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SUBJECT: Responds to NRC questions re fire protection rept.Util intends to modify safe shutdown analysis portion of rept.

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October 5, 1995

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

10 CFR 50
Appendix R

Gentlemen:

In the Matter of)
Tennessee Valley Authority)

Docket Nos. 50-260
50-296

BROWNS FERRY NUCLEAR PLANT (BFN) - UNITS 2 AND 3 - BFN FIRE PROTECTION REPORT (FPR)

The purpose of this letter is to respond to NRC's questions regarding Units 2 and 3 BFN FPR (Reference 1). Specifically, NRC requested TVA to: (1) provide information identified during the September 8, 1995, telephone call regarding high impedance fault issue; (2) inform the staff of the changes to the Units 2 and 3 BFN FPR TVA intends to make concerning the inclusion of the Main Steam Isolation Valves (MSIVs) in the Safe Shutdown Analysis portion of the report; and (3) clarify the timeline for completing Low Pressure Coolant Injection (LPCI) initiation.

Enclosure 1 of this letter provides the information requested during the September 8 telephone call. The enclosure describes the methodology used for performing high impedance fault analysis for multiple unit operation. A description of the enhancements TVA is making to the Safe Shutdown Instructions (SSIs) to ensure that any effects of high impedance current will not impede the ability to achieve safe shutdown from an Appendix R fire is also provided.

With regards to the MSIVs, TVA intends to modify the Safe Shutdown Analysis Portion of the Units 2 and 3 BFN FPR by revising Paragraph 5.4.3, "High-Low pressure Interface," and adding the MSIVs to Table 5-2, "High-Low Pressure Interface Components."

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As a result of a SSI walkdown conducted on September 28, 1995, NRC has requested TVA to clarify the timeframe at which TVA initiates reactor vessel depressurization and establishes LPCI flow during an Appendix R event.

In the Appendix R Safe Shutdown Analysis Safety Evaluation (Reference 2), NRC published a timeline for manual operations that must be performed to safely shutdown a unit involved in an Appendix R fire. The timeline indicated that in the first 20 minutes of an event the operator would have completed the steps necessary for inventory control (i.e., the reactor depressurization is completed, the selected Residual Heat Removal (RHR) pump is started and the LPCI inboard isolation valve is open).

In contrast, for multiple unit operation TVA's timeline for manual operations is as follows: In certain fire areas hot shutdown is achieved through manual depressurization of the reactor vessel, and inventory is maintained using LPCI. Within the first 20 minutes of the event, the operator would initiate manual depressurization of the reactor vessel. This is followed by starting of the selected RHR pump and opening of the associated LPCI injection valve. For more details see Section C of Enclosure 1.

Enclosure 2 provides the commitments made in this response. If you have any questions regarding this submittal, please contact me at (205) 729-2636.

Pedro Salas
Manager of Site Licensing

Enclosures
cc: See page 4

References:

1. TVA letter dated December 20, 1994, "Browns Ferry Nuclear Plant (BFN) - Unit 2 and 3 Browns Ferry Nuclear Plant Fire Protection Report."

2. NRC letter Dated December 8, 1988, "Browns Ferry Nuclear Plant Unit 1, 2, and 3 - Appendix R Safe Shutdown System Analysis (TAC 60627, 60628, 60629)"

cc (Enclosures):
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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 2 AND 3

BFN FIRE PROTECTION REPORT (FPR)

BFN MULTI-UNIT CONSIDERATION OF HIGH IMPEDANCE FAULTS FOR APPENDIX R ASSOCIATED CIRCUITS

A. BACKGROUND

By letter dated December 20, 1994, Unit 2 and 3 Browns Ferry Nuclear Plant Fire Protection Report, TVA provided the combined Unit 2 and 3 FPR for staff review. During the review of the FPR the staff questioned BFNs methodology for determining the effects of high impedance fault current on the electrical power distribution system boards/panels required for safe shutdown from an Appendix R event.

