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

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

ATTACHMENT 4D-C

NEI 05-01 [Rev A]

Severe Accident Mitigation Alternatives (SAMA) Analysis

Guidance Document

November 2005

7 PHASE II SAMA ANALYSIS

Perform a cost-benefit analysis on each of the remaining SAMA candidates.

The benefit is the difference in the baseline cost of severe accident risk (maximum benefit from Section 4.5) and the cost of severe accident risk with the SAMA implemented (Section 7.1). The cost is the estimated cost to implement the SAMA (Section 7.2). If the estimated cost of implementation exceeds the benefit of implementation, the SAMA is not cost-beneficial.

For multi-unit sites, assure that the benefits and implementation costs are provided on a consistent basis, e.g., all benefit and all cost estimates are on a per-site basis. If benefit and cost estimates are provided on a per-unit basis, the impact (and efficiencies) associated with implementation of the SAMA at multiple units should be reflected in the estimated implementation costs.

7.1 SAMA BENEFIT

7.1.1 SEVERE ACCIDENT RISK WITH SAMA IMPLEMENTED

Perform bounding analyses to determine the change in risk following implementation of SAMA candidates or groups of similar SAMA candidates.

For each analysis case, alter the Level 1 internal events or Level 2 PSA model to conservatively consider implementation of the SAMA candidate(s). Then, calculate the severe accident risk measures using the same procedure used for the baseline case described in Section 3.

For SAMAs specifically related to external events, estimate the approximate benefits through use of the external events PRA, if available, or bounding-type analysis, (e.g., estimating the benefit of completely or partially eliminating the external event risk).

Describe the changes made to the PSA models for each analysis case.

For example,

LBLOCA

This analysis case was used to evaluate the change in plant risk profile that would be achieved if a digital large break LOCA protection system was installed. Although the proposed change would not completely eliminate the potential for a large break LOCA, a bounding benefit was estimated by removing the large break LOCA initiating event. This analysis case was used to model the benefit of SAMA 7.

DCPWR

This analysis case was used to evaluate plant modifications that would increase the availability of Class 1E DC power (e.g., increased battery capacity or the installation of a diesel-powered generator that would effectively increase battery capacity). Although the proposed SAMAs would not completely eliminate the potential failure, a bounding benefit was estimated by removing the battery discharge events and battery failure events. This analysis case was used to model the benefit of SAMAs 4, 5, 10, 12, and 24.

7.1.2 COST OF SEVERE ACCIDENT RISK WITH SAMA IMPLEMENTED

Using the risk measures from Section 7.1.1, calculate severe accident impacts in four areas: off-site exposure cost, off-site economic cost, on-site exposure cost, and on-site economic cost using the same procedure used for the baseline case described in Section 4.

As in Section 4.5, sum the severe accident impacts and combine with the external events multiplier (Section 3.1.2.4) to estimate the total cost of severe accident risk with the SAMA implemented. Use of the external events multiplier is inappropriate for some SAMAs. For example, SAMAs specifically related to external events that would not impact internal events (e.g., enhanced fire detections) and SAMAs related to specific internal event initiators (e.g., guard pipes for main steam line break events). Provide a discussion of SAMAs on which the external events multiplier was not applied.

7.1.3 SAMA BENEFIT

Subtract the total cost of severe accident risk with the SAMA implemented from the baseline cost of severe accident risk (maximum benefit from Section 4.5) to obtain the benefit.

List the estimated benefit for each SAMA candidate.

Table 11 provides a sample portion of a Phase II SAMA candidate list with estimated benefits listed.

7.2 COST OF SAMA IMPLEMENTATION

Perform a cost estimate for each of the Phase II SAMA candidates. Describe the cost estimating process and list the cost estimate for each SAMA candidate.

As SAMA analysis focuses on establishing the economic viability of potential plant enhancement when compared to attainable benefit, often detailed cost estimates are not required to make informed decisions regarding the economic viability of a particular modification. SAMA implementation costs may be clearly in excess of the attainable benefit estimated from a particular analysis case. For less clear cases, engineering judgment may be applied to determine if a more detailed cost estimate is necessary to formulate a conclusion regarding the economic viability of a particular SAMA. Nonetheless, the cost of each SAMA candidate should be conceptually estimated to the point where economic viability of the proposed modification can be adequately gauged.

