Hello:

Attached please find Comment Seabrook NUREG-1437, Supplement 46, Section 5.0 submitted by Mary Lampert, Raymond Shadis, and David Agnew.

We would appreciate your replying by return email to indicate receipt and that the comments will be docketed.

Thank you and have a pleasant afternoon,

Mary
The following comments are focused on Section 5.0 Environmental Impacts of Postulated Accidents. They are submitted by the following parties. Mary Lampert is a stakeholder owning two residential properties in Boston on Beacon Hill that are located within 50-miles of Seabrook Station. Friends of the Coast – Opposing Nuclear Pollution (Friends of the Coast) and New England Coalition, Inc. (NEC) are co-signing the comments. They have standing and are a party to the LRA proceedings. Friends of the Coast/NEC has numerous members that reside in the immediate vicinity Seabrook Station and throughout New England; said members’ concrete and particularized interests will be directly affected by this proceeding. Capedownwinders, although approximately 70 miles distant from Seabrook, are nevertheless at risk as evidenced by the spread of direct and indirect actual impacts in Japan.

We contend that NRC Staff incorrectly found the SAMA analysis adequate. NextEra’s SAMA analysis improperly minimized offsite consequences and costs when filed in 2010 and those inadequacies were underscored, and others made apparent, by the new and significant issues raised by Fukushima regarding the probability of both a severe accident and containment failure, and subsequent larger off-site consequences and costs. If properly accounted for, mitigations that the public deserves to reduce risk would be found cost justified. The SAMA must be redone. NRC Staff are wrong.

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS-POST FUKUSHIMA

I. INTRODUCTION

In the license renewal process, the Applicant is required under 10 CFR
§51(c)(ii)(L) to perform a severe mitigation analysis if they had not previously done so. The purpose of a SAMA review is to ensure that any plant changes that have a potential for significantly improving severe accident safety performance are identified and addressed.

Post Fukushima Daiichi, it plainly is necessary to redo NextEra’s SAMA analysis to take into account new and significant information learned from Fukushima regarding the probability of a severe accident, including containment failure, in the event of an accident and the concomitant probability of a significantly larger volume of off-site radiological releases and costs.

NRC Staff’s pre-Fukushima statement that, “The generic analysis (GEIS) applies to all plants... and that the probability-weighted consequences of atmospheric releases fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants” (SEIS 5-2, 5-3) requires a fresh look.

Further the Staff says that they “identified no new and significant information related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS.” (Ibid, 5-3) Prior to Fukushima the analysis was wrong; Post-Fukushima it is ludicrous and NEPA requires NRC to perform a new analysis before license renewal.

II. NATIONAL ENVIRONMENTAL POLICY ACT

National Environmental Policy Act, NEPA, 42 USC § 4332, requires that the Staff look at new and significant information in order to “help public officials make decisions that are based on understanding of environmental consequences, and take decisions that protect, restore and enhance the environment.” 40 CFR § 1500.1(c) (Emphasis added)
NRC “ha[s] a duty to take a hard look at the proferred evidence” *Marsh v Oregon Natural Resources Council, 490 U.S. 360, 385 (1989)* before relicensing Seabrook and before finalizing the SEIS. NEPA requires an agency to consider the environmental effects before decisions are made; the NRC must ensure that “important effects will not be overlooked or underestimated only to be discovered after resources have been committed or the die otherwise cast.” *Robertson v Methow Valley Citizens Council, 490 U.S. 332, 349 (1989)* NRC cannot rely on NextEra’s June 1, 2010 SAMA analysis and minor updates.

The fundamental purpose of the National Environmental Policy Act, NEPA, 42 USC § 4332, is to “help public officials make decisions that are based on understanding of environmental consequences, and take decisions that protect, restore and enhance the environment.” 40 CFR § 1500.1(c)

In its application for license renewal of Seabrook, NextEra was required under 10 CFR § 51 to provide an analysis of the impacts on the environment that could result if it is allowed to continue beyond its initial license. The environmental impacts that must be considered in NextEra’s EIS include those which are “reasonably foreseeable” and have “catastrophic consequences, even if their probability of occurrence is low.” 40 CFR §1502.22(b)(1). Therefore the Staff’s position that the probability of a severe accident is remote is not simply wrong after Fukushima but immaterial to satisfying NEPA’s obligations.

The NRC must assure Seabrook’s SEIS and adjudication process considers issues raised by Fukushima prior to relicensing Seabrook; the Fukushima events plainly show that, even if they are not yet all conclusively understood, the environmental impacts of the NRC relicensing
Seabrook may “affect the quality of the human environment in a significant manner or to a significant extent not already considered.” *Marsh* at 374; see also *Marsh* at 372-373

Unless the NRC Staff take the “hard look” required by NEPA and adjust the cost/benefit analysis based on lessons now learned, NextEra’s 20106 SAMA analysis will stand as is, based on pre-Fukushima assumptions that seek to show that mitigation is not justified, that the risks to society are really too low, and that there is no need to spend that money for safety enhancements we now know the public needs and deserves. The degree to which a project may affect public health or safety is a major consideration under NEPA. See 40 C.F.R. 1508.27.

The public is not obligated to perform a complete and new SAMA analysis or conduct a comprehensive review of potential mitigation measures before the NRC that is obligated to take a hard look at the lessons learned from Fukushima: “[i]t is the agency, not an environmental plaintiff, that has a ‘continuing duty to gather and evaluate new information relevant to the environmental impacts of its actions.’ *Friends of the Clearwater v. Dombeck*, 222 F.3d 552, 559 (9th Cir. 2000) (quoting *Warm Springs Dam Task Force v. Gribble*, 621 F.2d 1017, 1023 (9th Cir. 1980)); see also *Te-Moak Tribe v. U.S. Dept of the Interior*, 608 F.3d 592, 605-06 (9th Cir. 2010); *Davis v. Coleman*, 521 F.2d 661, 671 (9th Cir. 1975) (“compliance with NEPA is a primary duty of every federal agency; fulfillment of this vital responsibility should not depend on the vigilance and limited resources of environmental plaintiffs.”). NRC Staff has an obligation to go back to the drawing board and take the required “hard look” at issues raised herein and any other new, significant and material issues that arise from Fukushima.

As the First Circuit remarked in *Dubois v. U.S. Dept. of Agric.*, 102 F.3d 1273, 1291 (1st Cir. 1996), discussing the public’s role under NEPA:
The purpose of public participation regulations is simply to ‘provide notice’ to the agency, not to ‘present technical or precise scientific or legal challenges to specific provisions’ of the document in question. Moreover, NEPA requires the agency to try on its own to develop alternatives that will “mitigate the adverse environmental consequences” of a proposed project. Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 351 (1989)

III. LESSONS LEARNED FROM FUKUSHIMA - INADEQUACIES SEIS 5.0

Based on new and significant information from Fukushima, the Environmental Report is inadequate post Fukushima Daiichi. NextEra’s SAMA analysis ignores new and significant issues raised by Fukushima regarding the probability of both containment failure, and subsequent larger off-site consequences.

A. New and Significant Information Regarding The Probability of a Severe Accident

1. Probability of Reactor Core Damage and Radioactive Release - Cumulative

   Direct Experience

   The probability of severe core damage and radioactive release can be estimated either from a PRA study or from direct experience. Fukushima has expanded our knowledge and provides a reality check for PRA estimates.

   Estimating core-damage probability using PRA

   The accident at Fukushima showed that Seabrook’s SAMA analysis underestimates the extent of core damage (CDF) by an order of magnitude. Core damage probability, post Fukushima shows that of the 12 core-damage accidents at NPPs, five have occurred at Generation II plants and involved substantial core melting. These were at Three Mile Island, Unit 2(PWR), Chernobyl Unit 4 (RBMK plant) and Fukushima Units 1 through 3. (BWRs). These 5 occurred in a worldwide fleet of of commercial NPPS of which 440 are currently in
operation. The data provides a reality check on PRA estimates of CDF. Confidence is enhanced because the 5 occurred in different countries, at three different types of reactor designs, and over a period of 32 years. The 5 core damage accidents over a world wide experience of 14,500 RY can be translated to a CDF of 3.4E-04 per RY (1 event per 2,900 reactor years). This is significantly different than NextEra’s SAMA’s baseline 1.5 X 10⁻⁵ RY (1.5 events per 100,000 RY). Therefore the SAMA analysis done by NextEra pre Fukushima must be redone with a baseline CDF orders of magnitude higher.

2. **Flooding and Seismic Hazards:** The probability of flooding and seismic hazards is higher than previously estimated post Fukushima. The October 11, 2011 SECY attests to its significance. Seabrook’s location places it at a significant risk for flooding, a risk that will increase in subsequent years as a consequence of global warming.

3. **Station Blackout:** The probability of SBO is higher than previously estimated post Fukushima and increases the probability of a severe accident at Seabrook. The October 11, 2011 SECY attests to its significance. Lack of reliability of electric power is not properly accounted for in the PRA due to: (a) Seabrook’s submerged Non- EQ (environmentally qualified) electric cables that carry offsite electricity needed to power safety systems; and (b) backup systems are insufficient and susceptible to damage from manmade and natural events.

4. **Spent Fuel:** Higher releases than initially reported by the Japanese and releases from the spent fuel pool cannot be discounted post-Fukushima.


The disaster at the Fukushima Daiichi nuclear plant in March released far more radiation than the Japanese government has claimed. So concludes a study \(^1\) that combines radioactivity data from across the globe to estimate the scale and fate of emissions from the shattered plant.

The study also suggests that, contrary to government claims, pools used to store spent nuclear fuel played a significant part in the release of the long-lived environmental contaminant caesium-137, which could have been prevented by prompt action. The analysis has been posted online for open peer review by the journal Atmospheric Chemistry and Physics\(^2\).

Stohl believes that the discrepancy between the team's results and those of the Japanese government can be partly explained by the larger data set used. Japanese estimates rely primarily on data from monitoring posts inside Japan, which never recorded the large quantities of radioactivity that blew out over the Pacific Ocean, and eventually reached North America and Europe. "Taking account of the radiation that has drifted out to the Pacific is essential for getting a real picture of the size and character of the accident," says Tomoya Yamauchi, a radiation physicist at Kobe University who has been measuring radioisotope contamination in soil around Fukushima.

The new analysis also claims that the spent fuel being stored in the unit 4 pool emitted copious quantities of caesium-137. Japanese officials have maintained that virtually no radioactivity leaked from the pool. Yet Stohl's model clearly shows that dousing the pool with water caused the plant's caesium-137 emissions to drop markedly.

5. **Concrete Degradation**: Concrete is degrading presently at Seabrook Station; there is no evidence that it shall not continue. The environmental consequences are not analyzed in the SEIS

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such as the environmental and economic consequences from lime leached from the concrete into the environment.

B. New and Significant Information Regarding the Magnitude of Release and Increased Offsite Costs

1. **Duration of Release:** The MACCS2 computer code used by NextEra limits the total duration of a radioactive release to no more than four (4) days, if the Applicant chooses to use four plumes occurring sequentially over a four day period. NextEra chose not to take that option and limited its analysis to a single plume having a total duration of the maximum-allowed 24 hours. The Analysis and SEIS fail to say how many hours were actually modeled by NextEra and we request that information. In any case either a 24-hour plume or a four-day plume is insufficient duration in light of lessons learned from Fukushima. The Fukushima crisis now stretches into its seventh month and shows that releases can extend into many days, weeks, and months; a longer release will cause more significant offsite consequences that, in turn, will affect cost-benefit analyses. Any attempt to deny this would be counterintuitive and absurd.

