NextEra Energy Seabrook, LLC
(Seabrook Station, Unit 1)
License Renewal Application

NRC Staff Answer to Motion for Summary Disposition of Contention 4D

ATTACHMENT 4D-B

NEXTera ENERGY SEABROOK

March 19, 2012

SBK-L-12053
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
Supplement 2 to Severe Accident Mitigation Alternatives Analysis
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. 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 ML110140810)
3. NextEra Energy Seabrook, LLC letter SBK-L-11067, "Seabrook Station Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Application," April 18, 2011. (Accession Number ML1122A075)
4. NextEra Energy Seabrook, LLC letter SBK-L-11125, "Supplement to Response to Request for Additional Information - April 18, 2011, " June 10, 2011. (Accession Number ML11166A255)

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. In Reference 2, 3 and 4, NextEra submitted responses to the NRC staff's RAIs.

A144
NRR

The original SAMA was submitted in May 2010 (Reference 1) and was based on Seabrook's base case PRA model of record SSPSS-2006 (model SB2006). In NextEra Letter SBK-L-11001 (Reference 2), the next periodic update to the PRA model was discussed. NextEra has completed the PRA update (SSPSS-2011) and is providing, in this letter, a supplemental SAMA analysis based on this PRA update.

The License Renewal Application, Appendix E, page F-6 contains a list of acronyms used in this supplement. 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.

for

Paul O. Freeman
Site Vice President

Enclosure

cc:

W.M. Dean,	NRC Region I Administrator
J. G. Lamb,	NRC Project Manager, Project Directorate I-2
W. J. Raymond,	NRC Resident Inspector
A.D. Cunanan,	NRC Project Manager, License Renewal
M. Wentzel,	NRC Project Manager, License Renewal

Mr. Christopher M. Pope
Director Homeland Security and Emergency Management
New Hampshire Department of Safety
Division of Homeland Security and Emergency Management
Bureau of Emergency Management
33 Hazen Drive
Concord, NH 03305

John Giarrusso, Jr., Nuclear Preparedness Manager
The Commonwealth of Massachusetts
Emergency Management Agency
400 Worcester Road
Framingham, MA 01702-539

NEXTera™ ENERGY
SEABROOK

I, Thomas A. Vehec , Plant General Manager 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

19 day of March, 2012

Thomas A. Vehec
Plant General Manager

Notary Public

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

Enclosure to SBK-L-12053

NextEra Energy Seabrook, LLC

Supplement 2 to

Severe Accident Mitigation Alternatives Analysis

4.2 SUPPLEMENTAL SAMA RESULTS

PRA Level 1 and 2 Quantitative Results

The core damage frequency (CDF) has decreased from the 2006 results to the 2011 results by approximately 14.5%, from 1.44E-05/yr (SB2006) to 1.23E-5/yr (SB2011). The large early release frequency (LERF) has decreased by approximately 20%, from 1.15E-07/yr (SB2006) to 9.2E-08/yr (SB2011).

Maximum Averted Benefit

The consequences of a severe accident have increased as a result of the revised Level 2 release source term modeling. This has resulted in an increase to the offsite dose/cost risk and offsite property/cost risk despite the reduction in annual core damage and large early release frequencies.

The nominal maximum attainable benefit (MAB) is $3,050,815 (SB2011). This represents a factor increase of 3.7 over the previous MAB of $818,721 (SB2006). This increase in MAB is primarily the result of higher release category source terms. The original SAMA analysis was based on previous, historical source terms, which were developed from industry source term information and early versions of MAAP for various accident release fractions and accident timing. The new source term assessment provides a state of the art and consistent approach to analyzing accident source terms.

SAMA Sensitivity Assessments

Annual Met Data Set

The meteorological data sets used in the updated SAMA evaluation are the same as in the original SAMA evaluation and included years 2004 through 2008. Each data set was evaluated to ensure that the data year that provides the maximum dose risk and cost risk is used. Based on the assessment, the met data associated with year 2005 provides the maximum dose risk and cost risk (same as in original assessment) and was chosen as the baseline data set for the updated SAMA.

Meteorology Specification in last Spatial Segment

Consistent with the original SAMA evaluation, the updated baseline SAMA evaluation assumes continuous rainfall imposed from 40 to 50 miles from release to force conservative population exposure for base case. The sensitivity case allows the 40-50 mile segment meteorology to follow the onsite meteorology. Elimination of the continuous rainfall assumption reduces the population dose risk to approximately 86% of the baseline and the cost risk to approximately 85% of the baseline. These results are consistent with the sensitivity results observed in the original SAMA study.

Sea-breeze Sensitivity

The sea-breeze effect on population dose risk and economic cost risk was re-evaluated similar to the previous analysis described in NextEra Energy's response to RAI #4g (Reference 2) to account for the new release category source terms. The results of the latest evaluation indicate that the population dose and offsite economic cost risks increase by 0.4% and 0.6% when applying a conservative sensitivity to account for sea breeze effects. The sensitivity of the thermal internal boundary layer (TIBL) lid height was also investigated by specifying a 110 meter height; a decrease of 10 meters (from 110 to 100 meters) was found to change the dose and offsite cost risks by 0.8% and 0.5%. Based on this evaluation and when considering other conservative SAMA assumptions (e.g., perpetual rainfall in the outer ring) the sea-breeze effects do not change the conclusions of the SAMA analysis.

> Note - The previous sea-breeze assessment in RAI #4 (Reference 2) estimated sea-breeze effects could result in an increase to the population dose risk by 4% and economic cost risk by 7%. These previous results were calculated in MACCS2 using the Monte Carlo random bin sampling technique. The revised evaluation summarized above used the MACCS2 sequential hour analysis technique, which provides a more accurate result compared to the Monte Carlo bin sampling technique. Thus, the latest results are shown to be less than previous results despite of the increase in release category source terms.

Release Category LE4 Sensitivity to No Evacuation

As summarized in Section 3.1, Release Category LE4 is used to represent extreme seismic events where it is assumed that evacuation could be delayed beyond 20 hours and therefore, the release is assigned to LERF. The Level 3 base case population dose and economic cost consequences of LE4 are determined assuming normal evacuation occurring at the General Emergency declaration beginning at core uncovery. If no evacuation is assumed, the LE4 dose consequence increase is less than 1% (from a total base case dose of 1.11E+07 person-rem to 1.12E+07 person-rem). The overall economic cost consequence does not change.

The LE4-specific dose consequence during the early phase of the release (exposure to the passing plume) for the no-evacuation scenario is 9% greater than the base case (with evacuation). However, the early phase dose is only 16% of the total LE4 dose consequence. The remaining 84% of the dose consequence occurs during the late phase and is a result of long-term exposure to the plume, independent of evacuation. Compounding the relatively small consequence of no-evacuation, with the relatively small portion of the total dose that can be affected by the action to evacuate results in a negligible affect (<1%) on the total LE4 dose consequence.

