June 22, 2000

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

SUBJECT: BROWNS FERRY UNITS 1, 2 AND 3, INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS (IPEEE) AND RELATED GENERIC SAFETY ISSUES, ISSUANCE OF STAFF EVALUATION (TAC NOS. M83595, M83596, M83697)

Dear Mr. Scalice:

On June 28, 1991, the staff issued Supplement 4 of Generic Letter 88-20, "Individual Plant Examination of External Events for Severe Accident Vulnerabilities." The supplement requested licensees to address five external events (1) earthquakes, (2) internal fires, (3) high winds, (4) external flooding and (5) transportation and nearby facilities' accidents. Tennessee Valley Authority's (TVA's) responsive submittals came in several parts submitted at different times. One part (submitted on July 24, 1995) was the fire analysis for Unit 2, together with the high winds, floods, transportation and other external events portion for Units 1, 2, and 3. On June 28, 1996, TVA submitted the seismic portion for Units 2 and 3. On July 11, 1997, TVA submitted the fire portion for Unit 3. The staff has completed its review.

Details of the staff's review are provided in the enclosed Staff Evaluation Report (SER) and the Technical Evaluation Reports attached thereto. Based on its review, the staff considers, with the noted exceptions, the following issues to be resolved for Browns Ferry Units 2 and 3:

MPA B-118	Generic Letter 88-20, Supp. 4, IPEEE
USI A-45,	Shutdown Decay Heat Removal Requirements
GSI-131	Potential Seismic Interaction Involving the Movable In-core flux Mapping System Used in Westinghouse Plants (Not Applicable)
GSI-103	Design for Probable Maximum Precipitation
GSI-57	Effects of Fire Protection System Actuation on Safety-Related Equipment
FRSS	Fire Risk Scoping Study Issues of NUREG/CR-5088 (with the exception, as noted in the enclosure, of a portion dealing with misdirected manual fire suppression activities).
GSI-147	Fire-Induced Alternate Shutdown/Control Room Panel Interactions
GSI-148	Smoke Control and Manual Fire-Fighting Effectiveness (with the exception, as noted in the enclosure, of a portion dealing with misdirected manual fire suppression activities).
GSI-156	Systematic Evaluation Program

GSI-172 Multiple System Responses Program (this generic safety issue (GSI) has 11 subissues, some of which overlap other GSIs. All are resolved except that of common cause failures associated with human errors.)

The staff has not yet determined when or what additional actions, if any, may be initiated with respect to resolution of the two exceptions noted above. By this letter, we are closing the IPEEE TACs for all Browns Ferry units. TAC No. M83595, for Unit 1, although closed, is identified as a restart issue for Unit 1. If you have any questions regarding the enclosed SER, please contact me at 301-415-3026.

Sincerely,

/RA/

William O. Long, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-296 & 50-296

Enclosure: Staff Evaluation w/TERs

cc w/enclosure: See next page

GSI-172 Multiple System Responses Program (this generic safety issue (GSI) has 11 subissues, some of which overlap other GSIs. All are resolved except that of common cause failures associated with human errors.)

The staff has not yet determined when or what additional actions, if any, may be initiated with respect to resolution of the two exceptions noted above. By this letter, we are closing the IPEEE TACs for all Browns Ferry units. TAC No. M83595, for Unit 1, although closed, is identified as a restart issue for Unit 1. If you have any questions regarding the enclosed SER, please contact me at 301-415-3026.

Sincerely,

/RA/

William O. Long, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-296 & 50-296

Enclosure: Staff Evaluation w/TERs

cc w/enclosure: See next page

DISTRIBUTION:
PUBLIC
PDII-2 Reading
OGC
RCorreia
WLong
BClayton
ACRS
PFredrickson, RII
ARubin
ABuslik
LWiens
RHernan

Accession Number ML003725976

*See previous concurrence

OFFICE	PDII-2/PM		PDII-2/LA		PDII-2\SC			
NAME	WLong		BClayton		RCorreia/KNJ for			
DATE	06/15/00		06/15/00		06/21/00			

Official Record Copy

ENCLOSURE

STAFF EVALUATION REPORT (SER)

ON THE

INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS

FOR

THE BROWNS FERRY NUCLEAR PLANT UNITS 2 AND 3

STAFF EVALUATION
GENERIC LETTER 88-20 SUPPLEMENT 4
INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS
BROWNS FERRY NUCLEAR PLANT UNITS 2 AND 3

I. INTRODUCTION

On June 28, 1991, the U.S. Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 88-20, Supplement 4 (with NUREG-1407, Procedural and Submittal Guidance) requesting all licensees to perform individual plant examinations of external events (IPEEE) to identify plant-specific vulnerabilities to severe accidents and to report the results to the Commission together with any licensee-determined improvements and corrective actions. The IPEEE submittal for the Browns Ferry Nuclear Plant (BFN) consisted of several parts, submitted at different times. On July 24, 1995, the licensee, Tennessee Valley Authority (TVA), submitted the IPEEE fire analysis for BFN Unit 2, and the high winds, floods, transportation and other external events (HFO) portion of the analysis, for all three units. On June 28, 1996, TVA submitted the seismic IPEEE analysis for BFN Units 2 and 3, in a joint submittal which also addressed the Unresolved Safety Issue (USI) A-46, "Seismic Qualification of Equipment in Operating Plants." On July 11, 1997, TVA submitted the IPEEE fire analysis for BFN Unit 3. Unit 1 has been shut down since March 19, 1985, and no IPEEE fire and seismic analysis was submitted for Unit 1. Although the HFO portion of the IPEEE submittal covered all three units, the seismic and fire portions of the submittal covered only Units 2 and 3. Accordingly, this Staff Evaluation Report (SER) applies to Units 2 and 3.