2. **Computer Codes In Use Are Totally Incapable Of Modeling A Chain Reaction That Continues After A Scram.** MACCS2 is no exception. Like all the computer codes, it is incapable of modeling a “severe accident” release that lasts weeks and months. The MACCS2 code used by NextEra, and all other codes, assumes that the reactor is scrammed when the accident begins, and that the production of all fission products ceases at that time. We know that criticality was continuing at Fukushima Unit 2 through and past April 27, 2011, and to shorter duration at Unit 1, because of their continued post-scram high findings of I-131 reported by

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4 The MACCS2 uses a Gaussian plume model with Pasquill-Gifford dispersion parameters (Users code 5-1). Its equation is limited to plumes of 10 hour duration.
TEPCO. The reactors were shut down, scrambled, on March 11th. I-131 has an 8-day half-life. If criticality had stopped after the reactors scrambled, the I-131 would have largely decayed. It would not be at the levels TEPCO reported, that exceeded the Cesium readings. Conventional accident analysis of reactor accidents begin at reactor scram, t=0, and assume that the fission chain reaction ceases completely at that time, and that thereafter there is only “spontaneous” nuclear decay, with it being common practice to ignore the very tiny amount of “spontaneous fission” triggered by random neutrons from cosmic radiation hitting a fissile atom and creating infinitesimal amounts of I-131. A large problem created by the ongoing chain reaction is the calculation of food doses. The code has no way of modeling the continual production of I-131 and I-134 which can get to people both by milk and from fresh leafy-vegetable consumption.

The NRC Staff has an obvious duty to re-evaluate the Applicant’s SAMA analysis on the basis of this new and significant information and its public health and safety consequences.

3. **Probability of Higher Releases - Post Fukushima Analyses deficiencies in Mitigation Measures-EDMGs/SAMGs**

The NRC Task Force and October 3 SECY to the Commissioners, *Prioritization of Recommended Actions to Be Taken in Response to Fukushima Lessons Learned Task Force*, substantiate that NextEra’s assumptions regarding probability and consequences pre-Fukushima were incorrect and overly “optimistic” regarding the effectiveness of mitigation measures. One fundamental problem is that both the SAMGs and EDMGs are voluntary and not evaluated or enforced by NRC. Therefore the weight given them in assuming a lower probability of an accident is not justified.

The capability of operators to mitigate an accident at Seabrook would affect the
probability of a radioactive release from the accident, including from a spent fuel pool fire. Fukushima showed that events can result in high radiation fields and explosions, and long periods without fresh water and electricity.

**Examples- strategies to provide make-up water**

Spent Fuel Pools: Review of NEI’s newly-disclosed EDMGs (NEI, B.5.b Phase 2 &3 Submittal Guideline, NEI 06-12, Revision 2, December 2006) show that they are inadequate to respond to the type of accident we now can expect post-Fukushima. For example: various strategies are discussed to provide makeup water. However important considerations are ignored such as:

- Events that initiate the accident such as: hurricanes, ice storms, and blizzards could render the water supply unavailable.
- A radioactive release from the reactor or spent fuel pool could produce radiation fields that render the water supply truck unavailable or preclude its use.
- There is no recognition that spraying water on exposed fuel could exacerbate the accident and cause a steam explosion or in the pool feed a zirconium-steam fire.

Containment: There is recognition in the Severe Accident Mitigation Guidelines (SAMGs) of the need for huge amounts of water during a severe accident but in a narrow way. The weight of the water along with how much space it would occupy was considered. The SAMGs have a provision for using water from the lake, river, or ocean to fill the containment until the level is higher than the top of the active fuel in the reactor core. This option seeks to cool the reactor core, assuming all other means failed, by immersion in water. The plant-specific calculations performed to support this SAMG step consider how high the containment must be flooded to achieve this condition. The SAMGs direct the operators to position motor-operated valves and such to their desired positions before submerging them in water and disabling them. The SAMGs
also look at how much water much be added to achieve the desired level and the weight (water weighs about 8 pounds per gallon) this level has on the structural integrity of the containment.

However the SAMGs do not consider the need, as seen in Japan, to continuously fill because of evaporation and leakage; nor does it consider the added weight from the water in the containment in its seismic calculations. Probabilities are improperly assumed lower.

**Feed & Bleed**

Last the SAMGs do not consider the effect on contaminating the waters from the reactor bleeding large volumes of highly contaminated water into the ocean and significantly increasing offsite consequences/costs.

Prior to Fukushima NRC Staff in reviewing Seabrook’s SAMA apparently did not consider the probability that a huge volume of water required to be poured into the reactor in a severe accident after the type of events that we see are now credible and the consequent huge amount of highly contaminated water flowing out directly into the ocean.

The Areva method to decontaminate the water failed. The Scientific American reported that “a trial run of the new filtration system was halted on June 18 in less than five hours when it captured as much radioactive cesium 137 in that span as was expected to be filtered in a month.” The inability to store large volumes of decontaminated water was not modeled.

An additional problem in Japan was that the currents are such that the contaminants keep coming back to shore and are predicted to bring the contaminants back for 20-30 years. There is

5 http://www.scientificamerican.com/article.cfm?id=fukushima-meltdown-radioactive-flood&print=true Scientific American, Three months after its meltdown, the stricken nuclear power plant continues to struggle to cool its nuclear fuel--and cope with growing amounts of radioactive cooling water, David Biello | Friday, June 24, 2011
no indication that so-called "feed and bleed" and the effects of currents were modeled in Next Era’s SAMA; thereby consequences/costs were minimized.

There are numerous press reports describing the impact on the environment from feed and bleed, ignored by NextEra’s SAMA. For example: *Fukushima’s radioactive sea contamination lingers*, Andy Coghlan, New Scientist, September 30, 2011

Peak leaks: Official estimates from the Japanese government and TEPCO, the company that owns Fukushima-Daiichi, suggest that 3500 terabecquerels of caesium-137 from the plant entered the ocean between 11 March and late May. The pollution was exacerbated in April by problems locating a persistent leak of contaminated water and a decision by TEPCO to dump contaminated water at sea. A further 10,000 terabecquerels of caesium-137 is thought to have found its way into the ocean after escaping as steam from the facility. And TEPCO said last week that Fukushima-Daiichi may still be leaking as much as 500 tonnes of contaminated water into the sea every day. (Emphasis added)

*Radioactive cesium may be brought back by Ocean in 20-30 years*, Tokyo Times, 09.16.11

Radioactive substances from the Fukushima nuclear facility which spilled into the ocean in the aftermath of the March quake and tsunami may reach the Japanese coasts again in 20-30 years, according to a new research.

The Meteorological Research Institute and the Central Research Institute of Electric Power Industry compiled a study indicating that the leaked radioactive cesium may travel clockwise through the northern Pacific Ocean and return to the Japanese coast in two or three decades.

*Radioactive plankton found near Fukushima plan*, Mark Willacy, Reuters Kodo, October 15, 2011

Researchers say high concentrations of radioactive caesium have been detected in plankton in the Pacific Ocean off the shattered Fukushima nuclear plant.

The Fukushima nuclear plant was badly damaged in the March earthquake and tsunami that struck Japan, and has been leaking radiation ever since.

It is feared more radiation could now enter the food chain.

Researchers from Tokyo University collected plankton from the sea south of the Fukushima nuclear plant, discovering nearly 700 becquerels per kilogram of caesium in plankton close to the shore.

Research leader professor Takashi Ishimaru told Japan’s NHK network sea currents had carried contaminated water south from the nuclear plant, heavily contaminating the plankton.

A wide range of fish and other marine species feed on the plankton, leading to fears it could have a serious impact on the food chain.

The GEIS, like the SEIS, modeled *atmospheric releases fallout on open bodies of water* but apparently not leaks of large quantities of water from the necessity to dump tons of water on
the top of the reactor followed by tons of water leaking out from the bottom through cracks into adjacent waters.

The generic analysis (GEIS) applies to all plants... and that the probability-weighted consequences of atmospheric releases fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants.” (SEIS 5-2, 5-3, emphasis added)

4. Cleanup Challenges and Offsite Costs Not Considered

New and significant information from Fukushima underscore what was already known and add new and significant information to show that the SAMA analysis for Seabrook significantly minimized offsite cleanup costs so that mitigation measures that properly should have been found cost effective to implement were not.

a. Size Area Contaminated- Underestimated (Duration Release, Meteorology & Averaging)

*Estimated 13,000 square km eligible for decontamination* Asahi.com (Asahi Shimbun), Oct 12, 2011 reported that 8077 miles will be decontaminated:

The central government will be responsible for decontaminating about 13,000 square kilometers across eight prefecture, or about 3 percent of Japan’s total landmass

Lessons learned from Fukushima confirmed that costs of offsite cleanup will reflect the size of the area contaminated. As discussed above (at 5) the MACCS2 code used by NextEra limits the total duration of a radioactive release to a single plume having a total duration of the maximum-allowed 24 hours\(^6\) that is insufficient duration in light of lessons learned from

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\(^6\) The MACCS2 uses a Gaussian plume model with Pasquill-Gifford dispersion parameters (Users code 5-1). Its equation is limited to plumes of 10 hour duration.
Fukushima. A longer release will cause offsite consequences that will increase contamination, and result in required re-decontamination, and significantly increase cleanup costs and the overall cost-benefit analyses. Assumptions need to be changed post-Fukushima.

**Plume, Straight-line Variable:** Fukushima showed that the plume did not travel simply in a straight-line. Fukushima Daiichi, like Seabrook, is on the coast and the area around it topographically varied. The wind in Japan was variable, as it is and would be in a severe accident at Seabrook.

Further it is obvious that releases extending over a longer duration than a day will travel in varied directions over that extended time period. However, the MACCS2 code’s ATMOS module, used by NextEra, assumes a straight-line Gaussian plume. Consequently it fails to predict the area impacted and significantly minimizes it. NEPA requires the SAMA analysis to be redone using a variable plume model.


**RADIOISOTOPE RECONSTRUCTION**

Radiation levels in Japan vary greatly by location. The Japanese Ministry of Education, Culture, Sports, Science and Technology has been posting radiation levels by prefecture on its

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7 Gov’t radiation info in English http://radioactivity.next.go.jp/en/
Mainichi Daily News reported that:

The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) has released a new map showing the spread of radiation from the crippled Fukushima No. 1 Nuclear Power Plant across 10 prefectures, including Tokyo and Kanagawa.

The map released on Oct. 6 shows levels of radioactive cesium (cesium-137 and cesium-134) that have accumulated in soil in the prefectures of Yamagata, Miyagi, Fukushima, Tochigi, Gunma, Ibaraki, Saitama, Chiba, Kanagawa and Tokyo.

The map shows 30,000 to 60,000 becquerels of radioactive cesium per square meter of soil in the areas of Higashikanamachi, Mizumotokeen and Shibanata in Tokyo's Katsushika Ward, as well as some parts of Kitakoiwa in Tokyo's Edogawa Ward.

Radioactive amounts ranging between 30,000 and 100,000 becquerels per square meter were detected in the mountain areas in northwestern Okutama, in western Tokyo.

Further, the press has numerous recent reports on the spread of contamination. For example:


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9 Mainichi News, http://mdn.mainichi.jp/mdnnews/news/20111007p2a00m0na009000e.html
feelings over the discovery of radioactive strontium in Yokohama’s Kohoku Ward, some 250 kilometers away from the crisis-hit Fukushima No. 1 Nuclear Power Plant.”

