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.

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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

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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

Shirley Sweeney
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

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

1.0 INTRODUCTION

This report provides an update to the original SAMA analysis for Seabrook Station. The original SAMA was submitted in December 2009 and was based on Seabrook's base case PRA model of record SSPSS-2006 (model SB2006). In NextEra Energy Seabrook Letter SBK-L-11001 (Reference 2), the next periodic update to the PRA model was discussed. NextEra Energy Seabrook has completed the PRA update (SSPSS-2011) and is providing, in this letter, a supplemental SAMA analysis based on this PRA update.

Section 2.0 summarizes the method used to develop and evaluate SAMA candidate changes. Section 3.0 describes changes in the current PRA (SSPSS-2011) from the PRA update used for the original SAMA submittal (SSPSS-2006). Section 4.0 provides the results of the supplemental SAMA and identifies several additional SAMA candidates as being potentially cost beneficial.

2.0 METHOD

The SAMA supplement builds upon the original assessment provided in NextEra Energy Seabrook Letter SBK-L-10077 (Reference 1) and subsequent RAI responses in NextEra Energy letters SBK-L-11001 (Reference 2), SBK-L-11067 (Reference 3) and SBK-L-11125 (Reference 4). The SAMA supplement follows the same industry guidance outlined in NEI 05-01, and uses the same technical process as the original SAMA. The general approach to the reassessment is summarized here:

a) Latest PRA models are used to determine the nominal and uncertainty public risk/consequences and associated maximum averted benefit (MAB).

b) The previous Phase 1 SAMA candidates, which were qualitatively screened from further detailed assessment based on the SAMA not being applicable to the plant design or the SAMA intent being met by the plant design, are not reviewed further in this supplement.

c) Previously-identified Phase II SAMA candidates are re-evaluated for possible changes to their cost-benefit worth. Phase II SAMA candidates identified as intent-met in RAI responses are not reviewed further in this supplement.

d) In addition to the previously-identified Phase II SAMA candidates, new potential SAMA candidates are identified based on a review of the latest PRA model results and risk ranking of the top-ranked initiating events and basic events that contribute to CDF and LERF. In addition, the top-ranked basic events associated with release categories that contribute to the top 90% of public risk are assessed. These top initiating events and basic events are evaluated by linking to an existing candidate Phase II SAMA evaluation or are specifically evaluated in Phase II as a possible new SAMA candidate.

e) The SAMA cost-benefit assessment is based on development of new PRA cases to conservatively (and in some cases, more realistically) estimate the potential cost-benefit worth based on the updated model. All SAMA cost-benefits are assessed for nominal (best estimate) and uncertainty (upper bound) with and without the seismic multiplier to account for the potential increase in seismic risk per GSI-199 information.

f) The implementation cost of each SAMA is reassessed as necessary to ensure that the costs continue to be representative of the SAMA scope based on recent experience.

3.0 PRA MODEL

The NextEra Energy Seabrook PRA model has been updated and is identified as SSPSS-2011, Model SB2011. The updated features of the SB2011 PRA model incorporated the following:

- The Level 1 PRA model update includes a detailed assessment of internal flood initiating events, an update to latent human actions assessment, plant hardware changes and miscellaneous modeling changes.
- The Level 2 PRA model update includes a detailed assessment of release category source terms.
- The Level 3 PRA model update includes the revised release category source terms and associated frequencies from the Level 2 PRA model.

The original Seabrook SAMA was based on PRA model SB2006, the model of record and in use at the time the Seabrook SAMA was performed in support of the License Renewal Application submitted on 05/27/2010, Letter SBK-L-10077 (Reference 1). Subsequent to the SAMA submittal, the Seabrook PRA was updated in 2009 (Model SB2009) and most recently in 2011 (Model SB2011).

The PRA model changes made in SB2009 were summarized in NextEra Energy's response to RAI 1a (Letter SBK-L-11001, Reference 2). As stated in the RAI response, the updated SB2009 PRA model baseline core damage frequency decreased compared to the SB2006 PRA model by ~19 percent, from 1.44E-05/yr (SB2006) to 1.17E-05/yr (SB2009). The LERF also decreased by ~30 percent, from 1.15E-07/yr (SB2006) to 8.1E-08/yr (SB2009). In addition, there was no significant shift in the relative importance of initiating events or components. Thus, as stated in the RAI 1a response (Reference 2), the plant changes incorporated into the SB2009 PRA model did not have a significant impact on the overall SAMA results.

Based on the PRA model changes made in SB2011, as described below, the updated SB2011 PRA model baseline core damage frequency increased compared to the SB2009 PRA model by ~5 percent, from 1.17E-05/yr (SB2009) to 1.23E-05/yr (SB2011). The LERF also increased by ~14 percent, from 8.1E-08/yr (SB2009) to 9.2E-08/yr (SB2011). In addition, there was no significant shift in the relative importance of initiating events or components except for the addition of new internal flood initiators.

3.1 LEVEL 1, LEVEL 2 and LEVEL 3 PRA CHANGES

The specific plant changes and model changes made to the most recent PRA model SB2011 are summarized below.

Plant Changes

Two significant plant changes were incorporated into the updated PRA model. These include the switchyard upgrade and PRA modeling of the fire protection system flow orifice.

- *Plant Change - Switchyard Upgrade - Breakers and Interconnections*

  Switchyard breakers and interconnections were revised to reflect the Switchyard Project upgrade. The switchyard project improved the reliability and availability of the ring bus and enclosed a major portion of the switchyard/components for improved protection from weather and salt spray hazards. The PRA update included incorporation of new breakers and buses to reflect the completed, as-built configuration. The switchyard upgrade modification will have a positive influence on the reliability of offsite power. The loss-of-offsite-power (LOOP) initiator model is quantified based on overall generic and plant specific LOOP data, not the specific configuration of the switchyard. However, over the longer term, the switchyard improvements should result in a reduction to the frequency of the plant-specific plant-centered loss of offsite power events.

- *Plant Change - Flow Orifice in Fire Protection Piping in the Control Building*

  Insights from the updated internal flood risk assessment identified that Control Building flood scenarios from postulated pipe breaks in the fire protection 6" and 4" diameter standpipe, while representing a low risk in an absolute sense, dominated the risk of internal flood. A modification was proposed to reduce the risk of Control Building flood by installing a flow limiting orifice upstream in the fire protection system. This orifice would effectively limit the maximum postulated break flow, yet not impact the design function of downstream hose stations during normal fire fighting activities. This flow limiting orifice modification was identified as SAMA #192 in NextEraEnergy's response to RAI 1a (Reference 2). This design change was recently installed and is undergoing final acceptance testing. It is included in the SB2011 model update because of progress of the final design work and expected near-term acceptance. The reduction in CDF as a result of the flow orifice installation is approximately 4E-06/yr (~24 percent reduction in overall risk).

Model Changes

A number of modeling and documentation changes were made to improve the PRA quality and completeness. The most significant model changes include upgrade to the internal flood risk assessment and revision to the Level 2 release category source terms. Incorporation of the revised latent human action assessment and other minor modeling changes did not have a significant impact to the modeling/results and are not discussed further. The significant modeling changes are summarized below.

- *Level 1 Model Change - Upgrade to the Internal Flood (IF) Risk Assessment*

  The current SB2011 PRA model is based on a complete re-analysis of internal flood hazard. The re-analysis was performed to: (1) incorporate plant design and operational changes since the previous studies, (2) include available EPRI data and guidance for performing internal flood probabilistic risk assessments, and (3) meet the requirements of the current PRA Standard. The updated internal flood model meets the requirements of Part 3 to ASME/ANS RA-Sa–2009, *Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications*, and Regulatory Guide 1.200 Rev 2, *An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results* *for Risk Informed Activities.* The internal flood analysis upgrade includes credit for the future plant modification (flow restricting orifice) as described above in plant changes. With this one exception, the internal flood analysis is based on the as-built and as-operated plant as of 2011.

The assessment of internal flood events produced 27 new flood initiating events for quantitative evaluation. This is compared to 3 internal flood events that were evaluated in the original study. The total core damage frequency from the 27 internal flood initiating events is approximately 2.6E-06/yr, compared to 5.4E-07/yr for the original 3 initiators. There were no Level 2 containment isolation vulnerabilities identified in the internal flood study.

- *Level 2 and Level 3 Model Change - Revised Release Category and Source Terms*

  Radiological source terms represent the fission product fractions and timings of releases to the environment, given a core damage accident with containment functional failure. The source terms are the input to the Level 3 analysis (Refer to Section 3.2) to allow calculation of offsite public impacts. The radiological source terms were significantly revised during the 2005 PRA model update based on the updated Level 2 analysis performed by Westinghouse Electric Company, LLC. The source terms were further revised during the SB2011 PRA model update based on more detailed modeling using the Modular Accident Analysis Program (MAAP), Version 4.0.7. The revised Level 2 analysis includes modeling of the following 13 source term groups, with the related release categories.

Seabrook Source Term Release Categories

Source Term Group	**Source Term Title**	**Related Release Categories ***
LE1	Large/Early Containment Bypass – SG Tube Rupture	LE11a, LE12a, LE13a
LE2	Large/Early Containment Bypass – ISLOCA	LE21a, LE21b, LE22a
LE3	Large/Early Containment Penetration Failure to Isolate (Containment Online Purge valve failure)	LE3a, LE3b
LE4	Large Containment Basemat Failure with Delayed Evacuation	LE4a
SE1	Small/Early Containment Bypass – SG Tube Rupture with Scrubbed Release	SE11b, SE12b
SE2	Small/Early Containment Bypass - ISLOCA with Scrubbed Release	SE2b
SE3	Small/Early Containment Penetration Failure to Isolate	SE3b
LL3	Large/Late Containment Venting	LL3b
LL4	Large/Late Containment Overpressure Failure	LL4b
LL5	Large/Late Containment Basemat Failure	LL5a
SELL	Small/Early Containment Penetration Failure to Isolate and Large/Late Containment Basemat Failure	SELL3b, SELL4b, SELL5a
INTACT1	Nominal Containment Leakage	INTACT1
INTACT2	Excessive Containment Leakage	INTACT2

(*) Release category IDs ending in “a” are “dry” scenarios while “b” release categories are “wet” scenarios.

As shown in the table, in some cases, there is a one to one relationship between source terms and release category. In other cases, a representative source term was selected to cover several release categories. The basis for this grouping is discussed below in the description of each source term. The source terms were evaluated using MAAP code Version 4.0.7 for a large set of accident sequences within each release category. The MAAP code accounts explicitly for source term release and depletion methods based on the current best estimate understanding of severe accident phenomenon. The MAAP code was used to generate source terms by running Seabrook-specific models.

The release category source term definitions, based on specific representative MAAP cases, are summarized below and in the table of Seabrook Release Category Source Term Definitions. The information in the Release Category Source Term Definitions table is intended to provide a summary representation of the scenario/releases from associated MAAP cases.

Source Term LE1, Large/Early Containment Bypass – SGTR: Source term LE1 is used for containment bypass releases through a ruptured steam generator tube, with no feedwater to the faulted steam generator so that the release is unscrubbed. This source term represents three sets of Level 2 release categories: LE11a, LE12a, and LE13a.

One set (LE11a) includes core damage sequences where the steam generator tube rupture (SGTR) occurs as the accident sequence initiator. The second set (LE12a) includes core damage sequences where the SG tube rupture is pressure-induced as a result of anticipated transient without scram (ATWS) and steam line break (SLB) initiators. The third set (LE13a) includes Level 2 sequences with thermally-induced tube rupture resulting from the high pressure, high temperature conditions during the core melt progression.

The vast majority of LE1 sequences are from release category LE11a, SGTR-initiated with failure of steam generator cooling or failure of operator to restore feed flow to the faulted steam generator before significant release.

The frequency of release category LE12a is about a factor of 10 less than LE11a due to the low probability of these core melt sequences along with the conditional probability of a tube rupture.

The frequency for release category LE13a is negligible (~1e-11/yr) based to the best-estimate severe accident phenomena in MAAP, specifically that the hot leg creep rupture (HLCR) is much more likely to occur than rupture of the steam generator tubes for the high pressure core melt sequences. In fact, MAAP sequences thermally induce steam generator tube rupture only when HLCR is turned off. This set of sequences could be screened out due to low frequency. However, the frequency is preserved in LE1.

The release category LE11a, LE12a, and LE13a sequences are similar with regard to the containment failure mode, through a ruptured steam generator direct to the environment with little opportunity for retention. As a result, they are subsumed into a single source term, LE1. Because the LE11a sequences make up about 90% of the LE1 frequency, the LE11a sequences are used to define the release category source term. MAAP code Case 103m is used as the representative scenario for LE1. For the 2011 update, a series of existing and new SGTR sequences were run in MAAP407.

Case 103m represents the situation where containment is bypassed via a failed steam generator tube, there is no feed to the steam generators, no emergency core cooling system injection, and the reactor coolant system remains at full pressure (i.e., not depressurized to containment). This results in an early core melt (~3 hrs), early reactor pressure vessel failure (~7 hrs), and an initial fission product release (puff #1) based on CsI fraction released of

1.4%. This is somewhat below the LERF threshold of 3%. In the long term, the containment fails due to over-pressure which is responsible for the puff #2 with significant particulate release. This is conservatively categorized as a LERF.