The staff contracted with Brookhaven National Laboratory to conduct a screening review (a review for completeness and reasonableness) of the seismic portion of the licensee's IPEEE submittal and contracted with Sandia National Laboratories to conduct a screening review of the fire portion of the IPEEE submittal. The HFO portion of the IPEEE submittal was reviewed by the NRC staff. On the basis of the initial review of the IPEEE submittal, the staff sent a request for additional information (RAI) to the licensee. The licensee partially responded to this RAI in a letter dated November 25, 1998, and replied in full in a letter dated January 29, 1999. (The latter response is complete and incorporates the response of November 25, 1998.) Based on the results of the review of the original submittal and the responses to the requests for additional information, the staff concluded that the aspects of fire, earthquakes and HFO were adequately addressed. The review findings are summarized in the evaluation section below. Details of the contractors' and staff's findings are in the technical evaluation reports (TERs) attached to this staff evaluation report. There are separate TERs on the BFN Unit 2 and Unit 3 fire IPEEE analyses, since the two analyses were submitted on different dates.

An IPEEE Senior Review Board (SRB) was established and meets on a regular basis. The purposes of the SRB are (1) for the contractor (or the staff, if the staff has performed the review) to present the findings and conclusions of its review and the bases for its conclusions, and (2) for the SRB members to provide their perspectives on the contractor's (or staff's) finding and conclusions and to make recommendations based on their technical expertise. In this manner, the SRB provides additional assurance that (1) the scope of the review meets the

objectives of the program, and (2) critical issues that have the potential to mask vulnerabilities are not overlooked.

II. EVALUATION

BFN consists of three General Electric boiling water reactors with Mark I containments. Units 2 and 3 each have a licensed power rating of 3458 MWt. Commercial operation of Units 1, 2 and 3 began on August 1, 1974, March 1, 1975, and March 1, 1977, respectively. The BFN site is located on the north shore of Wheeler Lake in north Alabama. It is approximately 10 miles southwest of Athens, Alabama, and 10 miles northwest of Decatur, Alabama.

Core Damage Evaluation

Seismic

The three BFN units are binned in the 0.3g focused-scope category of NUREG-1407. The design basis earthquake (DBE) for each unit has a peak ground acceleration (pga) of 0.20g, defined at the top of sound rock. The licensee evaluated the seismic risk for BFN Units 2 and 3 by using the Seismic Margins Assessment (SMA) methodology as given in Electric Power Research Institute (EPRI)-NP-6041. Because of the nature of the evaluation method used, a seismic core damage frequency was not calculated. The licensee states that the high-confidence-of-low-probability-of-failure (HCLPF) capacities of all components on the safe shutdown equipment list (SSEL) are at least equal to the review level earthquake (RLE) pga of 0.3g, except for two 4kV/480V transformers, located in the Units 1 and 2 diesel generator building. The licensee states that these transformers have an HCLPF capacity of 0.26g pga, and that the HCLPF capacity for Units 2 and 3 is at least 0.26g. Moreover, the seismic IPEEE report for BFN Units 2 and 3 ("Seismic IPEEE Report Browns Ferry Nuclear Plant," June 1996, Revision 0) notes, on page 44, that these transformers will be replaced eventually as part of their long-term PCB and asbestos removal program. The attached TER on the seismic portion of the IPEEE states that the licensee's estimate of plant HCLPF appears reasonable. Therefore, the staff considers that BFN Units 2 and 3 each have an HCLPF capacity close to the RLE pga of 0.3g, at the present time, and do not have a vulnerability with respect to seismic core damage frequency. After the transformers are replaced, the HCLPF capacity of all SSEL equipment will exceed 0.3g, at both Unit 2 and Unit 3.

Fire

The licensee's fire assessments for BFN Units 2 and 3 is based on EPRI's Fire-Induced Vulnerability Evaluation (FIVE) methodology, supplemented with information from the Individual Plant Evaluation (IPE); the IPE information was used to calculate the conditional core damage probabilities, given a fire which fails specified targets. The TER (Attachment 1, Accession No. ML003720987) on the BFN Unit 2 fire IPEEE submittal gives the core damage frequency (CDF) from fire as less than 1.24E-5 per year (see Section 2.1.7 of the TER, and the accompanying table.) The fire CDF value was obtained by summing the contributions to the CDF over all fire zones. Since some of the contributions to the CDF were upper bound screening values, the sum is likely an overestimate of the true contribution to the CDF from all fires, and therefore the total fire CDF is given as less than 1.24E-5 per year. This value of the fire CDF includes changes made by the licensee in a response (dated January 29, 1999) to an

RAI; the response to the RAI modified the contribution to the Unit 2 CDF from Unit 2 control room fires. It also includes the contribution of Unit 1 control room fires to the Unit 2 CDF; this contribution was not included in the response to the RAI (for details, see the Attachment 1 TER on the BFN Unit 2 IPEEE fire submittal). Since the estimates of CDF contributions from some fire locations were upper bound screening values, the licensee judges that the total fire CDF obtained by summing the results over all fire scenarios is a considerable overestimate.