Sensitivity to Variation in Other Level 3 Parameters

The sensitivity of the updated SAMA results to variations in other Level 3 parameters is expected to be consistent with previous sensitivity results. The previous Level 3 sensitivity cases included variations in release height, release heat, building wake effects, and evacuation speed, preparation, warning time and population fraction. Although the radionuclides released in the updated SAMA were different amounts compared to the original evaluation, the physical surroundings such as meteorology, population distribution and economy are unchanged. Therefore, the conclusions drawn from the original Level 3 sensitivity evaluation are representative of the updated SAMA evaluation.

Sensitivity to Variation in Discount Rate

The nominal (baseline) cost-benefit assessment considers a "nominal" discount rate of 7%. Cost-benefit sensitivity to the discount rate is considered at 3% (conservative discount rate) and 8.5%

(best estimate discount rate). The nominal 7% rate and the conservative 3% rate are consistent with the NEI 05-01 industry guidance. The best estimate rate of 8.5% is specific to Seabrook Station and is consistent with the original Seabrook SAMA evaluation. The 3% conservative discount rate results in an increase the cost-benefit above the nominal, whereas the best estimate rate of 8.5% provides a cost-benefit slightly lower than the nominal rate. No new potentially cost-beneficial SAMAs where identified as a result of the 3% and 8.5% sensitivity calculations. The cost-benefit worth of all SAMA candidates at the 3% conservative discount rate is shown to be less than the SAMA cost-benefit worth when considering the uncertainty (upper bound) benefit.

Sensitivity to Extended Period

The nominal cost-benefit assessment considers a nominal benefit period of 20 years. The SAMA cost-benefit sensitivity to an extended period was explored to account for possible near term approval of the renewed license. Consistent with the original SAMA evaluation, an extended period of 41 years is used to represent the total period of the extended/renewed operating license. Based on this sensitivity study, the cost-benefit worth (MAB) during the extended period is a factor of ~1.3 greater than the nominal MAB, but significantly less than the upper bound (95th percentile) MAB. The cost-benefit worth of all SAMA candidates assuming the 41 year extended period is shown to be less than the SAMA cost-benefit worth when considering the uncertainty (upper bound) benefit.

Sensitivity to Upper Bound Accident Costs

The nominal cost-benefit assessment considers the mean (best estimate) core damage/accident release frequencies derived from the Seabrook SB2011 PRA. To account for upper bound uncertainty in the PRA model results, the best estimate accident costs are multiplied by an uncertainty factor of 2.35 to represent the cost-benefit associated with the 95th percentile (upper bound) accident release impacts. The increase factor of 2.35 is based on the ratio of the best estimate CDF mean value of 1.23E-05/yr to the CDF upper bound (95th percentile) value of 2.86E-05/yr. This approach is consistent with the NEI 05-01 industry guidance. The upper bound cost-benefit of each SAMA candidate is considered when judging the candidate as being potentially cost-beneficial. Although this approach is consistent with NRC expectation for identification of potentially cost-beneficial SAMAs, it is noted that final determination of cost and benefit would include a more realistic assessment of both the cost of a specific modification and its associated value in risk reduction.

Sensitivity to Increased Seismic Risk

The nominal and upper-bound cost-benefit values of each SAMA candidate are increased by a factor of 2.1 to account for possible higher seismic risk. The basis for the 2.1 multiplier is discussed in Section 4.1 of this report. This sensitivity approach is consistent with NRC expectations for identification of potentially cost-beneficial SAMAs.

Potential Cost Beneficial SAMAs

The four SAMA candidates that were identified as potentially cost-beneficial in the previous analysis remain as potentially cost-beneficial in the supplemental analysis. Three new potential cost-beneficial SAMAs are identified for further consideration within Seabrook's Long Range Plan (LRP) system. The potentially cost-beneficial severe accident mitigative alternatives identified do not involve aging management of passive, long-lived systems, structures, or components during the period of extended operation. All previous (p) and new (n) potentially cost beneficial SAMAs are identified in the following table.

Seabrook Station - Potential Cost-Benefit SAMAs

SAMA #	Description	Potential Benefit
157 (p)	Independent AC power source for battery chargers (e.g., portable generator to facilitate timely charging of station batteries).	Reduce the risk of core damage from long-term SBO sequences by extending battery life to allow more time to recover offsite/onsite power.
164 (n)	Method to refill the Condensate Storage Tank (CST) from alternate water sources (e.g., modify 10" condensate filter flange connection to facilitate timely CST makeup from other sources such as firewater or alternate pump via hose connection).	Reduce the risk of long term core damage sequences that rely on long term SG makeup via feedwater and CST suction source.
165 (p)	Method to refill Reactor Water Storage Tank (RWST) from firewater during containment injection (e.g., modify 6" RWST flush flange connection to facilitate timely firewater makeup capability).	Reduce the risk of containment failure and release during long term containment injection sequences that would benefit from additional makeup.
172 (n)	Replace existing RCP seal design with improved low leakage seal (e.g., evaluate installation of a "shutdown seal" developed by Westinghouse).	Reduce risk of core damage from transients sequences with seal cooling hardware failures, which result in RCP seal LOCA events.
192 (p)	Install flow limiting device in the fire protection piping located in the Control Building to limit flood consequence of major pipe break (e.g., install flow orifice).	Reduce the risk of core damage from internal flood sequences resulting from a postulated pipe break in Control Building fire protection piping.
193 (p)	Replace outboard containment isolation valve CS-V-167 with a valve design that is independent of AC power (e.g., replace existing MOV with an AOV).	Reduce the risk of release during SBO / seismic sequences that lead to core melt; improve reliability of containment isolation of RCP seal water return line.
195 (n)	Hardware changes to improve PCCW temperature control reliability - update of existing equipment or provide additional redundancy in instrumentation / controls	Reduce risk of core damage and release due to sequences involving loss of PCCW cooling function.

4.3 SUPPLEMENTAL SAMA EVALUATION RESULTS TABLES

The cost-benefit assessment of each previous Phase II SAMA candidate is provided in Table 1. The cost-benefit assessment of each of the top 15 dominant BE-related SAMA candidates and IE-related SAMA candidates is provided in Table 2. The expected SAMA cost and bases are provided in Tables 1 and 2. SAMA candidates that were previously identified as "intent met" in the initial submittal or in subsequent RAI responses are not reviewed further in this supplement.

NextEra Energy Seabrook, LLC
Supplement to Severe Accident Mitigation Alternatives Analysis

