate Service Water Supply.	Screened Phase 1, Criterion B – Intent Met. Seabrook is a single unit site. Seabrook is currently equipped with a four-train (two-division) Ocean Service Water System. The alternate service water supply is provided by the service water cooling tower, which consists of two pump divisions and a cooling tower water basin with a capacity of greater than 3M gallons. The cooling tower service water supply is independent of the ocean supply.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #10	Provide Procedural Guidance for Faster Cooldown on Loss of RCP Seal Cooling.	Screened Phase 1, Criterion B – Intent Met. RCS cooldown and depressurization procedures are addressed in Seabrook SAMA #50. Seabrook's emergency procedures include actions to cooldown and depressurize the RCS at a rate of 30 to 50 F/hr while maintaining adequate subcooling margin and to establish conditions for operation of RHR shutdown cooling. These actions are currently modeled in the PRA and any changes to further enhance the procedures are judged to have negligible benefit on the accident sequences.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1
(Other Plant SAMAs are from Seabrook Response to RAI 5k)

SAMA	SAMA Description	Seabrook Original Evaluation (RAI 5k)	Sensitivity Evaluation to Seismic Risk Increase of 2.1x
SAMA #11	Modify Plant Procedures to Make Use of Other Unit's PDP for RCP Seal Cooling.	Screened Phase 1, Criterion B – Intent Met. Seabrook's charging system design includes two centrifugal charging pumps A and B and a single positive displacement pump (PDP). The PDP is powered from a non-safety electrical power source and requires component cooling from PCCW train B. The PDP is credited for seal injection in the loss of RCP seal injection initiating event in the PRA. Replacement of this pump with a centrifugal pump was evaluated as Seabrook SAMA # 170.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #12	Improve Flood Barriers Outside of 220/440VAC Switchgear Rooms.	This SAMA is applicable to Seabrook SAMA #192, installation of flow limiting device in Control Building fire protection piping. Refer to Seabrook response to RAI 1a.	Seabrook SAMA #192 (installation of flow limiting device in Control Building fire protection piping) has been evaluated for sensitivity to seismic risk increase. This SAMA is potentially cost beneficial. Refer to Table X-2.
SAMA #14	Expand AMSAC Function to Include Backup Breaker Trip on RPS Failure.	Screened Phase 2, Not Cost-Beneficial. Seabrook SAMA #174 is judged similar to this Salem Station SAMA for ATWS mitigation. SAMA #174 evaluated the cost-benefit of providing an alternate scram button to remove power from the MG-sets to the control rod drives. This change was judged not cost-beneficial in the Seabrook Phase 2 assessment.	Seabrook SAMA #174 has been evaluated for sensitivity to seismic risk increase and has been shown not to be cost beneficial. Refer to Table X-2.
SAMA #17	Enhance Procedures and Provide Additional Equipment to Respond to Loss of EDG Control Room Ventilation.	Screened Phase 1, Criterion A - Not Applicable. Seabrook Station does not have EDG control rooms or EDG control room ventilation systems.	SAMA not applicable, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #24	Provide Procedural Guidance to Cross-tie Salem 1 and 2 Service Water Systems.	Screened Phase 1, Criterion B – Intent Met. Seabrook is a single unit site. Seabrook is currently equipped with a four-train (two-division) Ocean Service Water System. The alternate service water supply is provided by the service water cooling tower, which consists of two pump divisions and a cooling tower water basin with a capacity of greater than 3M gallons. The cooling tower service water supply is independent of the ocean supply.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #27	In Addition to the Equipment Installed for SAMA 5, Install Permanently Piped Seismically Qualified Connections to Alternate AFW Water Sources.	Screened Phase 1, Criterion B - Intent Met. This SAMA, involving seismic connections to alternate AFW water sources, is similar to the current Seabrook capability. At Seabrook, the CST is seismically qualified and is protected from external events by a rugged, seismic structure. A permanent, seismically qualified flanged connection exists to allow connection of an alternate water supply to the EFW turbine driven pump suction and/or refill of the CST.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1 (Other Plant SAMAs are from Seabrook Response to RAI 5k)			