This enclosure describes BFN's methodology for calculating the effects of high impedance fault current on the electrical power system. Also, the enclosure describes additional steps TVA is taking to ensure that the effects of high impedance fault current do not impede the ability to achieve safe shutdown in the event of an Appendix R fire.

B. BFN Methodology For Calculating High Impedance Fault Current

In order to meet the required aspects of Appendix R, the effects of high impedance faults on the Safety Related Electrical system were considered during the Appendix R review for multiple unit operation. It should be noted that this evaluation goes beyond that performed for Unit 2 only safe shutdown. To evaluate the susceptibility of the electrical power distribution boards and panels to high impedance fault current, TVA performed the "Appendix R - Margin Calculation For Required AC and DC Power Boards/Panels" analysis using the following method:

1. Identify and quantify the expected Appendix R electrical board or panel loading.

2. Identify the largest normally operating non-Appendix R required load and assume that the supply cable experiences a high impedance fault just below the trip rating of its supply breaker.

3. Verify that the sum of the current from 1 and 2 above will not be large enough to trip the incoming board/panel feeder breaker (i.e., determine that there is margin available).

This approach to the evaluation of low probability multiple high impedance faults was based on the following reasoning:

1. The requirement to verify that adequate margin is available ensures that additional circuits may experience a high impedance fault current condition without reaching the trip setting of the incoming board/panel feeder breaker. Considering the largest normally operating load bounds several (i.e., multiple) smaller loads in a concurrent high impedance fault condition.

2. The calculated margin for the required Appendix R power distribution boards/panels is conservative. The calculated margin is based on all normal shutdown loads being operational at the initiation of the event. This is a conservative assumption for purposes of this analysis. The loads considered include Appendix R and non-Appendix R loads. Due to the diversity in BFN's electrical systems, TVA has determined that the electrical board loading at the onset of the event would be less than the normal shutdown loads.

3. The probability of multiple high impedance faults in a given area is minimized. The majority of the fire area/zones at BFN are relatively large open spaces. Appreciable spacial separation exist where the cables exit the fire area/zone where the board is located. This condition limits the number of cables which could be concurrently effected.

4. It is not credible that multiple non-Appendix R required circuits would sustain faults just below the breaker trip rating for any appreciable length of time. If a postulated Appendix R fire resulted in multiple high impedance faults in cables, it would influence cables at different times and at different rates. A high impedance fault current of this type would vary in magnitude and quickly develop into a low impedance fault current tripping the load breaker.

   During a high impedance fault current condition, arcing is the primary resultant. This arcing will cause the fault to rapidly propagate into a low impedance fault which would result in the tripping of the upstream load circuit breaker (especially at higher voltages, 480V and above). In order for a board main feeder breaker to sustain a high impedance fault current trip, currents in excess of one thousand seconds (16 minutes) would be required. It is highly improbable that multiple circuits would arc and bridge across high impedance materials, such as charred insulation, and sustain concurrent faults for that length of time. The probability of a sustained multiple high impedance

fault current event is further reduced by the introduction of fire protection water from the automatic suppression systems, located in areas other than primary electrical board locations, during a fire.

C. CHANGES TO THE BFN SAFE SHUTDOWN INSTRUCTIONS (SSIs)

BFN is divided into 34 fire areas/zones. Multi-unit safe shutdown capability for an Appendix R event for all but 14 fire zones/areas consist of the use of High Pressure Coolant Injection (HPCI) and/or the Reactor Core Isolation Cooling (RCIC) systems (TVA analysis shows that RCIC is available for Unit 3 only).

For those fire areas/zones where either the HPCI or RCIC system is available, those systems would operate from the beginning of the event to maintain normal water level in the vessel. Should one of the required feeder breakers for these systems trip, the operator would have approximately 20 minutes to clear the affected board, re-establish the required electrical alignment, and re-initiate the HPCI or RCIC system. Therefore, for those areas where HPCI or RCIC system is available, TVA has determined that there is adequate time to restore any boards/panels lost due to a high impedance fault current condition. For these described conditions, TVA will provide written instructions to the operator for restoration of a board/panel which trips due to a high impedance fault condition.

