



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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Note For: William T. Russell, Director
Office of Nuclear Reactor Regulation

Thru: Frederick J. Hebdon, Director *Frederick J. Hebdon*
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Subject: BROWNS FERRY NUCLEAR PLANT MULTI-UNIT PROBABILISTIC RISK
ASSESSMENT

On April 14, 1995, the Tennessee Valley Authority (TVA) submitted a probabilistic risk assessment (PRA) for the Browns Ferry Nuclear Plant (BFN) Unit 2 based upon simultaneous multi-unit operation at the site. This submittal is supplemental to the BFN Unit 2 PRA provided in response to Generic Letter (GL) 88-20, and is the third major revision of the BFN Unit 2 PRA completed by TVA in the past three years. This analysis reflects several significant changes in the plant configuration and modeling assumptions. The BFN Unit 2 core damage frequency (CDF) during multi-unit operation is estimated to be $2.8E-5$ /reactor-year (RY), vs. $7.6E-6$ /RY for single unit operation. These results are summarized in Table 1.

TVA did not identify any severe accident vulnerabilities for multi-unit operation based on this analysis. The staff has performed a preliminary review of the analysis, and has used those insights for planning a risk-based inspection of operations and maintenance. Based on its preliminary review of this analysis and the results of the inspection, no evidence has been found which would indicate that any new or unacceptable risks would be posed by restart of Browns Ferry Unit 3. However, this preliminary review indicates that analytic assumptions by TVA may limit the usefulness of this PRA. The staff will conduct a thorough review for closure of IPE activities at the Browns Ferry site.

The regulatory background and preliminary insights from the multi-unit PRA are discussed below.

BACKGROUND

On October 30, 1989, in response to Generic Letter 88-20, TVA committed to submit a Level 1 PRA and containment analysis for BFN Unit 2. On August 13, 1990, the NRC staff noted that the three BFN units share many important safety systems, and expressed a concern that multiple unit operation may reduce the systems' capability to cope with a severe accident. Therefore, the staff requested that TVA provide expanded PRAs addressing the simultaneous operation of all three BFN reactors.

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On October 12, 1990, TVA declined to perform an expanded PRA, stating that such an analysis was not within the scope of GL 88-20. TVA did commit to provide dependency matrices illustrating the systems interrelationships for multiple unit operation. In a letter to TVA dated June 28, 1991, the staff stated that the information TVA proposed to submit appeared to provide the information sought by GL 88-20. The staff acknowledged that the expanded PRAs were not required to satisfy GL 88-20. However, the staff continued to encourage TVA to perform such an analysis. TVA and the staff met on September 6, 1991 to discuss the staff's continuing concerns.

On February 7, 1992, TVA submitted a description of systems shared between the BFN units. TVA also provided a description of its evaluation of potential operating configurations, concluding the most limiting configuration occurred when all three reactors are operating. TVA committed to perform a limited scope Level 1 PRA assessing the impact of the ten most important shared systems for two initiating events resulting in shutdown of all three units. TVA stated that it did not consider this commitment to be a prerequisite for BFN Unit 3 restart. This proposal was discussed with the staff in a meeting on May 28, 1992. The staff accepted TVA's proposal on June 23, 1992, agreeing that the analysis was not a prerequisite for BFN Unit 3 restart.

On September 1, 1992, TVA submitted a PRA in response to GL 88-20. The staff evaluation of this submittal, issued on September 28, 1994, concluded that TVA had provided the information sought by GL 88-20 for Browns Ferry Unit 2, but requested that TVA address two potential enhancements (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. The staff also noted that closure of IPE activities for the Browns Ferry site is dependent on review of the multi-unit PRA.