SAMA	**SAMA Description**	**Seabrook Original Evaluation (RAI 5k)**	**Sensitivity Evaluation to Seismic Risk Increase of 2.1x**
Diablo Canyon Proposed SAMA Candidates			
SAMA #12	Improve Fire Barriers for ASW and CCW Equipment in the Cable Spreading Room.	Screened Phase 1, Criterion B – Intent Met. Additional barriers for fire areas were screened out based on the Seabrook Station plant design with 3-hour rated fire barriers. Also, a review of the fire risk by location in the most recent update supports this screening that additional fire barriers would not significantly impact fire risk (refer to RAI 5.f.)	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #13	Improve Cable Wrap for the PORVs in the Cable Spreading Room.	Screened Phase 1, Criterion B – Intent Met. The Cable Spreading Room (CSR) at Seabrook was screened from detailed evaluation based on the absence of ignition sources and the fact that only small amounts of transient combustibles would likely be found in the area. Also, the area is equipped with fire detection and suppression. Cables for the two safety trains enter the room at different locations and are separated. Cables travel from the separate trays to the control room from through metal wire ways to the penetrations in the ceiling.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #24	Prevent Clearing of RCS Cold Leg Water Seals.	Screened Phase 2, Not Cost-Beneficial. The context of this SAMA is that clearing of the water seals in the cold legs after core damage could result in a greater challenge to a SG thermally induced tube rupture (SGTI) due to the resulting unobstructed flow path of hot gas between the reactor vessel and SG(s). Thus, a procedure change to ensure that the cold legs are not cleared would reduce the SGTI challenge and reduce the associated release. To assess this SAMA for Seabrook, PRA case XSGTIS was run, which eliminated 100% of the potential for SGTI. The results of this case show that SGTI has minimal contribution to release. The reason SGTI does not contribute significantly to release is because successfully maintaining SG water inventory or depressurizing the RCS also effectively mitigate the SGTI tube rupture challenge. It is noted that the first two steps in Seabrook's Severe Accident Management Guideline (SAMG) diagnostic flow chart is to ensure SG water level greater than 10% narrow range and RCS pressure <285 psi. The associated nominal and upper bound cost-benefits of this SAMA are both less than $1K. This SAMA is judged not cost-beneficial based on the estimated cost for a procedure modification, which is in the range of $15 to $20K.	SAMA evaluation not sensitive to seismic risk increase based on the low benefit. No impact on SAMA evaluation.
SAMA #25	Fill or Maintain Filled The Steam Generators to Scrub Fission Products.	Screened Phase 1, Criterion B – Intent Met. The context of this SAMA is for plant procedures to ensure that there is sufficient water level in the SGs (preferably a faulted SG) so that fission product release through a postulated tube rupture will be reduced by scrubbing effects. At Seabrook, procedures specifically address SG water level and isolation of a faulted SG to minimize the possibility of release. In addition, severe accident guidelines, which are entered before the onset of core damage (at 1100 °F), further address the importance to inject into the SGs and to maintain SG inventory for the purpose of: (1) protecting the SG tubes from creep rupture, (2) scrubbing fission products that could enter the SG from tube leakage, and (3) making the SGs available as a heat sink for the RCS.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1 (Other Plant SAMAs are from Seabrook Response to RAI 5k)			
SAMA	**SAMA Description**	**Seabrook Original Evaluation (RAI 5k)**	**Sensitivity Evaluation to Seismic Risk Increase of 2.1x**
Vogtle Station Proposed SAMA Candidates			
SAMA #2	Maintain full-time black start capability of the Plant Wilson combustion turbines.	Screened Phase 2, Not Cost-Beneficial. Seabrook Station is a single unit site with no other onsite power generation capability (except for onsite emergency and supplemental diesel generators). Installation of additional onsite power generation capability was evaluated in Seabrook SAMA #13 (buried offsite power source), SAMA #14 (gas turbine), and SAMA #156 (install alternate offsite power source). These SAMA candidates were judged not cost-beneficial in Phase 2.	Seabrook SAMAs #13, #14 and #156 have been evaluated for sensitivity to seismic risk increase and have been shown not to be cost beneficial. Refer to Table X-2.