Using the licensee's values for the CDF contribution from each fire location, and summing the results, one obtains about 8E-6 per year for BFN Unit 3, after revisions which the licensee made in the RAI response dated January 29, 1999. Again, the licensee judges that this total fire CDF is a considerable overestimate.

High Winds, Floods, Transportation, and Other (HFO) External Events

These events were screened out in a manner consistent with the guidance given in NUREG-1407, and a contribution to the core damage frequency was not obtained.

Dominant Contributors

Seismic

Because an SMA approach was used, CDF contributions from dominant sequences were not obtained. Bounding calculations showed that, except for two 4kV/480V transformers, the HCLPF capacity of all other items on the SSEL exceeded 0.3g pga. The two transformers were estimated to have an HCLPF of 0.26g pga, so these were nominally the weakest components, but it is not possible to estimate their contribution to the core damage frequency, because an SMA approach was used for the seismic analysis. These transformers will be replaced as part of the long-term asbestos removal program. The licensee did not give HCLPF values for the other equipment on the SSEL, but just noted that the HCLPF values exceeded 0.3g. Therefore, there is insufficient information to determine the weakest components once the transformers are replaced.

Fire

For BFN Unit 2, the Unit 2 Control Room was the dominant fire location, with a contribution to the CDF of 3E-6 per year, according to the licensee's revised analysis given in the RAI response of January 29, 1999. In addition (see "Core Damage Evaluation," above, and Attached 1 on the BFN Unit 2 IPEEE fire analysis), the staff and its contractors estimate a fire in the Unit 1 control room contributes 2.6E-6 per year to the CDF for BFN Unit 2. The licensee estimates that fires in the Unit 2 Battery Room contribute about 5.5E-7 per year to the CDF.

For BFN Unit 3, the Unit 3 control room was the dominant fire location, with a contribution to the CDF of 3E-6 per year according to the licensee's revised analysis given in the RAI response of January 29, 1999. Fires in the transformer yard propagating to the turbine building contribute 8E-7 per year to the CDF for BFN Unit 3, according to the licensee's analysis. The licensee estimated that fires originating in the turbine building contribute about 7E-7 per year to the CDF for BFN Unit 3.

HFO

By the nature of the screening approach used by the licensee, dominant contributors were not obtained.

Assessment of Licensee's Determination of Dominant Contributors

The seismic analysis was an SMA; it is, therefore, not possible to determine the dominant contributors to the seismic core damage frequency. However, the seismically weakest components are the components with lowest HCLPF values. These were identified as two transformers, but these transformers were scheduled to be replaced. The licensee appears to have identified these seismically weakest components correctly, for BFN Units 2 and 3. With respect to fire, the licensee appears to have identified the dominant accident sequences for BFN Units 2 and 3, except for the identification of the contribution to the Unit 2 CDF from a fire in the Unit 1 control room. This appears to be a documentation oversight in the RAI response dated January 29, 1999. For HFO events, dominant accident sequences were not developed. The licensee's HFO evaluation appears to be consistent with the guidance given in NUREG-1407, and the staff believes that no severe accident vulnerabilities were overlooked in the licensee's HFO analysis for BFN Units 1, 2, and 3.

Containment Performance

Seismic

Containment performance for seismic events is discussed in Section 9 of the seismic IPEEE report. In accordance with the guidance given in NUREG-1407, a walkdown was performed to evaluate any possible unusual conditions, such as spatial interactions or unique penetration configurations. Penetration cooling systems were determined not to be necessary for the safe operation of the plant or for the maintenance of containment integrity. Relay chatter, which could cause containment isolation system failures by containment system actuations, was evaluated. No vulnerabilities with respect to containment integrity were found by the licensee, for BFN Units 2 and 3. For more information, see the Attachment 2 TER (Accession No. ML003721066) on the seismic portion of the IPEEE for BFN Units 2 and 3.

Fire

The licensee's evaluation of containment performance for fires is discussed in Section 2.3 of the Attachment 1 TER on the fire portion of the IPEEE BFN Unit 2 submittal, and in Section 2.3 of the Attachment 3 TER (Accession No. ML003721076) on the fire portion of the IPEEE BFN Unit 3 submittal. The licensee noted (see Section 8.1 of the Unit 2 fire submittal, and the same section of the Unit 3 fire submittal) that the frequency of loss of safe shutdown capability at BFN is less than 1E-6 per year per fire area or compartment. Therefore, the licensee concluded that, since the fire CDF for each location was so small, it was not necessary to evaluate containment performance, except for containment bypass sequences. The licensee's revision of the analysis for control room fires (in the January 29, 1999, response to an RAI, Accession No. 9902080134) means that fires in the Unit 2 control room contribute about 3E-6 per year to the core damage frequency for Unit 2, and the staff's analysis of fires in the Unit 1 control room, along the same lines as the licensee's analysis for a Unit 2 control room fire, show that a Unit 1

control room fire contributes almost 3E-6 per year to the Unit 2 CDF. This means that, strictly speaking, the licensee should have evaluated containment performance for control room fire core damage sequences. However, the Unit 2 CDF contributions from the Unit 1 and Unit 2 control room fires are close to 1E-6 per year, so the omission of the evaluation of the non-containment-bypass modes of containment failure for control room fire core damage sequences is not a serious weakness in the licensee's analysis for BFN Unit 2. Similar comments hold for the licensee's Unit 3 containment performance evaluation, since the contribution to the fire CDF was revised to 3E-6 per year in the January 29, 1999, response to an RAI.

