June 1, 2006

Mr. Michael Kansler
President
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR THE VERMONT YANKEE NUCLEAR POWER STATION (TAC NO. MC9670)

Dear Mr. Kansler:

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the Severe Accident Mitigation Alternatives (SAMA) analysis submitted by Entergy Nuclear Operations, Inc. (Entergy), in support of its application for license renewal for the Vermont Yankee Nuclear Power Station (VYNPS), and has identified areas where additional information is needed to complete its review. Enclosed is the NRC staff's request for additional information (RAI).

We request that you provide your responses to these questions within 60 days of the date of this letter, in order to support the license renewal review schedule. If you have any questions, please contact me at 301-415-4049 or via e-mail at RLE@nrc.gov.

Sincerely,

/RA/

Richard L. Emch Jr., Senior Project Manager
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-271

Enclosure:
As stated

cc w/encl: See next page

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Request for Additional Information
Regarding the Analysis of Severe Accident Mitigation Alternatives (SAMAs)
for the Vermont Yankee Nuclear Power Station (VYNPS)

1. The SAMA analysis is said to be based on the most recent version of the VYNPS Probabilistic Safety Analysis (PSA) (VY04R1). Provide the following information regarding these PSA models:

   a. Table E.1-8 indicates that the core damage frequency (CDF) associated with station blackout sequences (Classes IBE and IBL) is 1.2E-06 per year. This is considerably more than the CDF due to loss of offsite power (LOOP) (7.2E-7 per year in Table E.1-2) and is comparable to the total CDF due to LOOP and loss of alternating current (ac) bus initiating events. Provide the station blackout (SBO) CDF frequency along with its derivation.

   b. The VYNPS extended power uprate (EPU) application and response to EPU requests for additional information indicate that the VY02R6 model had a CDF of 7.77E-06 per year and that this increased to 8.1E-06 for EPU conditions. This is different from the current value of 5E-06. Provide a summary of the major Levels 1 and 2 PSA versions and their CDFs from the individual plant examination (IPE) to the present, including the version reviewed by the Boiling Water Reactors Owners Group (BWROG). Also, indicate the major changes to each version from the prior version and the major reasons for changes in the CDF.

   c. Discuss the overall conclusion of the BWROG peer review relative to the use of the VYNPS PSA.

   d. Internal flooding initiating events are the dominant contributors to CDF at VYNPS. Briefly describe the internal flooding analysis and its evolution, including internal and external peer reviews, the results of these reviews, and any subsequent model updates. It is noted that the BWROG A and B facts and observations did not include internal flooding. Clarify whether the internal flooding analysis was covered in the BWROG peer review.

2. Provide the following information relative to the Level 2 Analysis:

   a. Section E.1.2.2.5 implies that the binning of Level 1 results into plant damage states (PDSs) is the principal means of ensuring the proper Level 1 to Level 2 interface. Section 4.3 of the IPE states that binning is only used to summarize and report the results. Clarify the use of PDSs, including whether the containment event tree is directly linked to the Level 1 models (such that Level 1 failures are recognized by the Level 2 analysis).

   b. Provide the fission product release characteristics for each release category, including fission product release fractions, release times and duration, warning time, release elevation, and energy of release.

c. Briefly describe the approach used to determine the source terms for each release category. Clarify whether new modular accident analysis program (MAAP) analyses were performed as part of the development of the current model and how the MAAP cases were selected to represent each release category (i.e., based on the frequency-dominant sequence in each category or on a conservative, bounding sequence).

d. Clarify whether the Level 2 model was included in the BWROG peer review. If so, describe the conclusion relative to this element. If not, describe the internal and external reviews of the Level 2 analysis that have been performed, the results of these reviews, and any subsequent model updates.

e. Approximately 75 percent of the CDF results in an "early" release. Explain this relatively high percentage and describe the containment failures/release modes that lead to these releases.

3. With regard to the treatment and inclusion of external events in the SAMA analysis:

a. The environmental report (ER) uses the staff's conclusions from a prior SAMA evaluation to justify that the VYNPS fire CDF is conservative by a factor of three. Provide a description of the conservatism in the dominant VYNPS fire CDF sequences (e.g., related to fire initiating event frequencies, severity factors, or recovery actions that were not credited) that would support this factor of three.

b. The seismic CDF at VYNPS is not mentioned in the ER or included within the multiplier used to account for additional SAMA benefits in external events. Provide the estimated seismic CDF at VYNPS, and an assessment of the impact on the external event multiplier, and on the SAMA analysis results if the seismic CDF is included.

c. Entergy's baseline evaluation of SAMA benefits considers only the risk reduction associated with internal events, and neglects the additional risk reduction that a SAMA could have in external events. Entergy does consider the potential for additional risk reduction in external events, but this is done in the context of an upper bound assessment in which the internal event benefits are increased by a factor of ten to account for the combined effect of external events and analysis uncertainties. The impact of external events should be reflected in the baseline evaluation, rather than combining the impact of external events with the uncertainty assessment. In this regard, provide a revised baseline evaluation (using a 7 percent discount rate) that accounts for risk reduction in both internal and external events, and an alternate case using a 3 percent discount rate. (Note that the CDF for external events after Entergy's adjustment in the ER is 3.7 times higher than the internal events CDF. This would justify a multiplier of 4.7 or 5, rather than a multiplier of 4 as stated in the ER.)

d. Provide an assessment of the impact on the baseline evaluation results (i.e., the revised baseline evaluation, which accounts for external events) if risk reduction estimates are increased to account for uncertainties in the analysis.

