

July 12, 2005

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SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION (NRC) COMMENTS ON  
NUCLEAR ENERGY INSTITUTE (NEI) 05-01, "SEVERE ACCIDENT  
MITIGATION ALTERNATIVES (SAMA) ANALYSIS GUIDANCE DOCUMENT"  
(REVISION A)

Dear Messrs. Marion and Lochbaum:

By letter dated April 8, 2005, the NEI submitted for review, NEI 05-01, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document," Revision A, March 2005. The NRC staff has completed its review of the subject document. Staff comments are provided in the enclosure. The focus of the staff's review was on identifying areas where further guidance could improve the quality of licensee SAMA submittals and reduce the need to issue requests for additional information (RAIs). In preparing these comments, we considered insights from the SAMA reviews completed to date, as well the degree to which topics raised in recent RAIs have been addressed within the guidance document.

A meeting is scheduled for July 21, 2005, between the NRC and NEI to discuss generic license renewal topics. This meeting provides an opportunity for a general discussion of the comments and the schedule for NEI's submittal of a revision to NEI 05-01 addressing the comments. If a more detailed discussion of the comments is needed, a separate meeting will be arranged.

If you have any questions regarding this matter, please contact Mr. Richard Emch, at 301-415-1590 or e-mail [RLE@nrc.gov](mailto:RLE@nrc.gov).

Sincerely,

*/RA/*

Pao-Tsin Kuo, Program Director  
License Renewal and Environmental Impacts Program  
Division of Regulatory Improvement Programs  
Office of Nuclear Reactor Regulation

Project No. 690

Enclosure: As stated

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**NRC Comments on NEI 05-01 (Revision A)  
Severe Accident Mitigation Alternatives (SAMA) Analysis  
Guidance Document**

1. Page 1, Section 1 (also Page 16, Section 4, 1<sup>st</sup> paragraph) - Correct the cited NUREG to read NUREG/BR-0184. Suggest adding a reference to NUREG/BR-0058, Revision 4, which contains guidance on discount rates that should be used in a cost-benefit analysis.
2. Page 1, Section 1 - Clarify whether the method also incorporates insights gained from review of NRC SAMA evaluations.
3. Page 1, Section 1.1 (also Page 24, Section 5) - Add a discussion of the scope of SAMAs to be considered, i.e., SAMAs that improve core damage prevention or containment performance, hardware changes, procedure changes, and enhancements to licensee programs, including training and surveillance programs.
4. Page 2, Section 2, SAMA Identification - Add a statement that importance analyses should be used to identify both SAMAs that prevent core damage and SAMAs that prevent significant releases from containment.
5. Page 2, Section 2, Final Screening - Suggest better wording for “reduction in cost of severe accident risk.”
6. Page 3, Section 2, Sensitivity Analysis - Add “and analysis uncertainties” after “assumptions.”
7. Page 4, Section 3 - Add the following to the list of items to be provided: (1) describe the evolution of the plant-specific risk model subsequent to the individual plant examination (IPE) and individual plant examination of external events (IPEEE), and subsequent to any peer reviews, and (2) for multi-unit sites, provide either separate results for each unit or results for a single unit with rationale for why the single analysis is representative or bounding for the other unit(s).
8. Page 4, Section 3.1.1.1 (also Page 11, Section 3.2.1) - Section title and discussion assume that the “current” probabilistic safety assessment (PSA) model is the same version as used for the SAMA analysis. This may not always be the case, e.g., if the PSA was revised subsequent to completion of the SAMA analysis. Also, different PSA versions might be used for identifying SAMAs (importance analysis) and for quantifying the risk reductions for the SAMAs. The section should be revised to focus on the version(s) of the PSA used to support the SAMA analysis. If applicable, a description should be provided of any PSA versions more recent than the version used for the SAMA analysis and how use of the later version would impact the risk profile, and the identification and dispositioning of SAMAs. If different PSA versions are used for different portions of the SAMA analysis, e.g., for identifying SAMAs and for quantifying risk reductions, the impact of using the later version should be similarly described.
9. Page 4, Section 3.1.1.1 - Specify that the contribution to core damage frequency (CDF) from station blackout (single unit and dual unit) and anticipated transient without scram events be included since these events are typically of interest for SAMA.

