



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

STAFF EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO BROWNS FERRY, UNIT 3, NUCLEAR POWER PLANT

INDIVIDUAL PLANT EXAMINATION

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 3

DOCKET NO. 50-296

A. INTRODUCTION

The Browns Ferry nuclear (BFN) site consists of three boiling-water reactor (BWR) Mark I units. The following provides a background and history of the Individual Plant Examination (IPE) review for BFN Unit 3.

- On September 6, 1991, the U.S. Nuclear Regulatory Commission (NRC) staff met with the Tennessee Valley Authority (TVA) to discuss NRC's request, subsequently summarized in writing on November 1, 1991, to perform a probabilistic risk assessment (PRA) for Units 1 and 3 (the Unit 2 IPE PRA was already scheduled to be submitted in September 1992).
- In a letter dated February 7, 1992, TVA committed to provide a multi-unit PRA (MUPRA), which, while not a PRA for each unit, would address the change in Unit 2 core damage frequency (CDF) associated with all three units in operation. Although originally committed by TVA as a limited scope PRA covering selected systems and only a few initiating events, as ultimately submitted on April 14, 1995, it covered a more comprehensive list of initiating events and systems.
- On September 1, 1992, TVA submitted a PRA for BFN, Unit 2, (Rev. 0) in response to Generic Letter (GL) 88-20. At that time, Units 1 and 3 were shut down. The IPE submittal did not include multi-unit operation. It consisted of a Level 1 PRA, along with a limited containment analysis, which assumed only Unit 2 in operation and Units 1 and 3 shutdown.
- On September 28, 1994, the NRC issued its staff evaluation (SE) covering the BFN, Unit 2, PRA (Rev. 0). The NRC noted that closure of IPE activities for the BFN site was dependent on receipt and review of the MUPRA. The SE concluded that TVA had provided the information sought by GL 88-20 for BFN Unit 2, but requested that TVA address two potential containment performance improvement (CPI) enhancements for Unit 2 (use of a diesel-driven fire pump for vessel injection, and installation of an alternate power source for automatic depressurization system solenoid valves) in the multi-unit analysis. Thus, the September 28, 1994, SE concluded IPE activities for BFN Unit 2, pending submission of additional information on the CPI enhancements. BFN Units 1 and 3 IPE activities remained open pending receipt and review of additional information such as the MUPRA.

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Enclosure

- On April 14, 1995, TVA submitted the MUPRA, estimating the effect of operation of all three BFN reactors on core damage frequency for Unit 2. It was based on a revised version (Rev. 1) of the original (Rev. 0) Unit 2 PRA which was performed to account for plant changes since the IPE. The MUPRA submittal also provided the information requested by the staff in the September 28, 1994, staff evaluation addressing the two containment performance improvement items discussed above for Unit 2, closing out the IPE open items for that unit.
- On June 19, 1997, the staff issued a request for additional information (RAI) to TVA subsequent to its review of the MUPRA for applicability to Unit 3.
- On July 7, 1997, TVA submitted a letter to NRC declining to provide a response to the staffs RAI (their reasons are discussed in Section II).
- On February 25, 1997, NRC requested a copy of the Unit 3 PRA, which TVA developed for purposes other than the IPE program. It was made available on August 6, 1997. The staff reviewed the Unit 3 PRA to determine the extent to which it, in conjunction with the MUPRA, met the intent of GL 88-20. The staff reviewed the Unit 3 PRA to determine if it accounted for: Unit 3 plant-specific features, the treatment of shared systems between units, and the impact on Unit 3 system success criteria with Unit 1 remaining in lay-up.