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW									
SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
2	Replace lead-acid batteries with fuel cells	Extended DC power capability during an SBO	NOSBO1	22	6	224K (470K)	525K (1.1M)	1.75M	Not cost beneficial. The original PRA case NOSBO and recent PRA case NOSBO1 both conservatively assume elimination of all station blackout events by assuming guaranteed success of both EDGs for all events and independent of all support systems (control power, cooling, etc.) Cost of physical plant modifications and analysis judged comparable in scope and complexity to "providing additional DC battery capacity" (Davis Besse AC/DC-01).
13	Install an additional, buried off-site power source	Reduced probability of loss of off-site power	NOLOSP	18	17	531K (1.2M)	1.24M (2.7M)	>3M	Not cost beneficial. The original and recent PRA case NOLOSP conservatively assumed elimination of all LOSP events. Cost of physical plant modifications and analysis judged comparable in scope and complexity to "Burying off-site power lines" (Callaway 24). Cost of installing buried, alternate power source expected to significantly exceed benefit. Reduction in seismic risk would not be significant unless offsite power source is seismically rugged.
14	Install a gas turbine generator	Increased availability of on-site AC power	NOSBO1	22	6	224K (470K)	525K (1.1M)	2M	Not cost beneficial. The original PRA case NOSBO and recent PRA case NOSBO1 both conservatively assume elimination of all station blackout events by assuming guaranteed success of both EDGs for all events and independent of all support systems (control power, cooling, etc.) Reduction in seismic risk would not be significant unless gas turbine is seismically rugged. Cost of physical plant modifications and analysis judged comparable to other plants that presently do not have these features (Davis Besse AC/DC-14). Some of the potential benefit of this SAMA would be realized with SAMA #172, RCP shutdown seal.
16	Improve uninterruptible power supplies	Increased availability of power supplies supporting front-line equipment	NOSBO1	22	6	224K (470K)	525K (1.1M)	>2M	Not cost beneficial. The original PRA case NOSBO and recent PRA case NOSBO1 both conservatively assume elimination of all station blackout events by assuming guaranteed success of both EDGs for all events and independent of all support systems (control power, cooling, etc.) Cost of engineering and implementing this upgrade is based on Seabrook engineering estimate. It is noted that due to the importance of improving reliability of uninterruptable power supplies, an action item has been entered into the Long Range Plan to assess future upgrade to the ELGAR inverters.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW									
SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.	($)	
20	Add a new backup source of diesel cooling	Increased diesel generator availability	DGSW	<1	1	25K (59K)	53K (124K)	2M	Not cost beneficial. The original PRA case NOSBO conservatively assumed elimination of all station blackout events by assuming guaranteed success of both DGs for all events and independent of all support systems (control power, cooling, etc.). The updated PRA case DGSW assumes success of SW components (valves) that are associated with DG cooling and alignment of the SW system (ocean and cooling tower). Guaranteed success of these components and the resulting increase in SW reliability is representative of the DG cooling water reliability gained from installing a backup source of cooling water. Insights from this analysis are that the existing arrangement of SW cooling to the DGs is of a reliable design; and making the DGs less dependent on SW does not provide a significant risk reduction because other train-specific components, such as ECCS pumps, also depend on SW cooling. Cost of physical plant modifications and analysis judged comparable to other plants that presently do not have these features (Grand Gulf 10).
24	Bury off-site power lines	Improved off-site power reliability during severe weather	NOLOSP	18	17	531K (1.2M)	1.24M (2.7M)	>3M	Not cost beneficial. The original and recent 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. Cost of physical plant modifications and analysis judged comparable in scope and complexity to "Burying off-site power lines" (Callaway 24).

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
25	Install an independent active or passive high pressure injection system	Improved prevention of core melt sequences	CSBX	22	34	1.1M (2.3M)	2.5M (5.3M)	8.8M	Not cost beneficial. The original PRA case LOCA02 conservatively assumed 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 was judged conservatively high. A more realistic PRA Case CSBX assumes that CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B. 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. Cost of physical plant modifications and analysis judged comparable to other plants that presently do not have these features (Grand Gulf 20). 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. In addition, Grand Gulf SAMA #20 estimated the cost of a similar plant change at >$8.8M. Given these industry estimates and based on the Seabrook plant design, the cost for SAMA implementation would be expected to be in the range of $6 to $10M or more. These estimates significantly exceed the upper bound sensitivity benefit and a more refined estimate is not warranted. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
26	Provide an additional high pressure injection pump with independent diesel	Reduced frequency of core melt from small LOCA and SBO sequences	CSBX	22	34	1.1M (2.3M)	2.5M (5.3M)	8.8M	Not cost beneficial. The original PRA case LOCA02 conservatively assumed 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 was judged conservatively high. A more realistic PRA Case CSBX assumes that CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B. 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. Cost of physical plant modifications and analysis judged comparable in scope and complexity to other plants that presently do not have these features (Grand Gulf 20). 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. In addition, Grand Gulf SAMA #61 estimated the cost of a similar plant change at >$6.4M and >8.8M for Grand Gulf SAMA #20. Given these industry estimates and based on the Seabrook plant design, the cost for SAMA implementation would be expected to be in the range of $6M to $10M or more. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.
28	Add diverse low pressure injection system	Improve injection capability	LOCA03	2	2	68K (143K)	160K (336K)	>1M	Not cost beneficial. The original PRA case LOCA03 conservatively assumed elimination all low pressure injection failures including injection pump trains, suction, accumulators and low pressure recirculation. A more realistic yet conservative PRA case for LOCA03 was performed to better address this SAMA, which is focused on adding diversity in for injection. The revised PRA case assumes guaranteed success of the low head "injection" function provided by the pump trains when support systems are available. Accumulators and containment recirculation are assumed to be subject to random failures. Cost to engineer and Install an additional low pressure injection system is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	13	10	312K (655K)	731K (1.53)	>3M	Not cost beneficial. The original and recent PRA case LOCA04 conservatively assume 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. Cost to engineer and install is based on two trains, replacing manual valves with new 8" MOVs including control system design and associated hardware and cabling. Design change to include a revised LOCA and Containment analysis. Additional analysis would be required to verify ECCS flow balance and NPSH for low, intermediate and high head SI pumps. The implementing modification would need to address design anc licensing basis changes as well as post mod testing to validate required flow balance is achieved.
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	DSIPP	<1	0	<1K (<1K)	<1K (<2K)	>5M	Not cost beneficial. The original PRA case LOCA02 conservatively assume 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 was conservatively high. Of the four SI pump trains, the intermediate head pumps contribute slightly more to the CDF than the high head SI/charging pumps. A more realistic PRA Case DSIPP case assumes that the existing intermediate head SI pump trains do not rely on AC power, but continue to rely on DC control power and room cooling. This is judged representative of replacing the SI pump motors with diesel engines. The high head SI/charging pumps are assumed to remain dependent on AC power. 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. Cost to engineer and Install diverse pump drivers is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	2	1	27K (57K)	64K (134K)	>1M	Not cost beneficial. The original and recent PRA cases LOCA01 conservatively assume elimination small LOCA events. Cost to engineer and install an RCS depressurization system is based on Seabrook previously reported estimate.
43	Add redundant DC control power for SW pumps	Increased availability of SW	SW01	<2	0	11K (24K)	26K (55K)	>100K	Not cost beneficial. The original and recent PRA cases SW01 conservatively assume that the SW pumps are not dependent on DC power. Cost to engineer and install an independent DC power system for the SW pumps is based on Seabrook previously reported estimate.
44	Replace ECCS pump motors with air-cooled motors	Elimination of ECCS dependency on component cooling system	CCW01	14	31	919K (1.93M)	2.15M (4.6M)	>6M	Not cost beneficial. The existing ECCS pump "motors" are air cooled motors, which rely on ventilation cooling for long term ambient room cooling. Ventilation cooling is provided by the Emergency Air Handling System (EAH) which cooled by CCW. The ECCS pump components also rely on CCW cooling (for example lube oil cooling, stuffing box cooling, etc.) The original and recent PRA case CCW01 conservatively assume guaranteed success of the component cooling water (CCW) systems to assess the possible benefit of eliminating the ECCS pump dependence on CCW (room cooling and pump cooling). However, because CCW contributes is an important system that contributes to the decay heat removal function, the benefit calculated with case CCW01 is highly conservative. Cost to engineer and implement design modifications to replace the ECCS pumps with a design that does not depend on CCW (if even practical) is estimated greater than $6M. This estimate is based on plant modifications judged to be of comparable yet less scope and complexity to SAMA #39, replacing ECCS pumps ($5M). It is also likely that modifications to room ventilation systems would still be needed at a cost of $1M (similar to SAMA #80) to achieve full benefit.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW									
SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	CSBX	28	34	1.04M (2.2M)	2.45M (5.2M)	>6.4M	Not cost beneficial. The original PRA case RCPLOCA conservatively assumed that RCP seal LOCA events are eliminated. A more realistic PRA Case CSBX assumes tha CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to "installing a backup water supply and pumping capability" (Grand Gulf #61). Grand Gulf SAMA #61 estimated the cost of a similar plant change a >$6.4M. In addition, 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. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.
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	CSBX	28	34	1.04M (2.2M)	2.45M (5.2M)	>6.4M	Not cost beneficial. The original PRA case RCPLOCA conservatively assumed that RCP seal LOCA events are eliminated. A more realistic PRA Case CSBX assumes tha CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B. Cost to engineer and implement plant modifications judged comparable in scope and complexity to "installing a backup water supply and pumping capability" (Grand Gulf #61). Grand Gulf SAMA #61 estimated the cost of a similar plant change at >$6.4M. The cost of installing an independent seal injection system with or without a dedicated diesel is expected to significantly exceed benefit. Refer above to SAMA #55. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.