The licensee used a more stringent criterion for containment bypass than for other containment failure modes (see Section 5.3 of the BFN Unit 2 fire IPEEE submittal). Here, the licensee, using guidance in the EPRI Fire Probabilistic Risk Assessment (PRA) Implementation Guide, used a 1E-7/yr screening criterion for containment bypass sequences. The licensee evaluated, for BFN Unit 2, two fire areas with screening CDF values in excess of 1E-7 per year, and found that the equipment impacted by fires in these areas would not lead to containment bypass. However, the licensee did not, in its containment performance evaluation, evaluate the control room fire core damage scenarios for containment bypass. These sequences contributed less than 1E-7 per year in the original analysis. However, in the revised analysis submitted by the licensee in the January 29, 1999, response to an RAI, the licensee estimated a Unit 2 CDF contribution from a Unit 2 control room fire of 3E-6 per year, and consequently containment bypass sequences should have been evaluated. Moreover, the staff estimates a Unit 1 control room fire contributes about 3E-6 per year to the Unit 2 CDF. Consequently, control room fire core damage sequences should have been evaluated for containment bypass. Nevertheless, it appears that, except for additional random failures such as a stuck open relief valve coupled with failure of main steam isolation (which would have low probabilities), the only way a fire in the control room could result in a containment bypass scenario is by a high-low pressure system spurious actuation resulting in an interfacing LOCA. This was considered, to a certain extent, by the licensee in the response dated January 29, 1999, to Question 6 of an RAI, and was considered in much more detail in the licensee's Appendix R fire protection report. The conditional probability of such a containment bypass scenario given a control room fire seems very low. The same comments hold for BFN Unit 3. Therefore, the staff considers that the licensee did not overlook any unique fire-related containment performance vulnerability at BFN Unit 2 or Unit 3.

HFO

NUREG-1407 does not require a containment performance analysis for HFO events if the screening criteria given in Chapter 5 of NUREG-1407 are met. Since the BFN HFO analysis is consistent with the guidance given in NUREG-1407, no containment performance analysis is required.

Assessment of Licensee's Containment Performance Analysis

The licensee’s containment performance analyses do not appear to have significant weaknesses and are consistent with the intent of Supplement 4 to GL 88-20.

Generic Safety Issues

As a part of the IPEEE, a set of generic and unresolved safety issues (USI A-45, GSI-131, GSI-103, GSI-57, and the Sandia Fire Risk Scoping Study (FRSS) issues) were identified in Supplement 4 to GL 88-20 and its associated guidance in NUREG-1407 as needing to be addressed in the IPEEE. The staff's evaluation of these issues is provided below.

1. USI A-45, "Shutdown Decay Heat Removal Requirements"

The licensee performed an acceptable SMA for BFN Units 2 and 3, and found that the HCLPF for the components in the SSEL will essentially meet the pga of 0.3g associated with the RLE, given the plant modifications performed for USI A-46. These plant modifications have already been completed (Ref: Staff Safety Evaluation for USI A-46 Program Implementation at Browns Ferry Nuclear Plant, Units 2 and 3" issued March 21, 2000, ADAMS Accession No. ML003691720). Therefore, with high confidence, the components in the SSEL will perform successfully, given the RLE seismic event. Proper functioning of the components in the SSEL means that shutdown decay heat removal can be performed successfully for an RLE, and implies that there are no decay heat removal vulnerabilities for seismic events.

The fire PRAs performed by the licensee for BFN Units 2 and 3 would, in the staff's judgment, find any vulnerabilities associated with loss of decay heat removal as a result of fires.

Similarly, the licensee's HFO analysis for BFN Units 1, 2, and 3 would, in the staff's judgment, identify any vulnerabilities associated with loss of decay heat removal initiated by HFO events. No vulnerabilities were found.

Since the staff judges that the process used by the licensee is capable of finding decay heat removal vulnerabilities, and no vulnerabilities were found, the staff considers that the external events aspects of USI A-45 are resolved for BFN Units 2 and 3.

2. GSI-131, "Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System Used in Westinghouse Plants"

The Browns Ferry Units are General Electric boiling water reactors, and, therefore, this issue is not applicable.

3. GSI-103, "Design for Probable Maximum Precipitation (PMP)"

This issue concerns itself with the fact that the National Weather Service has developed new PMP criteria, which give higher rainfall intensities over shorter time intervals and smaller areas than had previously been considered. Section 2.4 of NUREG-1407 requests that licensees assess the effects of these new PMP criteria in terms of onsite flooding from flood runoff and site ponding, and in terms of greater roof ponding. More information on this issue is given in GL 89-22.