Source Term LE2, Large/Early Containment Bypass – ISLOCA: Source Term LE2 is used for release categories to represent Level 2 sequences involving an intersystem LOCA through the Residual Heat Removal (RHR) system, with large containment bypass from the reactor coolant system direct to the environment. The sequence is identified as the "V-sequence" based on WASH-1400 terminology. This source term represents three sets of Level 2 release categories: LE21a, LE21b,and LE22a. The release path for LE21a and LE21b is a RHR pipe break in the RHR vaults as a result of failure of the RHR motor-operated isolation valves which pressurizes the low pressure RHR system to the reactor coolant system pressure.

The break elevation is assumed to be high in the RHR vaults, above the water level accumulated from discharge of the reactor coolant system and Reactor Water Storage Tank (RWST) inventories into the vault. The release will not be scrubbed by the accumulated water level in the RHR vault for this case; however, some retention does occur as a result of pathways and building surfaces. Release category LE21a includes the RHR pipe break scenario with no emergency core cooling system flow; LE21b includes the RHR pipe break scenario with Charging pump flow. In addition, release category LE22a is similar to LE21a, with no emergency core cooling system flow, except the loss of coolant inventory is through the RHR pump seal – a smaller loss of coolant accident (LOCA) with release at the bottom of the RHR vault. Since LE22a has no emergency core cooling system flow, the release is unscrubbed (except for building pathways as mentioned earlier) and is subsumed into LE2. A similar sequence with RHR pump seal failure but with emergency core cooling system flow is modeled in SE2.

The frequency contribution to LE2 is dominated by release category LE21b (RHR pipe break with Charging pump flow). MAAP case #104j is used as the representative scenario for LE2. This case is a large LOCA (8" diameter) with release to the RHR vault and Charging pump flow until the RWST is emptied at about 10 hours.

Source Term LE3, Large/Early Containment Penetration Failure to Isolate: Source term LE3 is used for release categories containing core damage sequences with a large containment isolation failure. The result of the 8-inch diameter containment on-line purge valves (COP) failing to close is a direct release from the containment to the environment.

This source term represents two sets of Level 2 release categories: LE3a and LE3b. Release category LE3a includes "dry" containment sequences, i.e., with no RWST injection via Emergency Core Cooling (ECCS) or Containment Building Spray (CBS). Release category LE3b includes "wet" containment sequences, i.e., with RWST injection via ECCS or CBS. The total frequency of LE3 sequences is very low (~1e-9), with the dominant contribution from LE3b. Thus, the representative scenario is the "wet" containment case: MAAP Case #104k, medium LOCA with no ECCS injection, successful CBS injection, and failure of the COP valves.

Source Term LE4, Large Containment Basemat Failure with Delayed Evacuation: This is a new release category introduced as part of the source term revision. Source term LE4 is used for release categories which contain core damage sequences with a large containment structural failure due to basemat melt-through. This is a long term scenario, with the release beginning more than 20 hours after the sequence initiation. However, LE4 is used to represent extreme seismic events where it is assumed that evacuation would be delayed beyond 20 hours. Thus, this source term is identified with an "early" release category because of the potential for the release to occur before effective evacuation.

This source term represents a single Level 2 release category: LE4a, the "dry" containment scenario (MAAP case #104m). Extreme seismic event sequences would include a large LOCA with station blackout. Thus, the assumption of a dry containment (no RWST injection) is consistent with the scenario definition.

Source Term SE1, Small/Early Containment Bypass – SGTR with Scrubbed Release: Source term SE1 is used for containment bypass releases through a ruptured steam generator tube, with feedwater to the faulted steam generator so that the release is scrubbed. Specifically, this includes steam generator tube rupture (SGTR) sequences with recovery of steam generator cooling to the ruptured generator prior to release. This source term represents two sets of Level 2 release categories: SE11b and SE12b. One set (SE11b) includes core damage sequences where the steam generator tube rupture occurs as the accident sequence initiator. The second set (SE12b) includes core damage sequences where the steam generator tube rupture is pressure-induced as a result of ATWS or SLB initiators. The vast majority of SE1 sequences are from release category SE11b, SGTR-initiated with steam generator cooling and operator restoration of feed flow to the faulted steam generator before significant release. The frequency of release category SE12b is about a factor of 100 less than SE11b due to the low probability of these core melt sequences along with the conditional probability of a tube rupture.

The release category SE11b and SE12b sequences are similar with regard to the containment failure mode, through a ruptured steam generator with opportunity for fission product retention. As a result, they are subsumed into a single source term, SE1. Because the SE11b sequences make up about 99% of the SE1 frequency, the SE11b sequences are used to define the release category source term. MAAP Case #103k is used as representative scenario for SE1. This scenario was initiated by SGTR with restoration of feed flow to the faulted steam generator following core damage. The submerged release resulted in a significantly reduced particulate release in comparison with LE1.

Source Term SE2, Small/Early Containment Bypass – ISLOCA with Scrubbed Release: Source Term SE2 is used for release categories representative of Level 2 sequences involving an intersystem LOCA (ISLOCA) through the RHR system, with containment bypass from the reactor coolant system to the bottom of the submerged RHR vault.

This source term represents one Level 2 release category, SE2b. SE2b is similar to release category LE21b, with ECCS flow, except the inventory loss is through the RHR pump seal – a smaller LOCA with release at the bottom of the RHR vault. This is also similar to release category LE22a, with the LOCA through the RHR pump seal, but with ECCS flow. Since this scenario has ECCS flow, the release is scrubbed and should be significantly reduced from LE2. MAAP case #104l is used as the representative scenario for SE2. This case is a small LOCA with release near the bottom of the RHR vault and Charging pump flow until the RWST is emptied at about 10 hours.

Source Term SE3, Small/Early Containment Penetration Failure to Isolate: Source term SE3 is used for release categories containing core damage sequences with a small containment isolation failure but with long term containment cooling. The result of the Reactor Coolant Pump (RCP) seal return line isolation valves failing to close is a small release from the containment to the environment.

SE3 source term represents one Level 2 release category: SE3b. Release category SE3b includes "wet" containment sequences, i.e., with CBS injection and sump recirculation. The representative scenario for SE3 is the "wet" containment case: MAAP Case #105k, small LOCA and failure of ECCS injection and failure of small containment isolation valves, but success of CBS injection and recirculation.

Source Term LL3, Large/Late Containment Venting (Wet): Source term LL3 is used for release categories containing core damage sequences with RWST injection – wet containment but with loss of containment cooling - and operator action to intentionally vent the containment per SAMGs. LL3 results in a large, late release from the containment to the environment.

This source term represents one Level 2 release category: LL3b. Release category LL3b includes "wet" containment sequences, i.e., with ECCS injection and/or CBS injection, but with no sump recirculation.

The representative scenario for LL3b is the "wet" containment case: MAAP Case #107a, medium LOCA, CBS injection, and containment venting when containment pressure exceeds 130 psia. The release begins when the first venting occurs, at about 16 hours.

Source Term LL4, Large/Late Containment Overpressure Failure (Wet): Source term LL4 is used for release categories containing core damage sequences with RWST injection – wet containment but with loss of containment cooling. This results in a large, late release from the containment to the environment.

This source term represents a single Level 2 release category, LL4b (wet containment). A dry containment could lead to a late overpressure failure, but it is much more likely to result in basemat melt-through. As a result, all long term containment failures with a dry containment are modeled through source term LL5. The representative scenario for LL4b is the "wet" containment case: MAAP Case #107d, medium LOCA with ECCS injection and CBS injection. The release begins when the containment reaches the overpressure failure pressure, at about 32 hours.

Source Term LL5, Large/Late Containment Basemat Failure (Dry): Source term LL5 is used for release categories containing core damage sequences with no RWST injection – dry containment. The containment fails by basement erosion from core-concrete interaction before long term over-pressure failure of the containment. This results in a large, late release from the containment to the environment.

The representative source term is MAAP Case #106f, a station blackout with Emergency Feedwater (EFW) success for 12 hours and with intact containment initially but with no power recovery. Thus, basemat melt through occurs at about 49 hours.

Source Term SELL, Small/Early, Large/Late Containment Failure: This is a new release category introduced as part of the source term revision. Source term SELL is used for release categories containing core damage sequences with initial small containment isolation failure but with failure of long term containment cooling. The results of the RCP seal return line isolation valves failing to close is a small release from the containment to the environment. However, in the long term, the containment fails due to overpressure or basemat melt-through resulting in a large, late release from the containment to the environment.

This source term represents three Level 2 release categories, small early release (SE3) with one of the three large late release categories (LL3b, LL4b, and LL5a). The frequencies of these release categories are all small (SELL3b, 7e-9; SELL4b, 2e-8; SELL5a, 7e-8). Since SELL5a has the highest frequency and LL5a has the most significant source term of the large, late release categories, it is used to represent this source term. The SELL3b / 4b / 5a release categories are subsumed into SELL.

The representative scenario for SELL5a is the "dry" containment case: MAAP Case #106g, station blackout with EFW success for 12 hours and small containment isolation failure. Note, this is the same case as for LL5 except for the addition of the small containment isolation failure.

Source Term INTACT1, Nominal Containment Leakage: Source term INTACT1 represents Level 2 sequences with containment intact except for nominal leakage at the maximum Technical Specification allowable limits.

The representative source term is MAAP Case #102o, with containment spray injection and sump recirculation functional. This assures long term containment cooling as well as fission product scrubbing.

Source Term INTACT2, Excessive Containment Leakage: Source term INTACT2 represents Level 2 sequences with containment intact except for leakage that exceeds Technical Specification allowable limits by a factor of 10, consistent with previous modeling of the source term.

The representative source term is MAAP Case #102q, with containment spray injection and sump recirculation functional. This assures long term containment cooling as well as fission product scrubbing.

Seabrook Release Category Source Term Definitions (Representative Summary)

Source Term ID	Description	Reference MAAP Case	[a] Release Start Time (hrs)	[b] Release Duration (hrs)	[c] Warning Duration (hrs)	Release Fraction [d]				
						Xe, Kr Group	CsI Group	Te Group	Sr Group	Ru Group
LE1	Steam Generator Tube Rupture core melt with no feed flow to faulted steam generator (direct release without scrubbing)	#103m (Puff #1)	3.2	1.0	0.3	0.15	0.014	0.008	1.4e-5	2.1e-4
		#103m (Puff #2)	39.3	100.0	--	0.85	0.25	0.21	1.3e-3	2.5e-4
LE2	Interfacing system LOCA with RHR pipe rupture (direct release without scrubbing)	#104j	11.7	2.0	0.1	1.00	0.42	0.43	0.021	0.051
LE3	Medium LOCA with no ECCS and failure of large containment penetration (Containment Online Purge (COP) valves)	#104k	1.1	5.0	0.1	1.00	0.31	0.23	1.9e-3	5.8e-3
LE4	Seismic, large LOCA with no ECCS and containment basemat melt-through (delayed evacuation)	#104m	20.8	2.0	20.1	1.00	0.33	0.12	2.7e-5	2.0e-5
SE1	Steam generator tube rupture core melt with delayed feed flow to faulted steam generator (scrubbed release)	#103k	30.6	2.0	4.4	0.063	3.3e-4	6.2e-5	3.2e-7	7.2e-6
SE2	Interfacing system LOCA with RHR pump seal failure (scrubbed release)	#104l (Puff #1)	12.9	10.0	0.3	0.88	0.021	0.019	1.8e-3	4.7e-3
		#104l (Puff #2)	81.0	20.0	--	0.12	0.073	0.014	--	--
SE3	Small LOCA without ECCS but with CBS injection and sump recirculation -- intact containment except for small penetration unisolated	#105k	1.4	1.0	0.2	0.19	2.4e-3	2.7e-3	2.4e-5	4.5e-4
LL3	Medium LOCA without ECCS but with CBS injection (wet containment) and vented containment per SAMG	#107a	16.4	30.0	15.4	1.00	9.4e-3	5.3e-3	2.7e-5	5.4e-4

Source Term ID	**Description**	**Reference MAAP Case**	[a] **Release Start Time** (hrs)	[b] **Release Duration** (hrs)	[c] **Warning Duration** (hrs)	**Release Fraction** [d]				
						Xe, Kr Group	**CsI Group**	**Te Group**	**Sr Group**	**Ru Group**
LL4	Medium LOCA without ECCS but with CBS injection (wet containment) and long term containment overpressure failure	#107d	31.9	2.0	30.9	1.00	0.092	0.068	2.6e-4	6.1e-5
LL5	Station blackout with dry containment (RWST not injected) and long term containment basemat melt-through	#106f	49.4	1.0	30.5	1.00	0.52	0.23	1.6e-5	1.6e-6
SELL	Station blackout with small penetration unisolated and dry containment (RWST not injected) and long term containment basemat melt-through	#106g (Puff #1)	19.5	10.0	0.7	0.46	0.022	0.022	5.5e-4	8.3e-4
		#106g (Puff #2)	49.8	10.0	--	0.54	0.095	0.039	--	--
		#106g (Puff #3)	100.0	30.0	--	--	0.377	0.085	--	--
INTACT1	Loss of feedwater with feed and bleed failure but with CBS injection and sump recirculation -- intact containment (TS allowed leakage only)	#102o	2.3	2.0	n/a	0.0078	1.4e-6	9.9e-7	1.3e-7	8.7e-7
INTACT2	Loss of feedwater with feed and bleed failure but with CBS injection and sump recirculation -- intact containment (TS allowed leakage x 10)	#102q	2.3	2.0	n/a	0.074	1.4e-5	8.6e-6	1.9e-7	4.0e-6

TABLE NOTES:

(a) Release Start Time = "Time to Containment Failure" EXCEPT "Time to Core Exit TCs > 1800°F" for containment bypass or isolation failure.

