April 28, 2004

Mr. J. A. Scalice
Chief Nuclear Officer & Executive Vice President
Tennessee Valley Authority
6 A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR THE BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3 (TAC NOS. MC1768, MC1769, AND MC1770)

Dear Mr. Scalice:

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed Tennessee Valley Authority's (TVA) analysis of severe accident mitigation alternatives (SAMAs) submitted in support of TVA's application for license renewal for the Browns Ferry Nuclear Plant, Units 1, 2 and 3. The NRC staff 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 RAIs by July 2, 2004, in order to support the license renewal schedule. If you have any questions, please contact me at (301) 415-1191.

Sincerely,

/RA/
Michael T. Masnik, Senior Project Manager
Environmental Section
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260 and 50-296

Enclosure: As stated

cc w/enclosure: See next page

April 28, 2004

Mr. J. A. Scalice
Chief Nuclear Officer and Executive Vice President
Tennessee Valley Authority
6 A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR THE BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3 (TAC NOS. MC1768, MC1769, AND MC1770)

Dear Mr. Scalice:

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed Tennessee Valley Authority's (TVA) analysis of severe accident mitigation alternatives (SAMAs) submitted in support of TVA's application for license renewal for the Browns Ferry Nuclear Plant, Units 1, 2 and 3. The NRC staff 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 RAIs by July 2, 2004, in order to support the license renewal schedule. If you have any questions, please contact me at (301) 415-1191.

Sincerely,
/RA/
Michael T. Masnik, Senior Project Manager
Environmental Section
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260 and 50-296

Enclosure: As stated

cc w/enclosure: See next page

DISTRIBUTION:

RLEP R/F	A. Hodgdon	R. Hannah(RII)	R.Emch
J. Tappert	J. Yerokun	K. Jabbour	T. Terry
B. Palla	B. Holbrook(RII)	M. Masnik	M. Sackschewsky (PNNL)

Accession no.: **ML041200517**

DOCUMENT NAME: C:\ORPCheckout\FileNET\ML041200517.wpd

OFFICE	PM:RLEP:DRIP	LA:RLEP:DRIP	SC:RLEP:DRIP
NAME	MMasnik	MJenkins	JTappert (TKenyon for)
DATE	4/28/04	4/28/04	4/28/04

OFFICIAL RECORD COPY

REQUEST FOR ADDITIONAL INFORMATION REGARDING THE ANALYSIS OF SEVERE ACCIDENT MITIGATION ALTERNATIVES (SAMA) FOR BROWNS FERRY NUCLEAR PLANT (BFNP) UNITS 1, 2, AND 3

1. The SAMA analysis is based on the most recent version of the Browns Ferry Unit 2 and 3 Probabilistic Safety Assessments (PSAs) for internal events, i.e., August 2003, which is a modification to the Individual Plant Examination (IPE) submittal. Please provide the following information regarding this PSA model:

    a. Discuss any internal and external peer reviews of the Level 1 PSA, containment performance analysis, and offsite consequence model used for the SAMA analysis (beyond the 1997 peer review of an earlier PSA model).

    b. Provide a characterization of the findings of the most recent peer reviews, and the impact of any identified weaknesses on the SAMA identification and evaluation process. Specifically, discuss those elements in Table VII-1 that were given Certification Grades of 2. Provide the facts and observations (F&Os) that led to these grades and discuss the impact of any unresolved issues on the SAMA analysis. Also, indicate whether any Grade 3 elements were contingent on resolving any F&Os.

    c. Provide more specific information relative to the reasons for the over one order of magnitude reduction in the BFNP Unit 2 core damage frequency (CDF) from the IPE value to the value used in the SAMA analysis, including major modeling and hardware changes.

    d. Section II of the Environmental Report (ER) presents the results of the consequence analysis in terms of release categories (Table II-7). Section III (Tables III-3 and III-4) discusses and presents the results of the Level 1 analysis in terms of key plant damage states (KPDS). The basis for the KPDS is given to be the BFNP IPE. Please explain why the release categories have the same identifier as the key plant damage states, and provide more information concerning the mapping of key plant damage states to release categories.

    e. The grouping of plant damage states into KPDS used in the Level 2 analysis is shown in Figures III-1 and III-2. In a number of cases, plant damage states of a higher frequency are characterized by a KPDS of significantly lower frequency. For example, NIG is characterized by NIH, PJA is characterized by PJH and MLC is characterized by PLF. Justify this characterization and discuss its impact on risk.

    f. Provide a breakdown of the population dose (person-rem per year within 50 miles) by containment release mode, such as containment isolation failure, early containment failure, late containment failure, and no containment failure.