## B. EVALUATION

At issue is whether the MUPRA or the Unit 3 PRA has provided an adequate basis for assessing whether Unit 3 has met the intent of GL 88-20. Unit 1 is currently defueled and in a lay-up condition with no immediate restart prospects, so it is not addressed here. To help determine its adequacy for Unit 3, the staff reviewed the MUPRA despite the fact that it was not in the format recommended in NUREG-1335 and did not provide all the information requested in the report. The review was conducted to ascertain the adequacy of the MUPRA, and TVA's use of it, in identifying potential Unit 3 vulnerabilities, and, if identified, to evaluate cost-effective plant improvements proposed to rectify them. An RAI was issued on June 19, 1997. The RAI focused on two broad areas of inquiry: (1) the appropriateness of the MUPRA as an integrated plant evaluation of Unit 3, and (2) the overall technical quality of the MUPRA.

In their response, dated July 7, 1997, TVA declined to provide responses to the RAI. In declining to address the issues raised in the RAI, TVA expressed their belief that no additional staff review was warranted for the Browns Ferry site and that "there is no necessity for performing any additional work related to the BFN MUPRA and that a more than adequate basis exists for closing out the IPE program at BFN without the expenditure of additional TVA or NRC resources." TVA discussed the following issues in support of their position:

1. The MUPRA provided a bounding assessment of CDF for Unit 2 by including operation of the other units. In addition, it considered the effects of the ten major shared systems between units and the two most important initiators (loss of offsite power and loss of plant air) that directly result in shutdown of all three units. Further, the MUPRA is a historical, superseded document, and it would be inappropriate to expend TVA/NRC resources trying to resurrect it as a basis for Unit 3 IPE conformance, particularly since TVA has developed separate PRAs for Unit 2 (with Unit 3 in operation) and Unit 3 (with Unit 2 in operation). The Unit 3 PRA goes even further by providing adjustments to success criteria and the effects on shared systems with Unit 3 the focus of the PRA.

2. GL 88-20 did not request licensees of multiple unit sites to perform individual PRAs for each plant at a site or address the effect of shared systems between units. TVA's official commitment for the Browns Ferry site consisted of performing a single Level 1 PRA/containment analysis for Unit 2 only in which it was assumed that Units 1 and 3 were shutdown.
3. With the publication of NUREG-1560, "Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance," essentially all information is now known about plant-specific vulnerabilities and the IPE program should be closed as suggested in the Nuclear Energy Institute letter/position paper to NRC on May 9, 1997.
4. The increased costs of responding to NRC questions will not result in a commensurate increase in public health and safety and should be carefully scrutinized because additional TVA effort should not be necessary based on prior staff assurances.

The staff provides the following response to these points:

1. A bounding assessment such as the MUPRA, while it might appear conservative by including operation of all three units, may not completely identify the most likely accident sequences and contributors associated with Unit 3, given Unit 1 shutdown and Unit 2 operational. The recently submitted Unit 3 PRA appears to be a credible effort aimed at the response of the Browns Ferry site to initiating events specifically focused on Unit 3, given the most likely plant configuration, i.e., with Unit 2 in operation and Unit 1 shutdown. However, that analysis calculated that approximately 36 percent of core damage results from loss of residual heat removal (RHR). Typically in BWRS, there is some system (e.g., control rod drive, condensate, or service water) that could be used along with containment venting to forestall core damage. Failure to model these systems, while bounding, may result in a distorted view of the dominant sequences and core damage frequency.

Other significant staff concerns, however, regarding the Unit 3 PRA, are that many of the major components of the analysis, and some minor ones, are not discussed in either the predecessor MUPRA or the Unit 3 PRA. For instance, neither the MUPRA nor the Unit 3 PRA presented the information requested in Sections 2.1, 2.2, and 2.3 of NUREG-1335, covering the basic format and content for IPE submittals, or Supplement 1 of the Generic Letter, addressing containment performance improvement issues.

In the June 19, 1997 RAI, the staff raised questions concerning the human reliability analysis (HRA) performed as part of the MUPRA. It did not appear that a plant-specific HRA was performed for the MUPRA (or subsequently for the Unit 3 PRA). The HRA assumptions could significantly affect the results of the PRA, especially because of the relatively low values used in the analyses.

No back-end source term or containment failure results were provided in either the MUPRA or the Unit 3 PRA nor did there appear to be an assessment performed as to the applicability of the Unit 2 containment design to Unit 3. Plant damage state groupings may not be the same for Unit 3 compared to the Unit 2 MUPRA because the individual sequences were not identical between the two units.