The scope of TVA's multi-unit PRA submittal of April 14, 1995 is much more comprehensive than the limited-scope analysis discussed above, and is substantially beyond TVA's commitment. Rather than perform a limited scope evaluation for selected systems and a limited number of initiating events, the multi-unit PRA comprehensively addresses plant systems, whether shared or not. It also addresses a scope of initiating events similar to those evaluated in the IPE PRA, and also includes new initiator categories, such as loss of control bay ventilation and cooling, and the loss of 500 kV electric power to a single unit. TVA also addressed the enhancements as requested by the staff in the IPE PRA staff evaluation, and the effect of the hardened wetwell vent and other plant modifications which had been installed after the IPE PRA was submitted.

INITIAL STAFF INSIGHTS

To support BFN Unit 3 restart, NRR and RES staff examined the multi-unit PRA to provide insights for an operations and maintenance inspection which was conducted the week of September 18, 1995. The staff has determined there is no reason to suspect that restart of BFN Unit 3 will introduce any new severe accident vulnerabilities. However, this preliminary review indicates that analytic assumptions by TVA may limit the usefulness of this PRA.

RES representatives visited the site on September 7, 1995 to review background documents and discuss the multi-unit PRA with TVA and its contractors. Based on this visit and review of the April 14, 1995 multi-unit PRA submittal, the staff has concluded that the results are driven by analytical assumptions and boundary conditions, vs. plant-specific design or operations factors.

For example, TVA did not credit alternate coolant injection systems and operator actions such as use of the use of standby coolant from the RHRSW system or HPCI suction realignment to the condensate storage tank, even though these actions are reflected in the plant emergency procedures. These assumptions are conservative for estimating the overall CDF, since possible success paths are instead assumed to lead to core damage. However, these assumptions also prevent an assessment of the importance of these systems and functions, since they are not part of the model. The staff believes the analysis will not be useful to operations and engineering personnel unless these limitations are thoroughly understood.

Insights gleaned from this preliminary review were discussed with NRR and Region II staff representatives on September 11, 1995, and were used in planning a risk-based inspection during the week of September 18. The inspection verified that operators are familiar with mitigative functions which were not modelled in the multi-unit PRA. These potential success paths are proceduralized, and are part of operator training and requalification. The inspection found no evidence that Unit 3 restart would pose any new or unacceptable risks.

As noted above, the closure of IPE activities for Browns Ferry is contingent on staff review of the multi-unit PRA. This review should be completed in 1996.

If you have questions about this discussion, please contact me at 415-1470.

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**TABLE 1. BROWNS FERRY UNIT 2 PRA SUMMARY
INITIATING EVENT GROUP CLASSIFICATION CONTRIBUTIONS TO CORE DAMAGE FREQUENCY**

INITIATING EVENT CATEGORY	IPE PRA		PRA Rev 1A		Multi-Unit PRA	
	Mean CDF	% of total	Mean CDF	% of total	Mean CDF	% of total
Loss of Offsite Power	3.3E-5	69	1.5E-6	20	1.1E-5	39
Internal Floods	4.7E-6	10	1.1E-6	15	6.1E-6	22
Support System Failures	6.6E-7	1	1.7E-7	2	5.8E-6	21
Transients with Reactor Not Isolated	4.5E-6	9	2.1E-6	28	2.3E-6	8
Transients with Reactor Isolated	3.9E-6	8	1.9E-6	25	2.0E-6	7
Loss of Coolant Accidents	7.0E-7	1	5.1E-7	7	4.6E-7	2
Stuck-open Relief Valves	7.3E-7	2	1.9E-7	3	1.9E-7	1
Interfacing System LOCAs	4.6E-8	< 1	4.6E-8	< 1	4.6E-8	< 1
TOTAL	4.8E-5		7.6E-6		2.8E-5	

PRA - Analysis provided to support TVA's September 1, 1992 IPE submittal, based on Unit 2 operation only.

Rev 1A - Analysis performed by TVA to reflect plant upgrades and analysis changes after the IPE submittal, and is based on Unit 2 operation only. This analysis was not submitted to the staff.

Multi-Unit PRA - Revision performed assuming all three units at the site are operating. Analysis submitted on 11/14, 1995.

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