NextEra Energy Seabrook, LLC
Supplement to Severe Accident Mitigation Alternatives Analysis

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
59	Install an additional component cooling water pump	Reduced likelihood of loss of component cooling water leading to a reactor coolant pump seal LOCA	PCCABCD	4	11	335K (704K)	785K (1.7M)	>6.1M	Not cost beneficial. The original PRA case CCW01 conservatively assumed guaranteed success of the component cooling water (CCW) systems to provide heat removal. Thus, the benefit of installing an additional CCW pump was conservatively high. A more realistic PRA Case CCABCD assumes that all of the CCW pumps are guaranteed success when their AC and DC power support systems are available. This case is used to represent the benefit of an additional "parallel" CCW pump connected to the system. 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. Cost to engineer and implement modifications for additional pump judged comparable in scope and complexity to "adding a service water pump" at other plants that presently do not have these features (Columbia SAMA CW-07) It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.
65	Install a digital feed water upgrade	Reduced chance of loss of main feed water following a plant trip	MAB	--	--	3.05M (6.41M)	7.15M (15.0M)	30M	Not cost beneficial based on inspection of the MAB. Cost to engineer and implement installation of the digital feedwater control upgrade is based on Seabrook previously reported estimate.
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	MAB	--	--	3.05M (6.41M)	7.15M (15.0M)	>>15M	Not cost beneficial based on inspection of the MAB. A passive heat removal system using air as the ultimate heat sink would be extremely large. Cost to engineer and implement installation of large passive air cooling system is far in excess of the attainable 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	PORV	<1	0	1.7K (4K)	4.1K (9K)	>2.7M	Not cost beneficial. The original PRA case FW01 conservatively assumed elimination of all loss of feedwater initiating events including all reactor trip events, whether or not the trip events were the result of a loss of feedwater. A more realistic PRA case PORV assumes guaranteed success of the PORVs. This case is used to represent a change in PORV success criteria to reflect larger capacity valves. The cost of replacing the PORVs to increase capacity and improve feed and bleed performance is expected to significantly exceed benefit. Cost to engineer and implement hardware design changes and replacement of PORVs judged comparable to other plants that presently do not have these features (Calvert Cliffs SAMA #77).

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
80	Provide a redundant train or means of ventilation	Increased availability of components dependent on room cooling	HVAC2	3	5	152K (320K)	357K (750K)	>1M	Not cost beneficial. The original and updated PRA case HVAC2 conservatively assume no HVAC dependency for CS, SI, RHR and CBS pumps. Cost to engineer and implement redundant ventilation design modification judged comparable to other plants that presently do not have these features (Callaway SAMA #80).

