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

June 12, 1998

MEMORANDUM TO: Loren R. Plisco, Director
Division of Reactor Projects
Region II

FROM: Frederick J. Hebdon, Director
Project Directorate II-3
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

SUBJECT: REQUEST FOR TECHNICAL ASSISTANCE (TIA 97-008) REGARDING SWITCHYARD CONTROL POWER AT BROWNS FERRY NUCLEAR PLANT (TAC NO. M98305)

By memorandum dated March 31, 1997, the Division of Reactor Projects, Region II (DRP), requested the assistance of the Office of Nuclear Reactor Regulation (NRR) in evaluating certain aspects of the Browns Ferry Nuclear Plant (BFN) electrical switchyard control power system. Specifically, NRR was asked:

1. Does the configuration of the transmission switchyard control power at BFN meet the requirements of General Design Criterion 17 (GDC 17)?

2. Is it necessary for the licensee to consider faults/failures involving control power, other than complete loss of power, when evaluation whether the equipment "... is designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure...."?

On March 5, 1997, at 10:40 a.m., CST, BFN, Unit 3 experienced a loss of offsite power. At this time, Unit 3 was in a refueling outage with the refueling cavity filled and connected to the spent fuel pool. Offsite power was being supplied to Unit 3 by the 161 kV transmission lines, as permitted by technical specifications (TS). The 500 kV offsite power path was inoperable due to ongoing maintenance on the main transformers. Offsite power was restored to Unit 3 at 11:24 a.m., and no significant complications or additional equipment problems were identified.

The Tennessee Valley Authority (TVA), the licensee, determined that the loss of 161 kV power was the result of poor workmanship that allowed in an intermittent short of the power leads to a feedwater pump oil pump motor. The motor was powered from the same 250 volt dc battery board that was supplying switchyard control power. The shorting indirectly actuated some Westinghouse AR relays associated with a sudden-pressure protection feature on the cooling tower transformers causing the 161 kV incoming transmission lines to be isolated.

The control power for all switchyard breakers (500 kV and 161 kV switchyard) is supplied by a single battery board. The resident inspectors questioned this apparent vulnerability and it was not clear to the inspectors if the single control power source for both the 500 kV and 161 kV switchyards meets the requirements of GDC 17.

The NRR Electrical Engineering Branch staff has completed a review of the BFN offsite power system design and has determined that:

- During a design basis accident with a single failure of the dc control power the immediate offsite power source to the shutdown buses may not be available. However, GDC 17 does not require the offsite power system to meet the single failure criterion. Therefore, in this scenario a loss of offsite power will occur at BFN and the diesel generators will power the safety loads. We believe this scenario is no worse than taking a loss of the startup transformer at a plant which supplies immediate power source to both the safety buses.

- The delayed offsite power source can be made available in less than 30 minutes. The HPCI and RCIC will be available to maintain reactor coolant inventory until manual transfer to the delayed offsite source (161 kV) is completed. The above meets the requirement of GDC 17 for a delayed offsite power source.

Therefore, with regard to the first question, the staff has concluded that the design of the offsite power system at BFN meets the requirements of GDC 17. However, the staff believes that this situation can be improved considerably by providing a separate control supply to the Unit 2 main generator breaker control and its associated unit boards where transfer of power from 500 kV source to 161 kV source occurs. With regard to the second question, it has been staff's practice to require licensees to consider the worst-case scenarios in their designs.

This memorandum completes our action on TIA 97-007, and TAC No. M98305 is closed. Additional discussion is contained in the attached staff evaluation.

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

Attachment: Staff Evaluation

cc w/attchment: C. Hehl, RI
G. Grant, RIII
T. Gwynn, RIV

CONTACT: A. De Agazio, NRR
301-415-1443

EVALUATION OF THE BROWNS FERRY NUCLEAR PLANT

OFFSITE POWER SYSTEM DESIGN (TAC NO. M98305)

1. BACKGROUND

On March 5, 1997, at 10:40 a.m., CST, Browns Ferry Nuclear Plant (BFN), Unit 3 experienced a loss of offsite power. At this time, Unit 3 was in a refueling outage with the refueling cavity filled and connected to the spent fuel pool. Offsite power was being supplied to Unit 3 by the 161 kV transmission lines, as permitted by technical specifications. The 500 kV offsite power path was inoperable due to ongoing maintenance on the main transformers. Offsite power was restored to Unit 3 at 11:24 a.m., and no significant complications or additional equipment problems were identified.

During the follow-up of this event, the resident inspectors noted that the control power for all switchyard breakers (500 kV and 161 kV switchyard) is supplied by a single battery board. The resident inspectors questioned whether the single control power source for both the 500 kV and 161 kV switchyards meets the requirements of GDC 17. By memorandum dated March 31, 1997, the Division of Reactor Projects, Region II (DRP), requested the assistance of the Office of Nuclear Reactor Regulation (NRR) in evaluating the BFN electrical switchyard control power system.

2. DISCUSSION

NRR was asked by DRP to determine if:

1. the configuration of the transmission switchyard control power at BFN meets the requirements of General Design Criterion 17 (GDC 17); and

2. it is necessary for the licensee to consider faults/failures involving control power, other than complete loss of power, when evaluation whether the equipment "... is designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure...."?

BFN receives offsite power from either the 500 kV or the 161 kV system. Units 1, 2 and 3 generate power and feed into the 500 kV transmission system. Each unit has a generator breaker which permits startup, operation and shutdown power to be immediately available from the preferred power source, the 500 kV system. In the event of a unit trip during power operation, the generator breaker opens and offsite power is backfed from the 500 kV system through the main transformer and the unit station transformers. This is the preferred offsite power source for all three BFN units.