In the response dated January 29, 1999, to an RAI, the licensee pointed out that Hydrometeorological Report HMR-56, used in the BFN IPEEE report, addresses the concerns of GSI-103.

On the basis that the licensee's treatment of the PMP event is consistent with the guidance provided in Section 6.2.2.3 of NUREG-1407, and on the basis that no vulnerabilities were found, the staff considers that GSI-103 is resolved for BFN Units 2 and 3.

4. GSI-57, "Effects of Fire Protection System Actuation on Safety-Related Equipment"

Inadvertent actuation of fire suppression equipment could be initiated as a result of a seismic event. NUREG-1472, which presents the regulatory analysis for GSI-57, concludes that the dominant risk contributor associated with inadvertent fire protection system actuation is seismic actuation of the fire protection system.

Seismic actuation of the fire protection system is discussed in Section 8.2.1.2 of the IPEEE fire submittal for BFN Unit 2 and in the same section of the IPEEE fire submittal for BFN Unit 3. It is noted in these sections of the IPEEE submittals that fire suppression damage evaluations have been made as part of the Appendix R analysis for BFN. This analysis concluded that spurious discharge of water from fire suppression systems will have no adverse impact on the safe shutdown capability of the plant.

The staff finds that the licensee’s GSI-57 evaluation is adequate and would likely have found any vulnerabilities if they existed. No vulnerabilities were found. Therefore, the staff considers this issue resolved for BFN Units 2 and 3.

5. Fire Risk Scoping Study (FRSS) Issues

Several of these issues are also GSIs which are discussed separately. These generic issues include GSI-57, discussed above; GSI-148, "Smoke Control and Manual Fire Fighting Effectiveness"; and GSI-147, "Fire-Induced Alternate Shutdown/Control Room Panel Interactions." The FRSS issues are discussed in Section 8.2 of the IPEEE fire submittal for Unit 2, and the same section of the IPEEE fire submittal for Unit 3. The licensee's analysis followed the guidance given in the FIVE methodology, which has been accepted by the staff. However, a part of GSI-148 concerns misdirected manual fire suppression activities caused by smoke. The smoke can cause obscuration of vision to the point where the fire source cannot be located. As a result, misdirected manual fire suppression could damage equipment not damaged by the fire. This part of GSI-148 is not addressed by the FIVE methodology, and is not addressed by the licensee in their IPEEE fire analyses for BFN Units 2 and 3. For the other FRSS issues, the staff considers these issues to be resolved for BFN Units 2 and 3 on the basis that the licensee used an acceptable methodology for evaluating these issues, and the licensee found no plant vulnerabilities in their evaluation.

Other Generic Safety Issues

In addition to those safety issues discussed above that were explicitly requested in Supplement 4 to GL 88-20, four generic safety issues were not specifically identified as issues to be resolved under the IPEEE program; thus, they were not explicitly discussed in Supplement 4 to GL 88-20 or NUREG-1407. However, subsequent to the issuance of the generic letter, the NRC evaluated the scope and the specific information requested in the generic letter and the associated IPEEE guidance, and concluded that the plant-specific analyses being requested in the IPEEE program could also be used, through a satisfactory IPEEE submittal review, to resolve the external event aspects of these four safety issues. The following discussions summarize the staff's evaluation of these safety issues for BFN Units 2 and 3.

1. GSI-147, "Fire-Induced Alternate Shutdown/Control Room Panel Interactions"

This issue includes the following:

- Electrical independence of remote shutdown control circuits
- Loss of control power before transfer from the main control room to the alternate shutdown panel
- Total loss of system function
- Spurious actuation of components

This issue is discussed in Section 8.2.5 of the IPEEE fire submittal for BFN Unit 2, and in the same section of the IPEEE fire submittal for BFN Unit 3. The submittals state that the remote shutdown system provides for plant monitoring and control stations from which to perform a safe shutdown of the plant from outside the control bay in the event of control system damage due to a fire in the control room, cable spreading room, or the 593-foot elevation of the control building; state that Section 7.18 of the Updated Final Safety Analysis report describes the remote shutdown capability; and state that this capability is implemented by the abnormal operating procedures for control room abandonment. Because of the lack of detail in the IPEEE fire submittals, an RAI was sent which asked for a description of the procedures for dealing with these issues and the location of important equipment. As noted in the two TERs on the fire portions of the IPEEE submittals, a satisfactory response to the RAI was obtained.

The staff judges that the licensee has adequately addressed this issue, and considers it resolved for BFN Units 2 and 3.

2. GSI-148, "Smoke Control and Manual Fire-Fighting Effectiveness"

As already noted above, under the discussion of the FRSS issues, the issue of smoke-induced misdirected fire suppression activities, which is part of GSI-148, was not considered by the licensee. Other aspects of manual fire-fighting effectiveness are generally not relevant to the licensee's analysis, since manual fire fighting is not

explicitly credited in the fire scenarios, except for the control bay, control room, and cable spreading room. In Section 8.2.3 of the BFN Unit 2 IPEEE fire submittal, and the same section of the BFN Unit 3 IPEEE fire submittal, the licensee addresses the steps taken at the plant to improve manual fire fighting effectiveness. Section 2.2.4 of the TER on the fire portion of the BFN Unit2 IPEEE submittal, and the same section of the TER on the fire portion of the BFN Unit 3 IPEEE submittal further evaluate the licensee's treatment of this issue.