(b) Release Duration = Time from ~10% to ~80% of Noble Gas release.

(c) Warning Duration = Time from core exit temperature exceeding 1100°F to Release Start Time.

(d) Release Fractions = Five representative chemical groups from parameters FREL(1), FREL(20, FREL(3), FREL(4), FREL(5) in MAAP. These five groups are presented as a summary representation of the release. MAAP also includes seven other isotope groups, CsOH, Ba, La, Ce, Sb, Te and U [FREL(6) to FREL(12)] (not presented).

3.1.1 LEVEL 1 AND LEVEL 2 PRA MODEL RESULTS

Level 1 Results

The updated SB2011 was quantified using a truncation level of E-14 consistent with previous PRA models. The baseline results are provided in the following table and compared with the SAMA-based PRA model SB2006. The mean core damage frequency (CDF) has decreased by approximately 14.5%, from 1.44E-05/yr (SB2006) to 1.23E-5/yr (SB2011).

Level 1 Results	**SB2011**	**SB2006**
Mean Core Damage Frequency (CDF)	1.23E-05/yr	1.44E-05/yr
Uncertainty Lower Bound (5th percentile) CDF	3.29E-06/yr	7.37E-06/yr
Uncertainty Upper Bound (95th percentile) CDF	2.86E-05/yr	2.75E-05/yr

Initiating Event Contribution to CDF

The following table lists the top 15 initiating events contributing to CDF.

The first four initiators are hazard-type events that fail offsite power and contribute 25% of the core damage risk:

- Seismic events causing loss of offsite power initiator (E7T, E10T),
- Severe weather causing loss of offsite power initiator (LOSPW), and
- Internal flood in the Turbine Bldg causing loss of offsite power initiator (F4TREL).

The top 10 initiators account for almost 50% of CDF and include seismic events (E7T, E10T, E14T), other losses of offsite power (LOSPW, LOSPG), internal flood events (F4TREL, F1SWCY), LOCAs (SGTR, LOC1MD), and reactor trip (RXT1).

The internal flood initiating events (F4TREL and F1SWCY) are new as a result of the internal flood upgrade. The change in the relative CDF contribution of initiating events between PRA models SB2011 and SB2006 is primarily due to the relative increase in the internal flood risk. In general, there is not a dramatic shift in the CDF contribution of the top initiating event groups compared to the previous SB2006 PRA model results.

Initiating Event Contribution to CDF (sorted by CDF) (SB2011)

Init. Event ID	Description	IE Frequency (per yr)	CDF(IE) (per yr)	Percent of CDF Total	SB2006 Contribution
E7T	Seismic 0.7g Transient Event	9.30E-06	9.33E-07	7.6%	6.3%
E10T	Seismic 1.0g Transient Event	1.77E-06	8.88E-07	7.2%	5.9%
LOSPW	Loss of Off-Site Power due to Weather	7.65E-03	6.82E-07	5.6%	10.0%
F4TREL	Major Flood - Rupture of HELB / impact Relay Rm	2.73E-04	5.89E-07	4.8%	New (Internal Flood)
SGTR	Steam Generator Tube Rupture	4.09E-03	5.69E-07	4.6%	4.0%
RXT1	Reactor Trip – Condenser Available	7.38E-01	5.41E-07	4.4%	6.4%
LOC1MD	Medium LOCA Event	1.88E-04	5.31E-07	4.3%	2.3%
LOSPG	Loss of Off-Site Power -Grid-Related Events	1.15E-02	4.53E-07	3.7%	6.2%
F1SWCY	Rupture of SW Common Return Pipe in Yard	1.27E-05	4.06E-07	3.3%	New (Internal Flood)
E14T	Seismic 1.4g Transient Event	6.00E-07	3.64E-07	3.0%	2.5%
FCRPL	Fire in Control Room – PORV LOCA	4.51E-05	3.62E-07	3.0%	1.0%
FSGBE6	Fire SWGR Room B – Loss of Bus E6	1.00E-03	3.46E-07	2.8%	2.6%
LACPA	Loss of Train A Essential AC Power (4kV Bus E5)	4.40E-03	3.19E-07	2.6%	2.4%
FSGAE5	Fire in SWGR Room A – Loss of	1.10E-03	3.05E-07	2.5%	2.5%

Init. Event ID	Description	IE Frequency (per yr)	CDF(IE) (per yr)	Percent of CDF Total	SB2006 Contribution
	E5				
LPCCB	Loss of Train B PCCW System	9.90E-03	3.03E-07	2.5%	1.8%

Hazard Event Contribution to CDF

The following table provides the contribution to CDF from a set of six hazard groups. Example initiating events are provided to help define each hazard group. With the exception of the revised internal flood hazards contribution, there is not a dramatic shift in the relative contribution of the hazards groups compared to previous SB2006 PRA model results.

CDF Contribution from External & Internal Event Initiators (SB2011)

Hazard Group	IE Examples in Each Hazard Group	CDF (group)	Percent CDF	Previous SB2006
Internal Events	RXT1 (reactor trip), LOC1MD (medium LOCA)	4.50E-06	36.7%	54.4%
External Flood	EXFLSW (external flood impacting ocean SW pumps)	2.40E-08	0.2%	0.2%
Internal Fire	FCRPL (fire in control room opening PORV)	1.39E-06	11.3%	9.0%
Internal Flood	F4TREL (internal flood in turbine bldg failing offsite power)	2.61E-06	21.3%	5.4%
Seismic Events	E7T (0.7 g earthquake causing loss of offsite power)	3.06E-06	24.9%	21.0%
Severe Weather	LOSPW (loss of offsite power due to severe weather)	6.82E-07	5.6%	10.0%
CDF Total		1.23E-05	100.0%	

Basic Event Contribution to CDF

The following table lists the top 15 basic events contributing to CDF sorted by Risk Reduction Worth (RRW). The basic event RRW from the previous SB2006 PRA model is provided for comparison.

Top 15 Basic Events Contributing to CDF (SB2011)

Basic Event ID	**Basic Event Description**	**RRW**	**Previous SB2006**
ZZ.SY1.FX	Loss of offsite power subsequent to plant trip initiator	1.06	1.04
[DGDG1A.FR3]	DG-1A fails to run for 24 hours	1.05	1.08
HH.OALT1.FL	Operator Action - Manual Alignment of Alternate Cooling to Charging Pumps	1.04	1.002
[DGDG1B.FR3]	DG-1B fails to run for 24 hours	1.04	1.07
[CCP11A.FS CCP11B.FS CCP11C.FS CCP11D.FS]	PCCW Pumps A, B, C, D Common Mode Failure to Start	1.04	1.01
[EDESWG5.FX EDESWG6.FX]	4KV Emergency Buses 5 and 6 Fault (Common mode failure)	1.03	1.04
[EDESWG11A.FX EDESWG11B.FX]	DC Power Panels A, B Common Mode Failure	1.03	1.04
HH.OTSI3.FA	Operator Action - SI termination given successful cooldown and depressurization for SGTR	1.03	1.02
HH.OHSB1.FA	Operator Action - Maintain stable plant conditions with SG cooling during transients	1.03	1.02 (*)
HH.OSEP2Q.FA	Operator Action - Close SEPS breaker from MCB, given seismic event with SI signal	1.02	1.02
HH.OLPR2.FA	Operator Action - Align ECCS for Low Pressure Sump Recirculation for MLOCA	1.02	1.02
HH.OSGLC3.FL	Operator Action - Control SG level locally, with EFW thru EFW Discharge	1.02	1.00 (*)
HH.OHSB6.FL	Operator Action - Maintain stable plant conditions with SG cooling during transients, CR fire event	1.02	1.02 (*)
SEPSDG2B.FR3	1-SEPS-DG-2-B fails to run within 24 hours	1.02	1.03
SEPSDG2A.FR3	1-SEPS-DG-2-A fails to run within 24 hours	1.02	1.03

(*) Operator actions developed in SB2009; RRW reflects the SB2009 model.

Level 2 Results

The large early release frequency (LERF) is 9.2E-08/yr. This is a decrease of approximately 20% compared to the SB2006 model LERF result of 1.15E-07/yr.

Release Category Frequency

The following table lists the release categories with their release frequency. These 13 release categories are based on total release magnitude (small, large) and release timing (early, late) as well as specific containment failure modes.

Containment Release Categories and Frequencies (SB2011)

Release Type	Release Category	Frequency (per year)	Description
LARGE EARLY Release	LE1	5.19E-08	Large/Early Containment Bypass – SG Tube Rupture
	LE2	1.81E-08	Large/Early Containment Bypass – ISLOCA
	LE3	8.61E-10	Large/Early Containment Penetration Failure to Isolate (Containment Online Purge valve failure)
	LE4	2.11E-08	Large Containment Basemat Failure with Delayed Evacuation
SMALL EARLY Release	SE1	5.08E-07	Small/Early Containment Bypass – SG Tube Rupture with Scrubbed Release
	SE2	2.79E-08	Small/Early Containment Bypass - ISLOCA with Scrubbed Release
	SE3	9.97E-07	Small/Early Containment Penetration Failure to Isolate
LARGE LATE Release	LL3	1.75E-07	Large/Late Containment Vent
	LL4	5.79E-08	Large/Late Containment Overpressure Failure
	LL5	3.10E-06	Large/Late Containment Basemat Failure
	SELL	9.84E-08	Small/Early Containment Penetration Failure to Isolate and Large/Late Containment Basemat Failure
INTACT (Leakage Release)	INTACT1	7.07E-06	Nominal Containment Leakage
	INTACT2	6.90E-08	Excessive Containment Leakage

Basic Event Contribution to LERF

The following table lists the top 15 basic events contributing to LERF sorted by RRW. The basic event RRW from the previous SB2006 PRA model is provided for comparison.

Top 15 Basic Events Contributing to LERF (SB2011)

Basic Event ID	Basic Event Description	RRW	Previous SB2006
HH.XOEFW1.FA	Operator establishes feed to faulted steam generator prior to significant release	1.36	1.19
ZZ.SY2.FX	Loss of offsite power subsequent to LOCA initiator	1.24	1.18
HH.XOINE3.FA	Operator Fails to start containment injection early without AC power (gravity drain of RWST)	1.20	1.00
HH.OTSI3.FA	Operator action for Safety Injection termination given successful cooldown and depressurization for steam generator tube rupture	1.19	1.09
HH.ORWMZ1.FA	Operator action to minimize ECCS flow w/ sump recirculation failed during Small LOCA and Interfacing Systems LOCA (ISLOCA) sequences	1.10	1.06
FWP37A.FR	Turbine Driven Pump FW-P-37A fails to run	1.09	1.42
RCV24.FTO	RHR Train A suction relief valve failure to open	1.08	1.00
RCV89.FTO	RHR Train B suction relief valve failure to open	1.08	1.00
FWP37A.FS1	Turbine Driven Pump FW-P-37A fails to start	1.05	1.08
HH.ORWCD1.FA	Cooldown and depressurize RCS to minimize leak w/ sump recirculation failed during Small LOCA and ISLOCA sequences	1.04	1.01
HH.XOSMP1.FA	Operator aligns containment sump recirculation after core melt	1.04	1.00
HH.ORWLT1.FA	Operator maintains stable primary and secondary conditions for extended steam generator cooling (hot standby) during LOCA or steam generator tube rupture (SGTR)	1.03	1.006
HH.ORWIN1.FL	Initiate makeup to RWST, given Small LOCA with recirculation failure (LOCA, SGTR)	1.02	1.007
RCPSY403A.FM	PS403A pressure switch fails high (pressure permissive to open RHR suction RC-V-23)	1.02	1.00
RCPSY405A.FM	PS405A pressure switch fails high (pressure permissive to open RHR suction RC-V-87)	1.02	1.00

3.2 LEVEL 3 MODEL CHANGES

The Level 3 analysis was revised using the new accident release category definitions from the SB2011 PRA model. The probability of occurrence, timing (release times and duration) and rate/quantity of radionuclides released to the environment, and public warning times related to the release timing for each of the categories from the Level 2 analysis were also reflected in the Level 3 analysis. All other data used in the Level 3 calculation (e.g., meteorology, population distribution, agriculture and economy, rates of evacuation) were unchanged from the previous analysis.

The Release Tables provide the radionuclide release parameters for the revised model. The tables provide the MELCOR Accident Consequence Code System (MACCS2, version 1.13.1) parameters which simulate the release during the entire duration as provided by the plant-specific MAAP results used to characterize the Level 2 release categories. Note that, because of MACCS input requirements of a maximum of 4 plumes, each with a maximum duration of 1-day, the impact analysis compacts the entire 7-day MAAP calculated release in a compressed time period.