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	<1	0	<1K (2K)	<$2K (4K)	>250K	Not cost beneficial. The original and updated PRA case OEFWVS and OEFWV conservatively assume no HVAC dependency for EFW pumps. Cost to engineer and implement HVAC system design changes to allow for DC power supply is based on Seabrook previously reported estimate.
91	Install a passive containment spray system	Improved containment spray capability	CONTX1	0	40	1.2M (2.5M)	2.7M (5.7M)	>10M	Not cost beneficial. The original PRA case CONT01 conservatively assumed the containment does not fail due to overpressure. A revised PRA Case CONTX1 assumes that one division of Containment Building Spray CBS (including spray injection, containment recirculation, and heat removal) does not depend on AC/DC power or PCCW support systems except for initiation signal. This case more realistically represents the potential risk reduction benefit that might be provided by installation of an independent division of containment spray. Cost to engineer and implement passive containment heat removal system judged comparable in scope and complexity to plants that presently do not have these features (Callaway SAMA #91).
93	Install an unfiltered, hardened containment vent	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products	XOVNTS	0	1	39K (82K)	92K (193K)	>$3M	Not cost beneficial. The original PRA case CONT01 conservatively assumed the containment does not fail due to overpressure. It is noted that the Seabrook Station design includes the Containment On-line Purge (COP) and Combustible Gas Control (CGC) systems, which can function to vent containment during an accident after all other means of containment decay heat removal have failed. Use of these systems to depressurize containment to the environment is included as a severe accident strategy in the Seabrook Severe Accident Management Guideline SCG-2. Containment venting using the COP system is currently credited in the Level 2 PRA as a means of preventing over-pressure containment failure when support systems are available. The COP and CGC systems discharge pathways are to the plant stack (located at the top of containment) via a combination of pipe and rugged ductwork and fan/filter enclosures. Cost to engineer and implement vent to allow decay heat removal capacity is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	CONTX1	0	40	1.2M (2.5M)	2.7M (5.7M)	>7.8M	Not cost beneficial. The original conservative PRA case CONT01 assumed 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. A more realistic PRA Case CONTX1 assumes that one division of Containment Building Spray CBS (including spray injection, containment recirculation, and heat removal) does not depend on AC/DC power or PCCW support systems except for initiation signal. This case is used to represent the potential risk reduction benefit that might be provided by installation of a filtered vent to prevent containment overpressure failure while retaining some of the fission products. Cost to engineer and implement decay heat capacity filtered vent judged comparable to other plants that presently do not have these features (Calvert Cliffs SAMA 12 provided an estimate of $5.7M in 1998, escalated to $7.8M in 2012).
96	Provide post-accident containment inerting capability	Reduced likelihood of hydrogen and carbon monoxide gas combustion	H2BURN	0	1	18K (39K)	43K (90K)	>100K	Not cost beneficial. The original and updated PRA case H2BURN conservatively assume that hydrogen burns and detonations do not occur. Cost to engineer and implement a containment inerting system is based on Seabrook previously reported estimate.
99	Strengthen primary/secondary containment (e.g., add ribbing to containment shell)	Reduced probability of containment over-pressurization	CONTX1	0	40	1.2M (2.5M)	2.7M (5.7M)	11.5M	Not cost beneficial. The context of this SAMA is to eliminate or reduce containment overpressure failure events by adding reinforcement to containment. The original PRA case CONT01 conservatively assumed the containment does not fail due to overpressure. A more realistic, yet still conservative PRA Case CONTX1 is used to estimate the risk benefit associated with strengthening containment. The new PRA case CONTX1 assumes one division of Containment Building Spray CBS (including spray injection, containment recirculation, and heat removal) does not depend on AC/DC power or PCCW support systems except for initiation signal. This case more realistically represents a reduction in the containment pressure challenge that might be realized by further strengthening of the containment shell itself. It is noted that the installation of structural support members sufficient enough to gain further design pressure margin to the containment building is judged not practical at Seabrook Station. Cost to engineer and implement installation of reinforcing steel to strengthen containment is estimated at >$11.5M for design, materials and installation.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2:1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
102	Construct a building to be connected to primary/sec. containment and maintained at a vacuum	Reduced probability of containment over-pressurization	CONTX1	0	40	1.2M (2.5M)	2.7M (5.7M)	56.7M	Not cost beneficial. The context of this SAMA is to eliminate or reduce containment release events by adding a system to maintain evacuation (negative pressure) in the containment. It is noted that Seabrook Station already has an enclosure building around the primary containment building, which is maintained in a negative pressure condition. The original PRA case CONT01 conservatively assumed the containment does not fail due to overpressure. A more realistic PRA Case CONTX1 is used to estimate the risk benefit associated with improvements to the enclosure building to make it more robust relative to severe accident challenges, such as adding an additional building with filtration system. The new PRA case CONTX1 assumes one division of Containment Building Spray CBS (including spray injection, containment recirculation, and heat removal) does not depend on AC/DC power or PCCW support systems except for initiation signal. This case more realistically represents the postulated reduction in the release challenge that might be realized by an evacuation building to capture releases. Cost to engineer and construct a new building adjacent to containment with ventilation systems capable of maintaining a negative pressure is estimated at greater than $56M for design, materials and installation.
105	Delay containment spray actuation after a large LOCA	Extended reactor water storage tank availability	OLPR	3	0	11.7K (25K)	27.4K (58K)	>100K	Not cost beneficial. The original and updated PRA Case OLPRS and OLPR conservatively assume 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. Cost to engineer and implement control circuitry to delay containment spray actuation for large LOCA is based on Seabrook previously reported estimate.
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	13	10	312K (656K)	731K (1.54M)	>3M	Not cost beneficial. The original and updated PRA case LOCA04 conservatively assume 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. Cost to engineer and implement automatic flow throttling control system is estimated at greater than $3M. This assumes that both LOCA and Containment Mass Energy calculations need 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.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
107	Install a redundant containment spray system	Increased containment heat removal ability	CONTX1	0	40	1.2M (2.5M)	2.7M (5.7M)	>10M	Not cost beneficial. The context of this SAMA is to eliminate containment overpressure failure events by adding a redundant containment spray system. The original conservative PRA case CONTX1 assumed that a division of containment building spray (CBS) was guaranteed successful. A more realistic PRA Case CONTX1 assumes that one division of Containment Building Spray CBS (including spray injection, containment recirculation, and heat removal) does not depend on AC/DC power or PCCW support systems except for initiation signal. This case is used to represent the potential risk reduction benefit that might be provided by installation of an additional redundant spray system. Cost to engineer and implement redundant spray system is estimated at greater than $10M. This is based on the cost of physical plant modifications and analysis judged comparable in scope and complexity to "installing a passive containment spray system" at plants that presently do not have these features (Callaway SAMA #91).
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	0	1	18.3K (39K)	43K (90K)	>100K	Not cost beneficial. The original and updated PRA case H2BURN conservatively assume that hydrogen burns and detonations do not occur. Cost to install an independent power supply to the H2 control system is based on Seabrook previous reported estimate. 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	0	1	18.3K (39K)	43K (90K)	>100K	Not cost beneficial. The original and updated PRA case H2BURN conservatively assume that hydrogen burns and detonations do not occur. Cost to install a passive hydrogen control system is based on Seabrook previous reported estimate.

NextEra Energy Seabrook, LLC
Supplement to Severe Accident Mitigation Alternatives Analysis