10. Page 4, Section 3.1.1.1 - Rather than specifying that only “internal events importance measures” be provided, suggest less restrictive wording, such as “importance measures for internal events, and external events if included within the PSA model.”
11. Page 4, Section 3.1.1.2 - Add a statement that PSA revisions/model changes since the PSA peer review should be included within the discussion of the PSA evolution.
12. Page 5, Section 3.1.2, 2<sup>nd</sup> paragraph - The statement that “quantified external events should not be compared directly with the results of the best-estimate internal events analysis” is unrealistic and fails to recognize that such comparisons will be made by the public and are in fact made in the SAMA methodology itself when deriving an external events multiplier.
13. Page 5, Section 3.1.2, last paragraph, 3<sup>rd</sup> sentence - Add “and outliers that have not been addressed” after “implemented.”
14. Page 7, Section 3.1.2.1.1, last sentence - Add a statement that further enhancements to address dominant contributors should also be considered, and if potentially cost-beneficial, included in the list of Phase I SAMA candidates.
15. Page 7, Section 3.1.2.2.1, Recommended Improvements - Specify that a discussion be included on A-46 resolution and whether all identified outliers have been addressed. Modify the last sentence to read “Unresolved outliers and potential improvements ...”
16. Page 8, Section 3.1.2.4, Fire-Induced Vulnerability Evaluation (FIVE) and seismic margins analysis (SMA) Methods - Add a statement that although the SMA method does not provide a quantitative CDF, an approximate estimate of the seismic CDF could be developed by other means, e.g., based on high confidence in low probability of failure (HCLPF) values for limiting systems, structures and components in conjunction with site-specific seismic hazard curves.
17. Page 8, Section 3.1.2.4, FIVE and SMA Methods (also Page 9, Fire PSA and SMA Method) - The statement that “... the FIVE results may be considered representative of total events risk” is site-specific and not generally applicable. The contribution to risk from seismic events (and the potential for seismic-related SAMAs) would need to be considered unless the contribution is estimated to be much lower than internal events, and all seismic outliers have been addressed.
18. Page 9, Section 3.1.2.4, Fire PSA and SMA Method (also Page 9, FIVE Method and Seismic PSA, and Page 10, Fire PSA and Seismic PSA) - The document states that if the PSA analysis contains numerous conservatisms, a more realistic assessment could result in a substantially lower CDF, and that engineering judgement should be used to determine a reduction factor to obtain a more realistic fire (and seismic) CDF. In concept, fire and seismic PSAs will have removed many of the conservatisms existing in margins-type analyses, such as FIVE. Hence, in general, the CDF from the PSAs should not be further adjusted, especially based on only engineering judgement. Factor of four changes to PSA-based CDF estimates (as implied on Page 10) would be difficult

