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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 258 TO FACILITY OPERATING LICENSE NO. DPR-60

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-260

By letters dated March 6, 1997, and May 13, 1997, Tennessee Valley Authority (the licensee), proposed replacement of the existing analog power range monitoring system in the Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, with a digital General Electric (GE) Nuclear Measurement Analysis and Control (NUMAC) power range neutron monitoring system (PRNMS). The licensee's submittal also requested TS changes related to the proposed NUMAC-PRNMS modification. By letters dated June 16, 1997, and April 3, 1998, the U.S. Nuclear Regulatory Commission (NRC) approved technical specification (TS) amendments for the average power range monitoring portion of the NUMAC-PRNMS. The license amendment did not include the oscillation power range monitoring (OPRM) function, which was to be operated in the "indicate only" configuration for one fuel cycle for testing purposes.

By letter dated September 8, 1998, as supplemented by letter dated February 22, 1999, the licensee proposed license amendments to the Technical Specifications (TS) for the BFN, Unit 2, to include provisions for enabling the OPRM Upscale trip function in the Average Power Range Monitor (APRM). The APRM is part of the PRNMS and includes an OPRM Upscale trip function which monitors small groups of local power range monitor signals to detect thermal-hydraulic instabilities in the reactor core. The OPRM Upscale trip function provides protection from exceeding the fuel Minimum Critical Power Ratio (MCPR) safety limit in the event of thermal-hydraulic power oscillations, and thereby, provides compliance with General Design Criteria (GDC) 10 and 12 of 10 CFR 50, Appendix A.

By letter dated December 15, 1998, at the conclusion of the test period, the licensee requested NRC approval to connect the OPRM function to the reactor protection system. The staff reviewed the licensee's submittal of proposed setpoints for the corner frequency, and period tolerance and found the setpoints to be acceptable. The associated TS amendment addresses OPRM function operability, surveillance requirements, and associated Bases.

The GE NUMAC-PRNMS design was approved by the staff in its review of GE Licensing Topical Report NEDC-32410P, "Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC-PRNM) Retrofit Plus Option III Stability Trip Function," which addresses the boiling water reactor (BWR) power instability issue addressed in GE licensing topical report NEDO-31960, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology." The staff also reviewed Supplement 1 to NEDC-32410P, "Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC-PRNM) Retrofit

Plus Option III Stability Trip Function, Supplement 1." The staff safety evaluation for Supplement 1 was issued December 18, 1996. The staff's review and acceptance of the design changes and associated technical specification amendments is discussed in this safety evaluation.

1.0 BACKGROUND

GDC 10 requires that the reactor core be designed with appropriate margin to assure that specified acceptable fuel design limits will not be exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. GDC 12 requires assurance that power oscillations which can result in conditions exceeding specified acceptable fuel design limits are either not possible or can be reliably and readily detected and suppressed.

Under certain conditions, BWRs may be susceptible to coupled neutronic/thermal-hydraulic instabilities. These instabilities are characterized by periodic power and flow oscillations. If power and flow oscillations become large enough, the fuel cladding integrity MCPR safety limit and GDC 10 and 12 requirements may be challenged. Based on this possibility, BFN Units 2 and 3 are currently operating with certain interim corrective actions recommended by GE and previously approved the NRC.

To detect core instabilities and provide a reactor scram signal to the reactor protection system (RPS), the licensee selected Boiling Water Reactor Owners Group Stability Option III as the long-term stability system solution (LTSSS) for BFN Unit 2. The LTSSS Option III approach consists of detecting and suppressing stability-related power oscillations by automatically inserting control rods (scramming) to terminate power oscillations. Implementation of Option III provides compliance with GDC 10 and 12 by protecting the reactor fuel rods from exceeding the fuel MCPR safety limit during thermal-hydraulic power oscillations.

The licensee implemented the Option III stability solution by replacing the power range portion of the original BFN Neutron Monitoring System (NMS) with a GE NUMAC-PRNM retrofit system. By letters dated June 16, 1997, and April 3, 1998, the NRC approved TS amendments for the APRM portion of the NUMAC-PRNMS. The licensee operated the OPRM function part of the NUMAC-PRNMS in the "indicate only" mode. During this test period, the existing interim corrective actions for determining and mitigating power oscillations remained in effect.

By letters dated September 8, 1998, and February 22, 1999, the licensee submitted proposed TS changes required to enable the OPRM trip functions for BFN Unit 2. The proposed TS changes follow the example proposed by GE in NEDC-32410P-A, Supplement 1, which the NRC reviewed and approved in a letter to GE dated August 15, 1997. The TS changes provide operability requirements, limiting conditions for operation (LCO), surveillance requirements (SR), and TS Bases for the newly enabled OPRM trip functions. In addition, the proposed changes delete certain existing stability monitoring restrictions on core flow, which are no longer required.