Averaging Meteorological Data: Fukushima also makes plain the effect the Applicant’s choice of averaging has on estimating consequences. The User can choose the averaging method in the code’s OUTPUT file. If the mean is chosen, as was the case in Seabrook’s SAMA, then the site’s meteorological variability is washed out - made meaningless. For example sea breeze occurs only in warmer months; therefore at the 95th percentile its impact is accounted for but not if the mean is used. Averaging is a choice; no NRC rule requires the Applicant to use the MACCS2 code or a particular statistical method. Whether NRC determines that the Applicant made the correct choice depends if: NRC Staff is on the side of NextEra and wishes to assure that they will not be required to spend monies for mitigation in the post- Fukushima world; or whether NRC is on the side of assuring public safety.

Explanation MACCS2 code’s averaging: For each plant damage state, the code is run over a meteorological data set to produce a set of consequence results. For each consequence endpoint, the values corresponding to various statistical parameters of the resulting data set (mean, median (50th percentile), 95th percentile, 99th percentile, and the maximum value over all weather trials considered) are provided in the MACCS2 code’s OUTPUT file. Then, it is necessary for the SAMA analysis to determine which statistical parameter should be used as input into the SAMA analysis: e.g., the mean, the median or the 95th percentile. Once this input parameter is chosen, then the population dose-risks and off-site economic dose risks can be calculated, summed and compared to the costs of mitigative measures. The choice of statistical input parameter determines the level of protection which mitigative measures would be expected to provide. A choice of 95th percentile, for example, means that mitigative measures would be considered cost-beneficial if they were no more expensive than the value of the averted risk to the public from a severe accident for 95 percent of the meteorological conditions expected to occur over the course of a year. In contrast, use of the mean consequences would imply that measures would be cost-beneficial if they were no more expensive than the (significantly lower) value of the averted risk to the public for an accident occurring under average meteorological conditions. This is analogous to the situation of a homeowner who is considering whether to spend the money to install windows to protect against a 20-year storm or just an average storm. Thus the outcome of the SAMA analysis is functionally dependent on the choice of statistical input.
Comparative Studies Missing: We note also that the NRC Staff did not provide reference to, or ask the Applicant for, a single study that compared the results from: using a variable plume model versus a Gaussian plume model; or statistically treating the data with the 95th percentile versus the mean. Consequently, we question the basis for the Staff’s assurance that they “identified no new and significant information related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS.” (Ibid, 5-3)

Further, we also understand that the NRC does not have the capability or knowledge to run the MACCS2 code. If this is so, and we deserve to know, on what basis did the staff approve NextEra’s analysis?

b. Cleanup Standard

Estimated 13,000 square km eligible for decontamination Asahi.com (Asahi Shimbun), Oct 12, 2011 reported that a change in cleanup standard dramatically affected the area required to be cleaned up and costs 7-fold.

The central government will be responsible for decontaminating about 13,000 square kilometers (8077 miles) across eight prefecture, or about 3 percent of Japan’s total landmass, under new standards for cleaning up radiation from the Fukushima No. 1 nuclear power plant, according to Asahi Shimbun estimates.

The Environment Ministry on Oct. 10 endorsed a basic policy to make the government responsible for decontaminating all areas with radiation levels exceeding 1 millisievert per year. (100 mlrem)

Based on an earlier annual threshold of 5 millisieverts, the ministry initially said about 1,800 square km of land in Fukushima Prefecture would be subject to decontamination. But under the new standard, the size of the area will grow sevenfold.

The cleanup standards that will determine what clean-up is required (and hence its cost) have not been defined in the U.S. and without defining how “clean is clean” there was no way for NextEra to make any reasonable estimate of offsite costs or for NRC Staff to make its evaluation in the SEIS.

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Further lessons learned at Fukushima have shown that absent a cleanup standard set before the accident, there is added delay in getting started. Time is important in cleanup. The longer it takes to start the process of decontamination will result in an increase in damage to the environment, public health, and economy via resuspension and contamination of agricultural products – again increasing overall offsite costs.

Additionally, Fukushima has shown that the public will demand a lower standard and more inclusive area to be compensated because of known health effects from radiation and the discovery of hot spots resulting in variation from property to property and resuspension.

_In One Japanese City, Hot Spots to Avoid_, Wall Street Journal, Phred Dvorak, Sept 3, 2011

The new hot spots are devilishly small and scattered: one out of five houses in the neighborhood of Kaki-no-uchi; six households of 10 in Aiyoshi. In some cases, next-door neighbors have received differing recommendations.

In radiation-contaminated Date, Japan, Morio Onami was told his house doesn't qualify for evacuation, even though his son’s home, just a few steps away, does. Date residents complain the measurements aren't reliable, and that the line between who stays and who goes is fuzzy. Families who qualify for evacuation get breaks on property taxes, insurance premiums and medical fees—assistance potentially worth thousands of dollars—fanning jealousy among neighbors who get nothing. And many residents aren’t convinced it is safe to stay behind, particularly when others nearby are moving.

**Background:** As background to supplement lessons learned from Fukushima, the US Department of Homeland Security has commissioned studies for the economic consequences of a Rad/Nuc attack and although much more deposition would occur in reactor accident, magnifying consequences and costs, there are important lessons to be learned from these studies.

Barbara Reichmuth’s study, Economic Consequences of a Rad/Nuc attack: Cleanup Standards Significantly Affect Cost, 2005,[1] Table 1 Summary Unit Costs for D & D (Decontamination and Decommissioning) Building Replacement and Evacuation Costs provides

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estimates for different types of areas from farm or range land to high density urban areas. Reichmuth’s study also points out that the economic consequences of a Rad/Nuc event are highly dependent on cleanup standards. “Cleanup costs generally increase dramatically for standards more stringent than 500 mrem/yr;” however currently a cleanup standard is not agreed upon by NRC and EPA and appears to range from 15 mrem/yr to 5 rem/yr.

Source: Battelle Study-locations range from a small rural community to densely populated NYC)

The General Accounting Office (GAO) reports that the current EPA and NRC cleanup standards differ and these differences have implications for both the pace and ultimate cost of cleanup.² NextEra’s SAMA does not account for this issue.

² GAO, “radiation Standards Scientific Basis Inconclusive, and EPA and NRC Disagreement Continues,” June 2004
A similar study was done by Robert Luna, *Survey of Costs Arising from Potential Radionuclide Scattering Events.*[3] Luna concluded that,

...the expenditures needed to recover from a successful attack using an RDD type device ...are likely to be significant from the standpoint of resources available to local or state governments. Even a device that contaminates an area of a few hundred acres (a square kilometer) to a level that requires modest remediation is likely to produce costs ranging from $10M to $300M or more depending on the intensity of commercialization, population density, and details of land use in the area.” (Luna, Pg., 6)

Therefore a severe accident at Seabrook from lessons learned at Fukushima is likely to result in huge costs; costs not accounted for by NextEra, because of the type and magnitude of radionuclides released in comparison with a RDD type device.

In place of the outdated decontamination cost figure in the MACCS2 code, the SAMA analysis for Seabrook must be redone to incorporate the lessons learned from ongoing actual experience in Japan.

**Again, there is no basis for the Staff's assurance** that they “identified no new and significant information related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS.” (Ibid, 5-3)

c. **Waste Disposal - ignored**

It is evident from Japan’s efforts today to deal with contaminated waste that NextEra and the MACCS2 code ignored the real costs and issues associated with radioactive waste disposal.

*Radioactive soil can fill 23 Tokyo Domes. Five prefectures' nuclear burden a hot potato no one wants to catch,* Setsuko Kamiya, Japan Times, September 29, 2011

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Radioactive soil and vegetation that must be removed in Fukushima and four adjacent prefectures could reach up to 28.79 million cu. meters, equal to filling the Tokyo Dome 23 times, according to a recent Environment Ministry estimate.

But finding a disposal or temporary storage site will be a tall order.

The estimate covers soil and dead leaves mainly from areas with radiation levels of more than 5 millisieverts per year in the prefectures of Fukushima, Miyagi, Yamagata, Tochigi and Ibaraki, whose data were used to mete out the rough figures.

In Fukushima, home of the nuclear plant leaking all the radiation, about 17.5 percent of the prefecture is contaminated to that level.

The estimate was submitted Tuesday to a 12-member expert panel working out decontamination plans. The panel assumed that 5 cm of topsoil should be removed from contaminated areas, including pinpoint decontamination efforts in certain locations with radiation of 1 to 5 millisieverts per year.

The government is hammering out details on plans to remove and store the soil and leaves. But finding a location to temporarily store such a huge amount of radioactive materials will be an extremely sensitive and politically difficult task for the central government.

Breaking down the total, contaminated soil from residential areas was estimated at 1.02 million cu. meters, farm land at 17.43 million cu. meters and forests at 8.76 million cu. meters, the Environment Ministry said.

A single facility capable of housing the entire 28.79 million cu. meters of soil would have to be 1 sq. km in area and 30 meters deep. But if the central government decides on multiple facilities, negotiations would have to be completed with numerous local governments.

The location for a temporary facility is still undecided, but the government is reportedly considering Fukushima Prefecture.

*Contaminated soil can amount to 29 million cubic meters.* Denki Shimbun, Sep. 30, 2011 estimated that the amount of soil contaminated from Fukushima could be as much as 29 million cubic meters (38 million cubic yards). For context, the waste if placed on a football field, including the end zones, would make a pile 6,000 feet high or over a mile.

Reuters in May estimated that the cleanup would take 10-20 years, cost $100 Billion dollars, require 10,000 nuclear cleanup workers, decontamination of a 100,000 square mile area, and produce 100,000 gallons of waste. They made note of the facts that: “Japan doesn’t have robust shipping plans for nuclear waste and will have to develop them as the need comes to
transport and figure out how and where to bury, burn or ship the waste; Japan has no storage capability currently to contain the highly radioactive core and SFP debris.11"

The types of isotopes found offsite in Japan show what can be expected to be found in a severe accident here and represent unique waste disposal challenges. Japan Discovers Plutonium Far From Crippled Reactor, Wall Street Journal, Toko Sekiguchi, Oct 1, 2011 reported that, "TOKYO—Trace amounts of plutonium were found as far as 28 miles from the damaged Fukushima Daiichi nuclear-power plant, the first time that the dangerous element released from the accident was found outside of the immediate area of the plant."

In the meantime absent an acceptable storage facility for the waste, public health and the environment are impacted that will result in increased offsite costs. The same would happen here. Today, neither New Hampshire nor Massachusetts has access to a low-level radioactive waste disposal facility.

*Japan faces costly, unprecedented radiation cleanup,*12 Yoko Kubota, TOKYO, Thu Aug 25, 2011 8:25am EDT

Another major headache is where to store the radioactive waste like dirt and water generated from cleanup work.

Currently, as with Takita's efforts, the waste is stored within the property where the cleanup took place. Some schools have a heap of radioactive dirt in the corner of their playgrounds, covered with plastic sheets, and residents bury sacks of contaminated waste in their yards.

11 *The Enormity Of Decontaminating Japan And Decommissioning Fukushima,* Fukushima Project, Reuters, May 17, 2011 (Hyperlink)

"The issue of disposal zones is the most important for decontamination and unless plans are made, it won't move forward," said Kunihiro Yamada, a professor at Kyoto Seika University who does cleanup work in Fukushima city.