A total accident release/duration of 7 days is assumed in the base case Level 3 runs. This is a conservative assumption that will overstate the public impact and the cost-benefit of candidate SAMAs because the model gives only modest credit for long-term release mitigation actions that are likely to be strategized and implemented via execution of the Severe Accident Mitigation Guidelines.

Seabrook Severe Accident Release Parameters for 7-Day Release

RC LE1				
	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	9328			
Plume Duration, sec	3982	86400	73091	86400
Plume Start Time, sec from SCRAM	9328	13309	99709	172800
Radionuclide Group Release Fractions				
NOBLE (Xenon, Krypton)	1.48E-01	4.00E-03	5.80E-02	7.89E-01
I (Iodine)	1.39E-02	2.00E-04	1.71E-02	2.36E-01
CS (Cesium)	9.73E-03	8.08E-05	1.85E-02	2.55E-01
TE (Tellurium)	8.31E-03	1.60E-04	1.39E-02	1.92E-01
SR (Strontium)	9.73E-06	4.77E-06	8.65E-05	1.16E-03
MO (Molybdenum)	1.81E-04	2.30E-05	2.50E-05	2.28E-04
LA (Lanthanum)	1.13E-06	6.00E-08	1.82E-06	2.47E-05
CE (Cerium)	3.72E-06	4.60E-07	4.62E-05	6.36E-04
BA (Barium)	1.36E-04	8.00E-06	4.80E-05	6.02E-04
SB (Antimony)	3.47E-03	7.00E-05	1.11E-02	1.52E-01

RC LE2

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	40162			
Plume Duration, sec	7898	38340	86400	86400
Plume Start Time, sec from SCRAM	40162	48060	86400	172800
Radionuclide Group Release Fractions				
NOBLE	9.16E-01	4.60E-02	7.00E-03	3.10E-02
I	3.57E-01	1.90E-02	6.00E-03	3.50E-02
CS	3.47E-01	1.81E-02	1.24E-02	6.25E-02
TE	3.48E-01	2.71E-02	1.02E-02	5.01E-02
SR	1.55E-02	4.40E-03	2.00E-04	1.10E-03
MO	1.21E-02	3.86E-02	0.00E+00	0.00E+00
LA	1.37E-04	7.10E-05	2.40E-05	1.18E-04
CE	7.43E-04	2.87E-04	3.10E-04	1.54E-03
BA	2.46E-02	8.40E-03	1.00E-04	5.00E-04
SB	1.45E-01	5.70E-02	4.80E-02	2.40E-01

RC LE3

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	2984			
Plume Duration, sec	6113	76025	86400	86400
Plume Start Time, sec from SCRAM	4262	10375	86400	172800
Radionuclide Group Release Fractions				
NOBLE	3.35E-01	8.50E-02	9.70E-02	4.83E-01
I	1.14E-01	2.50E-02	2.80E-02	1.41E-01
CS	1.14E-01	2.32E-02	2.62E-02	1.30E-01
TE	1.04E-01	1.75E-02	1.96E-02	9.81E-02
SR	1.56E-03	5.00E-05	5.00E-05	2.60E-04
MO	3.49E-03	3.00E-04	3.40E-04	1.69E-03
LA	3.15E-05	1.20E-06	1.40E-06	6.80E-06
CE	1.35E-04	4.00E-06	5.00E-06	2.30E-05
BA	3.43E-03	1.30E-04	1.50E-04	7.30E-04
SB	3.97E-02	3.02E-02	3.41E-02	1.72E-01

RC LE4

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	1984			
Plume Duration, sec	71633	11642	86400	86400
Plume Start Time, sec from SCRAM	3125	74758	86400	172800
Radionuclide Group Release Fractions				
NOBLE	2.82E-03	2.19E-02	1.62E-01	8.13E-01
I	1.57E-04	7.29E-03	5.41E-02	2.70E-01
CS	7.37E-05	4.17E-03	3.10E-02	1.55E-01
TE	4.87E-05	2.67E-03	1.98E-02	9.92E-02
SR	1.08E-06	5.60E-07	4.20E-06	2.10E-05
MO	3.04E-06	3.60E-07	2.70E-06	1.35E-05
LA	8.50E-08	5.20E-08	3.85E-07	1.93E-06
CE	8.91E-07	6.29E-07	4.70E-06	2.35E-05
BA	1.04E-06	1.14E-06	8.42E-06	4.23E-05
SB	3.53E-05	8.69E-03	6.46E-02	3.23E-01

RC SE1

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	75413			
Plume Duration, sec	41393	742	55249	86400
Plume Start Time, sec from SCRAM	75416	116809	117551	172800
Radionuclide Group Release Fractions				
NOBLE	2.78E-02	2.65E-02	1.00E-03	7.90E-03
I	1.54E-06	2.35E-04	1.10E-05	8.60E-05
CS	1.14E-06	1.41E-04	6.42E-06	5.21E-05
TE	3.84E-07	2.80E-05	3.80E-06	2.99E-05
SR	6.00E-09	1.67E-07	1.70E-08	1.31E-07
MO	1.06E-07	1.61E-06	6.20E-07	4.85E-06
LA	6.80E-12	1.13E-08	6.00E-10	4.70E-09
CE	2.10E-13	4.36E-08	2.60E-09	2.01E-08
BA	1.97E-08	1.68E-06	1.20E-07	9.30E-07
SB	3.34E-06	7.96E-06	1.20E-06	9.10E-06

RC SE2

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	42865			
Plume Duration, sec	23638	19894	86400	86400
Plume Start Time, sec from SCRAM	42869	66506	86400	172800
Radionuclide Group Release Fractions				
NOBLE	6.44E-01	2.10E-02	5.60E-02	2.79E-01
I	1.33E-02	3.70E-03	1.29E-02	6.45E-02
CS	1.30E-02	2.78E-03	6.94E-03	3.48E-02
TE	1.08E-02	1.91E-03	3.49E-03	1.75E-02
SR	8.19E-05	8.71E-05	2.71E-04	1.35E-03
MO	1.64E-03	8.90E-04	3.70E-04	1.84E-03
LA	2.81E-06	1.35E-06	2.53E-06	1.26E-05
CE	1.37E-05	5.30E-06	1.37E-05	6.83E-05
BA	4.87E-04	2.31E-04	3.32E-04	1.65E-03
SB	2.82E-03	3.96E-03	1.91E-02	9.51E-02

RC SE3

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	3445			
Plume Duration, sec	7024	74268	86400	86400
Plume Start Time, sec from SCRAM	5108	12132	86400	172800
Radionuclide Group Release Fractions				
NOBLE	2.32E-02	2.05E-02	2.39E-02	1.19E-01
I	2.38E-03	1.00E-05	0.00E+00	4.00E-05
CS	2.25E-03	8.34E-07	0.00E+00	1.25E-05
TE	2.67E-03	1.20E-10	1.40E-10	1.00E-05
SR	2.40E-05	0.00E+00	0.00E+00	0.00E+00
MO	4.45E-04	0.00E+00	0.00E+00	0.00E+00
LA	1.08E-06	0.00E+00	0.00E+00	1.00E-08
CE	8.40E-06	0.00E+00	0.00E+00	1.00E-08
BA	8.05E-05	0.00E+00	1.00E-07	1.00E-07
SB	6.35E-04	2.00E-06	2.00E-06	9.00E-06

RC LL3

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	2988			
Plume Duration, sec	5875	76244	86400	86400
Plume Start Time, sec from SCRAM	4280	10156	86400	172800
Radionuclide Group Release Fractions				
NOBLE	9.38E-05	1.28E-01	1.45E-01	7.26E-01
I	2.80E-05	1.20E-03	1.36E-03	6.82E-03
CS	2.80E-05	1.32E-03	1.49E-03	7.48E-03
TE	2.21E-05	7.29E-04	8.28E-04	4.13E-03
SR	4.08E-07	3.36E-06	3.80E-06	1.90E-05
MO	1.04E-06	6.93E-05	7.87E-05	3.92E-04
LA	7.74E-09	1.58E-07	1.79E-07	8.95E-07
CE	4.01E-08	3.21E-07	3.63E-07	1.82E-06
BA	8.06E-07	1.46E-05	1.66E-05	8.30E-05
SB	9.30E-06	1.11E-03	1.26E-03	6.29E-03

RC LL4

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	2988			
Plume Duration, sec	5875	86400	76244	86400
Plume Start Time, sec from SCRAM	4280	10156	96556	172800
Radionuclide Group Release Fractions				
NOBLE	9.38E-05	2.95E-03	1.19E-01	8.78E-01
I	2.80E-05	1.41E-05	1.09E-02	8.09E-02
CS	2.80E-05	1.36E-05	1.08E-02	8.05E-02
TE	2.21E-05	1.53E-05	8.25E-03	6.14E-02
SR	4.08E-07	5.88E-07	3.03E-05	2.25E-04
MO	1.04E-06	1.17E-05	7.90E-06	4.00E-05
LA	7.74E-09	2.62E-08	3.77E-07	2.77E-06
CE	4.01E-08	5.60E-08	1.41E-05	1.05E-04
BA	8.06E-07	2.37E-06	1.90E-05	1.38E-04
SB	9.30E-06	2.18E-05	2.50E-02	1.86E-01

RC LL5

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	63529			
Plume Duration, sec	10249	10037	86400	81295
Plume Start Time, sec from SCRAM	71219	81468	91505	177905
Radionuclide Group Release Fractions				
NOBLE	1.60E-04	3.47E-04	2.98E-03	9.97E-01
I	3.83E-05	1.17E-05	1.01E-04	5.20E-01
CS	1.96E-05	4.83E-06	4.17E-05	4.76E-01
TE	3.82E-05	3.43E-06	2.96E-05	2.28E-01
SR	6.95E-08	1.16E-07	9.95E-07	1.43E-05
MO	2.42E-07	1.60E-08	1.38E-07	1.21E-06
LA	3.85E-09	1.01E-08	8.70E-08	1.24E-06
CE	1.96E-08	1.17E-07	1.01E-06	1.56E-05
BA	2.93E-07	7.10E-08	6.13E-07	4.14E-05
SB	1.11E-05	3.10E-06	2.70E-05	3.21E-01

RC SELL

	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	63378			
Plume Duration, sec	10829	4536	86400	86400
Plume Start Time, sec from SCRAM	71035	81864	86400	172800
Radionuclide Group Release Fractions				
NOBLE	4.57E-02	8.30E-03	1.58E-01	7.88E-01
I	1.01E-02	4.20E-03	7.99E-02	4.00E-01
CS	5.38E-03	2.98E-03	5.68E-02	2.84E-01
TE	1.47E-02	1.12E-03	2.20E-02	1.10E-01
SR	1.60E-04	3.00E-06	6.40E-05	3.18E-04
MO	5.94E-04	2.00E-06	3.90E-05	1.95E-04
LA	3.03E-06	3.30E-07	6.24E-06	3.12E-05
CE	2.38E-05	3.80E-06	7.24E-05	3.64E-04
BA	2.31E-04	2.00E-06	4.50E-05	2.24E-04
SB	3.05E-03	3.61E-03	6.87E-02	3.44E-01

RC INTACT1				
	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	6527			
Plume Duration, sec	11858	65585	86400	86400
Plume Start Time, sec from SCRAM	8957	20815	86400	172800
Radionuclide Group Release Fractions				
NOBLE	1.70E-04	8.50E-04	1.13E-03	5.61E-03
I	1.27E-06	2.00E-08	2.00E-08	1.00E-07
CS	4.44E-07	6.25E-09	8.08E-09	4.13E-08
TE	9.51E-07	4.00E-09	6.00E-09	2.80E-08
SR	2.62E-08	9.70E-09	1.29E-08	6.42E-08
MO	6.50E-07	2.50E-08	3.30E-08	1.64E-07
LA	9.80E-10	1.73E-09	2.29E-09	1.14E-08
CE	1.73E-09	2.06E-09	2.72E-09	1.36E-08
BA	1.30E-07	1.10E-08	1.60E-08	7.50E-08
SB	9.14E-07	2.10E-08	2.70E-08	1.38E-07

RC INTACT2				
	Plume-1	Plume-2	Plume-3	Plume-4
Category General Emergency Declaration, sec from SCRAM	6523			
Plume Duration, sec	12035	65412	86400	86400
Plume Start Time, sec from SCRAM	8953	20988	86400	172800
Radionuclide Group Release Fractions				
NOBLE	1.70E-03	8.10E-03	1.07E-02	5.35E-02
I	1.23E-05	2.00E-07	2.00E-07	1.00E-06
CS	4.42E-06	5.33E-08	7.17E-08	3.49E-07
TE	8.25E-06	3.00E-08	5.00E-08	2.20E-07
SR	7.65E-08	1.22E-08	1.63E-08	8.00E-08
MO	2.07E-06	2.20E-07	2.80E-07	1.42E-06
LA	2.48E-09	2.70E-10	3.60E-10	1.78E-09
CE	5.17E-09	5.50E-10	7.30E-10	3.65E-09
BA	3.42E-07	2.70E-08	3.50E-08	1.78E-07
SB	4.47E-06	1.80E-07	2.50E-07	1.21E-06

3.2.1 LEVEL 3 MODEL RESULTS

The Level 3 base case release category offsite public dose and economic risk results are summarized in the following table.