Each unit has a nonsafety-related 250 Vdc battery (Batteries 4, 5, and 6) which provides control power to its respective generator breaker and the 4 kV Unit Boards. The Unit 2 nonsafety-related Battery 4 also provides control power to both the 500 kV and 161 kV switchyard breakers from distribution panel 9-24 which is located in the Unit 1/2 control room. The distribution panel has a normal supply from nonsafety-related Battery 4 and an alternate supply from safety-related Battery 2. When Battery 4 fails, an alarm "BATT NO. 4 SYS ABNORMAL" is received in the control room and Alarm Response Procedure provides guidance for operator response. The operator can access the equipment and transfer (generally in less than five minutes) panel 9-24

to its alternate source. Restoration of the switchyard control power will allow the operator to make alignment changes as necessary. The transfer of offsite powers (500 kV source to 161 kV source) takes place at the 4 kV Unit Boards.

Failure of the 500 kV source or main power transformers/unit station service transformers (USSTs) of Unit 1 or 2, initiates an automatic transfer for both safety and nonsafety related buses. The nonsafety related buses transfer to the 161 kV source, the common station service transformers (CSSTs). The safety-related buses transfer to the alternate unit's USST if voltage is available; otherwise, they will transfer with the nonsafety buses to the CSST. If the CSSTs subsequently fail, only the safety-related buses are automatically transferred to the diesel generators. For Unit 3, following the failure of the 500 kV source or main transformer/USST, both safety and nonsafety related buses are transferred to the CSST.

Loss of the Unit 1 or 3 non-safety related dc control power results in loss of control function to their respective generator breakers and 4 kV Unit boards. However, loss of Unit 2 nonsafety-related dc control power (Battery 4) results in a loss of control function to the generator breaker, the 4 kV Unit Boards 2A and 2B, and 500 kV and 161 kV switchyard breakers. Therefore, the loss of nonsafety related Battery 4 is the most limiting case. For this event, no breaker position changes will occur (there is no interruption of offsite power and all switchyard breakers will remain closed) and the plant auxiliary loads will continue to operate and support plant functions without interruption. A concurrent loss of the 500 kV source and Battery 4 will result in 4 kV Shutdown Bus 2 automatically transferring, due to loss of voltage relaying, to 4 kV Unit Board 1B, if voltage is available. No transfers will occur at 4 kV Unit Boards 2A or 2B due to lack of control power (Battery 4). Control power to the generator breaker and unit boards can be reestablished by manually transferring to the alternate source at the Turbine Building Distribution Board 2 located in the Turbine Building. The control room operator can then transfer to the delayed source per Operating Instructions (OI-57-A). This transfer to the delayed source will take less than 30 minutes.

Additionally, if a safety injection signal is initiated at the same time when Battery 4 is unavailable, the generator will be tripped, but the generator breaker will remain closed and offsite power will be provided to the safety-related buses from the 500 kV system. In this case remote protective relaying will cause offsite substation 500 kV breakers to trip and result in the isolation of the Unit 2 generator and loss of offsite power to the shutdown buses and safety buses.

If the loss of the 500 kV source also has affected Unit 1 and Unit 3, 4 kV Unit Boards 1A, 1B, 3A and 3B will automatically transfer to the 161 kV source (control power from Batteries 5 and 6 is available). Unit Board 1A will supply power to 4 kV Shutdown Bus 1 and Unit Board 1B will supply power to 4 kV Shutdown Bus 2. The 4 kV Shutdown Buses feed the Unit 1 and 2 Shutdown Boards. Similarly, Unit Board 3A will supply power to 4 kV Shutdown Boards 3EA and 3EB, and Unit Board 3B will supply power to 4 kV Shutdown Boards 3EC and 3ED. This transfer to the delayed source will take less than 30 minutes. HPCI and/or RCIC will be available since they are fed from a safety-related dc supply, to maintain reactor coolant inventory until manual transfer to the delayed offsite source (161 kV) is completed.

3. CONCLUSION

On the basis of our review of the BFN offsite power system design, we find that during a design basis accident with a single failure of the dc control power the immediate offsite power source to the shutdown buses may not be available. However, GDC 17 does not require the offsite power

system to meet the single failure criterion. Therefore, in this scenario a loss of offsite power will occur at BFN and the diesel generators will power the safety loads. We believe this scenario is no worse than a loss of the startup transformer at a plant which supplies immediate power source to both the safety buses.

The delayed offsite power source can be made available in less than 30 minutes. The HPCI and RCIC will be available to maintain reactor coolant inventory until manual transfer to the delayed offsite source (161 kV) is completed. The above meets the requirement of GDC 17 for a delayed offsite power source. Therefore, we conclude that the design of the offsite power system at BFN meets the requirements of GDC 17. However, we believe that this situation can be improved considerably by providing separate control supply to Unit 2 main generator breaker control and its associate unit boards where transfer of power from 500 kV source to 161 kV source occurs.

With regard to the concern of considering scope of control power faults/failures other than a complete loss of power, it has been the staff's practice to require licensees to consider the worst-case scenarios in their designs.

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The NRR Electrical Engineering Branch staff has completed a review of the BFN offsite power system design and has determined that:

- During a design basis accident with a single failure of the dc control power the immediate offsite power source to the shutdown buses may not be available. However, GDC 17 does not require the offsite power system to meet the single failure criterion. Therefore, in this scenario a loss of offsite power will occur at BFN and the diesel generators will power the safety loads. We believe this scenario is no worse than taking a loss of the startup transformer at a plant which supplies immediate power source to both the safety buses.
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