March 18, 2004

Mr. Mano K. Nazar
Senior Vice President and Chief Nuclear Officer
Indiana Michigan Power Company
500 Circle Drive
Buchanan, Michigan 49107

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR THE DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

Dear Mr. Nazar:

The staff has reviewed Indiana Michigan Power Company's (I&M) analysis of severe accident mitigation alternatives (SAMAs) submitted in support of its application for license renewal for the Donald C. Cook Nuclear Plant (CNP), and has identified areas where additional information is needed to complete its review. Enclosed is the staff's request for additional information.

As discussed with your staff, we request that you provide your responses to these RAIs within 60 days of the date of this letter. If you have any questions, please contact me at (301) 415-1312.

Sincerely,
/RA/
Robert G. Schaaf, Project Manager
Environmental Section
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-315 and 50-316

Enclosure: As stated

cc w/encl: See next page

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DATE	3/12/04	3/15/04	3/17/04	3/18/04

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Request for Additional Information Regarding the Analysis of Severe Accident Mitigation Alternatives (SAMAs) for the D.C. Cook Nuclear Plant (CNP)

1. The Severe Accident Mitigation Alternatives (SAMA) analysis is based on the most recent version of the CNP Probabilistic Risk Assessment (PRA) for internal events (i.e., August 2001 Level 1 model and October 2003 Level 2 model), which is a modification to the revised individual plant examination (IPE) submittal transmitted to the U.S. Nuclear Regulatory Commission (NRC) in October 1995. Please provide the following information regarding this PRA model:

    a. A description and the results of the internal and external peer reviews of the Level 2 and 3 portions of the PRA that have been performed since the IPE. This should include a description of the internal and external peer reviews of the MELCOR Accident Consequences Code System (MACCS2) and MAAP analyses (see also SECY-03-0222).

    b. An assessment of the impact of the weaknesses/areas for improvement identified in the Westinghouse Owners Group (WOG) peer review on the SAMA identification and evaluation process, (e.g., since one identified weakness is common cause analysis, how would SAMAs be impacted by improving the common cause analysis?).

    c. A description of the major differences from the Revised IPE submittal, Level 1 PRA modeling changes that have resulted in the new core damage frequency (CDF) and large early release frequency (LERF). Also provide the revised importance measures for basic events (both risk increase and risk decrease), and the importance measures formulations. Please include a discussion of the reasons for the difference in the station blackout (SBO) fraction of CDF from the IPE (1.8%) and current reported value (22.8%) in Table F.2-2.

    d. A description of the changes in the PRA Level 2 methodology since the IPE submittal, including major modeling assumptions, plant response tree (PRT)/containment event tree (CET) structure. Please confirm that the large early release frequency (LERF) values in the Indiana Michigan Power Company's (I&M) SAMA analyses are based on the October 2003 Level 2 PRA update.

    e. A description of the methodology and criteria for binning endstates into the 8 accident sequences/release categories shown in Table F.2-6 and used in the current Level 3 analysis.

    f. The specific source terms used to represent each of the 8 accident sequence/release categories, and a containment matrix describing the mapping of Level 3 results into the various accident sequences/release categories.

g. A description of the accident sequences used to represent each of the 8 accident sequences/release categories shown in Table F.2-6, and how each sequence was chosen to represent a bin.

h. A breakdown of the population dose (person-rem per year within 50 miles) by containment release mode, such as steam generator tube rupture (SGTR), interfacing systems loss-of-coolant accident (ISLOCA), containment isolation failure, early containment failure, late containment failure, and no containment failure.

2. In Section F.2.1, the CDF for internal events is given as 5.0×10^{-5} and the CDF for internal fires and seismic events are given as, 3.8×10^{-6} and 3.2×10^{-6} respectively. These internal fires and seismic CDFs, and the individual plant examination of external events (IPEEE) models, were not used in the identification and screening of SAMAs. Also, it is not clear whether/how SAMAs to address internal flooding events were considered in the SAMA analysis. In this regard, the following information is needed:

a. NUREG-1742 ("Perspectives Gained from the IPEEE Program", Final Report, April 2002), lists the significant fire area CDFs for CNP (page 3-14 of Volume 2). For each fire area, please explain what measures were taken to further reduce the CDF, and explain why these CDFs cannot be further reduced in a cost effective manner.

b. Please identify those SAMAs from Table F.4-2 that could provide a significant risk benefit in the important seismic, internal fire, and internal flood events at CNP. For each of these SAMAs, provide an estimate of the additional benefit that these SAMAs would provide in the respective events.

c. The SAMA analysis for Catawba Nuclear Station identified a cost beneficial enhancement involving installation of a watertight wall around a 6900/4160V transformer in the turbine building basement (to reduce the risk from flooding events). Please discuss whether a similar modification was evaluated or would be applicable for CNP.