SAMA # 4	Prepare procedures and operator training for cross-tying an opposite unit DG.	Screened Phase 1, Criterion A – Not Applicable. Seabrook Station is a single unit site with no other onsite power generation capability (except for onsite emergency and supplemental diesel generators). Phase 1 screening is consistent with Seabrook SAMA# 12, Create AC Cross-tie Capability with Other Unit (multi-unit site).	SAMA not applicable, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #6	Implementation of a bypass line for the cooling tower return isolation valves.	Screened Phase 2, Not Cost-Beneficial. The purpose of this Vogtle SAMA is to reduce the likelihood of a Vogtle-specific SW failure mode that could lead to loss of EDG cooling following a LOSP event. The proposed modification is to install redundant, quick opening valves in parallel with existing cooling tower isolation valves, which are signaled to close and re-open during a LOSP event. Failure to re-open would result in loss of cooling to the respective EDG. Thus, redundant parallel valves would tend to increase the reliability of EDG cooling. The EDGs at Seabrook are also cooled by Service Water (SW). SW to each EDG is normally isolated by a closed AOV designed to fail open on loss of power or instrument air. The AOVs open automatically upon EDG demand and are not cycled closed and opened similar to the Vogtle design. The Seabrook AOVs have a history of reliable operation. As a result, installation of redundant, parallel SW valves would not significantly improve EDG reliability and would not be cost-beneficial based on inspection of PRA Case NOSBO (which is very conservative) and cost of implementation judged to be on the order of $500K. Detailed (less optimistic) evaluation would further show this option as being not cost-beneficial.	SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation. The proposed Vogtle SAMA is not applicable to Seabrook. The costs of modifying the SW system to accommodate parallel redundant valves would be similar to SAMA 161 with a cost estimate of >$1M. A detailed less optimistic risk evaluation would further show this option as being not cost-beneficial.
SAMA #16	Enhance procedures for ISLOCA response.	Screened Phase 2, Not Cost-Beneficial. This Vogtle SAMA did not identify any specific procedural changes to improve the risk of ISLOCA events. Vogtle simply calculated a decrease in risk assuming elimination of all ISLOCA risk. Seabrook PRA Case LOCA06 also quantified the risk benefit associated with elimination of ISLOCA risk. Based on this optimistic assessment, the UB benefit was determined to be on the order of $53K. Based on a review of procedures, any changes to procedures are judged not to have a significant impact on ISLOCA risk. The cost of procedure changes and training are judged to be in the range of $30 to $40K. Detailed (less optimistic) evaluation would further show this option as being not cost-beneficial.	SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation. ISLOCA procedures are sufficiently detailed and evaluated in the PRA human reliability analysis. Any changes to procedures are judged not to have a significant beneficial impact on ISLOCA risk.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1 (Other Plant SAMAs are from Seabrook Response to RAI 5k)			
SAMA	**SAMA Description**	**Seabrook Original Evaluation (RAI 5k)**	**Sensitivity Evaluation to Seismic Risk Increase of 2.1x**
Indian Point Proposed SAMA Candidates			
SAMA #30	Provide a portable diesel-driven battery charger.	Not screened – Potentially Cost-Beneficial – however, similar to Seabrook SAMA #157 Installing portable diesel generator for charging batteries is similar to Seabrook SAMA #157 (provide independent AC power source for battery chargers). This SAMA was shown to be potential cost beneficial to extend main station battery life during long term SBO sequences.	Portable Battery Charger – Seabrook SAMA #157 (provide independent AC power source for battery chargers) has been evaluated for sensitivity to seismic risk increase. This SAMA is potentially cost beneficial. Refer to Table X-2.