2.1 System Description

The GE NUMAC-PRNM system consists of four APRM channels and four voter channels. Trip signals from each of the four APRM channels are sent to all four voter channels. One voter module is dedicated to each RPS trip relay. A reactor trip occurs when two or more of the four APRM functions, or two or more of the four OPRM functions calculate a trip condition. The voters perform a vote of the OPRM channel trip outputs separate from the APRM trip outputs. For example, an OPRM trip in one channel and an APRM trip in another channel will not result in a reactor trip from 2-out-of-4 voters in a trip state.

Hardware to implement the OPRM Upscale trip function into the APRM channel, the OPRM Inop function, and the OPRM 2-out-of-4 Voter function are included with the corresponding APRM Inop and APRM 2-out-of-4 Voter function. The integration of the OPRM Inop with the APRM Inop reflect actual system design (i.e., conditions that cause an Inop signal in either APRM or OPRM trip functions cause an Inop signal in both functions). However, unlike the APRM trip functions, the OPRM Upscale trip function is voted independently from the Inop trip in the 2-out-of-4 Voter function. Thus, an APRM/OPRM Inop trip in one APRM channel and an OPRM Upscale trip in another channel will result in two half-trips in each of the four Voter channels, but no RPS trip. Conversely, an Inop trip in any two APRM/OPRM channels or an OPRM Upscale trip in any two channels will result in RPS trip outputs from all four Voter channels.

For the APRM Flux trip functions, an APRM/OPRM Inop trip in one APRM channel and an APRM Upscale trip in another channel will result in RPS trip outputs from all four voters. This reflects a somewhat more conservative APRM design in response to channel failures when compared with the OPRM design. This additional conservatism is of limited value in the OPRM design. If the OPRM Upscale trips were combined in logic with Inop trips to generate RPS trip signals, spurious and unnecessary reactor scrams might result. However, an automatic trip will occur upon an unexpected systematic failure of multiple APRM channels. This will result in an APRM/OPRM Inop trip in two or more unbypassed channels, regardless of the OPRM Upscale (or APRM Flux) trip status.

3.0 EVALUATION

The staff reviewed the licensee's proposed OPRM set points and TS amendments. The results of this review are described in the following sections.

3.1 OPRM Trip Set Points

The Staff approved NEDO-32465A, "BWR Owners' Group Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology And Reload Applications," describing OPRM set point values and margins on March 4, 1996. The licensee submitted the results of the online OPRM system testing conducted in preparation for enabling the system on December 15, 1998. During the evaluation period, the licensee discovered that the settings for the period based algorithm in option III were too sensitive and susceptible to spurious alarms and trips, when the least set points defined in NED-32465A are used. The licensee determined that by modifying the corner frequency and period tolerance, the system would function as designed. The licensee supplied test data to support a request for modifications of the OPRM settings to 3 Hertz and 50 milliseconds. These settings are less sensitive than the

previous settings of 2.5 Hertz and 100 milliseconds. According to the licensee, the proposed set point changes provide margin to spurious alarms and trips during stable reactor operation and do not compromise the ability of the OPRM to detect instabilities and initiate an automatic reactor scram prior to violating the MCPR safety limit. In the NRC staff's review of NEDO-32465, the NRC staff concluded that the detect and suppress set point methodology should produce set point values that will result in a very low likelihood of exceeding critical power ratio safety limits during instability events in Solution III plants. The set point values proposed by the licensee meet this criterion and, therefore, are acceptable.

The proposed changes to incorporate provisions for enabling the OPRM trip functions on BFN Unit 2 are based on the conversion package to the improved technical specifications (ITS) submitted to NRC as TS-362 on September 6, 1996 and approved on July 14, 1998. Subsequent submitted changes related to the NUMAC-PRNM installation as described in NEDC-32410P-A Supplement 1 also were used as the basis for these proposed changes.

3.2. Pages 3.3-1 and 3.3-2, LCO 3.3.1.1, Reactor Protection System (RPS) Instrumentation

The Actions table for LCO 3.3.1.1 is revised to add appropriate requirements applicable to the OPRM Upscale trip function, Function 2.f. In Required Action A.2, the Note is revised to say that the Required Action also is not applicable for new Function 2.f. In Condition B, the Note is revised to say that Condition B also is not applicable for new Function 2.f.