3. According to Table F.4-1, I&M evaluated 194 SAMA candidates. Of these 194 candidates, 32 were obtained from CNP-specific documents. It is not clear that the set of SAMAs evaluated in the environmental report (ER) addresses the major risk contributors for CNP. In this regard please provide the following:

a. A description of how the dominant risk contributors at CNP, including dominant sequences and cut sets from the current PRA and equipment failures and operator actions identified through importance analyses were used to identify potential plant-specific SAMAs for CNP.

b. The number of cut sets reviewed/evaluated and what percentage of the total CDF they represent.

c. A listing of equipment failures and human actions that have the greatest potential for reducing risk at CNP based on importance analysis and cut set screening.

d. A list of the top ten items from "reliability issues" initially considered as SAMA candidates.

e. For each dominant contributor identified in the current PRA (August 2001), a cross-reference to the SAMAs evaluated in the ER which addresses that contributor. If a SAMA was not evaluated for a dominant risk contributor, justify why SAMAs to reduce these contributors would not be cost beneficial.

4. According to Section F.5, the I&M analysis was performed based on a single unit implementation. It is not clear which SAMAs would benefit both units, and how the single unit cost for such SAMAs were estimated (i.e., were the implementation costs divided by 2 to arrive at the single unit implementation costs?). Please provide a list of those SAMAs (both procedural and hardware based) where both units would benefit, and confirm that the reported costs and benefits were developed on a consistent basis (i.e., a single-unit basis).

5. From the SAMAs in Table F.4-2, 16 SAMAs, grouped into five areas, were identified as cost beneficial. Even though the cost beneficial SAMAs are not aging-related, they appear to warrant further consideration for implementation under the current operating license. Please provide a further evaluation of the most cost-effective means of reducing risk in each of the risk improvement areas. This evaluation should include a consideration of the costs and benefits associated with each of the 16 SAMAs, and the potential to achieve a large portion of the risk reduction at a minimum cost by implementation of a carefully selected subset of the SAMAs. The result of this discussion should be an assessment of which SAMAs, if implemented as a set, would offer a significant cost-beneficial risk reduction. Also, please discuss I&M's plans and schedules for implementing cost beneficial plant improvements.

6. For certain SAMAs considered in the ER, there may be lower cost alternatives that could achieve much of the risk reduction. Please confirm that low cost SAMAs were considered, and provide a brief discussion of these low cost alternatives.

7. SAMA candidates were considered potentially cost-beneficial if the cost of implementation was estimated to be less than two times the calculated benefit, so as to account for "other risk contributions not specifically quantified by the CNP PRA models". The staff is not convinced that this factor of two is sufficient to encompass the collective impact of several potentially non-conservative assumptions in the baseline analysis, and the added impact of uncertainties in the analysis on the SAMA evaluation process and results. In this regard, please address the following:

   a. Provide a list and brief description of these "other risk contributions" that were not quantified, and an estimate of the contribution of each to the factor of two. Examples identified by the staff, that should be addressed in the response, include:

i. The total bounding benefit estimated for each of the SAMAs only accounts for the benefits obtained during the 20 year period of the proposed life extension. This could underestimate the total benefit by about 15 percent since CNP has more than 10 years of operation remaining on its existing license.

ii. The estimates of the benefits for each SAMA are made in base years that are 5-10 years earlier that the base years for the estimates of the costs of implementation. This could underestimate the total benefit by about 20 to 50 percent assuming an average inflation rate of 4% per year.

iii. Sensitivity analyses performed as part of previous SAMA evaluations for MACCS2 inputs such as evacuation and population assumptions could yield variations in population dose of about 20 percent.