The amount of radioactive waste from decontamination is likely to be tens of millions of tonnes and the government in the long run plans to build an underground disposal facility to store this, though when and where is unclear. (Emphasis added)

NextEra's SAMA application does not specifically mention a waste disposal plan and estimated costs. Section F.3.4.2 says simply: Cost of farm decontamination for the various levels of decontamination ($/hectare) = $1,084 & $3,408; Cost of non-farm decontamination for the various levels of decontamination ($/person) = $5,779 & $15,412; Average cost of decontamination labor ($/person-year) = $67,427. And at F.4.2 Offsite Economic Costs, it says that the process for cleanup and refurbishment or decontamination; but the total estimated cost for each process is not provided. Also, the SEIS fails to provide any information.

**Background:** For context, it is important to understand that the MACCS2 code assumptions were based upon a weapons event. In a weapon's event the waste could be shipped to Utah or to the Nevada Test Site. The Greater-than-Class C waste expected in a reactor accident would not have a repository likely available to receive such a large quantity of material in the foreseeable future. Like in Japan, it would be orphaned.

Also, the costs incurred for safeguarding the wastes and preventing their being re-suspended or seeping through to the groundwater is not accounted for in the model. Even optimistically assuming a repository becoming available, (Utah site is approximately one-square mile and the volume of waste from a severe accident at NextEra, as we have seen from Fukushima would likely require an unimaginably larger facility) it seems unlikely that there would be a sufficient quantity of transport containers and communities not objecting to the hazardous materials going over their roads and through their communities. Fukushima is now
showing that leaving it in piles covered by tarps does not isolate it from the environment—groundwater or air.

Radioactive waste disposal conundrum slowing recovery efforts, Mainichi, Sept 5, 2011

FUKUSHIMA -- The law had not anticipated the radioactive contamination beyond the gates of nuclear power plants, and has left not only Fukushima Prefecture but also municipalities in the Tokyo metropolitan area with radiation-tainted waste that has no place to go.

In Fukushima Prefecture, the need to decontaminate residences and roads has become increasingly urgent, while little headway has been made in securing temporary storage for radiation-tainted mud. And while the central government is hoping to set up interim storage facilities in the prefecture, no concrete timeline has been established. In addition, rubble still litters Japan's northeastern coast.

The Date Municipal Government has plans to decontaminate the entire city, which will involve the removal of mud and grass from gutters and gardens, where radioactive materials tend to accumulate. And while it is searching for waste storage locations in the five towns that existed before they were incorporated into the city, for the time being residents will be asked to keep the tainted materials on their property.

Residents have been instructed by the city to store the waste in thick plastic bags, preventing the contents from seeping into groundwater. But those who use well water in their daily lives are not convinced of the measure's effectiveness.

"We want the decontamination process to take place as soon as possible, and for the young people who have evacuated elsewhere to come back," Kanno said.

Fukushima is the third largest prefecture in the country, with a large area of mountainous terrain. As a result, use of water mains stands at 92.4 percent of the population -- lower than the national average of 97.5 percent -- leaving many residents, like those in Kanioguni, worried about the effects of radioactive waste on their groundwater.

The central government announced on Aug. 26 that "for the time being, it is realistic for cities, towns, villages and communities to set up temporary storage space for tainted waste that is left over from decontamination measures." While the government's nuclear disaster headquarters is aware that local governments are having difficulty securing temporary storage sites, it says, "We have no choice but to ask each municipality to make those decisions."

"The government will likely force interim storage facilities onto the communities close to the nuclear power plant, where the chances of residents being able to return home are slim," one said.

"It will take quite some time before (the government) earns the understanding and cooperation of residents. (Emphasis added)

Slow cleanup efforts and the absence of available interim secured waste disposal will result in recontamination of cleaned-up areas, increasing offsite costs.
Mainichi Japan reported, October 11, 2011, *Residents near Fukushima mountains face nuclear recontamination every rainfall* reported that:

...worries are growing particularly among Fukushima Prefecture residents over drawn-out and in some cases apparently futile nuclear decontamination operations.

The unease is especially strong in areas in and around mountains that must be repeatedly decontaminated, as every rainfall brings a new batch of radioactive substance-contaminated leaves and soil washing down from the hills. *(Seabrook's LRA, 2.10 “The terrain varies from hilly to mountainous except along the coast.”)*

"There's no point in doing just one round of official decontamination," he told the Mainichi. "We residents will get nowhere near anything like peace of mind if decontamination operations can't be done regularly."

According to guidelines in a Ministry of Agriculture, Forestry and Fisheries study released on Sept. 30, removing fallen leaves and other natural forest debris from the area within about 20 meters of residential properties is effective in keeping contamination at bay. However, the guidelines also warn that "conifer needles also accumulate radioactive cesium over time, and can normally be expected to fall after three to four years," signaling a constant and long-term need to keep clearing properties of fallen needles. *(SAMA does not consider)*

Furthermore, the problem of where to put all the contaminated material collected in the cleanups remains a serious headache.

On top of concerns about the sheer volume of contaminated material and manpower, there is also the issue of the important natural roles played by forests, such as collecting water that eventually ends up as well water.

The village plans to decontaminate all the forest under its jurisdiction over the next 20 years, but "the village needs the forests to guarantee its source of fresh water," the decontamination project official said. "Is there no way to do decontamination while at the same time preserving the functions of the forest, without cutting down the trees?" *(Seabrook's LRA, F.4.2 implies 10 years for remediation/cleanup)*

**Burning the contaminated materials**, as we have seen in Japan, simply results in contaminating other areas and does not solve the waste problem due to the huge amount of "orphaned" radioactive ash.

Japan cities face growing radioactive ash, troubles ahead, Kiyoshi Takenaka, Reuters UK, October 17, 2011 reported that:

Although the government aims to bring the Fukushima crisis under control by December, researchers say that problems arising from the radiation, scattered over mountains, rivers and residential areas, are set to persist for years.
Residents say they are worried about their children's health and grandchildren's health. Faced with such pleas, we just cannot make a move," an Ohtawara city official said, explaining why the ash has not been taken to a nearby city dump.

Ohtawara has already cut the frequency of garbage collection by half to hold down the generation of radioactive ash, by-product of burning contaminated leaves and branches. Nonetheless, fresh bags of radioactive ash will have to be left in empty outdoor space at the incineration facility with no proper shelter around them, the official said.

A draft plan by the Environment Ministry calls for the government to take responsibility for disposing of ash and sludge with radiation levels above 8,000 becquerels/kg, but a ministry official said nothing concrete has been decided.

Following hydrogen explosions at the Fukushima plant in March, rainfall has brought radiation down to the earth's surface.

In northern Japan, stored-up radioactive ash and dehydrated sludge from the sewage treatment process alone totalled 52,000 tonnes in mid-September, up 63 percent from levels at the end of July, data from the Transport Ministry showed.

The volume is still growing by about 360 tonnes a day.

The growing piles of radioactive ash are also causing financial headaches for local governments. "I doubt the problem will go away in a year or two. It takes 30 years for caesium 137 to decay by half. Each time it rains, caesium deposited in mountains will be washed down to where people live," Kobe University professor Tomyo Yamauchi said.

In the meantime absent an acceptable storage facility for the waste, public health and the environment are impacted that will result in increased offsite costs. The same would happen here.

Once again, there is no basis for the Staff's assurance that they "identified no new and significant information related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS." (Ibid, 5-3)

d. Decontamination Methods Assumed in Model Ineffective – Costs Will Increase

Young, May 1998. Section 7.5 Decontamination Plan describes some of its cleanup assumptions. It says at 7-10 that,

Many decontamination processes (e.g., plowing, fire hosing) reduce groundshine and resuspension doses by washing surface contamination down into the ground. Since these processes may not move contamination out of the root zone, the WASH-1400 based economic cost model of MACCS2 assumes that farmland decontamination reduces direct exposure doses to farmers without reducing uptake of radioactivity by root systems. Thus decontamination of farmland does not reduce the ingestion doses produced by the consumption of crops that are contaminated by root uptake. (Emphasis added)

The Japanese are using hosing and plowing under fields and demonstrate that this assumed method of cleanup, there and here, is not effective. Hosing and plowing do not remove the contamination; instead, it simply moves it to another place, such as the groundwater, to reappear at a later date and require more monies to either start again or bare the cost of writing off the area permanently.

*True radiation decontamination still a long way away, Mainichi October 7, 2011*

The three main decontamination methods that have been highly publicized through media reports are: the stripping away of surface soil from school playgrounds and athletic fields, the removal of mud accumulated in gutters, and the washing of roofs using high-pressure water cleaners. While the first method is considered effective, the remaining two have been found to be effective only to a certain point, and some especially warn against overestimating the effects of high-pressure water cleaners.

"It might make you feel like you're decontaminating, but there's a limit to the amount of radioactive cesium that's caked onto roofs that can be eliminated with high-pressure water cleaners," says Kunihiro Yamada, a professor of environmental science at Kyoto Seika University. "The water cleaners wash surface dirt off, but then that tainted water goes into sewers and can contaminate rivers, thereby affecting farm goods and seafood. If people in highly populated areas were to begin using water cleaners, we may end up finding people forcing tainted water onto each other."

According to Yamada, ("Radiation Contamination and Recovery Project" with colleagues from Fukushima University and Osaka University) radioactive cesium is believed to exist in three states: dissolved in water, loosely bonded to organic materials such as moss and leaves, or tightly bonded to rock such as silicate salt. In other words, if soil is removed and washed away with high-pressure water cleaners, radioactive cesium found in surface soil and gutters can be eliminated. The cesium that has become affixed to roofs remains, however.

"Apparently the roof had been cleaned using high-pressure water cleaners, but that was as low as the radiation levels got," says Yamauchi. "To bring the roof's radiation levels down, there's probably no other way but to replace the roof. First and foremost, we must aim to bring indoor radiation levels to 0.05 microsieverts, which they were before the disaster unfolded, and thereby creating safety zones."
According to Yamauchi, just like what has happened with roofs, radioactive cesium has become stuck to asphalt on the road, concrete utters and cobblestones, and high-pressure water cleaners can only do so much.

At a lecture held at the Japan National Press Club in Tokyo on Sept. 30, Kodama explained that radiation decontamination referred to isolation of radioactive materials in the environment to await its radioactive decay, and that the "radiation decontamination" that he had thus far conducted at kindergartens and other facilities in the Fukushima Prefecture city of Minamisoma were not enough. "The decontamination I've done is a type of emergency measure to protect children and pregnant women, and not true decontamination." He continued: "Permanent decontamination requires the knowledge and technology of experts and corporations, and a massive amount of funds. It must not become an interest-driven public project."

"What residents want is not half the exposure to radiation." says Yamada. "What they want is for a return to levels that allow them to live with peace of mind. Massive amounts of radioactive materials have been spread across wide areas in the ongoing disaster, so we can't count on the weathering effect. There's also the possibility that radiation will not only spread, but will start to accumulate in large concentrations in certain places. The half life of cesium 137 is approximately 30 years, but that of cesium 134 is 2 years. What the government has said is the equivalent of saying that they won't engage in full-fledged decontamination activities."

With challenges such as the designation of temporary radioactive waste dumps and interim storage facilities yet unsolved, the road to true decontamination remains a long one gage in full-fledged decontamination activities.

**Why did the MACCS2 code, NRC Staff, NextEra and Japanese authorities assume hosing and plowing under fields was cleanup?** Again, there is no basis for the Staff's assurance that they "identified no new and significant information related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS." (Ibid, 5-3)

The MACCS2 economic cost model, is based on WASH-1400; WASH-1400, in turn, was based on clean up after a nuclear explosion. However, cleanup after a nuclear bomb explosion is not comparable to clean up after a nuclear reactor accident and assuming so will underestimate cost. Nuclear explosions result in larger-sized radionuclide particles; reactor accidents release small sized particles. Decontamination is far less effective, or even possible, for small particle sizes. Nuclear reactor releases range in size from a fraction of a micron to a couple of microns; whereas nuclear bomb explosions fallout is much larger- particles that are ten to
hundreds of microns. These small nuclear reactor releases get wedged into small cracks and crevices of buildings making clean up extremely difficult or impossible.