Seabrook Station Release Category Public Dose and Economic Risk Results – Level 3 Model SEABRK

RELEASE CATEGORY	LE-1	LE-2	LE-3	LE-4	SE-1	SE-2	SE-3	LL-3	LL-4	LL-5	SELL	INTACT1	INTACT2	INTACT
Frequency (per yr)	5.19E-08	1.81E-08	8.61E-10	2.11E-08	5.08E-07	2.79E-08	9.97E-07	1.75E-07	5.79E-08	3.10E-06	9.84E-08	7.07E-06	6.90E-08	7.14E-06
Dose Conseq. (Person-REM)	1.26E+07	4.27E+07	2.41E+07	1.11E+07	2.43E+05	8.60E+06	1.36E+06	3.63E+06	7.27E+06	1.03E+07	1.48E+07	2.62E+03	1.79E+04	2.77E+03
Econ. Conseq. (Dollars)	5.60E+10	7.14E+10	6.80E+10	4.91E+10	3.27E+08	3.09E+10	2.67E+09	9.05E+09	3.10E+10	5.24E+10	6.53E+10	4.52E+01	2.21E+05	2.18E+03
Dose Risk (Person-REM/yr)	6.54E-01	7.73E-01	2.08E-02	2.34E-01	1.23E-01	2.40E-01	1.36E+00	6.35E-01	4.21E-01	3.19E+01	1.46E+00	1.85E-02	1.24E-03	1.98E-02
% Dose Risk Contribution	1.73%	2.04%	0.05%	0.62%	0.33%	0.63%	3.58%	1.68%	1.11%	84.33%	3.85%	--	--	0.05%
Econ. Risk (dollars/yr)	2.91E+03	1.29E+03	5.85E+01	1.04E+03	1.66E+02	8.62E+02	2.66E+03	1.58E+03	1.79E+03	1.62E+05	6.43E+03	3.20E-04	1.52E-02	1.56E-02
% Econ. Risk Contribution	1.60%	0.71%	0.03%	0.57%	0.09%	0.48%	1.47%	0.87%	0.99%	89.63%	3.55%	--	--	0.00%

Note:

(1) Table results are based on the Level 2 frequencies from model SB2011 (base case) and Level 3 SEABRK 7 day offsite release duration consequences.

(2) Consistent with the original SAMA evaluation and for simplification, release categories INTACT1 and INTACT2 are combined into INTACT. The frequency of INTACT is simply the sum of the INTACT1 and INTACT2 frequencies:

INTACT frequency = frequencyINTACT1 + frequencyINTACT2

The consequence of INTACT is based on the sum of the probability-weighted INTACT1 and INTACT2 consequences:

INTACT consequence = (conseqINTACT1 * freqINTACT1 + conseqINTACT2 * freqINTACT2) / (freqINTACT1 + freqINTACT2)

3.3 PRA MODEL CHANGE REVIEW

Level 1 Model Review

The upgraded internal flood risk assessment was peer reviewed in late 2009. The peer review resulted in 26 findings and observations that have been further categorized into significance levels as follows: 3 "B" level F&Os and 23 "C/D" level F&Os. There was no level "A" significance findings. All 26 internal flood peer review findings have been addressed in the SB2011 model update. The internal flood events PRA model meets the supporting requirements (SRs) identified in Part 3 to ASME/ANS RA-Sa–2009 (PRA Standard) and Regulatory Guide 1.200 Rev 2.

Level 2 Model Source Term Review

The Seabrook source term analysis was performed by the Seabrook PRA group and was reviewed by industry experts at ERIN Engineering and Research, Inc. The scope of this review included an examination of the source term analyses and assessment of the representative sequences selected for each source term bin. In addition, all MAAP code results were reviewed to assure that the cases had been executed properly and that the results followed expected trends. Overall, the Seabrook source term analysis was found to represent a strong technical body of work and a solid basis for the License Renewal SAMA evaluation. The review concluded that the analysis addressed the major parameters impacting fission product release and the selection of representative sequences was appropriately made.

Level 3 Model Review

The Level 3 model was performed by industry experts at Tetra Tech NUS and received independent review.

4.0 COST OF SEVERE ACCIDENT RISK / MAXIMUM BENEFIT

4.1 SCOPE OF COST BENEFIT EVALUATION

The SAMA reassessment builds upon the original assessment and follows the same industry guidance outlined in NEI 05-01. The same technical process is used as in the original SAMA analysis. The approach to the reassessment is summarized here:

1. All originally-identified Phase II SAMA candidates are revaluated to identify if any of these SAMAs are now potentially cost beneficial (or "more" potentially cost beneficial).
2. The original Phase 1 SAMA candidates that were qualitatively screened from further detailed assessment based on the SAMA not being applicable to the plant design or the SAMA intent was met by the plant design, are not reviewed further in this supplement.
3. In addition to the originally-identified Phase II SAMA candidates, new potential SAMA candidates are identified based on a review of the latest SB2011 PRA model results and risk ranking of the top-ranked initiating events and basic events that contribute to CDF and LERF.
4. The top-ranked basic events associated with release categories that contribute to the top 90% of public risk are assessed in Phase II. These top initiating events and basic events are evaluated by linking to an existing candidate SAMA Phase II evaluation or are specifically evaluated in Phase II as a possible new SAMA candidate.

5. The SAMA cost-benefit assessment is based on development of new PRA cases to conservatively (and in some cases, more realistically) estimate the potential cost-benefit worth based on the updated PRA model. All SAMA cost-benefits are assessed for nominal (best estimate) and uncertainty (upper bound) with and without the seismic multiplier identified in response to RAI #4 (Reference 3) to account for the potential increase in seismic risk as suggested by NRC using GSI-199 information.
6. The implementation cost of each previously evaluated SAMA is reassessed as necessary to ensure that the costs continue to be representative of the SAMA scope based on plant-specific and industry experience. The implementation cost of each new SAMA candidate is also estimated based on plant-specific and industry experience. The implementation costs and their bases are provided in Table 1 and Table 2.

Seismic Risk Multiplier

The conservative seismic risk multiplier of 2.1 is used in the SAMA evaluation. Development of the Seismic multiplier was provided in NextEra Energy response to RAI #4 in Letter SBK-L-11067 (Reference 3). The multiplier is re-developed below based on the previous approach which credits the seismic benefit of the Supplemental Emergency Power Supply (SEPS):

- The SB2011 PRA model seismic contribution (benefit) of the SEPS is approximately 26% (same as previous). Thus, the estimated maximum seismic contribution from the NRC suggested GI-199 seismic risk of 2.2E-05/yr (which does not credit SEPS) can be reduced by 26%

  2.2E-05/yr * (1.0 - 0.26) = 1.6E-05/yr
- The baseline CDF from internal and external events is 1.23E-05/yr (SB2011)
- The seismic contribution to baseline CDF is 3.06E-06/yr (SB2011)
- Overall seismic increase factor is 2.05 and is rounded to 2.1

  (1.23E-05/yr – 3.06E-06/yr + 1.6E-05/yr) / 1.23E-05/yr = 2.05 factor increase in CDF

Dominant Basic Events

SAMA candidates are evaluated for the top 15 basic events contributing to CDF, LERF and the dominant Level 2 release categories that cumulatively contribute to approximately 90% of the total public risk (dose and economic risks). The release categories that contribute to approximately 90% of the public risk include the following:

Dose Risk: LL-5 (84.3%), SELL (3.8%) and SE-3 (3.6%) = 91.7% of dose risk

Economic Risk: LL-5 (89.6%), SELL (3.5%) = 93.1% of economic risk

The top 15 basic events that contribute to each sequence group, CDF, LERF, LL-5, SE-3 and SELL are listed in the following table. This results in a total of 45 basic events, since some basic events contribute to multiple sequence groups.

CDF Dominant Initiating Events

SAMA candidates are evaluated for the top 15 initiating events (IEs) relative to CDF. The top 15 initiators to CDF are listed above in the Level 1 results.

Top 15 Basic Events Contributing to CDF, LERF, and RC Contributing to 90% of the Public Risk

Basic Event	Description	Contributing Metric CDF, LERF, RC
HH.OALT1.FL	Operator Action - Manual Alignment of Alternate Cooling to Charging Pumps before RCP seal LOCA	CDF, LL-5, SELL
[CCP11A.FS CCP11B.FS CCP11C.FS CCP11D.FS]	PCCW Pumps A, B, C, D Common Mode Failure to Start	CDF, LL-5, SELL
[EDESWG11A.FX EDESWG11B.FX]	DC Power Panels A, B Common Mode Failure	CDF, LL-5, SELL
HH.XOEFW1.FA	Operator establishes feed to faulted SG prior to significant release	LERF
HH.OTSI3.FA	Operator action for SI termination given successful cooldown and depressurization for SGTR	CDF, LERF
HH.OHSB1.FA	Operator action to maintain stable plant conditions with SG cooling during transients	CDF, LL-5
HH.OLPR2.FA	Operator Aligns ECCS for Low Pressure Sump Recirculation for MLOCA	CDF
HH.OSGLC3.FL	Operator fails to control SG level locally, with EFW thru EFW Discharge	CDF
HH.OHSB6.FL	Operator action to maintain stable plant conditions with SG cooling during transients, CR fire events	CDF
HH.XOINE3.FA	Operator Fails to start containment injection early without AC power (gravity drain of RWST)	LERF, LL-5, SELL
HH.ORWMZ1.FA	Operator action to minimize ECCS flow w/ sump recirculation failed during SLOCA and ISLOCA sequences	LERF
HH.ORWCD1.FA	Cooldown and depressurize RCS to minimize leak w/ sump recirculation failed during SLOCA and ISLOCA sequences	LERF
HH.ORWLT1.FA	Operator maintains stable primary & secondary conditions for extended SG cooling (hot standby) during LOCA or SGTR	LERF
HH.ORWIN1.FA	Initiate makeup to RWST, given SLOCA w/ sump recirculation failure (LOCA, SGTR)	LERF

Basic Event	Description	Contributing Metric CDF, LERF, RC
RCPSY403A.FM	PS403A pressure switch fails high (press. permissive to open RHR suction RC-V-23)	LERF
RCPSY405A.FM	PS405A pressure switch fails high (press. permissive to open RHR suction RC-V-87)	LERF
ZZ.SY1.FX	Loss of offsite power subsequent to plant trip initiator	CDF, LL-5, SE-3, SELL
ZZ.SY2.FX	Loss of offsite power subsequent to LOCA initiator	LERF
CCTE2171.FZ	PCC Train A Temperature Element CC-TE-2171 transmits false low	LL-5
CCTE2271.FZ	PCC Train B Temperature Element CC-TE-2171 transmits false low	LL-5
CCE17A.RT	PCC Ht Ex 17A rupture/excessive leakage during operation	LL-5
CCE17B.RT	PCC Ht Ex 17B rupture/excessive leakage during operation	LL-5
HH.ORHPI2.FA	Operator action to restore charging/HPI/RCS for long term makeup after recovery of support systems during various trans/accidents	LL-5
[SWAFN63.FS]	CT SWGR Train B FAN SWA-FN-63 fails to start on demand	LL-5
[SWAFN64.FS]	CT SWGR Train A FAN SWA-FN-64 fails to start on demand	LL-5
[SWFN51A.FS]	SW Cooling Tower FAN SW-FN-51A fails to start on demand	LL-5
HH.OSEP2Q.FA	Operator fails to close SEPS breaker from MCB, given seismic event with SI signal	CDF, SE-3, SELL
[DGDG1A.FR3]	DG-1A fails to run for 24 hours	CDF, SE-3, SELL
[DGDG1B.FR3]	DG-1B fails to run for 24 hours	SE-3, SELL
ZZ.CIS.PRE.EXIST	Small pre-existing unidentified containment leakage	SE-3, SELL
SEPSDG2A.FR3	1-SEPS-DG-2-A fails to run within 24 hours	SE-3, SELL
SEPSDG2B.FR3	1-SEPS-DG-2-B fails to run within 24 hours	SE-3, SELL
HH.OSEP1Q.FA	Operator fails to close SEPS breaker from MCB, given seismic event	SE-3, SELL
HH.OCI2Q.FL	Operator fails to close CSV-167 manually/locally	SE-3
[DGDG1A.FR3	DG1A and DG1B common mode failure to run for 24 hours	SE-3, SELL

Basic Event	Description	Contributing Metric CDF, LERF, RC
DGDG1B.FR3]		
[EDESWG5.FX EDESWG6.FX]	4KV Emergency Buses 5 and 6 Fault (Common mode failure)	CDF, SE-3
[CSV167.FTC]	Penetration X-37 Isolation MOV CS-V-167 fails to close on demand	SE-3
FWP37A.FR	Turbine Driven Pump FW-P-37A fails to run	LERF, SE-3
FWP37A.FS1	Turbine Driven Pump FW-P-37A fails to start on demand	LERF, SE-3
SEPSDG2A.FS	1-SEPS-DG-2-A fails to start on demand	CDF, SE-3
SEPSDG2B.FS	1-SEPS-DG-2-B fails to start on demand	CDF, SE-3
HH.XOSMP1.FA	Operator aligns containment sump recirculation after core melt	LERF, SELL
HH.XOINE1.FA	Operator fails to start containment injection early to prevent RPV failure	SELL
RCV24.FTO	RHR Train A suction relief valve failure to open	LERF
RCV89.FTO	RHR Train B suction relief valve failure to open	LERF

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.