- to defend. If changes of this magnitude are believed to exist, the external event analysis should be formally updated to incorporate the more realistic models/assumptions.
19. Page 9, Section 3.1.2.4, FIVE Method and Seismic PSA - The statement that NRC has accepted that a more realistic fire CDF may be a factor of three less than the screening value obtained from a FIVE analysis, should be appended with the statement “if sufficient technical justification is provided to show that certain aspects of the analysis have been addressed in a conservative fashion.”
  20. Page 11, Section 3.2.1 - Add the following to the list of items to be provided: (1) a table or matrix describing the mapping of Level 1 accident sequences into Level 2 release categories, (2) a description of how the sequences selected to represent each release category were chosen, and (3) a description of any Level 2 PSA versions more recent than the version used for the SAMA analysis, and how the use of the later version would impact the risk profile, and the identification and dispositioning of SAMAs.
  21. Page 11, Section 3.2.1 - Specify that “fission product release characteristics (release fractions, timing, and energy)” be provided, rather than “fission product release fractions (source terms).”
  22. Page 11, Section 3.2.1 - Clarify that the Level 2 importance measures to be provided should not be based on consideration of only large early release frequency contributors, but should include the consideration of other release categories that are major contributors to population dose, such as medium magnitude-early releases, and large magnitude-late releases.
  23. Page 11, Section 3.2.2 - Add the following to the list of items to be provided: Clarify whether accident progression/source term calculations were updated since the IPE.
  24. Page 11, Section 3.2.2 - Add a statement that PSA revisions/model changes since the PSA peer review should be included within the discussion of the PSA evolution.
  25. Page 12, Section 3.3, last paragraph - Insert the words “at least” before “a qualitative discussion.”
  26. Page 12, Section 3.3 - Add the following to the list of items to be provided: (1) provide a quantitative assessment of the impacts of any unresolved, significant peer review findings if the impacts are able to be readily quantified, e.g., if the probabilistic risk assessment (PRA) version used for the SAMA analysis was subsequently updated to address the peer review finding, and (2) identify the types of sequences for which the CDF or release frequency could be increased by resolution of the peer review finding, and the candidate SAMAs related to those sequences. Discuss whether resolution of the finding could result in identification or retention of additional SAMAs.
  27. Page 13, Section 3.4.1 - The statement that extrapolation to a later date adds conservatism to the analysis is true in general, however, at some sites a population reduction is actually projected, in which case extrapolation to an earlier date (e.g., the mid-point of the extended period of operation) would be more reasonable.

28. Page 14, Section 3.4.2 - Rather than “Provide the following economic estimates,” suggest “Describe the values and bases for the following economic estimates.”
29. Page 14, Section 3.4.3 - Add a discussion to the effect: “However, consideration should be given to the applicability of the MELCOR Accident Consequence Code System 2 (MACCS2) data. MACCS2 inventories are based on a 3-year fuel cycle (12-month reload) with an average power density for the assembly groups ranging from 24 to 30 MW/MTU. Current fuel management practices may use longer fuel cycles and result in significantly higher burnups. As such, use of the MACCS2 data (scaled by the ratio of power level) could substantially underestimate the inventory of long-lived radio nuclides, and the benefits of certain SAMAs. Use of a plant-specific core inventory representative of that expected during the period of extended operation is recommended. If power scaling is used, the impact of potentially higher radio nuclide inventories on the SAMA identification and screening should be addressed.”
30. Page 14, Section 3.4.4 - Replace “site-specific emergency evacuation plan” with “site-specific emergency action levels and emergency evacuation plan, and onsite-specific evacuation time estimates, where available.”
31. Page 14, Section 3.4.4 - Replace “conservative” with “reasonable.”
32. Page 15, Section 3.4.4 - Suggest identifying the specific table in Reference 3 to which this discussion is referring (Table 3.28?).
33. Page 15, Section 3.4.5 - The example discussion is adequate as a general explanation, but does not indicate why data for a specific year might have been selected as representative. Expand the example to include such rationale, e.g., “Population doses were evaluated based on three different years (1999, 2000, and 2001). Data from year 2001 was selected because ...”
34. Page 15, Section 3.5 - Add the following to the list of items to be provided: (1) provide a breakdown of the annual population dose risk (person-rem per year) by containment release mode, and (2) report results for all release categories, including those with normal containment leakage/intact containment. Add a note that the sum of release frequencies should equal the total CDF, and that any differences should be explained.
35. Page 16, Section 4, 2<sup>nd</sup>, and 3<sup>rd</sup> paragraphs (also Page 32, Section 8.6) - A sensitivity analysis (or baseline analysis) using the period from the time of the SAMA analysis to the end of the period of extended operation is unnecessary. The impacts of the longer time period would also be bounded by the 3% discount rate case.
36. Page 16, Section 4, 4<sup>th</sup> paragraph (also Page 31, Section 8.5, 1<sup>st</sup> paragraph) - The discussion on calculations using alternative discount rates misses an important point. Use of both 7% and 3% real discount rates in regulatory analyses is specified in Office of Management Budget guidance (Circular A-4, September 17, 2003) and NUREG/BR-0058, Revision 4. The two discount rates represent the differences 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. An analysis using a 5% discount rate will not meet the intent of the latter calculation.