SAMA #52	Open city water supply valve for alternative AFW pump suction.	Screened Phase 1, Criterion B – Intent Met. This SAMA is similar to Seabrook SAMA #66 and SAMA #75. Seabrook currently has the capability to connect several alternate water sources to supply the EFW suction header. These include: the fire system using a diesel-driven fire pump; the portable diesel-driven pump with suction connected to the fire main; and the cooling tower portable makeup pump using either the cooling tower basin or Browns River. In addition, the water contents in the DWST can be gravity drained to the CST.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #55	Provide hard-wired connection to one SI or RHR pump from the Appendix R bus (MCC 312A).	Screened Phase 1, Criterion B – Intent Met. Seabrook currently has two, separate Remote Safe Shutdown (RSS) panels, one panel for each division. The panels are located in the respective divisional emergency switchgear room. Each RSS division has the capability to use the associated EDG and emergency buses to control/stabilize RCS inventory using boric acid transfer pump and/or high head charging pump; perform plant cooldown using ASDVs and EFW, and initiate shutdown cooling using an RHR pump.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #61	Upgrade the Alternate Safe Shutdown System (ASSS) to allow timely restoration of seal injection and cooling.	Screened Phase 1, Criterion B – Intent Met. Seabrook's Remote Safe Shutdown (RSS) panels currently have the capability to provide both seal injection and cooling. Seal injection is provided using a high head charging pump. Seal cooling is provided using a thermal barrier cooling (TBC) pump with PCCW and SW pumps for heat sink.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #62	Install flood alarm in the 480VAC switchgear room.	This SAMA is applicable to Seabrook SAMA #192, installation of flow limiting device in Control Building fire protection piping. Refer to Seabrook response to RAI 1a.	Seabrook SAMA #192 (installation of flow limiting device in Control Building fire protection piping) has been evaluated for sensitivity to seismic risk increase. This SAMA is potentially cost beneficial. Refer to Table X-2.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1 (Other Plant SAMAs are from Seabrook Response to RAI 5k)			
SAMA	**SAMA Description**	**Seabrook Original Evaluation (RAI 5k)**	**Sensitivity Evaluation to Seismic Risk Increase of 2.1x**
Wolf Creek Proposed SAMA Candidates			
SAMA #1	Permanent, Dedicated Generator for the NCP with Local Operation of TD AFW After 125V Battery Depletion.	Screened Phase 1, Criterion B – Intent Met. The context of this Wolf Creek SAMA is to reduce SBO RCP seal LOCA scenarios by installing an additional, dedicated diesel generator power source for the normal charging pump (NCP). Seabrook currently has 2 EDGs that are dedicated to their respective emergency bus. In addition, Seabrook has a third diesel generator unit - supplemental emergency power supply (SEPS), which can be aligned from the control room to either emergency power division. Once the breaker for SEPS is manually closed onto the aligned bus, the load sequencer connects the required loads. Because SEPS can be quickly aligned from the control room to re-energize an emergency bus, restoration of the thermal barrier cooling and seal injection functions is accomplished in time to preserve RCP seal integrity and avoid seal failure.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #2	Modify the Controls and Operating Procedures for Sharpe Station to Allow for Rapid Response.	Screened Phase 2, Not Cost-Beneficial. Seabrook Station is a single unit site with no other onsite power generation capability (except for onsite emergency and supplemental diesel generators). Installation of additional onsite power generation capability was evaluated in Seabrook SAMA #13 (buried offsite power source), SAMA #14 (gas turbine), and SAMA #156 (install alternate offsite power source). These SAMA candidates were judged not cost-beneficial in Phase 2.	Seabrook SAMAs #13, #14 and #156 have been evaluated for sensitivity to seismic risk increase and have been shown not to be cost beneficial. Refer to Table X-2.
SAMA #3	AC Cross-tie Capability.	Screened Phase 1, Criterion B – Intent Met. The context of this Wolf Creek SAMA is to provide enhanced capability to cross-tie the emergency 4kV buses. This SAMA is similar to Seabrook SAMA #11. Seabrook currently has 2 EDGs that are dedicated to their respective emergency bus. In addition, Seabrook has a third diesel generator unit - supplemental emergency power supply (SEPS), which can be aligned to either emergency power division.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1
(Other Plant SAMAs are from Seabrook Response to RAI 5k)

SAMA	SAMA Description	Seabrook Original Evaluation (RAI 5k)	Sensitivity Evaluation to Seismic Risk Increase of 2.1x
SAMA #4	Upgrade emergency procedures to direct local, manual closure of the RHR EJHV8809A and EJHV8809B valves if they fail to close remotely.	Screened Phase 2, Not Cost Beneficial. The context of this Wolf Creek SAMA is to provide a procedural enhancement for operators to locally, manual close RHR valves to isolate an ISLOCA should the valves fail to close remotely. At Seabrook, ISLOCA events are postulated to occur in the RHR system due to: (1) multiple MOV failures in the RHR suction supply from the RCS hot legs, and (2) multiple check valve failures in the RHR injection lines to the RCS cold/hot legs. Remote manual isolation of an ISLOCA event in RHR is detailed in plant EOPs. From a PRA perspective, isolation of a postulated ISLOCA originating from the RHR suction valve failures is assumed not possible and thus is not credited in the PRA. Isolation of a postulated ISLOCA originating from RHR injection valve failures is possible via manual closure of valve RH-MOV-14 or RH-MOV-26. However, only limited isolation credit is given in the PRA for events when RHR relief valves are successful and RHR piping and heat exchanger pressure boundaries remain intact. Thus, ISLOCA leakage is a result of relief valve opening and RHR pump seal degradation. Failure of the operator action to isolate RHR valve 14 (26) has an RRW of only 1.0001. Given this extremely low risk reduction, the actual cost-benefit of making improvements to associated procedures or valve hardware will be well below the range of $28K to $53K, which assumed elimination of all ISLOCA risk in PRA Case LOCA06. Therefore, this SAMA is judged not cost-beneficial.	SAMA evaluation not sensitive to seismic risk increase based on the low benefit. There is no change to the SAMA conclusion based on the original Seabrook evaluation.