It is not clear from either the MUPRA or the Unit 3 PRA where the use of generic data ends and plant-specific data begins. Even if the delineation were made clearer, the staff is concerned that the plant-specific data from Unit 2 MUPRA may not apply to Unit 3 in areas such as component unavailability or operability. Similarly, the applicability of the Unit 2

models to Unit 3 depends to some extent on such details as: the similarity in operating characteristics between the units in areas such as reactor core isolation cooling high back pressure trip set points, pump shutoff heads, equipment qualification limits, safety relief valve back pressure closure, differing equipment locations between the units, varying procedures, the extent of uniform upgrades between units, and the similarity of maintenance and testing between units. Information has not been provided to the staff to enable it to address these identified concerns.

2. No relationship exists between commitments agreed to between TVA and NRC for the restart of Unit 3 and those that may apply toward meeting the intent of GL 88-20. For multi-unit sites, NUREG-1335 requested licensees to address differences between units "including all functional interdependencies among the systems... that are shared among multi-unit plants" (pg. 2-5). In addition, the licensees were expected to provide IPEs which accurately reflected the as-built, as-operated configuration at their site.
3. NUREG-1560 was published in December 1997. The purpose of the report, however, is to highlight the significant safety insights resulting from the IPE program and to show how nuclear plant safety has been improved by the IPE initiative. It is not intended to be a plant-specific review of the IPE analyses in determining whether licensees' IPEs met the intent of GL 88-20. It is stated in both draft and final versions of the report that "the staff did not consider the quality (e.g. accuracy) of the analyses when determining the implications of the collective IPE results." Further, NUREG-1560 does not eliminate the responsibility of each utility to individually provide a plant-specific response to GL 88-20. On the contrary, the plant-specific input provided by each utility formed the primary basis for the report.
4. The staff reviewed the MUPRA for applicability to the Unit 3 IPE, as committed in the September 28, 1994, letter to TVA. This formed the basis for the June 19, 1997, RAI. The staff has also incorporated the newly developed Unit 3 PRA into the review process. However, the staff believes that, even taken collectively, the information provided in the MUPRA and the follow-up Unit 3 PRA is still incomplete and, therefore, it is not possible to conclude that Unit 3 has met the intent of GL 88-20.

### C. CONCLUSION

The purpose of GL 88-20 was to identify "plant-specific" vulnerabilities and cost-effective improvements to reduce or eliminate the vulnerability. In addition, in the Generic Letter, four specific objectives were stated which were for each utility, in regard to the examined plant, to: (1) develop an appreciation for severe accident behavior, (2) understand the most likely severe accident sequences that could occur at its plant, (3) gain a more quantitative understanding of the overall probabilities of core damage and fission product releases, and (4) if necessary, reduce the overall probabilities of core damage and core damage fission product releases by modifying, where appropriate, hardware and procedures that would prevent or mitigate severe accidents.

Based on the results of our evaluation and the information currently available, the staff is unable to conclude that Browns Ferry, Unit 3, has meet the intent of GL 88-20. Information is incomplete in the following areas:

- plant-specific HRA modeling

- the lack of back-end containment failure results (including a discussion of the CPI issues) and radio nuclide source terms for Unit 3 including containment comparisons for applicability of the Unit 2 containment model to the Unit 3 containment
- the basis for loss of RHR sequence modeling resulting in a relatively high CDF contribution
- verification of the appropriateness of data (either plant specific or generic) as applied to Unit 3
- verification of similarities between Units 2 and 3 that enable significant portions of the Unit 2 PRA model to be applied to the Unit 3 PRA. These include: (1) detailed plant operating characteristics, e.g., emergency system setpoints, and comparable plant improvements/upgrades over the service lives of Units 2 and 3, (2) similarity of test and maintenance schedules for major systems and components at Units 2 and 3, and (3) similarity of plant procedures and instrumentation (impacting important human actions) between Units 2 and 3.

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