37. Page 23, Section 4.5, last paragraph - Rather than using a maximum attainable benefit (MAB) that does not account for uncertainties for the initial Phase I screening, and re-screening later using a “modified MAB” that includes uncertainties, should present the option of performing the initial screening using the modified MAB.
38. Page 24, Section 5 - Clarify that hardware changes considered should not be limited to permanent changes involving addition of new, safety-grade equipment, but should also include lower cost alternatives, such as temporary connections using commercial grade equipment (e.g., portable generators and temporary cross-ties).
39. Page 24, Section 5, 1<sup>st</sup> sentence - Replace “contributors to CDF” with “contributors to CDF and population dose based on the plant-specific risk assessment.” Insert the following words at the end of the sentence: “and the SAMAs found to be potentially cost beneficial in the SAMA analyses for similar plants.”
40. Page 24, Section 5.1, 1<sup>st</sup> paragraph - Add a statement that contributors to both CDF and population-dose should be considered.
41. Page 24, Section 5.1, 2<sup>nd</sup>, and 3<sup>rd</sup> paragraphs - Add a statement that the rationale for the cutoff values should be provided.
42. Page 25, Section 5.3 - Clarify this statement to indicate that potential improvements and/or outliers from the IPEEE should be identified, and their implementation status should be discussed. Those improvements/outliers that have not been implemented or resolved should be included in the list of Phase I SAMA candidates.
43. Page 25, Section 5.3 - Add the following guidance: “In addition to any potential improvements specifically identified in the IPEEE, the dominant contributors to external event CDF and release frequency should be systematically assessed to determine whether any additional improvements might be justified, e.g., improvements to fire detection or suppression, equipment separation, or heat shielding in dominant fire areas; improvements to the seismic capacity of components with limiting HCLPF values; improvements to flood barriers/doors. (This might also be addressed in Sections 3.1.2.1.1 and 3.1.2.2.1.)
44. Page 25, Section 5.4 - Add a statement that SAMAs that were found to be potentially cost beneficial in SAMA analyses for similar plants should also be included in the list of Phase I SAMAs.
45. Page 26, Section 6, Bullet 4 - Add the following guidance: “In screening SAMAs based on excessive implementation costs, consideration should be given to whether low cost alternatives (e.g., use of portable rather than permanently installed equipment, or

procedure and training enhancements rather than hardware changes) could offer much of the potential risk reduction at a fraction of the cost.”