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 eliminatio 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 tha 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 tha 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 wa 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 t $10M or more. These estimates significantly exceed the upper bound sensitivity benefi and a more refined estimate is not warranted. It is noted that some of the potential benefits of this SAMA would be realized with SAM #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.

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 SAM #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.

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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.

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				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.

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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
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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.

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				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.

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				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.

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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.

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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.

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.

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.

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.		
BE #2 CCP11A/B/C/D	CDF LL5 SELL	PCCW Pumps A, B, C, D Common Mode Failure to Start	Related SAMA #59. Install a diverse and independent CCW pump, reduce potential for common mode failure	PCCABCD	4	11	335K (704K)	785K (1.65M)	>6M	Not cost beneficial. The SAMA concept is to improve CCW pump reliability (eliminate common cause pump failures) by installing an additional diverse CCW pump. PRA case PCCABCD conservatively assumes guaranteed success of the four existing component cooling water pumps provided the pumps have the necessary AC and DC power support systems. Based on this case, adding an additional pump will not significantly reduce plant risk. Installation of an additional pump would still rely on the same power supplies as the existing pumps. An independent diesel-driven CCW pump is judged not practical. The cost of installing an additional CCW pump is expected to significantly exceed the conservative benefit. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Columbia SAMA CW-07 estimated at $6.1M, which added a SW Pump to provide cooling to vital loads.

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.		
BE #3 EDESWG11AB	CDF LL5 SELL	DC Power Panels A, B Common Mode Failure	Related SAMA #16. Improve Bus 11A/B reliability, reduce potential for common mode failure	SWG11AB	3	10	289K (608K)	678K (1.42M)	> 1.8 M	Not cost beneficial. The SAMA concept is to improve DC bus reliability (eliminate common cause bus failures) by installing an additional diverse DC bus. The PRA case conservatively assumes elimination of bus failures that could cause failure of the associated power division during mission time (support system model) by assuming guaranteed success of both buses. 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. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Columbia SAMA AC/DC-01estimated at $1.8M, which would provide additional DC Battery Capability. This BE SAMA is considered similar to Seabrook Table 1, SAMA #16 (improve uninterruptible power supplies). An action has been entered into the Long Range Plan to assess future upgrade to the ELGAR inverters.

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.		
BE #4 HH.XOINE1.FA	SELL	Operator fails to start containment injection early to prevent RPV failure	Related SAMAs #90, #100, #101 and #188, all of which are "intent met". Hardware change to improve the reliability of containment injection for sequences where cont'mt press is low.	XOINE0	<1	10	291K (612K)	683K (1.43M)	> 1.5 M	Not cost beneficial. The SAMA concept is to install hardware changes to improve early containment injection reliability during various scenarios when AC power is available, recovered, and not available (SBO) to prevent RPV failure. PRA case XOINE0 assumes guaranteed success of "all" of the operator actions to perform early injection during these AC power scenarios (actions XOINE1, XOINE2 and XOINE3. 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. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Davis Besse SAMA CC-19 to automate controls for injection switch over is similar in magnitude and complexity was estimated at $1.5M.
BE #5 HH.OHSB1.FA	CDF LL5	Operator action to maintain stable plant conditions with SG cooling during transients	Hardware change to improve ability to maintain stable primary and secondary conditions with plant in hot standby.	OHSB0	4	5	143K (301K)	335K (705K)	>1M	Not cost beneficial. The SAMA concept is to incorporate hardware change to improve operator's ability to control/maintain stable hot standby conditions following transient/accident events. Operator must monitor and control primary and secondary conditions including PZR level and pressure, RCS temperature and SG levels to maintain stable hot standby conditions for extended cooling using the SG. PRA case OHSB0 assumes guaranteed success of "all" actions OHSB1 (trans), OHSB2 (SBO), OHSB3 (SLOCA/SLB) and OHSB4 (SGTR) for maintaining stable hot standby conditions. Procedures directing these actions are sufficiently detailed and evaluated in the PRA human reliability analysis. Any changes to procedures are judged not to have a significant beneficial

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.		
										impact on release risk. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Davis Besse SAMA CC-19 to automate controls for injection switch over is similar in magnitude and complexity was estimated at $1.5 M.
BE #6 HH.XOINE3.FA	LL5 SELL	Operator Fails to start containment injection early without AC power (gravity drain of RWST)	Related SAMAs #90, #100, #101 and #188, all of which are "intent met". Hardware change for automatic initiation of containment injection gravity drain, eliminate operator action	XOINE0	<1	10	291K (612K)	683K (1.43M)	> 1.5 M	Not cost beneficial. Evaluated under SAMA BE #4.
BE #7 ZZ.SY1.FX	CDF LL5 SELL SE3	Loss of offsite power subsequent to plant trip initiator	#13, #156, #160 Eliminate consequential loss of offsite power events	ZZSY12	7	5	144K (302K)	337K (709K)	>2M	Not cost beneficial. SAMA concept is to install hardware changes to reduce the likelihood of consequential loss of offsite power. PRA case ZZSY12 conservatively assumes complete elimination of all loss of offsite power events that occur subsequent to a plant trip (consequential loss of offsite power). Cost of power system upgrades that would significantly reduce or eliminate the potential for consequential loss of offsite power is based on Seabrook previously reported estimate.

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.		
BE #8 ZZ.SY2.FX	LERF	Loss of offsite power subsequent to LOCA initiator	#13, #156, #160 Eliminate consequential loss of offsite power events	ZZSY12	7	5	144K (302K)	337K (709K)	>2M	Not cost beneficial. PRA case ZZSY12 conservatively assumes complete elimination of all loss of offsite power events that occur subsequent to a plant trip (consequential loss of offsite power). Cost of power system upgrades that would significantly reduce or eliminate the potential for consequential loss of offsite power is based on Seabrook previously reported estimate.
BE #9 CCTE2171.FZ	LL5	PCC Train A Temperature Element CC-TE-2171 transmits false low	Make improvements to PCCW temperature control reliability	CCTE1	3	5	144K (302K)	337K (709K)	300K	**Potential cost beneficial SAMA**. NextEra has entered into the long range plan a modification to improve the reliability of CC-TV-2171/2271-1 & 2. Refer to new SAMA Case #195. 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 PCCW 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

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.		
										redundancy in instrumentation / controls. Cost to engineer and install improvements to CCW temperature control are expected to be less than the potential benefit.
BE #9A CCTE2271.FZ	LL5	PCC Train B Temperature Element CC-TE-2271 transmits false low	Make improvements to PCCW temperature control reliability	CCTE1	3	5	144K (302K)	337K (709K)	300K	**Potential cost beneficial SAMA.** Evaluated under SAMA BE #9.
BE #10 CCE17A.RT	LL5	PCC Ht Ex 17A rupture/excessive leakage during operation	Improve PCC Ht Ex reliability, eliminate potential for heat exchanger leakage	CCE17	2	4	116K (245K)	273K (574K)	Intent Met	SAMA Intent Met. PCCW Heat Exchanger tubes have been replaced with titanium. Experience to date has found this to be the best available technology.

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.		
BE #11 HH.ORHPI2.FA	LL5	Operator action to restore charging/HPI/RCS for long term makeup after recovery of support systems during various trans/accidents	Improve the reliability/capabiity of the operator to restore RCS makeup after support systems are made available.	ORHPI0	3	4	111K (233K)	260K (546K)	> 5M	Not cost beneficial. The SAMA concept is to provide hardware change for automatic restoration of high pressure injection sources following recovery of needed support systems. PRA case ORHPI2 conservatively assumes that all actions to restore high pressure injection long term are success; this includes ORHPI1, ORHPI2, ORHPI3 and ORHPI4. Current procedural guidance is judged adequate Procedures directing these actions 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. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Columbia; SAMAs CC-01 and CC-02 to diversify HPI that will reduce the probability of Human error at a cost of $5.2M.
BE #12 CC17B.RT	LL5	PCC Ht Ex 17B rupture/excessive leakage during operation	Improve PCC Ht Ex reliability, eliminate potential for heat exchanger leakage	CCE17	2	4	116K (245K)	273K (574K)	Intent Met	SAMA Intent Met. Evaluated under SAMA BE #10.
BE #13 SWAFN64.FS	LL5	CT SWGR Train A FAN SWA-FN-64 fails to start on demand	Improve reliability of the SWCT SWGR Room ventilation fans, eliminate potential for fan failure	SWAFN	1	3	91K (191K)	213K (445K)	480K	Not cost beneficial. The SAMA concept is to provide hardware changes to add redundant SWCT SWGR room fan or control equipment in the divisional SW SWGR room to improve reliability. PRA case SWAFN assumes that the ventilation fan and associated damper and temperature switch associated with Fan FN-64 are successful when support systems are available. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Columbia SAMA HV-02 is similar as to provide redundant train

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.		
										or means of ventilation and estimated at 480K. Also, Callaway SAMA 80 is similar and is estimated at > $1M.
BE #14 SWFN51A.FS	LL5	SW Cooling Tower FAN SW-FN-51A fails to start on demand	Improve reliability of the SW cooling tower fans, eliminate potential for fan failure	SWFN	1	2	74K (156K)	174K (366K)	>1M	Not cost beneficial. The SAMA concept is to provide a hardware change to improve the reliability of the SW Cooling Tower Fan 1-SW-FN-51A, by adding an additional or redundant cooling tower fan. PRA case SWFN assumes that the cooling tower cooling fan SW-FN-51A is completely successful when support systems are available. Benefit is overstated because model assumes that CT fans are needed 100% of the time and recovery of a failed fan (for which there is time) is not credited. Cost to engineer and install modifications is based on Seabrook estimate to utilize the abandoned unit 2 FN-51A. Large piping and MOV modifications to block U1 CT cell and align U2 CT cell when needed. Complete installation of U2 spray header and fan in addition to interfacing control changes.
BE #15 SWAFN63.FS	LL5	CT SWGR Train B FAN SWA-FN-63 fails to start on demand	Improve reliability of the SWCT SWGR Room ventilation fans, eliminate potential for fan failure	SWAFN	1	3	91K (191K)	213K (445K)	480K	Not cost beneficial. The SAMA concept is to provide hardware changes to add redundant SWCT SWGR room fan or control equipment in the divisional SW SWGR room to improve reliability. PRA case SWAFN is representative of SW-B Fan FN-63. This case assumes that the ventilation fan and associated damper and temperature switch are successful when support systems are available. Cost to engineer and implement plant modifications and analysis is same as SAMA

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.		
										BE #13.
BE #16 HH.XOSMP1.FA	SELL	Operator aligns containment sump recirculation after core melt	Provide a hardware modification for auto-control, eliminate operator action to align sump after core melt.	XOSMP0	<1	3	61K (128K)	142K (299K)	> 1.5 M	Not cost beneficial. The SAMA concept is to install hardware changes to improve reliability of sump alignment. PRA case XOSMP0 conservatively assumes guaranteed success of the operator action to align containment sump recirculation "late" after core melt, given recovery of Containment Building Spray (CBS). 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. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Davis Besse SAMA CC-19 to automate controls for injection switch is similar in magnitude and complexity was estimated at $1.5 M.