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW									
SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	HPME	0	0	<1K (<1K)	1K (2K)	>10M	Not cost beneficial. The original cost benefit was assessed based on MAB. The updated cost benefit assessment is based on PRA case HPME which assumes that high pressure melt ejection occurrences are completely eliminated. It is noted that high pressure melt ejection phenomenon dose not represent a significant challenge to containment because of the current robust pressure design of the Seabrook containment. Cost to engineer and implement barrier modifications judged comparable in scope and complexity to plants that presently do not have these features (Callaway SAMA #110).
112	Add redundant and diverse limit switches to each containment isolation valve	Reduced frequency of containment isolation failure and ISLOCAs	CONT02	0	6	115K (242K)	270K (566K)	>1M	Not cost beneficial. The original and updated PRA case CONT02 conservatively assume 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 $566K * 0.5 = $283K and is judged not cost beneficial. Cost to engineer and implement diverse CI valve limit switches judged comparable in scope and complexity to plants that presently do not have these features (Callaway SAMA #112).
113	Increase leak testing of valves in ISLOCA paths	Reduced ISLOCA frequency	LOCA06	<1	3	48K (101K)	114K (240K)	>1M	Not cost beneficial. The original and updated PRA case LOCA06 conservatively assume 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 $240K * 0.5 = $120K. Cost to engineer and implement leak test system modifications judged comparable to other plants that presently do not have these features (Callaway 113). As stated, testing cannot be performed during power operation. The cost of lost generation as a result of even one plant shutdown and cooldown for several days needed to perform the testing is expected to significantly exceed the benefit.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
114	Install self-actuating containment isolation valves	Reduced frequency of isolation failure	CONT02	0	6	115K (242K)	270K (566K)	>2M	Not cost beneficial. The original and updated PRA case CONT02 conservatively assume 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 $566K * 0.5 = $283K. Cost to install self-actuating valves based assuming two trains of CI valves requiring replacement of exiting containment valves with self actuating valves (assume AOVs). Piping and support changes, controls and wiring also needed to support modifications.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
115	Locate residual heat removal (RHR) inside containment	Reduced frequency of ISLOCA outside containment	LOCA06	<1	3	48K (101K)	114K (240K)	>1M	Not cost beneficial. The original and updated PRA case LOCA06 conservatively assume that ISLOCA events do not occur. Cost to relocate the RHR system function to inside containment is based on Seabrook previous reported estimate.
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	5	2	67K (141K)	157K (329K)	>500K	Not cost beneficial. The original and updated PRA case NOSGTR conservatively assume that SGTR events do not occur. Cost to perform 100% inspection each refueling outage is based on previous Seabrook reported estimate. 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	5	2	67K (141K)	157K (329K)	>500K	Not cost beneficial. The original and updated PRA case NOSGTR conservatively assume that SGTR events do not occur. Cost to engineer and analyze design to increase the SG secondary side pressure is based on Seabrook previously reported estimate.
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	5	2	67K (141K)	157K (329K)	>500K	Not cost beneficial. The original and updated PRA case NOSGTR conservatively assume that SGTR events do not occur. 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. Cost to install main steam safety valve spray system to reduce fission product release during SGTR is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	5	2	67K (141K)	157K (329K)	>>15M	Not cost beneficial. The original and updated PRA case NOSGTR conservatively assume that SGTR events do not occur. Cost to install a passive, closed loop SG heat removal system is greater than $15M. This is based on the water cooled isolation condenser being extremely large and expensive to install for a fully constructed plant. Conceptually this installation would be similar to SAMA 77.
129	Vent main steam safety valves in containment	Reduced consequences of a steam generator tube rupture	NOSGTR	5	2	67K (141K)	157K (329K)	>500K	Not cost beneficial. The original and updated PRA case NOSGTR conservatively assume that SGTR events do not occur. Cost to engineer and analyze design to locate main steam safety valves in containment or route existing Safety valve discharge to containment is based on Seabrook previously reported estimate.
130	Add an independent boron injection system	Improved availability of boron injection during ATWS	NOATWS	4	2	60K (126K)	139K (292K)	>500K	Not cost beneficial. The original and updated PRA case NOATWS conservatively assume that ATWS events do not occur. Cost to install independent boron injection system is based on Seabrook previously reported estimate.
131	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS	Improved equipment availability after an ATWS	NOATWS	4	2	60K (126K)	139K (292K)	>500K	Not cost beneficial. The original and updated PRA case NOATWS conservatively assume that ATWS events do not occur. Cost to install additional relief capacity is based on Seabrook previously reported estimate.
133	Install an ATWS sized filtered containment vent to remove decay heat	Increased ability to remove reactor heat from ATWS events	NOATWS	4	2	60K (126K)	139K (292K)	>500K	Not cost beneficial. The original and updated PRA case NOATWS conservatively assume that ATWS events do not occur. Cost to install filtered vent with capacity for ATWS heat removal is based on Seabrook previously reported estimate.
147	Install digital large break LOCA protection system	Reduced probability of a large break LOCA (a leak before break)	LOCA05	9	2	77K (162K)	181K (380K)	>500K	Not cost beneficial. The original and updated PRA case LOCA05 conservatively assume that LOCA events, as a result of pipe failures, do not occur. Cost to install a digital break detection system is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
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	<1	0	5K (11K)	11K (24K)	>500K	Not cost beneficial. The original and updated PRA case NOSLB conservatively assume that steam line break events do not occur. Cost to install secondary side pipe guards is based on Seabrook previously reported estimate.
154	Modify SEPS design to accommodate automatic bus loading and automatic bus alignment (Plant Personnel)	Improve reliability of onsite power; reduce SBO CDF contribution; remove dependence on operator action	OSEPS	8	2	64K (135K	151K (318K)	>750K	Not cost beneficial. The original PRA case OSEPALL and the updated PRA case OSEPS conservatively assume 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. Cost to install automatic control system is based on Seabrook previously reported estimate.
156	Install alternate offsite power source that bypasses the switchyard. For example, use campus power source to energize Bus E5 or E6 (IPE)	Improve offsite power reliability and independence of switchyard and SF6 bus duct; allow restoration of offsite power within a few hours	NOLOSP	18	17	531K (1.2M)	1.24M (2.7M)	>7M	Not cost beneficial. The original and updated PRA case NOLOSP conservatively assume elimination of all LOSP events. Cost to install alternate offsite power source that bypasses the current switchyard power source is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
157	Provide independent AC power source for battery chargers. For example, provide portable generator to charge station battery (IPE)	Reduce CDF of long term SBO sequences; extend battery life to allow additional time for recovery	INDEPAC	<2	1	34K (72K)	80K (168K)	30K	**Potential cost beneficial SAMA**. SAMA #157 was shown to be potentially cost beneficial in the previous study. The previous and updated PRA case INDEPAC conservatively assume that station batteries have AC power available for battery charging guaranteed success of AC power recovery to represent the benefit of extended battery life. Cost to implement portable battery chargers is expected to be less than the potential benefit.
159	Install additional batteries (IPE)	Reduce CDF of long term SBO sequences; extend battery life to allow additional time for recovery	INDEPAC	<2	1	34K (72K)	80K (168K)	>1M	Not cost beneficial. The previous and updated PRA case INDEPAC conservatively assume that station batteries have AC power available for battery charging by assuming guaranteed success of AC power recovery to represent the benefit of extended battery life. Cost to install additional batteries is based on Seabrook previously reported estimate.
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. (Expert Panel)	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	DGSW	<1	1	25K (59K)	53K (124K)	2M	Not cost beneficial. The original PRA case NOSBO conservatively assumed elimination of all station blackout events by assuming guaranteed success of both DGs for all events and independent of all support systems (control power, cooling, etc.). The updated PRA case DGSW assumes success of SW components (valves) that are associated with DG cooling and alignment of the SW system (ocean and cooling tower). Guaranteed success of these components and the resulting increase in SW reliability is representative of the DG cooling water reliability gained from installing a backup source of cooling water. Insights from this analysis are that the existing arrangement of SW cooling to the DGs is of a reliable design; and making the DGs less dependent on SW does not provide a significant risk reduction because other train-specific components, such as ECCS pumps, also depend on SW cooling. Cost of physical plant modifications and analysis judged comparable to other plants that presently do not have these features (Grand Gulf 10). Backup diesel cooling water system is also addressed in SAMA #20.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
162	Increase the capacity margin of the CST (Plant Personnel)	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	<2	1	35K (73K)	81K (171K)	>2.5M	Not cost beneficial. The original and updated PRA case CST01conservatively assume a continuous, successful CST suction source for EFW. Cost of expanding capacity of the CST is based on project scope of Installing a new (larger) safety grade condensate storage tank, which is judged necessary to achieve ful benefit. Cost of physical plant modifications and analysis are comparable to other plants that presently do not have this feature (Callaway SAMA #71).
163	Install third EFW pump (steam-driven) (Expert Panel)	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	5	12	356K (748K)	835K (1.8M)	>2M	Not cost beneficial. The original PRA case TDAFW conservatively assume guaranteed success of the turbine-driven EFW pump. For simplification, the updated PRA case assumes guaranteed success of the motor-driven pump, i.e., the EFW pump function is success and independent of AC power. Thus, the benefit of installing an additional turbine-driven pump is conservatively high. Cost of installing an additional steam-driven EFW pump is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
164	Modify 10" Condensate Filter Flange to have a 2½-inch female fire hose adapter with isolation valve (Plant Personnel)	Possible enhancement of long term core damage sequences that credit CST makeup	CST01	<2	1	35K (73K)	81K (171K)	>40K	**Potential cost beneficial SAMA.** The original and updated PRA case CST01 conservatively assume a continuous, successful CST suction source for EFW. Cost of modifying the condensate flange is expected to be less than the potential 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 (Plant Personnel)	Could enhance long term containment injection sequences that would benefit from RWST makeup	NORMW	5	2	57K (121K)	134K (283K)	50K	**Potential cost beneficial SAMA**. SAMA #165 was shown to be potentially cost beneficial in the previous study. The previous and updated PRA case NORMW conservatively assume guaranteed success of RWST makeup. Cost of modifying the RWST flange is expected to be less than the potential benefit.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
167	Install independent seal injection pump (low volume pump) with automatic start (IPE)	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures	CSBX	22	34	1.1M (2.3M)	2.5M (5.3M)	6.4M	Not cost beneficial. The original PRA case RCPLOCA conservatively assumed that RCP seal LOCA events are eliminated. A more realistic PRA Case CSBX assumes tha CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B, credited for seal injection. The new PRA case is judged conservative in that it benefits not only seal injection but also high pressure injection. Cost of this modification is estimated at greater than $6.4M. 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. In addition, Grand Gulf SAMA #61 estimated the cost of a similar plant change at >$6.4M. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.
168	Install independent seal injection pump (low volume pump) with manual start (IPE)	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures	CSBX	22	34	1.1M (2.3M)	2.5M (5.3M)	6.4M	Not cost beneficial. The original PRA case RCPLOCA conservatively assumed that RCP seal LOCA events are eliminated. A more realistic PRA Case CSBX assumes tha CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B, credited for seal injection. The new PRA case is judged conservative in that it benefits not only seal injection but also high pressure injection. Refer above to SAMA#167 for approximate cost estimate. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.
169	Install independent charging pump (high volume pump) with manual start (IPE)	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures; improve decay heat removal using feed & bleed	CSBX	22	34	1.1M (2.3M)	2.5M (5.3M)	6.4M	Not cost beneficial. The original PRA case RCPLOCA conservatively assumed that RCP seal LOCA events are eliminated. A more realistic PRA Case CSBX assumes tha CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B, credited for seal injection. The new PRA case is judged conservative in that it benefits not only seal injection but also high pressure injection. Refer above to SAMA#167 for cost basis. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
170	Replace the Positive Displacement Pump (PDP) with a 3rd centrifugal charging pump. Consider low volume and cooling water independence (Expert Panel)	Reduce CDF contribution from RCP seal LOCA events driven by seal cooling hardware failures	CSBX	22	34	1.1M (2.3M)	2.5M (5.3M)	6.4M	Not cost beneficial. The original PRA case RCPLOCA conservatively assumed that RCP seal LOCA events are eliminated. A more realistic PRA Case CSBX assumes tha CS division B of high pressure injection (CSB) is independent and does not rely on support systems (independent of AC / DC power, cooling, etc.). This case is used to represent a "parallel" pump with same suction as CS-B, credited for seal injection. The new PRA case is judged conservative in that it benefits not only seal injection but also high pressure injection. Refer above to SAMA#167 for cost basis. It is noted that some of the potential benefits of this SAMA would be realized with SAMA #172, RCP shutdown seal.
172	Evaluate installation of a "shutdown seal" in the RCPs being developed by Westinghouse (Expert Panel)	Reduce CDF contribution from transients with seal cooling hardware failures resulting in RCP seal LOCA events	RCPL	34	49	1.5M (3.2M)	3.5M (7.4M)	2M	**Potential cost beneficial SAMA**. The original and updated PRA cases RCPLOCA and RCPL conservatively assume elimination of the loss of RCP seal cooling initiating event (LRCPCS) and also assumes guaranteed success of seal cooling for transients, thus avoiding RCP seal LOCA events subsequent to a plant transient. Cost of installing the RCP shutdown seals is expected to be less than the potential benefit. It is noted that installation of the RCP low leakage shutdown seals will benefit SAMAs #14, #25, #26, #55, #56, #59, #167, #168, #169, #170 (Table 1) and BE#1, and BE#2 (Table 2).
174	Provide alternate scram button to remove power from MG sets to CR drives (IPE)	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	4	2	59.5K (125K)	139K (292K)	>500K	Not cost beneficial. The original and updated PRA case NOATWS conservatively assume elimination of all ATWS risk. Cost of modifying the scram system to provide an alternate scram button is based on Seabrook previously reported estimate.