ATTACHMENT

g. Provide the contributions to CDF, large early release frequency (LERF), and KPDS from anticipated transient without scram (ATWS) and station blackout (SBO) events.

2. To assure that the set of SAMAs evaluated in the ER addresses the major risk contributors for BFNP, please provide the following:

a. Provide the quantitative results of importance analyses that show the relative contribution to risk from systems, equipment, and human actions. Include the importance of the operator failing to inhibit auto depressurization following an ATWS.

b. For each dominant contributor identified in 2a (above), provide a cross-reference to the SAMA(s) evaluated in the ER that address that contributor.

c. In ER Section V.B, degraded electrical power conditions are identified as a major contributor to CDF. Likewise, in Section V.C, a loss of coolant accident (LOCA) with loss of level control is identified as a major contributor to LERF. Identify which SAMAs were evaluated to address these major contributors.

d. The list of BFNP-specific SAMAs is based on the review of the contributors to CDF and LERF from the Unit 2 and 3 PSAs. These PSAs assume that Unit 1 is not operating, and therefore, the list of potential SAMAs does not consider the potential impact of Unit 1 operation. The impact of Unit 1 operation would be expected to significantly change the importance of various contributors to risk and might add contributors that are not currently considered in the identification of BFNP-specific SAMA candidates. For example, the Multi-Unit PRA indicates that the top two sequences are initiated by an internal flood in the turbine building, and by loss of raw cooling water. However, neither of these sequences are listed in Section V.B as important contributors to total CDF. Thus, SAMAs that address important risk contributors from multi-unit operation may have been overlooked. Please identify the important contributors to each unit's CDF and LERF based on risk information that considers the impact of Unit 1 operation. Discuss whether consideration of the multi-unit risk information leads to identification of any additional SAMAs not included in the ER.

e. As discussed in Section VII of the ER, operation of Unit 1 is assumed to result in an increase in Unit 2 and 3 CDF by factors of 4 and 2 respectively. The rationale for increasing the mean CDF for Unit 2 is provided in Section VII.B, and is based on the ratio of the total CDF from the Multi-Unit PRA to the single unit PRA for Unit 2. However, the rationale for increasing the Unit 3 CDF by a factor of two is not supported. Provide additional justification for using a factor of two increase in the Unit 3 CDF to account for the operation of Unit 1.

3. As mentioned in RAI 2e above, the operation of Unit 1 is accounted for by increasing the Unit 2 and 3 CDF by factors estimated from the Multi-Unit PRA. These factors represent the estimated increase in Unit 2 and 3 total CDF due to changes in success criteria and system availability resulting from Unit 1 operation. These increases (or even larger increases) would occur in some sequences but not in others. For example, from Table 1-1 of the Multi-Unit PRA, Unit 1 operation results in an increase in CDF of a factor of seven for loss of offsite power initiated sequences, a factor of five for internal flood initiated sequences, and a factor of 34 for support system failure initiated sequences. This could significantly affect not only the selection of candidate SAMAs (addressed in RAI 2.d) but also the calculated benefits for candidate SAMAs involving these scenarios. Please discuss the sequence-specific impact of Unit 1 operation on the benefit analyses of the candidate SAMAs, particularly for those SAMAs that involve sequences for which the impact of Unit 1 operation can be expected to be greater than the total CDF increase factors of four and two for Units 2 and 3, respectively.

4. The SAMA analysis did not include an assessment of SAMAs for external events, or account for the potential reduction in external event risk from candidate SAMAs. The BFNP IPE for external events (IPEEE) study has shown that the CDF due to internal fire initiated events is about 9.8×10^{-6} per year for Unit 2, and 7.4×10^{-6} per year for Unit 3, which are factors of 3.7 and 2.2 greater than the internal events CDF for Units 2 and 3, respectively. In addition, the risk analyses at other commercial nuclear power plants indicate that external events could be large contributors to CDF and the overall risk to the public. In this regard, the following additional information is needed:

   a. For candidate SAMA B16 it is indicated that no fire-related SAMAs were quantitatively evaluated since no modifications were required as a result of the IPEEE. NUREG-1742 lists two fire zones (Unit 2) and one fire zone (Unit 3) for which the CDF is greater than 1×10^{-6} per year and 11 additional zones (Units 2 and 3) with CDF contributions of more than 1×10^{-7} per year. For each fire area, please explain what measures were taken to further reduce risk, and explain why these CDFs cannot be further reduced in a cost effective manner.