iv. The use of a reference pressurized water reactor (PWR) inventory scaled only for power (as opposed to a bounding operating cycle), could result in a significant underestimate of the fission product inventory of important long lived radionuclides that dominant population dose (e.g., an underestimate of about 50 percent for Sr-90 and Cs-137).

b. The SAMA analysis did not include an assessment of the impact of PRA uncertainties. Please provide the following information to address these concerns:

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i. An estimate of the uncertainties associated with the calculated core damage frequency (e.g., the mean and median internal events CDF estimates and the 5^{th} and 95^{th} percentile values of the uncertainty distribution),

ii. An assessment of the impact on the Phase 1 screening if risk reduction estimates are increased to account for uncertainties in the risk assessment, and

iii. An assessment of the impact on the Phase 2 evaluation if risk reduction estimates are increased to account for uncertainties in the risk assessment. Please consider the uncertainties due to both the averted cost-risk and the cost of implementation to determine changes in the net value for these SAMAs.

8. Table F.4-2 does not provide the estimated cost for those SAMAs where the estimated cost is ">2 x Benefit". This precludes an independent assessment of the relative cost-benefit conclusion, especially as it relates to the sensitivity analysis. In this regard please provide the following:

a. An estimated cost (approximate) for all of the screened out SAMAs. Also provide a brief description of the methodology, information sources, major cost elements, and assumptions (i.e., design assumptions, % contingency, unit costs, average hourly labor rates, etc.) used to develop these cost estimates. If no specific cost estimate was developed for a given SAMA because the cost was judged to be much greater than the estimated benefit, please provide the rationale for this conclusion.

b. Justification for the estimated cost for: (1) SAMA 154 - Make procedural changes only for the RCS depressurization option, which has a benefit of <$315,931 and (2) SAMA 171 - Enhanced screen wash, which has a benefit of <$221,837.

9. Please provide the following information concerning the MELCOR Accident Consequences Code System analyses:

a. The discussion of meteorology indicates that there are data voids in the 1997 data set used. A power law was used to extrapolate the 60-meter wind speeds from the 10-meter wind speeds. Provide a more detailed description of the power law application and a justification of its use (such as comparison of 10-meter and 60-meter wind speeds from known months against a power law extrapolation). Confirm that the 1997 data set is representative of the CNP site and justify its use.

b. The MACCS2 analysis uses a reference PWR core inventory at end-of-cycle calculated using ORIGIN. The ORIGIN calculations were based on a 3-year fuel cycle (12 month reload), 3.3% enrichment, and three region burnup of 11000, 22000, and 33000 Mwd/MTU. Current PWR fuel management practices use higher enrichments and significantly higher fuel burnup (>45000 Mwd/MTU discharge burnup). The use of a reference PWR core 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. For example, SAMAs 49, 124, 125, 139, 149, 153, and 185 offer a significant reduction in person-rem (per Table F.4-2), and might become cost-beneficial using a higher inventory. Please evaluate the impact on population dose and on the SAMA screening and dispositioning if the SAMA analysis were based on the fission product inventory for the highest burnup and fuel enrichment expected at CNP during the renewal period.

c. I&M estimated the population for year 2038 by extrapolating the growth rate between the 'actual' year 2000 and the 'estimated' year 2020 populations. I&M then applied this growth rate to the actual year 2000 population through the year 2038 assuming the growth rate would remain constant. If the actual population at year 2000 was higher than the estimated population at year 2000, the I&M extrapolation method would automatically predict a slowdown in population growth (and possibly a decrease) to year 2038 in the face of accelerated growth at year 2000. This is non-conservative and could significantly under predict the year 2038 population. Please evaluate the impact on the SAMA analysis if a more conservative approach for extrapolating population for year 2038 were used, such as using the estimated year 2000 population rather than the actual year 2000 population.

d. The I&M reported total population for year 2000 is consistent with the population tables reported in SECPOP2000 (NUREG/CR-6525, Rev. 1, Appendix F) for the 50 mile radius. However, the rosette population distribution differs significantly in the 30-40 and 40-50 mile radius for the sector regions NE/ENE and SW/WSW (Table F.2-7) compared to both the SECPOP2000 and licensee's reported populations (page F-4 of the stated reference). The I&M evaluation references SECPOP90. Please provide a discussion of the differences noted and potential impact. If the impact is significant, provide justification for which distribution is appropriate.