On the basis of the information presented by the licensee, the staff considers GSI-148 resolved for BFN Units 2 and 3, except for the part of the issue dealing with misdirected manual fire suppression activities that could potentially fail equipment that is not failed by the fire.

3. GSI-156, "Systematic Evaluation Program (SEP)"

The SEP issues are a set of issues associated with plants that were licensed prior to the time the 1975 Standard Review Plan was issued.

- Settlement of Foundations and Buried Equipment

  Supplement 5 to GL 88-20 states that soil-related failures need not be evaluated for focused-scope plants.

- Dam Integrity and Site Flooding

  Failure of the Wheeler Dam was addressed in the IPEEE submittal on HFO events, on p. 5-33, and it was concluded that failure of the dam would result in the need to shut down the BFN; it could be maintained indefinitely in a safe shutdown condition. As noted on p. 5-24 of the IPEEE submittal on HFO events, failure of the Guntersville Dam upstream of the plant, if it occurred at the most unfavorable time, would lead to a flood crest no greater than elevation 563.5 feet, including wind effects. The probable maximum flood level for the plant is 572.5 feet, and the safety-related structures are protected against all flood conditions up to elevation 578 feet (see p. 5-34 of the IPEEE submittal on HFO events). The licensee, in their response to an RAI on seismically-induced external flooding (see p. 7 of the January 29, 1999, response), noted that the probable maximum flood for the BFN considered failure of the earth sections of Fort Loudoun, Watts Bar, Chickamauga, Nickajack, and Guntersville Dams upstream.

- Site Hydrology and Ability to Withstand Floods

  The IPEEE HFO analysis for BFN Units 2 and 3 includes a satisfactory screening analysis of external floods, consistent with NUREG-1407 guidelines. The licensee has also satisfactorily addressed the PMP event (see GSI-103 discussion, above).

- Industrial Hazards

  The IPEEE submittal, together with the January 29, 1999, response to an RAI (HFO Question 2) presents an adequate analysis of these hazards, consistent with NUREG-1407 guidelines, for BFN Units 2 and 3.

- Tornado Missiles

  The effects of tornado missiles appear to have been satisfactorily considered in the HFO analysis, as is discussed in the attached TER on the HFO portion of the analysis for BFN Units 2 and 3.

- Severe Weather Effects on Structures

  The effects of high winds and floods were satisfactorily analyzed in the HFO section of the IPEEE submittal for BFN Units 2 and 3.

- Design Codes, Criteria, and Load Combinations

  Since the IPEEE submittal presents a satisfactory analysis of seismic events and HFO events for BFN Units 2 and 3, and found no vulnerabilities, it can be inferred that the Category I structures have adequate capacity.

- Seismic Design of Structures, Systems, and Components (SSCs)

  Since the seismic IPEEE submittal for BFN Units 2 and 3 presents a satisfactory analysis of seismic events, and found no vulnerabilities, it can be inferred that the seismic design of SSCs is adequate at BFN Units 2 and 3.

- Shutdown Systems and Electrical Instrumentation and Control Features

  A satisfactory IPEEE analysis, as was done by the licensee for BFN Units 2 and 3, automatically includes the study of systems required to remove decay heat, and the instrumentation and control systems required for safe shutdown.

Based on the overall results of the IPEEE submittal review, the staff considers that the licensee's process is capable of identifying potential vulnerabilities associated with GSI-156. On the basis that no potential vulnerability associated with these issues was identified in the IPEEE submittal, the staff considers the IPEEE-related aspects of these issues resolved for BFN Units 2 and 3.

4. GSI-172, "Multiple System Responses Program (MSRP)"

- Effects of fire protection system actuation on non-safety-related and safety-related equipment

This is issue GSI-57, and is discussed under that heading. See also Section 2.2.2 of the attached TER on the fire portion of the IPEEE for BFN Unit 2, and the same section of the attached TER on the fire portion of the IPEEE for BFN Unit 3.

- Seismically-induced fire suppression system actuation

  This is also part of GSI-57, and is discussed under that heading.

- Seismically-induced fires

  This is an FRSS issue. Seismically-induced fires were addressed in the seismic capability walkdowns performed as part of the seismic IPEEE for BFN Units 2 and 3 (see Section 8.2 of the seismic IPEEE submittal for BFN Units 2 and 3). The attached TER on the fire IPEEE submittal for BFN Unit 2 discusses seismically-induced fires in Section 2.2.5, the attached TER on the fire IPEEE submittal for BFN Unit 3 discusses seismically-induced fires in the same section, and the attached TER on the seismic portion of the IPEEE for BFN Units 2 and 3 discusses seismically-induced fires in Section 2.11.