   b. For candidate SAMA B17 it is indicated that no seismic related SAMAs were quantitatively evaluated since all outliers as a result of the seismic IPEEE have been resolved. The conclusion from the IPEEE that no further modifications were necessary was not made on the basis of a cost benefit analysis and it cannot be concluded that none would be cost effective if they were quantitatively evaluated. Please discuss the results of the seismic IPEEE from the standpoint of potential SAMAs for the SSCs with the lowest seismic margins, and provide an assessment of whether any SAMAs to increase the seismic capacity of these limiting components would be cost beneficial. Also, confirm that the two transformers in the DG building that were identified in NUREG-1742 have been replaced. If not, please provide an explanation.

5. As indicated in RAI 4, TVA has not accounted for any contributions to risk from external events. The fire CDF is almost a factor of four greater than the internal events CDF for Unit 2 and a factor of at least two greater than the internal events CDF for Unit 3, which suggests that the estimated benefit for the SAMAs should be increased by at least a factor of four and two, respectively, to account for external events. In order to determine if external events have been satisfactorily accounted for, please provide the following information:

   a. the current CDF for fire-initiated events, and
   b. an assessment of the impact on the initial and the final screenings if the internal events risk reduction estimates are increased by a factor that would bound the risk from fire and seismic events.

6. The impact of uncertainty on the SAMA evaluations was considered by increasing the benefits by a factor of three, which is approximately the ratio of the 95th percentile CDF to the mean CDF. This same factor will not, however, apply to the specific accident sequences that are affected by the various candidate SAMAs. For example, the uncertainty in the ATWS sequence would be expected to be significantly higher than the uncertainty in the total CDF. Please qualitatively discuss the appropriateness, conservatism, and non-conservatism of the use of a single value of three for the evaluation of the impact of uncertainty on the benefits of all candidate SAMAs, and the effect of using a more appropriate, sequence-specific uncertainty factor on the results of the cost-benefit evaluation for each SAMA.

7. In evaluating the candidate SAMAs, the benefits and implementation costs are compared on a per site rather than per unit basis. Since the benefit is higher for Units 1 and 2, a SAMA which may not be cost beneficial for all three units may still be cost beneficial for Units 1 and 2. Similarly, it may be less expensive to implement a SAMA at Unit 1 than at the other units if it can be implemented as part of other planned modifications. Confirm whether any SAMAs that were not cost beneficial on a per site basis might be cost beneficial if: (a) only implemented at Unit 1, or (b) only implemented at Units 1 and 2.

8. Please provide the following information concerning the MACCS2 analyses:

   a. The meteorological data used in the MACCS2 analysis was for the year 1980. Explain why more recent data was not used. Confirm that the 1980 data set is representative for the BFNP site and justify its use.

   b. On Page E-405 of the ER it is stated that the current design basis core inventory is provided in Table II-3. However, the ER goes on to say that data from three distinct fuel types each representing extended power uprate (EPU) conditions are provided in the table. Clarify which condition and power level is represented in the table (current versus planned EPU). Confirm that the fission product inventory input to the MACCS2 code calculations represents the inventory for the highest burnup and fuel enrichment expected at BFNP during the renewal period.

c. Table VIII-3 was developed to answer past RAIs or refer the staff to those sections of the ER that address the past RAIs. The table entry for 5a suggests that a detailed evacuation analysis has not been performed. In addition to the delay time, list the other the assumptions used for evacuation for each of the release categories/MAAP cases, including: time general emergency is declared, time of core melt (for each release), percent of population evacuated, and radial evacuation speed.

9. Section IV.E of the ER describes the calculation of replacement power costs. A correction factor of 1190 MWe/910 MWe was applied to account for the size of the units relative to the “generic” reactor described in NUREG/BR-0184. However, it is not clear if the 1190 MWe is for the current plant rating or for the rating of the plant after the EPU. Clarify for which power level the replacement power costs were calculated.

10. For the low cost alternative of a direct-drive diesel to power an AFW pump, TVA states that the maximum benefit is on the order of $100K/unit (see Table VIII-3, item 6c). The benefit does not include the impact of Unit 1 operation or the additional risk reduction in external events. If the impact of Unit 1 operation is included, as in the SAMA evaluations performed, it would make this modification cost beneficial. Please discuss.

