May 22, 2006

Mr. Michael Kansler
President
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601-1839

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR PILGRIM NUCLEAR POWER STATION (TAC NO. MC9676)

Dear Mr. Kansler:

The U.S. Nuclear Regulatory Commission staff (the staff) has reviewed the Severe Accident Mitigation Alternatives (SAMA) analysis submitted by Entergy Nuclear Operations, Inc., in support of its application for license renewal for the Pilgrim Nuclear Power Station, and has identified areas where additional information is needed to complete its review. Enclosed is the 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 301-415-1878 or via e-mail at ARW1@nrc.gov.

Sincerely,

/RA/

Alicia Williamson, Project Manager
Environmental Section B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-293

Enclosure:
Staff's RAI

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 Pilgrim Nuclear Power Station (PNPS)

1. The SAMA analysis is said to be based on the most recent version of the PNPS Probabilistic Safety Analysis (PSA) (Revision 1 April 2003). Provide the following information regarding these PSA models:

   a. The PNPS individual plant examination (IPE) evaluated total and partial loss of offsite power events. The current PSA model includes only a single loss of offsite power (LOOP) event. Characterize this LOOP event relative to the IPE events.

   b. It is stated that the PSA represents the plant operating configuration and design changes as of September 30, 2001. Identify any changes to the plant (physical and procedural modifications) since September 2001 that could have a significant impact on the results of the PSA. Provide a qualitative assessment of their impact on the PSA and their potential impact on the results of the SAMA evaluation.

   c. The Boiling Water Reactor Owners Group (BWROG) peer review in 2000 apparently reviewed the original 1992 IPE instead of the 1995 revision. Explain why the 1995 revision was not peer reviewed.

   d. The environmental report (ER) states that all major issues and observations from the BWROG peer review have been addressed and incorporated in the current PSA. Describe the "non-major" issues that have not been incorporated, and their potential impact on the results of the SAMA evaluation. Discuss the overall conclusion of the BWROG peer review relative to the use of the Pilgrim PSA.

   e. The description of the revisions of the peer reviewed 1992 IPE to produce the current 2003 PSA indicates that almost all of the elements of IPE were completely revised. Provide more detail on the steps taken to ensure the technical adequacy of the current Level 1 and Level 2 PSA, including the review criteria used, a summary of the results of the peer review described in paragraphs 2 and 4 of ER Section E.1.4.1, and an identification of any open items from this review and their potential impact on the conclusions of the SAMA analysis.

   f. The ER appears to provide a listing of the major plant and PSA model changes since the 1995 IPE Update. However, it is not clear whether these changes include differences between the 1992 IPE and 1995 IPE update. Provide a listing of the changes between the 1992 and 1995 models and between the 1995 and 2003 models. Indicate which changes were the major contributors to the reduction in core damage frequency (CDF).

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

a. In ER Section E.1.2.2.1 it is stated that "The Level 1 and plant system information is passed through to the [containment event tree] (CET) evaluation in discrete [plant damage state] (PDS)." ER Table E.1-4 identifies seven PDS groups and ER Table E.1-8 identifies 48 more detailed PDSs. It is noted that for certain PDSs, the frequency in the Table E.1-4 does not equal the sum of the frequencies for like-PDSs in Table E.1-8. Provide a description of the mapping of Level 1 results into the various containment end states/release categories, and the relevance of the PDS as input to the CET. Address whether the PDSs uniquely define failed equipment for the CET analysis or whether this is done by inputting the cutsets. Also, discuss whether the sequences that make up a PDS are combined and entered into the CET as a frequency, or whether the cutsets that make up each group of core damage sequences are entered into the CET, and the relevance of the two inconsistent sets of frequency values in Tables E.1-4 and E.1-8.

b. ER Table E.1-7 defines 7 release categories and Table E.1-10 provides the frequency of these categories. Source term characteristics are, however, defined for 19 collapsed accident progression bins (CAPBs) in Tables E.1-9 and E.1-11. There appears to be some disconnect between the release categories and the CAPBs. For example, CAPB-15 is indicated to involve late containment failure (Table E.1-9) and a high CsI release fraction of 27 percent (Table E.1-11), yet Table E.1-10 indicates the frequency of Late High release is 0.0. Also, none of the so-called late containment failure CAPBs have release start times greater than 24 hours (8.64E+04 seconds) which is Entergy's definition of late. Describe the use of the release categories and how they are related to the CAPBs.

c. With regard to source terms, provide the following information:

   I. Briefly describe the approach used to determine the source terms for each release category. Clarify whether new 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).

   ii. ER Section E.1.2.2.6 indicates that the source terms were grouped into a much smaller number of source term groups with frequency-weighted mean source terms for each group. Clarify whether the source terms prior to this grouping process correspond to the accident sequence-CET endpoints, and the smaller number of source term groups correspond to the CAPBs. Discuss the development of a frequency-weighted mean source term for each group.

d. ER Section E.1.2.2.6 indicates that the accident progression bins for each of the 48 PDS were sorted into the CAPBs based on a number of attributes. Not included in the list are the CET fission product removal and reactor building nodes identified in Table E.1-5 or containment venting. These would appear to impact the release fractions. Please explain.

e. Only about 3 percent of the CDF leads to early containment failure, with the majority of the releases occurring late (after 24 hours following event initiation). Explain this relatively small percentage in terms of the early containment failure modes associated with Mark I containments, including liner melt-through by molten core debris and containment venting. Clarify how sequences involving containment venting (from the suppression chamber or the drywell) are assigned using the release categories of ER Table E.1-10.