46. Page 26, Section 6, last paragraph - Add the following guidance: “Provide a description of the screening process and its results, in sufficient detail that a reader can understand how the initial set of Phase I SAMAs was reduced to the more limited set of Phase II SAMAs, e.g., an accounting of the SAMAs eliminated by each criterion.”
47. Page 27, Section 7 - Add the following guidance: “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.”
48. Page 27, Section 7.1.1 - Add the following guidance: “For SAMAs specifically related to external events, estimate the approximate benefits through use of: (1) the external events PRA, if available, or (2) bounding-type analysis, e.g., estimating the benefit of completely or partially eliminating the external event risk.”
49. Page 28, Section 7.1.2 - Add the following to the list of items to be provided: (1) discuss when external event multipliers might not apply, for example, SAMAs that relate to specific internal event initiators (e.g., guard pipes for main streamline break events), and external event SAMAs that would not impact internal events (e.g., enhanced fire detection), and (2) discuss when larger multipliers might be appropriate.
50. Page 30, Section 8 - Consider adding a subsection addressing the impact of PRA modifications subsequent to the SAMA analysis. The guidance would indicate that if the PRA has been modified subsequent to the SAMA analysis, the impact of the changes on the identification and dispositioning of candidate SAMAs should be addressed.
51. Page 30, Section 8.1, 2<sup>nd</sup> paragraph (also Page 31, Section 8.3, 2<sup>nd</sup> paragraph; Page 31, Section 8.5, 2<sup>nd</sup> paragraph; and Page 32, Section 8.6, 3<sup>rd</sup> paragraph) - Add the words “Assure that” before the words “Sufficient margin.”
52. Page 30, Section 8.2, 1<sup>st</sup> paragraph - The discussion places too much emphasis on the ratio of the 95<sup>th</sup> percentile to the mean CDF value, and not enough emphasis on the objective of the uncertainty assessment, i.e., whether/how the results of the SAMA identification and screening might be impacted by uncertainties in various aspects of the analysis. The rationale for performing this assessment should be further explained. The statement that “a discussion of CDF uncertainty and conservatism in the SAMA analysis that offset uncertainty should be included” is important and might also be expanded.
53. Page 31, Section 8.4, 1<sup>st</sup> paragraph - The statement that population dose is highly dependent on radial evacuation speed should be reconsidered. Evacuation-related sensitivity calculations provided in previous SAMA analyses show only a minor impact. Note that, although evacuation-related sensitivity calculations typically don’t show much impact on results, they may be important for sites with emergency preparedness issues or concerns.

54. Page 31, Section 8.4, 1<sup>st</sup> paragraph - Rather than using the sensitivity analysis to show that the evacuation speed is conservative, it might be used to show that variations in this parameter would not impact the results of the analysis.
55. Page 32, Section 8.6, 2<sup>nd</sup> paragraph - If this section is retained, the discussion regarding plant obligations and commitments should be removed (2<sup>nd</sup> through 4<sup>th</sup> sentences).
56. Page 33, Section 9 - Add the following guidance: (1) In instances where multiple SAMAs appear to be potentially cost beneficial, consider further analyses to identify an optimum subset of these SAMAs, i.e., that provides a majority of the risk reduction with a minimum impact/cost. Such an analysis could lead to a “recommended” set of SAMAs that can be further evaluated for implementation by the licensee as part of its normal corrective actions programs; and (2) Include a discussion of licensee plans for implementation or further evaluation of potentially cost-beneficial SAMAs.
57. Page 38, Table 5 - The sample MACCS2 economic costs provided in the table represent an increase of approximately 60% over the corresponding values used in Sample Problem A of NUREG/CR-6613, Volume 1, Appendix C (1998). In the most recent NRC-sponsored MACCS2 calculations, these economic costs have been increased even further (by a factor of 1.4 to 3.2 over the values in Sample Problem A). Further discussion is needed on the appropriate economic cost values to be used in the MACCS2 calculations.
58. Page 40, Table 8 - Results should be reported for all release categories, including intact containment, in order to provide a complete accounting of all core damage events/frequency. In the case of this example, the results for release category E-E should also be reported.
59. Page 41, Table 9 - To be more representative, the first column of this table should list basic events from either CDF or population-dose importance calculations.
60. Page 41, Table 9 - All relevant Phase I SAMAs should be identified in the third column, whether they were implemented or not. If the Phase I SAMA survived the screening, the corresponding Phase II SAMA number should also be listed.
61. Page 42, Table 10 - It would be helpful to illustrate (within the sample list) some low cost alternatives to major plant modifications, e.g., “Add a portable generator ...” Also, suggest adding “Phase I” to the heading of column 1.
62. Page 43, Table 11 - Suggest adding “Phase II” to the heading of column 1, and numbering the SAMAs in this table so that they don’t conflict with the SAMA numbers in Table 10.
63. Page 45, Table 13 and Page 57, Table 14 - The boiling-water reactor table is titled “Sample List” and the pressurized-water reactor table is titled “Standard List.” Suggest using consistent wording.

64. Page 70, Figure 1 - The screening criteria depicted in the figure do not completely match the screening criteria described on Page 26. The figure and text should be made consistent.

NUCLEAR ENERGY INSTITUTE

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