- Effects of hydrogen line rupture

  As noted in Section 2.2.7 of the attached TER on the fire IPEEE submittal for BFN Unit 2, and the same section of the attached TER on the fire IPEEE submittal for BFN Unit 3, ruptures of hydrogen lines were not discussed in the submittal. However, it is noted in Section 8.2 of the seismic IPEEE submittal for BFN Units 2 and 3 that during the seismic walkdowns obvious sources of combustion were subjectively evaluated. This would include hydrogen lines. As for non-seismically induced failures of hydrogen lines, the licensee followed the FIVE methodology to perform the fire hazards evaluation at BFN Units 2 and 3. Since Table 1.2 of FIVE (EPRI-TR-100370) lists miscellaneous hydrogen fires as a fire source to be considered, it can be inferred that fires caused by valve and piping failures in hydrogen lines were considered in the IPEEE fire analyses for BFN Units 2 and 3.

- The IPEEE-related aspects of common cause failures associated with human errors

  This issue, as far as external events are concerned, refers to whether the treatment of human errors in an external-event-initiated accident sequence properly takes into account the impact of the external event on human actions.

  The IPEEE seismic analysis for BFN Units 2 and 3 used the seismic margins approach and, as such, does not explicitly treat human error. According to the guidance given in Section 3.2.5.8 of NUREG-1407, success paths should be chosen based on a screening criterion applied to nonseismic failures and needed human actions, and the failure modes and human actions should be clearly identified and have low enough probabilities to not affect the seismic margins evaluation. In the January 29, 1999, response to an RAI, the licensee identified the operator actions necessary for safe shutdown after an earthquake, and estimated the associated human errors probabilities. The licensee judged the human error probabilities sufficiently low so as not to affect the seismic margins assessment. The licensee's estimates of human error probabilities do not

appear to take into account the effect of the earthquake, and were taken directly from the BFN Individual Plant Examination. Section 2.10 of the attached TER on the seismic portion of the IPEEE submittal evaluates the licensee's treatment of human error after a seismic event.

As noted in Section 2.2.8 of the attached TERs on the BFN Units 2 and 3 fire IPEEE submittals, the IPEEE fire submittals do not discuss the impact of the fire on the human errors. An RAI response (response dated January 29, 1999, to fire question No. 5) noted that no new human reliability analysis was performed for the IPEEE fire studies for BFN Units 2 and 3. The response noted that most human actions take place in the control room, and stated that such actions would not be impacted by a fire outside the control room. However, it appears that actions which require the operators to pass through areas where there is a fire were not reevaluated, and the human error probabilities for such actions were not adjusted to account for the fire. The RAI response noted that recovery was credited for equipment in the same room as the fire, but not impacted by the fire. In such cases, the recovery probability was modified from the IPE value. It is not clear how this was done, since the response also states that separate human action evaluations were not performed for the IPEEE fire evaluation.

This issue is not resolved for BFN.

- Non-safety-related control system/safety-related system dependencies

  As far as the IPEEE is concerned, this issue reduces to that of seismically induced spatial and functional interactions, an MSRP issue discussed below, and GSI-147, on fire-induced alternate shutdown and control room panel interactions, which has already been discussed.

- Effects of flooding and/or moisture intrusion on non-safety related and safety-related equipment

  Flooding from external floods is discussed in the HFO portion of the IPEEE (see Section 5.2); the staff evaluation is given in the Attachment 4 TER on the HFO portion of the IPEEE submittal (“Technical Evaluation Report on the High Winds, Floods, Transportation and Other External Events (HFO) Portion of the Browns Ferry Nuclear Power Station Units 1, 2 and 3 IPEEE Submittal,” Accession No. ML003721099). Flooding from the actuations of fire protection systems is a GSI-57 issue, and is discussed under that heading. Seismically induced flooding is discussed below, under "Seismically induced flooding."

- Seismically induced spatial and functional interactions

  Seismically induced spatial interactions were addressed by the licensee in the seismic walkdowns, and are discussed in Section 5.4 of the IPEEE seismic submittal for BFN Units 2 and 3. Functional interactions are incorporated in the SSEL.

- Seismically induced flooding

Seismically induced flooding was addressed in the seismic capability walkdowns performed as part of the seismic IPEEE, and is discussed in Section 5.4 of the IPEEE submittal for BFN Units 2 and 3.

- Seismically-induced relay chatter

  Seismically-induced relay chatter is discussed in the "Relay Evaluation Report for USI A-46 and IPEEE, Browns Ferry Nuclear Plant, Units 2 and 3," submitted together with the IPEEE seismic submittal for BFN Units 2 and 3, and in Section 7 of the IPEEE seismic submittal for BFN Units 2 and 3. The licensee's relay chatter evaluation is discussed in Section 2.8 of the attached TER on the seismic portion of the IPEEE submittal. For a focused scope plant, if low-seismic-ruggedness relays are discovered during the USI A-46 reviews, the relay review should be expanded to include relays outside the scope of USI A-46 but within the scope of the IPEEE. The Relay Evaluation Report notes that there are 84 potential relay outliers (including both the USI A-46 relays, and all relays examined for the IPEEE). The safety evaluation report for the BFN Units 2 and 3 USI A-46 program (Memorandum from E. Imbro to H. Berkow, dated March 1, 2000) noted that the licensee has completed resolution of all 84 relay outliers. This item is resolved for BFN Units 2 and 3.