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

   a. The fire CDF (noted as a screening value) has been lowered since the individual plant examination of external events (IPEEE) as a result of updated equipment failure probability and unavailability values. However, the ER states that a more realistic value may be about a factor of three less, or 6.37E-06 per year. Provide a description of the conservatism in the dominant Pilgrim 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. Since the IPEEE, the seismic CDF has been reduced to 3.22×10^{-5} per year, and is stated to be a conservative value. The ER states that a more realistic value would be a factor of two less, based on engineering judgement. Provide justification to support the factor of two reduction.

   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 six 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 3.5 times higher than the internal events CDF. This would justify a multiplier of 4.5 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 2001 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 Pilgrim is based on a core inventory from a mid-1980 analysis, scaled by the power level for Pilgrim. 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 Pilgrim during the renewal period.

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

a. Table 3-15 of the IPEEE submittal provides a listing of important seismic faults. While no importance values are provided, a number of these faults appear to involve equipment for which some strengthening may be relatively inexpensive. Also, as indicated in the IPEEE and the staff safety evaluation report on the IPEEE, the diesel generator building was found to have limiting fragilities that could significantly impact the CDF. Discuss and evaluate, as necessary, the potential for cost-beneficial SAMAs based on this listing and the known diesel generator building weaknesses.

b. The IPEEE submittal (page 3-44) states that the seismic PRA assumed that low ruggedness relays judged essential under A-46 had been replaced. ER Section E.1.3.1 indicates that the recent reevaluation of seismic risk included the replacement of certain relays with seismically rugged models. Explain this apparent contradiction.

c. ER Table E.1-12 includes a list of the contributors to the updated fire CDF. A number of these have CDF values significantly above 1E-06 per year. For each fire area or dominant fire sequence, explain what measures were taken to further reduce risk, and explain why the fire CDFs cannot be further reduced in a cost-effective manner.

d. ER Section E.2.1 states that several enhancements from the IPE or IPEEE were recommended and implemented and that these were included as Phase I SAMA candidates 248 through 281. Provide a detailed accounting of the potential enhancements from the IPE and IPEEE. For each enhancement, indicate if the improvement has been implemented, is no longer being considered and why, and if credit is taken for the improvement in the current PSA. For those enhancements not implemented, indicate their importance and why they should not be considered as Phase II SAMA candidates.

e. Loss of direct current (dc) bus initiators contribute almost 50 percent of the CDF. The only SAMA that directly addresses improving existing dc system reliability is Phase II SAMA 27 and this SAMA reduced CDF by less than 5 percent. Discuss the loss of dc initiators in more detail, their major causes, and the potential for other modifications to reduce the CDF.

f. ER Table E.1-3 indicates that Phase I SAMAs, including procedure and instrumentation improvements, have been implemented to address event FXT-XHE-FO-V4T2 (and FXT-XHE-FO-DWS). In spite of these improvements, this event is the highest risk reduction worth ranked non-initiator event. The Phase II SAMAs (57 and 59) cited do not appear to effectively address this event which is an operator error. Identify and evaluate other SAMAs that might lower the importance of this event.

g. ER Table E.1-3 indicates that Phase II SAMA 45 was considered to address event FXT-ENG-FR-P140. This SAMA includes the addition of an entire new system. The addition of a redundant diesel fire pump would appear to be more cost-effective. Provide an evaluation of the costs and benefits of adding a redundant diesel fire pump, in lieu of Phase II SAMA 45.

h. ER Table E.1-3 indicates that Phase II SAMA 53 was evaluated to address event CIV-XHE-FO-DTV (operator fails to vent containment). This SAMA, controlling containment venting within a narrow pressure band, would be subject to the same failure to vent human error as in the basic event. Conversion of the containment vent system to a passive design would appear to be more effective in reducing the risk from this event. Provide an evaluation of the costs and benefits of converting the vent system to a passive design.

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

a. For a number of the Phase II SAMAs listed in ER 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 3, 6, 7, 10, 20, 21, 22, 27, 28, 29, 35, 43, 47, 53, and 55.

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 Pilgrim is a single-unit site, some of the cost estimates should be one-half of what has been cited (i.e., Phase II SAMAs 26, 29, 33, 40, 41, 42, 43, 44, and 45) 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 38, 46, and 50). For these cases, provide appropriate (specific to Pilgrim) cost estimates.

c. For Phase II SAMA 12, it is stated that probability of vessel failure was modified. Describe the modification considered, and the initial and revised probability of failure.

d. Phase II SAMA 53, 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 $300,000 appears high for what appears to be a procedure and training issue. Justify the benefit and cost for this SAMA.

e. In ER 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.

f. Phase II SAMA 47 is stated to include items which reduce the contribution of anticipated transient without scram. Indicate which items are included.

g. Phase II SAMA 49 involves providing instrument signals to open safety/relief valves for medium loss-of-coolant accident. Discuss whether the signals already exist in the automatic depressurization system.

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 Pilgrim:

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

b. Enhance dc power availability (provide cables from diesel generators 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 reactor core isolation cooling following loss of dc power.

f. Enhance loss of salt service water procedure to provide more specific guidance to deal with or prevent a complete loss of the system.

Pilgrim Nuclear Power Station

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