4. Provide the following information concerning the MACCS analyses:

   a. Annual meteorology data from the year 2002 were used in the MACCS2 analyses. Provide a brief statement regarding the acceptability of use of this year's data rather than a different year's data.

   b. For the emergency response assumptions, indicate what percentage of the population was assumed to evacuate.

   c. The MACCS2 analysis for VYNPS is based on a core inventory from a mid-1980 analysis, scaled by the power level for VYNPS. Current boiling-water reactor BWR fuel management practices use longer fuel cycles (time between refueling) and result in significantly higher fuel burnups. The use of the older BWR core inventory, instead of a plant-specific cycle, could significantly underestimate the inventory of long-lived radionuclides important to population dose (such as Sr-90, Cs-134 and Cs-137), and thus impact the SAMA evaluation. Justify the adequacy of the SAMA cost benefit evaluation, given the fuel enrichment and burnup expected at VYNPS.

5. Provide the following with regard to the SAMA identification and screening processes:

   a. Section E.1.3.1 indicates that no simple cost-effective enhancements have been identified that will significantly improve the high confidence in low probability of failure (HCLPF) for the condensate storage tank (CST) of 0.25. Provide a cost-benefit analysis for the seismic improvement of the CST similar to that for the other SAMAs.

   b. The individual plant examination of external events (IPEEE) found that the diesel fuel oil storage tank had a HCLPF of 0.29. The ER states that all improvements identified in NUREG-1742 (which include the diesel fuel oil storage tank) have been implemented. Describe the actions taken for the diesel fuel oil storage tank.

   c. The VYNPS IPEEE lists a number of seismic improvement opportunities that are not specifically included in NUREG-1742 (specifically, seismic items 3 (ii) and 7 of IPEEE Section 7.2.2). Confirm that these have been implemented.

   d. Describe any further efforts made to determine if any SAMA candidates exist to address seismic risk beyond those already identified in the IPEEE.

   e. The listing of "risk significant terms," provided in Table E.1-3, includes numerous different internal flooding initiators, and the SAMAs considered to address these initiators. For most of these initiators, various Phase I SAMAs are identified as having been implemented, and Phase II SAMA 47 was evaluated to further reduce the internal flooding contribution.

I. For each of the previously implemented changes, clarify whether the change is credited in the current PSA. If not, provide an assessment of the impact of the change on the internal flood CDF. If the change has already been credited, it would not appear to have been completely effective (as evidenced by the high residual risk of the initiating event) and additional SAMAs specific to the flooding event listed in the table could be cost-beneficial.

ii. Phase II SAMA 47 does not appear to address any of the specific internal flooding events listed in the table. Clarify which specific flooding scenario is addressed by SAMA 47.

f. Provide the current status of the 14 opportunities for improvement identified in the IPEEE for internal flooding, indicating if they have been implemented and if credit is taken for them in the current PSA. For those not implemented, indicate their importance and why they should not be considered as SAMA candidates.

g. The fire CDF, even after the factor of three reduction, is almost four times the internal events CDF. While the ER states that the improvements that address fire risk at VYNPS recommended in NUREG-1742 have all been implemented, the fire CDF is still substantial. SAMA candidates based on internal risk contributors will not necessarily address the fire risk. For each fire area or dominant fire sequence, explain what measures were taken to further reduce risk, and explain why the fire CDFs can not be further reduced in a cost-effective manner.

h. In Table E.1-3, the entry for "Transient with [power conversion system] available - initiating event" (risk reduction worth (RRW) of 1.0287) cites SAMA 046 to improve main steam isolation valve (MSIV) design. Explain how this impacts the initiator which must have the MSIV open.

I. As an alternative to Phase II SAMA 2, consider operating procedure revisions to provide additional space cooling via the use of portable equipment or by blocking doors open.

j. Phase II SAMA 59 considers installing instruments for opening safety/relief valves (SRVs) for medium loss-of-coolant accidents (LOCAs). Explain why the benefits of this SAMA in small LOCAs and transients are not included in the benefit assessment.

k. Table E.1-3 indicates that failure of torus venting components has a RRW of 1.0948. Describe the failures considered in this assessment. Provide an assessment of the costs and benefits associated with: 1) adding redundant components, and 2) converting the vent system to a passive design.

l. The Table E.1-3 entry for "Operator Action: Operator fails to start a [turbine building closed cooling water] (TBCCW) pump" indicates that no Phase II SAMAs were recommended. Provide an assessment of the costs and benefits of starting a TBCCW pump automatically.