WASH-1400's referenced nuclear weapon clean up experiments involved cleaning up fallout involving large mass loading where the there was a small amount of radioactive material in a large mass of dirt and demolished material. Only the bottom layer will be in contact with the soil and the massive amount of debris can be swept up with brooms or vacuums resulting in a relatively effective, quick and cheap cleanup that would not be the case with a nuclear reactors fine particulate. The Japanese have learned the hard way that it is not possible to get the contaminants out of crevices and off roofs and roads, as those in Chernobyl before had discovered.

Third a weapon explosion results in non-penetrating radiation so that workers only require basic respiration and skin protection. This allows for cleaning up soon after the event. In contrast a reactor release involves gamma radiation and there is no gear to protect workers from gamma radiation. Therefore cleanup cannot be expedited, unless workers health shamefully and unethically is ignored. Decontamination is less effective with the passage of time.

e. **Topography- Areas Unlikely to be Decontaminated- Ignored**

Lessons learned from Fukushima show that forests and shorelines, for example, cannot realistically be cleaned up and decontaminated. The area within 50-miles of Seabrook Station is mountainous, hilly, and encompasses large and small waterways, miles of beaches, wetlands, forests and park land. If properly considered offsite costs will escalate. **Again, there is no basis for the Staff's assurance** that they "identified no new and significant information
related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS.” (Ibid, 5-3)

Forests: Institute probing radioactive contamination of Fukushima forests, Japan Times, Sep. 17, 2011

In August, the government acknowledged difficulties in removing soil and ground cover from the forests, due mostly to the volume of radioactive waste that would be generated by the effort.

"Huge volumes of soil and other (contaminated) items would be involved because the forests occupy a huge area."

The government effectively shelved any approach to decontaminating forests when it said that removing both the contaminated soil and compost materials would strip the forests of important ecological functions, including water retention.

Ocean: Lessons learned from Fukushima shows that it is necessary to understand the ocean currents to determine whether or not the contamination will linger for years contaminating and re-contaminating beaches and marine life increasing costs from a continuous need to cleanup and pay for damages to the environment.13 (Discussed above, page 9)

Urban areas: Fukushima also shows that urban areas will be considerably more expensive and time consuming to decontaminate and clean than rural areas. The LRA clearly shows urban areas within 50-miles likely to be contaminated in a release of long duration.

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13 Fukushima's radioactive sea contamination lingers, Andy Coghlan, New Scientist, Sept 30, 2011; Radioactive cesium may be brought back by Ocean in 20-30 years, Tokyo Times, 09.16.11; Radioactive plankton found near Fukushima plant, Mark Willacy, ABC News, October 15, 2011
5. **Costs Severe Accident Will Be Huge- What Federal Agency will be in Charge and Will Pay?**

No third party (NRC, EPA, or FEMA) has clear authority to cleanup offsite after a severe accident at Seabrook; Cleanup Standards are not determined; and no funding source for cleanup is identified.

On November 10, 2010, Inside EPA released a report (published by Inside Washington, Inside EPA/s Superfund Report), *Agencies Struggle to Craft Offsite Cleanup Plan for Nuclear Power Accidents*, by Douglas Guarino, Associate Editor. The report, along with its supporting FOIAs, is available on line.\(^ {14} \) If there is no federal authority in charge cleanup will take longer and the longer it takes the more expensive the process will be and the less likely cleanup will occur. Also if EPA is in charge state and local governments and the public are required to be allowed to participate in decision-making. This will increase costs. The impact of no agreed upon cleanup standard is discussed above. No funding source for cleanup has obvious implications for the nation’s economy as a whole. None of these issues are addressed by Staff.

Fukushima has the exact same issues and underscores that until these issues are resolved – who is in charge, who pays, and what are the cleanup standards - cleanup will be delayed and result in higher consequences and costs. Consequences and offsite costs are related to time. The following articles make this plain.

Tokyo Electric Power Co. intends to ask the government a sum of 1 trillion yen (US Dollars $13,027,611,657) to help in the immediate compensation of victims of the nuclear disaster in the Fukushima Daiichi power plant.

The amount will cover compensation for mental sufferings of victims as a result of evacuation and to pay for the losses incurred by small businesses following the nuclear disaster.

It is estimated that compensation for victims would cost TEPCO around 4.5 trillion yen in a two-year period. The 1 trillion yen sought from the government would cover the amount of compensation for victims for this fiscal year.

In the article, U.S. ill-equipped to deal with Japan-like nuclear meltdown, Eliot Caroom, Star-Ledger, September 2011 quoting Howard Kunreuther, a Univ Pennsylvania Wharton School Professor, said:

The disaster in Fukushima has laid bare one truth on which experts and officials from the Nuclear Regulatory Commission agree: A disaster here would result in losses requiring the government to make payouts of epic proportions.

That’s because ... the U.S. nuclear insurance fund, established by a 1957 law called the Price-Anderson Act, only has around $12.6 billion in reserve.

"If you have an accident or something like Fukushima, then Price-Anderson can’t handle those kinds of losses," said Wharton School professor Howard Kunreuther, who specializes in public policy.

Even though U.S. plants aren’t threatened by tsunamis like Japan’s, they can still be damaged by hurricanes, terrorist attacks or earthquakes.

The Associated Press reported this month that although the risk of an earthquake causing an accident at a U.S. nuclear plant is small, it’s far greater than previously thought — 24 times as high in one case. Last week, staff at the NRC recommended nuclear power plant owners immediately re-evaluate earthquake and flooding hazards at their plants, following the advice of a task force created after Fukushima.

If a catastrophe did strike and a nuclear accident rose to the level of Fukushima, who would pay the tab? The insurance mandated by the Price-Anderson act has more than $12 billion in it, an amount that has been raised over the years since the law was implemented in 1957.

"If you broke down what the damage was, the cost of Fukushima, business interruption, supply chain problems, my guess is the (United States) government would not step in on any of that," said Kunreuther. "At the end of the day, there may very well be lawsuits or some kind of settlements with respect to what the government would have to do or the utilities would have to do."
Findings:

Potential Authorities and/or Funding Sources for Off-Site Cleanup Following a Nuclear Power Plant Incident

- Price-Anderson Act:
  - ANI does not cover environmental cleanup costs under their primary insurance policy. It is anticipated that the secondary insurance policy will behave in a similar manner.

Again, there is no basis for the Staff's assurance that they "identified no new and significant information related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS." (Ibid, 5-3)

IV. ADDITIONAL DEFICIENCIES IGNORED BY NRC STAFF THAT MINIMIZED OFFSITE COSTS

The SAMA analysis for Seabrook minimized the potential amount of radioactive releases in a potential severe accident at Seabrook Station in additional ways, many underscored by Fukushima. They include the following and were not properly considered in the draft SEIS. Before finalizing the SEIS we respectfully request that Staff consider the following; if the Staff disputes the points raised we ask that a written response is provided that includes the bases for the dispute inclusive of all references and studies for independent verification.
A. Source Term

The source terms used by NextEra to estimate the consequences of severe accidents (radionuclide release fractions generated by the Modular Accident Analysis Progression, MAAP$^{15}$) code, has not been validated by NRC. They are consistently smaller for key radionuclides than the release fractions specified in NUREG-1465 and its recent revision for high-burnup fuel. The source term used results in lower consequences than would be obtained from NUREG-1465 release fractions and release durations.

It has been previously observed that MAAP generates lower release fractions than those derived and used by NRC in studies such as NUREG-1150. A Brookhaven National Laboratory study that independently analyzed the costs and benefits of one SAMA in the license renewal application for the Catawba and McGuire plants noted that the collective dose results reported by the applicant for early failures...

...seemed less by a factor between 3 and 4 than those found for NUREG-1150 early failures for comparable scenarios. The difference in health risk was then traced to differences between [the applicant's definitions of the early failure release classes] and the release classes from NUREG-1150 for comparable scenarios ... the NUREG-1150 release fractions for the important radionuclides are about a factor of 4 higher than the ones used in the Duke PRA. The Duke results were obtained using the Modular Accident Analysis Package (MAAP) code, while the NUREG-1150 results were obtained with the Source Term Code Package [NRC's state-of-the-art methodology for source term analysis at the time of NUREG-1150] and MELCOR. Apparently the differences in the release fractions ... are primarily attributable to the use of the different codes in the two analyses.$^{16}$

Thus the use of source terms generated by MAAP, a proprietary industry code that has not been independently validated by NRC, appears to lead to anomalously low consequences when compared to source terms generated by NRC staff. In fact, NRC has been aware of this

$^{15}$ See, for example, ER. E. F-32, F-45-48
discrepancy for at least two decades. In the draft "Reactor Risk Reference Document" (NUREG-1150, Vol. 1), NRC noted that for the Zion plant (a four-loop PWR), that "comparisons made between the Source Term Code Package results and MAAP results indicated that the MAAP estimates for environmental release fractions were significantly smaller. It is very difficult to determine the precise source of the differences observed, however, without performing controlled comparisons for identical boundary conditions and input data." We are unaware of NRC having performed such comparisons.

The NUREG-1465 source term was also reviewed by an expert panel in 2002, which concluded that it was "generally applicable for high-burnup fuel." This and other insights by the panel on the NUREG-1465 source term are being used by the NRC in "radiological consequence assessments for the ongoing analysis of nuclear power plant vulnerabilities."

In light of this, it is clear that Next Era should not have used a MAAP-generated source terms in its SAMA analysis. It minimized consequences. NRC Staff is silent on this source of minimization and we request a response justifying their apparent approval of NextEra’s choice of the MAAP code that has not been validated by NRC.

**B. Meteorology**

1. **Straight-Line Gaussian Plume Model Used by NextEra is Deficient**

   **Introduction**

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The straight-line Gaussian plume model does not subsume all reasonably possible meteorologic patterns, and is not appropriate for Seabrook’s coastal location. It did not predict site-specific atmospheric dispersion. The MACCS2 code used by NextEra could not model many site-specific conditions and did not determine economic costs for Seabrook’s affected area that includes within its 50-mile radius densely populated areas. Appendix E (2.2) says that, “There are two metropolitan areas within 50 miles of the site; Manchester, New Hampshire (31 miles west-northwest), and Boston, Massachusetts (41 miles south-southwest).”

The Gaussian plume model assumes that a released radioactive plume travels in a steady-state straight-line, i.e., the plume functions much like a beam from a flashlight. The MACCS2 code used by NextEra was based upon this straight-line, steady-state model; it also assumed meteorological conditions that are steady in time and uniform spatially across the study region. However, the assumption of a steady-state, straight-line plume are inappropriate when complex inhomogeneous wind flow patterns happen to be prevailing in the affected region. The meteorological inputs that NextEra’s Gaussian plume model ignored or minimized by use of the mean include the variability of winds, sea breeze effects, the behavior of plumes over water, and re-suspension of contaminants.

Another significant defect in NextEra’s model - its meteorological inputs (e.g., wind speed, wind direction, atmospheric stability and mixing heights) into the MACCS2 are based on data collected by Applicant at a single, on-site anemometer and that the data is from only one year.

