July 15, 2013

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
NextEra Energy Seabrook, LLC	)	Docket No. 50-443-LR
	)	
(Seabrook Station, Unit 1)	)	

AFFIDAVIT OF JOHN G. PARILLO
CONCERNING NEXTERA'S MOTION FOR SUMMARY DISPOSITION
OF FRIENDS OF THE COAST/NEW ENGLAND COALITION CONTENTION 4D
(SAMA ANALYSIS ATMOSPHERIC MODELING)

I, John G. Parillo, do hereby state as follows:

1. I am employed by the United States Nuclear Regulatory Commission ("NRC") as a Senior Reactor Engineer in the Office of Nuclear Reactor Regulation, Division of Risk Assessment, Accident Dose Branch. I have been employed by the NRC since 2005. Shortly after being promoted to Senior Reactor Engineer in June of 2010, my responsibilities expanded to include the review of severe accident mitigation alternatives ("SAMA") analyses submitted as part of the license renewal application ("LRA") process. I am the primary reviewer of the SAMA analysis portions of the Seabrook Station, Unit 1 ("Seabrook") LRA. As such, I was responsible for the preparation of Chapter 5 and Appendix F of the Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants: Seabrook Station – Second Draft Report for Comment, NUREG-1437, Supplement 46 (April 2013) ("DSEIS"). I am also involved in the review of the SAMA analyses for the license renewal applications for Davis-Besse Nuclear Power Station, Callaway Plant, and the Byron and Braidwood Stations. A statement of my professional qualifications is attached as Staff Attachment 4D-A.

2. I have thoroughly reviewed the various inputs and assumptions used in the NextEra Energy, Inc. ("NextEra" or "Applicant") SAMA analysis, as submitted in the Applicant's May 2010 Environmental Report ("ER") and revised in the Applicant's Supplement 2 to Severe Accident Mitigation Alternatives Analysis (SBK-L-12053) (March 19, 2012) ("March 2012 SAMA supplement (SBK-L-12053)"),[1] to calculate offsite consequences associated with a postulated severe accident at Seabrook. I have reviewed the SAMA analysis revisions and clarifications provided in response to NRC Staff requests for additional information ("RAIs"). I have also reviewed relevant supporting technical documentation for Seabrook's SAMA analysis as well applicable guidance documents including: American Society of Mechanical Engineers ("ASME") and American Nuclear Society ("ANS"), ASME/ANS-RA-Sa-2009, "Addenda to ASME RA-S-2008, Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications" (including clarifications and qualifications as per RG 1.200, Rev. 2, March 2009, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities"); NUREG/BR-0184, Regulatory Analysis Technical Evaluation Handbook, Final Report ("Regulatory Analysis Handbook"); NUREG-1555, Standard Review Plans for Environmental Reviews for Nuclear Power Plants – Supplement 1: Operating License Renewal, Revision 1 (June 2013) ("ESRP"); Nuclear Energy Institute ("NEI") 05-01, "Severe Accident Mitigation Alternatives (SAMA) Analysis," ("NEI 05-01");[2] and other applicable NRC regulations and guidance documents, and relevant technical documents and studies. I thus have personal knowledge of the modeling methods, inputs, and assumptions

[1] *See* NextEra Energy Seabrook, LLC, Supplement 2 to Severe Accident Mitigation Alternatives Analysis (SBK-L-12053) (March 19, 2012) ("March 2012 SAMA supplement (SBK-L-12053)"). Staff Attachment 4D-B contains an excerpt of the March 2012 SAMA supplement (SBK-L-12053). The full version of this document can be found at Agencywide Documents Access and Management System ("ADAMS") Accession No. ML12080A137.

[2] *See* NEI 05-01, Rev. A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document" (Nov. 2005) ("NEI 05-01"). Staff Attachment 4D-C contains an excerpt of NEI 05-01. The full version of this document can be found at ADAMS Accession No. ML060530203. The NRC Staff has endorsed NEI-05-01. Final License Renewal Interim Staff Guidance LR-ISG-2006-03: Staff Guidance for Preparing Severe Accident Mitigation Alternatives Analyses (Aug. 2007).

used in the Seabrook SAMA analysis, as described in the Seabrook ER and other related documentation.