NextEra Energy Seabrook, LLC
Supplement to Severe Accident Mitigation Alternatives Analysis

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
179	Fire induced LOCA response procedure from Alternate Shutdown Panel (IPEEE)	Possible reduction in CDF if mitigating fire-induced LOCA	FIRE1A	0	0	<1K (<1K)	<1K (<2K)	>20K	Not cost beneficial. The original PRA case FIRE1 conservatively assumed complete elimination of the control room fire initiating event that results in a PORV challenge. A refined PRA Case FIRE1A assumes guaranteed success of the operator action to close the PORV block valve during the postulated control room fire event (thus the CR fire event is assumed to occur at its current frequency). 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. Cost of modifying the operator response procedures and controls is based on Seabrook previously reported estimate.
181	Improve relay chatter fragility (IPEEE)	Reduce CDF contribution from relay chatter	SEISMIC01	12	3	87K (182K)	204K (467K)	>600K	Not cost beneficial. The original and updated PRA case SEISMIC01 conservatively assume 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. Cost of modifying/replacing existing relays is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
182	Improve seismic capacity of EDGs and steam-driven EFW pump (IPEEE)	Improve component fragility and reduce seismic event contribution to CDF	SEISMIC02	<1	0	2.4K (6K)	5.6K (12K)	>500K	Not cost beneficial. The original and updated PRA case SEISMIC02 conservatively assume no seismic failures of the EDGs and turbine-driven EFW pump occur. Cost of upgrading the EDGs or the TD-EFW pump is based on Seabrook previously reported estimate.
184	Control/reduce time that the containment purge valves are in open position (IPE)	Purge path is large opening. Reduce exposure time of open path, improve reliability/availability of CI, reduce CI failure contribution to large release	COP	0	0	<1K (<1K)	<1K (<2K)	>20K	Not cost beneficial. The original PRA case PURGE and the updated PRA case COP conservatively assume that the containment purge valves are continuously in the closed position and are not opened periodically. Cost of procedural changes is based on Seabrook previously reported estimate.
186	Install containment leakage monitoring system (IPE)	Improve containment reliability by reducing the potential for pre-existing containment leakage	CISPRE	0	0	4.4K (12K)	10.4K (27K)	>500K	Not cost beneficial. The original and updated PRA case CISPRE conservatively assume complete elimination of pre-existing containment leakage. Cost of installing leakage monitoring system is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
187	Install RHR isolation valve leakage monitoring system (IPE)	Reduce ISLOCA challenge to RHR by identification of upstream valve failure	LOCA06	<1	3	48K (101K)	113K (238K)	>500K	Not cost beneficial. The original and updated PRA case LOCA06 conservatively assume complete elimination of all ISLOCA risk contribution. However, improved leak detection will eliminate some but not all ISLOCA events. For SAMA purposes, installing a leak detection system is assumed to reduce the ISLOCA frequency by 80%. Thus, the PRA case upper bound benefit is estimated at $238K * 0.8 = $190K. Cost to install a leakage monitoring system at the RHR isolation valves is judged comparable to other plants that presently do not have these features (Callaway SAMA #111). This modification will require pressure and/or temperature transmitters installed in containment between isolation valves, the use of additional containment electrical penetrations to allow remote readouts/alarms in the control room to alert the operator that lower pressure piping is being challenged by RCS leakage.
189	Modify or analyze SEPS capability; 1 of 2 SEPS for LOSP non-SI loads, 2 of 2 for LOSP SI loads (Plant Personnel)	Allow all equipment to be run following LOSP with EDG failure but successful start and load of SEPS	SEPS	6	2	63K (133K)	148K (311K)	>2M	Not cost beneficial. The original PRA case assumed a change to the SEPS success criteria in that one of two SEPS DGS was capable of handling AC loads without a SI (LOCA) signal present, with no change to the manual alignment scheme. For simplification, the updated PRA case conservatively assumes guaranteed success of al SEPS hardware and no change to the current scheme of manual alignment. Cost to modify SEPS is based on Seabrook engineering estimate.
190	Add synchronization capability to SEPS Diesel (Plant Personnel)	Eliminate current requirement for dead bus transfer from SEPS to normal power	NOSBO1	22	6	224K (470K)	525K (1.1M)	>6.4M	Not cost beneficial. The original PRA case NOSBO and recent PRA case NOSBO1 both conservatively assume elimination of all station blackout events by assuming guaranteed success of both EDGs for all events and independent of all support systems (control power, cooling, etc.) The cost to install synchronization capability to the SEPS diesel is based on Seabrook engineering estimate.
191	Remove the 135F temperature trip of the PCCW pumps (Plant Personnel)	Potential for some improvement in PCCW reliability by eliminating consideration of spurious trip	PCTES	<1	0	<1K (<1K)	<1K (<2K)	>100K	Not cost beneficial. The original and updated PRA Case PCTES assume elimination 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). Cost and scope of modifying the temperature trip is based on Seabrook previously reported estimate.