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.		
BE #17 ZZ.CIS.PRE.EXIST	SELL SE3	Small pre-existing unidentified containment leakage	Related SAMA #186. Hardware or procedural change to eliminate or reduce likelihood of small pre-existing unidentified leakage	CISPRE	0	<1	4K (12K)	10K (27K)	50K to 100K	Not cost beneficial. The SAMA concept 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 conservatively assumes complete elimination of the probability of all pre-existing containment leakage; small leakage (CIS.PRE) and large (CIL.PRE). 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. Cost to engineer and install hardware system for leakage detection system is based on Seabrook previously reported estimate.
BE #18 DGDG1A.FR3	CDF SELL SE3	DG-1A fails to run for 24 hours	Related SAMA #9, #10, #14, #155.	NOSBO1	22	6	224K (470K)	525K (1.1M)	2M	Not cost beneficial. SAMA concept is to install additional DG to improve overall reliability of onsite emergency power. PRA case NOSBO1 conservatively assumes elimination of all station blackout events by assuming guaranteed success of onsite emergency diesel generators. This assumes complete independence of DG support systems (DC power, SW). Thus, the benefit of modifying the onsite electrical power system to add or modify a DG to substantially improve reliability and reduce/eliminate DG start and run failures, is conservatively high. Cost to engineer and install additional DG needed to significantly improve reliability of onsite power based on Seabrook cost to install the SEPS DGs exceeding $5M. Also Davis-Besse SAMA AC/DC-14 to install a Gas

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.		
										turbine is estimated to be at least 2M.
BE #19 DGDG1B.FR3	CDF SELL SE3	DG-1B fails to run for 24 hours	Related SAMA #9, #10, #14, #155.	NOSBO1	22	6	224K (470K)	525K (1.1M)	2M	Not cost beneficial. Evaluated under SAMA BE #18.
BE #20 HH.OSEP2Q.FA	CDF SELL SE3	Operator fails to close SEPS breaker from MCB, given seismic event with SI signal	Related SAMA #154. Hardware change for auto closure of SEPS breaker to eliminate operator action	OSEPS	8	2	64K (135K)	151K (318K)	>750K	Not cost beneficial. The SAMA concept is to install a control system to automatically close the SEPS DG breaker to the desired bus. The PRA case OSEPS 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. Cost to install automatic control system is based on Seabrook previously reported estimate

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.		
BE #21 SEPSDG2A.FR3	CDF SELL SE3	1-SEPS-DG-2-A fails to run within 24 hours	Related SAMA #9, #14, #189. Elimination of all potential for SEPS failure	SEPS	6	2	63K (133k)	148K (312K)	>2M	Not cost beneficial. SAMA concept is to modify the SEPS electrical power system by installing or modifying a DG to substantially improve reliability and reduce /eliminate DG start and run failures. PRA case SEPS conservatively assumes elimination of all SEPS DG hardware failures (assumes guaranteed success of SEPS DG A and B). Cost to engineer and install additional DG needed to significantly improve reliability of onsite power based on Seabrook cost to install the SEPS DGs exceeding $5M. Also Davis-Besse SAMA AC/DC-14 to install a Gas turbine is estimated to be at least 2M.
BE #22 SEPSDG2B.FR3	CDF SELL SE3	1-SEPS-DG-2-B fails to run within 24 hours	Related SAMA #9, #14, #189. Elimination of all potential for SEPS failure	SEPS	6	2	63K (133k)	148K (312K)	2M	Not cost beneficial. Evaluated under SAMA BE #21.
BE #23 DGDG1A/1B. FR3	SELL SE3	DG1A and DG1B common mode failure to run for 24 hours	Related SAMA #9, #10, #14, #155.	NOSBO1	22	6	224K (470K)	525K (1.1M)	2M	Not cost beneficial. Evaluated under SAMA BE #18.
BE #24 HH.OSEP1Q.FA	SELL SE3	Operator fails to close SEPS breaker from MCB, given seismic event	Related SAMA #154. Hardware change for auto closure of SEPS breaker to eliminate operator action	OSEPS	8	2	64K (135K)	151K (318K)	>750K	Not cost beneficial. Evaluated under SAMA BE #20.
BE #25 HH.OCI2Q.FL	SE3	Operator fails to close CSV-167 manually/locally	Related SAMA #193. Provide a hardware modification	OCI2	--	--	--	--	--	This SAMA basic event candidate is related to basic event CSV167.FTC and SAMA #193,

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.		
			(additional signals or remote capability) to allow closure of V-167							which has been shown to be potentially cost beneficial based on assumed replacement of MOV with FC AOV. Refer to SAMA #193.
BE #26 CSV167.FTC	SE3	Penetration X-37 Isolation MOV CS-V-167 fails to close on demand	Related SAMA #193. Hardware change to eliminate MOV AC power dependence	CSV167	0	5	86K (181K)	201K (422K)	>300K	**Potential cost beneficial SAMA**. This BE SAMA is related to SAMA #193, which 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.
BE #27 FWP37A.FR	SE3	Turbine Driven Pump FW-P-37A fails to run	Related SAMA #163. Install additional EFW pump (steam driven)	TDAFW	5.3	12	356K (748K)	835K (1.75M)	>2M	Not cost beneficial. This BE SAMA is related to SAMA #163 to install an additional steam-driven EFW pump. 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.
BE #27A FWP37A.FS1	SE3	Turbine Driven Pump FW-P-37A fails to start	Related SAMA #163. Install additional EFW pump (steam driven)	TDAFW	5.3	12	356K (748K)	835K (1.75M)	>2M	Not cost beneficial. Evaluated under SAMA BE #27.

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.		
BE #28 SEPSDG2A.FS	SE3	1-SEPS-DG-2-A fails to start on demand	Related SAMA #9, #14, #189. Elimination of all potential for SEPS hardware failure	SEPS	6	2	63K (133k)	148K (312K)	2M	Not cost beneficial. Evaluated under SAMA BE #21.
BE #29 SEPSDG2B.FS	SE3	1-SEPS-DG-2-B fails to start on demand	Related SAMA #9, #14, #189. Elimination of all potential for SEPS hardware failure	SEPS	6	2	63K (133k)	148K (312K)	2M	Not cost beneficial. Evaluated under SAMA BE #21.
BE #30 HH.OTSI3.FA	CDF LERF	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	OTSI0	3	1	26K (55K)	61K (128K)	>300K	Not cost beneficial. SAMA concept is to install hardware to significantly improve reliability of operator termination of SI for SGTR mitigation. Cost to install automatic control system is based on Seabrook previously reported estimate.
#31 HH.OLPR2.FA	CDF	Operator Aligns ECCS for Low Pressure Sump Recirculation for MLOCA	Related SAMA #105. Hardware change to improve reliability of ECCS transfer to long term recirculation	OLPR	3	0	12K (25K)	27K (58K)	>100K	Not cost beneficial. SAMA concept is to install hardware modifications to improve reliability of ECCS transfer to long term recirculation. PRA case OLPR conservatively assumes 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

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.		
										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.
BE #32 HH.OHSB6.FL	CDF	Operator action to maintain stable plant conditions with SG cooling during transients, CR fire events	Hardware change to improve ability to maintain stable primary and secondary conditions with plant in hot standby during CR fire events	OHSB670	3	1	29K (61K)	68K (143K)	>420K	Not cost beneficial. The SAMA concept is to provide hardware changes to improve operator ability to control/maintain stable hot standby conditions following transient/accident events due to CR fire. PRA case OHSB670 assumes success of operator actions OHSB6 (transient) and OHSB7 (w/seal LOCA) occurring during a control room fire with evacuation and control at the RSSP. Thus, the benefit is conservative. Cost to engineer and implement plant modifications and analysis judged comparable in scope and complexity to Grand Gulf SAMA 39 and 55, which provide proposals to improve ability to maintain stable primary and secondary conditions with plant in hot standby during CR fire events; estimates are >$420K.
BE #33 HH.OSGLC3.FL	CDF	Operator fails to control SG level locally, with EFW thru EFW Discharge	Hardware change to improve operator reliability or provide automatic feature to control SG levels via EFW discharge pathway	OSGLC0	2	1	29K (62K)	68K (144K)	>500K	Not cost beneficial. The SAMA concept is to provide a hardware change that would significantly improve the operator action reliability and capability to control EFW flow and SG level during various transients including SBO. PRA case OSGLC0 assumes success of actions OSGLC1 (via EFW/SUFP through EFW discharge), OSGLC2 (via EFW/SUFP through EFW discharge), and OSGLC3 (locally via EFW thru EFW discharge), and OSGLC4 (control via SUFP through MFW Disch). Cost to engineer and implement plant modifications and analysis judged comparable

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.		
										in scope and complexity to Callaway SAMA 163,which estimates a hardware change to increase reliability to feed steam generator secondary side at $500K.
BE #34 EDESWG56.FX	CDF SE3	4KV Emergency Buses 5 and 6 Fault (Common mode failure)	Improve Bus E6 reliability, eliminate potential for bus fault	SWGE561	6	3	104K (219K)	244K (513K)	>1.2M	Not cost beneficial. The SAMA concept is to provide a hardware change that would significantly improve the reliability of the 4kV electrical switchgear, Buses 5 and 6 and thus reduce or eliminate bus failures, including assumed common mode failures. PRA case SWGE561 conservatively assumes elimination of Bus E5 and E6 random failures 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. It is noted that due to their relatively passive design, 4kV buses are relatively reliable and have a low failure rate. Cost to engineer and install modifications is based on Seabrook estimate to design additional bus to achieve improvement in bus reliability with a cost of >$1M. Bus reliability improvements is also similar in scope to SAMA #16 (improved uninterruptible power supplies), at a cost of $2M.
BE #35 HH.XOEFW1.FA	LERF	Operator establishes feed to faulted SG prior to significant release	Hardware change to improve operator reliability to feed a faulted SG during SGTR	XOEFW	0	1	21K (44K)	50K (104K)	> 500K	Not cost beneficial. The SAMA concept is to provide a hardware change that would significantly improve the reliability of feeding the faulted SG during SGTR sequences to scrub/reduce release to the secondary plant. PRA case XOEFW assumes success of the operator action HH.XOEFW1.FA. Cost to engineer and implement plant modifications and analysis judged comparable in scope, complexity and cost to hardware

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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.		
										changes estimated for Basic event #33, which estimates a hardware change to increase reliability to feed steam generator secondary side at $500K.
BE #36 HH.ORWMZ1.FA	LERF	Operator action to minimize ECCS flow w/ sump recirc. failed during SLOCA and ISLOCA sequences	Hardware change to improve operator reliability or provide automatic feature to throttle ECCS	ORWMZ	2	0	15K (32)	35K (74K)	> 500K	Not cost beneficial. The SAMA concept is to provide hardware changes to improve operator ability to control/throttle ECCS flow for only certain scenarios when the containment sump is not available (during SLOCA and ISLOCA). PRA case ORWMZ assumes guaranteed success of the operator action. Thus, the benefit is conservative. The cost of hardware changes needed to realize the benefit are expected to significantly exceed the upper bound benefit and no further refinement of the benefit or cost estimate is warranted. Cost to engineer and implement plant modifications and analysis judged comparable in scope, complexity and cost to hardware changes estimated for Basic event #33, which estimates a hardware change to increase reliability to feed steam generator secondary side at $500K.

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.		
BE #37 HH.ORWCD1.FA	LERF	Cooldown and depressurize RCS to minimize leak w/ sump recirc. failed during SLOCA and ISLOCA sequences	Hardware change to improve operator reliability or provide automatic feature to cool & depress RCS	ORWCD1	<1	0	5.3K (11K)	12K (26K)	> 500K	Not cost beneficial. The SAMA concept is to provide hardware changes to improve operator ability to control RCS cooldown and depressurization for only certain scenarios where the containment sump is not available (during SLOCA and ISLOCA). PRA case ORWCD1 assumes guaranteed success of the operator action. Thus, the benefit is conservative. Cost to engineer and implement plant modifications and analysis judged comparable in scope, complexity and cost to hardware changes estimated for Basic event #33, which estimates a hardware change to increase reliability to feed steam generator secondary side at $500K.
BE #38 HH.ORWLT1.FA	LERF	Operator maintains stable primary & secondary conditions for extended SG cooling (hot standby) during LOCA or SGTR	Hardware change to improve operator reliability or provide automatic feature to maintain stable plant conditions.	ORWLT1	<1	0	5.3K (11K)	11K (24K)	> 500K	Not cost beneficial. The SAMA concept is to provide hardware changes to improve operator ability to maintain stable primary and secondary conditions to extend SG cooling (during SLOCA and ISLOCA). PRA case ORWLT1 assumes guaranteed success of the operator action. Thus, the benefit is conservative. Cost to engineer and implement plant modifications and analysis judged comparable in scope, complexity and cost to hardware changes estimated for Basic event #33, which estimates a hardware change to increase reliability to feed steam generator secondary side at $500K.
BE #39 HH.ORWIN1.FA	LERF	Initiate makeup to RWST, given SLOCA w/Recirc Failure (LOCA, SGTR)	Hardware change to improve operator reliability or provide automatic feature to initiate RWST makeup.	ORWIN	<1	0	4K (8.4K)	9.3K (20K)	> 500K	Not cost beneficial. The SAMA concept is to provide hardware changes to improve operator ability to initiate makeup to the RWST to extend ECCS injection (during SLOCA and ISLOCA) with recirculation failed. PRA case ORWIN1 assumes guaranteed success of the

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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.		
										operator action. Thus, the benefit is conservative. Cost to engineer and implement plant modifications and analysis judged comparable in scope, complexity and cost to hardware changes estimated for Basic event #33, which estimates a hardware change to increase reliability to feed steam generator secondary side at $500K.
BE #40 RCPSY403A.FM	LERF	PS403A pressure switch fails high (press. permissive to open RHR suction RC-V-23)	Hardware change to improve the reliability of the low pressure permissive signal.	PS40XA	2	0	9K (20K)	21K (44K)	> 500K	Not cost beneficial. The SAMA concept is to provide hardware changes to improve the reliability of the low pressure permissive signal needed to align the RHR suction. PRA case PS40XA assumes guaranteed success of PSY403A (Train A) and PSY405A (Train B). Thus, the benefit is conservative. Cost to engineer and implement plant modifications and analysis judged comparable in scope, complexity and cost to hardware changes estimated for Basic event #33, which estimates a hardware change to increase reliability to feed steam generator secondary side at $500K.
BE #41 RCPSY405A.FM	LERF	PS405A pressure switch fails high (press. permissive to open RHR suction RC-V-87)	Hardware change to improve the reliability of the low pressure permissive signal.	PS40XA	2	0	9K (20K)	21K (44K)	> 500K	Not cost beneficial. Evaluated under SAMA BE #40.