3. In preparing this Affidavit, I also reviewed the relevant Orders issued by the Atomic Safety and Licensing Board ("Board") and the Commission in this proceeding. Additionally, I have reviewed the relevant pleadings of the parties, including NextEra's Motion for Summary Disposition of Friends of the Coast/New England Coalition Contention 4D (SAMA Analysis Atmospheric Modeling) ("Motion") and its supporting documents including the Joint Declaration of Steven R. Hanna and Kevin R. O'Kula in Support of NextEra's Motion for Summary Disposition of Contention 4D (SAMA Analysis Atmospheric Modeling).

4. This Affidavit describes how the NRC Staff performs its review of SAMAs, specifically, how the NRC considers uncertainty in a SAMA analysis. As explained in further detail below, the Staff expects applicants to use additional criteria, not used by NextEra in its Motion, to determine whether a SAMA is potentially cost-beneficial. Specifically, the Staff expects applicants to consider uncertainty in the identification of potentially cost-beneficial SAMAs.[3] The most common means of performing this analysis is by multiplying baseline results by an uncertainty factor.

5. Uncertainties in SAMA analyses derive from several sources, including uncertainties in core damage frequency ("CDF") estimates, offsite consequence estimates, the estimated risk reduction for each candidate SAMA, and the estimated implementation costs for each SAMA.[4] The impacts of uncertainties on some of these factors are offset by using conservative estimates of those factors.[5]

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[3] The Staff's expectation that applicants perform an additional uncertainty analysis is based on the NRC-endorsed guidance in NEI 05-01 (Attachment ("Att.") 4D-C), and principles and practice for technically adequate probabilistic risk assessments in conjunction with ASME/ANS-RA-Sa-2009 and RG 1.200, Rev. 2. In its March 2012 SAMA supplement (SBK-L-12053), NextEra acknowledges that this is the Staff's expectation. *See* March 2012 SAMA supplement (SBK-L-12053) (Att. 4D-B), at 35.

[4] NEI 05-01 (Att. 4D-C), at 30; NUREG-1555, Standard Review Plans for Environmental Reviews for Nuclear Power Plants – Supplement 1: Operating License Renewal, Revision 1 (June 2013) ("ESRP"), at 5.2.-6; NUREG/BR-0184, Regulatory Analysis Technical Evaluation Handbook, Final Report

6. Uncertainties in the SAMA analysis are typically addressed through: (1) the use of conservative assumptions in the cost-benefit analysis (e.g., underestimating SAMA implementation costs by neglecting certain cost factors, or overestimating SAMA benefits by assuming the SAMA completely eliminates the sequences/failures it is intended to address), (2) the conduct of sensitivity analyses to explore the impact of alternative models or assumptions on SAMA results (e.g., differences in meteorology or the elevation of the fission product release), and (3) the use of an uncertainty factor typically based on the ratio of the 95th percentile internal event CDF to the mean or point estimate internal event CDF, if available.[6]

7. This approach is consistent with the NRC-endorsed guidance in NEI 05-01. Specifically, NEI 05-01 states:

> A discussion of CDF uncertainty, and conservatisms in the SAMA analysis that off-set uncertainty, should be included. For example, use of conservative risk modeling to represent a particular plant change may be used to offset uncertainty in risk modeling; use of conservative implementation cost estimates may be used to offset uncertainty in cost estimates; and use of an uncertainty factor derived from the ratio of the 95th percentile to the mean point estimate for internal events CDF may be used to account for CDF uncertainties. Estimate an uncertainty factor based on this discussion and perform a sensitivity analysis using the uncertainty factor on the results. [Based on analysis to date the ratio of the 95th percentile to the mean point estimate for typical internal events CDF values is 2 to 5 (Reference 1).][7]

8. In its March 2012 SAMA supplement (SBK-L-12053), NextEra used the approach described in NEI 05-01 in its SAMA analysis by multiplying the baseline results by an uncertainty factor.[8] Specifically, in its determination of cost beneficial SAMAs, NextEra used an uncertainty factor of 2.35 (235%) to account for the uncertainty in the probabilistic risk

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("Regulatory Analysis Handbook"), at 5.3 - 5.8.