11. For the Phase 2 SAMAs, the following information is needed to better understand the modification and/or the modeling assumptions:

a. Candidate SAMA B01 is described as automating the opening of selected SRVs in response to the unavailability of high-pressure level control. The estimated cost to accomplish this is given as $1.5M/unit. The installed automatic depressurization system (ADS) already accomplishes this function. Discuss how this SAMA would be different than the ADS and indicate why the cost is so high.

b. Candidate SAMAs B02 and B15 both address the unavailability of high-pressure injection. BO2 adds a redundant train of a steam driven pump (which apparently still has the same long term failure modes as the HPCI and RCIC) while B15 adds a motor-driven startup feedwater pump (which would still have AC power dependence). Indicate whether a diesel-driven pump would be more effective than either of the above two options evaluated. Provide justification to support the conclusion.

c. The evaluation of candidate SAMA B18 for internal flooding considers the impact of eliminating all flood-initiated events with very high cost flood barriers that would mitigate all flooding events. The PSA results provided in Section III indicate that 70 to 75% of the total internal flooding CDF is due to a small flood in the turbine building. In addition, the Multi-Unit PRA indicates that one flooding sequence has a frequency of $1.2x10^{-6}$ per year. Discuss the potential for an inexpensive SAMA to mitigate the risk of the dominant internal flood contributors to CDF.

d. The cost avoidance for SAMA G14 takes credit for only eliminating the failure of breakers that transfer non-emergency buses from the unit service transformer. Indicate the importance of all 4 kV breakers. Indicate whether this SAMA would be cost effective when all 4 kV breakers are considered.

12. Discuss the potential benefit and implementation costs for the following SAMAs at BFNP:

    a. Provide a means for alternate safe shutdown makeup pump room (or equivalent room) cooling, either via the use of the fire protection system, or procedures to open doors and use portable fans.

    b. Provide procedures for (a) bypassing major DC buses; (b) locally starting equipment.

    c. Develop procedures to control feedwater flow without 125 VDC to prevent tripping feedwater on high/low level.

    d. Demonstrate RCIC operability following depressurization, i.e., develop procedures to stop reactor depressurization at required level.

    e. Develop or enhance procedures to control containment venting within a narrow band of pressure.

    f. Develop procedures to use a cross connect to the other unit's containment cooling service water (or equivalent at BFNP) as an alternate containment spray source.

    g. Develop procedures to align LPCI or core spray to the condensate storage tank on loss of suppression pool cooling.

13. Appendix F to the LRA contains TVA's plans and schedules for Unit 1 restart activities affecting the LRA. Several permanent modifications at Unit 1 are planned in order to make its licensing basis consistent with that for Units 2 and 3, e.g., fire protection, hardened vent, and ATWS. Given that these plant changes are still to be implemented, the modifications can be further refined to reflect insights from the updated PSAs. For example, the hardened vent could be implemented as a passive feature (e.g., using a rupture disk rather than a manual valve), thereby removing the reliance on operator actions to open the vent (which is the second most important operator action in the BFNP PSA). For each of the major modifications planned for Unit 1, please discuss how these modifications might be enhanced to further reduce risk at Unit 1. Discuss the associated costs and benefits of these enhancements.

BROWNS FERRY NUCLEAR PLANT
Tennessee Valley Authority

cc:
Mr. Karl W. Singer, Senior Vice President
Nuclear Operations
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. James E. Maddox, Acting Vice President
Engineering & Technical Services
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Ashok S. Bhatnagar, Site Vice President
Browns Ferry Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Decatur, AL 35609

General Counsel
Tennessee Valley Authority
ET 11A
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. Robert J. Adney, General Manager
Nuclear Assurance
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Robert G. Jones, Plant Manager
Browns Ferry Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Decatur, AL 35609

Mr. Mark J. Burzynski, Manager
Nuclear Licensing
Tennessee Valley Authority
4X Blue Ridge
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Timothy E. Abney, Manager
Licensing and Industry Affairs
Browns Ferry Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Decatur, AL 35609

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
Browns Ferry Nuclear Plant
P.O. Box 149
Athens, AL 35611

State Health Officer
Alabama Dept. of Public Health
RSA Tower - Administration
Suite 1552
P.O. Box 303017
Montgomery, AL 36130-3017

Chairman
Limestone County Commission
310 West Washington Street
Athens, AL 35611

Mr. Fred Emerson
Nuclear Energy Institute
1776 I St., NW., Suite 400
Washington, DC 20006-3708