There are nine fire areas/zones in Unit 2 and five areas/zones in Unit 3 that TVA has determined neither the HPCI nor RCIC systems are assured available for hot shutdown. In these areas, hot shutdown would be achieved through manual depressurization of the reactor vessel utilizing the Main Steam Relief Valves (MSRVs) and maintaining reactor vessel level inventory by use of the Residual Heat Removal (RHR) system operating in the Low Pressure Injection (LPCI) mode. Based on the analysis performed by General Electric, the manual depressurization of the reactor vessel is to be initiated within 20 minutes for fires in those fire zones/areas where spurious operation of a MSRV may occur and within 30 minutes for those areas where spurious operation does not occur. Within the 20 minute timeframe, the operators would align the Auxiliary Power System (APS) to support the MSRV operation and the LPCI loop required to support safe shutdown. Once the APS is aligned, manual depressurization of the reactor vessel is initiated. Then the selected RHR pump is started and the associated LPCI injection valve is opened.

For those fire areas/zones where the LPCI system is required for hot shutdown, the time required to re-align a lost board/panel could become critical. To further address this possibility, BFN has performed additional analysis for the fire areas/zones requiring LPCI for safe shutdown. This

analysis takes into consideration all of the required loads and the non-required operating loads routed in the fire area/zones relying on LPCI. The analysis verifies that the total multiple high impedance fault current from these loads will not trip the board/panel feeder breaker at the 60 second trip rating[1] (at and below 480V). Utilizing this analysis TVA has reduced the number of manual actions which would otherwise be required for time critical loads. Also, the equipment available to the operator to achieve hot shutdown is maximized. For time critical loads, TVA intends to reduce the electrical loading on specific boards or panels at the beginning of a postulated Appendix R event. As a result, restoration procedures are not required for time critical boards/panels for those fire areas/zones relying on the LPCI system to mitigate an Appendix R event. TVA will provide the operator with instructions in the SSIs to reduce loads on specific boards/panels.

It can be noted that TVA analysis shows that the 4KV Shutdown Boards have adequate margin when aligned to the offsite power system to withstand 100% of the non-required energized circuits. Likewise, when the boards are aligned to the Emergency Diesel Generators, the incoming board/panel feeder breaker will not trip on high impedance fault current.

D. CONCLUSION

TVA has considered the effects of high impedance fault current as required by NRC Generic Letter 86-10[2] for BFN. The key aspects of BFN's analysis are as follows: The Appendix R margin calculation is conservative, there is diversity in the cable routing, and a high impedance fault will develop into a low impedance fault and trip it's respective breaker. In addition, TVA has performed analysis to ensure that time dependent loads will not be lost due to multiple high impedance fault current.

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[1] The approach to utilizing the 60 second trip current is based on proceedings from the American Power Conference, Volume 52, Pages 345-351, "Multiple High Impedance Fault Analysis And Resolution For Nuclear Power Facilities," prepared by H. Ovunc and P. Zavadiviker of Bechtel Corporation.

[2] NRC Generic Letter 86-10, "Implementation Protection Requirements"

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 2 AND 3

BFN FIRE PROTECTION REPORT (FPR)
LIST OF COMMITMENTS

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1. TVA will provide written instructions to the operator for the restoration of a board/panel which trips due to a high impedance fault current. TVA intends to complete this action prior to the startup of Unit 3.

2. TVA will provide the operator with written instructions in the Safe Shutdown Instructions to reduce loads on specific boards/panels. TVA intends to complete this action prior to the startup of Unit 3.

3. TVA will revise the Safe Shutdown Analysis portion of the Unit 2 and 3 FPR paragraph 5.4.3 "High-Low Pressure Interface," and add the MSIVs to Table 5-2, "High-Low Pressure Interface Components." TVA intends to complete this action prior to the startup of Unit 3.