SAMA #5	Enhance procedures to direct operators to open EDG Room doors for alternate room cooling.	Screened Phase 1, Criterion B – Intent Met. The context of this Wolf Creek SAMA is to provide for alternate EDG room cooling during favorable outdoor ambient temperature conditions by opening room doors. At Seabrook, the diesel air handling (DAH) systems consists of a supply and exhaust fan and associated dampers for ventilating/cooling the respective diesel room. The DAH is included in the PRA model due to the relatively short heatup times. Note, however, that during a substantial time of the year, the outside temperature is low enough that ventilation may not be required. DAH compensatory ventilation actions exist for maintaining acceptable DG room temperatures depending on outdoor ambient temperatures when DAH components are unavailable. In addition, DG room high temperature alarm response procedures recommend several actions including monitoring of DG temperatures and providing portable fans to cool the affected room.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.

Table X-8 Seabrook Station Sensitivity Evaluation of Other Plant SAMAs using Seismic Risk Multiplier of 2.1 (Other Plant SAMAs are from Seabrook Response to RAI 5k)			
SAMA	**SAMA Description**	**Seabrook Original Evaluation (RAI 5k)**	**Sensitivity Evaluation to Seismic Risk Increase of 2.1x**
SAMA #13	Alternative Fuel Oil Tank with Gravity Feed Capability.	Screened Phase 1, Criterion B – Intent Met. Seabrook currently has 2 EDGs that are dedicated to their respective emergency bus. The capability to cross-tie the divisional EDG fuel oil tanks exists. Fuel oil makeup to the respective EDG day tank is accomplished via the divisional fuel oil transfer pump. Gravity drain from the fuel oil storage tanks to the associated day tank is not practical. However, the discharge from each fuel oil transfer pump can be aligned to supply the opposite division EDG day tank. This provides flexibility to maintain day tank inventory should a problem develop with one transfer pump. In addition, as noted above, Seabrook has a third diesel generator unit - supplemental emergency power supply (SEPS), which can be aligned to either emergency power division. The SEPS has a dedicated fuel oil, independent of the EDG fuel oil.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.
SAMA #14	Permanent, Dedicated Generator for the NCP, one Motor Driven AFW Pump, and a Battery Charger.	Screened Phase 1, Criterion B – Intent Met. The context of this Wolf Creek SAMA is similar to Wolk Creek SAMA #1 but with increased diesel generator capacity to also operate a motor-driven AFW pump. As noted above, Seabrook has already installed a third diesel generator unit - supplemental emergency power supply (SEPS), which can be aligned from the control room to either emergency power division. Once the breaker for SEPS is manually closed onto the aligned bus, the load sequencer connects the required loads. Because SEPS can be quickly aligned from the control room to re-energize an emergency bus, restoration of the thermal barrier cooling and seal injection functions is accomplished in time to preserve RCP seal integrity and avoid seal failure. The SEPS diesel generator load is maintained at or below 5280kW. This is sufficient capacity to operate many important systems including: motor-driven EFW pump or the startup feedwater pump, SW pump, PCCW pump, battery charger, etc.	SAMA intent is met, therefore SAMA evaluation not sensitive to seismic risk increase. No impact on SAMA evaluation.