For hardware modifications, the cost of implementation may be established from existing estimates of similar modifications from previously performed SAMA and SAMDA analyses. Costs associated with implementation of a SAMA including procurement, installation, long-term maintenance, surveillance, calibration, and training should be considered.

Discuss conservatisms in the cost estimates. For example, cost estimates may not include the cost of replacement power during extended outages required to implement the modifications. They also may not include contingency costs associated with unforeseen implementation obstacles. Estimates based on modifications that were implemented or estimated in the past may be presented in terms of dollar values at the time of implementation (or estimation), and not adjusted to present-day dollars. In addition, implementation costs originally developed for SAMDA analyses (i.e., during the design phase of the plant) do not capture the additional costs associated with performing design modifications to existing plants (i.e., reduced efficiency, minimizing dose, disposal of contaminated material, etc.).

Table 11 provides a sample portion of a Phase II SAMA candidate list with cost estimates.

8 SENSITIVITY ANALYSES

Evaluate how changes in SAMA analysis assumptions would affect the cost-benefit analysis. Perform the following sensitivity analyses, as applicable.

Table 12 contains sample sensitivity analysis results.

8.1 PLANT MODIFICATIONS

Major changes to the plant, such as power uprate or steam generator replacement, may be planned or may have occurred since the model freeze date, as described in Section 3.1 and Section 3.2. If the Level 1 or Level 2 PSA model used for the SAMA analysis does not address a major plant change, a sensitivity analysis may be performed to support discussion of the impact of the change on the SAMA analysis results.

In this sensitivity analysis, modify the PSA model (or its results) to simulate incorporation of the plant modification and perform the Phase II analysis with the revised severe accident risk results. Sufficient margin exists in the maximum benefit estimation that the Phase I screening should not have to be repeated in the sensitivity analysis.

Discuss the plant modification and how its effects were simulated in the PSA model. Provide pertinent results and discuss how they affect the conclusions of the SAMA analysis. If SAMAs appear cost-beneficial in the sensitivity results, discussion of conservatisms in the analysis, (e.g., conservatisms in cost estimates discussed in Section 7.2), and their impact on the results may be appropriate.

8.2 UNCERTAINTY

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

Provide pertinent results and discuss how they affect the conclusions of the SAMA analysis. If SAMAs appear cost-beneficial in the sensitivity results, discussion of conservatisms in the analysis, (e.g., conservatisms in cost estimates discussed in Section 7.2), and their impact on the results may be appropriate.

8.3 PEER REVIEW FINDINGS OR OBSERVATIONS

If the model used for the SAMA analysis does not address significant findings or observations from the PSA peer review discussed in Section 3.3, sensitivity analyses may be performed to support discussion of the impact of the findings or observations on the SAMA analysis results.

In these sensitivity analyses, modify the PSA model (or its results) to simulate incorporation of the finding or observation and perform the Phase II analysis with the revised severe accident risk results. Sufficient margin exists in the maximum benefit estimation that the Phase I screening should not have to be repeated in the sensitivity analysis.

Discuss the finding or observation and how its effects were simulated in the PSA model. Provide pertinent results and discuss how they affect the conclusions of the SAMA analysis. If SAMAs appear cost-beneficial in the sensitivity results, discussion of conservatisms in the analysis, (e.g., conservatisms in cost estimates discussed in Section 7.2), and their impact on the results may be appropriate.

8.4 EVACUATION SPEED

Population dose may be significantly affected by radial evacuation speed, and uncertainties may be introduced during derivation of a single evacuation speed from emergency plan information, as discussed in Section 3.4.4. Therefore, perform sensitivity analyses to show that variations in this parameter would not impact the results of the analysis.

This sensitivity analysis should modify the evacuation speed assumed in the Level 3 PSA model and recalculate the baseline severe accident risk results. Multiple speeds may be evaluated as necessary.

Discuss uncertainty in the evacuation speed and how the modified speed was selected. Provide pertinent results and discuss how they affect the conclusions of the SAMA analysis.