[5] NEI 05-01 (Att. 4D-C), at 30.

[6] NEI 05-01 (Att. 4D-C), at 30.

[7] NEI 05-01 (Att. 4D-C), at 30.

[8] *See* March 2012 SAMA supplement (SBK-L-12053) (Att. 4D-B), at 35.

assessment ("PRA") model results.[9] This factor of 2.35 is based on the ratio of the 95th percentile CDF value of 2.86 x 10^{-5} per year to the mean CDF value of 1.23 x 10^{-5} per year.

9. In the DSEIS, the NRC staff reviewed NextEra's SAMA analysis and concluded that the methods used and their implementations were acceptable.[10] As explained in the Staff's DSEIS, NextEra compiled a list of 191 SAMAs in the ER and 4 additional SAMAs in its March 2012 SAMA supplement (SBK-L-12053).[11] Of these SAMAs, 117 were eliminated qualitatively,[12] leaving 78 candidate SAMAs for additional evaluation.[13] These candidates underwent more detailed design and cost estimates. As a result, three candidates were identified as being potentially cost beneficial in the baseline analysis (SAMAs 157, 165, and 192).[14]

10. NextEra also performed additional analyses to evaluate the impact of parameter choices and uncertainties. In its determination of cost beneficial SAMAs, NextEra used an uncertainty factor of 2.35 to account for the uncertainty in the PRA model results.[15] After accounting for uncertainty, three additional potentially cost-beneficial SAMAs (SAMAs 164, 172, and 195) were identified.[16]

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[9] *Id.* The Staff notes that the 32% increase in benefit suggested by the Exposure Index is far less than the 235% uncertainty factor.

[10] Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants: Seabrook Station – Second Draft Report for Comment, NUREG-1437, Supplement 46 (April 2013) ("DSEIS"), at 5-3 to 5-25.

[11] DSEIS at 5-12, 5-22.

[12] NextEra performed a qualitative screening using various criteria to eliminate SAMAs from further consideration. For example, a SAMA would be screened out if it was not applicable to Seabrook due to design differences. DSEIS at 5-12.

[13] DSEIS at 5-12.

[14] DSEIS at 5-14. These SAMA numbers correspond to the number designated to each SAMA by NextEra. *See* Table 1, March 2012 SAMA supplement (SBK-L-12053) (Att. 4D-B), at 38-65.

[15] March 2012 SAMA supplement (SBK-L-12053) (Att. 4D-B), at 35.

[16] DSEIS at 5-14.

11. In addition, NextEra performed a sensitivity analysis using a multiplier of 2.1 (applied to the baseline results with uncertainty) to account for the additional risk of seismic events.[17] This seismic multiplier does not represent an uncertainty, but is used to re-quantify the previous estimate for seismic events. This analysis identified one additional SAMA (SAMA 193) as being potentially cost-beneficial.[18]

12. After accounting for external events and uncertainty, NextEra identified seven potentially cost-beneficial SAMAs. NextEra indicated that all seven potentially cost-beneficial SAMAs will be entered into the Seabrook long-range plan development process for further implementation consideration. Accordingly, the NRC staff concluded in the DSEIS that, with the exception of the seven potentially cost-beneficial SAMAs, the costs of the other SAMAs evaluated would be higher than the associated benefits.[19]

13. In the Joint Declaration accompanying NextEra's motion for summary disposition of Contention 4D, NextEra's expert states as follows:

> Increasing each SAMA's total benefit value (with seismic multiplier) by approximately 32% to account for the CALMET-based [Exposure Index] methodology would not result in the identification of any potentially cost beneficial SAMAs. This is because there needs to be more than a factor of two increase in the best estimate SAMA benefit before another SAMA would be considered potentially cost beneficial. SAMA #77 is the closest to becoming potentially cost beneficial. Its best estimate (with seismic risk multiplier) total benefit of $6.41 million would need to