NextEra Energy Seabrook, LLC
Supplement to Severe Accident Mitigation Alternatives Analysis

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
192	Install flow orifice in fire protection system (New - Plant Personnel)	Reduce CDF contribution of CB flooding due to fire protection pipe break	NOCBFLD	24	11	470K (987K)	1.1M (2.3M)	370K	**Potential cost beneficial SAMA**. SAMA #192 was shown to be potentially cost beneficial in the previous study. The updated benefit of the SAMA was estimated from the ratios of the previous flood model MAB result to the updated model MAB. A new specific SAMA model case was not performed. Cost to install proposed flow reducing orifice is expected to be less than the potential benefit. Based on the previously estimated benefit of $161K (nominal) and $307K (UB), the proposed SAMA to install a flow reducing orifice in the Control Building fire protection system pipe continues to be potentially cost beneficial. Previous Flood model MAB: $1,042,683 (nominal), $1,982,048 (upper bound) Revised SEABRK model MAB: $3,050,815 (nominal), $7,154,678 (upper bound) Ratio increase: 2.92 (nominal), 3.61 (upper bound) Nominal = 2.92 * $161K = $470K ($978K) Upper bound = 3.61 * $307K = $1.1M ($2.3M)
193	Eliminate CSV167 AC power dependence (New – Plant Personnel)	Reduce containment isolation failure contribution of CSV167	CSV167	0	5	86K (180K)	201K (423K)	300K	**Potential cost beneficial SAMA**. SAMA #193 was shown to be potentially cost beneficial in the previous study. PRA case CSV167 assumes guaranteed success of the operator action to close containment isolation valve CS-V-167 locally. Cost to implement a change to the design of CS-V-167 is expected to be less than the potential benefit.
194	Purchase or manufacture of a "gagging device" that could be used to close a stuck-open steam generator safety valve (New – NRC RAI)	Improve release mitigation for a SGTR event prior to core damage	MSSVRS	0	0	<1K (<1K)	<1K (<2K)	>30K	Not cost beneficial. The original and updated PRA cases MSSVRS assume success of the MSSVs to reseat. Cost to implement a safety valve gagging device is based on Seabrook previously reported estimate.

TABLE 1 – SEABROOK – MAB & PHASE 2 SAMA REVIEW

SBK SAMA Number	Potential Improvement	Description	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
				CDF	Pop. Dose	Internal & External	With Uncert.		
195 New SAMA	Make improvements to PCCW temperature control reliability	PCC Train B Temperature Element CC-TE-2271 transmits false low	CCTE1	3	5	144K (302K)	337K (709K)	300K	**Potential cost beneficial SAMA**. NextEra has entered into the long range plan for a modification to improve the reliability of CC-TV-2171/2271-1 & 2. Refer to BE #9 (Table 2) **New SAMA** The SAMA concept is to install hardware changes to improve the reliability of the CCW systems and reduce the loss of CCW initiating event frequency. Based on inspection of the CCW PRA model, the component failures that contribute the most to the loss of CCW initiator are components associated with temperature control/modulation. In the PRA, these components are modeled as temperature elements (TE) causing failure of the temperature control scheme. PRA case CCTE1 is used to represent the potential risk reduction benefit. This case conservatively assumes guaranteed success of the TE function for PCC Trains A and B that could fail PCCW during the year (as an initiator) and during the mission time (support system model). Hardware changes to improve temperature control reliability – update of existing equipment or provide additional redundancy in instrumentation / controls. Cost to engineer and install improvements to CCW temperature control are expected to be less than the potential benefit.

NextEra Energy Seabrook, LLC
Supplement to Severe Accident Mitigation Alternatives Analysis

TABLE 2 - SEABROOK - BASIC EVENT & INITIATING EVENT SAMA REVIEW										
Basic Event (BE) or Initiating Event (IE)	RC Group	Event Description	Related SAMA #'s and Proposed SAMA(s)	PRA Case	% Risk Reduction		Total Benefit ($) Baseline (with 2.1 multiplier)		Expected SAMA Cost ($)	Evaluation
					CDF	Pop. Dose	Internal & External	With Uncert.		
Basic Event (BE) Related SAMAs										
BE #1 HH.OALT1.FL	CDF LL5 SELL	Operator Action - Manual Alignment of Alternate Cooling to Charging Pumps	Related SAMA #172. Provide automatic alignment of alternate cooling based on applicable signals	OALT0	4	11	340K (714K)	797K (1.7M)	> 2.4 M	Not cost beneficial. The SAMA concept is to enhance the operator's ability to align alternate cooling to the standby charging pump oil cooler in time to allow the standby pump to restart and restore RCP seal cooling before heatup of RCP seals. Success of the action avoids an RCP seal LOCA event. The PRA case conservatively assumes guaranteed success of the operator action to align alternate cooling. The cost of hardware changes to automate the alignment of alternate cooling will exceed the conservative benefit. Cost of physical plant modifications and analysis judged comparable in scope and complexity to STP SAMA #17, automation needed to protect RCP seals of 2.4M. This SAMA is related to SAMA #172 (RCP shutdown seal). The importance of this SAMA would be reduced or eliminated with the installation of the RCP shutdown seal, which has been shown to be potentially cost beneficial.