2. Deficiencies of NextEra’s Use of a Straight-Line Gaussian Plume Model to Characterize Consequences in Seabrook’s SAMA analysis
NextEra's straight-line, steady-state Gaussian plume model does not allow consideration for the fact that the winds for a given time period may be spatially varying, and it ignores the presence of sea breeze circulations which dramatically alter air flow patterns. Because of these failings the straight-line Gaussian plume model is not appropriate for Seabrook’s coastal location. The nearby presence of the ocean greatly affects atmospheric dispersion processes and is of great importance to estimating the consequences in terms of human lives and health effects of any radioactive releases from the facility, and that the transport, diffusion, and deposition of airborne species emitted along a shoreline can be influenced by mesoscale atmospheric motions. These cannot be adequately simulated using a Gaussian plume model.

3. Sea breeze effect

The sea breeze effect, ignored by NextEra’s model, is a critical feature to consider at Seabrook’s coastal location. The sea breeze circulation is well documented (Slade, 1968, Houghton, 1985, Watts, 1994, Simpson, 1994). ... [T]he presence of a sea breeze circulation changes the wind directions, wind speeds and turbulence intensities both spatially and temporally throughout its entire area of influence. The classic reference Meteorology and Atomic Energy, (Section 2-3.5) (Slade, 1968) succinctly comments on the importance of sea breeze circulations as “The sea breeze is important to diffusion studies at seaside locations because of the associated changes in atmospheric stability, turbulence and transport patterns. Moreover its almost daily occurrence at many seaside locations during the warmer seasons results in significant differences in diffusion climatology over rather short distances. Further “[t]he atmospheric model included in the [MACCS2] code does not model the impact of terrain effects on atmospheric dispersion.” 1997 User Guide for MACCS2.
Regarding sea breeze it is clear that:

- The meteorological data collected at the Seabrook site would not reflect the occurrence of the sea breeze in terms of wind speeds and direction is not necessarily true.

- A measurement at a single station tower will not provide sufficient information to allow one to project how an accidental release of a hazardous material would travel. Measurement data from one station will definitely not suffice to define the sea breeze.

- The sea breeze is not beneficial in dispersing the plume and in decreasing doses. In fact, the development of sea breeze flow that would transfer a release inland is the greatest danger. If the same meteorological conditions (strong solar insolation, low synoptic-scale winds) that are conducive to the formation of sea breezes at a coastal site occurred at a non coastal location, the resulting vertical thermals developing over a pollution source would carry contaminants aloft. In contrast, at a coastal site, the sea breeze would draw contaminants across the land and inland subjecting the population to potentially larger doses.

4. Behavior of Plumes over Water

NextEra’s Gaussian plume model assumed that plumes blowing out to sea would have no impact. A plume over water, rather than being rapidly dispersed, will remain tightly concentrated due to the lack of turbulence. The marine atmospheric boundary layer provides for efficient transport. Because of the relatively cold water, offshore transport occurs in stable layers. Wayne Angevine’s (NOAA) research of the transport of pollutants on New England’s coast concluded that major pollution episodes along the coast are caused by efficient transport of pollutants from distant sources. “The transport is efficient because the stable marine boundary layer allows the polluted air masses or plumes to travel long distances with little dilution or
chemical modification. The sea-breeze or diurnal modulation of the wind, and thermally driven convergence along the coast, modify the transport trajectories.” Therefore a plume will remain concentrated until winds blow it onto land. [Zager et al.; Angevine et al. 2006\textsuperscript{20}]. This can lead to hot spots of radioactivity in places along the coast. An alternative model that NextEra did not use, CALPUFF, could provide the ability to account for reduced turbulence over water and could be used for sensitivity studies.

5. Storms

The storm cycle consists generally of northeasters in the winter and spring and hurricanes sometimes occur in the late summer and fall. The accompanying strong and variable winds would carry a plume to a considerable distance. The storm cycle is projected to increase in frequency and in severity over the license renewal period - note noted by the Staff.

6. Geographical Variations, Terrain Effects, and Distance

The topography of a coastal environment plays an important role in the sea breeze circulation, and can alter the typical flow pattern expected from a typical sea breeze along the coastline. But “[t]he atmospheric model included in the [MACCS2] code does not model the impact of terrain effects on atmospheric dispersion.” [1997 User Guide for MACCS2.]

The Gaussian plume model also does not take terrain effects, which have a highly complex impact on wind field patterns and plume dispersion, into account. Wind blowing inland will experience the frictional effects of the surface which decrease speed and direction. EPA has recognized that “geographical variations can generate local winds and circulations, and modify

\textsuperscript{20} Angevine, Wayne; Tjernström, Michael; Žagar, Mark, Modeling of the Coastal Boundary Layer and Pollutant Transport in New England, Journal of Applied Meteorology and Climatology 2006; 45: 137-154
the prevailing ambient winds and circulations” and that “assumptions of steady-state straight-line transport both in time and space are inappropriate.“ [EPA Guidelines on Air Quality Models (Federal Register Nov. 9, 2005, Section 7.2.8, Inhomogeneous Local Winds, italics added EPA’s November 9, 2005 modeling Guideline (Appendix A to Appendix W) lists EPA’s "preferred model;" the Gaussian plume model used by NextEra (ATMOS) is not on the list. EPA recommends that CALPUFF, a non-straight-line model, be used for dispersion beyond 50 Km.21

The essential difference between the models that EPA recommends for dispersion studies and the two-generation-old Gaussian plume model (ATMOS) used by NextEra and the NRC is more than determining where a plume will likely to go. Major improvements in the simulation of vertical dispersion rates have been made in the EPA models by recognizing the importance of surface conditions on turbulence rates as a function of height above the ground (or ocean) surfaces. We know that turbulence rates and wind speeds vary greatly as a function of height above a surface depending upon whether the surface is rough or smooth (trees versus over water transport) (Roughness), how effectively the surface reflects or absorbs incoming solar radiation (Albedo) and the degree that the surface converts latent energy in moisture into thermal energy (Bowen ratio). These parameters are included in the AERMOD and CALPUFF models and determine the structure of the temperature, wind speed and turbulent mixing rate profiles as a function of height above the ground. NextEra’s ATMOS model does not include these parameters. This is an especially important deficiency when modeling facilities located along coastlines, such as Seabrook.

7. **NextEra’s Inputs to the MACCS2 Code Are Deficient and Did Not Account for Site-Specific Conditions**

   a. **Meteorological Inputs**

   One fundamental defect in NextEra’s use of the MACCS2 code is that its meteorological inputs to that code are all based on the straight-line Gaussian plume model. This model does not allow consideration of the fact that the winds for a given time period may be spatially varying. The 1997 User Guide for MACCS2, SAND 97-0594 makes the point: “The atmospheric model included in the code does not model the impact of terrain effects on atmospheric dispersion.”

   Indeed, the MACCS2 Guidance Report, June 2004, is even clearer that NextEra’s inputs to the code do not account for variations resulting from site-specific conditions such as those present at Seabrook. (1) The “code does not model dispersion close to the source (less than 100 meters from the source);” thereby ignoring resuspension of contamination blowing offsite. (2) The code “should be applied with caution at distances greater than ten to fifteen miles, especially if meteorological conditions are likely to be different from those at the source of release.” There are large potentially affected population concentrations more than 10-15 miles from Seabrook. (See LRA) (3) “Gaussian models are inherently flat-earth models, and perform best over regions where there is minimal variation in terrain.” According to the Seabrook License Renewal Application, “The terrain varies from hilly to mountainous except along the coast.” (ER. F, Section 2-10, pg., 2-70)

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23 MACCS2 Guidance Report June 2004 Final Report page 3-8: 3.2 Phenomenological Regimes of Applicability
A second defect in the Applicant’s inputs into the MACCS2 code lies in the data itself. NextEra input meteorological data for only a single year and the data was collected from a single, on-site weather station.

One year of data would have been insufficient even if more than one station had been used. Seasonal wind distributions can vary greatly from one year to the next. “The NRC staff considers 5 years of hourly observations to be representative of long-term trends at most sites,” although “with sufficient justification [not presented by NextEra here] of its representativeness, the minimum meteorological data set is one complete year (including all four seasons) of hourly observations.” (NRC Regulatory Guide 1.194, 2003)

The simple fact is that measurements from a single onsite anemometer will not provide sufficient information to project how an accidental release of a hazardous material would travel; certainly not for cases when the sea breeze was just developing and for cases when the onshore component winds do not reach entirely from the ground to the anemometer height. The occurrence of a sea breeze would not be identified. The anemometer would likely indicate an offshore wind indication. Further basing wind direction on the single on-site meteorological tower data ignores shifting wind patterns away from the Seabrook Plant including temporary stagnations, re-circulations, and wind flow reversals that produce a different plume trajectory. Since the 1970s, the USNRC has historically documented all the advanced modeling technique concepts and potential need for multiple meteorological towers especially in coastal regions. NRC Regulatory Guide 123 (Safety Guide 23) On Site Meteorological Programs 1972, states that, "at some sites, due to complex flow patterns in non-uniform terrain, additional wind and temperature instrumentation and more comprehensive programs may be necessary.”[Ibid]; and an EPA 2000 report, Meteorological Monitoring Guidance for Regulatory Model Applications,
EPA-454/R-99-005, February 2000, Sec 3.4 points to the need for multiple inland meteorological monitoring sites. See also Raynor, G.S.P. Michael, and S. SethuRaman, 1979, Recommendations for Meteorological Measurement Programs and Atmospheric Diffusion Prediction Methods for Use at Coastal Nuclear Reactor Sites. NUREG/CR-0936.

NextEra should have taken data from more locations over a longer period; and modified the MACCS2 code to account for the inability of the code that NextEra used to account for site-specific conditions. “The user has total control over the results that will be produced.” [1997 User Guide, Section 6.10].

Finally, MACCS2 is not a state-of-the-art computer model. It does not rely upon or utilize current understandings of boundary layer meteorological parameterizations such as those adopted by the EPA in the models AERMOD OR CALPUFF (EPA, 2001). The Gaussian plume model employed in the Seabrook MACCS2 model may be the standard for NRC but it is not the basis for advanced modeling used by other US regulatory agencies. Computational time should not be a major factor in the choice of a dispersion model used for non-real time applications. The idea that randomly chosen meteorological conditions would give the same results as inputting meteorological conditions as a function of time is erroneous. To accommodate the real role of persistence in dispersion modeling EPA requires sequential modeling for all averaging times from 3 hour averages to annual averages. The fact that a model may seem to be conservative in particular applications or in limited data comparisons does not mean that the model is better or should be recommended. Models can be conservative but have incorrect simulations of the underlying physics. Sensitivity studies do not add useful information if the primary model is flawed.
b. The Affected Area

NextEra’s choice of a straight-line Gaussian plume rather than a variable trajectory model drastically reduced, to a wedge, the size of the area that might potentially be impacted by a release. NextEra’s analyses also assumed a “small” accident that had no real impact beyond 10 miles. NextEra did not consider the potential of the by far largest, and perhaps also the most likely, potential radiological release – from the spent fuel pool. In addition, NextEra chose to use the MACCS2 Code that, absent site specific modifications that NextEra chose not to make, cannot provide credible cost estimates.

The use of a variable trajectory model, rather than the straight-line Gaussian plume, would have significantly increased the area potentially affected by a released radioactive plume, and thus would also greatly increase the size of the affected population and property, and the economic effect, beyond 10 miles. For example, NextEra’s MACCS2 analysis does not assume an evacuation zone of greater than 10 miles. A second major defect in the MACCS2 inputs is that NextEra apparently assumed that the only source of radiation in the event of an accident would be from the reactor within the containment. The potentially far greater source of leaked radiation, the spent fuel pool, contains far more radioactive material. It was ignored.