[17] In response to an NRC staff request to assess the impact on the SAMA evaluation of updated seismic hazard curves developed by the U.S. Geological Survey ("USGS") in 2008, NextEra provided a revised SAMA evaluation using a multiplier of 2.1 to account for the maximum estimated seismic CDF for the Seabrook of 2.2×10^{-5} per year. In the process of estimating an appropriate multiplier, NextEra considered that the estimated seismic CDF of 2.2×10^{-5} per year did not credit the installation of the supplemental electrical power system ("SEPS") diesel generators ("DGs") in 2004, which, based on a subsequent PRA estimate, reduced seismic CDF by 26%. Therefore, in estimating the multiplier, NextEra first reduced the 2.2×10^{-5} per year estimate for seismic CDF by 26% to 1.6×10^{-5} per year. Using a seismic CDF of 1.6×10^{-5} per year, the total CDF equates to 2.5×10^{-5} per year or 2.1 times the total CDF (internal and external events). DSEIS at 5-5, 5-9.

[18] DSEIS at 5-14.

[19] DSEIS at 5-14.

> increase by more than a factor of two in order to meet or exceed the expected SAMA cost of more than $15 million."[20]

The NRC Staff notes that the 32% increase (accounting for the CALMET-based Exposure Index methodology) was applied to the SAMA's total benefit[21] without using an uncertainty factor. The application of the 32% increase to the SAMA's total benefit without an uncertainty factor does not conform to the NRC Staff's expectation for the appropriate consideration of uncertainty in the PRA model results. Therefore, the NRC staff does not agree with NextEra's conclusion that, increasing each SAMA's total benefit value "by approximately 32% to account for the CALMET-based [Exposure Index] methodology would not result in the identification of any potentially cost beneficial SAMAs."

14. Assuming that each SAMA's total benefit should be increased by 32% based on NextEra's SAMA analysis contained in its Motion, 15 additional SAMA's would be identified as potentially cost beneficial, if an acceptable uncertainty factor is applied to what NextEra refers to as "SAMA's total benefit value (with seismic multiplier)." These additional potentially cost-beneficial SAMAs are identified in Table A below.

15. The SAMAs identified in the Staff's Table A are based on the SAMAs listed in Table 1 of NextEra's March 2012 SAMA supplement (SBK-L-12053) ("Table 1").[22] For example, SAMA 13 in the Staff's Table A refers to SAMA 13 on page 38 of NextEra's Table 1 regarding installation of an additional, buried off-site power source.

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[20] Joint Declaration of Steven R. Hanna and Kevin R. O'Kula in Support of NextEra's Motion for Summary Disposition of Contention 4D (SAMA Analysis Atmospheric Modeling) at ¶ 131. *See also* NextEra's Statement of Material Facts at ¶¶ 10, 11.

[21] In its Motion, NextEra uses the terms "SAMA's total benefit (with seismic multiplier)" and "SAMA's best estimate (with seismic multiplier)" interchangeably. *See* Joint Declaration of Steven R. Hanna and Kevin R. O'Kula in Support of NextEra's Motion for Summary Disposition of Contention 4D (SAMA Analysis Atmospheric Modeling) ¶ 131; NextEra's Statement of Material Facts at ¶¶ 10, 11.

[22] *See* Table 1, March 2012 SAMA supplement (SBK-L-12053) ("NextEra's Table 1") (Att. 4D-B), at 38-65.

16. The Staff's Table A, Column 1, "SAMA Number," identifies the SAMA number designated by NextEra in Table 1, Column 1, "SBK SAMA Number."

17. The Staff's Table A, Column 2, "Total Benefit"[23] identifies the SAMA's total benefit without uncertainty. This value corresponds to the value in parenthesis in NextEra's Table 1, Column 7, "Internal & External." For example, this value is 1.2M for SAMA 13.