10. In light of the issues raised in NUREG/CR-6427 concerning the likelihood of early containment failure in SBO events, please provide the following:

    a. A reevaluation of the benefits associated with SAMA 39 (Create/enhance hydrogen igniters with independent power supply) and SAMA 40 (Create a passive hydrogen ignition system) assuming a containment response consistent with the findings in NUREG/CR-6427 (i.e., using the conditional containment failure probabilities for DCH and non-DCH events provided in Tables 4.21 and 4.24 of NUREG/CR-6427, respectively). Indicate whether the PRA model was modified to reflect these conditional failure probabilities, and, if so, how the PRA model was modified to reflect these conditional failure probabilities.

    b. A breakout of the SBO CDF frequency at CNP in terms of the contribution from fast-SBO and from slow-SBO,

    c. The estimated time to the onset of core damage for the frequency-dominant fast-SBO and slow-SBO sequences,

    d. An assessment of the benefits (person-rem per year and dollars) of a pre-staged versus a portable backup power source for the hydrogen igniter system given the conditional containment failure probabilities in NUREG/CR-6427, and the estimated effectiveness of each implementation option in fast-SBO and slow-SBO events.

    e. A description of the basis for the estimated cost of $147,000 for both SAMA 39 and SAMA 40. Clarify whether this value reflects the per unit cost or the site cost.

11. Figure 6.1 of NUREG/CR-6427 displays the containment fragility curves for CNP. Confirm that this curve is the same as the curves used in the current CNP Level 2 PRA for Units 1 and 2 (October 2003). If not, please explain the differences and their impact on results.

12. Provide the requested information on the following issues:

    a. I&M review of "reliability issues" appears to have led to identification of 10 candidate SAMAs (SAMAs 185 through 194). Please provide the importance measures for risk increase for these reliability issues from the latest PRA model. Clarify whether the failure rates used in the PRA were modified from generic values to account for this reliability (failure) experience. If not, identify how the CDF and the relative contributions and importance measures might change using these failure data instead of generic failure rates. Also, please explain how both the cost and benefit was estimated for these SAMAs as the descriptions do not specifically identify how the reliability would be improved.

    b. Several SAMAs involving implementation of procedures were identified in Table F.4-1, at least in part, from the PRA. Some of these were screened out as already being implemented. Please address the following:

        i. If these SAMAs were implemented (and the implementation included in the PRA), but the related human error is still important based on the PRA, then another alternative needs to be identified. If this is the case, please identify a new alternative and re-evaluate that alternative.

        ii. If these SAMAs were implemented after the PRA was completed, please identify when/how the implementation was accomplished. Also, include a discussion of how the implementation changes the CDF based on the importance measures for each related human error.

    c. SAMAs 5, 9, 10, 12, and 13 all have relatively large benefits and are considered potentially cost beneficial. Each of these has some relationship to the loss of component cooling water (CCW); yet, adding a CCW pump (SAMA 17) has a relatively low benefit and is not cost beneficial. Please explain why SAMA 17 has a relative low benefit, given it can impact other SAMAs with higher benefits. Also, please identify any other improvements considered that would improve the CCW reliability and achieve some of the benefits identified in SAMAs 5, 9, 10, 12, and 13.

    d. SAMAs 5 and 9 concern adequate charging pump seal cooling, and SAMA 160 concerns emergency core cooling system (ECCS) pump seal cooling. SAMA 160 identified that ECCS self-cooling may be cost-beneficial. However, this does not appear to be considered as an option for the charging pumps. Please address whether self-cooling for the charging pump seals would be cost-beneficial.

e. The IPE identified that common mode failures for the safety injection (SI) pumps and compressed air system were significant contributors to CDF. The IPE also identified that a major reason for the significance of common mode failures was due to the modeling approach (i.e., not realistic). SAMAs 141, 142, and 143 appear to identify that the compressed air system did have legitimate common mode issues. However, the SI pumps do not appear to have had a significant common mode issue based on the treatment of SAMA 134 (screened out). Please verify that the significance of the IPE identified SI common mode failures were dominated by the modeling approach (or were corrected elsewhere).

Donald C. Cook Nuclear Plant, Units 1 and 2
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