Absent modifications to permit inputs that address the MACCS2 code limitations discussed above, the MACCS2 code used by NextEra is incapable of providing an accurate estimate of economic consequence.

8. NEPA’s Rule of Reason

In another licensing decision, CLI-10-22, pg., 9, the Commission stated that NEPA requirements are “tempered by a practical rule of reason” and an environmental impact statement
is not intended to be a "research document." If relevant or necessary meteorological data or modeling methodology prove to be unavailable, unreliable, inapplicable, or simply not adaptable for evaluating the SAMA analysis cost-benefit conclusions, there may be no way to assess, through mathematical or precise model-to model comparisons, how alternative meteorological models would change the SAMA analysis results."

The plume modeling advocated herein as appropriate for Seabrook’s SAMA analysis, instead of NextEra’s decision to use the straight line Gaussian model, are not techniques that require research. They are, in fact, established methods that are publically available, routinely used, and appropriate for quantifying atmospheric dispersion of contaminants. Although an effort may be required to adapt these methods for SAMA analyses, this would be very straightforward and research would not be required.

Appropriate meteorological data or modeling methodology is available. There is no shortage of appropriate meteorological data for a licensing model application. Alternative modeling methods that would use more extensive meteorological data are also available.

The applicant chose to use only one year of onsite data collected at the Seabrook’s site. Meteorological data is also available from nearby airports and, importantly, processed data on a gridded basis can be obtained from NOAA to augment the onsite meteorological data relied upon for the SAMA analyses that have been provided by NextEra. For example, see Jennifer Thorpe site-specific meteorological study. Also there are several publically available meteorological modeling methods that can simulate variable trajectory transport and dispersion

\[\text{Thorpe, Jennifer E., Eastern Massachusetts Sea Breeze Study, Thesis Submitted to Plymouth State University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Applied Meteorology, May 2009, Appendix A}\]
phenomena. MM5 is one which is routinely used nationally and internationally. There are other options as well. The present state of art of an appropriate meteorological model would use multi station meteorological measurement data as input to the meteorological model. The numerical computations, based upon numerical weather prediction techniques, would compute wind fields appropriate for modeling dispersion over a much larger geographic area than the a single measurement site would be appropriate for.

A second reasonableness criterion is that the modeling method must be reliable. The outputs from such meteorological models that are used to produce inputs for the dispersion models are well accepted and form the basis for the weather predictions provided by the national weather service as well as analyses of air pollution impacts of concern to regulatory agencies. These techniques have been proven to be reliable and acceptable for air quality permitting and policy applications in complex terrain and over large distances for the US EPA, the US Park Service as well as internationally. These techniques would be more reliable than using the straight line Gaussian model.

The third reasonableness criterion is that the modeling methods be applicable to SAMA analyses. The methods recommended herein are applicable because with straightforward modifications to incorporate nuclear radiation decay rates, they can produce the fields of concentration values and deposition rates needed for dosage calculations.

The fourth reasonableness criterion is that the modeling methodology be adaptable for evaluating SAMA analysis cost benefit conclusions. There is nothing inherent in variable trajectory models that would prohibit the output concentration and deposition fields from being applied to SAMA analyses.
None of the criteria cited would make the use of alternative models unreasonable to apply to the Seabrook’s SAMA analyses.

Further there is no basis to the argument that there may be no way to assess through mathematical or precise model to model comparisons, how alternative meteorological models would change the SAMA analysis results. Some assessments may necessarily be qualitative, based simply upon expert opinion. But this argument seems to undercut the very value of mathematical simulation models in general as a method to assess the impacts of nuclear reactor emissions.

Last, the rationale offered that the use of advanced models would be computationally too expensive and/or burdensome to use are not justified by the actual run time shown in our review of MACCS2 output files. With modern computers, the use of inappropriate models on the basis of differences of computational costs is indefensible.

Invoking the “practical rule of reason” to the most appropriate modeling methodology for application to the Seabrook SAMA analyses would be blatantly dismissive of the concept that the present methods are inappropriate and outdated and that there are indeed alternative modeling available.

There is no basis for the Staff’s assurance that they “identified no new and significant information related to the postulated accidents of other available information. Therefore there are no impacts related to postulated accidents beyond those discussed in the GEIS.” (Ibid, 5-3)
C. Averaging

NextEra fails to consider the uncertainties in its consequence calculation resulting from meteorological variations by only using mean values (LRA, Appendix E, 2.10) for population dose and offsite economic cost estimates. The Staff's SEIS analysis is inadequate in that it ignores (fails to justify and analyze the effect of) NextEra's choice of averaging in its SAMA.

Dr. Edwin S. Lyman, Senior Staff Scientist, Union of Concerned Scientists report commissioned by Riverkeeper, Inc., November 2007, A Critique of the Radiological Consequence Assessment Conducted in Support of the Indian Point Severe Accident Mitigation Alternatives Analysis25 provides valuable lessons to apply to Seabrook's SAMA.

The consequence calculation, as carried out by the MACCS2 code, generates a series of results based on random sampling of a year's worth of weather data. The code provides a statistical distribution of the results. We find, based on calculations done at other reactors such as Indian Point, that the ratio of the 95th percentile to the mean of this distribution is typically a factor of 3 to 4 for outcomes such as early fatalities, latent cancer fatalities and off-site economic consequences.

NextEra admits (LRA, F.8.2- Uncertainty) that, ... the inputs to the PRA cannot be known with complete certainty, there is a possibility that the actual plant risk is greater than the mean values used in the evaluation of the SAMA described in the previous sections.”

25 Report available at NRC Electronic Library, Adams Accession Number ML073410093
Kamiar Jamali (Use of risk in measures in design and licensing of future reactors, Reliability Engineering and Safety System 95 (2010) 935-943 www.elsevier.com/locate/ress) makes the same observation. He says that,

It is well-known that quantitative results of PRAs, in particular, are subject to various types of uncertainties. Examples of these uncertainties include probabilistic quantification of single and common cause hardware or software failures, occurrence of certain physical phenomena, human errors of omission or commission, magnitudes of source terms, radionuclide release and transport, atmospheric dispersion, biological effects of radiation, dose calculations, and many others. (935)."

Despite warning, NextEra describes an unconvincing sensitivity analysis (ER, F.8.2-Uncertainty) that they claim resolves the issue. They report, absent any specifics of the study, that “to consider the uncertainty, a sensitivity analysis was performed in which an uncertainty factor was applied to the frequencies calculated by the PRA and in subsequent upper bound (UB) benefits were calculated based upon the mean risk multiplied by the this uncertainty factor. The uncertainty factor applied to the ratio of the 95th percentile value of the CDF from the PRA uncertainty analysis to the mean value of the CDF. For Seabrook Station, the 95th percentile value of the CDF is 2.75 E-05/yr; therefore the uncertainty factor is 1.90.” NextEra’s approach at “proof” is not convincing.

Seabrook’s SAMA cost-benefit evaluation should be based on the 95th percentile of the meteorological distribution to be consistent with the approach taken in the License Renewal GEIS, which refers repeatedly to the 95th percentile of the risk uncertainty distribution as an appropriate “upper confidence bound” in order not to “underestimate potential future
environmental impacts."27

Additional discussion of statistical analysis and its impact in provided above at 13.

Again, there is no basis for the Staff's assurance in the draft SEIS that they “identified no
new and significant information related to the postulated accidents of other available
information. Therefore there are no impacts related to postulated accidents beyond those
discussed in the GEIS” (Ibid, 5-3) because: Staff ignores the impact of NextEra’s averaging
choice, do not provide any justification for doing so, or justification of why the 95% would not
be the appropriate choice, or show the difference using the 95% would make.

D. Economic Costs David Chanin author of the code's FORTRAN said, “If you want to
discuss economic costs ... the ‘cost model’ of MACCS2 is not worth anyone’s time. My sincere
advice is to not waste anyone’s time (and money) in trying to make any sense of it.” (and) “I
have spent many many hours pondering how MACCS2 could be used to calculate economic
costs and concluded it was impossible.”

The ER is required to include “a consideration of alternatives to mitigate severe accidents
(SAMA).” 10 CFR 51.53(c)(30)(ii)(L) That analysis depends upon an accurate calculation of the
cost of a severe accident in order to have a base line against which to measure proposed
mitigation measures. NextEra, instead, severely minimized decontamination and clean-up costs,
health costs (that includes inaccurately modeling evacuation time estimates), and minimized and
ignored a myriad of other economic costs that belong in a SAMA analysis. NRC Staff’s analysis
appears to be unaware of these facts.

1. Decontamination/Cleanup Costs: Discussed in the foregoing at 11-30.

27 U.S. NRC, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” NUREG-1437,
Vol. 1, May 1996, Section 5.3.3.2.1
2. Health Costs:

a. **Value of Life:** Health costs are an important part of economic consequences. NextEra’s “life lost” value is much too low. U.S. agencies other than NRC place a value on human life of between $5 million and $9 million. NRC despite the Office of Management and Budget’s warning that it would be difficult to justify a value below $5 million- has continued to value human life at $3 million since 1995.\(^{28}\) There is no excuse for NRC Staff to allow this valuation for a LR extension 20 years hence. Bringing the valuation in line with other agencies today would have a major effect of justifying mitigations to reduce risk that now are considered too expensive in NextEra’s underestimated SAMA.

b. **The population dose conversion factor** of $2000/person-rem used by NextEra to estimate the cost of the health effects generated by radiation exposure is based on a deeply flawed analysis and seriously underestimates the cost of the health consequences of severe accidents.

NextEra underestimates the population-dose related costs of a severe accident by relying inappropriately on a $2000/person-rem conversion factor. NextEra use of the conversion factor is inappropriate because it (i) does not take into account the significant loss of life associated with early fatalities from acute radiation exposure that could result from some of the severe accident scenarios included in NextEra’s risk analysis; and (ii) underestimates the generation of stochastic health effects by failing to take into account the fact that some members of the public exposed to radiation after a severe accident will receive doses above the threshold level for application of a dose- and dose-rate reduction effectiveness factor (DDREF).

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\(^{28}\) Appelbaum, B. 2011. A life’s value: It may depend on the agency, NYT, Feb 17.
The $2000/person-rem conversion factor is intended to represent the cost associated with the harm caused by radiation exposure with respect to the causation of "stochastic health effects," that is, fatal cancers, nonfatal cancers, and hereditary effects.\(^29\) The value was derived by NRC staff by dividing the Staff's estimate for the value of a statistical life, $3 million (presumably in 1995 dollars, the year the analysis was published) by a risk coefficient for stochastic health effects from low-level radiation of $7 \times 10^{-4}$/person-rem, as recommended in Publication No. 60 of the International Commission on Radiological Protection (ICRP). (This risk coefficient includes nonfatal stochastic health effects in addition to fatal cancers.) But the use of this conversion factor in NextEra's SAMA analysis is inappropriate in two key respects. As a result NextEra underestimates the health-related costs associated with severe accidents.

First, the $2000/person-rem conversion factor is specifically intended to represent only stochastic health effects (e.g. cancer), and not deterministic health effects "including early fatalities which could result from very high doses to particular individuals."\(^30\) However, for some of the severe accident scenarios evaluated by NextEra at Seabrook, we estimate that large numbers of early fatalities could occur representing a significant fraction of the total number of projected fatalities, both early and latent. This is consistent with the findings of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437).\(^31\) Therefore, it is inappropriate to use a conversion factor that does not include deterministic effects.