These changes are consistent with the changes described in NEDC-32410P-A, Supplement 1, and, therefore, are acceptable.

3.3. Page 3.3-3, LCO 3.3.1.1, RPS Instrumentation

The licensee added Condition I and Condition J, together with Required Actions and Completion Times to the LCO Actions table. Condition I and associated required actions and completion times are consistent with the changes described in NEDC-32410P-A, Supplement 1, and, therefore, are acceptable.

The licensee's proposed Required Action J.1 for Condition J requires the plant to be in Mode 2 in 4 hours if the required action and completion time of Condition I is not met. Required Action J.1 for Condition J in NEDC-32410P-A Supplement 1 requires the licensee to reduce thermal power to less than 25% in 4 hours. The licensee's proposed required actions are more conservative than the required actions in NEDC-32410P-A Supplement 1 and are, therefore, acceptable.

3.4. Page 3.3-6, Surveillance Requirements, RPS Instrumentation

The licensee's proposed surveillance requirements (SR) for SR 3.3.1.1.1, SR 3.3.1.1.7, SR 3.3.1.1.13, and SR 3.3.1.1.16 are equivalent to or more conservative than the corresponding SR in NEDC-32410P-A Supplement 1. The surveillance interval for

SR 3.3.1.1.17 is 24 months, which is longer than the bracketed interval for the equivalent SR 3.3.1.1.18 in NEDC-32410P-A Supplement 1. This longer interval is acceptable because

the interval specified in NEDC-32410P-A Supplement 1 corresponds to an interval that allows testing during refueling outages. The BFN units are on a 24-month refueling interval; therefore, the staff finds the proposed surveillance interval for SR 3.3.1.1.17 to be acceptable.

3.5. Page 3.3-8, Table 3.3.1.1-1, RPS Instrumentation

The licensee added to Table 3.3.1.1-1 (Page 3.3-8) APRM Function 2.f, the OPRM Upscale trip function, with Applicable Modes, Required Channels with footnote, Conditions Referenced, Surveillance Requirements, and Allowable Value.

For Applicable Modes or Other Specified Conditions, the licensee proposed Mode 1, which is more conservative than NEDC-32410P-A Supplement 1, which specifies applicability at ≥[25]% RTP (rated thermal power). The staff finds the proposed applicable mode to be acceptable.

The proposed Required Channels with footnote, Conditions Referenced, Surveillance Requirements, and Allowable Value are consistent with NEDC-32410P-A Supplement 1 and, therefore, are acceptable.

3.6. Proposed Technical Specification Bases Section 3.3.1.1, RPS Instrumentation

The licensee's proposed TS Bases are consistent with NEDC-32410P-A Supplement 1 and, therefore, are acceptable.

3.7. Page 3.4-1, LCO 3.4.1, Recirculation Loops Operating

LCO 3.4.1 is revised to delete the restrictions related to thermal-hydraulic stability regions, Figure 3.4.1-1. After the deletions, the LCO states, "Two recirculation loops with matched flows shall be in operation." This change is consistent with removal of the interim corrective actions and, therefore, is acceptable.

3.8. Page 3.4-1 and -2, LCO 3.4.1, Recirculation Loops Operating

In the Actions table, Condition A, Condition B and Condition E, together with associated Required Actions and Completion Times, are deleted. Conditions C and D are relabeled "A" and "B," respectively, and are revised such that the new Condition B applies to MODES 1 and 2. These changes are consistent with removal of the interim corrective actions and, therefore, are acceptable.

3.9. Page 3.4-3, Surveillance Requirements, Recirculation Loops Operating

SR 3.4.1.2, to verify that the reactor is outside of Regions I and II of Figure 3.4.1-1, and its associated Frequency, are deleted in their entirety. This change is consistent with removal of the interim corrective actions and, therefore, is acceptable.

3.10. Page 3.4-4, Figure 3.4.1-1

Figure 3.4.1-1, Thermal Power Versus Core Flow Stability Regions, is deleted in its entirety. This change is consistent with removal of the interim corrective actions and, therefore, is acceptable.

3.11. Proposed Technical Specification Bases Section 3.4.1, Recirculation Loops Operating

The licensee's proposed TS Bases are consistent with removal of the interim corrective actions and, therefore, are acceptable.

Based on the above review and justifications for TS changes, the staff concludes that the licensee's proposed TS changes are consistent with the approved guidance in NEDC-32410P-A, Supplement 1, and the removal of the interim corrective actions, and are, therefore, acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Alabama State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes a surveillance requirement. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (63 FR 53958). This proposed finding is not affected by the February 22, 1999, letter. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

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Date: March 5, 1999