8.5 REAL DISCOUNT RATE

Calculation of severe accident impacts also involves a real discount rate, r, which is typically assumed to be 7% (0.07/year) as recommended in NUREG/BR-0184. A value of 7% is conservative because cost estimates are usually performed by utilities using values between 11 and 15%. Use of both a 7% and 3% real discount rate in regulatory analysis is specified in Office of Management Budget (OMB) guidance (Reference 5) and in NUREG/BR-0058 (Reference 6). The two discount rates represent the difference in whether a decision to undertake a project requiring investment is viewed as displacing either private investment or private consumption. A rate of 7% should be used as a baseline for regulatory analyses and represents an estimate of the average before-tax rate of return on an average investment in the private sector in recent years. A rate of 3% should also be used and represents an estimate of the "consumption rate of interest," i.e., the real, after-tax rate of return on widely available savings instruments or investment opportunities. To address this concern, perform a sensitivity analysis using a 3% real discount rate.

In this sensitivity analysis, modify the real discount rate in the Level 3 PSA model and perform the Phase II analysis with the revised severe accident risk results. Sufficient margin exists in the maximum benefit estimation that the Phase I screening should not have to be repeated in the sensitivity analysis.

Provide pertinent results and discuss how they affect the conclusions of the SAMA analysis. If SAMAs appear cost-beneficial in the sensitivity results, discussion of conservatisms in the analysis, (e.g., conservatisms in cost estimates discussed in Section 7.2), and their impact on the results may be appropriate.

8.6 ANALYSIS PERIOD

As described in Section 4, calculation of severe accident impacts involves an analysis period term, t_f, which can be defined as either the period of extended operation (20 years), or the years remaining until the end of facility life (from the time of the SAMA analysis to the end of the period of extended operation) (25 years or more).

The value that is typically used for this term is the period of extended operation (20 years). However, NRC has asked several plants to perform a sensitivity analysis using the period from the time of the SAMA analysis to the end of the period of extended operation to determine if SAMAs are potentially cost-beneficial if performed immediately. This sensitivity analysis should be performed to provide the information wanted by the regulator.

In this sensitivity analysis, modify the analysis period in the calculation of severe accident risk and perform the Phase II analysis with the revised analysis period. The cost of additional years of maintenance, surveillance, calibrations, and training should be included in the cost estimates for SAMAs in this Phase II analysis. Sufficient margin exists in the maximum benefit estimation that the Phase I screening should not have to be repeated in the sensitivity analysis.

Provide pertinent results and discuss how they affect the conclusions of the SAMA analysis. If SAMAs appear cost-beneficial in the sensitivity results, discussion of conservatisms in the analysis, (e.g., conservatisms in cost estimates discussed in Section 7.2), and their impact on the results may be appropriate.

9 CONCLUSIONS

Discuss SAMAs that are cost-beneficial after the Phase II and sensitivity analyses. It may also be useful to discuss the combination of selected SAMAs and their impact on the overall plant risk. In some instances, addressing certain SAMAs may reduce the importance of the remaining candidates.

This analysis may not estimate all of the benefits or all of the costs of a SAMA. For instance, it may not consider increases or decreases in maintenance or operation costs following SAMA implementation. Also, it may not consider the possible adverse consequences of procedure changes, such as additional personnel dose. Since the SAMA analysis is not a complete engineering project cost-benefit analysis, the SAMAs that are cost-beneficial after the Phase II analysis and sensitivity analyses are only **potentially** cost-beneficial.

11 REFERENCES

1 Pages G-8 and G-28 of Draft NUREG-1437, Supplement 19, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Arkansas Nuclear One, Unit 2*, August 2004.

2 NUREG/CR-6613, Vol. 1, *Code Manual for MACCS2, User's Guide,* D. Chanin and M.L. Young, Technadyne Engineering Consultants and Sandia National Laboratories for U. S. Nuclear Regulatory Commission and U. S. Department of Energy, SAND97-0594, May 1998.

3 NUREG/CR-4551, *Evaluation of Severe Accident Risks: Quantification of Major Input Parameters, MACCS Input,* J. L. Sprung, et. al., Sandia National Laboratories for the U. S. NRC, Vol. 2, Rev. 1, Part 7, December 1990.

4 NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook,* U. S. Nuclear Regulatory Commission, 1997.

5 Office of Management and Budget, "Regulatory Analysis," Circular No. A-4, September 17, 2003. http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf

6 NUREG/BR-0058, Revision 4, *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,* September 2004.