According to NRC's guidance, "the NRC believes that regulatory issues involving deterministic effects and/or early fatalities would be very rare, and can be addressed on a case-specific basis, as the need arises." Based on our estimate of the potential number of early fatalities resulting from a severe accident at Seabrook Station, this is certainly a case where this need exists.

Second, the $2000/person-rem factor, as derived by NRC, also underestimates the total cost of the latent cancer fatalities that would result from a given population dose because it assumes that all exposed persons receive dose commitments below the threshold at which the dose and dose-rate reduction factor (DDREF) (typically a factor of 2) should be applied. However, for certain severe accident scenarios at Seabrook evaluated by NextEra, we estimate that considerable numbers of people would receive doses high enough so that the DDREF should not be applied. This means, essentially, that for those individuals, a one-rem dose would be worth "more" because it would be more effective at cancer induction than for individuals receiving doses below the threshold. To illustrate, if a group of 1000 people receive doses of 30 rem each over a short period of time (population dose 30,000 person-rem), 30 latent cancer fatalities would be expected, associated with a cost of $90 million, using NRC's estimate of $3 million per statistical life and a cancer risk coefficient of $1 \times 10^{-3}$/person-rem. If a group of 100,000 people received doses of 0.3 rem each (also a population dose of 30,000 person-rem), a DDREF of 2 would be applied, and only 15 latent cancer fatalities would be expected, at a cost of $45 million. Thus a single cost conversion factor, based on a DDREF of 2, is not appropriate when some members of an exposed population receive doses for which a DDREF would not be applied.

33 The default value of the DDREF threshold is 20 rem in the MACCS2 code input
A better way to evaluate the cost equivalent of the health consequences resulting from a severe accident is simply to sum the total number of early fatalities and latent cancer fatalities, as computed by the MACCS2 code, and multiply by a readjusted value of life figure (> $3 million figure). Again, we do not believe it is reasonable to distinguish between the loss of a “statistical” life and the loss of a “deterministic” life when calculating the cost of health effects.

Another way to explain why NextEra’s estimates of how many lives might be lost are too low is to look at the 1982 Sandia National Laboratory report, using 1970 census data, that estimated the number of cancer deaths at Seabrook in a severe accident to be 6,000; early fatalities 7,000; and early injuries 27,000. Peak fatalities were estimated by CRAC to occur within 20 miles of Seabrook; and peak injuries to occur with 65 miles of Seabrook from a core melt. (CRAC 2, Sandia, 1982\textsuperscript{34}) The population of the affected area, no matter what model is used, has greatly increased during the intervening almost 40 years; SAMAs project forward to 2050 based on projected demographics. NextEra estimated the population within 50-miles (2050) to total 5185206. (LRA, Section F.3.4.1, Table F.3.4.1-1) Further CRAC was based on old, and now outdated, dose response models.

In the SAMA, cancer incidence was not considered; neither were the many other potential health effects from exposure in a severe radiological event (National Academy of Sciences, BEIR VII Report, 2005) and risk differentiated for women and children that BEIR VII reported were far more susceptible.

NextEra’s cost-benefit analysis ignored a marked increase in the value of cancer mortality risk per unit of radiation at low doses (2-3 rem average), as shown by recent studies published on

\textsuperscript{34} Calculation of Reactor Accident Consequences, U.S. Nuclear Power Plants (CRAC-2), Sandia National Laboratory, 1982
radiation workers (Cardis et al. 2005) and by the Techa River cohort (Krestina et al. 2005). Both studies give similar values for low dose, protracted exposure, namely (1) cancer death per Sievert (100 rem). According to the results of the study by Cardis et al. and use of the risk numbers derived from the Techa River cohort the SAMA analyses prepared for Seabrook needs to be redone. It seems clear that a number of additional SAMAs that were previously rejected by the applicant’s methodology will now become cost effective.

Cancer incidence and the other many health effects from exposure to radiation in a severe radiological event (National Academy of Sciences, BEIR VII Report, 2005) must be considered; they were not. Neither did NextEra appear to consider indirect costs. Medical expenditures are only one component of the total economic burden of cancer. The indirect costs include losses in time and economic productivity and liability resulting from radiation health related illness and death.

Examination of NextEra’s Emergency Response analysis (LRA, Appendix E, Section F.3.4.4), approved by the SEIS, shows that the Applicant’s evacuation time input data into the code were unrealistically low and unsubstantiated; and that if correct evacuation times and assumptions regarding evacuation had been used, the analysis would show far fewer will evacuate in a timely manner, increasing health-related costs.


NextEra failed to reference specific KLD-type actual time estimates, instead references the “paper plan,” Seabrook Station Radiological Emergency Response Plan, Rev. 56, July 2008. No indication is provided, for example, that the following site-specific variables that would slow response time were taken into consideration in the analysis: shadow evacuation; evacuation time estimates during inclement weather coinciding with high traffic periods such as commuter traffic, peak commute time, holidays, summer beach/holiday traffic; notification delay delays because notification is largely based on sirens that cannot be heard in doors above normal ambient noise with windows closed or air conditioning systems operating.

The Applicant (ER E., F-160) claims that they assumed no evacuation of the population in a seismically induced severe accident and found only a small increase to the overall total accident dose risk and no change in economic risk. We find that sensitivity studies do not add useful information if the primary model is flawed, as we have shown is true. Lessons learned from Fukushima add that the 10 mile EPZ, the distance that evacuation time estimates were measured, is not an adequate distance to assume health effects extend. Panel proposes widening nuclear evacuation perimeter to 30 km (18 miles), Mainichi News, October 20, 2011

3. A myriad of other economic costs were underestimated or totally ignored by the applicant that when added together would in all likelihood add up collectively to a significant amount. The NRC Staff’s analysis in the Draft SEIS appears oblivious to these factors.

For example, NextEra did not appear to include in their economic cost estimates the business value of property and the incurred costs such as costs required from job retraining, unemployment payments, and inevitable litigation. They used an assumed value of non-farm
wealth that appeared not justified by review of Banker and Tradesmen sales figures. NextEra appears to underestimate Farm Value, for example, by not considering the value of the farm property for development purposes as opposed to agricultural; and farm land assessments are intentionally very low to encourage farming and open space.

NextEra also appears to ignore the indirect economic effects or the “multiplier effects” from a delayed and incomplete cleanup. For example, depending on the business done inside the building contaminated, the regional and national economy could be negatively impacted. A resulting decrease in the area’s real estate prices, tourism, and commercial transactions could have long-term negative effects on the region’s economy.

For example since Fukushima some European countries have canceled orders for new nuclear reactors and decided to phase out of nuclear power completely – an indirect economic effect in NextEra’s SAMA not modeled because it is outside the “50-mile area.” Also reports in the Japanese press are replete with food products unsold, outside the 50-mile zone, simply for fear that they may be contaminated and distrust of Government reports. It is causing economic havoc to producers. For example: *Radiation Bankrupts Japanese Cattle Ranch With $5.6 Billion in Liabilities*, Bloomberg, 2001-08-15, reported that “Agura Bokujo, operator of a cattle ranch north of Tokyo, became Japan’s biggest corporate failure this year after consumer fears over beef contaminated with radiation damaged sales, Tokyo Shoko Research said.” Rice market turned upside down by radiation fears, Japan Times, Philip Brasor & Masako Tsubuku October 6, 2011 reported that, “Supposedly, the government checked much of the rice grown in the region when it was immature and decided it was safe, but a lot of people are far from being reassured by such announcements. Consequently, the market for rice has been knocked on its
head. New rice (preferred in Asia) from the Tohoku region, usually flying off shelves at this time of the year, is being avoided, while old rice from last year's stocks are in high demand.”

V. CONCLUSION

A. MACCS2 Code

A fundamental problem with the SAMA missed by NRC Staff is that NextEra used the MELCOR Accident Consequence Code System (MACCS2) computer program. There is no NRC regulation requiring the use of that code, or any other particular code. It was a choice by NextEra and the wrong choice, not appreciated by NRC Staff. The cost formula and assumptions contained in the MACCS2 underestimate the costs likely to be incurred as a result of a severe accident, most of which is explained above, and summarized below.

1. The code is not Quality Assured. The MACCS & MACCS2 codes were developed for research purposes not licensing purposes – for that reason they were not held to the QA requirements of NQA-a (American Society of Mechanical Engineering, QA Program Requirements for Nuclear Facilities, 1994). Rather they were developed using following the less rigorous QA guidelines of ANSI/ANS 10.4. [American Nuclear Standards Institute and American Nuclear Society, Guidelines for the Verification and Validation of Scientific and Engineering Codes for the Nuclear Industry, ANSI/ANS 10.4, La Grange Park, IL (1987).

2. In addition to the meteorological inputs discussed above, important code input parameters include source, average (cumulative distribution function), probability, and a discount rate applied in CHRONC.

37 ER.E E, Attachment F, F.3.4
3. Source is chosen by NextEra and input to ATMOS. ATMOS outputs, based on NextEra's chosen source, are input into both EARLY and CHRONC which determine consequences of an accident from NextEra's chosen source. NextEra chose an unrealistically low source input for the purpose of avoiding having to take mitigation steps that would have to be taken if a realistic source input was used.

4. A discount rate is chosen by NextEra and input to CHRONC, which in determining consequences applies the discount rate to property that must be condemned. A discount makes little sense. Properties appreciate over 20 years, not depreciate.

5. The type of average and probability of an accident are also chosen by NextEra. The Output file "averages" consequences from EARLY and CHRONC and permits the user to "average" using any one of several percentiles, including "mean," 90th percentile, and 95th percentile. NextEra chose mean for the purpose of avoiding having to take mitigation steps that would have to be taken if a higher, i.e., 90th or 95th percentile had been chosen.

6. NextEra failed to consider the uncertainties in its consequence calculation resulting from meteorological variations by only using mean values for population dose and offsite economic cost estimates.

7. In the License Renewal GEIS refers repeatedly to the 95th percentile of the risk uncertainty distribution as an appropriate "upper confidence bound" in order not to "underestimate potential future environmental impacts."39

8. The consequence calculation, as carried out by the MACCS2 code, generates a series of results based on random sampling of a year's worth of weather data. The code provides a statistical distribution of the results. Based on calculations done at other reactors such as

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Indian Point, the ratio of the 95th percentile to the mean of this distribution is typically a factor of 3 to 4 for outcomes such as early fatalities, latent cancer fatalities and off-site economic consequences.  

9. The Output file also multiplies the consequences resulting from NextEra’s chosen consequence percentile by an assumed probability of an accident, which is also chosen by NextEra. NextEra improperly assumed, and chose, an extremely low probability for the purpose of avoiding having to take mitigation steps that would have to be taken if a probability that was realistic and would provide protection to the public had been chosen. The probabilities (CDF) do not stand post-Fukushima.

B. NEPA

As required by NEPA, the NRC Staff should consider the new and significant information arising from the Fukushima accident brought forward and totally reassess Section 5.0.

Respectfully submitted,

(Electronically signed)
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40 Dr. Edwin S. Lyman, Senior Staff Scientist, Union of Concerned Scientists report commissioned by Riverkeeper, Inc., November 2007, A Critique of the Radiological Consequence Assessment Conducted in Support of the Indian Point Severe Accident Mitigation Alternatives Analysis; available at NRC Electronic Library, Adams Accession Number ML073410093, Exhibit 12
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THE EASTERN MASSACHUSETTS SEA BREEZE STUDY

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THESIS

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