18. The Staff's Table A, Column 3, "Total Benefit + Exposure Index (32%)," identifies the SAMA's total benefit without uncertainty, but with the 32% exposure index increase in total benefits. For SAMA 13, this value was calculated by multiplying 1.2M (Table A, Column 2) by 1.32 (32%). Thus, the resulting total benefit without uncertainty, but with the 32% increase for SAMA 13 was 1.6M.

19. The Staff's Table A, Column 4, "Total Benefit + Exposure Index + Uncertainty (2.35)," identifies the SAMA's total benefit with the 32% exposure index increase in total benefits and with uncertainty. For SAMA 13, this value was calculated by multiplying 1.6M (Table A, Column 3) by an uncertainty factor of 2.35. This resulted in a new total benefit with uncertainty and with the 32% increase of 3.7M.

20. Table A, Column 5, "Expected SAMA Cost ($)," identifies the expected SAMA cost. This value corresponds to the value in NextEra's Table 1, Column 9, "Expected SAMA Cost ($)." For example, this value is 3M for SAMA 13.

21. If the new total benefit value with the 32% increase and with uncertainty in Table A, Column 4 exceeded the expected SAMA cost in Table A, Column 5, then the Staff identified the SAMA as potentially cost beneficial. For example, for SAMA 13, the new total benefit with the 32% increase and with uncertainty was 3.7M. This value exceeds the expected SAMA cost of 3M. Therefore, the Staff identified SAMA 13 as potentially cost-beneficial. The Staff used similar calculations to identify the 14 other SAMAs listed in Table A.

[23] Total benefit includes internal and external risk factors including the 2.1 seismic multiplier. It does not account for uncertainty.

Table A. Additional Potentially Cost-Beneficial SAMAs Accounting for a 32% Increase Applied to the Benefit with Uncertainty

SAMA Number	Total Benefit ($)			Expected SAMA Cost ($)[24]
	Baseline with 2.1 seismic re-quantifier			
	Total Benefit	Total Benefit + Exposure Index (32%)	Total Benefit + Exposure Index + Uncertainty (2.35)	
13	1.2M	1.6M	3.7M	3M
24	1.2M	1.6M	3.7M	3M
44	1.93M	2.55M	5.99M[25]	6M
55	2.2M	2.9M	6.8M	6.4M
56	2.2M	2.9M	6.8M	6.4M
77	6.41M	8.46M	19.9M	15M
96	39K	52K	120K	100K
108	39K	52K	120K	100K
109	39K	52K	120K	100K
147	162K	214K	503K	500K
163	748K	987K	2.32M	2M
167	2.3M	3M	7.1M	6.4M
168	2.3M	3M	7.1M	6.4M
169	2.3M	3M	7.1M	6.4M
170	2.3M	3M	7.1M	6.4M

[24] The Staff notes that the estimated costs of some of these SAMAs are expressed with a greater than sign preceding the cost in NextEra's Table 1. These greater than signs have been omitted from the Staff's Table A. When minimally-estimated costs substantially exceed even the total estimated benefit with uncertainty, applicants may choose not to refine their cost calculations further, hence the use of the ">" sign to indicate a minimum cost substantially in excess of the total benefit (with uncertainty).

[25] The Staff notes that there appears to be a small rounding error likely based on truncation of the values provided in NextEra's Table 1. For SAMA 44, when the Staff applied the 32% exposure index increase to the total benefit with uncertainty value in NextEra's Table 1, Column 8, "With Uncertainty," which was 4.6M (including the 2.1 seismic multiplier), this resulted in a new total benefit with uncertainty and with the 32% increase of 6.07M. This value of 6.07M is greater than the 6.0M expected SAMA cost for SAMA 44. Therefore, the Staff identified SAMA 44 as potentially cost-beneficial.

22. I declare under penalty of perjury that my statements set forth above and in my statement of professional qualifications attached hereto are true and correct to the best of my knowledge, information, and belief.

Executed in Accord with 10 CFR § 2.304(d)

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Executed in Rockville, MD
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