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.		
BE #42 RCV24.FTO	LERF	RHR Train A Suction Relief Valve failure to open	Hardware change to improve the reliability of relief valve opening on demand	RCVR	<1	2	23.5K (50K)	55K (116K)	> 500K	Not cost beneficial. The SAMA concept is to provide hardware modifications to improve the relief valve reliability to open when demanded for ISLOCA sequences. PRA case RCVR guarantees success of both relief valves RCV24 and RCV87 to open and reclose. Cost to engineer and implement plant modifications (redundant relief valve at each RHR suction location) is to significantly exceed the benefit.
BE #43 RCV89.FTO	LERF	RHR Train B Suction Relief Valve failure to open	Hardware change to improve the reliability of relief valve opening on demand	RCVR	<1	2	23.5K (50K)	55K (116K)	> 500K	Not cost beneficial. Evaluated under SAMA BE #42.

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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.		
Initiating Event (IE) Related SAMAs										
IE #1 E7T	CDF	Seismic 0.7g Transient Event	Related SAMA #181, #182. Hardware changes to reduce or eliminate impact of 0.7g seismic events.	E7T	8	2	77K (162K)	181K (380K)	>500K	Not cost beneficial. SAMA concept is to install hardware changes to improve the seismic response of the plant. PRA case E7T assumes complete elimination of the 0.7g seismic initiating event and therefore provides a conservative benefit. Cost to engineer and install upgrades is based on Seabrook previously reported estimate.
IE #2 E10T	CDF	Seismic 1.0g Transient Event	Refer to initiator E7T.	--	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #1
IE #3 LOSPW	CDF	Loss of offsite power due to weather-related events	Related SAMA #2, #9, #10, #13, #14, #16, #20, #24, #154, #155, #156, #160, #161, #190 - all are hardware changes to reduce the risk of LOSP.	NOLOSP	18	17	531K (1.2M)	1.24M (2.7M)	>3M	Not cost beneficial. LOSPW initiating event is covered by existing SAMAs. The NOLOSP case conservatively maximizes the benefit by assuming that all LOSP initiating events are completely eliminated. Cost of physical plant modifications and analysis, particularly to protect the plant from loss of offsite power due to weather-related events is judged comparable to burying power lines to protect the lines from possible weather impacts (refer to SAMA # 24). It is noted that Seabrook Station has recently completed 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 including weather-related events and should result in an overall

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.		
										reduction in loss of offsite power initiating event frequency.
IE #4 F4TREL	CDF	TB flood due to rupture of HELB piping in TB with direct impact on Relay Room & offsite power.	Provide analysis and hardware changes to protect Relay Room structure from postulated HELB impact.	F4TREL	5	1	46K (97K)	107KK (225K)	>300K	Not cost beneficial. Initiator F4TREL models a major rupture of a high energy pipe (condensate, steam, etc.) located in the vicinity of the Relay Room. Baseline modeling of this initiator conservatively assumes that the high energy break can impact the relay room structure resulting in damage to relay equipment and loss of offsite power. The PRA case F4TREL conservatively assumes complete elimination of this initiator. The proposed SAMA concept is to perform a detailed structural analysis and add structural support and/or guards to the relay room structure and adjacent high energy piping to limit or prevent the assumed pipe break impact on the relay room. Cost to engineer and implement plant modifications and analysis based on scope comparison to other Seabrook modifications.

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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.		
IE #5 SGTR	CDF LERF	Steam Generator tube rupture	Related SAMA #119, #121, #125, #126, #129.	NOSGTR	5	2	67K (141K)	157K (329K)	>500K	Not cost beneficial. The SGTR initiating event is covered by existing SAMAs that have been shown to be not cost beneficial. PRA case SGTR conservatively assumes complete elimination of the SGTR initiating event in addition to pressure and thermal-induced tube rupture. Cost to engineer and install upgrades aimed at eliminating SGTR based on Seabrook previously reported estimate.
IE #6 RXT1	CDF	Reactor trip with condenser available	Related SAMA – all BE SAMAs are related to plant trip. Improve overall Seabrook Station reliability; reduce potential for plant trip initiating event frequency.	RXT1	4	7	205K (431K)	481K (1.01M)	19M	Not cost beneficial. Initiating event is covered by existing SAMAs. Modifications to significantly reduce/eliminate reactor trip risk are judged not cost beneficial based on assumed complete elimination of initiator RXT1. Cost of physical plant modifications judged comparable in scope and complexity to other plants that do not have these features, for example Callaway SAMA 65 and Seabrook SAMA 65 ($30M) for digital controls feedwater upgrades. Seabrook Station is engaged in an ongoing a multi-phase, multi-million dollar project to install a digital feedwater control system and digital electro-hydraulic control system. These upgrades replaced obsolete components and enhance the reliability of the existing control systems and should result in an overall reduction in reactor trip initiating event frequency

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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.		
IE #7 LOC1MD	CDF	Medium LOCA Event	Related SAMA #147. Hardware changes to reduce/eliminate pipe break LOCA events.	LOCA05	9	2	77K (162K)	181K (380K)	>500K	Not cost beneficial. Initiating event is covered by existing SAMA. The LOCA05 case conservatively maximizes the benefit by assuming that all pipe break-type LOCA events, including small, medium and large break events, are eliminated. SAMAs are not practical to achieve the conservative benefit. Cost of physical plant modifications based on installation of leakage detection system, Seabrook SAMA #147.
IE #8 LOSPG	CDF	Loss of offsite power due to grid-related events	Refer to initiator LOSPW.	--	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #3.
IE #9 LOSPG	CDF	Loss of offsite power due to grid-related events	Refer to initiator LOSPW.	--	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #3.
IE 10 F1SWCY	CDF	Major flood due to rupture of SW common return piping in Yard	Hardware changes to reduce risk of SW common return line major rupture event in yard.	F1SWCY	3	9	263K (552K)	616K (1.3M)	>5M	Not cost beneficial. Initiator F1SWCY models a major rupture of the SW ocean return pipe common to both SW trains. The common return pipe is located underground in the yard and in the vicinity of SW Cooling Tower supply and return piping. The initiator baseline modeling is judged conservative. The base line model assumes that continued break flow for more than 60 minutes from the ruptured common ocean return pipe will eventually undermine the structural support for the SW CT pipes, thus causing failure of the SW CT divisions. The PRA case F1WCY assumes complete elimination of this initiator.

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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.		
										Cost to engineer replacement options for the buried SW piping is currently under review and is included in the station long range plan. Approximately 70% of the SW system piping is buried at approximately 25 feet below grade. It is estimated that >$5M per refueling outage will be necessary to support the plan.
IE #11 E14T	CDF	Seismic 1.4g transient event	Refer to initiator E7T.	E7T	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #1.
IE #12 FCRPL	CDF	Fire in Control Room – PORV LOCA Event	Related SAMA #179 Possible reduction in CDF if mitigating fire-induced LOCA.	FIRE1	3	0	14K (31K)	34K (71K)	>100K	Not cost beneficial. The SAMA concept is to provide hardware modifications to reduce the potential for the fire initiating event or spurious actuation of a PORV. PRA case FIRE1conservatively assumes complete elimination of the initiating event FCRPL. Thus, the benefit is conservative. SAMA #179 is related to this IE SAMA #12 and was shown to be not cost beneficial. Cost to engineer and install hardware changes needed to realize the benefit are judged to exceed the lower bound cost estimate for hardware changes.
IE #13 FSGBE6	CDF	Fire Switchgear B – Loss of Bus E6	Improve or reduce the CDF contribution of Switchgear Room B fire events.	FSGBE6	3	1	28K (58K)	65K (136K)	>500K	Not cost beneficial. The SAMA concept is to provide hardware modifications that will reduce or eliminate fire initiating events in Switchgear Room B. PRA case FSGBE6 assumes elimination of 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. The fire ignition frequency for scenario

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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.		
										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. Initiator FSGAE5 (Swithgear Room A) is similar. Cost to engineer and implement plant modifications and analysis based on scope comparison to STP SAMA 8 to enhance fire barriers in CRE Panel, estimated at $1.1M.
IE #14 LACPA	CDF	Loss of Train A essential AC power (4kV Bus E5)	Improve Bus E5 reliability and eliminate or reduce bus faults contributing to initiating events.	LACPA	3	1	44K (92K)	103K (216K)	>3M	Not cost beneficial. The SAMA concept is to provide hardware modifications to reduce or eliminate the potential for random loss of emergency bus as an initiating event. PRA case LACPA conservatively assumes complete elimination of the initiating event LACPA (Division A). Thus, the benefit is conservative. Cost to engineer and implement plant modifications and analysis based on scope comparison to STP SAMA 5, estimated hardware change to provide alternate feed to Bus at greater than $3M.

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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.		
IE #15 FSGAE5	CDF	Fire Switchgear A – Loss of Bus E5	Improve or reduce the CDF contribution of Switchgear Room A fire events.	FSGBE6	3	1	28K (58K)	65K (136K)	>500K	Not cost beneficial. Evaluated under SAMA IE # 13.
IE #16 LPCCB	CDF	Loss of PCCW Train B	Related SAMA #59, BE #2 and BE #9. Install hardware to improve the reliability of the CCW, thus reduce potential for loss of CCW initiators.	CCTE1	3	5	144K (302K)	337K (709K)	300K	This IE SAMA is related to SAMA #59, SAMA BE #2 and SAMA BE #9. SAMA #59 and SAMA BE #2 are not cost beneficial. Refer to SAMA BE #9 for evaluation of potential cost beneficial SAMA.
IE #17	LERF	ISLOCA – V-	Related SAMA #113,	LOCA06	<1	3	48K (101K)	113K (238K)	>500K	Not cost beneficial. The SAMA concept is to

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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.		
LOC1VI		sequence LOCA in RHR injection path	#115, #187. Hardware changes to reduce / eliminate ISLOCA risk.							provide hardware changes aimed at reducing the ISLOCA risk. PRA case LOCA06 conservatively assumes that ISLOCA events do not occur. Related SAMAs #113, #115 and #187 have all been shown not cost beneficial.
IE #18 LOC1VS	LERF	ISLOCA – V-sequence LOCA in RHR suction path	Related SAMA #113, #115, #187. Hardware changes to reduce / eliminate ISLOCA risk.	LOCA06	<1	3	48K (101K)	113K (238K)	>500K	Not cost beneficial. Evaluated under SAMA IE #17.
IE #19 E25L	LERF	Seismic 2.5g LOCA event	Related SAMA #147. Hardware changes to reduce or eliminate impact of 2.5g seismic events / LOCA.	LOCA05	9	2	77K (162K)	181K (380K)	>500K	Not cost beneficial. Evaluated under SAMA #147.
IE #20 E18L	LERF	Seismic 1.8g LOCA event	Refer to initiator E25L.	LOCA05	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #19.
IE #21 E18T	LERF	Seismic 1.8g Transient event	Related SAMA #181, #182. Hardware changes to reduce or eliminate impact of 1.8g seismic events / Transient.	E18T	<1	0	5.6K (12K)	13K (28K)	>500K	Not cost beneficial. . The SAMA concept is to provide hardware changes to increase the seismic response of the plant and reduce seismic-induced transient risk. PRA case E18T conservatively assumes complete elimination of transient event E18T. Cost to engineer and install seismic upgrades to significantly reduce the risk of seismic-induced transient risk is expected to significantly exceed the benefit.
IE #22 E25T	LERF	Seismic 2.5g Transient event	Refer to initiator E18T	E18T	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #21.

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.		
IE #23 E14A	LERF	Seismic 1.4g ATWS event	Related SAMA #130, #131, #132, #174	NOATWS	4	2	60K (126K)	139K (292K)	>500K	Not cost beneficial. PRA case NOATWS conservatively assume that ATWS events do not occur (including seismically initiated ATWS). Cost of installing seismic upgrades to significantly reduce the risk of ATWS is expected to significantly exceed the benefit.
IE #24 E18A	LERF	Seismic 1.8g ATWS event	Refer to initiator E14A	NOATWS	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #23.
IE #25 E25A	LERF	Seismic 2.5g ATWS event	Refer to initiator E14A	NOATWS	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #23.
IE #26 E10A	LERF	Seismic 1.0g ATWS event	Refer to initiator E14A	NOATWS	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #23.
IE #27 E7A	LERF	Seismic 0.7g ATWS event	Refer to initiator E14A	NOATWS	--	--	--	--	--	Not cost beneficial. Evaluated under SAMA IE #23.
IE #28 AMFW	LERF	ATWS with Loss of Main Feedwater	Related SAMA #130, #131, #132, #174	NOATWS	4	2	60K (126K)	139K (292K)	>500K	Not cost beneficial. Related SAMAs are #130, #131, #132, #174. PRA case NOATWS conservatively assume that ATWS events do not occur (including seismically initiated ATWS).

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.		
										Cost of installing upgrades to significantly reduce the risk of ATWS is based on related SAMA costs.
IE #29 MSLBO	LERF	Main Steam Line Break Outside Containment	Related SAMA #153	NOSLB	<1	0	5K (11K)	11K (24K)	>500K	Not cost beneficial. Related SAMA is #153 - install secondary side guard pipe protection. PRA case NOSLB conservatively assume that steam line break events do not occur. Cost of installing hardware changes to reduce or eliminate the risk of SLB events is based on SAMA #153.
IE #30 MSSVO	LERF	Main Steam Safety Valve Stuck Open	Related SAMA #194	MSSVO	<1	0	<1K (2K)	2K (4.5K)	>30K	Not cost beneficial. Related SAMA is #194. PRA case MSSVO assumes complete success of the safety valves to close. Cost to engineer and install hardware is based on SAMA #194.