- Evaluation of earthquake magnitudes greater than the safe shutdown earthquake (SSE)

  The licensee used a seismic margins approach with a 0.3 pga RLE. Earthquake magnitudes greater than the SSE are included because the RLE pga is higher than the SSE (or DBE) pga of 0.2g.

Based on the overall results of the IPEEE submittal review, the staff considers that the licensee's process is capable of identifying potential vulnerabilities associated with GSI-172 at BFN Units 2 and 3, except for the IPEEE-related aspects of common cause failures associated with human errors. Since no potential vulnerability associated with these issues was identified in the IPEEE submittal, the staff considers the IPEEE-related aspects of these issues resolved for BFN Units 2 and 3, except for the issue on common cause human errors.

Unique Plant Features, Potential Vulnerabilities, and Improvements

The BFN Unit 2 and 3 fire IPEEE submittals noted that the essential switchgear rooms had low conditional core damage frequencies, because of the large amount of partitioning between divisions and trains at BFN (see p. 7-6 of the Unit 3 fire IPEEE submittal). The licensee did not define the term vulnerability, but used the term in the fire IPEEE submittals for BFN Units 2 and 3. The licensee states that there were no vulnerabilities with respect to fire. The licensee states that no plant weaknesses were found in the HFO analysis, which is equivalent to stating that there are no plant vulnerabilities with respect to HFO events. In the seismic portion of the IPEEE submittal, the licensee stated that the plant HCLPF value was essentially the RLE, which implies the plant has no vulnerabilities with respect to seismic events. No plant modifications were found to be necessary as a result of the fire IPEEE for BFN Units 2 and 3. However, the submittals noted that plant training should continue to ensure that the fire brigade is cognizant of the fire hazards of oil filled transformers and reactor recirculation motor generator sets. The only seismic IPEEE improvements directly attributable to the seismic IPEEE are two valve

operators whose seismic capacities were upgraded (see Section 2.13 of the attached TER on the seismic IPEEE for BFN Units 2 and 3, and Section 11 of the seismic IPEEE submittal for BFN Units 2 and 3).

III. CONCLUSIONS

On the basis of the above findings, the staff notes that the IPEEE results are reasonable given the BFN Units 2 and 3 design, operation, and history. Therefore, the staff concludes that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities, and therefore, that the BFN Units 2 and 3 IPEEE submittals have met the intent of Supplement 4 to GL 88-20. The specific GSIs discussed in this SER are considered resolved by the staff, except for the portion of GSI-148 (and the associated FRSS issue) related to misdirected manual fire suppression, and the MSRP issue on the IPEEE-related aspects of common cause failures associated with human errors. The need for any additional assessment or actions related to the resolution of these issues for BFN Units 2 and 3 will be addressed by the NRC staff separately from the IPEEE program.

It should be noted that the staff focused its review primarily on the licensee's ability to examine BFN Units 2 and 3 for severe accident vulnerabilities. Although certain aspects of the IPEEE submittals were explored in more detail than others, the review was not intended to validate the accuracy of the licensee's detailed findings (or quantification estimates) that underlie or stemmed from the examination. Therefore, this SER does not constitute NRC approval or endorsement of any IPEEE material for purposes other than those associated with meeting the intent of Supplement 4 to GL 88-20 and the resolution of specific generic safety issues discussed in this SER.

Principal Contributor: A. Buslik, RES/DRAA/PRAB

Attachments: Technical Evaluation Reports (4)

ATTACHMENT 1

TECHNICAL EVALUATION REPORT

ON THE FIRE PORTION OF

THE BROWNS FERRY NUCLEAR PLANT UNIT 2

INDIVIDUAL PLANT EXAMINATION FOR EXTERNAL EVENTS

Accession No. ML003720987

ATTACHMENT 2

TECHNICAL EVALUATION REPORT

ON THE SEISMIC PORTION OF

THE BROWNS FERRY NUCLEAR PLANT UNITS 2 AND 3

INDIVIDUAL PLANT EXAMINATION FOR EXTERNAL EVENTS

Accession No. ML003721066

ATTACHMENT 3

TECHNICAL EVALUATION REPORT

ON THE FIRE PORTION OF

THE BROWNS FERRY NUCLEAR PLANT UNIT 3

INDIVIDUAL PLANT EXAMINATION FOR EXTERNAL EVENTS

Accession No. ML003721076

ATTACHMENT 4

TECHNICAL EVALUATION REPORT

ON THE

HIGH WINDS, FLOODS, TRANSPORTATION

AND

OTHER EXTERNAL EVENTS (HFO)

PORTION OF

THE BROWNS FERRY NUCLEAR POWER STATION UNITS 1, 2, AND 3

INDIVIDUAL PLANT EXAMINATION FOR EXTERNAL EVENTS (IPEEE)

Accession No. ML003721099

Mr. J. A. Scalice
Tennessee Valley Authority

BROWNS FERRY NUCLEAR PLANT

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

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

Mr. John T. Herron, Site Vice President
Browns Ferry Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Decatur, AL 35609

General Counsel
Tennessee Valley Authority
ET 10H
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. N. C. Kazanas, General Manager
Nuclear Assurance
Tennessee Valley Authority
5M 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
l0833 Shaw Road
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