6. Provide the following with regard to the Phase II cost-benefit evaluations:

   a. For a number of the Phase II SAMAs listed in Table E.2-1, the information provided does not sufficiently describe the associated modifications and what is included in the cost estimate. Provide a more detailed description of the modifications for Phase II SAMAs 6, 9, 10, 13, 23, 24, 33, 41, 52, 56, and 63.

   b. Several of the cost estimates provided were drawn from previous SAMA analyses for a dual-unit site (e.g., Peach Bottom). As such, many of those cost estimates reflect the cost for implementation in two units. Since VYNPS is a single-unit site, some of the cost estimates should be one-half of what has been cited (i.e., Phase II SAMAs 29, 35, 40, 49, 50, 51, 52, 53, and 54) while others are specific to a plant's design, such as the number of valves or batteries that need to be replaced or added (i.e., Phase II SAMAs 46, 55, and 60). For these cases, provide appropriate (specific to VYNPS) cost estimates. (Note that Phase II SAMAs 49, 50, 51, 53, and 54 are close to being potentially cost-beneficial when a 3 percent real discount rate is used.)

   c. Phase II SAMA 27 uses the same analysis case (Strengthen Containment) as Phase II SAMAs 13, 18, and 19 to evaluate the benefit. Yet, Table E.2-1 lists SAMA 27 as having a CDF reduction of 0.0 percent, while all other SAMAs for this analysis case list a CDF reduction of 7.36 percent. Explain this discrepancy.

   d. For Phase II SAMA 28 and 29 (and others) a 3 percent reduction in CDF was estimated by changing the time available to recover off-site power before high-pressure coolant injection/reactor core isolation coolant (RCIC) are lost from 4 hours to 24 hours. According to Table E.1-8, late SBO sequences (Class IBL) contribute about 17 percent of the total CDF. Explain why only a 3 percent reduction in CDF was estimated for this SAMA.

   e. For Phase II SAMA 42, a 1.3 percent reduction in offsite dose was estimated by reassigning the interfacing-systems loss-of-coolant accident (ISLOCA) sequences to the same end states as medium LOCAs. For Phase II SAMA 43, a 1.2 percent reduction in offsite dose was obtained by eliminating the CDF contribution due to ISLOCA. One would expect the dose reduction for SAMA 43 to be greater than that for SAMA 42. Also, the CDF contribution from ISLOCA is given in Table E.1-2 as 0.32 percent, while the CDF reduction from SAMA 43 is given as 0.83 percent. Explain these apparent discrepancies.

   f. Phase II SAMA 57 is stated to include items which reduce the contribution of anticipated transient without scram. Indicate which items are included.

   g. Phase II SAMA 59 involves providing instrument signals to open SRVs for medium LOCA. Discuss whether the signals already exist in the automatic depressurization system.

h. Phase II SAMA 63, Control Containment Venting Within a Narrow Band of Pressure, is intended to eliminate failures associated with successful venting. The benefit of this SAMA was determined by reducing the operator failure to vent by a factor of three. It is not clear that reducing the failure to vent probability is related to the actual benefit from this SAMA. Also, the cost of $250,000 appears high for what appears to be a procedure and training issue. Justify the benefit and cost for this SAMA.

I. Phase II SAMA 64, Provide Cross Tie from the residual heat removal service water (RHRSW) System to residual heat removal Loop B, has an estimated CDF reduction of 0.2 percent. The description given in Table E.1-3 for term diesel fire pump and John Deere Diesel for Alternate Injection, though, indicates that this term involves a cross tie for fire protection to RHRSW and has a RRW of 1.0584. Describe this SAMA more completely and indicate why the reduction in CDF is so small relative to the RRW.

j. In Table E.2-1, the percent change in CDF and population dose is reported for each analysis case. However, the change in the offsite economic cost risk (OECR) is not reported. Provide the change in the OECR for each analysis case.

7. For certain SAMAs considered in the ER, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, discuss whether any lower-cost alternatives to those Phase II SAMAs considered in the ER would be viable and potentially cost-beneficial. Evaluate the following SAMAs (previously found to be potentially cost-beneficial at other plants), or indicate if the particular SAMA has already been considered. If the latter, indicate whether the SAMA has been implemented or has been determined to not be cost-beneficial at VYNPS:

a. Use portable generator to extend the coping time in loss of ac power events (to power battery chargers.

b. Enhance direct current (dc) power availability (provide cables from diesel generator or another source to directly power battery chargers).

c. Provide alternate dc feeds (using a portable generator) to panels supplied only by dc bus.

d. Modify procedures and training to allow operators to cross-tie emergency ac buses under emergency conditions which require operation of critical equipment.

e. Develop guidance/procedures for local, manual control of RCIC following loss of dc power.

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